

KRZYSZTOF BIRKENMAJER & RYSZARD MYCZYŃSKI

## Middle Jurassic deposits and fauna of the Magura Succession, near Szlachtowa, Pieniny Klippen Belt (Carpathians)

**ABSTRACT:** Based on new finds of pelecypods and ammonites, a Middle Jurassic age of controversial deposits in the vicinity of Szlachtowa, Pieniny Klippen Belt (Polish Carpathians) has been established. These deposits, recently distinguished as the older Szlachtowa Formation and the younger Opaleniec Formation, represent the oldest lithostratigraphic units of the Magura Succession in Poland.

### INTRODUCTION

Mesozoic black flysch deposits (Szlachtowa Formation, previously "flysch Aalenian" or "Sztolnia beds") occur along the northern margin of the Pieniny Klippen Belt in Poland, belonging mainly to the Magura Succession. Microfaunal analysis indicated the presence of Jurassic foraminifers and ostracodes (Birkenmajer & Pazdro, 1968; Błaszyk, 1968). Cretaceous foraminifers reported by Sikora (1962a, b) were found only as contamination at the surface of rock fragments, but not inside the rock. Blaicher & Sikora (1969) and Sikora (1971a, b) expressed an opinion that the Jurassic microfauna described by Pazdro (*in* Birkenmajer & Pazdro, 1968) and Błaszyk (1968) occurs as secondary deposit in the Hauterivian-Cenomanian. Cretaceous age of the black flysch in question has also been accepted by Książkiewicz (1972, Figs 36—37).

Taking into account the above controversy, the present authors undertook in the years 1972—1974 a detailed search for macrofauna in the Sztolnia creek. As a result, numerous shells of *Bositra buchi* and less frequent Jurassic ammonites were found, both in the black flysch (Szlachtowa Formation) and in shaly rocks younger than the flysch

(Opaleniec Formation). The mode of occurrence of this fauna excludes the possibility of a secondary deposit. The Jurassic ammonites and bivalves described in the present paper have been determined by the junior author (R. Myczyński).

#### OCCURRENCE OF MIDDLE JURASSIC FAUNA IN THE SZTOLNIA CREEK

Two Middle Jurassic lithostratigraphic units of formation rank have been distinguished in the Magura Succession of the Sztolnia creek (Fig. 1): a lower Szlachtowa Formation and a higher Opaleniec Formation (Birkenmajer, 1977).

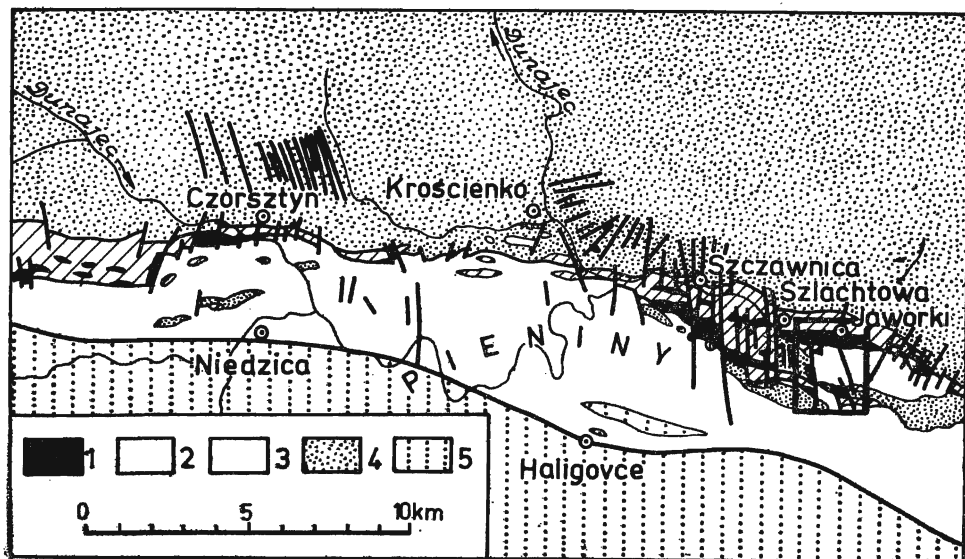


Fig. 1. Position of the area of the Sztolnia creek (rectangled) in the eastern part of the Pieniny Klippen Belt of Poland

1 Jurassic and Lower Neocomian of the Magura Succession; 2 Upper Neocomian — Senonian of the Magura Succession and the Senonian mantle of the Klippen Belt; 3 Jurassic and Cretaceous of the Klippen Successions; 4 Palaeogene of the Magura Succession and of the Klippen Belt mantle; 5 Palaeogene of the Podhale succession (also in the Klippen Belt — mantle)

Fresh-water Neogene deposits and andesite intrusions are omitted: Heavy lines denote major post-Palaeogene dislocations

The Szlachtowa Formation consists of flysch deposits ("flysch Aalenian" — Birkenmajer & Pazdro, 1968; Birkenmajer, 1970; "Sztolnia beds" — Sikora, 1962b, 1971b; Blaicher & Sikora, 1969), predominantly black or dark-grey shale with thin intercalations of strongly micaceous, fine-grained sandstone. Thin, graded crinoid limestone inter-

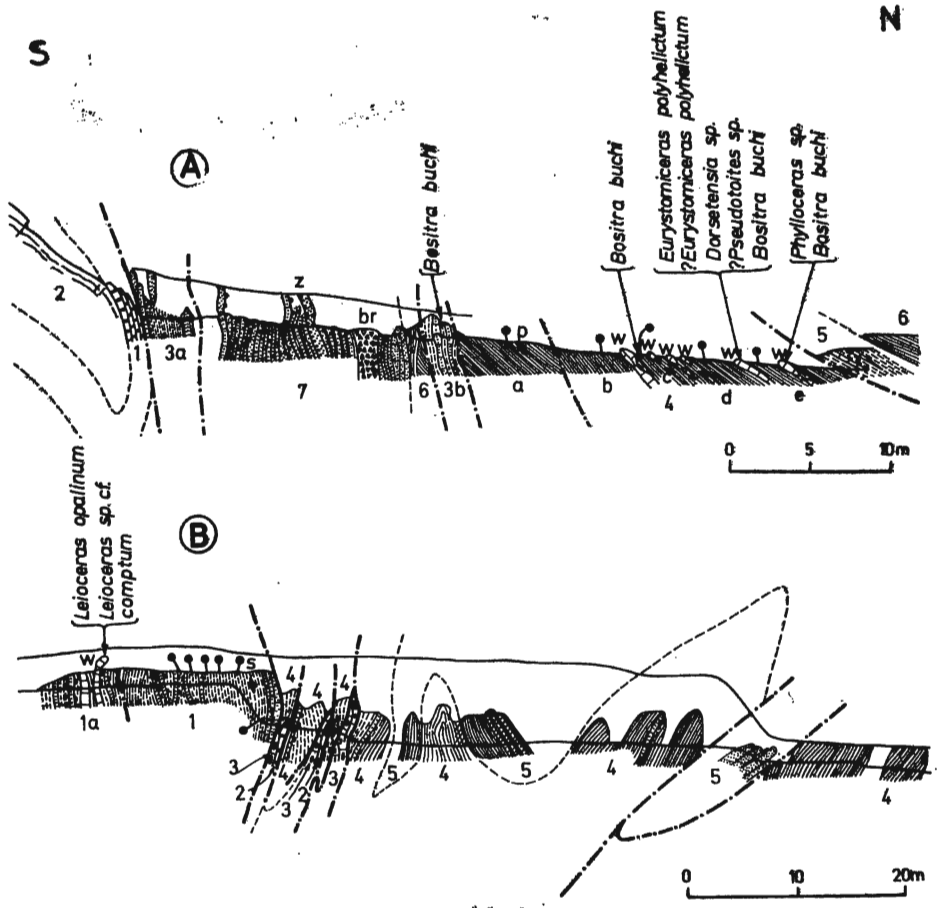


Fig. 2

A — Geological profile in the upper course of the Sztolnia creek, below big waterfall, and location of fauna

BRANISKO SUCCESSION: 1 Czajakowa Radiolarite Formation (Oxfordian); 2 Czorsztyń Limestone Formation (Kimmeridgian)

MAGURA SUCCESSION: 3a, b Szlachtowa Formation (Upper Toarcian? — Lower Aalenian); 4a—e Opaleniec Formation (Bajocian); 5 Hulina Formation (Albian-Cenomanian); 6 Mallnowa Shale Formation (Cenomanian-Campanian); 7 Jarmuta Formation (Maastrichtian); p pyrite concretions; w concretions and intercalations of spotty limestone and sideritic limestone (resp. ferruginous dolomite); br sedimentary braccia; z conglomerate.

Position of sole markings shown in sandstone beds; dashed-pointed line denotes tectonic contact; thick dots denote samples for microfauna (see Pazdro, in preparation); formal lithostratigraphic names after Birkenmajer (1977)

B — Geological profile in the middle course of the Sztolnia creek, near small waterfall, and position of fauna

MAGURA SUCCESSION: 1, 1a Szlachtowa Formation (?Upper Toarcian-Lower Aalenian); 2 Czajakowa Radolarite Formation (Oxfordian); 3 Pieniny Limestone Formation (Tithonian-Barremian); 4 Mallnowa Shale Formation (Cenomanian-Campanian); 5 Jarmuta Formation (Maastrichtian)

w intercalations of arenaceous spotty limestone; s siderite concretion

For the remaining symbols — see Text-fig. 2A; Formal lithostratigraphic names after Birkenmajer (1977)

calations passing upward into strongly micaceous sandstone, appear in the lowest part of the formation, near the outlet of the Sztolnia creek to the Grajcarek stream.

In the middle course of the Sztolnia creek, near a small waterfall (type locality of Sikora's "Sztolnia beds" — see Birkenmajer & Pazdro, 1968, Fig. 4B: 1), an upper part of the Szlachtowa Formation crops out. New exposures in the highest (southern) part of the waterfall section (Fig. 2B) show two spotty, grey or bluish pyritic limestone intercalations 20–30 cm thick within black to black-blue shale with blue-grey, fine-grained, strongly micaceous calcareous sandstone intercalations 15–25 cm thick. Flute casts (azimuth 290–300°) have been found on the soles of sandstone intercalations facing north. The limestone intercalations are often arenaceous and micaceous at the base. Calcified sponge spicules and cross-sections of thin-shelled bivalves resembling those of the *Bositra* microfacies are recognisable in thin plates. Silicification often appears.

The lower limestone intercalation (just below Quaternary terrace cover) yielded *Leioceras opalinum* (Reinecke) — No 44/1b (Fig. 5e) and *L. cf. comptum* (Reinecke) — No 44/1a (Fig. 5f; Pl. 1, Fig. 4). This fauna indicates a Lower Aalenian age of the uppermost part of the Szlachtowa Formation.

The second locality with fauna is in the upper course of the Sztolnia creek, just below big waterfall (see Birkenmajer & Pazdro, 1968, Fig. 4A: 3b; and Text-fig. 2A). A black shale intercalation between two layers of strongly micaceous sandstone yielded numerous *Bositra buchi* (Roemer) — Nos 46/1 (Fig. 7b; Pl. 2, Fig. 5), 46/2, 46/3 etc. The shells occurred in a zone barely 1–4 cm thick.

A large loose block of grey, spotty limestone with *Leioceras opalinum* (Reinecke) — Nos LB-1a, 1b, 2, 3 (Pl. 1, Figs 1, 2, 6; Pl. 2, Fig. 1) was found at the outlet of a small creek, tributary to the Sztolnia creek, about 100 m below the section shown in Figure 2B. The block possibly derived from a limestone intercalation in the upper part of the Szlachtowa Formation, concealed under weathering clay.

The Opaleniec Formation consists mainly of shale, lithologically very similar to the Lower Cretaceous Wronine Formation ("Wronine beds" of Birkenmajer, in Birkenmajer & Pazdro, 1968, Fig. 4A: 4a–e). The microfauna investigated by O. Pazdro from samples taken in 1972, indicates a Jurassic age of the sediment. The marl and limestone intercalations in the shales yielded comparatively well preserved pelecypods and poorly preserved ammonites of Middle Jurassic character.

*Layer 4c:* numerous *Bositra buchi* (Roemer) — Nos ZNG-1 (Fig. 6a), ZNG-2 (Fig. 6b), 45/6 (Pl. 2, Fig. 4). Lithology: dark-grey to black shaly marl or shale (3 cm) at the top of pyritic-sideritic limestone intercalation with black spots and fucoids;

*Layer 4d/e:* *Eurystomiceras polyhelictum* (Böckh) — No 45/3 (Fig. 5b; Pl. 1, Fig. 5); ?*Eurystomiceras polyhelictum* (Böckh) — No 45/1b (Fig. 5d); *Dorsetensia* sp. — No 45/1a (Fig. 5a); ?*Pseudotoites* sp. — No 45/5 (Fig. 5c); *Bositra buchi* (Roemer) — Nos 45/7 (Pl. 2, Fig. 7), 45/9, 45/8 (Pl. 2, Fig. 6). Lithology: grey sideritic limestone passing into grey spotty limestone, slightly siliceous (10–30 cm); yellowish or brownish if weathered;

*Layer 4e: Phylloceras* sp. — No 45/4; *Bositra buchi* (Roemer). Lithology: grey, bluish, grey-greenish, spotty limestone concretions (10—15 cm thick), slightly sideritic or siliceous, with pyrite concretions, aggregates and veinlets. The rock weathers to yellowish or brownish.

#### AGE OF THE SZLACHTOWA FORMATION

The presence of numerous complete or nearly complete, delicate shells of pelagic pelecypods *Bositra buchi* (Roemer) in the shales within the flysch beds of the Szlachtowa Formation (already reported by Birkenmajer & Pazdro, 1963a, and Birkenmajer, 1963, 1965, 1973 etc. from other localities in the Pieniny Klippen Belt of Poland), excludes the possibility of a secondary deposit. The *Bositra* shells are a characteristic element for Middle Jurassic pelagic sediments of the Pieniny Klippen Belt (mainly Harcygrund Shale Formation — see Myczyński, 1973; Birkenmajer, 1977). The lack of *Bositra* shells in coarser-grained sediments (sandstone, crinoid limestone), as well as the lack of fragments of Jurassic rocks as secondary deposit in the Szlachtowa Formation, confirm the autochthonous character of the shells in the shales.

The stratigraphic range of *Bositra buchi* (Roemer), viz. Upper Toarcian — Oxfordian, determines the age of the Szlachtowa Formation as Jurassic. Further information on the age of the formation is derived from the following data:

(1) *Bositra buchi* (Roemer) appears already at the base of the Szlachtowa Formation at Czorsztyn (Birkenmajer & Pazdro, 1963, p. 419, Fig. 1: 1—5) and at Jarmuta (No KB-4c — Fig. 7a; see Birkenmajer & Pazdro, 1963a, p. 428, Fig. 5: 4c);

(2) *Cornaptychus* gr. *A lythensis* (Quenstedt) Trauth var. *aff. sigmopleura* Trauth, and *Cornaptychus* sp. gr. A(?), determined by S. M. Gąsiorowski, appear at the base of the Szlachtowa Formation at Czorsztyn (Birkenmajer & Pazdro, 1963, p. 419; Birkenmajer, 1965, p. 343). These aptychi indicate a boundary of the Lower and Middle Jurassic;

(3) Occurrence of spotty limestone intercalations resembling "Opalinus marls" (= Krempachy Marl Formation, Domerian — Aalenian, Birkenmajer, 1977) at the top of the Szlachtowa Formation, with *Leioceras opalinum* (Reinecke) and *L. cf. comptum* (Reinecke), indicates that the upper boundary of the formation falls within the *Leioceras opalinum* Zone of the Lower Aalenian.

#### AGE OF THE OPALENIEC FORMATION

The fauna determined from the Opaleniec Formation at its type locality in Sztolnia creek, and particularly *Eurystomiceras polyhelictum* (Böckh), *Dorsetensia* sp., *?Pseudotoites* sp. and *Bositra buchi* (Roemer),

indicate a Bajocian age of the formation. The formation seems to be an age equivalent to the Podzamcze Limestone Formation (Birkenmajer, 1977), the Middle Bajocian age of which has recently been confirmed by Myczyński (1973). A Middle Jurassic age of the formation is also suggested by its microfauna (Pazdro, *in preparation*).

RELATION OF THE OPALENIEC FORMATION  
TO THE "SPRZYCNE BEDS"

In the middle course of the Sztolnia creek, Sikora (1971b, pp. 222—223, Fig. 34) distinguished above the "Sztolnia beds" (*i.e.*, Szlachtowa Formation *sensu* Birkenmajer, 1977) a 4.5 m thick complex of "grey-green calcareous Sprzycne beds (Cenomanian)", succeeded by the "Cenomanian correlation horizon" (2 m: green radiolarian shale, radiolarite, black, bituminous "manganese" shale). The microfauna determined

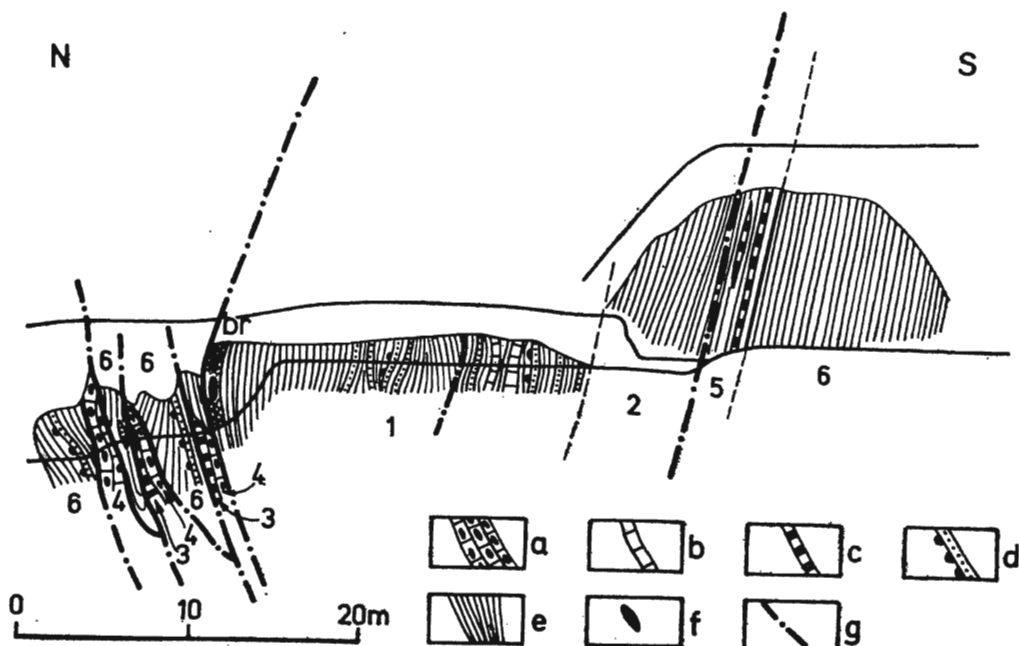


Fig. 3. Tectonic interpretation of a section in the middle course of the Sztolnia creek, nearby small waterfall (*cf.* Text-fig. 2B)

MAGURA SUCCESSION: 1 Szlachtowa Formation (?Upper Toarcian-Lower Aalenian); 2 „Sprzycne beds” *sensu* Sikora (= probably lower part of the Opaleniec Formation; Bajocian); 3 Czajakowa Radiolarite Formation (Oxfordian); 4 Pieniny Limestone Formation (Tithonian-Barremian); 5 Hulina Formation (Albian-Cenomanian); 6 Malinowa Shale Formation (Cenomanian-Campanian)

a cherty limestone; b spotty arenaceous limestone; c radiolarite and radiolarian shale; d sandstone; e shale; f siderite lense; g tectonic contacts; br tectonic breccia.

Formal lithostratigraphic names after Birkenmajer (1977)

first by J. Bläicher as Cretaceous, according to revision by Pazdro (in preparation), is very similar to that of the Opaleniec Formation, but much poorer. No typical Cretaceous foraminifers were found, and the ostracodes resembled those of the Opaleniec Formation.

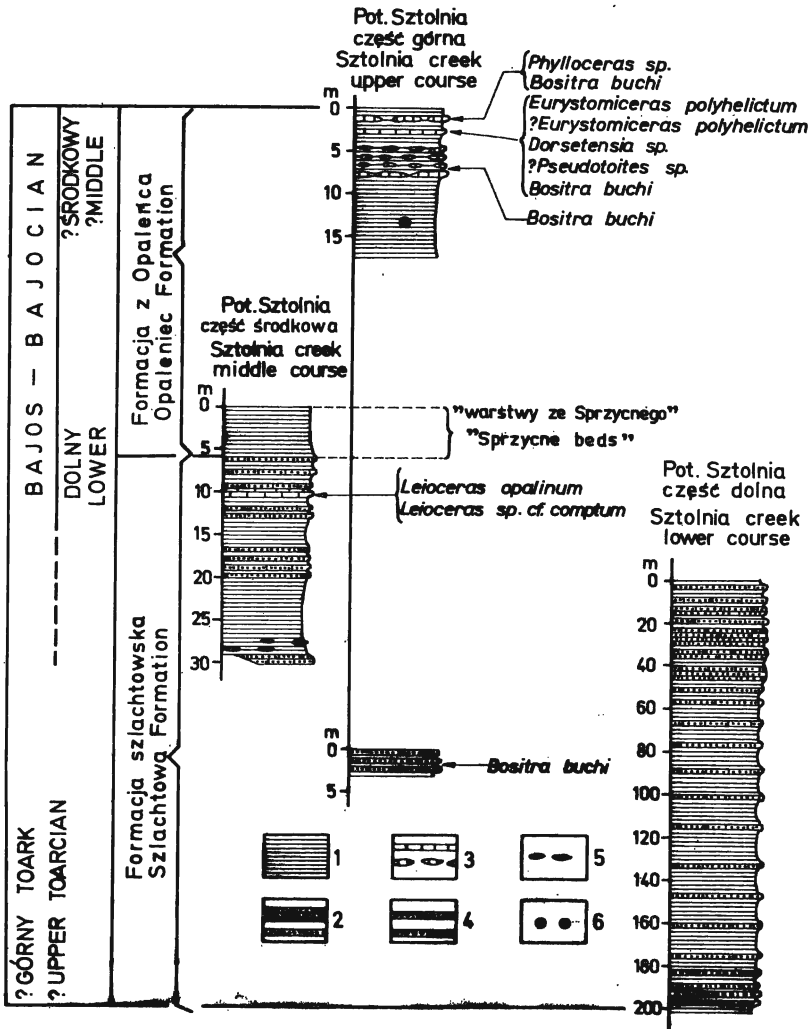


Fig. 4. Synthetic lithostratigraphic column of the Middle Jurassic of the Magura Succession, Sztolnia creek (Polish names for location, lithology, and stratigraphy are also used)

1 shale, marly shale; 2 sandstone; 3 sideritic limestone, arenaceous limestone and ferruginous dolomite; 4 crinoidal limestone; 5 sphaeroiderite; 6 pyrite concretions.

The "Sprzyczne beds" discussed lithologically resemble the lower part of the Opaleniec Formation at its type locality (upper course of the Sztolnia creek). According to the present data (Fig. 4), they represent the base of the Opaleniec Formation at its transition to the under-

lying Szlachtowa Formation. Tectonic interpretation of the geological relationships shows (Fig. 3) that there is no indication of an anticlinal structure as that suggested by Sikora (1971b, Fig. 34).

#### DESCRIPTION OF FAUNA

The fauna collected in the Sztolnia creek, though often poorly preserved, is stratigraphically significant. The ammonites were classified according to Arkell's (1957) taxonomy, the pelecypods according to Cox's (1969) taxonomy. All dimensions are given in mm.

Abbreviations used for ammonites: *D* — specimen diameter; *H* — height of the last whorl; *O* — diameter of umbilicus. For pelecypods: *H* — height of the valve; *L* — length of the valve;  $\alpha$  — apical angle.

#### AMMONITES

Family **Phylloceratidae** Zittel, 1884  
Genus **PHYLLOCERAS** Suess, 1865  
*Phylloceras* sp.

*Material*: — One fragment of whorl (No 45/4), *H* = ca 25.

*Remarks*. — Fragmentary preservation of the specimen precludes its specific determination. The presence of fine fasciculate ribs may suggest attribution to *Phylloceras kudernatschi* Hauer, 1854 (*vide* Besnosov, 1958, p. 62, Pl. 12, Fig. 1a, b; Myczyński, 1973, p. 58, Pl. 1, Fig. 2; Pl. 2, Fig. 2).

*Occurrence*. — Blue-grey, faintly spotty limestone with pyritic concretions, forming an intercalation in grey-green fucoidal marly shale of the Opaleniec Formation, upper part of the Sztolnia creek (Fig. 2A: layer 4e).

Family **Lytoceratidae** Neumayr, 1875  
Genus **EURYSTOMICERAS** Besnosov, 1958  
*Eurystomiceras polyhelictum* (Böckh, 1881)  
(Fig. 5b and Pl. 1, Fig. 5)

1937. *Lytoceras polyhelictum* Böckh; Horwitz, p. 186, Pl. 9, Fig. 3.

1958. *Eurystomiceras polyhelictum* (Böckh); Besnosov, p. 101, Pl. 33, Figs 2a, b, 3a, b; Text-Figs 38, 39.

1973. *Eurystomiceras polyhelictum* (Böckh); Myczyński, p. 64, Pl. 3, Fig. 4.

*Material*: One fragment of whorl (No 45/3), *H* = 7.2.

*Remarks*. — The presence of a deep constriction of the whorl rimmed from outside by a distinct swell, characteristic for Böckh's species, allows specific determination despite fragmentary preservation of the specimen.

*Occurrence*. — Grey, slightly spotty limestone intercalation within the Opaleniec Formation, upper course of the Sztolnia creek (Fig. 2A: layer 4d/e).

*Stratigraphic range*. — The species *Eurystomiceras polyhelictum* (Böckh) occurs in the Bajocian of Transcaucasus and Dagestan (Besnosov, 1958). In the Pieniny Klippen Belt it occurs in the *Stephanoceras humphriesianum* Zone of the Middle Bajocian (Horwitz, 1937; Myczyński, 1973).



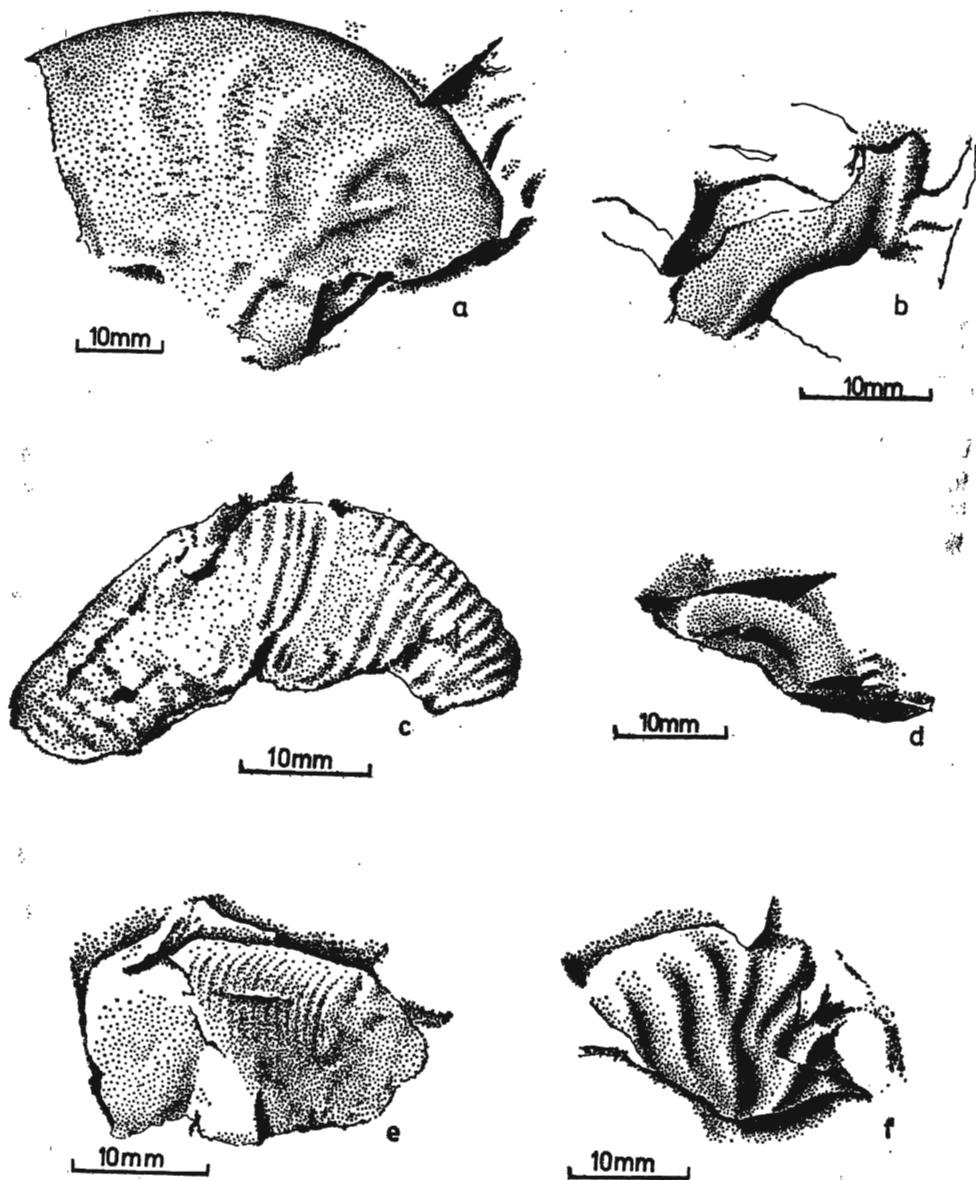


Fig. 5. Middle Jurassic ammonites of the Magura Succession, Sztolnia creek (a—d from the Opaleniec Formation; e—f from the Szlachtowa Formation; cf. Text-fig. 2, and Pls 1—2)

a *Dorsetensia* sp., No 45/1a; b *Eurystomiceras polyhelictum* (Böckh), No 45/3; c *Pseudototes* sp., No 45/5; d *Eurystomiceras polyhelictum* (Böckh), No 45/1b; e *Letoceras opalinum* (Reinecke), No 44/1b; f *Letoceras* cf. *comptum* (Reinecke), No 44/1a

*?Eurystomiceras polyhelictum* (Böckh)  
(Fig. 5d)

Material: One fragment of whorl (No 45/1b),  $H. = 4.5$ .

*Remarks.* — Two poorly visible constrictions rimmed by small swellings suggest attribution of the specimen to *Eurystomiceras polyhelictum* (Böckh).

*Occurrence.* — A lense of grey, slightly spotty limestone of the Opaleniec Formation, upper course of the Sztolnia creek (Fig. 2A: layer 4d/e), together with *Dorsetensia* sp. (No 45/1a).

Family **Graphoceratidae** Buckman, 1905

Genus *LEIOCERAS* Hyatt, 1867

*Leioceras opalinum* (Reinecke, 1818)

(Fig. 5e; Pl. 1, Figs 1, 2, 6; Pl. 2, Fig. 1)

1830. *Ammonites primordialis* Zieten; Zieten, p. 5, Pl. 4, Fig. 4.

1923. *Leioceras opalinum* (Reinecke); Siemiradzki, p. 21, Pl. 3, Fig. 16.

1961. *Leioceras opalinum* (Reinecke); Kriffholz, p. 78, Pl. 5, Figs 1—2.

1963. *Leioceras opalinum* (Reinecke); Rieber, p. 31, Pl. 8, Figs 11—13; Text-Figs 13q, 16s, t.

1973. *Leioceras opalinum* (Reinecke); Myczyński, p. 66, Pl. 3, Fig. 4; Pl. 4, Figs 1, 3, 4.

*Material:* — Five incomplete specimens (Nos LB-1a, LB-1b, LB-2, LB-3, 44/1b).

*Dimensions:* — LB-1a, H = ca 17.0; LB-1b, H = ca 14.0; LB-2, H = ca 14.0; LB-3, D = ca 43.0, H = 24.0, O = 7.0; 44/1b, H = ca 18.0.

*Remarks.* — Characteristic ornamentation of the specimens, consisting of thin, sinusoidal ribs converging near umbilicus, is typical of *Leioceras opalinum*.

*Occurrence.* — Specimens Nos LB-1a, LB-1b, LB-2, LB-3 were found in a loose block of spotty limestone with fine mica, about 100 m below the exposures of the Opaleniec Formation at Sztolnia creek (type locality). Lithologically, the limestone resembles that from intercalations in the upper part of the Szlachtowa Formation (Fig. 2B: 1a). Specimen No 44/1b was collected from grey-blue limestone intercalation with fine mica in the upper part of the Szlachtowa Formation (Fig. 2B: 1a):

*Stratigraphic range.* — The species is a zonal index of the Lower Aalenian *Leioceras opalinum* Zone.

*Leioceras* cf. *comptum* (Reinecke, 1818)

(Fig. 5f and Pl. 1, Fig. 4)

*Material:* One fragment of whorl (No 44/1a), H = ca 12.5.

*Remarks.* — Fragmentary preservation of the specimen precludes its specific determination. However, the presence of strong, wavy ribs, sometimes branching in three riblets of second order, make the specimen resemble *Leioceras comptum* (vide Rieber, 1963, p. 33, Pl. 1, Figs 1—8, 14—16; diagr. B, Kb-d; Text-Figs 13h—l, 15c, d, o—s, 16m, n, r; Fischer, 1970, p. 591, Fig. 4; Myczyński, 1963, p. 67, Pl. 4, Fig. 6).

*Occurrence.* — Spotty, blue-grey limestone of the upper part of the Szlachtowa Formation, middle course of the Sztolnia creek (Fig. 2B: 1a), together with *Leioceras opalinum* (Reinecke) No 44/1b.

*Stratigraphic range.* — The species *Leioceras comptum* (Reinecke) is known from the Aalenian (Rieber, 1963).

Family **Sonninidae** Buckman, 1892

Genus *DORSETENSIA*, Buckman, 1892

*Dorsetensia* sp.

(Fig. 5a and Pl. 2, Fig. 2)

*Material:* One fragment of whorl (No 45/1a), H = ca 37.0.

**Remarks.** — The flattening which is characteristic of the genus *Dorsetensia* Buckman, 1892, and the presence of strong, nearly straight ribs, makes the specimen resembling the Buckman's genus (vide Huf, 1968, p. 86). Fragmentary preservation of the specimen precludes its specific determination.

**Occurrence.** — Intercalation of grey, slightly spotty limestone of the Opaleniec Formation in the upper course of the Sztolnia creek, together with *Eurystomiceras polyhelictum* (Böckh) No 45/1b (Fig. 2A: layer 4d/e).

**Stratigraphic range.** — The genus *Dorsetensia* is characteristic of the Otoites sauzei and Stephanoceras humphriesianum zones of the Middle Bajocian (Huf, 1968).

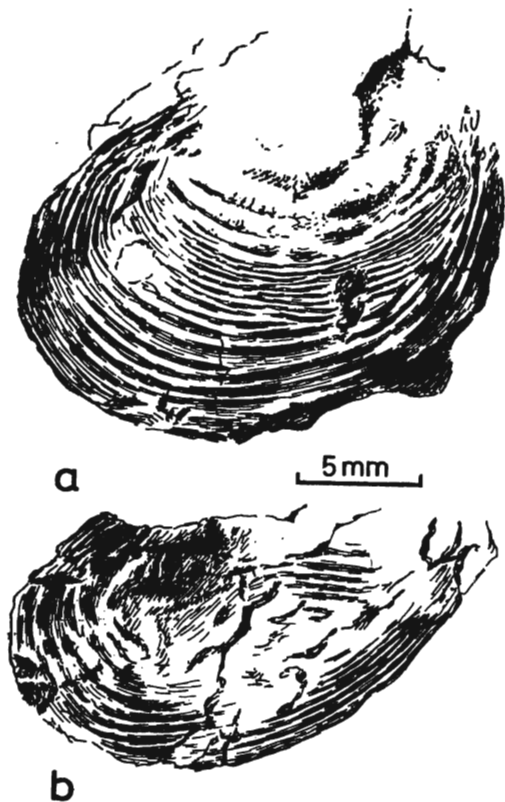


Fig. 6  
*Bositra buchi* (Roemer) from the Opaleniec Formation, Sztolnia creek (see Text-fig. 2A: layer 4c)  
a specimen No ZNG-1; b specimen No ZNG-2

#### Family Otoitidae Mascke, 1907

Genus *PSEUDOTOITES* Spath, 1939

?*Pseudotoites* sp.

(Fig. 5c and Pl. 1, Fig. 3)

**Material:** One flattened fragment of whorl with very faintly visible sculpture (No 45/5),  $H = ca\ 17.0$ .

**Remarks.** — The presence of riblets branching near the base and of thickenings at the points of branching, suggest attribution to the genus *Pseudotoites* Spath, 1930 (see Arkell, 1957, p. 289). However dense, radially arranged, faint riblets also resemble those of the genus *Emileia* Buckman, 1898, particularly *E. polymera* (d'Orbigny) — see Maubeuge (1951, Pl. 11, Fig. 1). Poor state of preservation of the specimen precludes exact determination of its systematic position.

**Occurrence.** — A layer of grey, slightly spotty limestone of the Opaleniec Formation, in the upper course of the Sztolnia creek (Fig. 2A: layer 4d/e).

**Stratigraphic range.** — The genera *Pseudotoites* and *Emileia* are known to occur in Middle Bajocian (Arkell, 1957).

#### PELECYPODS

#### Family Rhombopteridae Korobkov, 1960

#### Genus *BOSITRA* de Gregorio, 1886

#### *Bositra buchi* (Roemer, 1839)

(Figs 6—7 and Pl. 2, Figs 3—7)

1927. *Posidonomya alpina* Gras; Guillaume, p. 222, Pl. 10, Figs 4—13.

1937. *Posidonomya alpina* Gras; Horwitz, p. 177, Pl. 8, Fig. 2a, b.

1965. *Bositra buchi* (Roemer); Jefferies & Minton, p. 156, Pl. 19.

1969. *Bositra buchi* (Roemer); Newell, p. 343.

1973. *Bositra buchi* (Roemer); Myczyński, p. 102, Pl. 14, Fig. 6; Pl. 16, Fig. 3.

**Material:** Five nearly complete specimens (ZNG-1, ZNG-2, KB-4c, 45/6, 45/7) and numerous fragmentary specimens (46/1, 46/2, 46/3, 45/8, 45/9).

**Discussion.** — All specimens are consistent with descriptions and illustrations of *Bositra buchi* (Roemer) cited in synonymy. The specimen No ZNG-1 is identical with that illustrated by Jefferies & Minton (1965, Pl. 19, Figs 1, 4, 7) and with *Bositra buchi* (Roemer) collected by Myczyński (1973) from the Bajocian of the Klippen successions in Poland. The specimen No ZNG-2 is slightly more elongated than ZNG-1; its size and shape correspond to an ontogenic stage

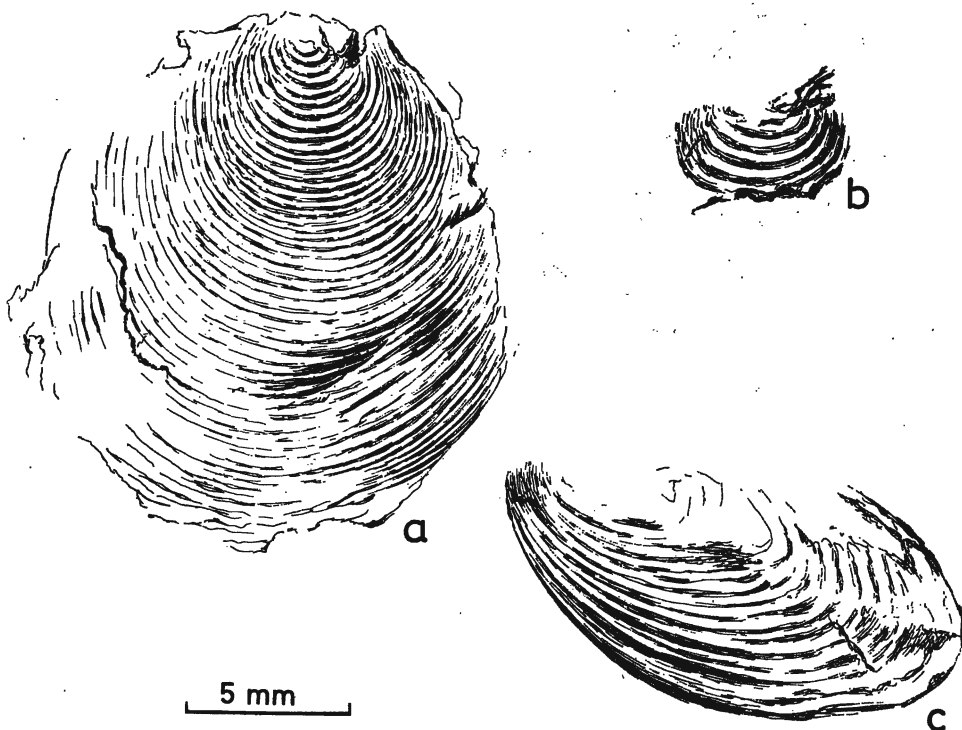


Fig. 7. *Bositra buchi* (Roemer) from the Szlachtowa Formation (a, b) and (c) from the Opaleniec Formation (cf. Text-fig. 2, and Pl. 2)  
 a specimen No KB-4c, Jarmuta; b specimen No 46/1, Sztolnia creek; c specimen No 45/6, Sztolnia creek

illustrated by Jefferies & Minton (1965, p. 170, Text-Fig. 7: 6); its ornamentation is consistent with that of Roemer's species. Ornamentation of specimens Nos ZNG-1 and ZNG-2 is also similar to ornamentation of the genus *Posidonia* Bronn, 1828 (*vide* Newell, 1969, p. 342, Fig. 5); which has, however, a different shape of hinge margin and apex. From the genus *Buchia* Rouillier, 1845, the investigated specimens differ in shape of valves, fainter apex and more delicate ornamentation.

*Occurrence.* — Specimens Nos ZNG-1 and ZNG-2 were collected from the Opaleniec Formation, upper course of the Sztolnia creek (Fig. 2A: layer 4c). Specimen KB-4c was collected by Birkenmajer from shale immediately below the "flysch Aalenian" (now: Szlachtowa Formation, Birkenmajer, 1977) at Jar-muta (*see* Birkenmajer & Pazdro, 1963, p. 428, Fig. 5: 4c) and determined as *Posidonomya alpina* (Gras). Specimens Nos 46/1, 46/2 and 46/3 were collected from shale of the Szlachtowa Formation in the upper course of the Sztolnia creek (Fig. 2A: layer 3b); Nos 45/7, 45/8 and 45/9 from slightly spotty limestone (Fig. 2A: layer 4d/e) and No 45/6 from grey-green shale of the Opaleniec Formation, upper course of the Sztolnia creek.

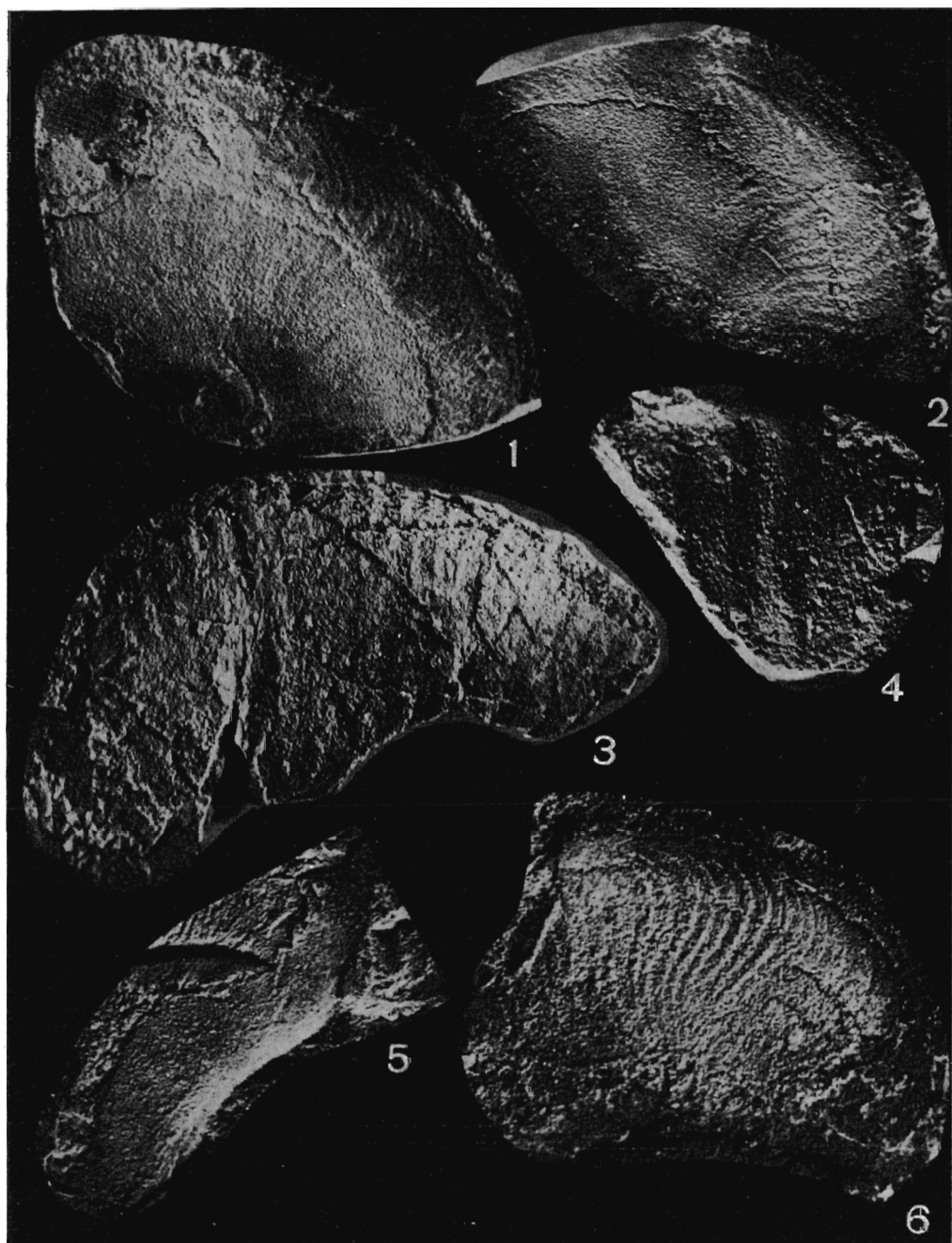
*Stratigraphic range.* — The species *Bositra buchii* (Roemer) is known from the Upper Toarcian to Oxfordian (Guillaume, 1927; Jefferies & Minton, 1965).

Polish Academy of Sciences,  
Institute of Geology,  
ul. Senacka 3, 31-002 Kraków, Poland (K. Birkenmajer)  
Al. Żwirki i Wigury 93, 02-089 Warszawa, Poland (R. Myczyński)

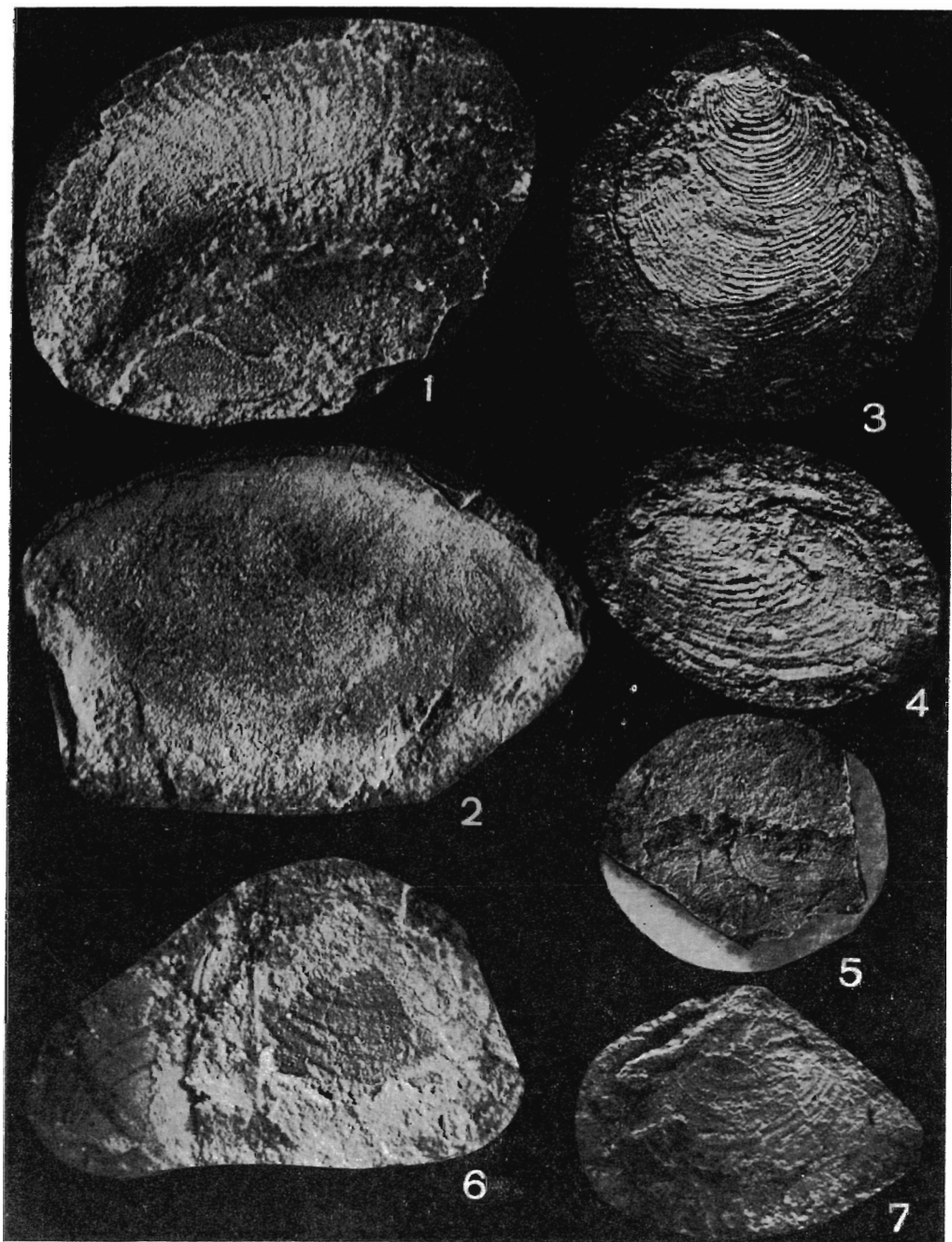
#### REFERENCES

- ARKELL W. J., 1957. Mesozoic Ammonoidea. In: R. C. Moore (Ed.), *Treatise on invertebrate paleontology*, Part L (Cephalopoda 4). Lawrence.
- BESNOSOV, N. V., 1958. Jürskie ammonity Severnogo Kavkaza i Krims. Phylloceratina i Lytoceratina. *Gostoptechizdat*, Leningrad.
- BIRKENMAJER K., 1963. Sedimentary problem of the flysch deposits in the Pieniny Klippen Belt, Carpathians. *Kwart. Geol.*, 7. Warszawa.
- 1965. Outlines of the geology of the Pieniny Klippen Belt of Poland. *Rocz. P.T.G. (Ann. Soc. Géol. Pol.)*, 35 (3). Kraków.
- 1970. Pre-Eocene fold structures in the Pieniny Klippen Belt, Carpathians, of Poland. *Studia Geol. Polon.*, 31. Warszawa.
- 1973. Jura, obszary występowania i stratygrafia: pieniński pas skałkowy. — *Budowa Geol. Polski*, vol. 1 (Stratygrafia), cz. 2 (Mezozoik). *Inst. Geol.*, Warszawa.
- 1977. Jurassic and Cretaceous lithostratigraphic units of the Pieniny Klippen Belt, Carpathians. *Studia Geol. Polon.*, 45. Warszawa.
- & PAZDRO O., 1963. On the age and geological position of the so-called "Sub-Flysch Beds" of the Pieniny Klippen Belt of Poland. *Rocz. P.T.G. (Ann. Soc. Géol. Pol.)*, 33 (4). Kraków.
- 1968. On the so-called "Sztolnia Beds" in the Pieniny Klippen Belt of Poland. *Acta Geol. Polon.*, 18 (2). Warszawa.
- BLAICHER J. & SIKORA W., 1969. W sprawie wieku ogniwa zwanego aalenem fliszowym w pienińskim pasie skałkowym Polski. *Kwart. Geol.*, 13 (3). Warszawa.
- BŁASZYK J., 1968. Ostracoda from the Sztolnia creek profile in the Pieniny Klippen Belt. *Acta Geol. Polon.*, 18 (2). Warszawa.

- COX N., 1969. In: *Treatise on invertebrate paleontology*, Part N, vol. 1 (Mollusca 6). Lawrence.
- FISCHER R., 1970. Ammoniten aus dem Aalenium der nördlichen Kalkalpen. *N. Jb. Geol. Pal. Mon.*, 10. Stuttgart.
- GUILLAUME L., 1927. Revision des Posidonomyes jurassiques. — *Bull. Soc. Géol. France, Sér. 4*, 27. Paris.
- HORWITZ L., 1937. La faune et l'âge des couches à Posidonomyes, Zone Piénine des Klippes, Karpates Polonaises; B. Partie détaillée. *Spraw. P.I.G. (Bull. Inst. Géol. Pol.)*, 9 (1). Warszawa.
- HUF W., 1968. *Über Senftenen und Dorsetensien aus dem Bajocien von Nordwest-Deutschland*. Inaug. Diss., Tübingen.
- JEFFERIES R. P. S. & MINTON P., 1965. The mode of life of two Jurassic species of "Posidonia". *Palaeontology*, 8 (1). London.
- KRIMHOLZ G., 1961. Ammonity nizhne i srednejurskich otlozhenij Severnogo Kavkaza. Izd. Leningr. Univ., Leningrad.
- KSIĄŻKIEWICZ M., 1972. Budowa geologiczna Polski, vol. 4 (Tektonika), cz. 3 (Karpaty). *Inst. Geol.*, Warszawa.
- MAUBEUGE L., 1951. Les Ammonites du Bajocien de la région frontière Franco-Belge. *Inst. Roy. Sci. Nat. Belg., Mém. 2, Sér. 42* Bruxelles.
- MYCZYŃSKI R., 1973. Middle Jurassic stratigraphy of the Branisko Succession in the vicinity of Czorsztyn, Pieniny Klippen Belt, Carpathians. *Studia Geol. Polon.*, 42. Warszawa.
- NEWELL N. D., 1969. In: *Treatise on invertebrate paleontology*, Part N, vol. 1. Lawrence.
- RIEBER H., 1963. Ammoniten und Stratigraphie des Braunjura der Schwäbischen Alb. *Palaeontogr. A*, 122. Stuttgart.
- SIEMIRADZKI J., 1923. Fauna utworów liasowych i jurajskich Tatr i Podhala. *Arch. Tow. Nauk we Lwowie, Dz. III, t. III, z. 3*. Lwów.
- SIKORA W., 1962a. Nowe dane o stratygrafii serii magurskiej w okolicy Szczawnicy. *Kwart. Geol.*, 6 (4). Warszawa.
- 1962b. New data on the geology of the Pieniny Klippen Belt. *Bull. Acad. Polon. Sci., Sér. Sci. Géol., Géogr.*, 10 (4). Warszawa.
- 1971a. Esquisse de la tectogénèse de la zone des Klippes de Pieniny en Pologne d'après de nouvelles données géologiques. *Rocz. P.T.G. (Ann. Soc. Géol. Pol.)*, 41 (1). Kraków.
- 1971b. Wycieczka D—2 (Karpaty). *Przew. 43 Zjazdu P. T. Geol. Kraków 12—14.IX.1971. Inst. Geol.*, Warszawa.
- ZIETEN C. H., 1830. *Die Versteinerungen Württembergs*. Stuttgart.



Middle Jurassic ammonites from the Magura Succession, Sztolnia creek  
 1 — *Leioceras opalinum* (Reinecke); No LB-3, loose block,  $\times 2$ ; 2 — *Leioceras opalinum* (Reinecke); No LB-2, loose block,  $\times 2$ ; 3 — *?Pseudotoites* sp.; No 45/5, Opaleniec Formation,  $\times 3$ ; 4 — *Leioceras* cf. *comptum* (Reinecke); No 44/1a, Szlachtowa Formation,  $\times 4$ ; 5 — *Eurystomiceras polyhelictum* (Böckh); No 45/3, Opaleniec Formation,  $\times 3$ ; 6 — *Leioceras opalinum* (Reinecke); LB-1, loose block,  $\times 2.8$



Middle Jurassic ammonites and pelecypods from the Magura Succession, Sztolnia creek (except of Fig. 3)

1 — *Letoceras opalinum* (Reinecke); No LB-1a, loose block,  $\times 3$ ; 2 — *Dorsetensia* sp.; No 45/1a, Opaleniec Formation,  $\times 1.3$ ; 3 — *Bositra buchi* (Roemer); No KB-4c, Szlachtowa Formation, Jarmuta,  $\times 3.5$ ; 4 — *Bositra buchi* (Roemer); No 45/6, Opaleniec Formation,  $\times 4$ ; 5 — *Bositra buchi* (Roemer); No 46/1, Szlachtowa Formation,  $\times 2$ ; 6 — *Bositra buchi* (Roemer); No 45/8, Opaleniec Formation,  $\times 2$ ; 7 — *Bositra buchi* (Roemer); 45/7, Opaleniec Formation,  $\times 3$