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Lower Tortonian chitons from the Korytnica clays, southern slopes of the Holy Cross Mts

ABSTRACT: A very rich assemblage of chitons from the Lower Tortonian *Pleurotoma* clays exposuring at Korytnica (southern slopes of the Holy Cross Mts, Central Poland), is represented by 17 species (including 5 new ones), the most frequent of which are *Lepidopleurus decoratus* (Reuss) and *Chiton denudatus* Reuss. The paper presents description of the species and characteristics of their life environment. The assemblage under study has been compared with assemblages from other Miocene localities and with the Recent Mediterranean community. A great similarity has been found to the chitons from the Vienna Basin and, on the other hand, a considerable impoverishment of the Mediterranean community as compared with the Miocene assemblages. The relationship between the Miocene and Recent species has also been discussed.

INTRODUCTION

The assemblage of chitons, described in the present paper, and being the richest in the European Miocene, was found by the writer in a classic locality of the Lower Tortonian deposits in Poland that is, in the *Pleurotoma* clays at Korytnica (southern slopes of the Holy Cross Mts, 24 km SSW of Kielce). The clays at Korytnica reach a thickness of *c.* 30 m and make up a sediment deposited within one of the bays, called the Korytnica Bay of the Miocene sea which, in the Lower Tortonian, transgressed onto the southern slopes of the Holy Cross Mts (Radwański 1964, 1969, 1970). Radwański's studies, mostly based on excellently preserved littoral structures, enabled an accurate reconstruction of the Miocene shoreline in this area.

An uncommonly rich and varied fauna, met with in the Korytnica clays, has been studied by many paleontologists since the early 19*th*

century. However, the occurrence of chitons has never been mentioned from this locality.

Acknowledgements. All photographs of the chitons presented in the paper (Pls 1—6) were taken by L. Łuszczewska, M. Sc., to whom the writer extends his sincere thanks.

THE KORYTNICA CHITONS AND THEIR LIFE ENVIRONMENT

Among an immense abundance of various fossils obtained by washing the Korytnica clays, the chiton valves are in principle very rare. In many samples from various points of the profile, they have not been found at all or occurred as single specimens. The only exception was represented by four samples in which chitons were frequent (the sampling places are shown in Fig. 1 and marked *A, B, C* and *D*). The assemblage of chitons, particularly rich in both species and individual specimens, comes from locality *A* situated 200 m north of Mt. Łysa at Korytnica. This locality is known (Bałuk & Jakubowski 1968) for the occurrence of opisthobranch bivalved gastropods of the species *Berthelinia krachi* Bałuk & Jakubowski. All other localities for the chitons are situated NW of the village Karsy (cf. Fig. 1). In the Korytnica clay sequence, the localities *A* and *B* occur in its uppermost part which makes up an upper member of clays distinguished by Radwański (1969). Localities *C* and *D* correspond to a somewhat lower part (in the case of locality *C*, some 3 m lower that locality *B*). A list of chiton species, found in individual localities, is given in Table 1.

The appearance of this chiton fauna was possible only in the case of the existence of particularly favourable conditions. Precisely such conditions were bound to predominate in the Korytnica Bay, which had a strongly varied shoreline (Fig. 1; cf. Radwański 1969, Figs 25 and 31). The western part of the bay, called by Radwański (1969) the Korytnica aquenum, was separated from the rest of the bay and from the open sea by several thresholds but connected with them by a few straits which assured the preservation of a normal salinity of water. The shores were rocky, fairly steep and built of Jurassic carbonate rocks. Zones of rubbles, composed of boulders torn by abrasion from the seashore and preserved in fragments up to the present, stretched along the foot of the shore slope (Radwański 1969, 1970). Clayey and/or silty sediments, which accumulated on the bottom of the entire Korytnica aquenum, are called the *Pleurotoma* clays of Korytnica, and outcrop from under the younger Tortonian deposits and the Quaternary in several places (Fig. 1).

During the deposition of the upper part of clays, that is, during the appearance of the presented chitons, the depth of the sea in the Korytnica aquenum was not more than 10 m and, in coastal zones, even still less,

which is shown by the entire faunal assemblage (Bałuk & Radwański 1967, Bałuk & Jakubowski 1968, Radwański 1969). Organisms which accompany chiton communities and which in Recent seas live in extremely shallow waters, are primarily represented by cirripeds of the genus *Creusia* Leach, domiciled in corals of the genera *Tarbellastraea*

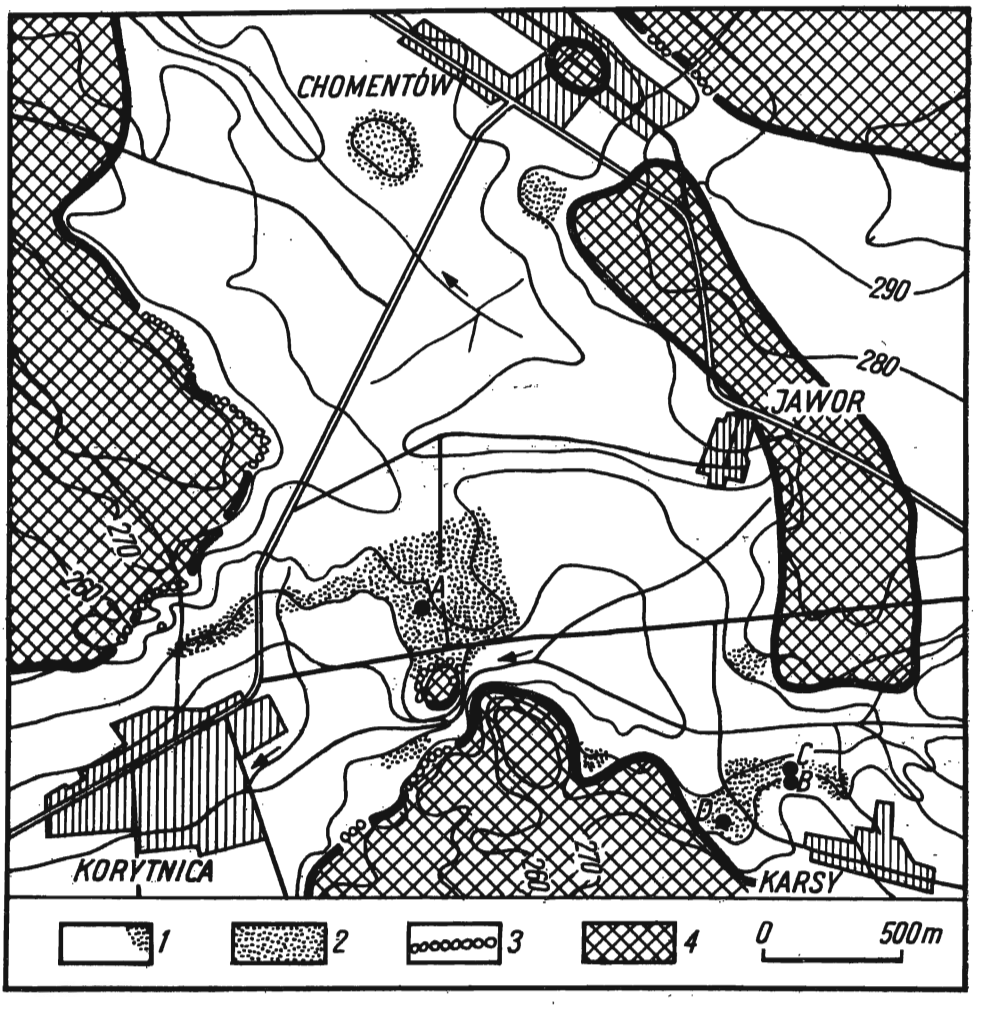

Fig. 1

Locality map of the chiton-bearing samples (*A, B, C, D*) from the Korytnica clays, and paleogeographic situation of the region during the Lower Tortonian time (cf. Radwański 1969, Figs 25 and 31)

1 marine area of the Korytnica aquenum during the Lower Tortonian transgression, *2* present-day outcrops of the *Pleurotoma* clays situated beneath the overlying Tortonian deposits and Quaternary cover, *3* preserved fragments of the Lower Tortonian littoral structures, *4* land (or island) areas along the Lower Tortonian seashores

Alloiteau and *Porites* Link, as well as bivalved gastropods of the genus *Berthelinia* Crosse. The former have been found in localities *A* and *B* and the latter in localities *A*, *B* and *C*. In addition, of the shallow-water organisms, occurring in locality *A*, noteworthy are also the gastropod *Diodora graeca* (Linnaeus) and cirripeds of the genera *Balanus* da Costa and *Verruca* Schumacher. The echinoids of the genus *Echinocyamus* Phelsum and the plates of starfishes of the family Goniasteridae Forbes belong to the fossils frequently met with in locality *C*.

Conclusions, concerning a very shallow-water life environment of the chitons in the Korytnica aquenum, may be drawn by analogy with the living conditions of closely related Adriatic species. Leloup's & Volz's studies (1938), conducted on the eastern coast of the Adriatic near Rovigno, indicate that *Lepidopleurus cajetanus* (Poli) and *Ischnochiton rissoi* (Payraudeau) live exclusively near the shore among littoral rubbles

Table 1

Chitons from the Korytnica clays and their occurrence in other European localities

Species	Sampling localities of the Korytnica clays at Korytnica and Karsy /cf. Fig.1/: A	B	C	D	Niskowa	Kninice	Rudoltice	Zidlochovice	Borač	Steinabrunn	Kostej
Lepidopleurus decoratus /Reuss/	+	+	+	+	+	+	+	•	+	+	•
Lepidopleurus thielei Šulc	+	+	+	•	•	•	•	•	•	+	•
Lepidopleurus srameki Šulc	+	•	+	•	•	•	+	•	•	•	•
Lepidopleurus sulci sp.n.	•	+	+	+	•	•	•	•	•	+	•
Hanleya multigranosa /Reuss/	+	•	•	•	•	•	+	•	•	•	+
Ischnochiton rudoltiensis Šulc	+	+	+	+	•	+	+	•	•	•	•
Ischnochiton korytnicensis sp.n.	+	•	•	•	+	•	•	•	•	•	•
Lepidochitona lepida /Reuss/	+	•	+	•	+	•	+	•	•	•	+
Lepidochitona subgranosa sp.n.	+	•	+	•	•	•	•	•	•	•	•
Callochiton zigzag Šulc	+	•	+	•	•	+	•	+	+	•	•
Callochiton rariplicatus /Reuss/	+	+	+	+	•	+	+	•	•	+	•
Chiton denudatus Reuss	+	+	+	+	•	+	+	+	•	+	•
Acanthochitona faluniensis /Rochebrune/	+	+	+	+	•	+	+	+	•	+	+
Acanthochitona lacrimulifera sp.n.	+	+	+	•	•	•	•	•	•	+	•
Craspedochiton schafferi Šulc	+	•	•	•	•	+	•	•	•	•	•
Craspedochiton minutulus sp.n.	•	•	+	•	•	•	•	•	•	•	•
Cryptoplax weinlandi Šulc	+	+	•	•	•	+	+	+	+	+	+
Other species					2	1	4	–	2	3	3
Total number of species					5	9	13	4	5	11	7

The data for particular localities (cf. Fig. 3) taken from the referenced papers (Reuss 1860, Procházka 1895, Boettger 1901, Šulc 1934, Zilch 1934, Bałuk 1965)

and rocky clefts. The valves of their ancestors which lived in the Korytnica aquenum, have been found in the clays. Other Adriatic species, e.g. *Chiton corallinus* Risso and *Callochiton laevis* (Montagu), also occur near-shore, but they may live as well in a somewhat deeper water, even below 30 m. Recent representatives of the genus *Cryptoplax* de Blainville live in fissures or holes in rocky or coral-reef substrates (Ladd 1966) and, therefore, they also belong to extremely shallow-water forms.

SYSTEMATIC DESCRIPTION

Class **Amphineura** von Ihering, 1876
Subclass **Polyplacophora** de Blainville, 1816
Order **Neoloricata** Bergenhayn, 1955
Suborder **Lepidopleurina** Thiele, 1910
Family **Lepidopleuridae** Pilsbry, 1892
Genus *LEPIDOPLEURUS* Leach *in* Risso, 1826
Lepidopleurus decoratus (Reuss, 1860)
(Pl. 1, Figs 1—4)

1860. *Chiton decoratus* m.n.sp.; A. E. Reuss, p. 257, Pl. 8, Fig. 7.
1895. *Chiton Reussi* Procházka; V. J. Procházka, p. 100, Fig. 29.
1897. *Middendorffia subcajetana* (D'Orb.); E. Sacco, p. 90, Pl. 7, Figs 21—25.
1934. *Lepidopleurus (Lepidopleurus) decoratus* Rss; J. Šulc, pp. 3—4.
1964. *Lepidopleurus (L) cajetanus* (Poli); J. Marinescu, p. 180, Pl. 1, Fig. 1, [may be also Figs 2 and 3].
1965. *Lepidopleurus decoratus* (Reuss); W. Bałuk, pp. 366—368, Pl. 1, Figs 1—4.

Material. — Eighteen head valves, 112 intermediate and 42 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	2.2	4.2
intermediate valve	2.5	5.1
tail valve	4.0	6.5

Description. — Concentric ridges and radial ribs form ornamentation on the head valve, on lateral areas of intermediate valves and on the posterior area of the tail valve. Concentric ridges vary in thickness and are unequally spaced. Radial ribs are delicate and closely spaced. Each of them represents a sort of a row of closely spaced round granules. Radial ribs are slightly more prominent on the tail valve than on the rest of them. Many longitudinal ribs, also composed of closely spaced granules, form the ornamentation of the central areas of intermediate valves and of the tail valve. These ribs run on the whole parallel to each other, but, sometimes, two or three fuse together in the process of growth forming a single rib of the same thickness. Insertion plates lacking; sutural plates narrow, widely spaced, subtriangular (Pl. 1, Fig. 3). In transverse section, intermediate valves are arcuate, not carinated in the jugal part.

Remarks. — *Lepidopleurus decoratus* (Reuss) is one of the most numerous species in the chiton assemblage from Korytnica. This is among the most frequent species in the Miocene of the Vienna Basin and adjoining areas (Reuss 1860, Rochebrune 1883, Procházka 1895, Šulc 1934, Sieber 1953). It is also known from the Mio-

cene of Southern Rumania (Marinescu 1964) and Italy (Sacco 1897, Malatesta 1962). In Poland, the species also occurs in the sands at Niskowa (Bałuk 1965). Specimens coming from both Polish localities do not differ at all from each other.

The Recent species *Lepidopleurus cajetanus* (Poli) lives in the Mediterranean Sea, as well as along the Atlantic coast of the Iberian Peninsula and near the Canary Islands (cf. Leloup & Volz 1938, Malatesta 1962, Riedl 1963). It is very similar to the Miocene species *Lepidopleurus decoratus* (Reuss) which is of a common belief to have formed as a result of the evolution of this Miocene species (Šulc 1934, Malatesta 1962). *Lepidopleurus cajetanus* (Poli) is also cited from the Pliocene of Italy and Spain (cf. Malatesta 1962).

Lepidopleurus thielei Šulc, 1934
(Pl. 1, Fig. 8)

1934. *Lepidopleurus (Parachiton) thielei* n. sp.; J. Šulc, pp. 7—8, Pl. 1, Figs 4—5.

Material. — Seven intermediate and six tail valves, all of them incomplete.
Dimensions of the largest tail valve (in *mm*): length 3.8, width 5.0.

Description. — Lateral areas of intermediate valves and of a tail valve are ornamented by very delicate, fine, closely spaced granules. A regularity, which consists in a tendency to the arrangement in rows, radially diverging from the mucro of valve, is marked in the situation of these granules on the posterior area. The intermediate areas are ornamented by longitudinal rows of closely spaced granules which are somewhat larger than those on lateral areas. Insertion plates lacking. Sutural plates narrow, triangular in outline. A longitudinal shape of the tail valve (Pl. 1, Fig. 8) is a very characteristic feature of this species. In the process of valve growth, the anterior increase in length is much larger than the posterior and, consequently, the mucro is situated markedly excentrically.

Remarks. — *Lepidopleurus thielei* Šulc is a very rare species. It has hitherto been known only from the Miocene deposits of Steinabrunn in the Vienna Basin, from which it was described by Šulc (1934) and where, the same as at Korytnica, only few of its intermediate and tail valves were found. A slight difference may be observed between the specimens from these two localities: on some of the specimens from Korytnica (Pl. 1, Fig. 8), the longitudinal ribs in the jugal part of the central area of the tail valve run parallel to each other, whereas on Šulc's specimens from Steinabrunn they slightly converge centrally.

According to Šulc (1934), the species is similar to the Recent *Lepidopleurus acuminatus* Thiele from which it, however, differs in a different shape of the tail valve. In *Lepidopleurus thielei* Šulc, this valve is posteriorly rounded, while in *Lepidopleurus acuminatus* Thiele — conspicuously triangular (cf. Thiele 1909, Pl. 1, Figs 66 and 67). This is the reason why the Miocene species under study is more similar to *Lepidopleurus verconis* (Cotton & Weeding) known from Southern Australia (cf. Cotton 1964).

Lepidopleurus srameki Šulc, 1934
(Pl. 2, Fig. 5)

1934. *Lepidopleurus (Lepidopleurus) šrameki* n. sp.; J. Šulc, p. 5, Pl. 1, Fig. 3.

Material. — Two intermediate valves, the larger of them being 1.3 mm long and 3.2 mm wide.

Description. — Viewed in profile, the intermediate valve is conspicuously carinated in the jugum and, consequently, their slopes are almost flat. Central area ornamented by rows of closely spaced granules forming a sort of granulate ribs, parallel to the animal's body axis and only near the boundary with lateral areas slightly bent towards the valve apex. On the specimen figured (Pl. 2, Fig. 5), the number of ribs reaching the anterior margin of the tegmentum amounts on both sides to 20 each. In jugum, the ribs are somewhat more closely spaced than on the slopes. In lateral areas, ornamentation consists of closely spaced granules (somewhat smaller than those in central area), arranged in rows concentrically diverging from the apex and, in addition, in radial rows. In the part adjoining the posterior margin of the tegmentum, the latter are deflected posteriorly. Insertion plates lacking. Sutural plates, on both specimens available, broken away.

Remarks. — The species *Lepidopleurus srameki* Šulc was erected by Šulc (1934) on the basis of only one tail valve. The specimens from Korytnica seem to be in conformity with the form described by Šulc, but, since these are intermediate valves, no complete comparison is possible. This species has hitherto been known only from Rudoltice, Bohemia (Šulc 1934).

The species *Lepidopleurus algesirensis* (Capellini), described also as *Lepidopleurus granoliratus* (Carpenter), lives at present in the western part of the Mediterranean Sea and along the Atlantic coasts from the Iberian Peninsula to the Canary Islands (cf. Bergenhayn 1932, Malatesta 1962). It is very closely related to the Miocene *Lepidopleurus srameki* Šulc and may beyond any doubt be considered as a descendant form.

Lepidopleurus algesirensis (Capellini) has also been noted from the Pliocene of Sicily (cf. Malatesta 1962).

Lepidopleurus sulci sp. n.
(Pl. 2, Figs 1—4)

Holotype: the specimen presented in Pl. 2, Fig. 3, housed in the writer's collection (numbered *BkK-A08*).

Type horizon: Lower Tortonian.

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: sulci — in honor of Jaroslav Šulc, a Czech paleontologist and investigator of the chitons.

Diagnosis. — In transverse section, the intermediate valves and the tail valve are strongly elevated and arcuate. Lateral and posterior areas covered with closely spaced, small, round granules, arranged in rows which run in three different directions, the most distinct of them being radial ones.

Material. — Two head, 11 intermediate and 10 tail valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.1	2.5
intermediate valve	1.2	3.2
tail valve	1.6	2.5

Description. — Head valve ornamented with radial rows of fine, round granules, which give the impression of delicate, granulate ribs. They are very closely spaced and their number increases with the process of valve growth, since new rows appear among the existing ones. The number of rows per 1 mm section of the anterior margin of the valve mostly amounts to 28.

Intermediate and tail valves are strongly arcuate, not carinated in the jugal part. Lateral areas are situated only slightly higher than the central ones. Central areas ornamented with longitudinal rows of subround granules which in the jugal part are narrower and more closely spaced than on the slopes. The number of rows on an intermediate valve 3 mm wide amounts to 60—70 and on a tail valve, 2.5 mm wide, to about 50. Subround granules, somewhat smaller than those on the central area, occur on the lateral areas and on the posterior area. They are very closely but regularly spaced and arranged in rows running in three different directions, the radial ones being the most distinct. The density of spacing the rows is identical with that on the head valve. In addition, concentric ridges, similar to those in *Lepidopleurus decoratus* (Reuss), but not so deep, are visible on lateral areas. The apex of the tail valve is situated centrally and the part of the valve, situated behind it, is slightly concave. Insertion plates lacking, sutural plates narrow and widely spaced.

Remarks. — This new species seems to be related to the Recent *Lepidopleurus cancellatus* (Sowerby) which is widely distributed (cf. Malatesta 1962) and likely to be its ancestral form. Judging by the dimensions of valves, the live individuals of *Lepidopleurus sulci* sp. n. were larger and reached a length slightly over 10 mm, while the largest *Lepidopleurus cancellatus* (Sowerby) do not exceed 7 mm (Leloup & Volz 1938, Malatesta 1962). In regard to the sculpture, *Lepidopleurus sulci* sp. n. is also similar to the Recent species *Lepidopleurus scabricus* (Jeffers) from which it only slightly differs in size of valves (cf. Bergenhayn 1932, Pl. 2, Fig. 47).

A tail valve found at Steinabrunn, Vienna Basin, and described but unfortunately not figured by Šulc (1934) as *Lepidopleurus* cf. *cancellatus* (Capellini) may also belong to *Lepidopleurus sulci* sp. n.

Family **Hanleyidae** Bergenhayn, 1955
Genus *HANLEYA* Gray, 1857
Hanleya? multigranosa (Reuss, 1860)
(Pl. 1, Figs 5—7)

1860. *Chiton multigranosus* m. n. sp.; A. E. Reuss, p. 259, Pl. 8, Fig. 8 [non Fig. 9].
1934. *Hanleya multigranosa* (Rss.); J. Šulc, pp. 9—10, Pl. 1, Figs 7—12.

Material. — Three head, 16 intermediate and 5 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.0	2.4
intermediate valve	1.8	3.4
tail valve	1.6	2.5

Description. — The tegmentum of valves is divided into the central, lateral (on intermediate valves) or posterior (on tail valve) areas. This division is, however, only slightly marked and inconspicuous. Subcircular or slightly elliptic granules markedly projecting above the surface make up ornamentation of the valve: In the jugal part, these granules are considerably smaller and more closely spaced than those on the slopes. The transition from small to larger granules is not gradual but rather abrupt. In central area, the granules are distributed in fairly regular, longitudinal rows, while in lateral and posterior areas they are irregular. The specimens available are frequently lacking the granules, which are broken away and small holes are visible in their places (cf. Pl. 1, Figs 5 and 7). On the head valve.

the tegmentum does not reach the anterior margin of the valve and, consequently, a fairly wide band of articulamentum is visible along this margin. The surface of this band is conspicuously corrugated radially (Pl. 1, Fig. 5).

On the tail valve, the insertion plate (*a* in Fig. 2) stretches along the entire posterior margin of the valve. A very distinct line, separating the plate from the rest of articulamentum, is visible on the internal side of the valve. On the margin, it is thickened, uneven and as if serrated. Slits lacking. Anteriorly, on both sides of the tail valve, the insertion plate terminates in a slight but distinc distension (*b* in Fig. 2) and its margin is thinner. Quite similar insertion plate, but devoid of such a distension stretches along the entire margin of the head valve. On intermediate valves, insertion plates are much less developed. Sutural plates (*c* in Fig. 2) are fairly large and subcircular in outline. On the tail valve, they are separated from distentions of the insertion plate, referred to above, by a not very deep notch.

Remarks. — The concordance of the specimens from Korytnica with the species *Chiton multigranosus* Reuss is indisputable, the assignment of which to the genus *Hanleya* Gray arouses, however, certain doubts. Šulc (1934) believes that Reuss

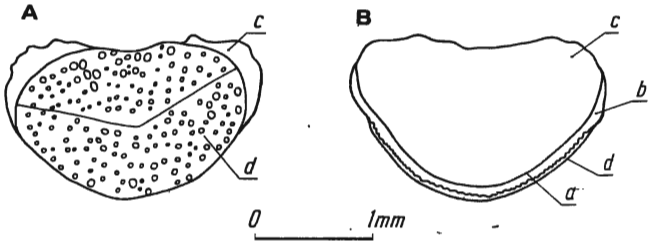

Fig. 2

Tail valve of *Hanleya? multigranosa* (Reuss) in outer *(A)* and inner *(B)* views

a, b insertion plate, *c* sutural plate, *d* tegmentum

species is related to the Recent *Hanleya hanleyi* (Bean). A considerable similarity of the two species is also confirmed by Malatesta (1962). The Miocene specimens do not, however, correspond to the diagnosis of the genus *Hanleya* Gray given by Smith (1960) in his modern elaboration of the class Amphineura. According to the last-named author, the tail valve in the genus *Hanleya* is supposed to be devoid of the insertion plate and, in his opinion, this character differs this genus from *Hemiarthrum* Carpenter *in* Dall, 1876. Unfortunately, the lack of comparative material prevents the present writer from dispelling the doubts. In addition, it should be mentioned that, according to Smith (1960), the genus *Hanleya* (as in fact the entire family Hanleyidae) has started its stratigraphic range as late as the Pleistocene, whereas the species *Hanleya multigranosa* (Reuss), known to him, comes from the Miocene.

Hanleya? multigranosa (Reuss) is a very rare species. Reuss (1860) and Šulc (1934) described it on the basis of few specimens coming from one and the same locality Rudoltice, Bohemia. The latter author also mentions two other localities, Kostej and Porzteich.

Suborder **Ischnochitonina** Bergenhayn, 1930
Family **Ischnochitonidae** Dall, 1889
Genus *ISCHNOCHITON* Gray, 1847
Ischnochiton rudolticensis Šulc, 1934
(Pl. 3, Figs 5—8)

1934. *Ischnochiton rudolticensis* n. sp.; J. Šulc, pp. 23—24, Pl. 2, Figs 41—43.

Material. — Six head, 50 intermediate and 15 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	c. 2.0	c. 4.0
intermediate valve	2.5	5.5
tail valve	3.5	5.0

Description. — Not very prominent, slightly undulating ribs, rather resembling wrinkles, make up ornamentation of the valves. On the head valves, on the lateral areas of intermediate valves and on the posterior area of the tail valve, these ribs run concentrically from the apex. An individual, concentrically running rib, may continue as a longitudinally running rib, but sometimes, longitudinal ribs are thinner and formed by the division of concentric ribs.

On the head and tail valves, the insertion plate is divided by many slits into a dozen or so sections. A row of pores runs from each slit to the apex. On intermediate valves, the insertion plate is cut by one slit from which a shallow groove full of pores, arranged in two rows, runs towards the apex. Sutural plates wide, rounded in outline.

Remarks. — The species has hitherto been found (Šulc 1934) only in two localities, Rudoltice and Kninice, Bohemia. Specimens previously assigned (Bałuk 1965) to this very species and which really do not belong here, are discussed below.

According to Šulc (1934), the Recent species *Ischnochiton rissoi* (Payraudeau), occurring in the Mediterranean Sea and near the Canary Islands (cf. Malatesta 1962, Riedl 1963), has appeared as a result of evolution of the Miocene species *Ischnochiton rudolticensis* Šulc.

Ischnochiton korytnicensis sp. n.
(Pl. 3, Figs 1—4)

1965. *Ischnochiton rudolticensis* non Šulc; W. Bałuk, pp. 369—370, Pl. 1, Fig. 7.

Holotype: the specimen presented in Pl. 3, Fig. 2, housed in the writer's collection (numbered *BkK-A15*).
Type horizon: Lower Tortonian.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.
Derivation of name: korytnicensis — after the locality Korytnica.

Diagnosis. — Ornamentation of the central area in the form of undulate, longitudinal ribs and that of lateral areas in the form of nodular elevations irregular and variable in outline.

Material. — Four head, 39 intermediate and 4 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	2.0	3.5
a half of intermediate valve (holotype, Pl. 3, Fig. 2)	2.5	3.1
tail valve	2.4	3.3

Description. — Closely spaced, nodular elevations, on the whole irregular in outline and irregularly distributed, form ornamentation of the head valve, lateral areas of intermediate valves and posterior area of tail valves. Sometimes, however, the outline of nodes resembles the letter *V* (Pl. 3, Figs 1 and 4) and they also may be arranged in radial rows (Pl. 3, Fig. 4). In central areas, the ornamentation consists of longitudinal, clearly undulate ribs. Frequently, in particular near lateral areas, they join each other or separate from each other, as a result of which the ornamentation takes the form of a network.

The insertion plate of the head and tail valves is dissected by numerous slits into a dozen or so sections (on tail valve, 12) and on intermediate valves by one slit. The margin of insertion plates is not pectinated. No complete sutural plates have been preserved on any specimen. As may be judged by the fragments, they are very wide and rounded in outline.

Remarks. — No species, with which the specimens described might be related, have been found by the writer among the known chitons, both fossil and Recent and, therefore, the new species *Ischnochiton korytnicensis* sp. n. have been erected. Intermediate valves identical with those, assigned here to this new species, were found by the writer in an assemblage of chitons from Niskowa near Nowy Sącz (Bałuk 1965); due to their seeming similarity to *Ischnochiton rudolticensis* Šulc, they were erroneously described by the writer under this very name. Now, a richer material from Korytnica being available, the writer states an indubitable separateness of the two species under study.

Genus *LEPIDOCHITONA* Gray, 1821
Lepidochitona lepida (Reuss, 1860)
(Pl. 4, Figs 6—12)

1860. *Chiton lepidus* m. n. sp.; A. E. Reuss, p. 259, Pl. 8, Figs 12—13.
1897. *Lepidopleurus* cf. *marginatus* (Penn.); F. Sacco, p. 90, Pl. 7, Fig. 32.
1934. *Middendorffia lepida* (Rss.); J. Šulc, pp. 10—11, Pl. 1, Figs 13—15.

Material. — Three head, 10 intermediate and 2 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.3	3.0
intermediate valve	2.3	5.0
tail valve	1.0	2.0

Description. — The surface of the entire tegmentum of all kinds of valves is ornamented by fine, but strongly convex granules. They are regularly distributed, forming two, intersecting systems of rows. The size of granules increases from the apex of the valve. On lateral areas, nodes are closely spaced, arranged one near another and on central areas they are rarer.

Insertion plates of head and tail valves are divided by slits into several sections (8—12) and of intermediate valves they are dissected by only one slit. Rows of pores run from the terminations of slits towards the apex. Sutural plates wide and rounded. Several radial ridges, running from the apex in these same places in which rows of pores stretch on the inner side, are visible on the outer surface of head valves on two of the three specimens available.

Remarks. — As compared with the specimens described by Šulc (1934), those from Korytnica differ only in the presence of the above mentioned ridges on the head valve. A few similar, although considerably slighter ridges may, however, be

also seen on the specimen illustrated by Šulc (1934, Pl. 1, Fig. 13). This species is assigned by the present writer to the genus *Lepidochitona* Gray, 1821. It is similar to the Recent species *Lepidochitona cinereus* (Linnaeus), which lives in the European seas (cf. Malatesta 1962). On the other hand, it considerably differs from the Recent species *Middendorffia caprearum* (Scacchi), with which it sometimes is compared (Malatesta 1962).

Lepidochitona lepida (Reuss) has hitherto been known from Rudoltice, Bohemia (Reuss 1860, Šulc 1934), Kostej and Lapugy, Transylvania (Šulc 1934), Hidas, Hungary (Csepreghy-Meznerics 1950) and Italy (Sacco 1897). The specimens, described as *Lepidochitona* sp. from Niskowa, Poland (Bałuk 1965) probably also belong to this species.

Lepidochitona subgranosa sp. n.
(Pl. 4, Figs 1—5)

Holotype: the specimen presented in Pl. 4, Fig. 5, housed in the writer's collection (numbered *BkK-A26*).

Type horizon: Lower Tortonian.

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: subgranosa — after slightly projecting granules which make up ornamentation of the valves.

Diagnosis. — Valves ornamented by slightly projecting and closely spaced granules; tail valve very slightly convex, almost flat.

Material. — Six head, 26 intermediate and 3 tail valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.4	3.3
intermediate valve	1.8	2.2
tail valve	1.0	2.0

Description. — Head valve with tegmentum ornamented by closely spaced, fine granules. Insertion plate cut by eight slits. On intermediate valves, the division into a central and lateral areas slightly marked. The entire tegmentum has a uniform ornamentation in the form of fine, slightly projecting granules, arranged in intersecting, arcuate rows. Insertion plates slightly projecting from below tegmentum and intersected by one slit, from which a row of pores runs from the apex on the inner side. Sutural plates short but wide. Tail valve very slightly convex, nearly completely flat. Ornamentation identical as on head and intermediate valves. Insertion plate cut by seven slits.

Remarks. — The specimens from Korytnica assigned to this species, do not correspond to any of the species described thus far. They differ from the most closely related *Lepidochitona reussi* (Rolle) from the Tertiary of Aquitaine (Rolle 1862, Šulc 1934) in a slightly larger size and considerably finer ornamentation. Much less prominent granules and, primarily, a different shape and degree of convexity of the tail valve differ them from *Lepidochitona lepida* (Reuss).

On six of all the intermediate valves available, the granules which make up an ornamentation, are particularly fine and these specimens are fairly distinctly different than the rest (Pl. 4, Fig. 4). This may be a symptom of specific variability, although their specific separateness cannot be precluded.

Family **Callochitonidae** Plate, 1899
Genus *CALLOCHITON* Gray, 1847
Callochiton zigzag Šulc, 1934
(Pl. 5, Figs 6—8)

1934. *Callochiton zig-zag* n. sp.; J. Šulc, p. 12, Pl. 1, Figs 17—19.

Material. — Two head, two intermediate and two tail valves; all specimens incomplete.

Dimensions of valves (in *mm*):

	length	width
head valve	1.2	3.0
intermediate valve	1.6	4.8
tail valve	c. 2.0	c. 4.0

Description. — Not very prominent, zigzagging wrinkles make up ornamentation of the head valve, lateral areas of intermediate valves and posterior area of tail valves. In addition, the surface of these parts of valves is finely granulate. The surface of central areas is ornamented by closely and regularly spaced, fine pits which radially diverge from the apex. Insertion plates of all valves are divided by very numerous slits into short sections, which are only slightly longer than the width of particular slits. On the inner side of valves, a row of pores runs, on each side of every slit, towards the apex which, with a considerable density of the distribution of rows, gives the impression as if the entire valve was densely perforated. On the specimen figured (Pl. 5, Fig. 6), which makes up about a half of a head valve, the number of rows of pores amounts to 23. On the intermediate valve (Pl. 5, Fig. 7), the insertion plate is cut by five slits and on a young tail valve (Pl. 5, Fig. 8), the number of slits amounts to 30. Sutural plates, preserved on only one intermediate valve (Pl. 5, Fig. 2), are relatively narrow, widely spaced and rounded in outline.

Remarks. — Erecting the species *Callochiton zigzag*, Šulc (1934) mentioned that the head valve was devoid of ornamentation. The head valve from Korytnica (Pl. 5, Fig. 6), with a very well-preserved outer surface, has an identical ornamentation as that described by Šulc (1934) for lateral areas of intermediate valves. The supposition may therefore be expressed that the head valves, available to him, had the outer surface abraded.

Callochiton zigzag Šulc has hitherto been known only from three Miocene localities in Bohemia (Šulc 1934).

Callochiton rariplicatus (Reuss, 1860)
(Pl. 5, Figs 1—5)

1860. *Chiton rariplicatus* m. n. sp.; A. E. Reuss, pp. 258—259, Pl. 8, Figs 9—11.
1934. *„Chiton" rariplicatus* Rss.; J. Šulc, pp. 27—28, Pl. 2, Fig. 5.

Material. — Nine head, 36 intermediate and 39 tail valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.2	3.0
intermediate valve	1.7	3.8
tail valve	1.9	2.8

Description. — Head valve in principle smooth; unusually fine and dense grooving is visible in strong magnification on the specimens with a very well-

-preserved outer surface. Many outlets of narrows canals are visible as well. The insertion plate is relatively thick and slitted. The number of slits usually fluctuates between 18 and 20. Particular sectors of the plate are not always uniform in size; in the anterior part of the valve they are on the whole narrower. A distinct depression parallel to the slits runs along the middle of most sectors.

The appearance of the outer surface of the intermediate valve is identical with that of the head valve, but, in addition, shallow and very distinct longitudinal furrows occur on the central area of most specimens. These furrows are situated near the boundary of lateral areas and do not reach the anterior margin of the tegmentum of the valve. Insertion plates are cut by 3 to 4 slits on each side of the valve. On the inner surface, a row of small pores runs from each slit towards the apex. In addition, 3 to 4 closely spaced rows of pores run between the boundary of the apical area and the first (from the posterior margin) slit. Sutural plates are large, very wide and usually connected with each other in the jugal part of the valve (Pl. 5, Figs 2 and 3).

On tail valves, ornamentation of the tegmentum and development of sutural plates are much the same as those on the valves described above. The insertion plate is multislitted; the slits (15—17) cut the plate into short sectors also varying in size.

Remarks. — *Callochiton rariplicatus* (Reuss) has hitherto been described merely two times and, in addition, only its intermediate valves were presented by Reuss (1860) and Šulc (1934). The head and tail valves were so far unknown. This species is seemingly very similar to another chiton (described below), that is, *Chiton denudatus* Reuss. With a simultaneous occurrence of the two species, it is possible to separate them by a various development of their insertion plates.

In the Miocene deposits, *Callochiton rariplicatus* (Reuss) has so far been found at Rudoltice and Kninice, Bohemia, as well as at Steinabrunn, Vienna Basin (Reuss 1860, Šulc 1934).

At present, *Callochiton laevis* (Montagu, 1803), very similar to this Miocene species, lives *i. a.* in the Mediterranean Sea (Leloup & Volz 1938, Malatesta 1962, Riedl 1963). Particularly similar are specimens having distinct furrows on central areas and which are usually described as *Callochiton doriae* (Capellini), which however belong, according to Leloup & Volz (1938) also to the species *Callochiton laevis* (Montagu). Beyond any doubt, the Recent species *Callochiton laevis* (Montagu) is a descendant of the Miocene *Callochiton rariplicatus* (Reuss).

Callochiton laevis (Montagu) is also known from the Pleistocene deposits of Italy (cf. Malatesta 1962).

Family **Chitonidae** Rafinesque, 1815
Genus *CHITON* Linnaeus, 1758
Chiton denudatus Reuss, 1860
(Pl. 5, Figs 9—11)

1860. *Chiton denudatus* m. n. sp.; A. E. Reuss, p. 259, Pl. 8, Figs 10—11.
1895. *Chiton denudatus* Reuss; V. J. Procházka, p. 99, Fig. 28.
1934. *Chiton (Clathropleura) corallinus denudatus* Rss.; J. Šulc, pp. 24—25, Pl. 2, Figs 44—45.

Material. — Thirty-two head, 200 intermediate and 36 tail valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	2.0	4.2
intermediate valve	3.1	6.6
tail valve	3.0	4.5

Description. — The head valve, the lateral areas of intermediate valves and the posterior area of the tail valve are smooth, except in some largest specimens, having barely visible radial ribs (cf. Pl. 5, Figs 8 and 10). In the axial part, central areas are smooth; laterally, they are provided with several (up to 10 on one side of a valve in the largest specimens), longitudinal furrows. In addition, the entire tegmentum is, on all types of valves, densely perforated by tiny, regularly distributed apertures which make up outlets of nervous canals. The insertion plate has a finely pectinated margin. On head and tail valves, it is cut by numerous slits. On a head valve, the number of slits reaches 10, on tail valve 15. On intermediate valves, the insertion plate is single slitted. Sutural plates are wide, but never connected with each other in the jugal part and, consequently, a sinus occurring between them is deep.

Remarks. — The species *Chiton corallinus* (Risso, 1826) which lives at present in the Mediterranean Sea (Leloup & Volz 1938, Malatesta 1962, Riedl 1963) is undoubtedly a descendant of the Miocene species under study. According to Šulc (1934), who considered these forms as mere separate subspecies, the difference consists in a different shape of their tail valve.

Few specimens of *Chiton denudatus* Reuss have so far been known only from Rudoltice, Knínice and Zidlichovice, Bohemia, and Steinabrunn, Vienna Basin (Reuss 1860, Procházka 1895, Šulc 1934).

Chiton corallinus (Risso) was recorded in the fossil state from the Pliocene and Pleistocene of Italy (cf. Malatesta 1962).

Suborder **Acanthochitonina** Bergenhayn, 1930
Family **Acanthochitonidae** Pilsbry, 1893
Genus *ACANTHOCHITONA* Gray, 1821
Acanthochitona faluniensis (Rochebrune, 1883)
(Pl. 2, Figs 10—15)

1860. *Chiton (Acanthochites) fascicularis* L. var.; A. E. Reuss, pp. 260—261, Pl. 8, Figs 4—6.
1883. *Acanthochites Faluniensis* Rochebr.; A. T. Rochebrune, pp. 60—61.
1934. *Acanthochiton faluniensis* Rochebrune; J. Šulc, pp. 17—18, Pl. 1, Fig. 29; Pl. 2, Figs 30—32; in texto Fig. 2.

Material. — Seven head, 22 intermediate and 9 tail valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.4	*c.* 3.5
intermediate valve	4.5	*c.* 8.0
tail valve	1.8	3.5

Description. — The valves of this species are relatively large and thick. Closely spaced nodes form ornamentation of their anterior, lateropleural and posterior areas. The nodes are low, round in outline and dorsally flattened. Their arrangement is in principle irregular, but a certain tendency to their arranging in longitudinal rows may be observed on intermediate valves. Jugal areas of valves are covered with narrow and shallow rows radially diverging from the apex.

The insertion plate of a head valve is cut by five slits, in the extension of which there run shallow grooves, identical in size with slits and reaching the boundary of the tegmentum. On intermediate valves, the insertion plate is cut by one slit on each side, while on a tail valve this plate is cut by two slits.

Remarks. — The valves from Korytnica, assigned to this species, fairly well correspond to specimens of *Acanthochitona faluniensis* (Rochebrune) from Rudoltice (cf. Šulc 1934). They also resemble a specimen of *Acanthochitona* sp. *II*, also coming from Rudoltice (cf. Šulc 1934, Pl. 2, Fig. 5), but, in the present writer's opinion, the separateness of Šulc's last-named specimen is rather problematic.

Acanthochitona faluniensis (Rochebrune) is one of the chiton species fairly frequent in the Miocene. It is known from several localities in the Vienna Basin, Bohemia and Transylvania (Šulc 1934). None of the chitons, which live at present in European seas, is similar to the species under study and, therefore, none of them may be considered as its descendant.

Acanthochitona lacrimulifera sp. n.
(Pl. 2, Figs 6—9)

Holotype: the specimen presented in Pl. 2, Fig. 9, housed in the writer's collection (numbered *BkK-A53*).

Type horizon: Lower Tortonian.

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: lacrimulifera — after a characteristic ornamentation by nodes the shape of which resemble fine tears.

Diagnosis. — On valves of all types, ornamentation of the tegmentum is formed by nodes the shape of which resemble fine tears.

Material. — Two head and 30 intermediate valves.

Dimensions of the largest valves (in *mm*):

	length	width
head valve	1.0	2.0
intermediate valve	2.5	4.2

Description. — Characteristically shaped nodes form the ornamentation of the anterior and lateropleural areas. The nodes are slightly elongate and resemble in outline fine tears or detaching drops. On the surface of the tegmentum they are so arranged that their tapering ends are pointing towards the apex of the valve. The dimensions of the nodes increase gradually but markedly with the process of growth. Jugal areas of valves are covered with not very prominent longitudinal ribs, which are closely spaced so that the interspaces have the form of longitudinal grooves with a slightly undulate trace.

The insertion plate of a head valve is cut by five slits, whereas of an intermediate valve is single slitted. All slits are narrow and very short; in their extension shallow, and groovelike depressions run up to the boundary of the tegmentum.

Remarks. — Here assigned valves very clearly resemble specimens of the Recent species *Acanthochitona fascicularis* (Linnaeus). It seems to be beyond any doubt that *Acanthochitona lacrimulifera* sp. n. is a Miocene ancestor of this Recent species.

A specimen described but not illustrated by Šulc (1934) from Steinabrunn as *Acanthochitona* aff. *fascicularis* (Linnaeus), should probably be assigned to *Acanthochitona lacrimulifera* sp. n. Similar specimens were also found in the Tortonian of northern Italy (*fide* Malatesta 1962).

Acanthochitona fascicularis (Linnaeus) lives at present near the shores of almost entire Europe from the Black up to the North seas (Malatesta 1962).

Genus *CRASPEDOCHITON* Shuttleworth, 1853
Craspedochiton schafferi Šulc, 1934
(Pl. 2, Figs 13—14)

1934. *Cryptoconchus (Notoplax) schafferi* n. sp.; J. Šulc, p. 15, Pl. 2, Figs 22—24.

Material. — Two incomplete intermediate valves.

Dimensions of the larger specimen (in *mm*): length 1.8, width 2.4.

Description. — Few and unfortunately incomplete valves are ornamented by oval nodes covering lateral parts of the tegmentum while the central part is smooth. The insertion plate has a single slit, in the extension of which a very distinct groove, laterally bounded by roller-like swellings, runs on the outer side of the valve, up to the boundary of the tegmentum. A semicirculary sutural plate is relatively narrow, situated nearer the marginal part of the valve and, consequently, the jugal sinus is wide.

Remarks. — The specimens found at Korytnica correspond to those described by Šulc (1934) as *Craspedochiton schafferi* (Šulc) from Kninice, Bohemia, Fortechnau, Vienna Basin, and Kostej, Transylvania, in all of which it is a very rare fossil.

Recent representatives of this genus live only in warm seas near the western coasts of Africa (Thiele 1909), as well as in the Indo-Pacific zone and near Australia (Smith 1960, Cotton 1964). The Miocene species under study slightly resembles in the ornamentation of its shell a Recent species *Craspedochiton liberiensis* Thiele from the African coast (Thiele 1909).

Craspedochiton minutulus sp. n.
(Pl. 6, Fig. 9—13)

Holotype: the specimen presented in Pl. 6, Fig. 9, housed in the writer's collection (numbered *BkK-A57*).

Type horizon: Lower Tortonian.

Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mts.

Derivation of name: minutulus — after a small size of the animal.

Diagnosis. — Valve very small, its jugal area relatively very wide and ornamented by not very prominent, longitudinal, granulate ribs.

Material. — Twenty intermediate and one tail valve.

Dimensions of the largest valves (in *mm*):

	length	width
intermediate valve	1.0	1.7
tail valve	0.6	1.2

Description. — Intermediate valve small, distinctly carinated in the jugal part and, consequently, its slopes are almost completely flat. Apex prominent, projecting slightly outside the posterior margin. Jugal area wide, ornamented by inconspicuous, flat, longitudinal ribs which are very closely spaced, and everyone makes up as if a row of slightly separated, flat granules. A division into pleural and lateral areas is marked on the rest of the tegmentum, although the boundary of the areas is indistinct. Lateral areas are slightly elevated as compared with pleural areas. Arcuate rows of oval granules somewhat flattened dorsally represent ornamentation of lateral and pleural areas. At first, these rows are closely spaced on the lateral area and, subsequently, they distinctly withdraw from each other on the pleural one. Articulamentum only slightly larger than tegmentum. Insertion plate is single slitted. Sutural plates small and widely spaced which results in a considerable width of the jugal sinus. Tail valve slightly convex, relatively short

and analogously ornamented as intermediate valves. Insertion plate cut by seven small slits into sectors varying in length so that the central sectors are considerably shorter.

Remarks. — None of the chitons described from the Tertiary deposits is similar or even merely related to these specimens from Korytnica. For this reason, a new species *Craspedochiton minutulus* sp. n. has been erected. No species has ever been found in European seas which might be considered as a descendant of this species.

Genus *CRYPTOPLAX* de Blainville, 1818
Cryptoplax weinlandi Šulc, 1934
(Pl. 6, Figs 1—8)

1901. *Cryptoplax weinlandi* (Rolle); O. Boettger, p. 180.
1934. *Cryptoplax weinlandi* (Rolle) Sulc; J. Sulc, pp. 21—23, Pl. 2, Figs 36—40.
1934. *Cryptoplax weinlandi* Sulc; A. Zilch, pp. 199—200, Pl. 1, Figs 18—22.
1964. *Cryptoplax weilandi* Sulc; J. Marinescu, pp. 183—184, Pl. 4, Figs a—e.

Material. — Ten head, 48 intermediate and 5 tail valves.
Dimensions of the largest valves (in *mm*):

	length	width
head valve	2.0	2.0
intermediate valve	5.5	2.4
tail valve	2.6	1.4

Description. — On a head valve, the tegmentum ornamented with closely spaced nodelike elevations (Pl. 6, Fig. 1). Near apex, they resemble fine granules and more peripherally they become considerably elongate and already form the ribs proper. On a intermediate and tail valve, the jugal area is smooth and lateral areas are ornamented by a few (to six on one side) longitudinal, slightly undulate ribs. At the apex, these ribs make up as if rows of pearlike nodes. Insertion plate on the head valve divided into four parts by three small slits, from everyone of which a narrow and very shallow groove runs over the outer surface of the articulamentum. Intermediate and tail valves have their insertion plates devoid of slits.

Remarks. — The specimens from Korytnica correspond well to those presented by Šulc (1934) from Steinabrunn (cf. Šulc 1934, Pl. 2, Figs 36 and 39) while that one from Kninice (cf. Šulc 1934, Pl. 2, Fig. 38) has more closely spaced and more numerous longitudinal ribs. They also do not differ from the specimens from Basesti, southern Rumania, figured by Marinescu (1964), two of which (cf. Marinescu 1964, Pl. 4, Figs *b* and *c*) represent, however, in the writer's opinion, tail valves and the other three (cf. Marinescu 1964, Pl. 4, Figs *a*, *d* and *e*) make up intermediate valves.

Cryptoplax weinlandi Šulc has hitherto been known from several localities in the Vienna Basin, Bohemia, Transylvania and Dacian Basin (Boettger 1901, Šulc 1934, Zilch 1934, Marinescu 1964). It is one of the most frequent Miocene chitons in Central Europe, particularly numerously represented at Lapugy and Kostej (Zilch 1934).

None of the species of the genus *Cryptoplax* is now recorded in the European seas. This genus is characteristic of warm seas and it abundantly occurs in the Indo-Pacific zone, Japan and Australia (Smith 1960, Cotton 1964).

A COMPARISON WITH OTHER CHITON ASSEMBLAGES FROM THE EUROPEAN MIOCENE AND WITH THE PRESENT MEDITERRANEAN COMMUNITY

Of the many various groups of animals that lived in the Miocene seas, the chitons are relatively poorly recognized. They have so far been described from comparatively few localities. Probably, there are two reasons for this fact. First, they did not belong to animals which lived in masses and their occurrence was limited only to near-shore zones, particularly exposed to the subsequent erosion. Secondly, after the animal' death their shells disintegrated in separate, usually small valves, which are in practice imperceptible in deposits. It is only the sifting or washing of fine fractions that allows one to find them.

The Miocene chitons are known in Europe from a few areas (Fig. 3). Their most numerous and best recognized localities are situated within Vienna Basin and its adjoining territory of eastern Bohemia, and in Transylvania (Reuss 1860, Procházka 1895, Šulc 1934). In addition, they

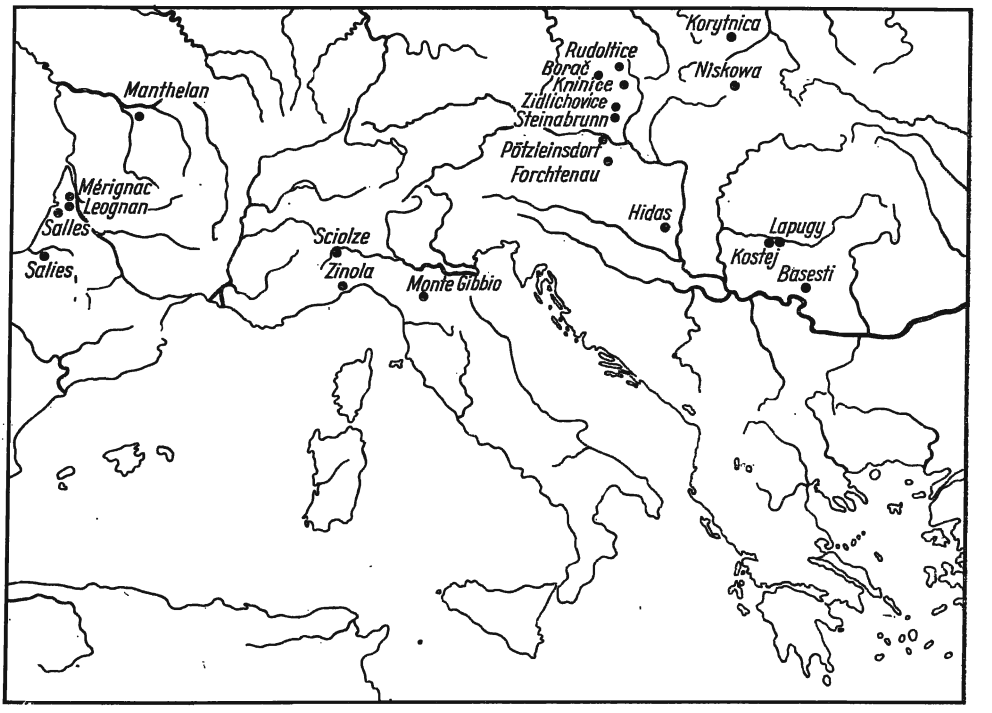

Fig. 3

Geographic distribution of the chitons in the Miocene deposits of Europe

Compiled on the data presented by: Sacco (1897), Cossmann & Peyrot (1917), Šulc (1934), Csepreghy-Meznerics (1950), Sieber (1953), Marinescu (1964), Bałuk (1965)

were described from northern Italy (Sacco 1897), from France, mostly from the Aquitanian Basin (Cossmann & Peyrot 1917) and from the western part of the Dacian Basin, Rumania (Marinescu 1964). In Poland they have so far been known only from Niskowa in the Carpathians (Skoczylasówna 1930, Bałuk 1965).

The chiton assemblage from Korytnica includes seventeen species and therefore appears to be the richest in the Miocene of Europe (cf. Table 1). It displays a striking resemblance to that from the Vienna Basin, in fact much the same as does the entire fauna which confirms the view on a direct connection between the Miocene sea of southern Poland and of the Vienna Basin. Out of 17 chiton species, found at Korytnica, as many as 14 occur also in the environs of Vienna and in eastern Bohemia. The number of species, common with the Korytnica assemblage, in particular localities is (Table 1) as follows: at Rudoltice — 9 out of 13 that occur there, at Steinabrunn — 8 out of 11, at Kninice — 8 out of 9. The species recorded at Korytnica occur, in varying numbers, in each of the remaining localities. In the environs of Lapugy and Kostej, Transylvania, widely known for their rich fauna, the assemblage of chitons includes 7 species, 4 of which are also present at Korytnica.

Far less convincing analogies result from the comparison between the Korytnica assemblage (and also assemblages from the Vienna Basin) and assemblages from northern Italy which yield a much lower number of common species.

Only few species of chitons, being besides quite different than those under study, have been described from France.

Comparing the Recent species from the Mediterranean Sea with Miocene forms, one may find that almost all of them have Miocene ancestors (cf. also Šulc 1934, Malatesta 1962). Such a hypothetic reletionship concerns the following pairs of species:

Miocene species	Recent species
Lepidopleurus decoratus (Reuss)	*Lepidopleurus cajetanus* (Poli)
Lepidopleurus sulci sp.n.	*Lepidopleurus cancellatus* (Sowerby)
Lepidopleurus srameki Šulc	*Lepidopleurus algesirensis* (Capellini)
?	*Lepidopleurus asellus* (Gmelin)
Hanleya multigranosa (Reuss)	*Hanleya hanleyi* (Bean)
Lepidochitona lepida (Reuss)	*Lepidochitona cinerea* (Linnaeus)
?	*Middendorffia caprearum* (Scacchi)
Ischnochiton rudolticensis Šulc	*Ischnochiton rissoi* (Payraudeau)
Callochiton rariplicatus (Reuss)	*Callochiton laevis* (Montagu)
Chiton bohemicus (Rochebrune)	*Chiton olivaceus* Spengler
Chiton denudatus Reuss	*Chiton corallinus* Risso
Acanthochitona sp. *I* (Šulc 1934)	*Acanthochitona communis* (Risso)
Acanthochitona lacrimulifera sp. n.	*Acanthochitona fascicularis* (Linnaeus)

The differences which occur between particular species, arranged above in pairs, seem to be in some cases so insignificant that one may even wonder whether or not they are actually separate species. This is an essential problem, a solution of which requires a detailed comparison of the fossil and Recent specimens. The lack of an appropriate comparative material has, however, prevented the writer from undertaking such studies.

A total number of the European species of chitons, cited from the Miocene deposits and representing in principle the Tortonian ones only, amounts to not much more than 30. Thus, it is considerably more as compared with the number of chiton species which have now been living in the Mediterranean Sea considered as a continuation of Miocene seas. The Mediterranean assemblage contains only 13 species (Malatesta 1962), 11 of them living in the Adriatic (Leloup & Volz 1938).

In addition to a lesser number of species forming the Mediterranean community of chitons, attention is also attracted by a lack of the representatives of the genera *Cryptoplax* de Blainville and *Craspedochiton* Shuttleworth which occurred in the Miocene seas of Europe.

The presented remarks suggest the question what was the cause of a distinct impoverishment of the Mediterranean chitons as compared with the Miocene assemblages. For, it is a well-known fact that this group of molluscs precisely at present reaches its peak development (Smith 1960). The answer should be looked for in the changed conditions of the chitons' life environment. However, both the character and configuration of the seashore, as well as the depth and salinity of water remained unchanged and on a general scale were probably much the same or even identical as those in, for instance, the Recent Adriatic. Thus, the temperature of water was bound to be an essential cause: the Miocene seas of southern and central Europe were certainly warmer. The drop in temperature in the late Pliocene exerted a deteriorating influence either directly on more stenothermal species of chitons or indirectly by causing a disappearance of marine flora which made up their basic food.

Conspicuously stenothermal organisms, found in the deposits of the Miocene seas give ample evidence of a higher temperature of their waters. This primarily concerns the cirripeds *Creusia* Leach and bivalved gastropods *Berthelinia* Crosse. Representatives of the genus *Creusia* live at present only in subtropical and tropical seas (cf. Bałuk & Radwański 1967), among other places, near the coasts of Florida, in the Red Sea and in the Indo-Pacific zone, while the gastropods referred to above, have been found, *i.a.* near the coasts of California, Jamaica, Madagascar, Japan, southern Austrialia and the Hawaiian Islands (cf. Bałuk & Jakubowski 1968). None on the representatives of these genera has been ever recorded in the Mediterranean or in any other seas that surround Europe.

Likewise, both genera of chitons named previously, *Cryptoplax* and *Craspedochiton* are known at present only from warm seas of western Africa, the Indo-Pacific zone, Japan, Austrialia and New Zealand (Thiele 1909, Smith 1960, Cotton 1964).

The conclusion on the higher water temperature is also true for the northernmost parts of the Miocene sea of central Europe (cf. Bałuk & Radwański 1967; Radwański 1969, 1970) where the Korytnica Bay was situated (Fig. 3), and in which all the stenothermal organisms here discussed lived.

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REFERENCES

BAŁUK W. 1965. Chitony z piasków tortońskich Kotliny Sądeckiej (Chitons from the Tortonian of the Nowy Sącz Depression, Poland). — Acta Palaeont. Pol., vol. 10, no. 3. Warszawa.

— & JAKUBOWSKI G. 1968. *Berthelinia krachi* n. sp., a new bivalved gastropod from the Miocene of Poland. — *Ibidem*, vol. 13, no. 2.

— & RADWAŃSKI A. 1967. Miocene cirripeds domiciled in corals. — *Ibidem*, vol. 12, no. 4.

BERGENHAYN J. R. M. 1932. Beiträge zur Malakozoologie der Kanarischen Inseln. Die Loricaten. — Arkiv för Zoologi, Bd. 2 *A*, H. 3, No. 13. Stockholm.

BOETTGER O. 1901. Zur Kenntnis der Fauna der mittelmiocänen Schichten von Kostej im Krassó-Szörényer Komitat. — Verh. u. Mitt. Siebenb. Ver. Naturw., Bd. 51. Hermannstadt.

COSSMANN M. & PEYROT A. 1917. Conchologie Néogénique de l'Aquitaine. Vol. 3, livre 1. Bordeaux.

COTTON B. C. 1964. South Australian Mollusca; Chitons. Adelaide.

CSEPREGHY-MEZNERICS I. 1950. A Hidasi (Baranya M.) tortonai fauna (Die tortonische Fauna von Hidas, Kom. Baranya, Ungarn). — A Magyar állani Földtani intézet Evkönyve (Ann. Inst. Geol. Publ. Hung.), vol. 39, no. 2. Budapest.

LADD H. S. 1966. Chitons and gastropods (Haliotidae through Adeorbidae) from the Western Pacific Islands. — U. S. Geol. Surv., Prof. Paper 531. Washington.

LELOUP E. & VOLZ P. 1938. Die Chitonen (Polyplacophoren) der Adria. — Thalassia, vol. 2, no. 10. Jena.

MALATESTA A. 1962. Mediterranean Polyplacophora Cenozoic and Recent. — Geol. Romana, vol. 1. Roma.

MARINESCU J. 1964. Reprezentanti ai clasei Amphineura in Miocenul din Oltenia. — Dari de Seama ale Sedintelor, vol. 50, no. 1. Bucuresti.

PROCHÁZKA V. J. 1895. Miocaen východočeský. — Archiv pro přírodověcké prozkoumání Čech, vol. 10, no. 2. Praha.

RADWAŃSKI A. 1964. Boring animals in Miocene littoral environments of Southern Poland. — Bull. Acad. Pol. Sci., Sér. Sci Géol. Géogr., vol. 12, no. 1. Varsovie.

— 1969. Transgresja dolnego tortonu na południowych stokach Gór Świętokrzyskich; strefa zatok i ich przedpola (Lower Tortonian transgression onto the southern slopes of the Holy Cross Mts). — Acta Geol. Pol., vol. 19, no. 1. Warszawa.
— 1970. Dependence of rock-borers and burrowers on the environmental conditions within the Tortonian littoral zone of Southern Poland. — *In:* Trace Fossils (Geol. Journal special issues, No. 3). Liverpool.
REUSS A. E. 1860. Die marinen Tertiarschichten Bohmens und ihre Versteinerungen. — S. B. Akad. Wiss. Wien, Bd. 39. Wien.
RIEDL R. 1963. Fauna und Flora der Adria. Hamburg — Berlin.
ROCHEBRUNE A. T. 1883. Monographie des espèces fossiles appartenant à la classe des Polyplaxiphores. — Ann. Sci. Géol., vol. 14. Paris.
ROLLE F. 1862. Über einige neue oder wenig gekannte Mollusken-Arten aus Tertiär-Ablagerungen. — S. B. Akad. Wiss. Wien, Bd. 44. Wien.
SACCO F. 1897. I Molluschi dei terreni terziarii del Piemonte e della Liguria, vol. 22. Torino.
SIEBER R. 1953. Die Tortonfauna von Pötzleinsdorf. — Verh. Geol. Bundesanst., Bd. 3. Wien.
SKOCZYLASÓWNA K. 1930. Przyczynek do znajomości miocenu kotliny sądeckiej (Beitrag zur Kenntnis der Miozänablagerungen in der Umgebung von Nowy Sącz). — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), t. 6. Kraków.
SMITH A. G. 1960. Amphineura. *In:* R. C. Moore (Ed.), Treatise on Invertebrate Paleontology, Part *I* (Mollusca *1*). Lawrence.
ŠULC J. 1934 (1936). Studie über die fossilen Chitonen. I — Die fossilen Chitonen in Neogen des Wiener Beckens und angrezenden Gebieten. — Ann. Naturhist. Mus. Wien, Bd. 47. Wien.
THIELE J. 1909. Revision der Systems der Chitonen. — Zoologica, Bd. 22, H. 56. Stuttgart.
ZILCH A. 1934. Zur Fauna des Mittel-Miocäns von Kostej (Banat). — Senckenbergiana, Bd. 16, H. 1—6. Frankfurt a. M.

W. BAŁUK

CHITONY Z IŁÓW KORYTNICKICH

(Streszczenie)

Szczątki chitonów w dolnotortońskich iłach pleurotomowych okolic Korytnicy, znanych powszechnie z bogactwa różnorodnych skamieniałości, występują jedynie w najwyższej części tych osadów, gdzie należą zresztą do rzadkości. W poszczególnych próbkach spotyka się pojedyncze skorupki tych zwierząt, a częstsze były one tylko w czterech próbkach (por. fig. 1 oraz tab. 1).

Wśród chitonów z iłów korytnickich oznaczono 17 gatunków (por. pl. 1—6), z których 5 jest dla nauki nowych: *Lepidopleurus sulci* sp. n., *Ischnochiton korytnicensis* sp. n., *Lepidochitona subgranosa* sp. n., *Acanthochitona lacrimulifera*

sp. n. oraz *Craspedochiton minutulus* sp. n. Cały zespół będący najbogatszym spośród wszystkich zespołów znanych w miocenie Europy, wykazuje uderzające podobieństwo do występujących w tortonie Basenu Wiedeńskiego i wschodnich Czech (*vide* Sulc 1934). Szczególnie podobne są zespoły z Rudoltic w Czechach i Steinabrunn w Basenie Wiedeńskim (por. fig. 3 oraz tab. 1).

W okresie sedymentacji górnej części iłów korytnickich, które osadzały się w obrębie jednej ze skalistych zatok morza dolnotortońskiego transgredującego na południowe stoki Gór Świętokrzyskich (Radwański 1964, 1969, 1970), rozwój bogatego i różnorodnego zespołu chitonów możliwy był dzięki istnieniu szczególnie korzystnych warunków dla życia tych zwierząt. Charakter całego zespołu chitonów, podobnie jak innej fauny, wśród której istotne znaczenie środowiskowe mają aberantne wąsonogi z rodzaju *Creusia* Leach (*vide* Bałuk & Radwański 1967) oraz dwuskorupowe ślimaki z rodzaju *Berthelinia* Crosse (*vide* Bałuk & Jakubowski 1968), dowodzi, że głębokość zatoki wynosiła wtedy zaledwie kilka metrów, a temperatura wody mogła dochodzić do 25—28°C (por. także Radwański 1969, 1970).

W pracy zwrócono uwagę, że szereg gatunków chitonów mioceńskich reprezentuje bez wątpienia przodków gatunków żyjących współcześnie w akwenie Morza Śródziemnego będącego kontynuacją mioceńskich mórz Europy. Liczba gatunków, które żyły w morzach mioceńskich, jest jednak znacznie większa. Zubożenie fauny chitonów akwenu Morza Śródziemnego wywołane zostało, zdaniem autora, ochłodzeniem wód tego obszaru, które zaznaczyło się już u schyłku pliocenu.

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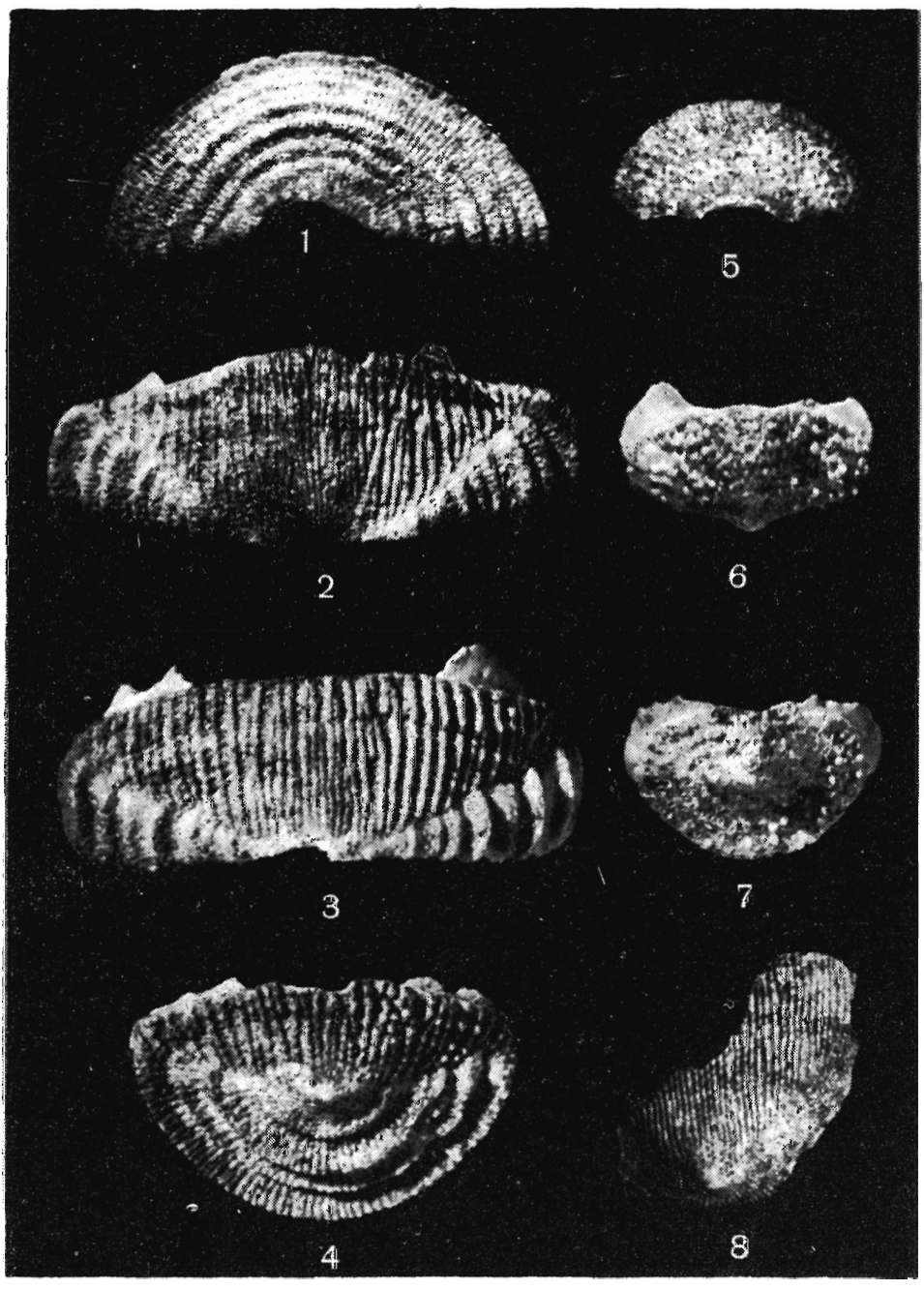
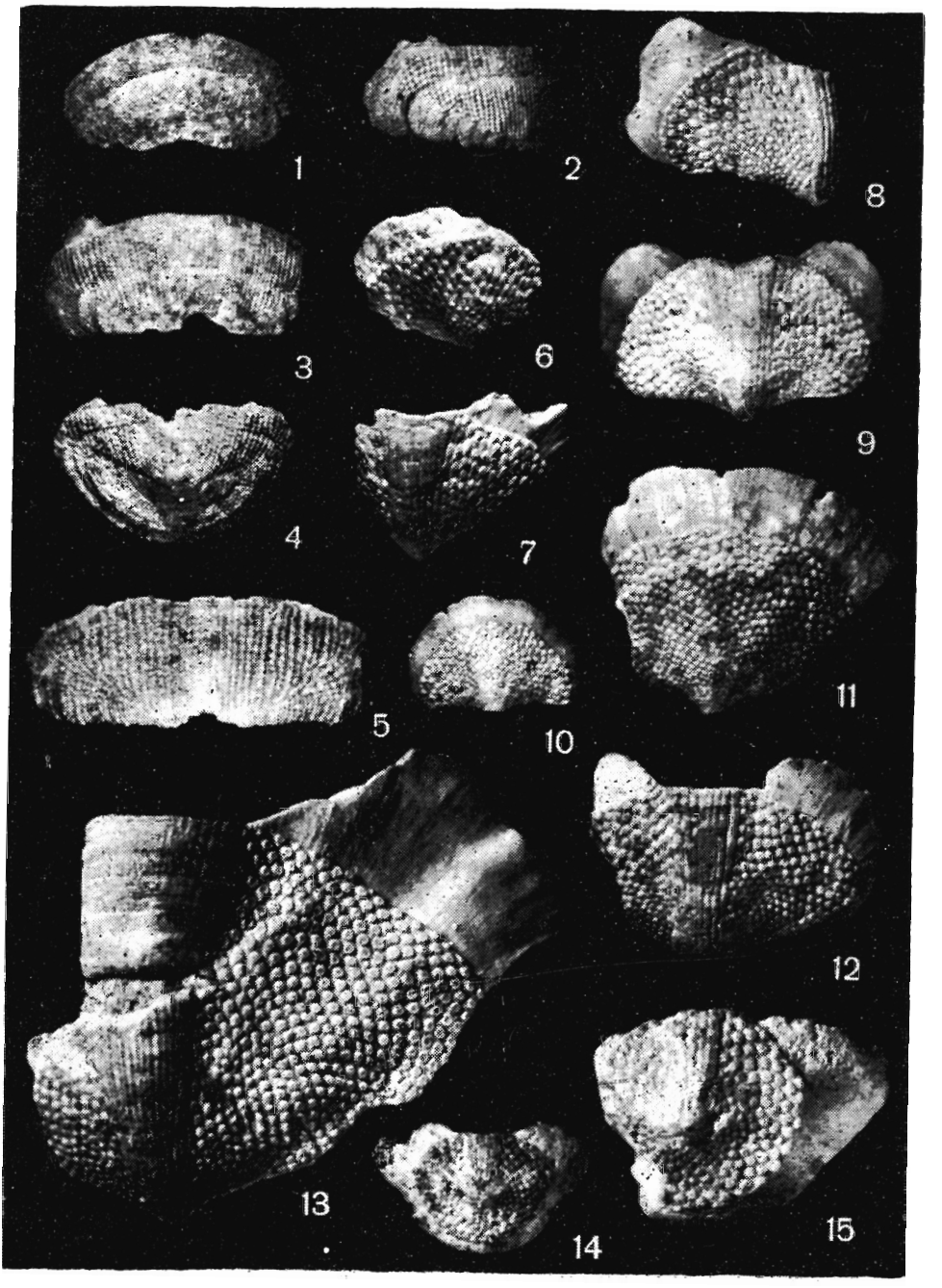


1-4 — *Lepidopleurus decoratus* (Reuss); *1* head valve, *2—3* intermediate valves, *4* tail valve.
5-7 — *Hanleya? multigranosa* (Reuss); *5* head valve, *6* intermediate valve, *7* tail valve.
8 — *Lepidopleurus thielei* Sulc; tail valve.
All figures × 15; taken by L. Łuszczewska, M. Sc.



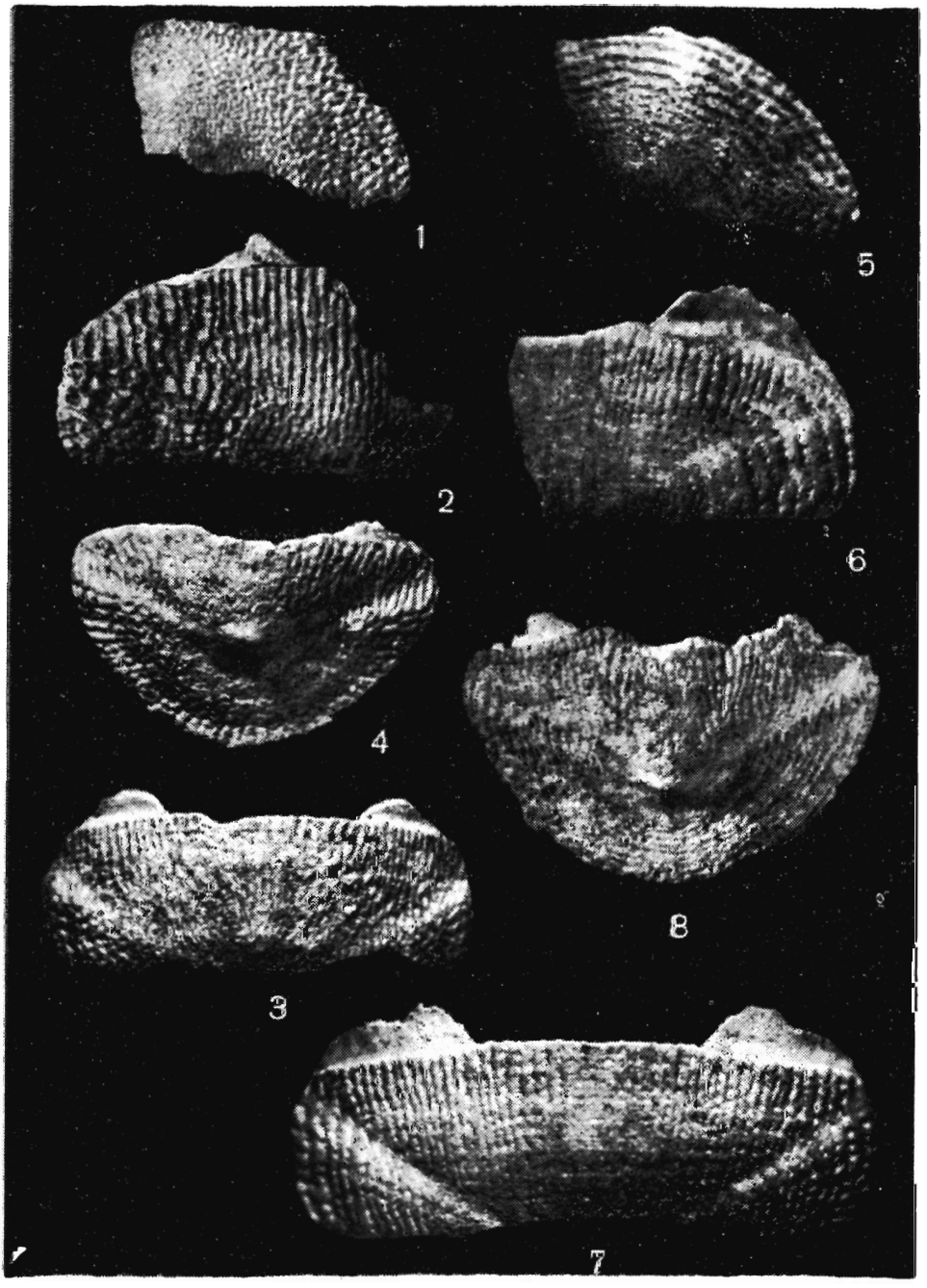
1-4 — *Lepidopleurus sulci* sp. n.; *1* head valve, *2—3* intermediate valves (*3* presents the holotype), *4* tail valve.

5 — *Lepidopleurus srameki* Šulc; intermediate valve.

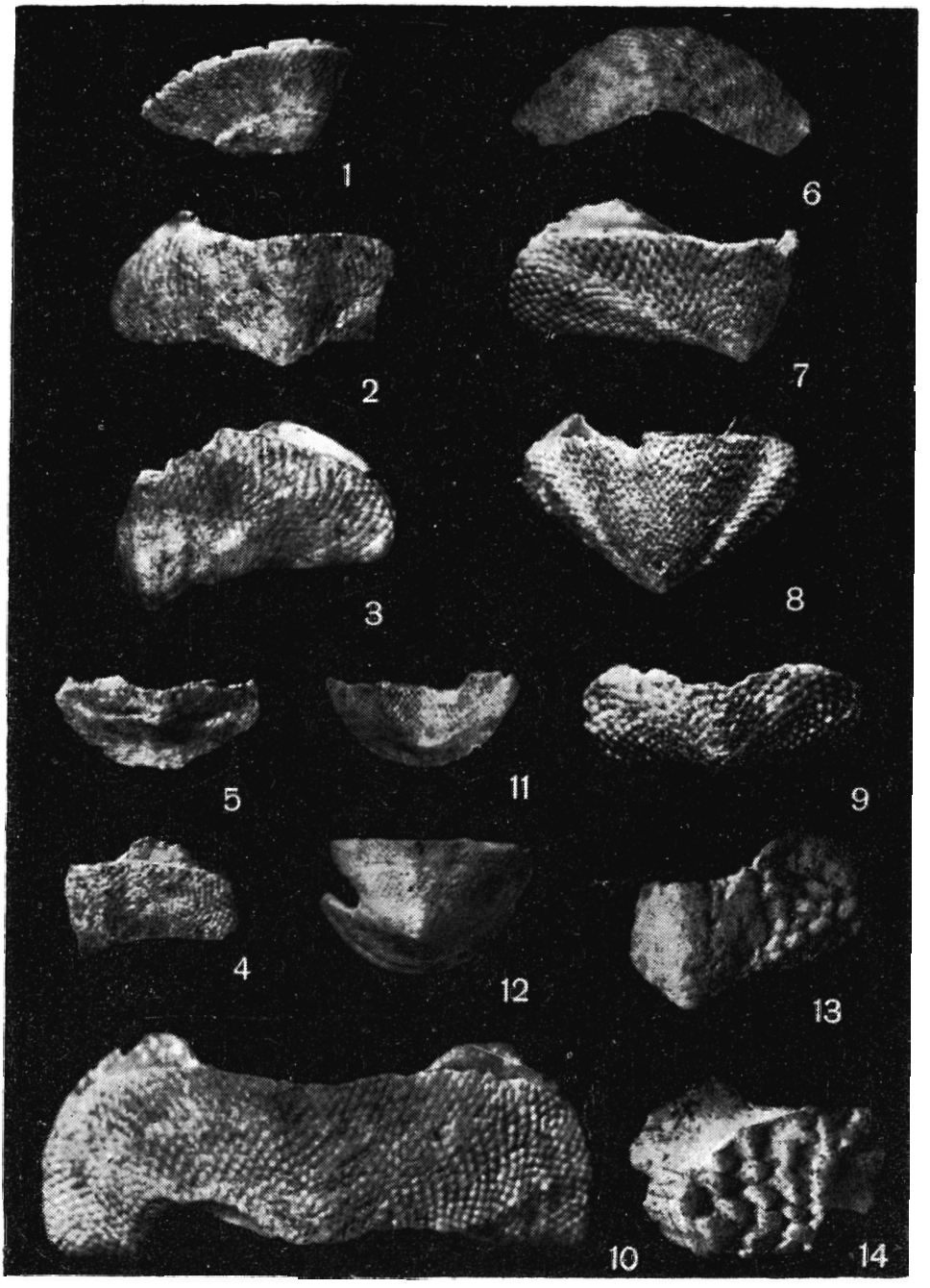
6-9 — *Acanthochitona lacrimulifera* sp. n.; *6* head valve, *7—9* intermediate valves (*9* presents the holotype).

10-15 — *Acanthochitona faluniensis* (Rochebrune); *10—11* head valves, *12—13* intermediate valves, *14—15* tail valves.

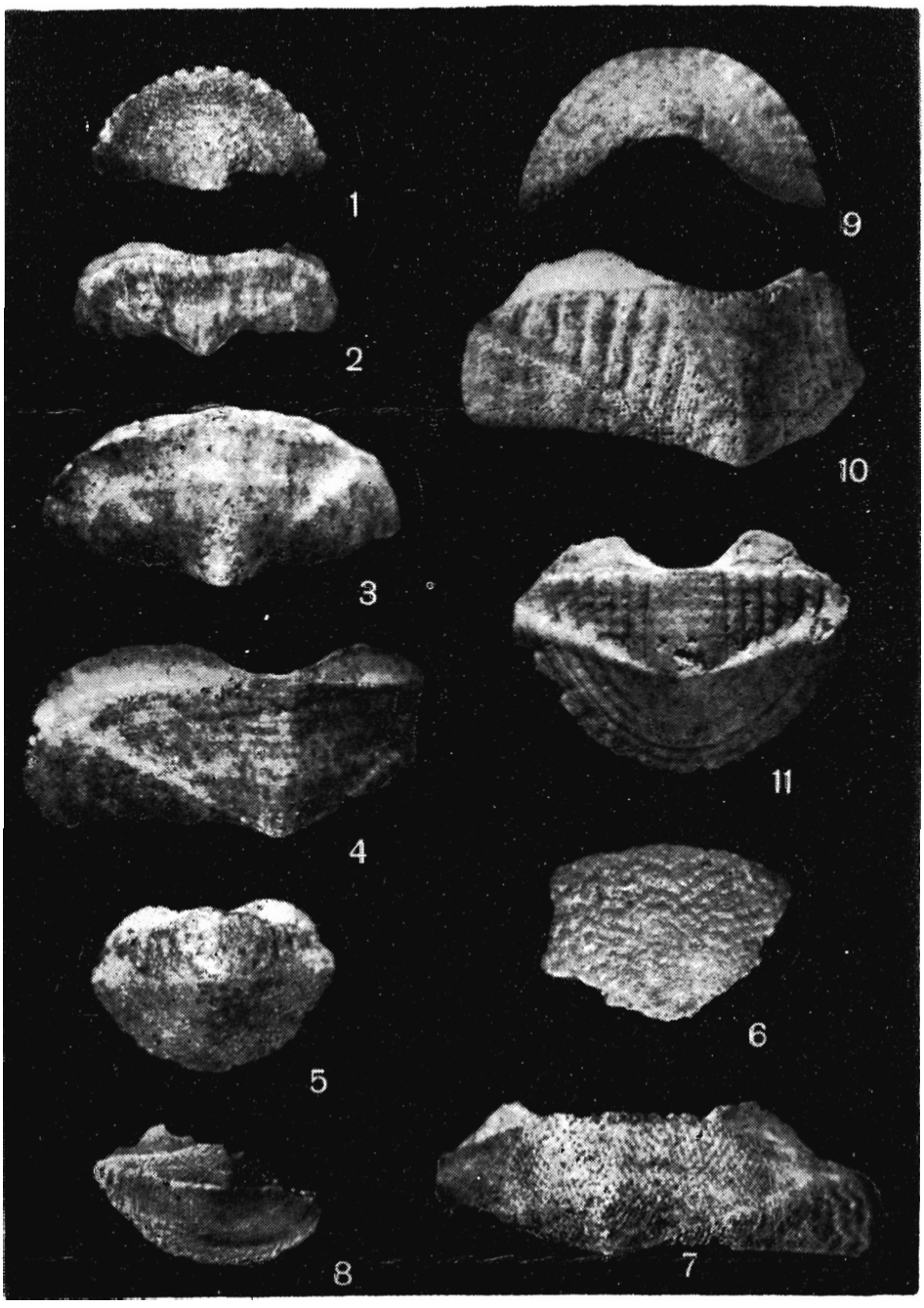
All figures × 15; taken by L. Łuszczewska, M. Sc.



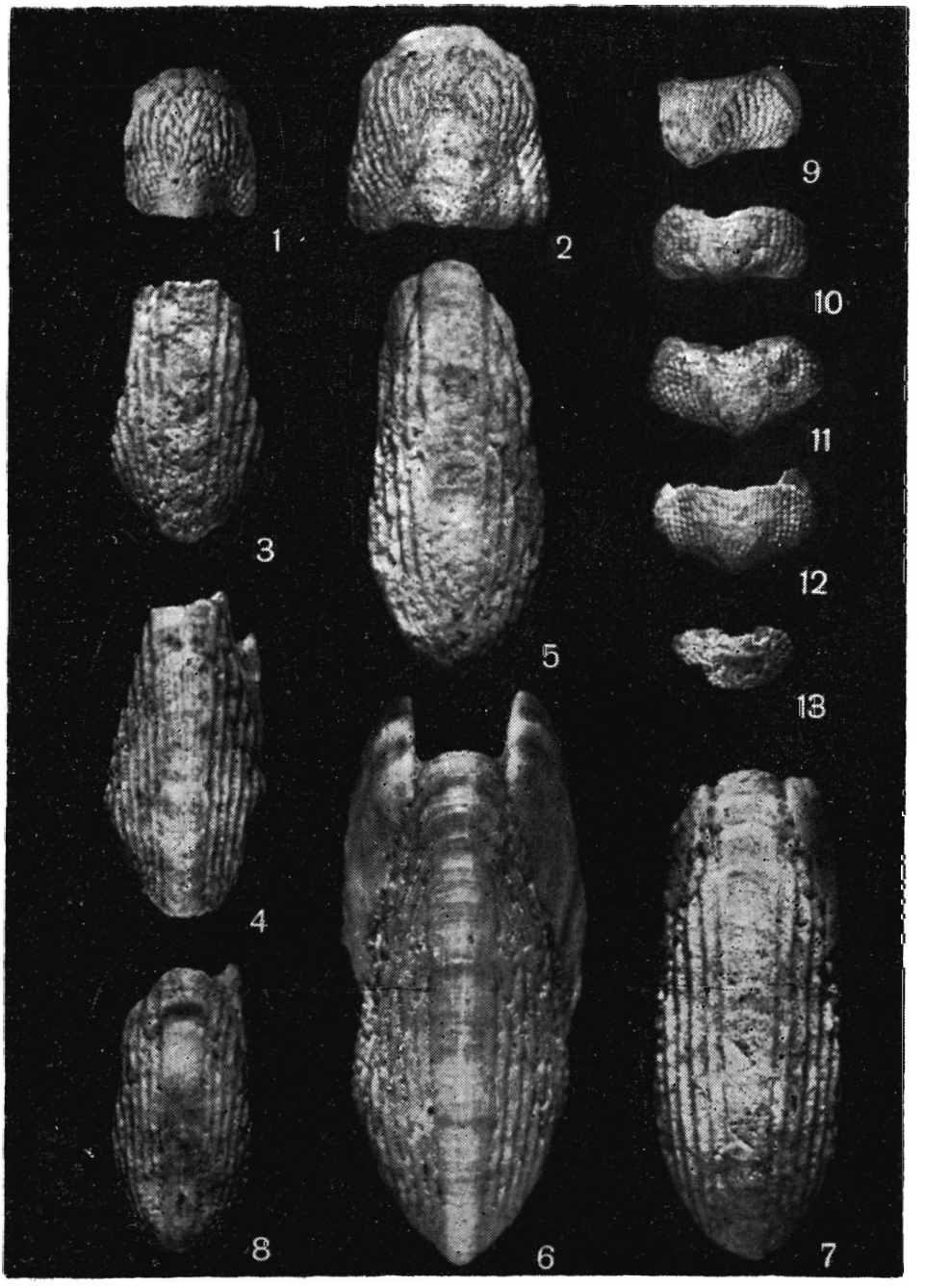
1-4 — *Ischnochiton korytnicensis* sp. n.; *1* head valve, *2—3* intermediate valves (*2* presents the holotype), *4* tail valve.
5-8 — *Ischnochiton rudolticensis* Sulc; *5* head valve, *6—7* intermediate valves, *8* tail valve. All figures × 15; taken by L. Łuszczewska, M. Sc.



1-5 — *Lepidochitona subgranosa* sp. n.; *1* head valve, *2—4* intermediate valves, *5* tail valve (holotype).
6-12 — *Lepidochitona lepida* (Reuss); *6* head valve, *7—10* intermediate valves, *11—12* tail valves.
13-14 — *Craspedochiton schafferi* (Sulc); intermediate valves.
All figures × 15; taken by L. Łuszczewska, M. Sc.



1–5 — *Callochiton rariplicatus* (Reuss); *1* head valve, *2—4* intermediate valves, *5* tail valve.
6–8 — *Callochiton zigzag* Sulc; *6* head valve, *7* intermediate valve, *8* tail valve.
9–11 — *Chiton denudatus* Reuss; *9* head valve, *10* intermediate valve, *11* tail valve.
All figures × 15; taken by L. Łuszczewska, M. Sc.



1-8 — *Cryptoplax weinlandi* Sulc; *1—2* head valves, *3—7* intermediate valves, *8* tail valve.
9-13 — *Craspedochiton minutulus* sp. n.; *9—12* intermediate valves (*9* presents the holotype), *13* tail valve.

All figures × 15; taken by L. Łuszczewska, M. Sc.