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The transgressive Cretaceous (Upper Albian through Turonian) deposits of the Polish Jura Chain

ABSTRACT: The paper deals with the transgressive Cretaceous deposits (Upper Albian through Turonian) occurring within the Polish Jura Chain (Southern Poland). Their stratigraphy and facial development in the central and northern part of the area are presented and the influence of pre-Albian morphology of the Upper Jurassic substrate is shown as controlling the sedimentation of the transgressive deposits. A general comment is given on the faunal assemblages while the ammonites are the subject of a detail paleontological description. The resulting conclusions and a comparison with the Cracow Upland lying farther south made it possible to recognize the development of the transgression throughout the whole area of the Polish Jura Chain, and to discuss the position of this region within the southern part of the Central European Basin, during the Upper Cretaceous time.

INTRODUCTION

The analytic material presented in this paper has been assembled by the writer during his fieldwork in 1968—1973. The identification of sponges, corals, polychaetes, bryozoans, gastropods, most of the pelecypods and all the cephalopods collected is the writer's own work. The brachiopods have been identified by Dr. E. Popiel-Barczyk, the Upper Albian inocerams from the vicinity of Solca by Dr. S. Cieśliński, the echinoids by Dr. S. Mączyńska and the teeth of fishes by Docent A. Radwański. The writer is greatly indebted to all these persons for their kindness and help.

Docent A. Radwański, University of Warsaw (temporarily now at the University of Aarhus, Denmark) must be sincerely thanked for the scientific tutorship all over the time of investigations, instructive discussions and thoughtful care extended during the final preparation of this paper. His suggestive remarks were helpful not only with respect to the subject matter but have also widened the writer's notions on the various problems and methods of scientific research. Moreover, many thanks are

due to Professor W. J. Kennedy, University of Oxford, for clearing up some doubts regarding the identification of Cenomanian ammonites, and to Docent J. Kutek, University of Warsaw, for many instructive discussions on stratigraphy and paleogeography of the investigated deposits. Thanks are also due to Professor H. Makowski, University of Warsaw, for his remarks concerning identification of ammonites. Thanks are also extended to the writer's colleague, A. Kozłowski, M. Sc., for careful drawings and some field photographs, as well as to B. Drozd, M. Sc., for photographs of the presented fossils.

PREVIOUS INVESTIGATIONS

This chapter contains only a very brief historical review of the previous research on the Upper Albian through Turonian deposits of the Polish Jura Chain. The papers reviewed here contain more detailed data and discussion on various problems of these deposits, although most of them was published in Polish language and offers only short summaries readable for the student abroad. The literature dealing with Cretaceous deposits of the Cracow Upland, *i.e.* the area lying south of the investigated region, will be discussed separately at the end of this chapter.

Pusch (1836, and the posthumous edition of 1883) accepted that the Jurassic members in the vicinity of Solca and Wolbrom are overlaid in sedimentary continuity by Cretaceous deposits. In his *"Geologie von Oberschlesien"*, Roemer (1870) incorrectly refers to the Senonian all the Cretaceous deposits of the Polish Jura Chain. The discovery by Zaręczny (1878) in the Cracow area of Cenomanian and Turonian rocks and his suggestions on the probable occurrence of the Cenomanian in the region of Zalesice and Lelów gave rise to the revision of the age of deposits described by Roemer. The first was Michalski (1888), who differentiated, within the area of Lelów — Poręba Dzierżna, three lithological horizons (quartz gravel; glauconitic sand and sandstone; sandy, inoceramus-bearing limestone) postulating that the first two correspond to the Cenomanian and the last one to the Turonian. A similar view on the age of these deposits was also advanced by Siemiradzki (1909). Detailed field investigations were carried out by Koroniewicz & Rehbinder (1913) while at the construction of the Kielce-Herby railway offering good exposures of Cretaceous deposits; near Zalesice and Staropole they reported the Lower Senonian with *Actinocamax quadratus* (Blainville) and Turonian with *Inoceramus labiatus* (Schlotheim). The quartz sands with glauconite and quartzitic sandstones with *Inoceramus* cf. *bohemicus* Leonhard were referred by them to the upper part of the Cenomanian while the unfossiliferous glauconitic sands with siliceous quartz sandstones were assigned to the lower part of the Cenomanian. The presence of the Cenomanian in the vicinity of Zalesice was not, however, reliably documented before the discovery by Mazurek (1923) of *Schloenbachia varians* (Sowerby) and *S. coupei* (Brongniart). The stratigraphic position of the quartzitic sandstones with *Inoceramus concentricus* Parkinson, *I. bohemicus* Leonhard and *I. striatus* Mantell was placed by Mazurek (1923) at the Cenomanian/ /Turonian boundary.

The compression of the stratigraphic range of *Inoceramus concentricus* Parkinson exclusively to the Albian was connected with the finding by Samsonowicz (1925) of this form within the *Hoplites* fauna at Rachów in the NE margin of the Holy Cross Mts (Central Poland). On this basis the member of quartzitic sandstones differentiated by Mazurek (1923) was lowered to the Albian, below the marly glauconitic sands and the quartz sandstones (Różycki 1937).

Różycki (1937) presented a detailed stratigraphic division of the Cretaceous deposits in the vicinity of Zalesice. This stratigraphic schema has been only slightly modified in result of progressing investigations (*cf.* Marcinowski 1970). Różycki (1937) constributed numerous data on paleogeography and sedimentary conditions of Cretaceous deposits, *i.a.* on the occurrence of discontinuity surface (hardground) and sedimentary gap throughout the Upper Turonian, Coniacian and Santonian, as well as on the pre-Cretaceous morphology of the Jurassic substrate. In the Lelów region, Różycki (1938) stated also that the stratigraphic gap occurring here above the Turonian (Inoceramus lamarcki Zone) narrows both at its top and bottom, and comprises only the last horizon of the Turonian and the Coniacian.

In the area of Solca, Wolbrom and Glanów, the Cretaceous deposits were investigated by Sujkowski (1926, 1929, 1934), whose papers contain however a number of stratigraphic inaccuracies, *i.a.* the differentiation of the Lower Albian, of the complete Turonian and of the Coniacian. As the consequence of the latter, Sujkowski incorrectly reported on a continuous sedimentation from the Turonian to the Coniacian and till the Santonian. Nevertheless, these papers by Sujkowski contain a great deal of analytic material and are based on work methods modern in relation to those times, particularly with regard to the petrographic and microfacial investigations. Hence, they were an important contribution to our knowledge on sedimentation and paleogeography of the Cretaceous deposits throughout the Polish Jura Chain, partly holding good up to now.

In vicinity of Solca, Kowalski (1948) modifies Sujkowski's (1934) stratigraphic division, and recognizes that all the stratigraphic members here distinguished have their equivalents in the neighboring areas, both in the region of Zalesice and Lelów (*cf.* Różycki 1937, 1938) and in the Cracow Upland (*cf.* Panow 1934).

The Cretaceous deposits near Wolbrom, were also investigated by Bukowy (1968), within the scope of the detailed 1:50 000 geological mapping. This author recapitulated the earlier data and was not exempt from some inaccuracies, such as placing in the stratigraphic column of the Cenomanian and Coniacian within the Turonian (*sic!*) and of the Santonian within the Campanian (*cf.* Bukowy 1968, Table 1); his opinions on sedimentary conditions and paleogeography of the Cretaceous deposits near Wolbrom are likewise not adequately documented by analytic data. Some remarks concerning the Cretaceous deposits in the region of Wolbrom and Glanów were also made by Burzewski (1969) in a description of the tectonic structure of this area.

For the last few years, the deposits of the transgressive Upper Albian — Turonian sequence of the whole area of the Polish Jura Chain have been investigated by the present writer (Marcinowski 1970, 1972; Głazek, Marcinowski & Wierzbowski 1971; Marcinowski & Szulczewski 1972).

The Cretaceous deposits of the Cracow Upland have problems in common with the other parts of the Polish Jura Chain and these all have a rich literature. Detailed and modern investigations of these deposits were started by Zaręczny (1878, 1894) by whom the Cenomanian and the Turonian were here differentiated and documented. This author's opinions on stratigraphy and tectonics are remarkable for the conscientiousness of the work methods and the perspicacity of judgement, so that they have partly retained their value up to now. Panow (1934) presented in detail a biostratigraphic subdivision of all the Cretaceous deposits of the Cracow Upland and, with but slight modifications resulting from the progress of investigations, this schema still holds good. On evidence that the oldest Cretaceous deposits herein represented the Upper Albian, Panow (1934) determined the beginning of the transgression onto the Upper Jurassic substrate. He also showed the presence of numerous discontinuity surfaces, of which that involving the last horizon of the Turonian and the Coniacian is of the longest duration and has the greatest regional range. Panow's (1934) stratigraphic subdivision of the Cretaceous deposits in the Cracow Upland cover the whole Polish Jura Chain, and on this basis several subsequent authors dealt with various problems of the Upper Albian through Turonian deposits. Their papers are mostly regional in character and concern both the stratigraphy, facial development, sedimentary conditions and paleogeography, as well as tectonics of the Cracow Upland (Kamieński & Piątkowski 1950; Dżułyński 1953; Alexandrowicz 1954, 1956, 1960, 1969; Barczyk 1956; Bukowy 1956, 1960; Rutkowski 1965, 1971; Jawor 1970; Gołonka & Rajchel 1972; Głazek, Marcinowski & Wierzbowski 1971, and *cf.* also Marcinowski & Szulczewski 1972).

Less attention has, so far, been given to the rich organic assemblages occurring in the Albian, Cenomanian and Turonian deposits of the Cracow Upland. The only monographs are those of globotruncans (Alexandrowicz 1956), brachiopods (Panow — posthumous editions in 1969; Popiel-Barczyk 1972), echinoids (Kongiel 1939; Mączyńska 1958, 1962, 1972; Popiel-Barczyk 1958) and remains of fishes, mostly teeth (Książkiewicz 1927). Some single specimens of bryozoans from the Cenomanian at Korzkiew were described by Maryańska (1968), and those of ammonites from the Turonian at Bociemiec by Marcinowski & Szulczewski (1972).

LITHOLOGICAL MEMBERS OF THE TRANSGRESSIVE SEQUENCE

General remarks

Within the part of the Polish Jura Chain here considered, the Albian, Cenomanian and Turonian deposits form a long belt of outcrops stretching for about 100 km (*cf.* Fig. 1C). For a simplification, the outcrops are grouped into three regions, for which presented are the detailed maps (Figs 3—4 and 9). When presenting the particular lithological members, their age is stated without discussion on stratigraphy, since this will be dealt with in further chapter on this paper. The lithological profiles are presented for the more satisfactory Albian, Cenomanian and Turonian outcrops while the occurrence of other exposures is discussed in connection with those. In the microfacial analysis of the profiles, for which investigated were sandstones and these limestones and marls, the detrital constituents of which are arenaceous, the method used was that of Carozzi (*e.g.* 1958), discussed and pronounced as suitable for the considered deposits previously (Marcinowski & Szulczewski 1972).

The nothern part of the investigated area (region of Mokrzesz, Lusławice and Julianka) has already been documented by the writer in a previous paper (Marcinowski 1970). The finding here of a number of new fossils has led to some additional observations which will be presented briefly at first. The thickness of the differentiated lithological

Fig. 1

A — general map of Poland, *B* — location of the Polish Jura Chain, *C* — investigated area of the Albian, Cenomanian and Turonian deposits: rectangled are the areas of detailed geological maps presented in Text-figs 3—4 and 9; hatched area is presented in a previous paper (Marcinowski 1970, Fig. 1); black spots mark the occurrence belts of the Albian and Cenomanian deposits members in this region and their mutual relations are shown in a chart of the profiles (Fig. 28) while for the localization of the outcrops the reader is referred to a sketch-map in that previous paper (Marcinowski 1970, Text-fig. 1).

Region of Mokrzesz-Lusławice-Julianka

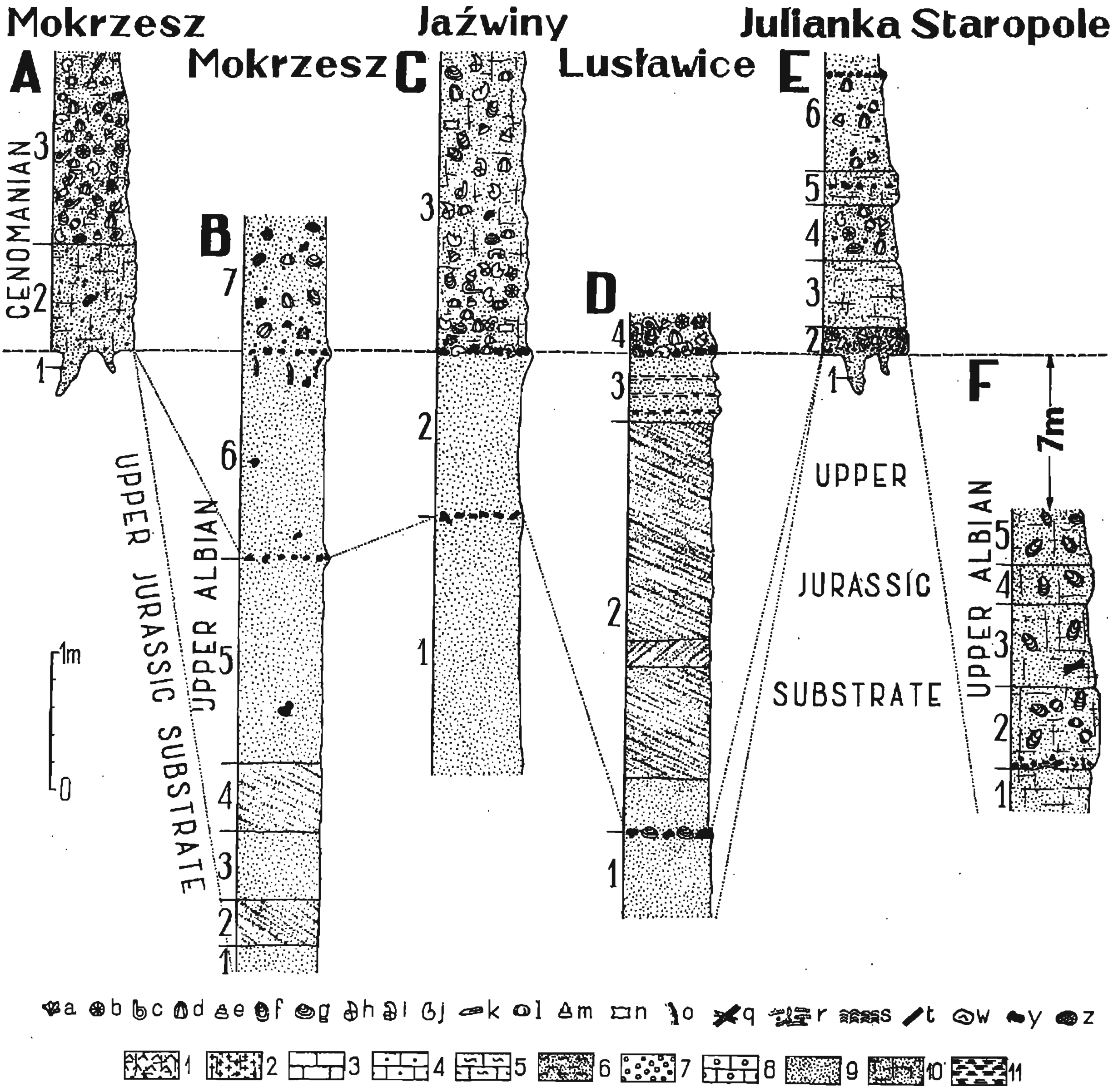
Upper Albian

The oldest lithological member in this region is developed as siliceous quartz sandstones with an admixture of glauconite and muscovite flakes. The rock is gray-brown in colour, occasionally fine-bedded with siliceous and sandy laminae. These sandstones occur in the vicinity of Sygątka and Julianka (Różycki 1937), also north of Krasice (Marcinowski 1970, outcrop *52*), and they bear a meagre fauna represented by specifically indeterminate sponges, inocerams and echinoids (*cf.* Koroniewicz & Rehbinder 1913, Różycki 1937). No direct contact of sandstones with the Jurassic substrate has been observed. The discussed sandstones may correspond either to the lower part of the Upper Albian or to the uppermost part of the Middle Albian (Marcinowski 1970).

The sandstones are overlaid by faunally documented Upper Albian deposits represented by a member of sands and poorly compact sandstones with a considerable amount of glauconite in which there are embedded irregular layers and masses of quartzitic sandstones. The latter sandstones have the same mineral composition as surrounding sands and poorly compact sandstones and they display strong recrystallization (Pl. 1, Fig. 5). In places, they also contain phosphatic nodules. The best outcrop of this member occurs near Staropole (Fig. 2*F*) where it bears an abundant fauna (Pl. 23, Figs 1—2; Pl. 27, Figs 2—3) represented exclusively by echinoids *Pseudholaster(?)* sp. and pelecypods *Inoceramus concentricus* Parkinson, *I. anglicus* Woods, *Neithea* sp. and *Exogyra* sp.

Analogous deposits are also exposed west of Staropole, near Zalesice (outcrops *78—82*), but the fauna they bear is very sparse and represented by more accurately indeterminable inocerams. In the poorly compact sandy deposits of this member (outcrop *79*) single burrows of the ichnospecies *Ophiomorpha nodosa* Lundgren are to be found.

The following member, belonging to the uppermost Albian, is developed as fine-grained, non-calcareous quartz sands with glauconite, partly obliquely bedded, and containing horizons of phosphatic and ferruginous-phosphatic nodules (*cf.* Fig. 2*B—D*). Occasionally, in the uppermost part of this member (*cf.* Fig. 2*D*, unit *3*), intercalations of gaizes and chalcedonites (Pl. 1, Figs 3—4) are also encountered. The fauna (Pl. 22, Fig. 6) occurs only in the abovementioned nodules and it is represented only by pelecypods *Aucellina gryphaeoides* (Sowerby).



Detailed profiles of the Upper Albian and Cenomanian deposits and their correlation in the region of Mokrzesz and Zalesice (*after* Marcinowski 1970, partly completed by new data: *A* Mokrzesz (outcrop *46*), *B* Mokrzesz (outcrop *46a*), *C* Jaźwiny (outcrop *53*), *D* Lusławice (outcrop *84*), *E* Julianka (outcrop *69*), *F* Staropole (outcrop *63*); location of the profiles given in a previous paper (Marcinowski 1970, Fig. 1)

Lithology and components of the deposits (for all the profiles presented in Text-figs 7—8, 10—11, 15, 18, 22 and 26): *1* butten limestones, *2* chalky limestones, *3* platy limestones, *4* sandy limestones, *5* marls, *6* sandy marls, *7* gravelstones, *8* conglomerates, *9* sands, *10* sandstones, *11* gaizes and chalcedonites

a sponges, *b* corals, *c* serpulids, *d* brachiopods, *e* gastropods, *f* pelecypods of the genus *Inoceramus*, *g* other pelecypods, *h* nautilids, *i* aberrant ammonites, *j* normally coiled ammonites, *k* belemnites, *l* echinoids, *m* shark teeth, *n* fish vertebrae and bones, *o* burrows *Ophiomorpha nodosa* Lundgren, *q* undetermined burrows, *r* burrows *Chondrites* sp., *s* stromatolites, *t* inoceram fragments, *w* clastic fragments of Upper Jurassic butten limestones, *y* sandy, phosphatic and ferruginous-phosphatic nodules, *z* sandy, lime-phosphatic nodules

These deposits are well exposed and their contact with the Cenomanian is observable in most of the outcrops. Burrows *Ophiomorpha nodosa* Lundgren (*cf.* Fig. 2*B*) occur here and there in the uppermost part of this member.

Cenomanian

The Upper Albian non-calcareous deposits, throughout the whole region under consideration, are overlaid by strongly marly coarse-grained sandstones (Pl. 1, Fig. 1) or by glauconitic quartz sands of Cenomanian age. At Julianka, in places where these deposits rest directly on the Upper Jurassic substrate (Fig. 2*E*, unit *2*), there occur marly-phosphatic quartz conglomerates with glauconite (Pl. 1, Fig. 2). The gravel of black Jurassic flints (Różycki 1937) is an important constituent of these conglomerates. At Mokrzesz, the sandy Cenomanian deposits overlap the Upper Albian non-calcareous deposits (Fig. 2*A*—*B*; also Marcinowski 1970, Fig. 4*A*—*C*); a similar situation is observable at Julianka (Różycki 1937; *cf.* also Fig. 2*D*—*F*). The sands, sandstones and conglomerates here considered bear an abundant fauna, and its abrupt increase is readily observable in all the profiles (Jaźwiny, Krasice, Mokrzesz, Lusławice, Julianka and Zalesice) contrasting these deposits with those of the Upper Albian. The faunal remains represent here practically all the types of invertebrates, but remains of vertebrates, such as teeth and vertebrae of fishes, or other bone fragments are numerous, too. The greatest abundace of the fossils is found at Mokrzesz and Jaźwiny, slightly less in the vicinity of Lusławice and Julianka.

The list of fossils is following[1]:
Sponges:
Exanthesis cf. *labrosus* (Smith) — Pl. 17, Fig. 1
Corals:
Micrabacia coronula (Goldfuss) — Pl. 17, Fig. 2
Polychaetes:
Serpula proteus Sowerby — Pl. 17, Fig. 4
Serpula sp.
Spirorbula sp.
Glomerula sp.
Bryozoans:
Multicrescis variabilis cracoviensis Maryańska — Pl. 17, Fig. 3
Brachiopods:
Orbirhynchia mantelliana (Sowerby) — Pl. 20, Figs 5—6
?O. cuvieri (d'Orbigny)
Cyclothyris cf. *difformis* (Valenciennes *in* Lamarck) — Pl. 21, Fig. 3
C.(?) schloenbachi (Davidson) — Pl. 21, Fig. 6
Cyclothyris sp.
Cretirhynchia minor (Pettitt) — Pl. 21, Fig. 7
C. cf. *minor* (Pettitt)
Cretirhynchia sp.
Lamellaerhynchia sp.
Lepidorhynchia sigma (Schloenbach) — Pl. 21, Fig. 1

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[1] The list comprises also the species recorded in previous paper (Marcinowski 1970). General distribution of particular fossils in the investigated sections is presented in chapter on the characteristics of the animal world (*vide* Tables 1—5).

Grasirhynchia martini (Mantell) — Pl. 21, Fig. 2
"Rhynchonella" gibbisiana (Sowerby)
Sellithyris(?) sp.
Arcuatothyris arcuata (Roemer) — Pl. 18, Fig. 2
Platythyris rugulosa (Morris) — Pl. 18, Figs 3—4
Praelongithyris sp. — Pl. 19, Fig. 3 and Pl. 20, Fig. 3
Gibbithyris sp. — Pl. 20, Fig. 1
Concinnithyris(?) *subundata* (Sowerby) — Pl. 18, Fig. 5
Concinnithyris sp.
Ornatothyris sp. — Pl. 20, Fig. 2
Terebratulina chrysalis (Schlotheim) — Pl. 19, Figs 4—5
Kingena arenosa (d'Archiac) — Pl. 19, Figs 1—2
Kingena sp.
Magas sp.
"Terebratula" disparilis d'Orbigny

Gastropods:
Emarginula althi Zaręczny — Pl. 22, Figs 1—2
Pleurotomaria sp.
Trochus sp.
Mitra sp.
Natica sp.

Pelecypods:
Nucula vibrayeana (d'Orbigny)
Nucula sp.
Trigonarca passyana (d'Orbigny)
Inoceramus bohemicus Leonhard — Pl. 24, Fig. 4
Chlamys sp.
Neithea quinquecostata (Sowerby) — Pl. 22, Fig. 4
Aucellina gryphaeoides (Sowerby)
Lima sp.
Ostrea sp.
Lopha colubrina (Lamarck) — Pl. 22, Fig. 7
Exogyra sp.
Isocardia heintzeli Wolleman
Unicardium cf. *tumidum* Briart & Cornet — Pl. 22, Fig. 5
Cyprina cf. *regularis* d'Orbigny
Cyprina sp.
Venilicardia ligeriensis (d'Orbigny) — Pl. 22, Fig. 3

Nautilids:
Eutrephoceras sublaevigatum (d'Orbigny) — vide Marcinowski 1970 (Pl. 2, Figs 1—2)
E. cf. *sublaevigatum* (d'Orbigny)
Cymatoceras deslongchampsianum (d'Orbigny) — vide Marcinowski 1970 (Pl. 2, Fig. 3)

Ammonites:
Phylloceras (Hypophylloceras) seresitense seresitense Perv. — Pl. 31, Fig. 2
Hamites sp. — vide Marcinowski 1970 (Pl. 2, Fig. 4)
Sciponoceras subbaculoides (Geinitz) — vide Marcinowski 1970 (Pl. 2, Fig. 7)
Hypoturrilites gravesianus (d'Orbigny) — Pl. 32, Figs 8, 10
H. aff. *gravesianus* (d'Orbigny) — Pl. 32, Fig. 9
H. mantelli (Sharpe) — vide Marcinowski 1970 (Pl. 3, Fig. 10 only)
H. tuberculatus (Bosc) — Pl. 32, Figs 1—3
H. aff. *tuberculatus* (Bosc) — Pl. 32, Figs 4—5
Hypoturrilites sp. — Pl. 32, Fig. 11
Ostlingoceras (Ostlingoceras) bechii (Sharpe) — vide Marcinowski 1970 (Pl. 3, Fig. 5)
O. (O.) puzosianum (d'Orbigny) — Pl. 32, Fig. 6
Mariella (Mariella) lewesiensis (Spath) — Pl. 32, Fig. 13
M. (M.) cenomanensis (Schlüter) — Pl. 32, Figs 14—15
M. (M.) cf. *cenomanensis* (Schlüter) — Pl. 32, Fig. 16
M. (M.) dorsetensis (Spath) — vide Marcinowski 1970 (Pl. 3, Fig. 1)
M. (M.) essenensis (Geinitz) — vide Marcinowski 1970 (Pl. 3, Figs 2—3)
Mariella (Mariella) sp. — Pl. 32, Fig. 7
Turrilites (Turrilites) costatus Lamarck
T. (T.) acutus Passy — vide Marcinowski 1970 (Pl. 3, Figs 7—8)
T. (T.) scheuchzerianus Bosc — vide Marcinowski 1970 (Pl. 3, Figs 11—12)
T. (T.) boerssumensis Schlüter — Pl. 32, Fig. 12

Scaphites (Scaphites) equalis Sowerby — vide Marcinowski 1970 (Pl. 2, Figs 5—6)
Hyphoplites campichei campichei Spath — Pl. 33, Fig. 1
H. falcatus aurora Wright & Wright — Pl. 33, Fig. 2
Schloenbachia varians (Sowerby) — vide Marcinowski 1970 (Pl. 4, Fig. 3)
S. cf. *varians* (Sowerby)
?*S. varians* var. *trituberculata* Spath — vide Marcinowski 1970 (Pl. 4, Fig. 1)
S. varians var. *tetrammata* (Sowerby) — vide Marcinowski 1970 (Pl. 4, Fig. 4)
S. subvarians Spath — Pl. 34, Fig. 3
S. subtuberculata (Sharpe) — vide Marcinowski 1970 (Pl. 6, Fig. 1)
S. sharpei Semenov — vide Marcinowski 1970 (Pl. 5, Fig. 2)
S. quadrata Spath — vide Marcinowski 1970 (Pl. 5, Figs 3—4)
S. ventriosa Stieler — vide Marcinowski 1970 (Pl. 4, Fig. 5; Pl. 5, Fig. 1)
S. subplana (Mantell) — vide Marcinowski 1970 (Pl. 4, Fig. 2)
S. intermedia (Mantell) — vide Marcinowski 1970 (Pl. 6, Fig. 2)
Schloenbachia sp.
Mantelliceras tuberculatum (Mantell) — Pl. 33, Fig. 4
M. aff. *costatum* (Mantell) — vide Marcinowski 1970 (Pl. 6, Fig. 3 — as *M. tuberculatum*
M. gr. *dixoni* Spath — Pl. 33, Fig. 5
M. saxbii (Sharpe) — Pl. 33, Fig. 3
Mantelliceras sp.
Sharpeiceras sp.
Acompsoceras sp.
Calycoceras (Lotzeites) aff. *lotzei* Wiedmann — Pl. 33, Fig. 6
Calycoceras sp.
Paracalycoceras cf. *wiestii* (Sharpe)

Belemnites:
Neohibolites ultimus (d'Orbigny) — Pl. 31, Fig. 2

Echinoids:
Salenia sp.
Polydiadema aff. *tenue* Agassiz
Polydiadema sp.
Phymosoma cenomanense Cotteau — Pl. 26, Fig. 1
Camerogalerus cylindricus (Lamarck) — Pl. 26, Fig. 4
Discoides subuculus (Klein) — Pl. 26, Figs 2—3
Pyrina ovalis d'Orbigny
Pseudholaster sp.
Holaster laevis Agassiz
H. poloniae Lambert — Pl. 27, Fig. 1
H. subglobosus Leske — Pl. 28, Fig. 2

Shark teeth:
Corax falcatus Agassiz — Pl. 30, Fig. 1
Oxyrhina angustidens Reuss — Pl. 30, Figs 2—3
?*O. mantelli* Agassiz — Pl. 30, Fig. 9
Otodus appendiculatus (Agassiz) — Pl. 30, Figs 4—8

Commonly associated are also various undetermined sponges as well as fragments of skeletons and isolated ossicles of starfishes.

In the western part of the region (Mokrzesz, Jaźwiny, Krasice), above the fossiliferous sands, on the hill sides, there occurs the rubble of non-calcareous white gaizes with an admixture of glauconite. These deposits are unfossiliferous and undoubtedly they appear below the Lower Turonian sediments; most likely they represent the upper parts of the Cenomanian. At Krasice, the thickness of gaizes, which may be possibly only intercalations within the sandy deposits, is about one meter.

In the eastern part of the region (Zalesice), marly fine-grained quartz sands with glauconite occur above the sandy deposits bearing a rich fauna. In these sands there are irregularly dispersed single sandy-phosphatic nodules. The fauna here is extremely sparse: at Zalesice (outcrop *74*, 10 cm below the Turonian boundary) there has been found *Actinocamax (Praeactinocamax) plenus* (Blainville) subsp. indet., moreover, the presence was noted of burrows *Ophiomorpha nodosa* Lundgren (*cf.* Marcinowski 1970: *also* Marcinowski & Szulczewski 1972, Fig. 3).

Turonian

The best outcrops of the Lower Turonian occur in the same places as those of the Upper Cenomanian (Zalesice, outcrop *74*). They are represented by marly quartz sandstones with a slight admixture of glauconite, passing upwards into sandy limestones; in these deposits there occur *Inoceramus labiatus* (Schlotheim), *Conulus ellipticus* (Zaręczny), *Orbirhynchia cuvieri* (d'Orbigny) and *Gibbithyris* sp. Successively lies white organodetrital limestone containing abundant inoceram and echinoid debris and better preserved specimens of *Inoceramus lamarcki* Parkinson. Similar deposits occur SE and NW of Zalesice, at Staropole and Krasice, where they yielded *Orbirhynchia cuvieri* (d'Orbigny), *Cretirhynchia* sp., *Gibbithyris* sp., *Inoceramus labiatus* (Schlotheim), *I. apicalis* Woods, *I. lamarcki* Parkinson, *Discoides minimus* (Agassiz), *Conulus ellipticus* (Zaręczny), *C. subrotundus* (Mantell). These limestones, containing *Inoceramus lamarcki* Parkinson are overlaid directly with a hardground surface by the Lower Campanian marls (Różycki 1937). A sedimentological description of the uppermost Cenomanian, Lower Turonian and lowermost Campanian deposits, as well as the remarks on a sedimentary gap between the Lower Turonian and the Campanian, have been presented previously (Marcinowski & Szulczewski 1972).

Region of Lelów

In the region of Lelów the Albian and Cenomanian outcrops are inadequate, and only a few occur at the foot of the cuesta of the Turonian and Senonian deposits (*cf.* Fig. 3).

Upper Albian

The oldest Cretaceous deposits occur westwardly of Irządze (outcrop *120* in Fig. 3). In the seasonally worked rural quarries the presence is seen of Upper Jurassic chalky limestones with karst sinkholes which are filled with green or greenish-brown, medium-grained quartz sands with an admixture of glauconite[2].

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[2] At Wygiełzów, between the Upper Jurassic limestones and the sandy Albian deposits, Różycki (1938; pp. 132—133, Fig. 1) reported a series of "black clays" which he recognized as corresponding to the uppermost Jurassic or the Neocomian. Actually they probably represent a marly assemblage within the Upper Jurassic limestones from the Idoceras planula Zone (*cf.* Wierzbowski 1966, Marcinowski 1969).

Concretions or lenses of poorly compact, clayey-siliceous sandstones occur among these sands. Both in the sands and the sandstones, the presence is noted of sparse quartz pebbles, not exceeding 1 cm in size. Sponges are sporadically encountered only in the sandstone concretions. The detritus of analogous rocks occurs west of the village Skrajniwa (*cf.* Fig. 3). The thickness of these deposits may be estimated between 14 and 15 meters.

The successive lithological member is represented by non-calcareous medium-grained quartz sands with glauconite, in which there occur irregular bodies of quartzitic sandstones, also lenses and intercalations of poorly compact sandstones. The colour of particular lithological varieties ranges from green to brown. Here and there the sands are obliquely bedded; in the upper part of the member there are numerous gravel intercalations. The best outcrops of these deposits occur in the vicinity of Lelów, within the valley of Białka Lelowska stream. Sands and poorly compact sandstones containing bodies of quartzitic sandstones also occur at the foot of the Cretaceous cuesta near Skrajniwa, and some low hills NW of Lelów are built of these deposits. The fauna they bear is extremely sparse and encountered only in the quartzitic sandstones. *Inoceramus concentricus* Parkinson is mentioned from this area by Różycki (1938), while the present writer besides two specimens representing this species also found one specimen of *Inoceramus* cf. *anglicus* Woods. The supposed thickness of deposits is c. 15 meters. In the Lelów region, the quartzitic sandstones do not form larger bodies which are so common in the Zalesice region (Różycki 1938).

Cenomanian

The Upper Albian non-calcareous deposits are overlaid by marly, medium-grained quartz sands containing a large amount of glauconite and few muscovite flakes; they are exposed in the ditches of field roads crossing the Cretaceous cuesta near Pniaki and Skrajniwa (outcrops *121, 122*), also near Podgaj (outcrop *119*). The fauna here is extremely rare and the writer is in possession of but two specimens: *?Lepidorhynchia* sp. (outcrop *122* in Fig. 3) and *Holaster* sp. (outcrop *121*). The Cenomanian deposits in the Lelów region are 4—5 m thick (Różycki 1938).

Turonian

The Turonian deposits are represented by poorly compact, marly quartz sandstones with glauconite, higher up grading into sandy limestones and limestones containing slight amounts of quartz and glauconite. Their thickness does not vary and is 1—1.5 m. At Skrajniwa (outcrop *122* in Fig. 3), at the bottom of the Turonian deposits there occurs a 5 cm thick horizon of ferruginous-phosphatic nodules with abundant detritus of inoceram shells. In this horizon the fauna is scarce, and represented by *Gibbithyris* sp. and *Ptychodus mammillaris* Agassiz (*cf.* Pl. 30, Fig. 11) never before reported from here.

The following faunal remains have been collected from the scree of the Turonian outcrop zone within the Lelów region: *Inoceramus apicalis* Woods, *I. lamarcki* Parkinson, *Conulus ellipticus* (Zaręczny), *C. subrotundus* (Mantell). Besides the above fossils, Różycki (1938) mentions from Podgaj (outcrop *119* in Fig. 3) "*Echinocorys* cf. *Gravesi*" Desor and "*Infulaster Wöhrmanni*" Nietsch which, in his opinion, suggest the presence of the lower part of the Upper Turonian, not reported from the northern part of this region (in this region only *Infulaster* sp. has been found by the writer). Lower Campanian marls rest directly on the hardground surface of the Turonian limestones (Różycki 1938). At Pniaki (outcrop *121*), at the top of Turonian deposits, there occur stromatolites not known from the other profiles of this region (Różycki 1938). An account in detail of the stromatolites from Pniaki and microfacial analysis of the Lower Turonian deposits and of the lowermost Campanian deposits in the Lelów region have been published previously (Marcinowski & Szulczewski 1972).

Region of Solca

In the region of Solca, the Cretaceous deposits occur over a large area and are cut by many faults[3] disturbing the monoclinal structure of the Jurassic and Cretaceous deposits (*cf.* Figs 4 and 5*a*—*b*). In the outcrops of the Upper Jurassic platy limestones, adjacent to some faults, one can readily observe their being strongly cracked and bent towards the Cretaceous deposits which occur in the downthrown block (*cf.* Fig. 5*a*—*b*). These observations indicate that a part of the faults here is associated with a flexural bending of the layers[4]. The disjunctive deformations are responsible here for the present-day different altitudes of the same stratigraphic member both of the Cretaceous and of the Jurassic, *e.g.* in the horst of Solca the sandy Upper Albian deposits occur some tens of meters higher up than in adjacent structures.

Upper Albian

The oldest lithological member (Sujkowski 1934), is represented by medium-grained non-calcareous quartz sands, containing very few glauconite. Within these non-diagenized sediments there are a few centimeters thick intercalations and lenses of poorly compact quartz sands cemented by chalcedony (Pl. 1, Fig. 6), in some places by opal. The best outcrops of these rocks are on the roadside south of Solca (outcrop *111c* in Fig. 4). In the sand here, there occur lenses of siliceous sandstones containing numerous sponge spicules visible under the magnifying glass. In the sandstones there also occur burrows of a constant diameter of 3—5 mm (sporadically 2—3 cm), while their observable length is 15 cm. No inter-crossing of the burrows has been observed, only some branching off. These burrows are close to those of the ichnogenus *Chondrites* Sternberg.

Analogous deposits occur over a large area, westward (outcrop *113* in Fig. 4) and north-westward of Solca; their scree is also often encountered near Siedliszowice, at a very short distance to the outcrops of the Upper Jurassic deposits. In all the sands intercalated by siliceous sandstones, here considered, there occur sandstone concretions with sponges as the only fossil remains. No direct contact of these deposits, *c.* 25 m thick, with the Upper Jurassic substrate has been observed.

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[3] These faults have been discovered and their general trend determined by Sujkowski (1934, Pl. 2; *cf.* also Figs 2—3).

[4] Synclines have been differentiated in the Cretaceous deposits of this region by Kowalski (1948, p. 27; *cf.* also Pl. 2), but this is not correct. In the region of Solca (*cf.* Figs 4 and 5*a*), the Upper Jurassic platy limestones are in tectonic contact with Santonian marls bearing the index fauna of this stage, viz. *Actinocamax verus*. Kowalski (1948, *cf.* his Pl. 1), however, places here Upper Albian deposits and this is, *i.a.* the cause of his erroneous interpretation of the tectonic structure of the considered deposits.

The successive lithological member is represented by medium-grained quartz sands with glauconite in which are embedded large-sized irregular bodies of quartzite (Fig. 6), characterized by strong recrystallization (Pl. 2, Fig. 1). In places (outcrop *111* in Fig. 4) the occurrence is noted in these deposits of some centimeters thick horizons of quartz pebbles and single pieces of Jurassic limestones, 0.5—1 cm in diameter. In the region of Solca the quartzitic sandstones occur as large bodies within the sands and their presence is often responsible for fairly high hills in morphology. The fauna they bear is rather scarce and poorly differentiated; southeastwardly of Solca (outcrop *111a* in Fig. 4) relatively numerous pelecypods[5] have been collected as follows:

Inoceramus anglicus Woods — *cf.* Pl. 23, Fig. 3 and Pl. 24, Figs 1—2
I. anglicus-crippsi media forma — *cf.* Pl. 23, Fig. 4 and Pl. 24, Fig. 3
Chlamys sp.
Neithea cf. *quinquecostata* (Sowerby)
Ostrea sp.
Exogyra sp.

It is interesting to note in this assemblage the forms called here as *Inoceramus anglicus-crippsi* m.f., which Dr. S. Cieśliński defined as transitional from *I. anglicus* Woods to *I. crippsi* Mantell. In the region of Solca, the sands with irregular bodies of quartzitic sandstones are *c.* 25 m thick.

In the region of Solca, all the lithological memebers of the Albian display a characteristic distribution. North-westwardly of Solca, near Siedliszowice, the Upper Jurassic substrate is overlaid by sandy deposits with sponges, here representing the oldest lithological member of the Upper Albian. On the other hand, south--eastwardly of that village (in the area of outcrops *111*, *111a—b*), and also near Przychody (outcrop *114*) these deposits are absent, or, if present, they are very thin and not detectable in the scree and soil. Here, directly on the Upper Jurassic substrate, rest sands containing irregular bodies of quartzitic sandstones which are the younger lithological member of the Upper Albian, the age of which is paleontologically documented. These data show that within the Solca region the Upper Albian deposits occur on an uneven Upper Jurassic substrate.

Cenomanian

Between the paleontologically documented Upper Albian and Lower Turonian there occur, throughout the whole Solca region, medium-grained, marly quartz sands containing abundant glauconite, and passing upwards into poorly compact sandstones (Pl. 3, Fig. 1). The sands and sandstones contain an admixture of coarse-grained fraction, but they are lacking of phosphatic nodules. They also bear no fauna, and only their position in the profile is responsible for their referring to the Cenomanian (Sujkowski 1934, Kowalski 1948); their thickness range between 6.5 to 9 m (Kowalski 1948).

Turonian

The Turonian deposits have been exposed by the writer in a trench at Przychody (outcrop *115* in Fig. 4); sandy limestones rest here in sedimentary continuity on Cenomanian poorly compact marly sandstones with glauconite (unit

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[5] *Inoceramus concentricus* Parkinson is *i.a.* reported from here by Kowalski (1948, pp. 17—18). The present writer has inspected these specimens in the collection of the Faculty of Geology of the Warsaw University; but actually they represent *I. anglicus* Woods. Many inoceram species are also mentioned by Sujkowski (1934) from here, but a part of them seems to be incorrectly identified since some species he mentions exclude the occurrence of others.

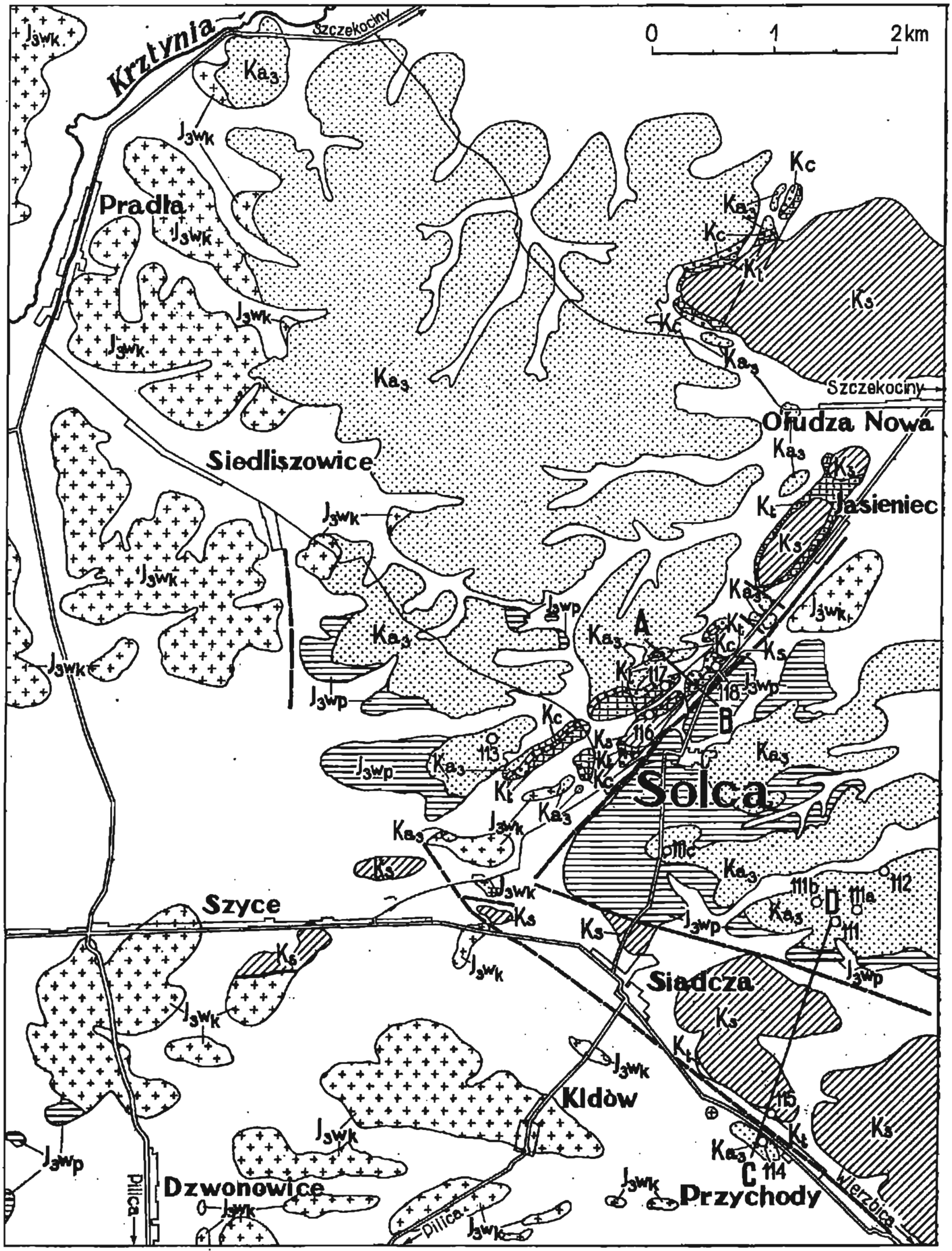


Fig. 4

Geological map of the region of Solca (explanations as in Text-fig. 3); *A—B* and *C—D* — lines of geological sections presented in Text-fig. 5*a—b*

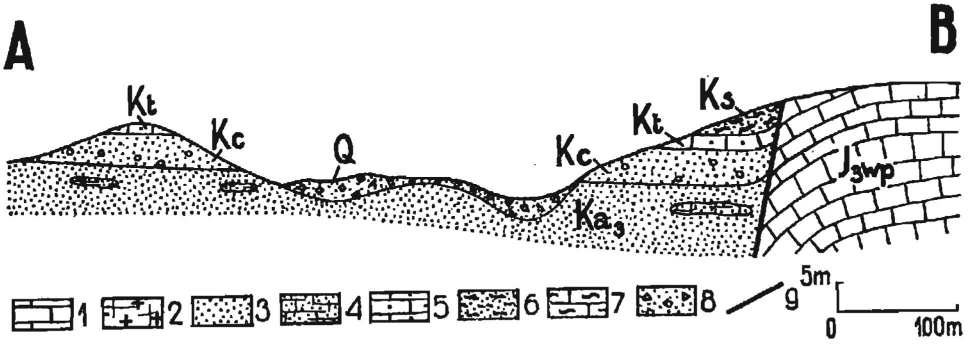


Fig. 5a

Geological sections near Solca (*cf.* Text-fig. 4)

1 in Fig 7; *cf.* Pl. 3, Fig. 1). The Cenomanian/Turonian boundary has been placed where quartz and glauconite decrease in amount, otherwise than organic remains do (*cf.* Fig. 7). *Pithonella* and planktic foraminifers are the main components of the Turonian sandy limestones; their amounts vary in the profile (*cf.* Fig. 7), resulting in the formation of various microfacies (Pl. 3, Figs 2—4; Pl. 4; Pl. 5, Fig. 1). The characteristics of the Turonian lithological units differentiated in the profile of Przychody are as follows (units *2—4* in Fig. 7):

2. Sandy limestones with inoceram fragments. In the vicinity of Solca (outcrop *118* in Fig. 4), *Conulus subrotundus* (Mantell), is found in analogous deposits.

3. Sandy limestones with frequent inoceram fragments and a horizon of ferruginous-phosphatic nodules (1—2 cm) at the top. The fauna here is scarce, and represented only by *Inoceramus lamarcki* Parkinson. Because of the high content of inoceram debris, this unit is easily identified throughout the region under consideration. In the vicinity of Solca (outcrops *116—118*) it bears the following fossils:

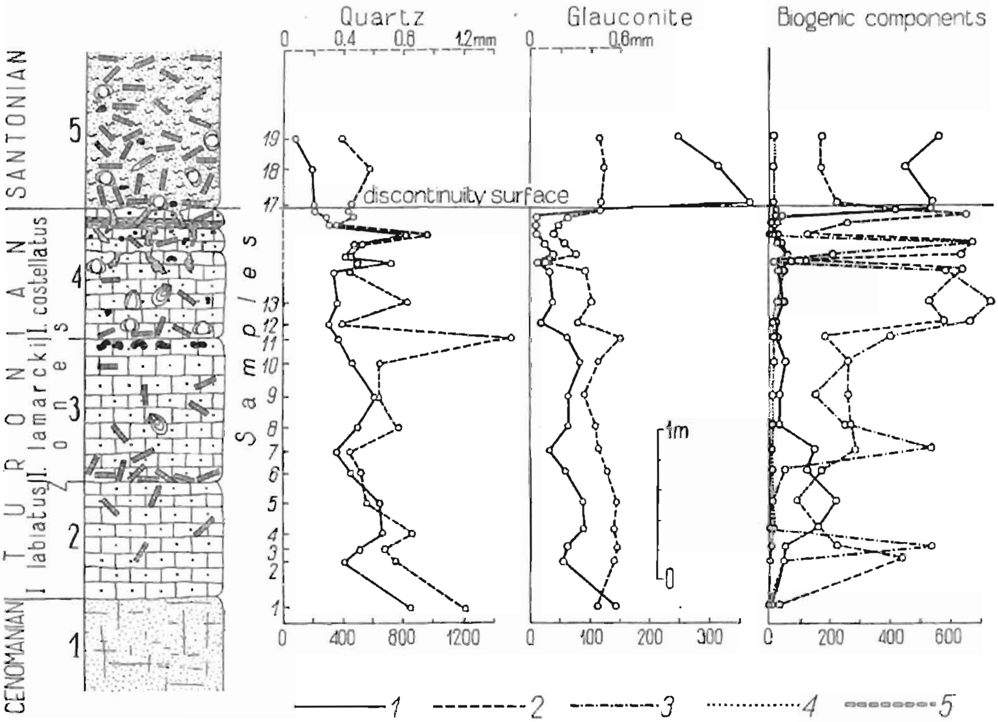
Inoceramus lamarcki Parkinson — *cf.* Pl. 25, Fig. 2.
Conulus ellipticus (Zaręczny)
C. subrotundus (Mantell) — *cf.* Pl. 29, Fig. 3

Fig. 5b

1 platy limestones, *2* chalky limestones, *3* sands, *4* sandstones, *5* sandy limestones, *6* sandy marls, *7* marls, *8* slope waste
J₃wp Upper Jurassic (platy limestones), *J₃wk* Upper Jurassic (chalky limestones), *Ka₃* Upper Albian, *Kc* Cenomanian, *Kt* Turonian, *Ks* Santonian, *Kk* Campanian, *Q* Quaternary

Fig. 6

Rural quarry at Solca (outcrop *111b* in Text-fig. 4); visible are Upper Albian quartzitic sandstones



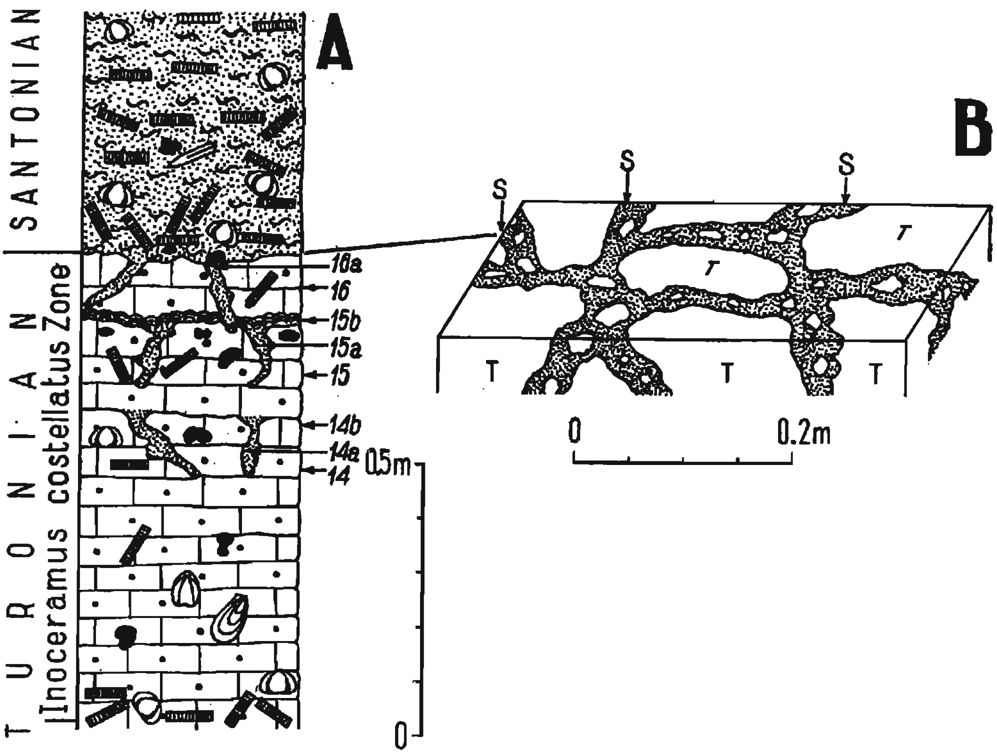


Fig. 8

Detailed profile and boundary of the Turonian and Santonian deposits at Przychody (*cf.* Text-fig. 7)

A — part of the profile with sampling omitted in Text-fig. 7; visible are three subaqueous discontinuity surfaces associated with small neptunian dykes enriched in quartz (*cf.* Pl. 4, Figs 2—3 and Pl. 5, Fig. 2)

B — fragment of the uppermost layer of the Turonian, occurring beneath the discontinuity surface (*cf.* Pl. 10, Fig. 2): *T* Turonian, *S* Santonian

Fig. 7

Vertical succession of microfacies in the Cretaceous deposits at Przychody (outcrop *115* in Text-fig. 4); dashed line denotes a sampled fragment of the profile presented in Text-fig. 8*A*

For quartz and glauconite: *1* frequency, *2* clasticity

For biogenic components: *1* inoceram fragments, *2* planktic foraminifers (mostly *Globigerina*, *Globotruncana*, *Rotalipora*), *3* *Pithonella ovalis* (Kaufmann), *4* benthic foraminifers, *5* sponge spicules (other explanations as in Text-fig. 2)

4. Sandy limestones containing a smaller amount of inoceram debris and single ferruginous-phosphatic nodules. Poor fauna is represented by unrecognizable brachiopods, and by *Inoceramus inconstans* Woods and *Sternotaxis planus* (Mantell). Outside the investigated profile, throughout the region under consideration, the deposits of this unit are poorly exposed. In the vicinity of Solca (near outcrops *116—118*) the following fossils have been collected in the scree:

Inoceramus inconstans Woods — *cf.* Pl. 25, Fig. 3
Cardiaster sp. — *cf.* Pl. 28, Fig. 1
Infulaster sp. — *cf.* Pl. 29, Fig. 1
Sternotaxis planus (Mantell)

The excavation of a trench at Przychody, exposing the boundary of sandy limestones with the Santonian deposits (*cf.* Figs 7—8), offered new data so far unknown from this region (*cf.* Sujkowski 1934, Kowalski 1948). There are namely three discontinuity surfaces within the sandy limestones from which the clastic neptunian dykes start downwardly, being filled with quartz sand (*cf.* Figs 7—8), and attaining the depth of 20 cm by their 2—3 cm width. Two of these discontinuity surfaces occur within the Turonian deposits, and the third one is placed on the Turonian/Santonian boundary (*cf.* Figs 7—8). In the part of the profile between sampling places *13—15b* (*cf.* Figs 7—8*A*) the contact between the dykes, and surrounding sandy limestones is very sharp (Pl. 4, Figs 2—3). It is noted that the increase in quartz within the dykes is accompanied by a simultaneous decrease in glauconite and biogenic components (*cf.* Fig. 7).

One of the discontinuity surfaces (*cf.* Figs 7—8*A*) is covered by stromatolite (Pl. 9 and Pl. 10, Fig. 1) which forms a 2—3 cm coating of the uneven surface of sandy limestones. These denivelations are much greater (2—3 cm) than those under the bottom of Turonian stromatolites at Pniaki near Lelów (*cf.* Marcinowski & Szulczewski 1972). The upper surface of the stromatolites layer is nearly flat, but composed of stromatolite domes (up to 0.5 cm high); in some places it is impregnated by iron hydroxides. The stromatolites coalesce well with the overlying layer (Fig. 8*A*).

The stromatolitic layer is built of particles partly chemical in origin, and partly organic or detrital. Some thin laminae are composed of phosphates. Planktic foraminifers are the main organic component (*cf.* Pl. 11, Fig. 1), but they are fewer in the columns than in the interstices (*cf.* Figs 7—8*A*, mostly sample *15* and *15b*). Quartz grains are also more fragment and bigger in the interstices (*cf.* Pl. 11, Fig. 3 and samples *15* and *15b* in Figs 7—8*A*). The stromatolitic columns are preserved all complete (*cf.* Pl. 11, Fig. 1) indicating the lack of abrasion in the interstices; some walls of the columns are encrusted with phosphates arranged (Pl. 11, Fig. 2) in colloform structures[6].

The Turonian deposits of the Solca region, attaining a thickness of *c.* 2.7 m, are directly overlaid by the Santonian (Kowalski 1948), this being connected with a submarine break in sedimentation (Różycki 1938). The topmost layer of the Turonian sandy limestones is cut be neptunian dykes with a fairly regular trend and stretching downwards below the stromatolites (*cf.* Fig. 8*A*—*B*). Sandy, glauconitic Santonian marls and rather small fragments of Turonian sandy limestones (*cf.* Fig. 8*B* and Pl. 10, Fig. 2) are infilling these dykes. The Santonian deposits contain a large amount of glauconite and inoceram debris (*cf.* Fig. 7 and Pl. 5, Figs 2—4) by which they are clearly distinguishable from the Turonian limestones (*cf.* Pl. 5, Fig. 1).

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[6] As observed by Wendt (1970, p. 438), the part played by algae in the formation of these structures does not seem reliably justified and their resemblance to the stromatolites is only in morphology. It may therefore be assumed, that Upper Cretaceous phosphate stromatolites from the vicinity of Cracow, described by Golonka & Rajchel (1972, Pls 6—7), are non-organic structures, genetically not connected with blue-green algal stromatolites.

Region of Poręba Dzierżna

In the region of Poręba Dzierżna the Cretaceous deposits are exposed only near the village bearing that name (outcrop *110* in Fig. 9). Recently only the upper part of the profile is visible in the outcrop (units *3—4* in Fig. 10), while the lower one (units *1—2*) has been compiled on Sujkowski's (1929) description. Cenomanian deposits to the top grading into Lower Turonian (*cf.* Fig. 10) rest here directly on the Upper Oxfordian marls (Idoceras planula Zone).

Cenomanian

1. Poorly compact quartz sandstones with glauconite, from which Sujkowski (1929) reported [7]: "*Terebratula* cf. *phaseolina* Lam., *Terebratulina* sp., *Modiola* sp., *Inoceramus* sp., *Pecten orbicularis* Sow., *Lima* cf. *semiornata* d'Orbigny, *Opis* cf. *neocomiensis* d'Orb., *Cyprina*(?) sp., *Holaster suborbicularis* Defr., *Discoidea subuculus* Klein, *Discoidea* sp., *Catopygus* sp., *Pyrina inflata* d'Orb.".

2. Quartz-glauconitic unfossiliferous sands.

3. Marly-sandy quartz gravelstones with glauconite, in the matrix of which (Pl. 6, Fig. 1) are embedded single pebbles of quartz and, less often of quartzites, not exceeding 1.5 cm in size. The gravelstones contain the following fossils: *Orbirhynchia mantelliana* (Sowerby), *Terebratulina* sp., "*Terebratula*" *dutempleí* d'Orbigny, *Inoceramus* sp. indet., other undetermined pelecypods, *Actinocamax (Praeactinocamax) plenus* (Blainville) subsp. indet., *Camerogalerus cylindricus* (Lamarck), *Pyrina ovalis ovalis* d'Orbigny, *Holaster poloniae* Lambert, *Oxyrhina angustidens* Reuss, and *Otodus appendiculatus* (Agassiz).

The Cenomanian deposits here exposed (units *1—3*) are 5.9 m thick.

Turonian

4. Limestones containing at the bottom an admixture of quartz grains and pebbles; higher up they grade into zoogenic limestones bearing abundant inoceram remains. The fauna is rich numerically but taxonomically poorly differentiated: *Inoceramus labiatus* (Schlotheim), *Discoides minimus* (Agassiz), *Conulus ellipticus* (Zaręczny), *C. subrotundus* (Mantell).

In the profile here considered, the transition of the Cenomanian deposits into Turonian is accompanied by a distinct and abrupt lithofacial change (*cf.* Fig. 10). At the Cenomanian/Turonian boundary there occurs a sharp decrease in the amount and size quartz and glauconite grains, also of single quartz pebbles while abundant organic remains make their appearance with the predominance of planktic foraminifers (Pl. 6, Fig. 2). Higher up, the admixture of quartz and glauconite grains disappears and, along with calcium carbonate, organic remains are the main components of various microfacies (Pl. 6, Figs 3—5).

The lowermost Turonian deposits near Poręba Dzierżna are overlaid by marls with glauconite, and containing (Sujkowski 1926) *Inoceramus lamarcki* Parkinson. In the scree higher up there occur white marly limestones with a small admixture of quartz and glauconite, and with *Inoceramus* cf. *inconstans* Woods, as well as fragments of other inocerams and echinoid tests.

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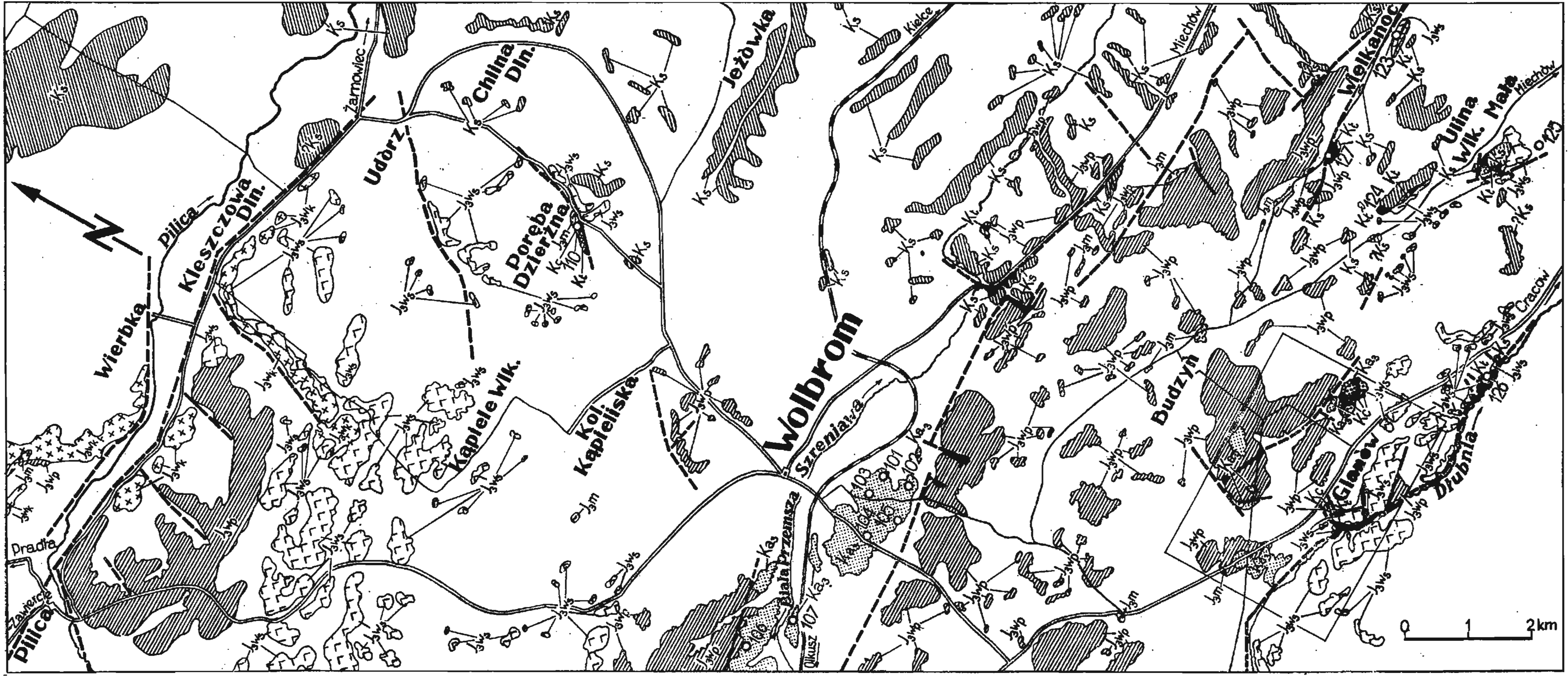
[7] Sujkowski's collection has been lost during the last war, and in view of the present taxonomic requirements — is impossible to state the true assigment of this fauna. It may be only remarked that *Holaster suborbicularis* Defr. probably represents *H. poloniae* Lambert (*cf.* Mączyńska *in* Marcinowski 1970, p. 421).

Załącznik 3

ACTA GEOLOGICA POLONICA, VOL. 24 (1, 1974)

R. MARCINOWSKI, FIG. 9

Geological map of the regions of Poręba Dzierżna, Wolbrom and Glanów (*after* Bednarek 1974, Zapaśnik 1974 and own observations): rectangled is the area magnified in Text-fig. 12, explanations as in Text-fig. 3)



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The Turonian deposits near Poręba Dzierżna are c. 10 m thick. Santonian marls occur higher up (Bukowy 1968) with a distinct stratigraphic gap.

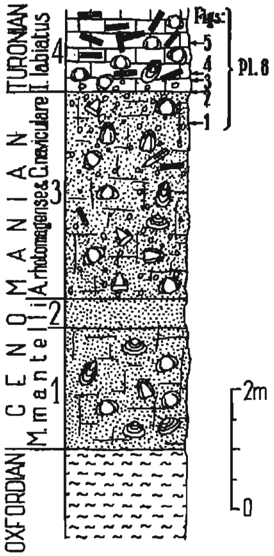

Fig. 10

Profile of the Cretaceous deposits at Poręba Dzierżna (outcrop *110* in Text-fig. 9); arrowed are the places of sampling for microfacial analysis of the Cenomanian/Turonian transitional beds (*cf.* Pl. 6, Figs 1—5); other explanations as in Text-fig. 2

Region of Wolbrom and Glanów

Within the Wolbrom-Glanów region the Albian-Turonian deposits occur over a large area and they are exposed in a number of outcrops (*cf.* Figs 9, 12). In the western part of the region, near Wolbrom, their exposures are represented only by the Upper Albian deposits resting on Upper Jurassic platy limestones, and which are preserved (Fig. 9) in a tectonic graben (Sujkowski 1926, Bukowy 1968). In the eastern part, near Glanów and Wielkanoc, along with the deposits of the Albian deposits are also represented those of the Cenomanian and Turonian; in some places these directly overlie the lithologically differentiated Jurassic substrate (*cf.* Figs 9, 12, 27).

Upper Albian

In the vicinity of Wolbrom no contact of the Cretaceous deposits with the Upper Jurassic substrate is now exposed, but the Upper Albian profile may be here subdivided into three parts.

The lowest part (outcrop *105* in Fig. 9) is represented by non-calcareous green clays with single quartz pebbles, discoidal in shape and not exceeding 1 cm in size. In other places (near outcrop *106* in Fig. 9), the Upper Jurassic platy limestones are directly overlaid by quartz sands and sandstones with glauconite, mixed with quartz gravel (Sujkowski 1926), and bearing rarely distributed sponges.

The middle part (outcrops *101, 103, 107* in Fig. 9) is developed as medium-grained quartz sands with glauconite without gravel intercalations. Within the

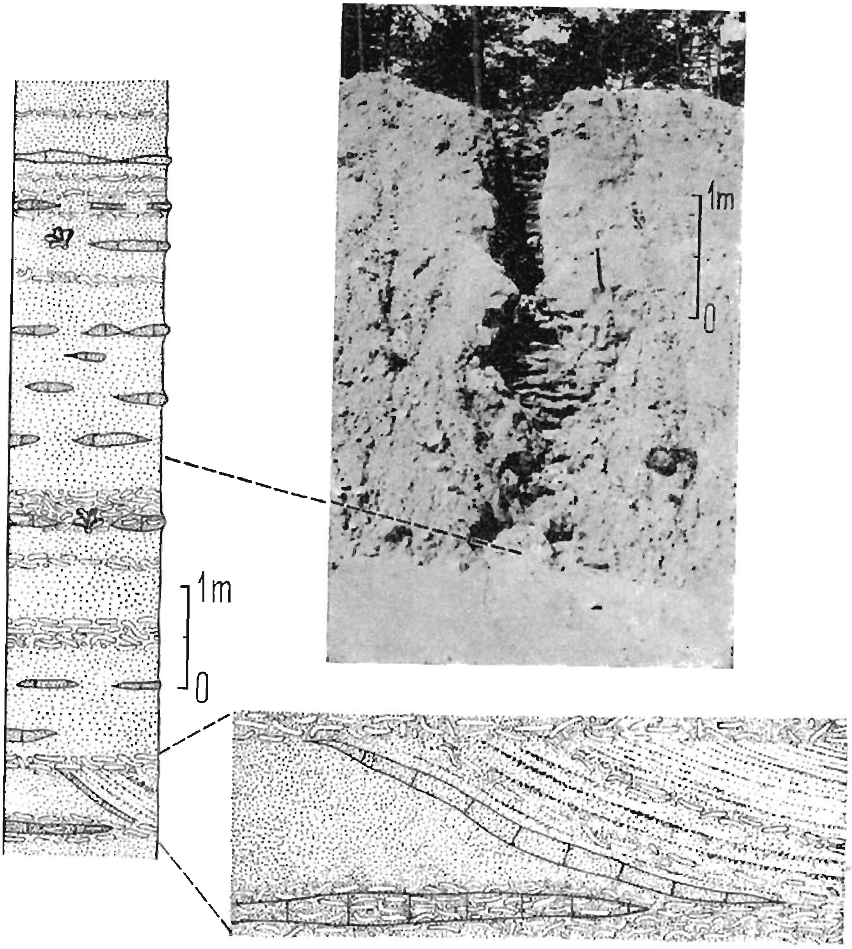

Fig. 11

Profile of the Upper Albian deposits at Wolbrom (outcrop *103* in Text-fig. 9); presented is distribution of traces fossils *Chondrites* sp. (*cf.* Pl. 16, Figs 1—2); other explanations as in Text-fig. 2

sands there are lenses and concretions of sandstones (Pl. 2, Fig. 2; *cf.* also Fig. 11) bearing very rare sponges. Burrows of the ichnogenus *Chondrites* Sternberg are here (outcrop *103* in Fig. 9) abundant (Fig. 11; Pl. 16, Figs 1—2). In some places the sands are obliquely bedded (*cf.* Fig. 11).

The upper part (outcrops *102, 104* in Fig. 9) is developed analogously as the latter, but it contains numerous intercalations of gravels and gravelstones, the quartz pebbles in which are discoidal in shape and 5—8 mm in size.

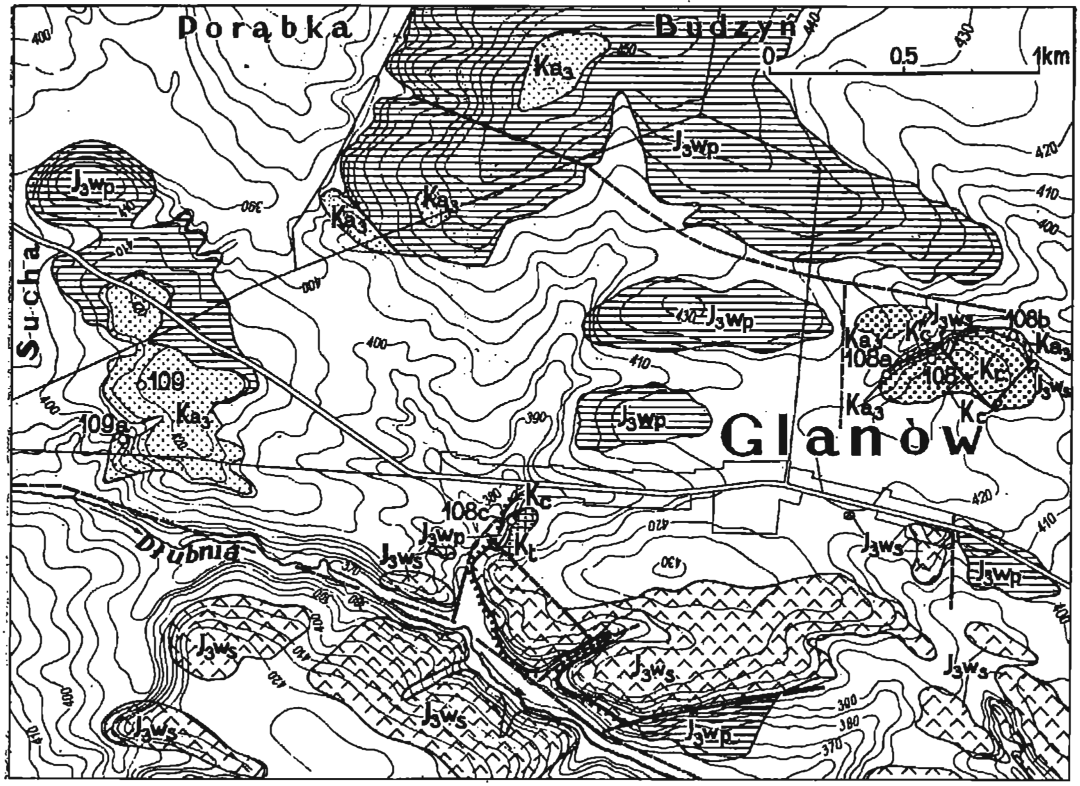

Fig. 12

Geological map of the vicinity of Glanów; explanations as in Text-fig. 3

The total thickness of all these deposits in the vicinity of Wolbrom exceeds 40 meters[8] (*vide* Fig. 28).

An interesting Upper Albian profile (Figs 13—14) is well exposed in a great sandpit at Sucha (outcrop *109* in Fig. 12). The presence is seen here of non-calcareous quartz sands with glauconite in which are embedded numerous lenses, irregular bodies or concretions of siliceous sandstones (Pl. 2, Fig. 3) sporadically containing sponges (Fig. 15). Opal encrustations often occur on the surface or in the crevices of these sandstones. The quartz fraction is medium-grained in the greater part of the profile (units *2*—*6* in Fig. 13), being coarse-grained only in the lower part (unit *1*). Throughout the profile the sand is diversely bedded forming several sedimentary structures. The arrangement of the intercalations of siliceous sandstones coincides with that of these structures. Burrows *Chondrites* sp. rather

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[8] The thickness of these deposits was determined by Bukowy (1968) at 18 m but the map attached to his paper indicates at least 25—30 m. On the basis of unreliable lithological evidence, the Albian and the Cenomanian were distinguished by Burzewski (1969, p. 37) in the Wolbrom region, stating their total thickness as 10 m. The remaining part of sands in this profile Burzewski assigned to the Quaternary (*sic*!). This is a misunderstanding since glauconite is present throughout this profile and the thickness of the sands and sandstones, with *Chondrites* sp. (outcrop *103* in Fig. 9), representing but the middle part of the Upper Albian profile, is in itself 8—12 meters.

numerous here display a similar arrangement. The characteristics of the individual units (*1—6* in Fig. 13) are as follows:

1. Sand with fine-scale oblique bedding, less often parallel: the individual laminae have variable angles and inclination directions resulting in flat wedge-like types of bedding. The planes separating various types of bedding are occasionally covered with gravel material. Burrows *Chondrites* sp. are numerous.

2. In the median part the fine-scale bedding is wedge-like (*cf.* Fig. 13) while in the top part it is oblique, tangential, truncated by erosion. In the remaining part of the unit the sand is a parallel bedded. Burrows *Chondrites* sp. (Pl. 14, Fig. 2) are not so numerous as in the above unit. Siliceous sponges occur only in the sandstone concretions.

3. Parallel-bedded sand containing a large admixture of clay. Sponges (Fig. 15) abound in the sandstone concretions, while silicified wood (up to 80 cm in size) is numerous in the sands; burrows *Chondrites* sp. are very rare. This unit does not truncate the underlying deposits (*cf.* Fig. 14*B*) and its direction (25°/8°S) determines the tectonic strike and dip.

4. The sand is large-scale (5 m) bedded (*cf.* Figs 13 and 14*B*), in most cases tangential, in some it passes into diagonal. The sandstone intercalations are rare (*cf.* Fig. 13), but there is an abundance of burrows *Chondrites* sp. (Pl. 14, Fig. 1 and Pl. 15), with its maximum frequency in the lower part of the unit (*cf.* Fig. 13).

5. The bedding of the sand is parallel throughout the unit. Burrows *Chondrites* sp. are scarce.

6. This unit truncate its substrate (units *4—5*) and fills a large erosional trough (*cf.* Fig. 14*B—C*). The bedding of sands follows the outline of the trough and this is also stressed by the direction of sandstone intercalations (Fig. 14*C*). The direction of the trough is nearly equatorial while its longitudinal axis plunges eastwardly; the truncation of underlying deposits (unit *4*) is observable in this very direction.

Analogous sands occur in a neighboring outcrop *109a* (*cf.* Fig. 12) but containing numerous concretions of siliceous sandstones. Moulds of various borings, made by sponges, polychaetes, pelecypods (i.a. *Gastrochaena* sp. — Pl. 17, Fig. 9) are sometimes present inside these concretions, and are filled with the same siliceous sandstone. The moulds are often stretching into the clayey residuum contained in the concretion interior and they outline the fragments of Jurassic limestones, calcium carbonate of which has been removed during further diagenesis (the sandstones are now completely decalcified).

North of Glanów there are outcrops (Fig. 16) of non-calcareous, fine-grained quartz sands with an admixture of glauconite and abundant muscovite flakes; they represent the uppermost Albian and grade with continuity into the Cenomanian (Fig. 17). An analysis of the distribution of the Upper Albian deposits near Glanów and Sucha shows their maximum thickness to be about 33 m (near outcrops *109* and *109a* — about 25 m).

Cenomanian

The Cenomanian deposits resting in sedimentary continuity on Upper Albian are exposed only northwardly of Glanów (outcrops *108*, *108b* in Fig. 12; *cf.* also Fig. 17); their profile being as shown below (Fig. 18, units *2—4*).

2. Marly-sandy gravelstones containing quartz pebbles and pieces of Jurassic flints. The matrix contains glauconite and single ferruginous-phosphatic nodules. Quartz pebbles are discoidal in shape and 2 cm in size; fragments of Jurassic flints (5—10 cm) are coated with a glauconitic film.

3. Marly, coarse-grained quartz sandstone with glauconite and single quartz pebbles, 1.5—2 cm in size and representing 15—20% of the rock volume. Ferruginous-phosphatic nodules are numerous, whereas the fauna is sparse: *Holaster poloniae* Lambert and *Otodus appendiculatus* (Agassiz).

4. Marly, medium-grained quartz sandstone containing a large amount of glauconite (Pl. 7, Fig. 1). In the upper part of the unit some parts of the rock are silicified. The fauna is relatively numerous, and represented by: *Orbirhynchia mantelliana* (Sowerby), *Lepidorhynchia sigma* (Schloenbach), *Inoceramus crippsi* Mantell, *Discoides subuculus* (Klein), *Holaster poloniae* Lambert, *Oxyrhina angustidens* Reuss and *Otodus appendiculatus* (Agassiz).

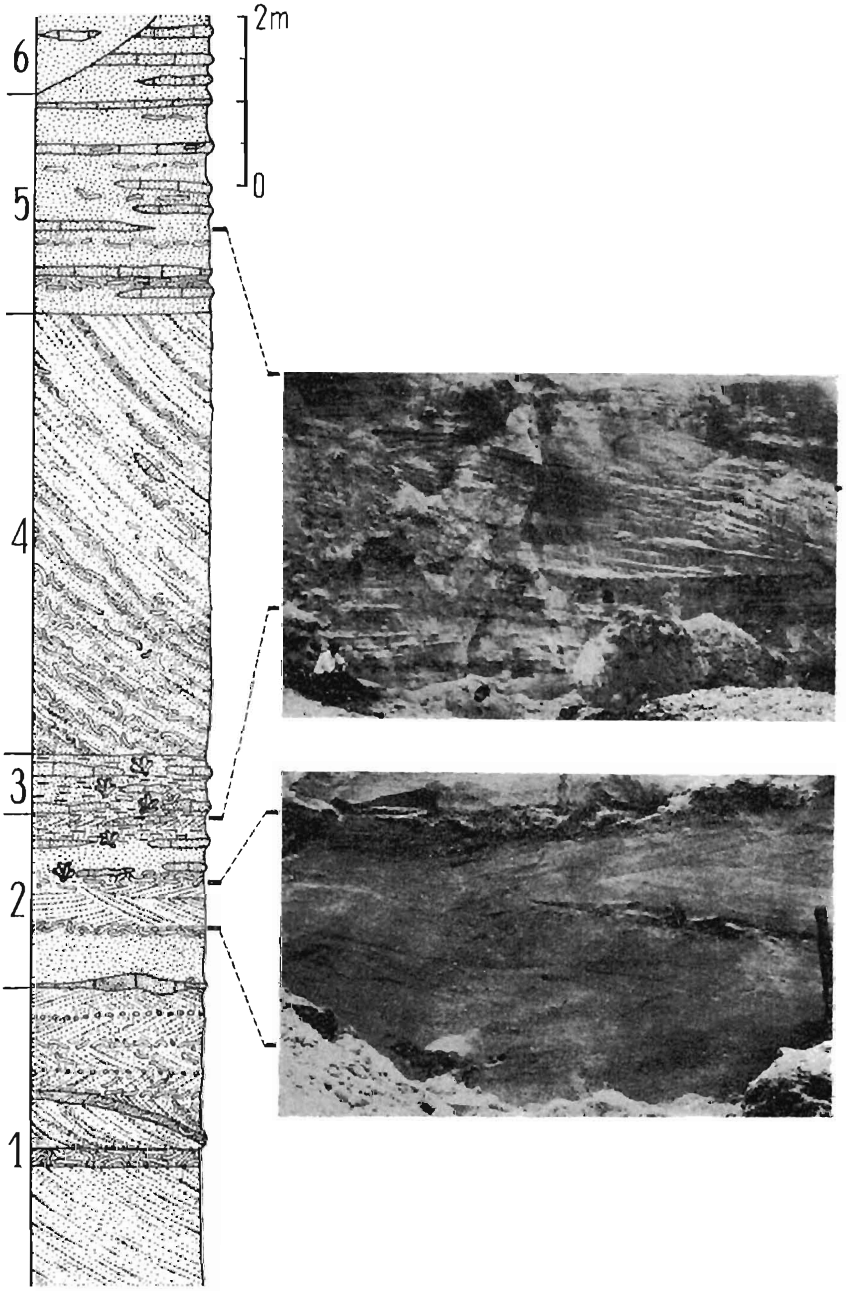
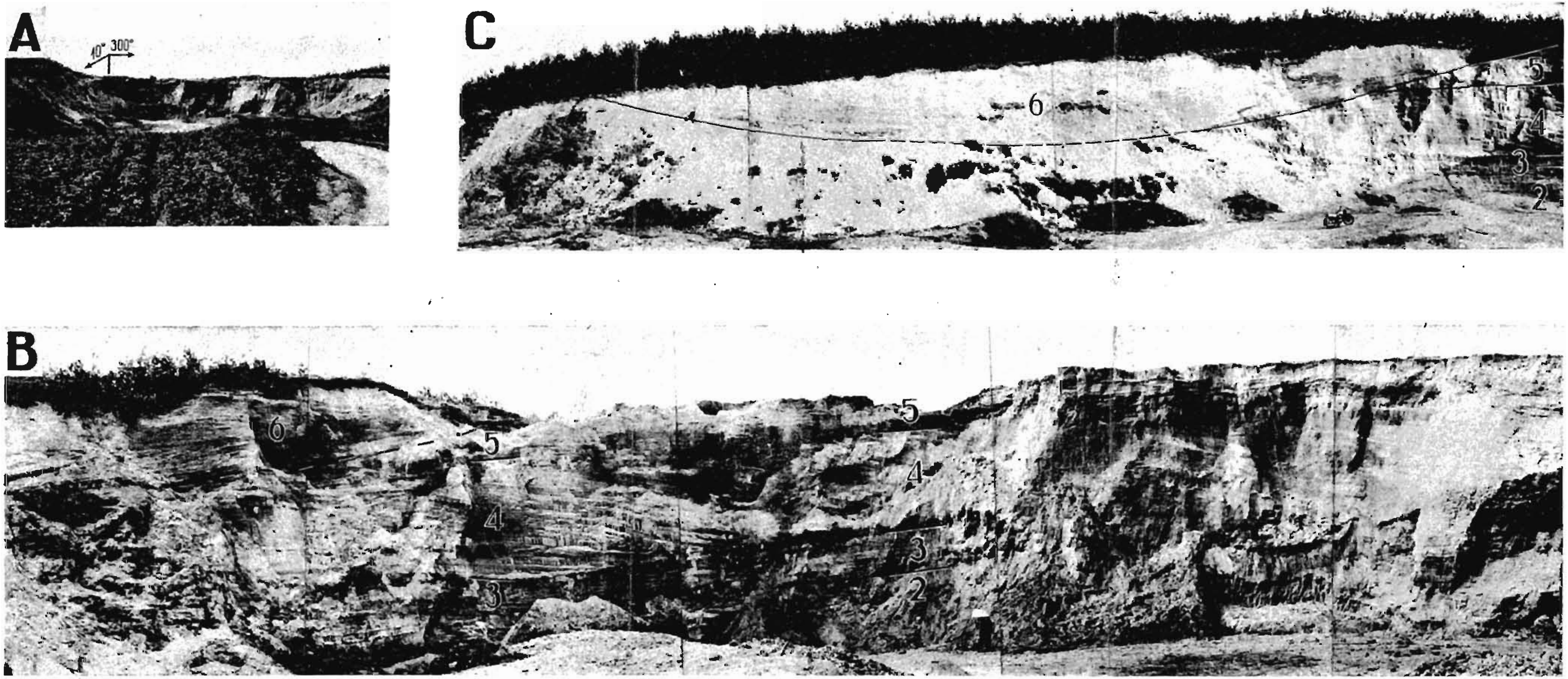


Fig. 13

Profile of the Upper Albian deposits at Sucha (outcrop *109* in Text-fig. 12, explanation as in Text-fig. 2; angle of diagonal bedding in unit *4* strongly exaggerated)



Sand-pit at Sucha — visible are Upper Albian deposits profiled in Text-fig. 13

A — general view of the outcrop, and azimuths of its walls (cf. *B* & *C* in this figure) *B* — southern wall of the outcrop *C* — eastern wall of the outcrop

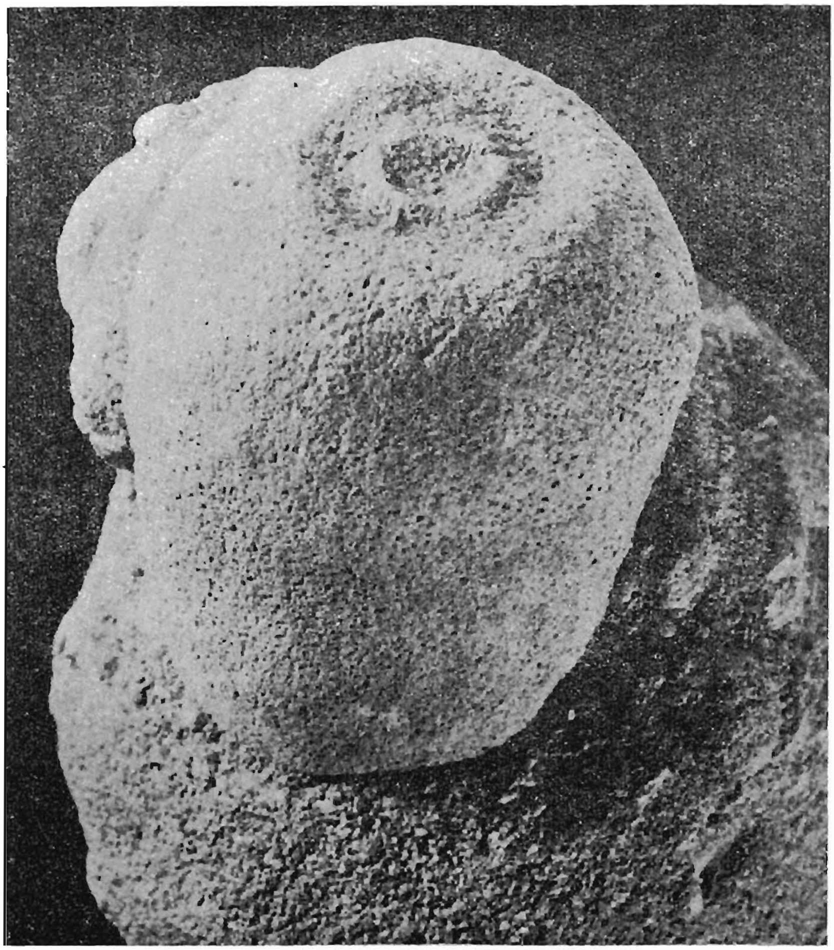


Fig. 15

Sponge in a siliceous concretion in sandstones; Upper Albian, Sucha (outcrop *109*)

Near the outcrops here discussed (*108, 108a*), the Albian and Cenomanian deposits are disturbed by a fault with a small throw (Fig. 19).

The Cenomanian deposits with a transition to the Turonian (Figs 20—22) have been exposed in a trench[9] on the western outskirts of Glanów (outcrop *108c* in Fig. 12). They are preserved in the downthrown limb of the fault (Sujkowski 1926) and therefore they are laterally in a tectonic contact with Upper Jurassic butten limestones (Fig. 21). In the section, they rest on Upper Jurassic platy limestones, the surface of which is uneven, and sculptured by small clefts (*cf.*

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[9] The trench is situated on the wall of an abandoned quarry, which for many years has been known in the literature, and yielded many fossils (*cf.* Sujkowski 1926; Panow 1934; Popiel-Barczyk 1958; Mączyńska 1958, 1962) though its more detailed lithological description and stratigraphic assignment have never been presented.

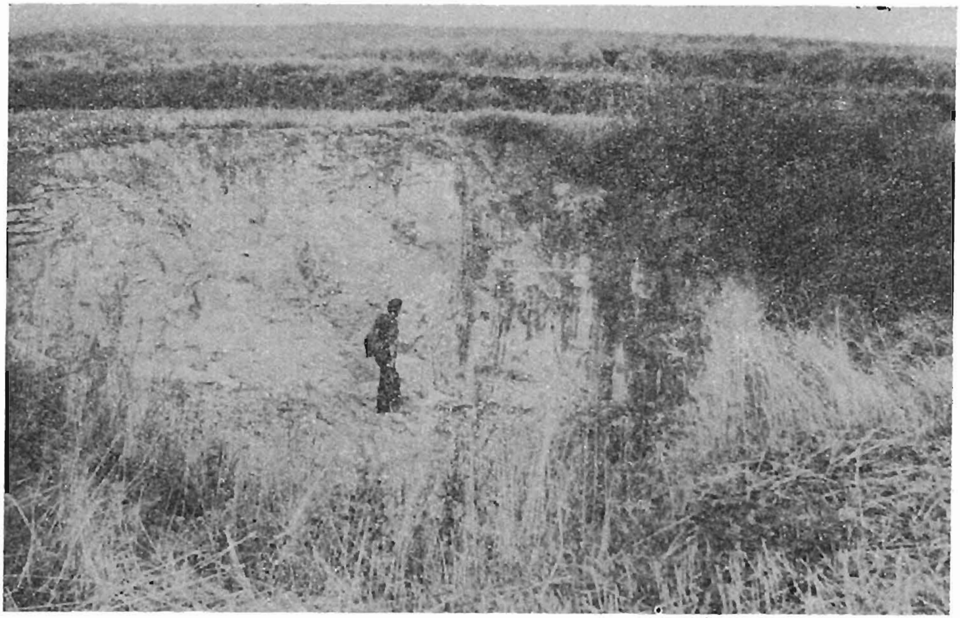

Fig. 16

Sands of the uppermost Albian at Glanów (outcrop *108a* in Text-fig. 12)

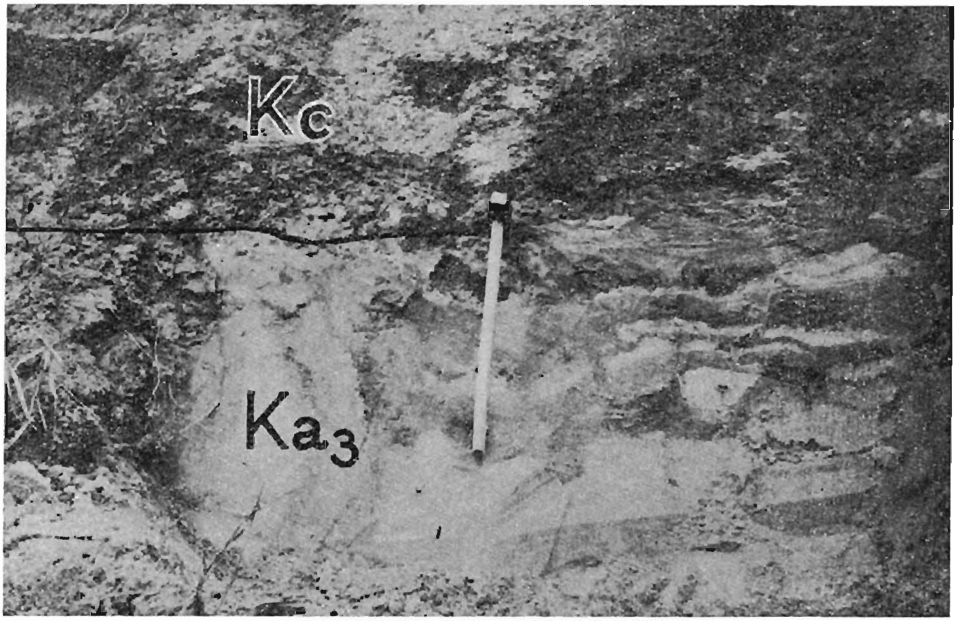

Fig. 17

Contact of the Albian and Cenomanian deposits at Glanów (outcrop *108* in Text-fig. 12): Ka_3 Upper Albian, *Kc* Cenomanian

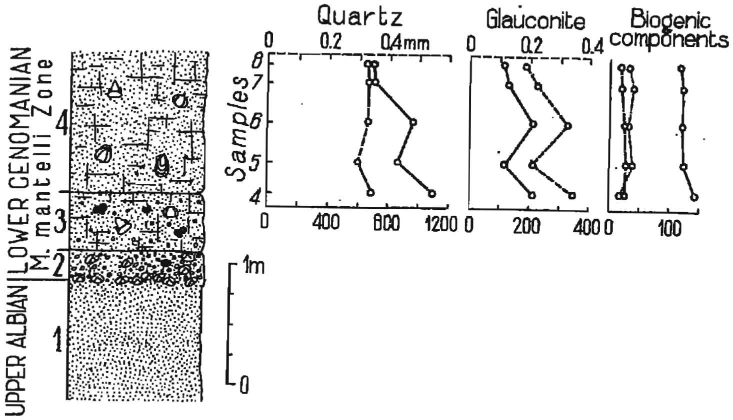

Fig. 18

Vertical succession of microfacies in the Lower Cenomanian deposits at Glanów (outcrop *108b* in Text-fig. 12; explanations as in Text-fig. 7)

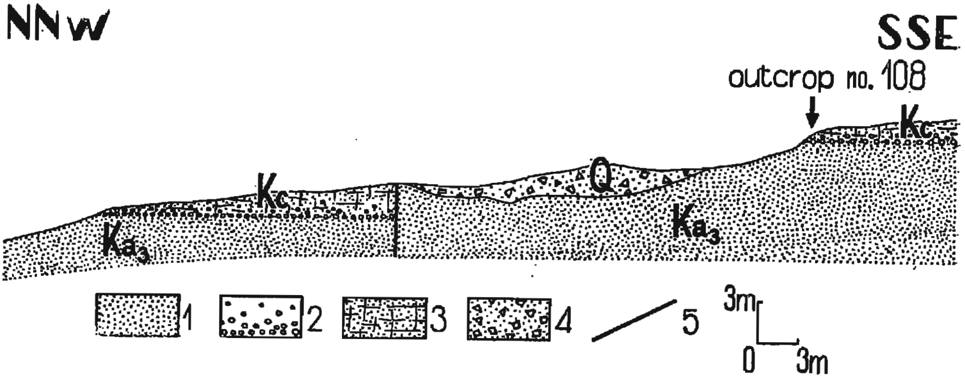

Fig. 19

Geological section of the Albian and Cenomanian deposits at Glanów (near outcrop *108*, cf. Text-fig. 12)

1 sands, *2* gravelstones, *3* sandstones, *4* slope waste, *5* faults
Ka_3 Upper Albian, *Kc* Cenomanian, *Q* Quaternary

Fig. 22). The lithological units differentiated here, and representing the Middle and Upper Cenomanian (Figs 20, 22) are of the characteristics as follows (units *2a*—*2d* in Fig. 22).

2a. Calcareous quartz conglomerate, which pebbles and rather few quartzite pebbles are discoidal and varying in size (0.3—3 cm, most commonly being 1—1.5 cm); they represent c. 70% of rock volume. The matrix consists of foraminifer limestone (Pl. 2, Fig. 4). In the

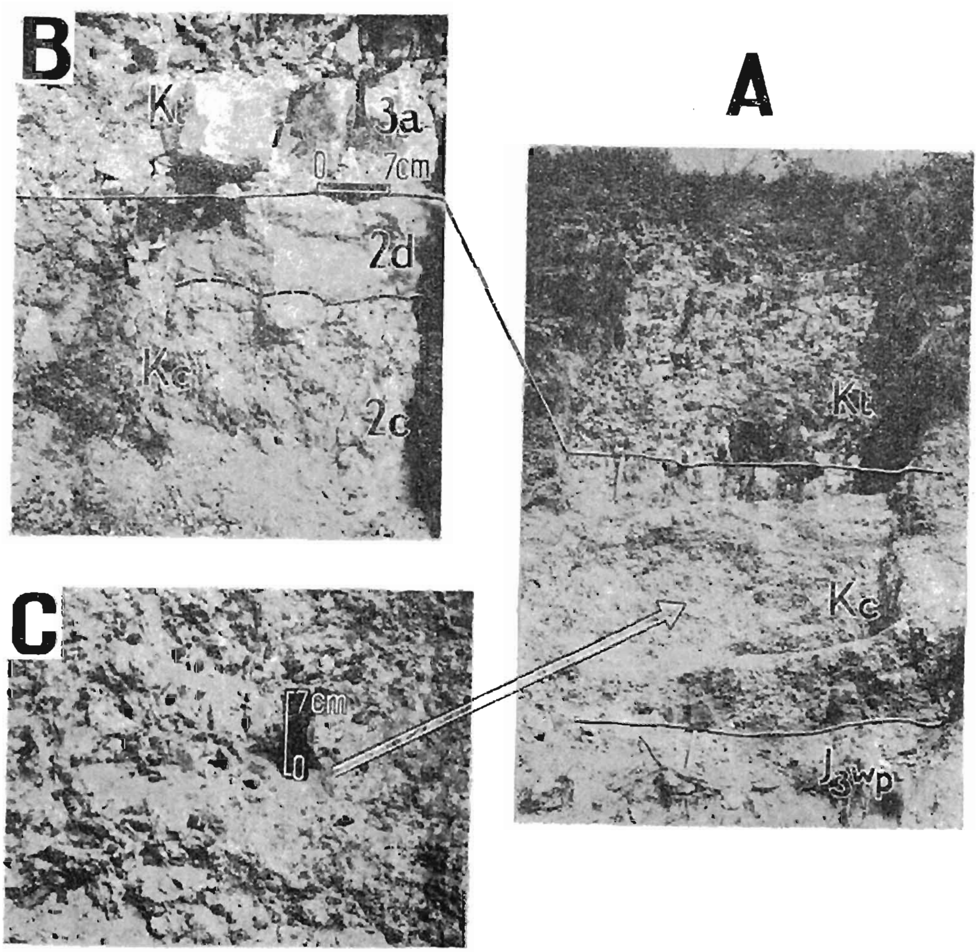

Fig. 20*A*—*C*

Trench through the Jurassic substrate and Cretaceous deposits at Glanów (outcrop *108c* in Text-fig. 12; explanations as in Text-fig. 21)

A general view, *B* Upper Cenomanian/Lower Turonian boundary (numbers denote the lithological units presented in Text-fig. 22), *C* fossiliferous Middle Cenomanian conglomerates with phosphatic nodules (unit *2a* in Text-fig. 22)

lower part of the unit the pebbles are arranged at random while in the higher part and in unit *2b* they are imbricated here and there. At the bottom, there occur pieces (10—15 cm) of Upper Jurassic limestones and flints, occasionally coated with a glauconitic film. All the pebbles are sometimes encrusted by serpulids (Pl. 17, Figs 5—8). The lime-phosphatic nodules are very abundant in this unit, in some places the conglomerate being completely phosphatized. The rich, but poorly preserved fossils are represented mainly by phosphatic moulds sometimes overgrown by serpulids.

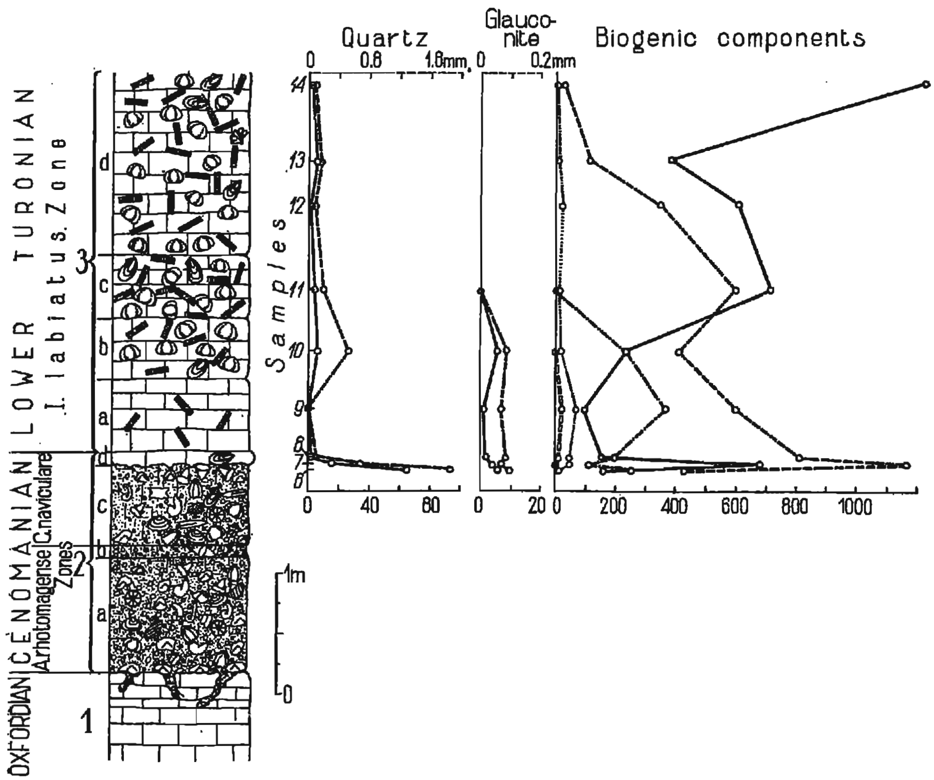

Fig. 22

Vertical succession of microfacies in the Cretaceous deposits at Glanów (outcrop *108c* in Text-fig. 12, explanations as in Text-fig. 7)

The list of fossils is following:

Various undetermined sponges,
Corals ex fam. Caryophylliidae,
Polychaetes *Glomerula gordialis* (Schlotheim) and other undetermined (Pl. 17, Figs 5—8)

Brachiopods:

Orbirhynchia mantelliana (Sowerby)
O. parkinsoni Owen — Pl. 20, Fig. 7
Cyclothyris antidichotoma (Buvignier)
Cretirhynchia plicatilis (Sowerby)
Lamellaerhynchia caseyi Owen — Pl. 21, Fig. 4
Sellithyris(?) sp. — Pl. 19, Fig. 6
Ornatothyris sulcifera (Morris)
Ornatothyris sp.
"*Terebratula*" *dutempiei* d'Orbigny — Pl. 18, Fig. 6

Pelecypods:

Cucullaea sp.
Pinna sp.
Chlamys sp.
Lima sp.
Ostrea sp.
Isocardia heintzeli Wolleman

Ammonites:

Sciponoceras subbaculoides (Geinitz) — Pl. 31, Fig. 1
Scaphites (Scaphites) equalis Sowerby
Puzosia (Puzosia) subplanulata (Schlüter) — Pl. 31, Fig. 4
Schloenbachia cf. *varians* (Sowerby)
S. subtuberculata (Sharpe) — Pl. 34, Figs 1—2
S. cf. *quadrata* Spath
S. ventriosa Stieler
Schloenbachia sp.
Acanthoceras sp. — Pl. 31, Fig. 5

Echinoids:

Discoides subuculus (Klein)
Pyrina ovalis ovalis d'Orbigny
Pygaulus pulvinatus d'Archiac — Pl. 26, Fig. 5
Holaster poloniae Lambert
Holaster sp.

Shark teeth:

Oxyrhina angustidens Reuss
Otodus appendiculatus (Agassiz)

2b. Marly quartz conglomerate with a relatively great admixture of clay, size of pebbles being distinctly smaller than in the preceding unit. Fauna scarce, represented only by shark teeth, *Oxyrhina angustidens* Reuss and *Otodus appendiculatus* (Agassiz).

2c. Calcareous quartz conglomerate in which the size of pebbles (0.5 cm) and their number volume decrease distinctly towards the top. In the lower part, the pebbles consist in c. 40—50% of rock volume and, moreover, the occurrence is observed here of single, rather small (2—4 cm) pieces of Upper Jurassic limestones. The uppermost part of the unit is developed as limestones containing rather few grains of quartz and glauconite (*cf.* Fig. 22), but very numerous fine-organic detritus (Pl. 7, Figs 2—3). Lime-phosphatic nodules occur throughout this unit, the topmost part of which displays evidences of submarine erosion.

The list of fossils, mostly from lower and middle part of the unit, is following:
Various undetermined sponges,
Corals ex fam. Caryophylliidae,

Brachiopods:

Orbirhynchia parkinsoni Owen
Cretirhynchia sp. — Pl. 21, Fig. 5
Arcuatothyris arcuata (Roemer) — Pl. 18, Fig. 1
Praelongithyris sp.
Gibbithyris sp.
Concinnithyris(?) *subundata* (Sowerby)
Ornatothyris sulcifera (Morris)
Ornatothyris sp. — Pl. 20, Fig. 4
"*Terebratula*" *dutempiei* d'Orbigny

Gastropods:

Trochus sp.
Pleurotomaria sp.
Natica extensa Sowerby

Pelecypods:

Inoceramus bohemicus Leonhard
"*Ostrea*" cf. *hippopodium* Nilssen
Exogyra sp.

Ammonites:

Sciponoceras subbaculoides (Geinitz)
Schloenbachia cf. *lymensis* Spath

Belemnites:

Actinocamax (Praeactinocamax) plenus plenus (Blainville) — vide Marcinowski 1972 (Pl. 1)
A. (P.) primus primus Arkhangelsky — vide Marcinowski 1972 (Pl. 2, Fig. 1)

Echinoids:

Conulus ellipticus (Zaręczny), only in the uppermost part of the unit
C. subrotundus (Mantell), only in the uppermost part of the unit
Pyrina ovalis ovalis d'Orbigny
P. ovalis plana Mączyńska
Pygaulus pulvinatus d'Archiac
Holaster cf. *subglobosus* Leske

Shark and ray teeth:

Oxyrhina angustidens Reuss
Otodus appendiculatus (Agassiz)
Scapanorhynchus rhaphiodon (Agassiz) — Pl. 30, Fig. 10
Ptychodus decurrens Agassiz — Pl. 30, Figs 12—15

2d. Laminated limestones resting on the uneven surface of the underlying unit; fossils rare, represented by *Inoceramus crippsi* Mantell (*cf.* Pl. 25, Fig. 1).

The total thickness of the Cenomanian deposits in the Glanów area (Lower Cenomanian — outcrop *108b*, Middle and Upper Cenomanian — outcrop *108c*) may be estimated at 5 meters.

Turonian

The Lower Turonian organodetrital limestones (Inoceramus labiatus Zone) are known only from the above described outcrop *108c* at Glanów where they occur in sedimentary continuity with Cenomanian deposits. These limestones (units *3a—3d* in Fig. 22) are composed mostly of inoceram and echinoid debris

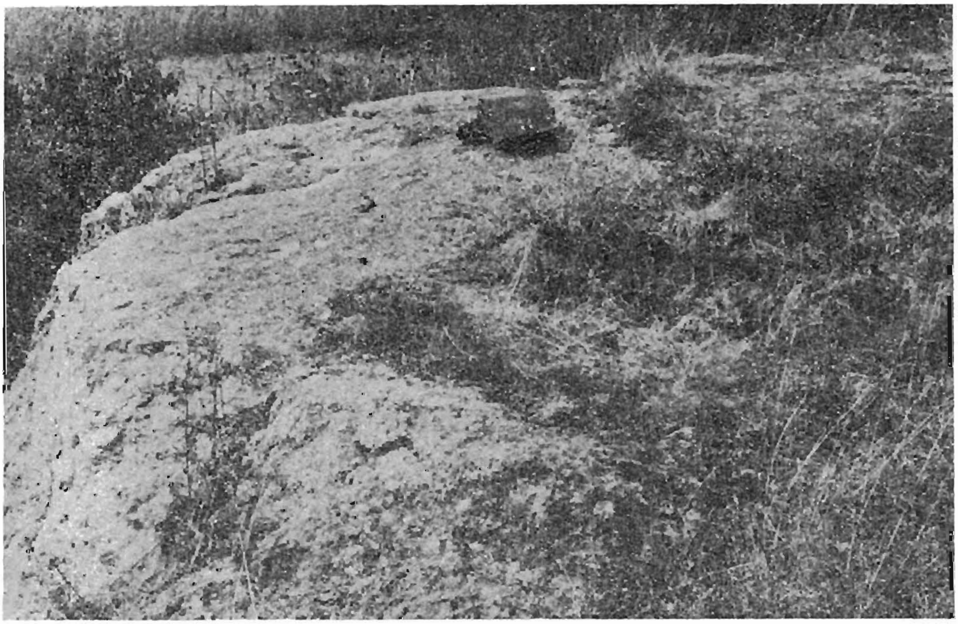

Fig. 23

Lower Turonian abrasion surface upon the Upper Jurassic butten limestones, Ulina Wielka (outcrop *124* in Text-fig. 9)

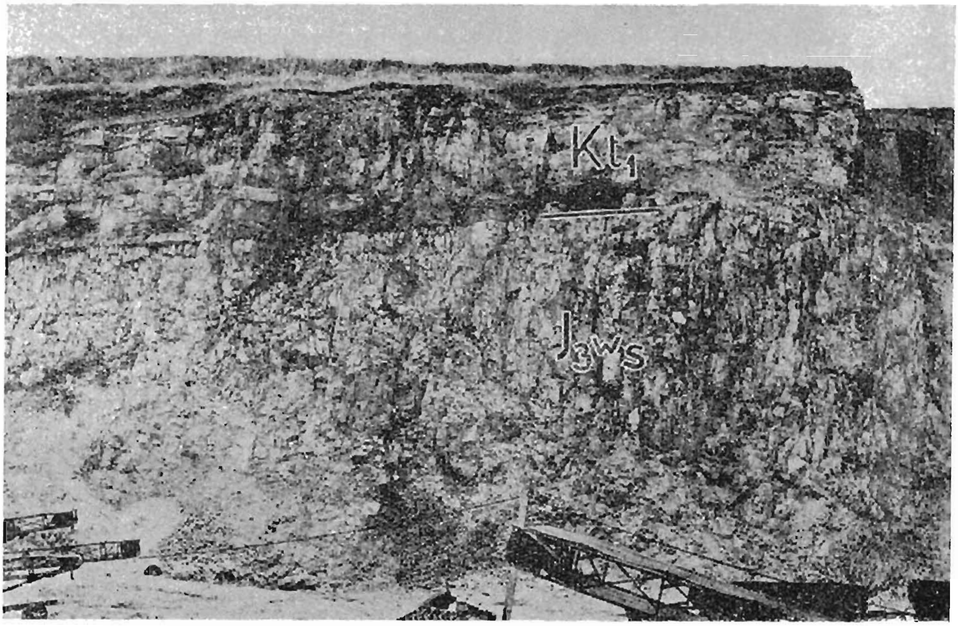

Fig. 24

Contact of the Lower Turonian deposits (Inoceramus lamarcki Zone) with the Upper Oxfordian substrate (Idoceras planula Zone), Wielkanoc (outcrop *123* in Text-fig. 9)

J_3ws Upper Oxfordian butten limestones, *Kt_1* Lower Turonian layered limestones

(*cf.* Fig. 22 and Pl. 7, Figs 4—5). The better preserved forms, being very abundant, are represented almost exclusively by *Inoceramus labiatus* (Schlotheim) and echinoids:

Discoides minimus (Agassiz)
Conulus ellipticus (Zaręczny) — *cf.* Pl. 29, Fig. 2
C. subrotundus (Mantell)

In the remaining part of the Glanów area (outcrops *123—126* in Fig. 9) there are presented limestones of the upper part of the Lower Turonian (Inoceramus lamarcki Zone) which are often resting on the abrasion surfaces developed in Upper Jurassic limestones (Figs 23—25). Sometimes, these limestones at the contact with the Upper Jurassic substrate contain single quartz pebbles of exotic origin (Pl. 2, Fig. 5). At Wielkanoc (outcrop *123* in Fig. 9), these deposits exposed now in a big quarry (*cf.* Figs 24—25), rest on a vast but flat abrasion surface developed on Upper Oxfordian butten limestones (Idoceras planula Zone). In some places the abrasion surface is cut by borings of polychaetes (Pl. 12, Figs 1—3) of the "*Potamilla*" type *C* (*cf.* Głazek, Marcinowski & Wierzbowski 1971). The Turonian deposits, lowermost in the profile, are sandy marls with a high content of quartz and glauconite (*cf.* Fig. 26 and Pl. 8, Fig. 1). Towards the top the marls grade into limestones, which display a diversity of microfacies (Pl. 8, Figs 2—4). Throughout the profile the fauna is abundant and represented by:

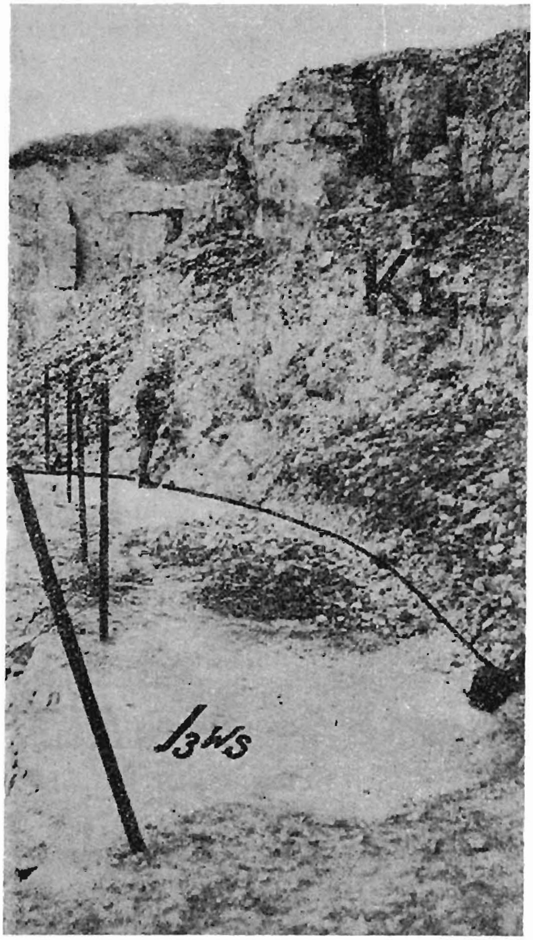

Fig. 25

Lower Turonian abrasion surface upon the Upper Oxfordian butten limestones, Wielkanoc (location and explanations as in Text-fig. 24)

Inoceramus lamarcki Parkinson
I. annulatus Goldfuss — *cf.* Pl. 22, Fig. 8
Discoides minimus (Agassiz)
Conulus ellipticus (Zaręczny)
C. subrotundus (Mantell)

Elsewhere the Turonian deposits rest on a layer of marl (5—6 cm) which intercalate the Upper Jurassic platy limestones (outcrop *127* in Fig. 9). Sujkowski (1926) mentions i.a. *Inoceramus* cf. *inconstans* Woods from the scree at Ulina Wielka, stressing the presence of higher Turonian zones. The total thickness of the Turonian deposits in the Wolbrom-Glanów region is *c.* 10 meters. It should be stressed that in this area the distribution of Cretaceous deposits is largely affected by morphology of the Upper Jurassic substrate, in result of which Cretaceous deposits of various age rest directly on Upper Jurassic limestones (Fig. 27); the same is also even near Wolbrom where locally Albian-Cenomanian deposits are lacking and the Turonian ones are the first on the substrate (borehole at Szreniawa — *cf.* Bukowy 1968).

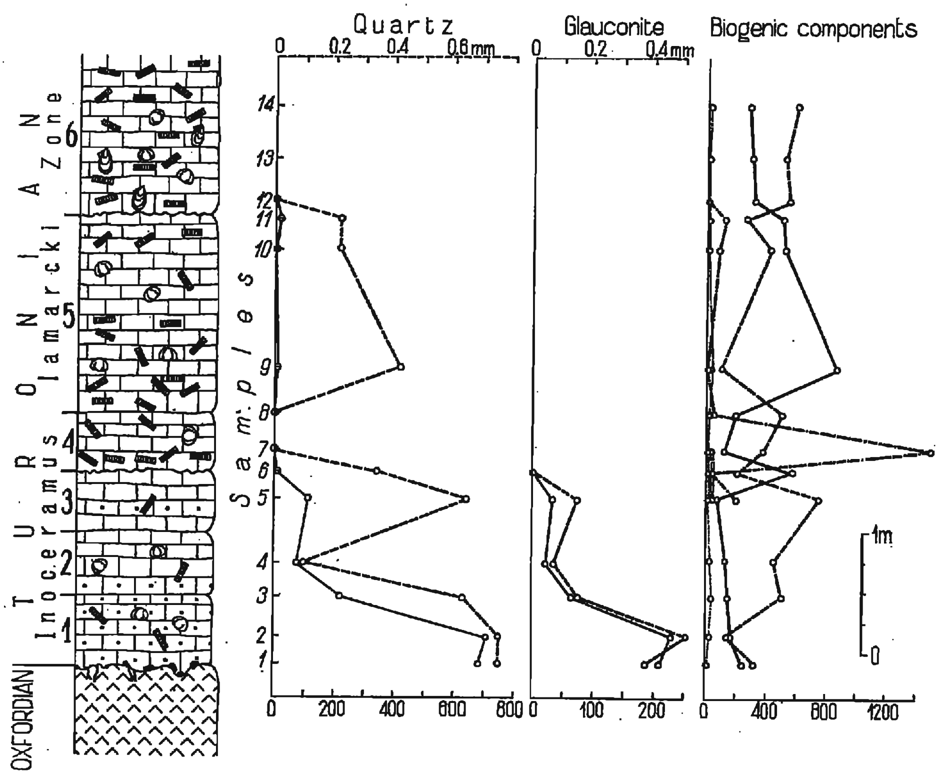

Fig. 26

Vertical succession of microfacies in the Lower Turonian deposits at Wielkanoc (outcrop *123* in Text-fig. 9, explanation as in Text-fig. 7); borings of the "*Potamilla*" type are marked in the Upper Oxfordian substrate

MICROFACIAL ANALYSIS

In the investigated area, the non-calcareous, sandy deposits of the Upper Albian and the marly-sandy ones of the Cenomanian (excepting the Middle and Upper Cenomanian at Glanów), are almost completely devoid of detrital organic particles. These appear en masse (*cf.* Figs 7, 22, 26) only within deposits having a high percent content of calcium carbonate (sandy limestones, limestones, sandy marls). In this connection the microfacial analysis covers only the Cenomanian and Turonian rocks, also those from the bottom parts of the Santonian, the description of the Cenomanian deposits being rather general for reasons as stated above. A description of the characteristics of the Upper Cenomanian, Lower Turonian and bottom Campanian layers, from the northern part of the area here discussed (vicinity of Zalesice and Lelów), has been presented

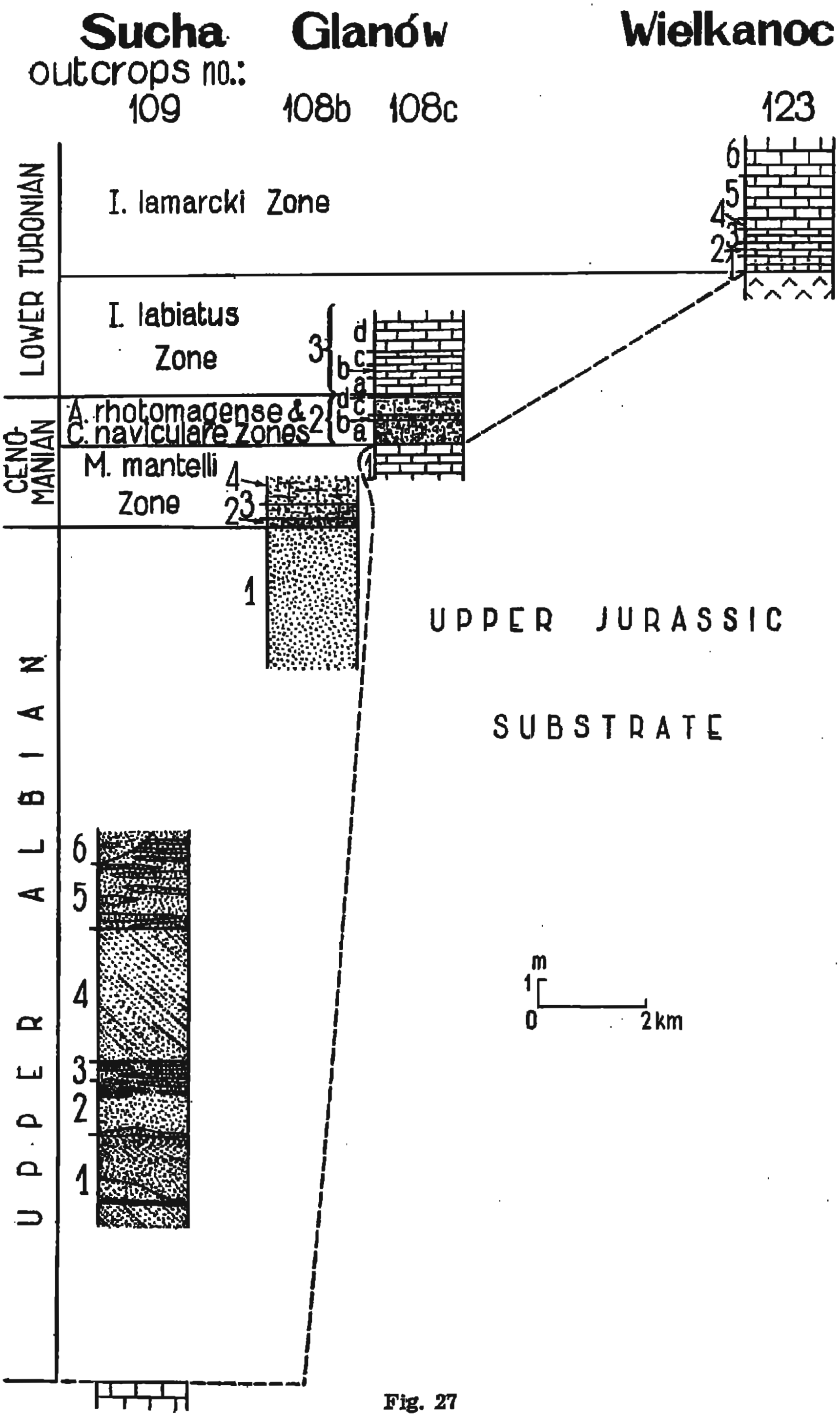

Fig. 27

Relation of the Cretaceous deposits to the Upper Jurassic substrate near Glanów and Wielkanoc (for location of the profiles see Text-figs 9 and 12) previously (Marcinowski & Szulczewski 1972). In the present paper, in an analogous manner (*cf.* Marcinowski & Szulczewski 1972, p. 518) a description is given of the other profiles, the stratigraphy of which has been recognized in detail (*cf.* Figs 7, 18, 22, 26).

Vertical succession of microfacies

Lower Cenomanian. — The occurrence frequency of quartz greatly exceeds that of biogenic components which are represented chiefly by inoceram and foraminifer fragments (*cf.* Fig. 18 and Pl. 7, Fig. 1); that of glauconite being high, too.

Middle and Upper Cenomanian. — In places where deposits representing this stage rest in sedimentary continuity on the Lower Cenomanian (Przychody, outcrop *115* in Fig. 4; Poręba Dzierżna, outcrop *110* in Fig. 9), the content of quartz and glauconite keeps high, while there are hardly any organic remains (*cf.* Fig. 7; Pl. 3, Fig. 1 and Pl. 6, Fig. 1).

At Glanów (outcrop *108c* in Fig. 12) the Middle and Upper Cenomanian quartz conglomerates rest directly on the Upper Jurassic substrate, and their matrix contains abundant organic remains (*cf.* Pl. 2, Fig. 4). In the uppermost Cenomanian the frequency of biogenic components is much higher than that of quartz and glauconite (*cf.* Fig. 22) and they represent the foraminifer-*Pithonella* and foraminifer-inoceram microfacies (Pl. 7, Figs 2—3) which occur already in the lowermost Turonian within the remaining part of the area (*cf.* Pl. 6, Figs 2—4; Pl. 3, Fig. 2).

Lower Turonian, Inoceramus labiatus Zone. — At Przychody (outcrop *115* in Fig. 4) there is a drop in the frequency of quartz and glauconite near to the bottom of this Zone while it attains its maximum about halfway and drops again towards the top resulting in a convex curve-line (*cf.* Fig. 7). The drop in the frequency of quartz and glauconite is accompanied by an increase in the content of biogenic components, chiefly of *Pithonella* and planktic foraminifers (*cf.* Fig. 7 and Pl. 3, Fig. 2). At Glanów (outcrop *108c* in Fig. 12) the deposits of this Zone almost completely lack quartz and glauconite, and are characterized by a high frequency of biogenic components (*cf.* Fig. 22 and Pl. 7, Figs 4—5). Also at Poręba Dzierżna (outcrop *110* in Fig. 9) quartz is present, but in the lowermost layer of this horizon, where it disappears rapidly (*cf.* Pl. 6, Figs 2—5).

Lower Turonian, Inoceramus lamarcki Zone. — At Przychody (outcrop *115* in Fig. 4) the quartz and glauconite frequency curve resembles that in the I. labiatus Zone (*cf.* Fig. 7) both as regards the shape and the absolute values. In the top of this Zone there is an abrupt increase in the clasticity index of quartz and glauconite. The local decrease in the frequency of these components is accompanied by an increase in that of the biogenic components, mainly of *Pithonella* and planktic foraminifers (*cf.* Fig. 7 and Pl. 3, Fig. 3). At Wielkanoc (outcrop *123* in Fig. 9), the deposits of this Zone, resting directly on the Upper Jurassic substrate, display strong variability in the vertical profile. At the contact with the abrasion surface, the frequency of quartz and glauconite exceeds considerably that of biogenic components (*cf.* Fig. 26 and Pl. 8, Fig. 1), *i.e.* of planktic foraminifers and inoceram prisms. It then drops abruptly along with an increase in the frequency of planktic foraminifers (Pl. 8, Fig. 2). Where quartz and glauconite are lacking there is a mass occurrence of *Pithonella* (Pl. 8, Fig. 3) while the other organic remains (*cf.* Fig. 26) are rather few. In the upper part of the profile, the quartz grains are extremely rare, glauconite disappears altogether while inoceram prisms (Pl. 8, Fig. 4) and planktic foraminifers predominate among the biogenic components.

Upper Turonian, Inoceramus costellatus Zone. — At Przychody (outcrop *115*) no important changes take place (*cf.* Fig. 7) at any time in the quartz and glauconite frequency which resembles that of their minimum in the two lower zones (Inoceramus labiatus and Inoceramus lamarcki). Only within the neptunian dykes (*cf.* Pl. 4, Figs 2—3) the amount of quartz increases considerably along with a simultaneous decrease of glauconite (*cf.* Fig. 7). Within the stromatolite layer (sample *15b* in Fig. 8), there is no essential change (*cf.* Fig. 7) in the frequency of quartz. Throughout the Zone the frequency of biogenic components, chiefly of *Pithonella* and the planktic foraminifers (Pl. 3, Fig. 4 and Pl. 4, Fig. 1), is more or less constant, while in the neptunian dykes it drops abruptly (*cf.* Fig. 7). The top layer of the Zone is characterized by a great abundance of planktic foraminifers (Pl. 5, Fig. 1), and smaller amount of quartz. The neptunian dykes in this layer consist of Santonian deposits (*cf.* Fig. 8; Pl. 10, Fig. 2).

Santonian (lower part). — A complete change in the microfacies takes place above the discontinuity surface (*cf.* Pl. 5, Figs 2—4). The frequency of quartz drops slightly but distinctly, along with an increase in the clasticity index, while the frequency and clasticity index of glauconite increase abruptly (*cf.* Fig. 7) with their maximum observable at the discontinuity surface. Towards the top, the frequency of glauconite decreases but in terms of absolute values it is still markedly greater than in the underlying Turonian deposits (*cf.* Fig. 7). Above the discontinuity surface there is also a characteristic abrupt increase in the amount of inoceram prisms, at the expense of other biogenic components, chiefly of the planktic foraminifers.

Interpretation of microfacial succession

Throughout the investigated area, there is a high quartz and glauconite content in the Lower Cenomanian deposits, accompanied by meagreness of organic remains. This indicates facial unification and a continued supply (similarly as during the Upper Albian) of great amounts of quartz from the alimentary area. No changes in the character of sedimentation are observable in places where Middle and Upper Cenomanian deposits (Zalesice, Lelów, Solca) occur in sedimentary continuity with the Lower Cenomanian. Only at Poręba Dzierżna, the Middle and Upper Cenomanian are represented by a lithofacies of sandy conglomerates and numerous organic remains. But, on the elevated places of the Upper Jurassic substrate where sedimentation did not set in before the Middle Cenomanian, as at Glanów (outcrop *108c* in Fig. 12), the matrix of the conglomerates is characterized by a high content of planktic foraminifers and calcium carbonate. The fact of a part of quartz pebbles and fragmentary limestones being overgrown by serpulids (*cf.* Pl. 17, Figs 5—8) reasonably suggests that after deposition the material remained fairly long at the floor of the basin. During the Upper Cenomanian there was a decrease in the amount and size of the quartz material here. The upper part of the unit *2c* (*cf*. Fig. 22) bears traces of submarine erosion. This indicates that, during the Upper Cenomanian, non-depositional conditions prevailed for some time in the sedimentary basin in the Glanów region, resulting in the removal of a part of the deposits. These conditions, when ended, were followed by carbonate sedimentation of the Uppermost Cenomanian (unit *2d* in Fig. 22).

During the Lower Turonian there is a general decrease in the frequency of quartz and glauconite as compared with the Cenomanian, though the values of the frequency and clasticity index in the individual profiles sometimes differs a great deal (*cf*. Figs 7, 22, 26). At Przychody (outcrop *115* in Fig. 4) changes in these indices display a rhythmic character (*cf*. Fig. 7) manifested by the existence of two maxima in the detrital inflow — one in the Inoceramus labiatus Zone, the other in the I. lamarcki Zone. Either of these maxima has a corresponding increase in the clasticity index of quartz and glauconite, though this does not quite accurately coincide with the frequency maximum of these components. A marked increase in the clasticity index of quartz and glauconite at the top of the I. lamarcki Zone together with a drop in the frequency of these components indicates higher energy currents — probably leading to a slowing down in the rate of sedimentation, and reduced inflow from the alimentary area.

In the southern part of the area (Poręba Dzierżna, Glanów, Wielkanoc) there are but slight amounts of quartz and glauconite in the Lower Turonian deposits. A high frequency of these components is observed only in the lower parts of profiles in places where the deposits of the I. lamarcki Zone rest on abrasion surfaces developed on the butten Upper Jurassic limestones. With the beginning of sedimentation on the abraded elevations, the work of the high energy current bringing quartz ceases and carbonate sedimentation prevails (*cf*. Fig. 26).

In the Upper Turonian (Przychody, outcrop *115*), within the I. costellatus Zone there are two discontinuity surfaces associated with neptunian dykes (*cf*. Figs 7—8*A*). The increased frequency of quartz in these dykes is connected with the reduced rate of chemical sedimentation and the infilling of submarine dykes with quartz material dragged on the surface of discontinuity. Stromatolite coatings (*cf*. Figs 7—8*A* and Pls 9, 11; Pl. 10, Fig. 1) are developed in an analogous manner as in the Lower Turonian stromatolites from the Lelów region, their formation being probably connected with the high energy shallow marine water below the intertidal zone and preceded by a slowing of sedimentation, most likely by a shallowing (Marcinowski & Szulczewski 1972).

In the investigated area, throughout all the Turonian Zones preserved, the curve of frequency of planktic foraminifers and *Pithonella* steadily displays an inverse variation with respect to the clasticity and frequency of quartz and glauconite. Hence, the appearance of planktic organisms is connected with cessation of the sedimentation of quartz and glauconite. It is not excluded that transport of the latter components involved a partial destruction of the delicate organic remains previously laid down on the bottom, so that the mutual interrelations now observable are a resultant of both the development of planktic communities and the supply of terrestrial material.

In all the Turonian Zones, throughout the area under investigation, *Pithonella ovalis* (Kaufmann) is present, and sometimes its accumulations result in characteristic microfacies (*cf.* Figs 7, 22, 26 and Pl. 3, Figs 3—4; Pl. 4, Fig. 1; Pl. 6, Fig. 3; Pl. 8, Fig. 3). The systematic position of *Pithonella ovalis* (Kaufmann) is, so far, an open question (*cf.* Borza 1961, Nowak 1963). This problematic microorganism, currently supposed to be a pelagic form, displays a wide stratigraphic range and geographic distribution and has long been known in Poland (previously often described as a foraminifer, *Fissurina*), *i.a.* from the investigated Turonian of the Polish Jura Chain (Sujkowski 1934, Alexandrowicz 1954, Barczyk 1956, Marcinowski 1970) and of the Lublin Upland (Sujkowski 1931, Pożaryski 1956), Middle Albian through the Coniacian of the Łódź synclinorium (Samsonowicz 1948), Upper Aptian through the Turonian of the Flysch Carpathians (Borza 1961, Nowak 1963), the exotics series at Bachowice including (*cf.* Książkiewicz 1956). In other countries it occurs also in younger deposits *e.g.* in the Santonian of Afghanistan (Deslo 1960; *fide* Jux, Kempf & Manze 1971, p. 713).

In the northern part of the area (Zalesice, Lelów, Solca) the particular Turonian Zones are far less thick and richer in quartz and glauconite than in the southern part (Poręba Dzierżna, Glanów, Wielkanoc — *cf.* Fig. 28), what is partly connected with the stronger stratigraphic condensation. Traces of submarine erosion of the topmost Turonian layer (*cf.* Fig. 8*A*—*B*) and the infilling of neptunian dykes (*cf.* Pl. 10, Fig. 2) with Santonian deposits resting with a stratigraphic gap on the Turonian, indicate high energy currents and corrosion of the underlying deposits during the duration (Inoceramus schloenbachi Zone till Coniacian) of non-depositional (hardground) conditions.

In the Santonian, the frequency of quartz decreases slightly but distinctly, along with a simultaneous increase in its clasticity index, indicating a decrease in the influence of the receding alimentary area. The abrupt growth in the frequency and clasticity index of glauconite at the very bottom of the Santonian reliably suggests that the long-spanning period of non-deposition and lack of carbonate sedimentation had some bearing on the process of the formation of this mineral in the lowermost Santonian. The high frequency of inoceram prisms, side by side with the drop in the frequency of quartz indicates a strong condition of water agitation and detrital inflow (Carozzi 1958, p. 147).

TRACE FOSSILS

Burrows

In the investigated area some of the Cretaceous deposits contain traces of burrowing activity, in most cases, however, the identification of the ichnotaxon they represent is hindered by their state of preservation. Well preserved and numerous *Ophiomorpha nodosa* Lundgren and *Chondrites* sp. are an exception here.

Ophiomorpha nodosa Lundgren

The burrows *Ophiomorpha nodosa* Lundgren, 1891, indicating a markedly shallow marine environment, have been found in the sandy deposits of the Upper Albian, Upper Cenomanian and lowermost Turonian in the region of Mokrzesz, Lusławice and Julianka. Their description and interpretation of their ecological requirements have been previously given (Marcinowski 1970, and referenced bibliography therein).

Chondrites sp.

The Upper Albian deposits in the Wolbrom-Glanów region contain numerous organic structures belonging to the ichnogenus *Chondrites* Sternberg, 1833 (Pls 13—16) not reported, so far, from the area under consideration. These burrows are here constant in diameter and round in cross-section. The biggest burrows are 6 cm (*cf.* Pl. 14, Fig. 1) in diameter, and *c.* 20 cm in length, which is not total as the burrows plunge at a small angle into the deposit. The smallest burrows are 2—3 mm in diameter and 3—4 cm in length, most of them having a 1—1.5 cm diameter.

Every burrow has a lining, readily recognizable both by the coloring of the infilling material and that of the surrounding sediment. Burrows filled in with sediment impoverished in glauconite are most common (Pls 13—16) and their linings are enriched in glauconite; this type corresponds exactly to *Chondrites* sp. *A* of Hakenberg (1967, pp. 151—152, Fig. 5; Pl. 1, Fig. 2; Pls 2—3). There occur but very few burrows where the pattern is the other way about, *i.e.* the infilling of the burrows consists of sandy material enriched in glauconite while the lining is built of material impoverished in glauconite. These burrows correspond exactly to *Chondrites* sp. *B* of Hakenberg (1967, pp. 152—153, Fig. 6; Pls 4—5). In the deposits here considered, *Chondrites* sp. *B* are those with the greatest dimensions (*cf.* Pl. 14, Fig. 1), but the both types of burrows sometimes occur together. Inter-crossing of the particular burrows has not been observed in either of the two types, whereas the branching is fairly frequent (always laterally), and its angle being variable (*cf.* Pl. 13). The burrows *Chondrites* occur in largest members in sandy, obliquely bedded sands or sandstones (*cf.* Figs 11, 13 and Pls 13—16), what reliably indicates that the diagenesis responsible for the formation of sandstones followed the burrowing activity of the *Chondrites*-makers. The state of the preservation of these burrows bars the reconstruction of their spatial arrangement in the deposit, and it is hardly possible to state whether they join into major systems with an outlet to the surface of the deposit as suggested for other occurrences (*cf.* Simpson 1957, Kennedy 1967, Osgood 1970).

The ichnogenus *Chondrites* Sternberg, 1833, is well defined, but its ecological interpretation as well as the pointing to the organisms responsible for their formation have not so far been adequately cleared up (*cf.* Simpson 1957, Häntzschel 1962, Hakenberg 1967, Kennedy 1967, Gregory 1969, Osgood 1970, Bandel 1973). Generally, these traces have been interpreted as dwelling or feeding burrows, and an analysis of the chondritids occurring in the investigated deposits not supplied new data diagnostic for this problem. It should be only remarked that *Chondrites* sp. here investigated are most often associated with sediments, the deposition of which was accompanied with activity of high-energy currents (various cross-bedded units) and the burrows themselves are characterized by a relatively large size (*cf.* dimensions reported by Hakenberg 1967, Kennedy 1967, Häntzschel & Reineck 1968, Bandel 1973).

Borings

The borings are not common in the investigated sequence, and they occur either in the abrasion surface at Wielkanoc, or as internal moulds in the previously mentioned concretions of siliceous sandstones (*cf.* Pl. 17, Fig. 9).

At Wielkanoc (outcrop *123* in Fig. 9), the Lower Turonian (Inoceramus lamarcki Zone) abrasion surface bears in some places borings of polychaetes (Pl. 12, Figs 1—3) which represent only the "*Potamilla*" type *C* of Głazek, Marcinowski & Wierzbowski (1971). These borings, as well as a rich assemblage of Cenomanian borings from the vicinity of Cracow (*cf.* Głazek, Marcinowski & Wierzbowski 1971) are developed on Upper Jurassic butten limestones [10].

In concretions of the Upper Albian siliceous sandstones, a rich assemblage of borings was found at Sucha (outcrop *109a* in Fig. 12). It is represented by sponges, polychaetes, pelecypods [11], the latter being represented *i.a.* by *Gastrochaena* sp. (Pl. 17, Fig. 9). The state of preservation of the borings (*cf.* description of the lithological members)

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[10] No borings have, so far, been observed in the numerous Turonian abrasion surfaces both in the Cracow Upland (*cf.* Alexandrowicz 1954).

[11] A detailed paleontological description and ecological interpretation of this assemblage is being prepared by the writer for a separate paper.

indicate that pieces or pebbles of Upper Jurassic limestones were delivered to and bored by lithophags in the sedimentary area of the Upper Albian sands. Hence, the existence here is evidenced during the Upper Albian transgression of denivelations of the Upper Jurassic substrate, which were affected by strong abrasion. An activity of rock-borrer communities is however very local here, as no similar phenomena are observable in the remaining area, although pre-Albian denivelations of the substrate are common and fairly important there (*cf.* Figs 27—28).

CHARACTERISTICS OF FAUNAL ELEMENTS OF THE UPPER ALBIAN, CENOMANIAN AND TURONIAN

Frequency of occurrence of organic remains in the deposits studied appears to be varying. Organic remains occurring in the Cenomanian deposits are the most abundant and taxonomically differentiated. Their mass occurrence results from stratigraphic condensation which took place in the area of the Polish Jura Chain during the Cenomanian. Upper Albian and Turonian strata are markedly less fossiliferous yielding mostly inocerams and echinoids. Similar situation may be observed outside the area of the Polish Jura Chain in contemporaneous strata from other parts of epicontinental Cretaceous basin of Poland (*cf.* Samsonowicz 1925, 1934; Cieśliński 1959, 1960b, 1965; Cieśliński & Tröger 1964). Various faunal groups are discussed below in systematic order. Cephalopods, stratigraphically the most important group occurring only in the Cenomanian, are discussed in a separate chapter.

Sponges

From the standpoint of paleontology and environmental requirements the problem of sponges surpasses the scope of the present paper. In the area studied, sponges are very common in sandy deposits of the Upper Albian and Cenomanian, and rather scarce in the Turonian ones. They often form nuclei of sandstone concretions (Fig. 15) occurring in the Upper Albian sands. They are also common in ferruginous-phosphatic and phosphatic nodules of the Upper Albian and Cenomanian. In the latter case they are usually represented by the genus *Exanthesis*. Siliceous sponges and their spicules sometimes occur in masses. In the Wolbrom and Glanów regions any organic remains, except for sponge fragments, are extremely rare. Such facies, which may be termed sponge facies, is characteristic of the Albian in some regions of Poland, *e.g.*, from the margins of the Holy Cross Mts (Cieśliński 1959, 1960a).

Corals

Corals are fairly scarce in the organic assemblages of the Cenomanian in Poland (*cf.* Cieśliński 1965) and were not studied in detail, except for the contribution by Siemiradzki (1926). In the author's collection there is almost 20 specimens, all from the Cenomanian. The corals represent the family Caryophylliidae Gray, 1847, except for one (Pl. 17, Fig. 2) belonging to *Micrabacia coronula* (Goldfuss), a highly characteristic species of the family Micrabaciidae Vaughan, 1905. In Poland, outside the area studied, this species was reported only from the Turonian of Lwówek basin in the Lower Silesia (Scupin 1912—1913). *Micrabacia coronula* (Goldfuss) is common in the Cretaceous of Europe and was reported from the Cenomanian of Podolia (Siemiradzki 1926), Baltic region (Noetling 1885, Ravn 1916), and SE England (Kennedy 1969), from the Turonian of Czechoslovakia (Frič 1911), and even from the Lower Senonian of the Hannover area (Römer 1841, *fide* Scupin 1912—1913).

No corals of the family Caryophyllidae were found in life position, *i.e.* overgrowing substratum or any larger rock fragments and organic debris. The corals are broken-off and redeposited.

Polychaetes

Serpulids were found in Cenomanian deposits only. Majority of them encrust pelecypod, ammonite, echinoid fragments or Jurassic rocks debris and quartz pebbles (*cf.* Pl. 17, Figs 5—8). Specimens attached neither to organic fragments nor to rock debris (Pl. 17, Fig. 4) are extremely rare. Representatives of the species *Serpula proteus* J. de C. Sowerby (Pl. 17, Fig. 4) are reported for the first time in Poland, besides the forms common in the Polish Cenomanian (*cf.* Cieśliński 1965). This species is known from the Turonian and Senonian of the south-eastern England (*cf.* British Mesozoic Fossils 1964) but is not known from the Cenomanian of that region (*cf.* Kennedy 1969).

Bryozoans

Bryozoans, occasionally found in the Cenomanian of Poland (Maryańska 1968), are accessory elements in faunal assemblages in the strata studied. Large, well-preserved colony (Pl. 17, Fig. 3) was found in the Cenomanian at Mokrzesz. The shape and internal structure of that colony correspond to the diagnosis of *Multicrescis variabilis cracoviensis* Maryańska. That subspecies was described from the Cenomanian of Korzkiew near Cracow. Hillmer (1971) noted that some details of the internal structure of that subspecies may be compared with those of the species

Table 1

Distribution of brachiopods in the investigated Albian-Turonian sections

Species	Number of the outcrop *																	Albian	Cenomanian	Turonian
	46	46a	52	53	64	69	70	71	72	73	83	84	108	108b	108c	110	122			
Orbirhynchia cuvieri /d'Orbigny/										+										+
?O. cuvieri /d'Orbigny/				+															+	
O. mantelliana /Sowerby/	+												+	+	+	+			+	
O. parkinsoni Owen															+				+	
Orbirhynchia sp.											+									+
Cyclothyris antidichotoma /Buvignier/															+				+	
C. cf. difformis /Valenciennes in Lamarck/	+																		+	
C./?/ schloenbachi /Davidson/	+																		+	
Cyclothyris sp.	+											+							+	
Cretirhynchia minor /Pettitt/	+																		+	
C. cf. minor /Pettitt/	+																		+	
C. plicatilis /Sowerby/															+				+	
Cretirhynchia sp.											+	+			+				+	+
Lamellaerhynchia caseyi Owen															+				+	
Lamellaerhynchia sp.	+	+		+															+	
Lepidorhynchia sigma /Schloenbach/	+	+	+	+		+	+	+	+					+					+	
Grasirhynchia martini /Mantell/	+																		+	
"Rhynchonella" gibbsiana /Sowerby/	+																		+	
Sellithyris/?/ sp.	+	+													+				+	
Arcuatothyris arcuata /Roemer/	+					+									+				+	
Platythyris rugulosa /Morris/	+																		+	
Praelongithyris sp.	+														+				+	
Gibbithyris sp.			+		+					+	+				+		+		+	+
Concinnithyris/?/ subundata /Sowerby/	+														+				+	
Concinnithyris sp.	+			+			+					+							+	
Ornatothyris sulcifera /Morris/															+				+	
Ornatothyris sp.			+	+					+						+				+	
Terebratulina chrysalis /Schlotheim/	+			+															+	
Terebratulina sp.																+			+	
Kingena arenosa /d'Archiac/	+			+															+	
Kingena sp.	+			+			+					+							+	
Magas sp.	+			+															+	
"Terebratula" disparilis d'Orbigny	+																		+	
"T." dutemplei d'Orbigny															+	+			+	

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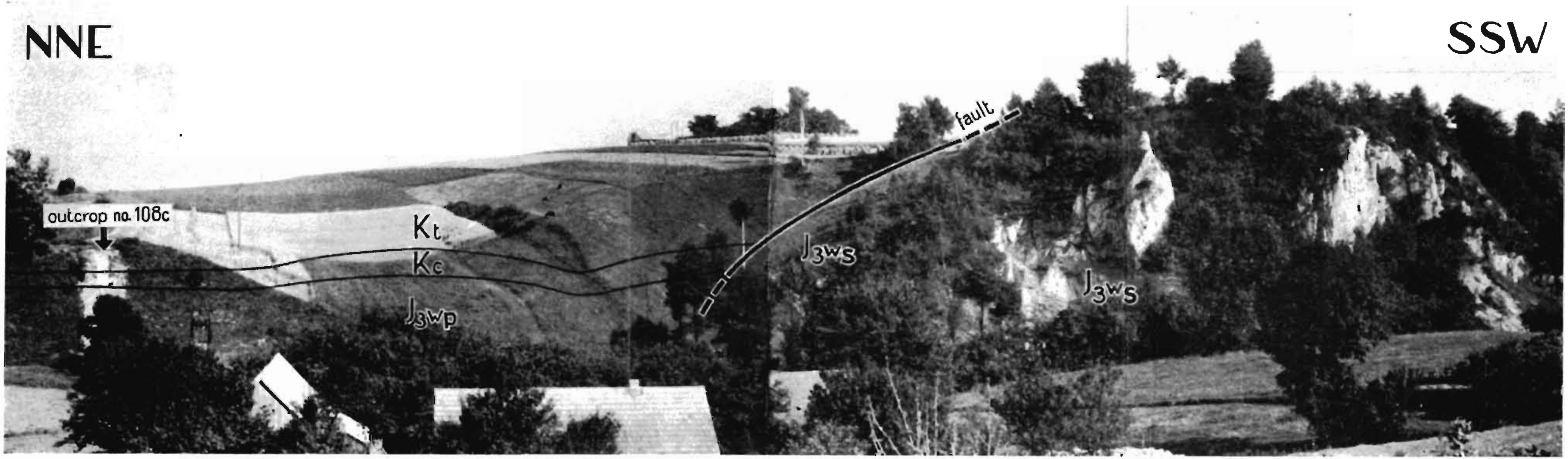
* Location of the outcrops numbered beneath 100 and listed in Tables 1—5 is given in Text-fig. 2 (*cf.* also Marcinowski 1970, Fig. 1); for location of other outcrops see Text-figs 3—4, 9 and 12.

Situation of the Cenomanian and Turonian deposits at Glanów (near outcrop *108c* in Text-fig. 12)



J_3ws Upper Jurassic butten limestones, *J_3wp* Upper Jurassic platy limestones, *Kc* Cenomanian conglomerates, *Kt* Turonian limestones

Multicrescis tuberosa (Roemer), known from the Lower Hauterivian of northern Germany. Single fragments of bryozoan colonies are also met in the Turonian (Pl. 3, Fig. 3*b*).

Brachiopods

Brachiopods (Table 1 and Pls 18—21) are generally well-preserved in comparison with the representatives of all the remaining faunal groups. They are preserved as phosphatic moulds or with valves, the latter being, commonly complete. The brachiopod assemblage yielded in Cenomanian and Turonian deposits appears strikingly similar to contemporaneous assemblage from the neighbouring Cracow region, being somewhat richer in the genera and species than the latter one (*cf.* Panow 1969). The remaining Cenomanian and Turonian brachiopod localities (except for the Cracow one) are still inadequately known. Popiel-Barczyk (1972) described over a dozen brachiopod species from the Albian and Cenomanian of Annopol (northern margins of the Holy Cross Mts). These species comprise only a part of a large collection (about 11,000 specimens) and belong to the genera rarely met in Poland (*cf.* Popiel-Barczyk 1972). However, a number of those scarce genera are also known from the Polish Jura Chain, hence the similarity of those brachiopod assemblages may be inferred [12].

Analysis of Glanów fauna carried out by Sujkowski (1926) showed that some species occurred later than in the western Europe. The same can be said about the brachiopod assemblage in question. Such species as *Orbirhynchia parkinsoni* Owen (syn. *Rhynchonella sulcata* Parkinson) and *"Terebratula" dutemplei* d'Orbigny occurring in the Cenomanian of the Polish Jura Chain are known from the Albian of the Tatra Mts (*cf.* Passendorfer 1930). Similarly, *Cyclothyris antidichotoma* (Buvignier) and *Lamellaerhynchia caseyi* Owen found in the Middle Cenomanian at Glanów (unit *2a* in Text-figs 21—22) are known from the Upper Aptian and Lower Albian of England (Owen 1962; Popiel-Barczyk, oral communicat). The differences in the time of spreading of these species result from the dependence of benthic organisms (including brachiopods) on facies conditions.

Gastropods

In the area studied, gastropods occur only in the Cenomanian deposits, in which they are fairly common. Gastropods are generally preserved in the form of worn-out moulds, that precludes any specific

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[12] The assemblage studied comprises *Arcuatothyris arcuata* (Roemer), the genus *Arcuatothyris* being, recently proposed by Popiel-Barczyk (1972) for some very common Cretaceous terebratulids.

identifications. Attention should be focussed on *Emarginula althi* Zaręczny, the species (Pl. 22, Figs 1—2) fairly common in the Cenomanian of Poland (*cf.* Cieśliński 1965, Cieśliński & Pożaryski 1970) and Podolia (Zaręczny 1874, Kokoszyńska 1931).

Pelecypods

Pelecypod material, although numerous, is generally poorly preserved. Majority of specimens are represented by mould of a single or,

Table 2

Distribution of pelecypods in the investigated Albian-Turonian sections

Species	Number of the outcrop																								Albian	Cenomanian	Turonian
	46	46a	52	53	63	64	69	70	71	72	73	74	83	84	108b	108c	110	111a	112	115	116	117	119	123			
Nucula vibrayeana /d'Orbigny/	+	+																								+	
Nucula sp.	+																									+	
Cucullaea sp.																+										+	
Trigonarca passyana /d'Orbigny/				+																						+	
Pinna sp.																+										+	
Inoceramus concentricus Parkinson					+																				+		
I. anglicus Woods					+													+	+						+		
I. anglicus - crippsi m.f.																		+							+		
I. crippsi Mantell															+	+										+	
I. bohemicus Leonhard	+		+	+				+		+				+		+										+	
I. labiatus /Schlotheim/						+					+	+	+			+	+										+
I. apicalis Woods													+														+
I. lamarcki Parkinson												+	+							+	+	+	+	+			+
I. annulatus Goldfuss																								+			+
I. inconstans Woods																				+	+						+
Chlamys sp.	+			+												+		+							+	+	
Neithea quinquecostata /Sowerby/	+			+			+																			+	
Neithea sp.					+													+							+		
Aucellina gryphaeoides /Sowerby/		+					+	+		+				+											+	+	
Lima sp.	+			+			+	+								+										+	
Ostrea sp.	+			+												+		+							+	+	
Lopha colubrina /Lamarck/	+			+																						+	
Exogyra sp.	+			+	+		+	+		+						+		+							+	+	
Unicardium cf. tumidum Briart & Cornet	+																									+	
Cyprina cf. regularis d'Orbigny	+			+				+																		+	
Cyprina sp.	+		+	+				+	+	+				+												+	
Venilicardia ligeriensis /d'Orbigny/	+			+				+																		+	
Isocardia heintzeli Wolleman	+			+						+				+		+										+	

occasionally, of both valves. The pelecypod assemblage from the area studied (Table 2 and Pl. 22, Figs 2—8; Pls 23—25) does not show any larger differences in respect to those from the remaining epicontinental areas of Poland (*cf.* Cieśliński 1960a, b, 1965; Cieśliński & Pożaryski 1970). All the species of that assemblage are known from England (*cf.* Woods 1899—1911). In the discussed assemblage, the inocerams, known from the whole Europe, are of the greatest stratigraphic value (*cf.* Woods 1910—1911; Dobrov & Pavlova 1959; Muromceva & Janin 1960; Najdin 1960, 1969; Moskvin 1962; Tröger 1967, 1969). Some species, such as *Inoceramus crippsi* Mantell, *I. labiatus* (Schlotheim), and *I. lamarcki* Parkinson are pandemic; they are known also from North America, from the same stratigraphic position as in Europe (*cf.* Adkins 1928, Jeletzky 1971, Cobban & Scott 1972).

In the uppermost Albian deposits from the area studied there occur inocerams identified as *Inoceramus anglicus-crippsi* m. f. (Pl. 23, Fig. 4 and Pl. 24, Fig. 3), unknown from other parts of Poland. These are transitional forms (*m.f.* assignation means *media forma*) from typical Upper Albian species *I. anglicus* Woods to the Cenomanian *I. crippsi* Mantell. Those transitional forms evidence an evolution of *I. crippsi* from *I. anglicus,* and thus support the phylogenetic scheme of Cretaceous inoceramids proposed by Woods (1912). Moreover, it is in contradiction with the statement of Tsagarelli (1942, *fide* Sornay 1966, Fig. 10) that the Albian species *"anglicus"* represents lateral, blind evolutionary line of inoceramids which did not produce any Cenomanian species.

Echinoids

Echinoids (Table 3 and Pls 26—29) are very common in the deposits studied. They usually have the whole test or at least a part of it preserved. A number of genera and species from the assemblage recognized here are also known from contemporaneous strata of England (*cf.* Wright 1864—1882), France, Belgium, Germany (*cf.* Mączyńska 1958, 1962, 1972; Popiel-Barczyk 1958), Caucasus and Crimea (*cf.* Poslavskaya & Moskvin 1959), as well as of the Cracow region (*cf.* Mączyńska 1958, 1962; Popiel-Barczyk 1958) and from the Holy Cross margins (*cf.* Cieśliński & Pożaryski 1970). However, there are some differences in composition of echinoid spectra. For example, in the northern part of the area studied, in Mokrzesz and Zalesice regions, the genera *Discoides, Camerogalerus,* and *Holaster* predominate in Cenomanian assemblages, and the genus *Pyrina* is represented in negligible numbers, whereas in the southern parts, in the Poręba Dzierżna and Glanów regions, contribution of echinoids of the genus *Pyrina* markedly increases, and some genera unknown in the north, such as *Pygaulus* and *Catopygus* occur (*cf.* Mączyńska 1972, and Table 3).

Cenomanian echinoid fauna of that area is the same as in the Cracow region (*cf.* Mączyńska 1958, 1962, 1972), neighbouring in the south with the area studied (*cf.* Fig. *1C*). This differentiation in echinoids probably result from differences in Cenomanian facies, sandy in the north, and gravelous in the south.

The species *Conulus ellipticus* (Zaręczny) and *Conulus subrotundus* (Mantell) were found in the Upper Cenomanian (top part of unit *2c* in Figs 20, 22) at Glanów; they were hitherto known only from the Turonian strata in Poland and hence a remarkable stratigraphic value was previously attributed to them (*vide* Popiel-Barczyk 1958, p. 58). Echinoids, presumably belonging to the genus *Pseudholaster* (identification by Dr.

Table 3

Distribution of echinoids in the investigated Albian-Turonian sections

Species	Number of the outcrop																									Albian	Cenomanian	Turonian
	46	46a	52	53	61	63	64	69	70	72	73	74	83	84	108b	108c	110	115	116	117	118	119	121	122	123			
Salenia sp.	+																										+	
Polydiadema aff. tenue Agassis	+			+				+																			+	
Polydiadema sp.	+			+																							+	
Phymosoma cenomanense Cotteau	+			+																							+	
Discoides subuculus /Klein/	+		+	+	+			+	+	+				+	+	+	+										+	
D. minimus /Agassis/													+			+	+								+			+
Camerogalerus cylindricus /Lamarck/	+	+	+	+					+								+										+	
Conulus ellipticus /Zaręczny/							+				+	+	+			+	+	+	+	+		+		+	+		+	+
C. subrotundus /Mantell/							+				+	+	+			+	+	+	+	+	+	+	+		+		+	+
Pyrina ovalis ovalis d'Orbigny																+	+										+	
P. ovalis plana Mączyńska																+											+	
P. ovalis d'Orbigny subsp. indet.	+			+				+																			+	
Pygaulus pulvinatus d'Archiac																+											+	
Holaster laevis Agassiz			+	+																							+	
H. poloniae Lambert	+		+	+											+	+	+										+	
H. subglobosus Leske				+																							+	
H. cf. subglobosus Leske																+											+	
Holaster sp.														+		+							+				+	
Cardiaster sp.																				+	+							+
Infulaster sp.																			+			+						+
Pseudholaster sp.				+																							+	
Pseudholaster/?/ sp.						+																				+		
Sternotaxis planus /Mantell/																		+		+	+							+

S. Mączyńska) were found in Upper Albian sandstones in the vicinity of Staropole. This genus was not reported from the Albian in the remaining parts of Poland (*cf.* Samsonowicz 1925, 1934; Cieśliński 1960a), with the exception of the Tatra Mts (*cf.* Passendorfer 1930).

Fish teeth

The material collected (Table 4 and Pl. 30) is abundant but relatively poorly preserved. Usually only peak parts of crowns are preserved and teeth with roots are extremely rare. In the assemblage the species *Otodus appendiculatus* (Agassiz) markedly predominates and all the remaining species are represented by single forms. All the species found were already known from the area studied (*cf.* Sujkowski 1926, Różycki 1937) as well as form the Cenomanian and younger strata of the Cracow area (*cf.* Zaręczny 1878, 1894; Książkiewicz 1927; Barczyk 1956). The assemblage studied (5 species of shark teeth and 2 species of rays) closely resembles assemblages known from the Cenomanian of Annopol (*cf.* Samsonowicz 1925, 1934), Sobków and Staniewice (*cf.* Radwański 1969) in the Holy Cross Mts. It is of interest that extensive searching in the Polish Jura Chain gave shark and ray teeth only, whereas the assemblages from the Holy Cross Mts also yield teeth of other elasmobranchs (*viz.* chimaeroids) and bone fishes and of various reptiles (*cf.* Samsonowicz 1925, 1934; Radwański 1968, 1969). The studied assemblage of shark and ray teeth

Table 4

Distribution of shark and ray teeth in the investigated Albian-Turonian sections

Species	Number of the outcrop												Albian	Cenomanian	Turonian
	46	52	53	69	70	71	72	84	108b	108c	110	122			
Corax falcatus Agassiz	+													+	
Oxyrhina angustidens Reuss	+		+	+	+			+	+	+	+			+	
?O. mantelli Agassiz			+											+	
Otodus appendiculatus /Agassiz/	+	+	+	+	+	+	+	+	+	+	+			+	
Scapanorhynchus rhaphiodon /Agassiz/										+				+	
Ptychodus mammillaris Agassiz												+			+
P. decurrens Agassiz										+				+	

comprises pandemic forms, which are known from the Cretaceous of Czechoslovakia (Fritsch = Frič 1878, 1911), Saxony (Geinitz 1875, Wanderer 1909), England (Woodward 1911—1912), and even of Madagascar (Priem 1907). In the Polish Jura Chain, similarly as in other parts of Poland and Europe, the recognized species are also known from younger stages of the Cretaceous, till the Maestrichtian (*cf.* Woodward 1911—1912, Książkiewicz 1927).

CENOMANIAN CEPHALOPODS

The collection of Cenomanian cephalopods (nautilids, ammonites, belemnites) from the Polish Jura Chain comprises about 700 specimens, 637 of which are ammonites. The collection includes specimens gathered by the present writer, in the years 1968—1972 and a few specimens from Glanów obtained through the courtesy of the Museum of Earth of the Polish Academy of Sciences in Warsaw.

Majority of nautilids and ammonites are preserved as phosphatic moulds and thus, as a rule, are more or less incomplete. The specimens usually represent phragmocones, sometimes with initial parts of body chambers. The present study comprises 200 of the best preserved specimens. Results of the writer's studies on Cenomanian cephalopods have in part been published previously (Marcinowski 1970, 1972). However, the following taxonomic corrections should be introduced with regard forms paleontologically analysed into the above papers:

As in Marcinowski (1970):

Pl. 3, Fig. 9 (only) *Turrilites mantelli* Sharpe — correctly *Hypoturrilites* aff. *tuberculatus* (Bosc)

Pl. 3, Fig. 10 *Turrilites mantelli* Sharpe — correctly *Hypoturrilites mantelli* (Sharpe)

Pl. 3, Fig. 6 *Turrilites tuberculatus* Bosc — correctly *Hypoturrilites tuberculatus* (Bosc)

Pl. 6, Fig. 3 *Mantelliceras tuberculatum* (Mantell) — correctly *Mantelliceras* aff. *costatum* (Mantell)

The present chapter deals with ammonites hitherto unknown from the Polish Jura Chain. In paleontological descriptions the writer followed taxonomic subdivision of Wright (1957) with some subsequent modifications introduced by other authors. Remarks and comparisons given in paleontological descriptions mostly refer to a monograph by Kennedy (1971), as the majority of ammonite species from the Polish Jura Chain are also known from England.

Systematic description of ammonites

Family **Phylloceratidae** Zittel, 1884
Subfamily **Phylloceratinae** Zittel, 1884
Genus *PHYLLOCERAS* Suess, 1865
Subgenus *HYPOPHYLLOCERAS* Salfeld, 1924
Phylloceras (Hypophylloceras) seresitense seresitense Pervinquière, 1907
(Pl. 31, Fig. 2*a*—*c*)

1860. *Ammonites Velledae*, Michelin; Pictet & Campiche, pp. 268—271, Pl. 36, Fig. 8.
1910. *Phylloceras Velledae* Michelin, var. *Seresitensis* Pervinquière; Pervinquière, p. 9, Text-fig. 2, Pl. 1, Figs 1—3.
[non] 1923. *Phylloceras seresitense*, Pervinquière; Spath, pp. 18—20, Pl. 1, Fig. 3; Pl. 2, Fig. 1 [= *Ph. (H.) seresitense tanit* Pervinquière].
1962. *Hypophylloceras seresitense seresitense* (Perv.); Wiedmann, pp. 142—144, Text-fig. 8, Pl. 8, Figs 1—2.
1963. *Phylloceras (Hyporbulites) seresitense* Perv.; Collignon, Pl. 241, Fig. 1038; Pl. 242, Fig. 1041.
1964a. *Ph. (H.) seresitense seresitense* Perv.; Wiedmann, pp. 221—224, Text-fig. 52, Pl. 15, Fig. 4; Pl. 21, Fig. 1.
1968. *Phylloceras (Hypophylloceras) seresitense seresitense* Pervinquière; Renz, pp. 17—18, Pl. 1, Fig. 1.
1968. *Ph. (Hypophylloceras) seresitense seresitense* Perv.; Wiedmann & Dieni, p. 26.

Material. — One mould, consisting of a part of the phragmocone.

Biometry (all linear measurements in *mm*):

	D	Wh	Wb	U	Wb/Wh
	14.5	8	6.9	1.5?	0.86
Ratio to D:		0.55	0.48	0.10?	

Remarks. — Wright (1957) and Wiedmann (1962) regarded *Hypophylloceras* Salfeld, 1924, as a taxon of the generic rank comprising Cretaceous ammonites of the family Phylloceratidae Zittel, 1884. However, subsequently Wiedmann (1964a), followed by Renz (1968) and Kennedy (1971), treated this taxon as a subgenus of *Phylloceras*.

Wiedmann (1964a, p. 173) distinguished three groups of species and subspecies of the subgenus *Hypophylloceras* on the basis of differences in the shape of suture line. The writer's specimen belongs to the species group *Phylloceras (Hypophylloceras) seresitense* Pervinquière, and its funnel-shaped narrow umbilicus and moderately high whorls are typical of the subspecies *Ph. (H.) seresitense seresitense* Perv. (*cf.* Wiedmann 1962, p. 142; 1964a, p. 221). The specimen in question (Pl. 31, Fig. 2*a*—*c*) belongs to forms characterized by relatively wide whorls (Wb/Wh = 0.86), wider than those of the forms typical of the subspecies (*cf.* dimensions reported by Wiedmann, 1964a, p. 223); so thick whorls bring it closer to the specimen *"IGD Coll. Ce 018"* described and figured by Wiedmann (1962). The specimen is preserved in the form of mould — it lacks radial striae observable on better preserved forms (*cf.* figures given by Wiedmann, 1962; 1964a).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). The species and its subspecies were not hitherto reported from Poland[13].

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[13] Passendorfer (1930, p. 456) when describing *"Phylloceras Velledae* Mich." from the high-tatric Albian of the Tatra Mts, identified flat-sided specimens as a variety *"seresitensis"* of the species *"velledae"*. Also Samsonowicz (1934, p. 43) cited *"Phylloceras Velledae* Mich." from the horizon of phosphatic nodules at Annopol in the Holy Cross Mts (uppermost Albian according to Cieśliński, 1959). It cannot

Phylloceras (H.) seresitense seresitense Pervinquière is known from the Albian and Cenomanian of France, Switzerland, northern Spain, Sardinia, Tunis, Algeria, Nathal, Madagascar, Zululand, southern India (Pervinquière 1910, Wiedmann 1962, Wiedmann & Dieni 1968, Renz 1968), and Upper Aptian of Majorca (Wiedmann 1964a). This species is also known from the Lower Cenomanian of England, being however extremely rare there (Kennedy 1971).

Family Turrilitidae Meek, 1876

Genus *HYPOTURRILITES* Dubourdieu, 1953

Hypoturrilites gravesianus (d'Orbigny, 1840)

(Pl. 32, Figs 8*a*—*b*, 10)

1822. *Turrilites tuberculatus*; Mantell, Pl. 24, Fig. 6 [only].
1840—1842. *Turrilites Gravesianus*, d'Orbigny; d'Orbigny, pp. 596—597, Pl. 144, Figs 3—5.
1959. *Turrilites gravesianus* d'Orbigny; Cieśliński, pp. 42—43.
1971. *Hypoturrilites gravesianus* (d'Orbigny); Kennedy, pp. 21—22, Pl. 6, Figs 11 only upper whorls, 12; Pl. 10, Figs 4—5 [with synonymy].

Material. — Four fragments of whorls.

Remarks. — Kennedy (1971, Pl. 6, Fig. 11) refigured Sharpe's (1857, Pl. 25, Fig. 1) specimen, the upper whorls of which correspond to *H. gravesianus* (d'Orb.) and lower to *H. tuberculatus* (Bosc), and interpreted it as chimaera. The writer had some doubt concerning the actual position of this specimen, *i.e.* whether it represents a form transitional between the two species, or a variation in ornamentation which occurred during ontogeny. Professor W. J. Kennedy explained (personal communication) that this specimen (*cf.* Kennedy 1971, Pl. 6, Fig. 11) actually represents two different specimens glued together by Mantell or Sharpe into one[14].

Occurrence. — Cenomanian, Jaźwiny (unit *3* in Fig. 2*C*), Lusławice (unit *4* in Fig. 2*D*). Outside the area studied, the species was reported in Poland from the Cenomanian of northern margins of the Holy Cross Mts (Cieśliński 1959).

Hypoturrilites gravesianus (d'Orbigny) is characterized by vast geographical distribution; it is common in the Cenomanian of Europe, northern Africa (Dubourdieu 1953), Madagascar (Collignon 1964), Australia (Wright 1963), India and North America (Clark 1965, Kennedy 1971).

Hypoturrilites aff. *gravesianus* (d'Orbigny, 1840)

(Pl. 32, Fig. 9*a*—*b*)

Material. — One fragment of the whorl.

Remarks. — A fragment of whorl (Pl. 32, Fig. 9*a*—*b*) differing from whorls of the typical forms in being more depressed, in having somewhat rounded cross-section, and in whorl contact devoid of crenulate suture. Because of these differences the specimen is identified as *Hypoturrilites* aff. *gravesianus* (d'Orbigny).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*).

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be excluded that a part of those specimens unfortunately nonfigured, belonged to the subspecies *Ph. (H.) seresitense seresitense* Perv.

[14] That glued tightly together specimen was reproduced in recent papers (Cieśliński 1959, Fig. 20; Clark 1965, Pl. 19, Fig. 9) as *Hypoturrilites tuberculatus* (Bosc).

Hypoturrilites aff. *tuberculatus* (Bosc, 1801)
(Pl. 32, Figs 4—5)

1970. *Turrilites mantelli* Sharpe, 1857; Marcinowski, pp. 433—434, Pl. 3, Fig. 9 [only].

Material. — One whorl and two fragments of whorls.

Description. — Outer surface of whorl convex, ornamented with three rows of tubercles. Tubercles of the first row are situated along the maximum convexity of the whorl. A well preserved specimen (Marcinowski 1970, Pl. 3, Fig. 9) displays 17 tubercles per whorl, and the remaining specimens (Pl. 32, Figs 4—5) — about 17—20 tubercles per whorl. Clavate tubercles of the two lower rows are markedly smaller in size, whereas the number of tubercles is the same or almost the same in every row. Tubercles of the third row are somewhat larger than those from the middle row and have a form of double ledge-like flatspot. Whorl contact with weakly crenulate suture. Lower whorl surface with weakly marked ribs, continuing from tubercles of the lowest row.

Remarks. — The writer's specimens resemble *Hypoturrilites tuberculatus* (Bosc) in number and shape of tubercles of the upper row and in weakly marked crenulate suture of the whorl contact. They are also similar to the species *cenomanensis* Schlüter of the genus *Mariella* Nowak in number and in size differentiation of tubercles as well as in highly convex ventral side. However, the writer's specimens (Pl. 32, Figs 4—5), although differing from typical representatives of the species *H. tuberculatus* (Bosc), show more features of that species than of the species *cenomanensis* Schlüter.

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*).

Hypoturrilites sp.
(Pl. 32, Fig. 11)

Material. — One whorl.

Description. — Whorl with ventral side flat, and ornamented with three rows of tubercles. Tubercles of the first row, 14 in number per whorl, are the largest, occurring in one-third of whorl height from the upper whorl surface; bases of the tubercles sub-elliptical in outline. The two lower rows of tubercles are situated close to the lower inter-whorl suture; the tubercles are markedly smaller than those of the upper row, clavate, about 22—24 in number per whorl; accurate number of tubercles is difficult to establish as the sculpture is somewhat worn-out. Tubercles of the third row give rise to distinct radial ribs continuing across the lower whorl surface.

Remarks. — The writer's specimen appears to be similar to *Hypoturrilites gravesianus* (d'Orbigny), differing in somewhat more numerous tubercles of the first row (about 14 tubercles in comparison with 10—12 large tubercles per whorl in typical representatives of *H. gravesianus*), smaller size of those tubercles, flat ventral side of whorls, and lower whorl height/shell diameter ratio. Those features separate this specimen also from *H.* aff. *gravesianus* (d'Orbigny) described above. In order to emphasize an isolated position of that specimen (Pl. 32, Fig. 11) from other specimens, and particularly from already atypical forms determined here as *H.* aff. *gravesianus* (d'Orbigny), it is identified as *Hypoturrilites* sp.

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig 2*A*).

Genus *OSTLINGOCERAS* Hyatt, 1900
Subgenus *OSTLINGOCERAS* Hyatt, 1900
Ostlingoceras (Ostlingoceras) puzosianum (d'Orbigny, 1840)
(Pl. 32, Fig. 6)

1840—1842. *Turrilites Puzosianus*, d'Orbigny; d'Orbigny, pp. 587—588, Pl. 143, Figs 1—2.
1862. *Turrilites Puzosianus*, d'Orb.; Pictet & Campiche, pp. 139—140, Pl. 59, Figs 3, 5—6, 4?
1930. *Turrilites* cf. *Puzosianus* d'Orb.; Passendorfer, p. 607.
1937. *Ostlingoceras puzosianum* (d'Orbigny); Spath, pp. 523—525, Text-fig. 163*a*—*c*, Pl. 58, Figs 38—40.
1963. *Ostlingoceras puzosi* d'Orb.; Collignon, Pl. 257, Fig. 1113.
1968. *Ostlingoceras (O.) puzosianum* (d'Orbigny); Renz, pp. 92—93, Pl. 18, Figs 12—15.

Material. — One fragment of the whorl.

Remarks. — The writer's specimen best corresponds to those figured by Spath (1937, Pl. 58, Fig. 38) and Renz (1968, Pl. 18, Fig. 14).

Occurrence. — ?Uppermost Albian — Cenomanian[15], Mokrzesz (unit *3* in Fig. *2A*). This species with the reservation *"conformis"* was reported from high-tatric Albian of the Tatra Mts by Passendorfer (1930).

Ostlingoceras (O.) puzosianum (d'Orbigny) is known from the uppermost Albian (dispar — perinflatum Subzone) from England, France, Switzerland (Spath 1937, Renz 1968), Tunis (Pervinquière 1907 *fide* Renz 1968) and Madagascar (Collignon 1963).

Genus *MARIELLA* Nowak, 1915
Subgenus *MARIELLA* Nowak, 1915
Mariella (Mariella) cenomanensis (Schlüter, 1876)
(Pl. 32, Figs 14—15)

1857. *Turrilites tuberculatus*, Bosc; Sharpe, p. 61, Pl. 25, Fig. 3 [only].
1876. *Turrilites cenomanensis*, Schlüt.; Schlüter, pp. 131—132, Pl. 37, Figs 6—8.
1926a. *Turrilites cenomanensis*, Schlüter; Spath, p. 429.
?1929. *Turrilites* cf. *cenomanensis* Schlüter; Collignon, p. 62, Pl. 6, Fig. 10.
1951. *Paraturrilites cenomanensis* (Schlüter); Wright & Wright, p. 16.
1953. *Turrilites cenomanensis* Schleuter; Dubourdieu, p. 52.
1959. *Paraturrilites cenomanensis* (Schlüter); Cieśliński, pp. 40—41.
?1964. *Paraturrilites cenomanensis* Schlüter; Collignon, p. 54, Pl. 331, Fig. 1492.
1971. *Mariella (Mariella) cenomanensis* (Schlüter); Kennedy, pp. 28—29.

Material. — Four fragments of whorls.

Remarks. — This species is characterized by upper-row tubercles markedly larger than clavate tubercles of the two remaining rows.

Differences among Cenomanian species of the genus *Mariella* Nowak were discussed by Spath (1937, pp. 512—513) and Kennedy (1971, pp. 27—28). Diagnosis of

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[15] *Ostlingoceras (O.) puzosianum* (d'Orbigny) is typical of the uppermost Albian and in the literature available to the writer was not reported from the Cenomanian. At Mokrzesz, this species cooccurs with Cenomanian forms, which seems to indicate the range of condensation (vide chapter on stratigraphy). It should be noted that the species *Ostlingoceras (O.) puzosiforme* Spath, morphologically similar and closely related to *O. (O.) puzosianum* (d'Orbigny) (*see* Renz 1968, p. 93) occurs in the Albian-Cenomanian junction beds, *viz.* it was recorded a few centimeters below the Albian/Cenomanian boundary in the Sainte-Croix section (Renz 1968, p. 93) and from the uppermost Albian and lowermost Cenomanian of England (Kennedy 1971, p. 26). However, the writer's specimen (Pl. 32, Fig. 6) is so close to *O. (O.) puzosianum* (d'Orbigny) that allocation to the latter species would rather be unsubstantiated.

the genus *Mariella* Nowak, 1915, and its subgenera, as well as problems of the priority of names were recently discussed by a number of authors (Wright 1957, Clark 1965, Renz 1968, Marcinowski 1970, Kennedy 1971). The writer wants to draw attention that Nowak indicated the type specimen of that genus already in 1915 (Nowak 1915, p. 10, *"Über die bifiden Loben der oberkretazischen Ammoniten..."*) and not 1916 (Nowak 1916, *"Zur Bedeutung von Scaphites..."*) as it is widely assumed.

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. *2A*). In Poland, outside the area studied, the species was recorded in the Cenomanian of northern margins of the Holy Cross Mts (Cieśliński 1959).

Mariella (M.) cenomanensis (Schlüter) is a common form in the Lower Cenomanian of southern England (Kennedy 1971), Germany (Schlüter 1876), French Alps (Porthault, Thomel & Villoutreys 1966), northern Africa and ?Madagascar (Collignon 1929, 1964; Dubourdieu 1953).

Mariella (Mariella) cf. *cenomanensis* (Schlüter, 1876)
(Pl. 32, Fig. 16)

1971. *Mariella (Mariella) cf. cenomanensis* (Schlüter); Kennedy; Pl. 8, Fig. 10.

Material. — Two fragments of whorls.

Remarks. — The forms determined as *Mariella (M.)* cf. *cenomanensis* (Schlüter) comprise some specimens (*cf.* Pl. 32, Fig. 16) characterized by tubercles of the second row situated somewhat lower than in typical specimens of the species *cenomanensis* (Schlüter) and closely resembling the form identified as *Mariella (M.)* cf. *cenomanensis* (Schlüter) by Kennedy (1971, Pl. 8, Fig. 10).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. *2A*).

Mariella (Mariella) sp.
(Pl. 32, Fig. 7)

Material. — One specimen with two whorls preserved.

Description. — Whorls with regularly convex outer surface ornamented with three rows of tubercles. Tubercles, equal in number in every whorl (24 per whorl), are translocated in relation to one another in each longitudinal row, which results in formation of transversal rows. Tubercles of the two upper rows are similar in size, but somewhat larger than those of the third row, situated very close to inter-whorl suture.

Remarks. — Small differentiation in size of tubercles makes this form similar to *Mariella (Mariella) lewesiensis* (Spath); however, any reliable specific identification of that specimen is precluded by the fact that it represents juvenile whorls.

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. *2A*).

Genus *TURRILITES* Lamarck, 1801
Subgenus *TURRILITES* Lamarck, 1801
Turrilites (Turrilites) boerssumensis Schlüter, 1876
(Pl. 32, Fig. 12*a*—*b*)

1857. *Turrilites costatus*, var.; Sharpe; Pl. 27, Fig. 12.
1876. *Turrilites Börssumensis*, Schlüt.; Schlüter, pp. 129—130, Pl. 38, Figs 6—7.

1951. *Turrilites* cf. *borssumensis* Schlüter; Wright & Wright, p. 17.
1971. *Turrilites (Turrilites) borssumensis* Schlüter; Kennedy, p. 31, Pl. 8, Fig. 6.

Material. — Well preserved half a whorl.

Remarks. — The specimen matches the diagnosis given by Schlüter (1876, p. 129), and closely resembles the forms previously figured under that name (*cf.* synonymy listed above).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). The species is recorded for the first time from Poland.

Turrilites (T.) boerssumensis Schlüter is known from the Cenomanian of England (Sharpe 1857, Kennedy 1971) and Germany (Schlüter 1876).

Family **Desmoceratidae** Zittel, 1895
Subfamily **Puzosiinae** Spath, 1922
Genus *PUZOSIA* Bayle, 1878
Subgenus *PUZOSIA* Bayle, 1878
Puzosia (Puzosia) subplanulata (Schlüter, 1871)
(Pl. 31, Fig. 4*a*—*b*)

1855. *Ammonites planulatus*, Sowerby; Sharpe, p. 29, Pl. 12, Fig. 3 [only].
1871. *Ammonites subplanulatus* sp. n.; Schlüter, pp. 4—7, Pl. 2, Figs 5—7.
1910. *Puzosia subplanulata* Schlüter; Pervinquière, pp. 34—35, Pl. 2, Figs 31?, 32.
1951. *Puzosia planulata* (J. Sowerby); Wright & Wright, p. 18.
?1959. *Puzosia* cf. *planulata* (Sowerby); Cieśliński, p. 46.
1966. *Puzosia* cf. *subplanulata* Schlut.; Collignon, p. 25, Pl. 12, Fig. 3.
1968. *Puzosia (Puzosia)* cf. *subplanulata* (Schlüter); Renz, pp. 21—22, Text-fig. 7*f*, Pl. 1, Fig. 9.
1971. *Puzosia (Puzosia) subplanulata* (Schlüter); Kennedy, p. 35, Pl. 9, Figs 1—2; Pl. 10, Fig. 3; Pl. 50, Fig. 5.

Material. — One specimen, preserved in a few fragments of whorls.

Remarks. — Representatives of the genus *Puzosia* Bayle, 1878, are characterized by changes in shell ornamentation proceeding along with ontogenetic development. For example, some Albian forms such as *Puzosia (Anapuzosia) tucuyensis* (v. Buch) (*vide* Renz 1972, Pl. 1, Fig. 3) have juvenile whorls similar to those of *Puzosia (Puzosia) subplanulata* (Schlüter) (*cf.* Renz 1972, p. 707). Similarly, *Puzosia (P.)* cf. *crebrisulcata* Kossmat (*cf.* Kennedy 1971, Pl. 14, Figs 5, 7) resemble in its inner whorls those of *Puzosia (A.) tucuyensis* (v. Buch) (*cf.* Renz 1972, Pl. 1, Fig. 2). Thus, at least some forms placed in different taxa depending on the development of their inner whorls may actually belong to the same subgenus or even species.

Occurrence. — Middle Cenomanian (*Acanthoceras rhotomagense* Zone), Glanów (unit *2a* in Fig. 22).

Outside the area studied the species was recorded in Poland from the Cenomanian of northern margins of the Holy Cross Mts (Cieśliński 1959). Specimen with features transitional between "*Puzosia Mayoriana* d'Orb." and "*Puz. planulata Sow.*" [recte *P. (P.) subplanulata* (Schlüter)] was reported by Passendorfer (1930, p. 467) from the high-tatric Albian of the Tatra Mts.

Puzosia (P.) subplanulata (Schlüter) is known from the uppermost Albian of Switzerland and France (Renz 1968), Lower and Middle Cenomanian of southern England and Germany (Schlüter 1871, Kennedy 1971), and from the Cenomanian of Algeria (Pervinquière 1910) and Marocco (Collignon 1966).

Family **Hoplitidae** Douvillé, 1890
Subfamily **Hoplitinae** Douvillé, 1890
Genus *HYPHOPLITES* Spath, 1922
Hyphoplites campichei campichei Spath, 1925
(Pl. 33, Fig. 1*a*—*c*)

1859. *Ammonites falcatus*, Mantell; Pictet & Campiche, p. 210, Pl. 27, Fig. 1 [only].
1925. *Hyphoplites campichei*, n. n.; Spath, p. 83.
1926. *Hyphoplites campichei*, Spath; Spath, p. 153.
1949. *Hyphoplites campichei* Spath; Wright & Wright, pp. 483—484, Pl. 29, Figs 5—6, 8 [non Fig. 1].
1951. *Hyphoplites campichei* Spath; Wright & Wright, p. 21 [pars].
1968. *Hyphoplites campichei campichei* Spath; Renz, p. 25, Text-figs 9*a*, 10*a*, Pl. 2, Fig. 7.
1971. *Hyphoplites campichei* Spath; Kennedy, pp. 42—43.

Material. — Half a whorl.

Biometry (all linear measurements in *mm*):

	D	Wh	Wb	U	$\frac{Wb}{Wh}$
	27?	12.7	6.9	6.3	0.54
Ratio to D:		?0.47	0.25	0.23	

Remarks. — The writer's specimen (Pl. 33, Fig. 1) represents a highly compressed morphotype; is characterized by whorl thickness to height ratio 0.54, in comparison to 0.61 in the holotype (*cf.* Renz 1968, p. 25). The highly compressed whorls and the ornamentation consisting of poorly developed ribs on whorl sides bring this specimen close to those figured by Wright & Wright (1949, Pl. 29, Figs 5—6). *Hyphoplites campichei* Spath evolved from the species group "*subfalcatus — coelonotus*" of the genus *Discohoplites* Spath, from which it differs in more irregular and generally less pronounced ribs and in well-marked latero-ventral margin of whorls (Wright & Wright 1949, pp. 483—484). The form regarded by Wright & Wright (1949, p. 479, Pl. 29, Fig. 1) as transitional between *Discohoplites subfalcatus* (Semenov) and *Hyphoplites campichei* Spath, was subsequently selected by Renz (1968) as the holotype of the subspecies *Hyphoplites campichei densecostatus* Renz. However, more recently Kennedy (1971) accepted the point of view of Wright & Wright (1949); thus some of his forms may not actually represent the subspecies "*campichei*" sensu Renz (1968). The subspecies "*densecostatus*" differs from the nominal subspecies "*campichei*" in such features: as whorls wider at umbilical margin, whorl sides more strongly converging towards the venter, shape of suture line, and of ribs (Renz 1968, p. 26).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). The species is recorded for the first time in Poland.

Hyphoplites campichei campichei Spath is known from the uppermost Albian ("dispar-perinflatum" Subzone), Lower Cenomanian of England (Wright & Wright 1949, Kennedy 1971), and from the Vraconian of Sainte-Croix in the Swiss Jura (Renz 1968).

Hyphoplites falcatus aurora Wright & Wright, 1949
(Pl. 33, Fig. 2*a*—*b*)

1949. *Hyphoplites falcatus* (Mantell) subsp. chron. *aurora* nov.; Wright & Wright, pp. 485—486, Pl. 29, Figs 3, 9; Pl. 30, Fig. 5.
1951. *Hyphoplites falcatus aurora* Wright & Wright; Wright & Wright, p. 21.
1968. *Hyphoplites falcatus aurora* C. W. et E. V. Wright; Renz, p. 26, Text-fig. 9*d*; Pl. 2, Fig. 15.
1971. *Hyphoplites falcatus aurora* Wright and Wright; Kennedy, p. 42.

?1972. *Hyphoplites* aff. *campichei* Spath transitional to *falcatus aurora* Wright and Wright; Hancock, Kennedy & Klaumann, p. 446, Pl. 81, Fig. 2a—c.

Material. — Fragment of the whorl.

Remarks. — The subspecies *H. falcatus aurora* Wright & Wright is very close to *H. campichei* Spath from which it evolved (Wright & Wright 1949, p. 486). It is easily distinguishable from *H. campichei campichei* Spath by a stronger, flat and wide primary ribs and lack of intercalary ribs.

Occurrence. — Cenomanian, Mokrzesz (unit 3 in Fig. 2*A*). This subspecies was not hitherto recorded from Poland[16].

Hyphoplites falcatus aurora Wright & Wright is known from the uppermost Albian of Dorset, and from the base of the Cenomanian on the Isle of Wight (Wright & Wright 1949, 1951; Kennedy 1971), from the Vraconian of Sainte-Croix (Renz 1968), and from the lowermost Cenomanian in the Rhine Massif (Hancock, Kennedy & Klaumann 1972).

Family **Acanthoceratidae** Hyatt, 1900

Subfamily **Mantelliceratinae** Hyatt, 1903

Genus *MANTELLICERAS* Hyatt, 1903

Mantelliceras tuberculatum (Mantell, 1822)

(Pl. 33, Fig. 4*a*—*b*)

1822. *Ammonites Mantelli* Var. *tuberculata*; Mantell, p. 114.
1857. *Ammonites Mantelli* var. *A*; Sharpe, p. 41, Pl. 18, Fig. 6 [only].
1859. *Ammonites Mantelli*, Sowerby; Pictet & Campiche, pp. 200—206, Pl. 26, Fig. 5 [only].
[non] 1970. *Mantelliceras tuberculatum* (Mantell, 1822); Marcinowski, pp. 442—443, Pl. 6, Fig. 3 [= *Mantelliceras* aff. *costatum* (Mantell)].
1971. *Mantelliceras tuberculatum* (Mantell); Kennedy, pp. 61—62, Pl. 24, Figs 2—3, 5, 7; Pl. 25, Fig. 1 [with synonymy].

Material. — Three fragments of whorls.

Biometry (all linear measurements in *mm*):

Specimen	D	Wh	Wb	U	Wb / Wh
1) Pl. 33, Fig.4	22.5	10.5	12.1	6.2	1.15
Ratio to D:		0.47	0.54	0.27	
2)	—	15.6	14.7	—	0.94
3)	—	11	10.9	—	0.99

Remarks. — The species is characterized by distinct ribbing and numerous well-pronounced tubercles; there are four tubercles on every primary rib, and two on intercalary rib. The specimens belonging to this species are characterized by maximum regularity of shell ornamentation among representatives of the genus *Mantelliceras* Hyatt found in the area studied.

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[16] Cieśliński (1959, pp. 53—54) cited *H. falcatus* (Mantell) from the margins of the Holy Cross Mts. The writer inspected the specimen kept in the Museum of the Geological Survey of Poland, in Warsaw. The specimen is poorly preserved but it may be supposed that it belongs to the nominal subspecies *H. falcatus falcatus* (Mantell).

Occurrence. — Cenomanian, Jaźwiny (unit *3* in Fig. 2C). Outside the area studied, the species was found in Poland in the Cenomanian of northern margins of the Holy Cross Mts (Cieśliński 1959).

Mantelliceras tuberculatum (Mantell) is common in the Cenomanian of western Europe (Kennedy 1971, Renz 1963), Spain (Wiedmann 1959, 1964b), northern Africa (Pervinquière 1910), and Madagascar (Collignon 1964).

Mantelliceras aff. *costatum* (Mantell, 1822)

1970. ***Mantelliceras tuberculatum*** **(Mantell, 1822); Marcinowski, pp. 442—443, Pl. 6, Fig. 3.**
[aff.] 1971. *Mantelliceras costatum* **(Mantell); Kennedy, pp. 57—58, Pl. 19, Figs 1—2; Pl. 24, Fig. 1.**

Material. — One fragment of the whorl.

Remarks. — The specimen figured in previous paper (Marcinowski 1970, Pl. 6, Fig. 3) as *M. tuberculatum* (Mantell) is characterized by whorl thickness almost equal to whorl height, and straight intercalary ribs of different length which are as strong as main ribs on the ventral side. The above characteristics allow to assign this specimen to *Mantelliceras costatum* (Mantell) (*see* Kennedy 1971, pp. 57—58, Pl. 19, Fig. 1). However, it differs from typical representatives of that species in more loosely spaced ribs and in less involute whorls, which justifies assignation of the specimen as "affinis" *costatum* (Mantell).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). The species was not hitherto recorded from Poland.

Mantelliceras gr. *dixoni* Spath, 1926
(Pl. 33, Fig. 5*a*—*b*)

Material. — Half a whorl.

Biometry (linear measurements in *mm*):

Wh	Wb
18.7	17.4

Description. — Whorl fragment with weakly convex sides, ovate in cross-section, thickest at mid-height. The whorl fragment available is ornamented with 13 ribs (number of ribs may be estimated at c. 30 per whorl). Main (longer) ribs rise from tubercles situated at umbilical margins, elongated in the same direction as ribs. Ribs are somewhat inclined forwards, slightly bending backwards at one-third of whorl height; main ribs are well-marked on the venter; ventro-lateral tubercle developed on every main rib. Main ribs are separated by two, sometimes one intercalary rib of different length, but shorter than the main ribs. Some intercalary ribs almost reach umbilical margin. Intercalary ribs almost as strong as main ribs at the venter, becoming progressively thinner towards umbilicus, which differs them from the latter ones. Umbilical wall vertical.

Remarks. — The form in question most closely resembles the specimen figured as *M.* gr. *dixoni* Spath by Kennedy (1971, Pl. 22, Fig. 2). That group was proposed by Kennedy (1969, 1970) for specimens differing from the holotype of *M. dixoni* in result of high variation in shell ornamentation. That variation may be related to changes of ornamentation along with ontogenetic development, or to pathology, as well as to a damage of shell of living individual (Kennedy 1971, p. 59).

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). The species was not hitherto recorded from Poland.

Mantelliceras gr. *dixoni* Spath is known from the upper part of the Mantelliceras mantelli Zone in England. Moreover, it was reported from southern France, presumably from the same stratigraphical position (*cf.* Hancock 1959, p. 250).

Mantelliceras saxbii (Sharpe, 1857)
(Pl. 33, Fig. 3)

1822. *Ammonites Mantelli* Var. *costata;* Mantell, pp. 113—114 [pars], Pl. 22, Fig. 1 [only].
1857. *Ammonites Mantelli,* Sowerby; Sharpe, pp. 40—41, Pl. 18, Fig. 4 [only].
1857. *Ammonites Saxbii,* Sharpe; Sharpe, p. 45, Pl. 20, Fig. 3.
?1959. *Mantelliceras* cf. *batheri* Spath; Cieśliński, p. 62, Pl. 8, Fig. 5.
1959. *Mantelliceras hyatti* Spath; Cieśliński, p. 63.
1959. *Mantelliceras saxbii* (Sharpe); Cieśliński, p. 64.
1971. *Mantelliceras saxbii* (Sharpe); Kennedy & Hancock, pp. 437—441, Text-fig. 1*a, e;* Pl. 79, Figs 1, 3; Pl. 80, Figs 1—4; Pl. 81, Figs 4, 6—8; Pl. 82, Fig. 2 [with all synonymy].

Material. — Two fragments of whorls.

Biometry (linear measurements in *mm*):

Specimen in	Wh	Wb
Pl. 33, Fig. 3	21.8	15

Remarks. — Systematic position of this species, its full synonymy and discussion are given by Kennedy & Hancock (1971). It follows from the synonymy given by those authors that the forms described as *Mantelliceras* cf. *batheri* Spath and *M. hyatti* Spath by Cieśliński (1959) from the northern margins of the Holy Cross Mts actually belong to this species.

Occurrence. — Cenomanian, Mokrzesz (unit *3* in Fig. 2*A*). In Poland this species is also represented in the Cenomanian of northern margins of the Holy Cross Mts (Cieśliński 1959; *cf.* remarks above).

Mantelliceras saxbii (Sharpe) is characterized by wide geographical distribution, as it is known from the Lower Cenomanian of England, northern and southern France, Germany (Kennedy & Hancock 1971, Kennedy 1971), Switzerland (Pictet & Campiche 1860, Renz 1963), northern Africa (Pervinquière 1910), Madagascar (Collignon 1964) and possibly also from the North America (Kennedy & Hancock 1971).

Genus *ACOMPSOCERAS* Hyatt, 1903
Acompsoceras sp.

Material. — Badly preserved fragment of the whorl.

Dimensions (in *mm*): Wh — ?42, Wb — 17.3.

Description. — Whorl slender, smooth, with gently convex sides, markedly higher than wide, thickest at mid-height. Venter narrow, rounded. Suture line poorly visible, with subphylloid folies of the pseudophylloceratoid type.

Remarks. — Very slender whorl shape, narrow and rounded venter, and the course of suture line bring this specimen close to *Acompsoceras essendiense* (Schlüter) var. *madagascariensis* Collignon (*see* Collignon 1964, Pl. 356, Fig. 1569; Pl. 357, Fig. 1570). Kennedy (1971, p. 69, Pl. 31, Fig. 2) regarded specimens belonging to that variety as *A.* aff. *essendiense* (Schlüter). Poor preservation of the writer's specimen precludes more accurate identification.

Occurrence. — Cenomanian, Jaźwiny (base of unit *3* in Fig. 2*C*). This genus hitherto was not reported from Poland.

The genus *Acompsoceras* Hyatt is known from the Cenomanian of England, France, Germany, northern Africa, Syria, Madagascar, North America (Wright 1957, Kennedy 1971); *Acompsoceras?* was reported from the Cenomanian of the Western Interior Region in Canada (Jeletzky 1971, p. 28).

Genus *CALYCOCERAS* Hyatt, 1900

Subgenus *LOTZEITES* Wiedmann, 1959

Calycoceras (Lotzeites) aff. *lotzei* Wiedmann 1959

(Pl. 33, Fig. 6*a*—*b*)

[aff.] 1959. *Calycoceras (Lotzeites) lotzei* n.sp.; Wiedmann, pp. 732—734, Text-fig. 1, Pl. 2, Figs 1—2.

[aff.] 1964b. *Calycoceras (Lotzeites) lotzei* Wiedmann; Wiedmann, pp. 121—122, Figs 2*a*—*b*, 3.

Material. — Well preserved fragment of the whorl.

Dimensions (in *mm*): Wh — 10.4, Wb — 11.7, Wbt (thickenes of the whorl on the lateral tubercles) — 14.3.

Description. — Whorl wider than high, with convex, rounded venter. Umbilicus with high, vertical umbilical wall. Umbilical margin ornamented with small inflattened tubercles, giving rise to short ribs. Ribs continue across whorl sides, reaching sharp, conical tubercles at poorly marked ventro-lateral margin. Ventro-lateral tubercles have spiny-like appearance and give rise to pairs of external ribs. The external ribs pass across and are progressively more distinct towards the venter. A single intercalary rib, developed in the same way as the remaining external ribs, is feebly connected with any ventro-lateral tubercle. External ribs much better marked than the internal (umbilical) ones.

Remarks. — The specimen in question is most similar to that presented by Wiedmann (1959, Pl. 2, Figs 1—2; and Text-fig. 1), differing somewhat in cross-section of whorl and in occurrence of intercalary ribs on ventral side. According to Professor W. J. Kennedy (written communicat) the writer's specimen may belong to the species *Calycoceras (Lotzeites) lotzei* Wiedmann, but features such as style of ribbing and strong tuberculation also bring it close to some representatives of *Calycoceras naviculare* (Mantell), which may form a transition to species of the subgenus *Lotzeites* (*cf.* Kennedy 1971, Pl. 47, Fig. 1).

Occurrence. — Cenomanian, Jaźwiny (upper part of unit *3* in Fig. 2*C*). The subgenus and species were not hitherto recorded from Poland.

Calycoceras (Lotzeites) lotzei Wiedmann is known from the middle part of the Upper Cenomanian (*V* zone) of Portugal and Spain (Wiedmann 1959, 1964b). This species is good guide fossil of the Upper Cenomanian (W. J. Kennedy, written communicat). Other species of that subgenus, outside Spain and Portugal, were reported from India, Madagascar, northern Africa, and England (Wiedmann 1959, 1964b; Kennedy 1971), and from the French Alps (Porthault, Thomel & Villoutreys 1966).

Subfamily **Acanthoceratinae** Hyatt, 1900

Genus *ACANTHOCERAS* Neumayr, 1875

Acanthoceras sp.

(Pl. 31, Fig. 5)

Material. — Badly preserved whorl fragment of a large specimen.

Remarks. — Whorl subquadrate in cross-section, ornamented with massive ribs. If the point of view of Kennedy & Hancock (1970) and Kennedy (1971) is accepted, allocation of the specimen in the genus *Acanthoceras* Neumayr, 1875, seems to be unquestionable. However, its poor preservation precludes any specific identification.

Occurrence. — Middle Cenomanian, Glanów (unit *2a* in Fig. 22). From the same exposure Sujkowski (1926) cited "*Acanthoceras rhotomagense* Defr."[17]. In Poland, specimens of the genus *Acanthoceras* Neumayr, 1875, are very rare, and were reported from the Upper Cenomanian of the Burzenin area, western margins of the Miechów synclinorium (Cieśliński 1958), and from the margins of the Holy Cross Mts (Cieśliński & Pożaryski 1970)[18]. This genus has world-wide distribution in the Middle and Upper Cenomanian.

General remarks on the ammonite fauna

The rich assemblage of Cenomanian ammonites found in the area studied yields a number of genera, species, and subspecies hitherto not reported from the area of Poland, *viz. Phylloceras (Hypophylloceras) seresitense seresitense* Pervinquière, *Turrilites (Turrilites) boerssumensis* Schlüter, *Hyphoplites campichei campichei* Spath, *H. falcatus aurora* Wright & Wright, *Mantelliceras* aff. *costatum* (Mantell), *M.* gr. *dixoni* Spath, *Acompsoceras* sp., and *Calycoceras (Lotzeites)* aff. *lotzei* Wiedmann.

Majority of cephalopods (*cf.* Table 5) reported from the area studied are also known from England (*cf.* Wright & Wright 1951, Kennedy 1971) and are characterized by the world-wide distribution (*vide occurrences* and Marcinowski 1970, Kennedy 1971). Average size of Polish specimens is generally smaller than that of comparable English representatives of the same species (Marcinowski 1970, p. 445).

Frequency of particular higher taxa of ammonites in the writer's collection comprising 637 specimens, is different, and the percentage contribution of various families is as follows:

	%
Schloenbachidae	63.74
Turrilitidae	21.51
Acanthoceratidae (mainly subfamily Mantelliceratinae)	5.34
Scaphitidae	4.70
Baculitidae	3.92
Hoplitidae	0.31
Phylloceratidae	0.16
Hamitidae	0.16
Desmoceratidae	0.16

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[17] Collection of cephalopods from the area in question, gathered by Sujkowski, was lost during the II world war. Thus, the writer is unable to state whether or not the identifications, and particularly specific identifications made by Sujkowski would be acceptable in the light of the present criteria.

[18] Those authors accept two-fold subdivision of the Cenomanian. Their Upper Cenomanian corresponds to a part of the Middle Cenomanian and to the whole Upper Cenomanian in the subdivision accepted in the present paper (*vide* chapter on stratigraphy).

Table 5

Distribution of Cenomanian cephalopods in the investigated area of the Polish Jura Chain; the list of species comprises both the forms monographed in this paper, as well as those previously described (Marcinowski 1970, 1972)

Species	Number of the outcrop											
	46	52	53	69	70	71	72	74	83	84	108a	110
NAUTILIDS												
Eutrephoceras sublaevigatum /d'Orbigny/	+		+							+		
E. cf. sublaevigatum /d'Orbigny/					+							
Cymatoceras deslongchampsianum /d'Orbigny/	+											
AMMONITES												
Phylloceras /Hypophylloceras/ seresitense seresitense Pervinquière	+											
Hamites sp.	+											
Sciponoceras subbaculoides /Geinitz/	+	+	+		+		+				+	
Hypoturrilites gravesianus /d'Orbigny/			+							+		
H. aff. gravesianus /d'Orbigny/	+											
H. mantelli /Sharpe/	+	+	+		+					+		
H. tuberculatus /Bosc/	+	+	+									
H. aff. tuberculatus /Bosc/	+											
Hypoturrilites sp.	+											
Ostlingoceras /Ostlingoceras/ bechii /Sharpe/	+											
O. /O./ puzosianum /d'Orbigny/	+											
Mariella /Mariella/ lewesiensis /Spath/	+											
M. /M./ cenomanensis /Schlüter/	+											
M. /M./ cf. cenomanensis /Schlüter/	+											
M. /M./ dorsetensis /Spath/			+									
M. /M./ essenensis /Geinitz/	+		+							+		
Mariella /Mariella/ sp.	+									+		
Turrilites /Turrilites/ costatus Lamarck	+		+									
T. /T./ acutus Passy	+	+	+									
T. /T./ scheuchzerianus Bosc	+	+	+			+				+		
T. /T./ boerssumensis Schlüter	+											
Scaphites /Scaphites/ equalis Sowerby	+	+	+		+					+	+	
Puzosia /Puzosia/ subplanulata /Schlüter/											+	
Hyphoplites campichei campichei Spath	+											
H. falcatus aurora Wright & Wright	+											
Schloenbachia varians /Sowerby/	+		+							+		
S. cf. varians /Sowerby/	+									+	+	
?S. varians var. trituberculata Spath	+											
S. varians var. tetrammata /Sowerby/	+		+									
S. subvarians Spath	+	+	+		+							
S. subtuberculata /Sharpe/	+		+							+	+	
S. sharpei Semenov	+		+									
S. quadrata Spath	+	+	+							+		
S. cf. quadrata Spath											+	
S. ventriosa Stieler	+	+	+		+	+	+			+	+	
S. subplana /Mantell/	+											
S. intermedia /Mantell/	+											
S. cf. lymensis Spath											+	
Schloenbachia sp.				+							+	
Mantelliceras tuberculatum /Mantell/			+									
M. aff. costatum /Mantell/	+											
M. gr. dixoni Spath	+											
M. saxbii /Sharpe/	+											
Mantelliceras sp.	+	+	+		+					+		
Sharpeiceras sp.	+											
Acompsoceras sp.			+									
Calycoceras /Lotzeites/ aff. lotzei Wiedmann			+									
Calycoceras sp.		+	+									
Paracalycoceras cf. wiestii /Sharpe/			+									
Acanthoceras sp.											+	
BELEMNITES												
Neohibolites ultimus /d'Orbigny/	+											
Actinocamax /Praeactinocamax/ plenus plenus /Blainville/											+	
A. /P./ plenus /Blainville/ subsp. indet.								+	+			+
A. /P./ primus primus Arkhangelsky											+	

It is of interest to note that the genus *Schloenbachia* Neumayr, 1875, predominating here, is also the most common in the Cenomanian of England, where "at many levels (it) forms 90% and more of the ammonite fauna" (Kennedy 1971, p. 45). Some other forms are as rare in Poland, as they are in England. For example, of the family Phylloceratidae Zittel, 1884, comprising typical representatives of the Mediterranean fauna, only two specimens of *Phylloceras (Hypophylloceras) seresitense* Pervinquière were found in the Cenomanian of England (Kennedy 1971). Although Cenomanian ammonite assemblages of the southern England and the Polish Jura Chain are very similar in composition, there are also distinct differences, particularly when lower taxa are compared. For example, ammonites of the genera *Hamites, Puzosia, Hyphoplites, Calycoceras,* and *Acanthoceras,* common in the Cenomanian of England, are extremely rare in the area studied; this can be related to differences in environmental conditions. In turn, some species of the family Turrilitidae Meek, viz. *Hypoturrilites gravesianus* (d'Orbigny), *H. tuberculatus* (Bosc), *Turrilites (T.) costatus* Lamarck, *Turrilites (T.) acutus* Passy, *Turrilites (T.) scheuchzerianus* Bosc, *Mariella (M.) lewesiensis* (Spath), seem to be equally common in Poland and in England. Moreover, some of these species of turrilids are known from the Cenomanian of North America (Clark 1965, Cobban & Scott 1972), South America (Benavides-Cáceres 1956), Australia (Wright 1963), and Madagascar (Collignon 1964). It is interesting that the benthic or epibenthic forms, to which belong representatives of the family Turrilitidae, show such a wide geographical distribution. This would indicate their lack of dependence or lack of sensitivity to general environmental changes in their juvenile stages when they, after a pelagic widespread of larvae, settled in various geographic zones.

STRATIGRAPHY

Accuracy of stratigraphic subdivision of the Albian-Turonian strata studied is influenced by frequency and stratigraphic value of particular faunal groups (*cf.* description of lithological members and Tables 1—5). Cephalopods (ammonites and belemnites), the group of orthostratigraphic importance, appear to be confined to the Cenomanian strata in the area studied. The Albian and Turonian strata are devoid of cephalopods, and inocerams are the only group of stratigraphic importance represented. Some strata are without stratigraphically important fossils and their age may only indirectly be established.

Upper Albian

In the area studied, the oldest deposits with faunal record (yielding *Inoceramus concentricus* Parkinson, *I. anglicus* Woods, and *I. anglicus-*

crippsi m.f.) are assigned to the Upper Albian. In the present paper this stratigraphic unit is interpreted in the same way as in England (*cf.* Spath 1926a, 1942) and in the remaining epicontinental areas of Poland (*cf.* Cieśliński 1959, 1960a), although lack of ammonites precludes more accurate stratigraphic definition of that unit.

In the vicinities of Mokrzesz-Lusławice-Julianka and Lelów, the oldest Cretaceous strata yield no fossils except for siliceous sponges. They infill all the larger depressions in the substrate formed by Upper Jurassic limestones, and are overlaid by middle Upper Albian strata with fossil record (*cf.* Fig. 28 — Zalesice, Lelów). Those faunistically bare strata correspond to the lower part of the Upper Albian and possibly to the uppermost Middle Albian (Marcinowski 1970). They are overlaid by quartz sandstones with irregular bodies of quartzitic sandstones and yielding i.a. *Inoceramus concentricus* Parkinson, *I. anglicus* Woods. Still younger inoceram association was found in the Solca region (*see* below), in the strata developed in the same facies. Thus the inoceram assemblage from quartzitic sandstones of Zalesice and Lelów should be regarded as indicative of the middle part of the Upper Albian. Also Cieśliński (1960a) regards the strata characterized by cooccurrence of *Inoceramus concentricus* Parkinson and *I. anglicus* Woods as being of the middle Late-Albian age. At Mokrzesz, Jaźwiny, and Lusławice, inoceram-bearing strata are overlaid by quartz sands with phosphatic nodules (units *1—6* in Fig. 2*B*, units *1—2* in Fig. 2*C*, units *1—3* in Fig. 2*D*) and with numerous *Aucellina gryphaeoides* (Sowerby). Those sands underlie Cenomanian strata with fossil record and represent the uppermost Albian (*cf.* also Cieśliński 1960a).

In the Solca region, bipartity of the lithological profile of the Upper Albian was found (*cf.* Fig. 28 — Solca): the lower part of the profile comprises sandy deposits with innumerous siliceous sponges, while the upper part is composed of quartz sands with irregular bodies of quartzitic sandstones (*cf.* Fig. 28). The quartzitic sandstone bodies yield *Inoceramus anglicus* Woods, and *I. anglicus-crippsi* m.f., and other fossils. However, *Inoceramus concentricus* Parkinson was not found. Lack of this form, and occurrence of *I. anglicus* Woods and *I. anglicus-crippsi* m.f., *i.e.* the form transitional between Upper Albian species *anglicus* and Cenomanian *I. crippsi* Mantell, suggest the latest Albian age of those strata. If it is the case, then the underlying sandy deposits with sponges roughly correspond to the lower and middle parts of the Upper Albian (*cf.* Fig. 28 — Zalesice-Solca).

In the Wolbrom and Glanów regions, Cenomanian strata with fossil record are underlaid by deposits facially corresponding to sandy deposits with sponges, known from the Zalesice, Lelów, and Solca regions (Fig. 28, *cf.* also Pl. 1, Fig. 6 with Pl. 2, Figs 2—3). Analysis of the profile (*cf.* Fig. 27 and Fig. 28 — Wolbrom-Glanów) shows that those deposits underlying the Cenomanian ones may correspond to the whole Upper Albian.

Maximum thickness of the Upper Albian is as follows: Zalesice — 25 m, Lelów 28—30 m, Solca 50 m, Wolbrom and Glanów — 43—33 m, decreasing to 0 at Mokrzesz, Poręba Dzierżna, and Glanów (profile *108c*). Such high variation in thickness of the Upper Albian strata, observed even at short distances (*e.g.* Mokrzesz and Glanów localities — *cf.* Figs 2, 27, and 28) relates mostly to denivelations of the Upper Jurassic substrate. It should be noted that fossiliferous deposits of middle and upper parts of the Upper Albian from the area studied are markedly thicker than contemporaneous phosphorite-bearing strata (A_7 and A_8 horizons) from north-eastern margins of the Holy Cross Mts (*cf.* Cieśliński 1959, 1960a).

Cenomanian

Previous division of the Cenomanian into three parts, used in Poland by Samsonowicz (1925), Panow (1934), Różycki (1937), Pożaryski (1947), *a.o.*, was based on inadequate biostratigraphic evidence. The forms regarded as guide fossils actually occur in the whole Cenomanian (*cf.* Cieśliński 1959, Marcinowski 1970). In connection with this Cieśliński (1959) proposed bipartite division of the Polish Cenomanian (*cf.* Table 6) following a subdivision of the English Cenomanian introduced by Wright & Wright (1951). Cieśliński's (1959) division was accepted in subsequent papers (*cf.* Cieśliński 1959, 1965; Cieśliński & Pożaryski 1970; Marcinowski 1970; Głazek, Marcinowski & Wierzbowski 1971). However, the bipartite division of the Cenomanian is not free from some drawbacks and often is not supported by adequate paleontological evidence (*cf.* Cieśliński 1959, Marcinowski 1970).

In recent years, classical sections of the Cenomanian in France and in England were reexamined and their ammonite sequence studied in detail. Those studies made it posible to divide the Cenomanian into three well-defined zones — the Mantelliceras mantelli, Acanthoceras rhotomagense, and Calycoceras naviculare zones (Hancock 1959; Kennedy 1969, 1971)[19].

The Cenomanian/Turonian boundary has not been so far accurately defined and the stratigraphic position of the strata of Actinocamax plenus Zone, occurring above the Calycoceras naviculare Zone, gives rise to some doubts (*cf.* Marcinowski 1972, and the literature cited). Recent studies showed that in southern England *Calycoceras naviculare* (Mantell) enters

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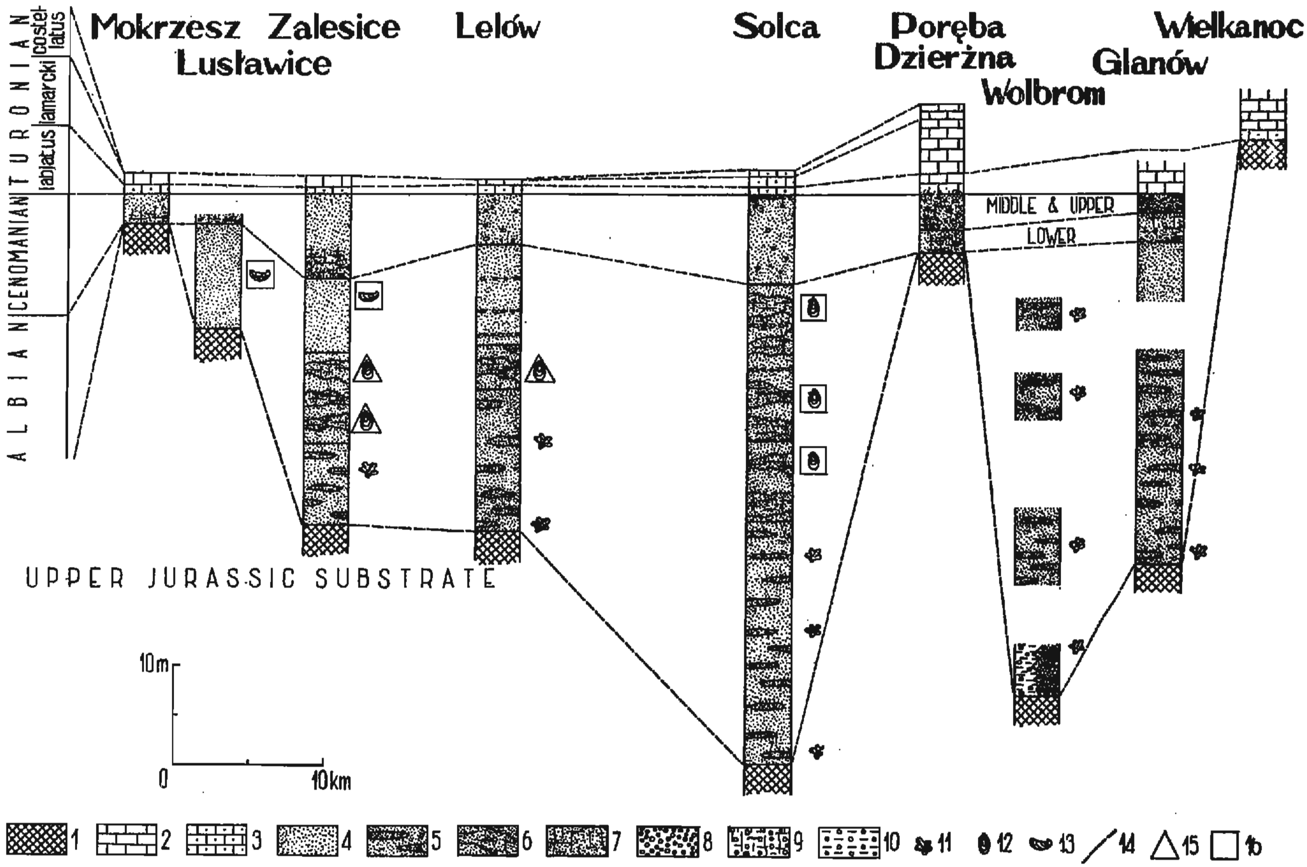
[19] S. Radwański (1966) in his study on the Cenomanian of the Middle Sudetes Mts in Poland distinguished these three ammonite zones after Hancock (1959), however, without any fossil records.

Correlation of the Cretaceous deposits and their relation to the Upper Jurassic substrate n the Polish Jura Chain, between Częstochowa and Glanów (for location of the profiles see Text-figs 1*C* and 9)



1 Upper Jurassic substrate, *2* limestones, *3* sandy limestones, *4* sands, *5* sands with concretional bodies of siliceous sandstones, *6* quartzitic sandstones developed as irregular layers in sands, *7* sandstones, *8* gravelstones, *9* conglomerates, *10* clays with single quartz pebbles, *11* sponges in the Albian deposits, *12* Albian inocerams, *13* Albian *Aucellina*, *14* stratigraphic boundaries, *15* fauna of middle part of the Upper Albian, *16* fauna of the uppermost Albian the lower part of the *plenus* Zone (*sensu* Hancock 1969; *cf.* Kennedy 1971, p. 103). In the area studied *Actinocamax (Praeactinocamax) plenus* (Blainville) cooccurs with *Schloenbachia* cf. *lymensis* Spath in the Calycoceras naviculare Zone (*see* below). Deposits of that zone are overlaid by the Lower Turonian (Inoceramus labiatus Zone) deposits in sedimentary continuity so it appears impossible to distinguish a separate *plenus* Zone. In the present paper the Calycoceras naviculare Zone is accepted as the upper zone of the Cenomanian (*cf.* Table 6), and interpreted in this way as comprising at least a part of the *plenus* Zone. It follows from the data recently published that the *plenus* Zone strata may be regarded as a range of correlation error in delineating Cenomanian/Turonian boundary.

The rich ammonite assemblage from the area studied (*cf.* Table 5) yields a number of forms characteristic of these abovelisted three zones. Moreover, Cenomanian ammonite assemblage from the Polish Jura Chain appears very close to the ammonite assemblage from England (*cf.* chapter — remarks on ammonite fauna). This makes it possible to adopt the division of the Cenomanian into three zones proposed by Kennedy (1969). The results of studies on the Polish profiles of the Cenomanian and the data gathered from the literature allow to compare the divisions of the Cenomanian applied in England and France, with that hitherto used in Poland (Table 6).

In the whole area studied, decalcified deposits of the Upper Albian are overlaid by Cenomanian ones (*cf.* Figs 2*B*—*D*, 17—18, 27—28). When Cenomanian deposits directly rest on Jurassic substrate, their lower part is represented by conglomerates (*cf.* Figs 2*E*, 20, 22). Cenomanian strata as a rule are highly marly, and the writer arbitrarily places the lower boundary of the Cenomanian at the point where calcium carbonate appears for the first time. At Mokrzesz (outcrop *46*, unit *3* in Fig. 2*A*), ammonite fauna shows that those calcium-carbonate-yielding deposits represent Lower and lower Middle Cenomanian (up to the *Turrilites acutus* assemblage *sensu* Kennedy, 1969, inclusively). The whole of the Cenomanian profile from Mokrzesz is of the condensational character, and the ammonite fauna occurring only in the unit *3* is mixed. It therefore is possible to estimate time interval of deposition of this unit but not to delineate the boundary between the Lower and Middle Cenomanian. It should be noted that *Ostlingoceras (Ostlingoceras) puzosianum* (d'Orbigny), the species widely recognized as typical of the Upper Albian (Spath 1937, Collignon 1963, Renz 1968) was found here together with Cenomanian forms. The occurrence of this species in the Mokrzesz profile may be explained in two ways:

(a) either the whole profile (units *1*—*3* in Fig. 2*A*) represents a condensed sequence of the uppermost Albian — lower Middle Cenomanian (including the *T. acutus* assemblage) and the accumulation of more or less reworked ammonite remains completed during the deposition of unit *3*;

Table 6

Zonal division of the Cenomanian in France, Southern England and Central Poland (correlation between Sarthe and Southern England *after* Kennedy 1971)

FRANCE /Sarthe/ /Hancock 1959/	SOUTHERN ENGLAND /Kennedy 1969, 1971/		CENTRAL POLAND /Cieśliński 1959, 1965/
Calycoceras naviculare	Calycoceras naviculare	/no data on possible assemblages/	Holaster subglobosus & Schloenbachia lymensis
Acanthoceras rhotomagense	Acanthoceras rhotomagense	assemblages: Acanthoceras jukes-brownei	
		Turrilites acutus	Schloenbachia varians
		Turrilites costatus	
Mantelliceras mantelli	Mantelliceras mantelli	assemblages: Mantelliceras gr. dixoni	
		Mantelliceras saxbii	
	No ammonites	Hypoturrilites carcitanensis	

(b) or the stratigraphic range of *Ostlingoceras (O.) puzosianum* (d'Orbigny) is not confined to the uppermost Albian but the species also enters the Lower Cenomanian.

In the case of Mokrzesz profile, attention should also be paid to the occurrence of *Hyphoplites campichei campichei* Spath and *H. falcatus aurora* Wright & Wright, the subspecies, known from the uppermost Albian ("dispar-perinflatum" Subzone) and Lower Cenomanian of England (*cf.* Wright & Wright 1949, Kennedy 1971), and from the Vraconian of Sainte-Croix in Switzerland (Renz 1968).

Cenomanian deposits at Jaźwiny (outcrop *53*, unit *3* in Fig. 2C) yield ammonites (*vide* Table 5) indicative of the three Cenomanian zones, since both Lower/Middle Cenomanian forms and *Calycoceras* (*Lotzeites*) aff. *lotzei* Wiedmann were found there. *Calycoceras (Lotzeites) lotzei* Wiedmann occurs in the middle part of the Upper Cenomanian (*V* zone) in Portugal and Spain (Wiedmann 1959, 1964b). Although the specimen from Jaźwiny somewhat differs from the type specimen, according to Professor W. J. Kennedy (written communicat) it may belong to this species and it undoubtedly represents a typical form of the Upper Cenomanian (from the Calycoceras naviculare Zone). The total thickness of Cenomanian deposits in the vicinities of Mokrzesz and Jaźwiny is estimated at about 3 m.

In Julianka and Zalesice regions, the places where the Cenomanian overlies Upper Albian deposits, the lower part of the Cenomanian sequence — about 3.5—4 m thick — is developed in the same way as at Mokrzesz, Lusławice, and Jaźwiny. The ammonite fauna in the former localities although somewhat poorer than in the latter (*cf.* Table 5), is indicative of the Lower and major part of the Middle Cenomanian (including the *T. acutus* assemblage). These deposits are overlaid by marly fine-grained sands with a few fossils including *Actinocamax (Praeactinocamax) plenus* (Blainville) subsp. indet. This belemnite was found below the base of the Lower Turonian and in the whole area studied it was not recorded outside the Upper Cenomanian (*cf.* Marcinowski 1972). In Julianka and Zalesice regions, the total thickness of Cenomanian deposits may be estimated at about 8 m.

The deposits from the Lelów and Solca regions are without faunal record and are assigned to the Cenomanian stage on the lithological premises (calcium carbonate admixture in sands and sandstones) and on their position in the profile, between faunistically dated uppermost Albian and Lower Turonian strata. Faunistically dated Cenomanian deposits are found further southwards at Poręba Dzierżna and Glanów. At Glanów (outcrops *108* and *108b* in Fig. 12), marly Cenomanian deposits (Figs 17—18) yield no identifiable ammonites and their age is generally shown by *Inoceramus crippsi* Mantell, *Discoides subuculus* (Klein), and *Holaster poloniae* Lambert. These deposits, being in stratigraphic continuity with the Upper Albian ones (*cf.* Fig. 18) and differing from the nearby Middle and Upper Cenomanian strata with faunal record (*cf.* Figs 20, 22 and description of lithological members) in lithology and microfacial development, are assigned to the Lower Cenomanian.

Faunistically dated Middle and Upper Cenomanian strata in some places of the Glanów region (outcrop *108c* in Fig. 12) rest directly on the Jurassic substrate (*cf.* Figs 20 and 22).

The Middle Cenomanian is represented by quartz conglomerates (unit *2a* — *cf.* Fig. 22) that yield *Acanthoceras* sp., *Schloenbachia* cf. *varians* (Sowerby), *S. subtuberculata* (Sharpe), *S.* cf. *quadrata* Spath, and *S. ventriosa* Stieler. Such assemblage may be assigned to the Acanthoceras rhotomagense Zone (*cf.* Kennedy 1969). Conglomerates of the unit *2b*, without fossil record, are arbitrarily assigned to that zone on the lithological premises.

The Upper Cenomanian is mainly represented by conglomerate-like deposits (unit *2c* in Fig. 22) yielding i.a. *Schloenbachia* cf. *lymensis* Spath, *Actinocamax (Praeactinocamax) plenus plenus* (Blainville), *A. (P.) primus primus* Arkhangelsky. These deposits represent the Upper Cenomanian, most probably its lower part (Marcinowski 1972). Top surface of the unit *2c*, with traces of submarine erosion, is overlaid by laminated limestones of the unit *2d*, yielding *Inoceramus crippsi* Mantell, the species known exclusively from the Cenomanian (Woods 1911; Cieśliński 1963, 1965; Tröger 1967). Thus, despite the obvious difference in lithology in respect to the underlying conglomerate units, and the similarity with the overlying Turonian deposits, the Turonian age of those limestones advocated by Sujkowski (1926), Panow (1934), Kongiel (1958 *in* Popiel-Barczyk), Burzewski (1969), and others[20], is here rejected, and the Cenomanian suggested. The total thickness of Cenomanian deposits from the Glanów region (Lower Cenomanian — outcrop *108b*, Middle and Upper Cenomanian — outcrop *108c*) may be estimated at about 5 m.

At Poręba Dzierżna (outcrop *110* in Fig. 9). deposits of the unit *1* (*cf.* Fig. 10) resting directly on the Jurassic substrate yield pelecypod and echinoid fauna known from the whole Cenomanian, whereas deposits of the unit *2* are without faunal record. These two units are lithologically similar and are assigned to the Lower Cenomanian on account of their position in the profile. Deposits of the unit *3* (*cf.* Fig. 10), occurring in sedimentary continuity with the latter, yield *Actinocamax (Praeactinocamax) plenus* (Blainville) subsp. indet., the species known in the Polish Jura Chain exclusively from the Upper Cenomanian (*cf.* Marcinowski 1972). Thus, the unit *3* is regarded as comprising both the Middle and Upper Cenomanian. The total thickness of Cenomanian deposits from Poręba Dzierżna is estimated at 6 m.

Turonian

In the present paper the interpretation of this stage follows that applied in the remaining epicontinental parts of Poland. The Lower Turonian comprises two zones: lower, the Inoceramus labiatus Zone, and upper, Inoceramus lamarcki Zone. The Upper Turonian also comprises two zones: lower zone, which is still lacking any precise definition and upper, the Inoceramus schloenbachi Zone (*cf.* Pożaryski 1938, 1948; Cieśliński 1960b, 1963; Cieśliński & Pożaryski 1970). The range of *Scaphites geinitzi* d'Orbigny covers the whole Turonian (Prescher 1963) hence this species cannot be used as a guide fossil for the lower part of the Upper Turonian (*cf.* Panow 1934), *i.e.*, for T_3 Zone of Cieśliński (1963). It therefore appears that a re-definition of that latter zone is needed. The writer suggests to replace the former Scaphites geinitzi Zone by the Inoceramus costellatus Zone with *Inoceramus costellatus* as the index species. The

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[20] Previously, the stratigraphy of all the above discussed Cenomanian deposits in the Wolbrom-Glanów region was differently interpreted (*cf.* Sujkowski 1926, Panow 1934, Burzewski 1969), primarily because of the lack of any more accurate definitions of stratigraphic zonation.

studies on the Turonian of Poland (Pożaryski 1938; Cieśliński 1960b, 1963) show that *Inoceramus costellatus* Woods occurs only in the lower part of the Upper Turonian. The lower boundary of that Zone should be defined by the first appearance of the species *Inoceramus costellatus* Woods and *I. inconstans* Woods, whereas the upper boundary — by the first appearance of *I. schloenbachi* Böhm (*cf.* Cieśliński 1960b, 1963; Cieśliński & Pożaryski 1970).

In the area studied the early Turonian age of the deposits is well defined by occurrence of *Inoceramus labiatus* Schlotheim and *I. lamarcki* Parkinson (*cf.* Sujkowski 1926; Różycki 1937, 1938; Kowalski 1948). The deposits of the Inoceramus labiatus Zone, wherever exposed, rest on the Cenomanian with sedimentary continuity (*cf.* Figs 10, 22, 27—28), whereas the deposits of the Inoceramus lamarcki Zone, from the southern parts of the area studied (Wolbrom and Glanów regions), often rest directly on the Upper Jurassic substrate (Figs 24—28). In the areas of Mokrzesz, Lusławice, Julianka, and in the northern part of the Lelów region, there occur only Lower Turonian deposits with hardground at the top, overlaid by Lower Campanian marls (Różycki 1938). In southern parts of the Lelów region and further southwards (*cf.* Fig. 28) there occur hitherto undivided Upper Turonian deposits (Sujkowski 1926, 1934; Różycki 1938; Kowalski 1948) with *Inoceramus inconstans* Woods, *I.* cf. *inconstans* Woods, *Cardiaster* sp., *Infulaster* sp., and *Sternotaxis planus* (Mantell). The occurrence of *Inoceramus inconstans* Woods indicates that these deposits represent the Inoceramus costellatus Zone. Also the echinoid association occurring in that zone is not known from older zones of the Turonian in the whole area studied. However, there are no paleontological premises which would enable to distinguish herein the uppermost zone of the Turonian, the Inoceranus schloenbachi Zone[21].

The Upper Turonian deposits, with hardground at their top, are overlaid by Santonian deposits (Różycki 1938, Kowalski 1948, Bukowy 1968). The problem of the gap between the Turonian and Santonian in the Polish Jura Chain was discussed separately (Marcinowski & Szulczewski 1972).

In various regions, the maximum thickness of the Turonian (*cf.* Fig. 28) is as follows: Zalesice — 1.8 m, Lelów — 1.5 m, Solca — 2.7 m, Poręba Dzierżna — 9 m, and Wolbrom and Glanów — about 9—10 m.

The thickness of Albian, Cenomanian and Turonian deposits is markedly reduced in the area studied as compared to other parts of epicontinental Poland. It is especially evident in the case of Cenomanian deposits, the thickness of which represents about 20 per cent, and in the

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[21] Although *Sternotaxis planus* (Mantell) is considered as the index species of the uppermost Turonian zone in England (Wright & Wright 1951, Peake & Hancock 1961), it should be remembered that this zone is interpreted much more widely in England than in Poland (*cf.* Cieśliński 1960b, 1963), and it comprises whole or almost the whole Inoceramus costellatus Zone proposed in the present paper.

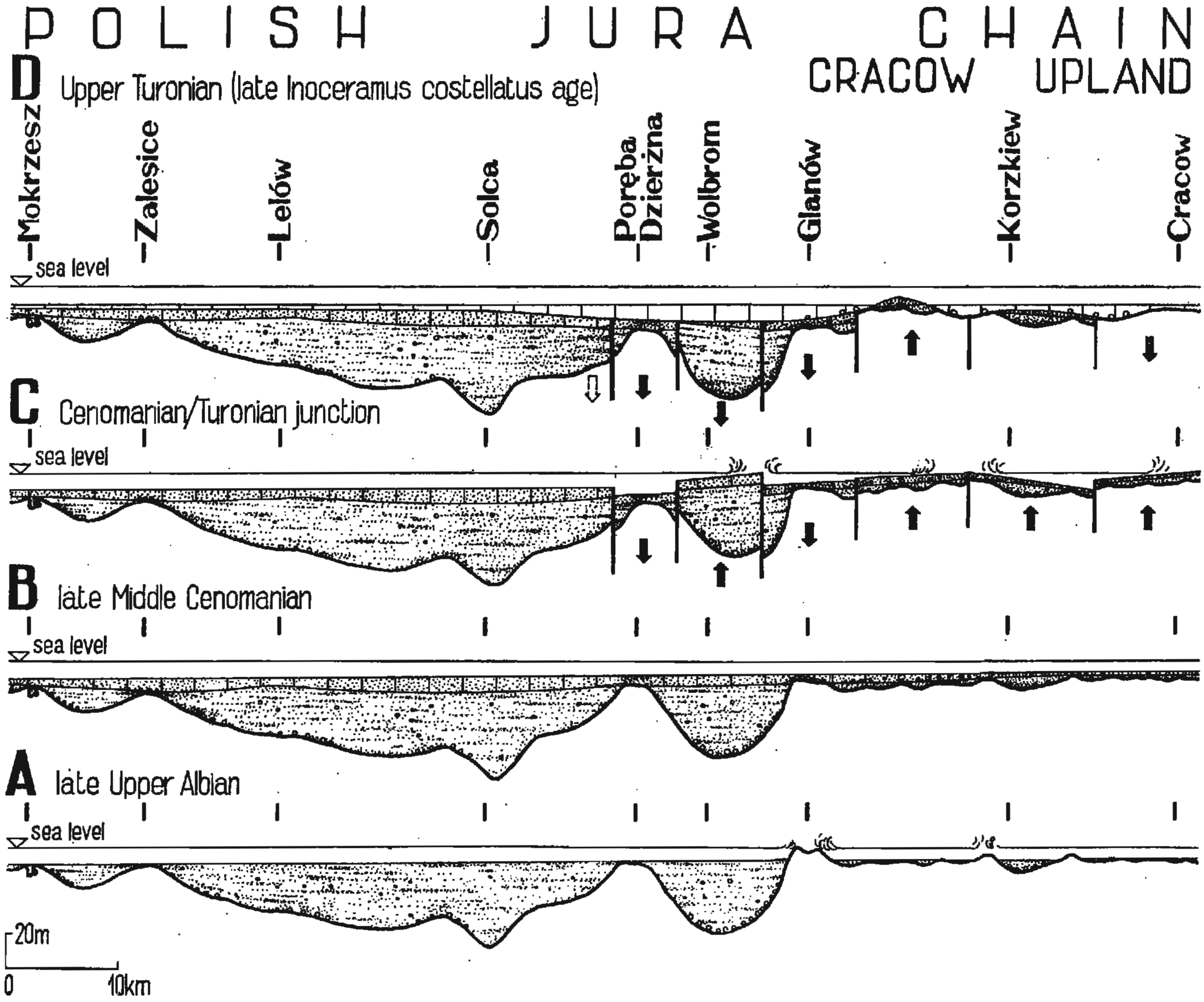
case of Turonian — about 5—6 per cent respectively, of the thickness of contemporaneous deposits from NE margins of the Miechów synclinorium (*i.e.* SW margins of the Holy Cross Mts). Despite the fact that in the area studied the Turonian is represented only by 3 zones, and all the Turonian zones in the latter area are known, a considerable difference is unquestionable. Its regional significance will be discussed in the chapter on paleogeography.

SEDIMENTARY CONDITIONS

The Albian through Cenomanian transgression, which involved the entire epicontinental Poland outside the Carpathians, encroached the area under consideration after the continental phase which lasted after the Upper Jurassic (Kimmeridgian-?Volgian or ?Neocomian) period of sedimentation. The epeirogenic movements on the Jurassic/Cretaceous boundary resulted in great-radius far-reaching deformations. During the continental phase, a part of the Upper Jurassic sediments had been removed by erosion, so that in the area here considered the Jurassic substrate consists of limestones or marls of the Upper Oxfordian Idoceras planula Zone with a monoclinal pre-Cretaceous dip of 1.5 degree. The denivelations resulting, from continental erosion caused facial differentiation within the Cretaceous sedimentary basin (*cf.* Figs 2, 27—29). Marine sedimentation, chiefly of quartz sands with a glauconite admixture, locally of quartz gravels, may have set here in the uppermost Middle Albian, but for sure in the Upper Albian (*cf.* chapter on stratigraphy). Occasionally, at the base of these deposits there is a large amount of local Jurassic material, represented mainly by detrital fragments and pebbles of Jurassic flints, to a smaller extent by fragments of sponges and silicified limestones (*cf.* the description of lithological members and Sujkowski 1926; Marcinowski 1970, Fig. 4C). The above evidence indicates that the Upper Jurassic substrate hed been, more or less distinctly, covered by a mantle of weathered continental materials reworked within the marine Upper Albian basin. The quartz material was brought from the south, an area now concealed under the nappes of the External (Flysch) Carpathians (Sujkowski 1929).

The presence of gravel intercalations in all the Upper Albian members reasonably suggests intermittent changes in the rate of erosion within the alimentary area, also of the supply of coarser material into the sedimentary basin. Throughout the area under investigation abrasion of substrate was but of minor importance during the Upper Albian transgression. The only substrate denivelations dwelled by lithophags and subjected to abrasion (*cf.* chapter on trace fossils and Fig. 29*A*) existed in the Glanów-Sucha region (*cf.* Fig. 12).

Idealized successive stages (*A*—*D*) of development of the Cretaceous (Upper Albian through Upper Turonian) basin in the Polish Jura Chain: *A* — late Upper Albian, *B* — late Middle Cenomanian, *C* — Cenomanian/Turonian junction, *D* — late Inoceramus costellatus age (lower part of the Upper Turonian)



Lithology the same as in Text-fig. 3; distance measurements are for the every two neighbouring profiles (their position is presented in Text-fig. 1B—C)

The persistance of numerous substrate denivelations (*cf.* Figs 2, 27—29*A*), along with the lack of more numerous traces of abrasion, indicates the rapid advance of the Upper Albian transgression and the flooding within a short time of the whole area. At the beginning the fauna is scarce and represented chiefly by siliceous sponges, later on other benthic organisms, such as pelecypods and echinoids, and this type of the faunal communities does not change all through the Upper Albian. In shallow places, as in the Glanów-Sucha area, the substrate hummocks populated by lithophags were subjected to abrasion (*cf.* Fig. 29*A*) and the weathered material was carried down into the surrounding depressions where sedimented quartz sands containing glauconite. The sedimentation here took place at small depths. This is suggested by the types of bedding and the presence of major erosional troughs (*cf.* Figs 13—14). It is not out of the question that the formation of such big troughs was connected with tides, generally accompanied by increased energy in the water hydrodynamics, while the morphological differentiation of the bottom around Glanów caused stronger hydrodynamic bearing on the previously deposited sediment. Analogous erosion troughs in Upper Cretaceous and Paleocene littoral sediments of Wyoming and South Dakota are interpreted by Wulf (1962) as connected with tides. The amount of glauconite increases at the top of the Albian, while burrows *Ophiomorpha nodosa* Lundgren (*cf.* Marcinowski 1970) built by shrimps of the genus *Callianassa* Leach make their appearance in the vicinity of Mokrzesz and Zalesice. Burrows of this kind recently occur in extremely shallow-marine, intertidal and sublittoral environments at depths not generally exceeding but a few meters (*cf.* Häntzschel 1952; Weimer & Hoyt 1964; Radwański 1967, 1970, 1973; Bałuk & Radwański 1968; Waage 1968; Kennedy & Macdougall 1969; Dike 1972). These burrows suggest temporary similar environmental conditions within the area under investigation. In the deposits here, glauconite probably formed in shallow zones, too, similarly as now on the western shores of Trinidad (*cf.* Van Andel 1954). The small depths and an analysis of the relation of Cretaceous deposits to the Upper Jurassic substrate (*cf.* Fig. 28) reliably suggest that, at the close of the Upper Albian, the sedimentary basin was infilled with deposits and its floor nearly completely levelled. The Upper Jurassic hummocks of the substrate projected but slightly and in very few places above the overlying deposits (*cf.* Fig. 29*A*).

During the Cenomanian the floor of the sedimentary basin was lowered, the lowering being without great depth but involving the whole area. This led to sedimentation on local hummocks of the Upper Jurassic substrate (*cf.* Fig. 29*B*), still an area of non-deposition during the Upper Albian. During the Lower Cenomanian, quartz-glauconite-bearing sands are the chief components of sediments, while gravels (Julianka — *cf.* Fig. 2*E*), or coarser material constituting an admixture in the sandy deposits (Glanów — *cf.* Fig. 18) are deposited in small amounts. In the Middle Cenomanian, sedimentation of sands continues in the northern parts (Zalesice — Solca) while gravels are laid down in the southern parts (Poręba Dzierżna — Glanów). The greatest number of phosphatic nodules and glauconite formed during Lower and Middle Cenomanian sedimentation. The also set in the precipitation of calcium carbonate which is a constant admixture in the sediment. An increase of calcium carbonate (*cf.* microfacial analysis) is always accompanied by the appearance of rather abundant planktic forminifers. During the Lower and Middle Cenomanian, organic life fluorishes and deposits of this age bear the richest fauna, which however abounds only in places where the phosphatic nodules are present (Mokrzesz, Jaźwiny, Lusławice, Zalesice, Poręba Dzierżna, Glanów), being elsewhere only sporadically encountered.

The state of preservation of organic remains in the richest assemblages of the Lower and Middle Cenomanian (Mokrzesz, Jaźwiny, Lusławice, Zalesice, Poręba Dzierżna, Glanów) are conducive to conclusions as regards sedimentary conditions. These remains are, namely, preserved as detrital fragments which are either phosphatized or coated by phosphatic nodules. Among ammonites complete phosphatized specimens are extremely rare. Generally the body chambers are missing, the most common specimens being fragmentary preserved whorls. Isolated valves of pelecypods, either phosphatized or coated by phosphatic nodules, are also numerous. Hence, it may be concluded that after the death of the mollusks, their shells were soon destroyed by hydrodynamic agents and phosphatization followed on the sea bottom as indicated by nodules encrusted by serpulids and pelecypods. In some places, the organic remains are accumulated in lenses indicating that after the death of the animals, their remains were transported off their life habitat.

The dimensions of the fauna vary within one and the same species; mature forms occur side by side with juvenile, suggesting that some organic communities, probably owing to the strong action of hydrodynamic factors, were destroyed during their life.

During the Upper Cenomanian, quartz-glauconite-bearing sands continued to sediment in the northern parts of the area (Zalesice, Lelów, Solca) and the character of sedimentation does not change substantially as compared with the Lower and Middle Cenomanian. At Zalesice, in these deposits the burrows *Ophiomorpha nodosa* Lundgren are present, reasonably suggesting sedimentation at depths of only some meters, similarly as during the Upper Albian. At Poręba Dzierżna and Glanów, chiefly gravels are sedimented during the Upper Cenomanian, while in the uppermost Cenomanian even carbonate sedimentation sets in locally. At Glanów, at the close of the Cenomanian, there is a short-lasting episode of non-depositional conditions, leading to the erosion of some deposits (*cf*. microfacial analysis and Marcinowski 1972). This erosion is probably connected with synsedimentary movements which resulted also in an uplift of some areas (*cf*. Fig. 29C). During the Upper Cenomanian the fauna decreases in numbers, this being a phenomenon characteristic not only of the Polish Jura Chain but also of all the epicontinental parts of Poland (*cf*. Cieśliński 1959, 1965).

Carbonate sedimentation continues during the Turonian: in the northern parts (Zalesice — Lelów) during Lower Turonian sedimentation, and near Solca during that of the Upper Turonian, too (Inoceramus costellatus Zone), no major movements occurred to differentiate the floor of the sedimentary basin. Hence, all the stratigraphic members occur here in sedimentary continuity (*cf*. Figs 28—29*D*). In this part of the basin the transition of the Cenomanian into the Turonian is gradual and characterized by a decrease in the quartz and glauconite content along with an increase of calcium carbonate (Marcinowski 1970, Marcinowski & Szulczewski 1972). No great deepening of the basin seems to have occurred then, as the burrows ***Ophiomorpha nodosa*** Lundgren (*cf*. Marcinowski 1970) continue to be encountered (Zalesice) in the lowermost Turonian — Inoceramus labiatus Zone. An increase in the calcium carbonate content reasonably suggests stabilization of sedimentary conditions, due to the considerable expansion of the marine basin and to the gradually diminishing supplies of terrigenic material. Stabilized sedimentary conditions favour the development of organogenic facies. The swept detritus of benthic organisms becomes abundant and planktic material makes its appearance represented by forminifers and *Pithonella ovalis* (Kaufmann). At the close of the Inoceramus lamarcki Zone, in the Zalesice-Solca region, there occurs a shallowing of the basin and a slowing down of the rate of sedimentation (*cf*. Marcinowski & Szulczewski 1972). Near Lelów (Pniaki) this process leads to formation of stromatolites which developed here in high energy shallow marine environment below the intertidal zone (Marcinowski & Szulczewski 1972). In the Zalesice-Lelów region sedimentation ends in the Inoceramus lamarcki Zone and it is followed by non-depositional (hardground) conditions which lasted through the Upper Turonian, Coniacian and Santonian (Różycki 1937, 1938). South of Lelów (Solca region), however, the floor of the sedimentary basin is slightly lowered and sedimentation of the lower part of the Upper Turonian, Inoceramus costellatus Zone, takes a places being however accompanied by non-depositional conditions resulting in numerous discontinuity surfaces. The latter are associated with neptunian dykes, and in one particular case they are covered by stromatolites (*cf*. Figs 7—8), the development of which (Przychody, outcrop *115* in Fig. 4) is analogous to that from the Inoceramus lamarcki Zone near Lelów (*cf*. Marcinowski & Szulczewski

1972). In the region of Solca, the sedimentation in the Inoceramus costellatus Zone was followed by non-depositional conditions (Inoceramus schloenbachi Zone through the Coniacian), during which takes place the action of high energy currents, and the corrosion of underlying deposits (*cf.* microfacial analysis).

The Turonian sedimentation (Inoceramus labiatus — Inoceramus costellatus Zone) in the southern part, *i.e.* Poręba Dzierżna, Wolbrom and Glanów regions, is accompanied by a synsedimentary block-faulting differentiating the basin floor. These movements are responsible for the uplifling of some blocks into the abrasion zone (*cf.* Fig. 29*C-D*) populated by lithophags (Wielkanoc, outcrop *123* in Fig. 9, *cf.* also the chapter on trace fossils). Sporadically some, most elevated blocks may have projected above the sea level, in most cases, however, abrasion occurred here under subaqueous conditions (*cf.* Dżułyński 1953, p. 393). The abrasion destroyed here the older (mostly Cenomanian) deposits, but it was rather not too strong as indicated by a very small amount of detrital material in neighbouring regions of Poręba Dzierżna and Glanów. The synsedimentary movements are responsible however for the resting of the Turonian deposits here directly on the Upper Jurassic substrate (*cf.* Figs 24—29*D*).

In the region of Poręba Dzierżna and Glanów, the Turonian sedimentation completes in the Inoceramus costellatus Zone, followed by non-depositional conditions displaying the same character and time-interval as in the Solca region (Inoceramus schloenbachi Zone till the Santonian).

The presented sedimentary conditions, during the development of the first phase of transgression — Upper Albian through the Turonian — display consequent changes. Initially, the basin was being infilled with clastic deposits (Upper Albian through the Cenomanian), while in the Turonian, with the considerable expansion of the sedimentary areas, clastic material ceases to be supplied, the influence of pre-Albian denivelations of the substrate gradually diminishes, being followed by a facial unification and carbonate sedimentation definitely ending the development of transgressive deposists.

PALEOGEOGRAPHY

The observations reported in the present paper cover Upper Albian, Cenomanian and Turonian deposits in the greater part of the Polish Jura Chain, *i.e.* within the Zalesice-Glanów area (*cf.* Fig. 1*B*—*C*). Only comparative observations have, however, been made by the writer in the Cracow Upland, situated south of Glanów. A correlation of observations from the detail-investigated area, with the general observations and data on the Upper Albian through Turonian deposits in the Cracow Upland, obtained from the literature, allowed to recognize the development of transgresion throughout the whole area of the Polish Jura Chain.

Taking into account the relation of the Cretaceous deposits to the Upper Jurassic substrate as well as the facial development, the area of the Polish Jura Chain may be divided into two parts: the northern comprising the Zalesie-Solca region and the southern with Poręba Dzierżna — Glanów and the Cracow Upland regions. In the northern part, the particular Cretaceous deposits as a rule occur in sedimentary continuity while the transgressive Upper Albian and Cenomanian are developed mostly as sands and sandstones. In the southern part various successively younger stratigraphic members of the Cretaceous are overlapping the Upper Jurassic substrate, sometimes truncating each other and displaying sedimentary gaps. A high per cent of gravel material is here characteristic in all the Upper Albian, Cenomanian and locally even Turonian deposits.

The Polish Jura Chain represents the northern part of the meta-Carpathian zone which separated the German-Polish syneclise (during the Cretaceous a major part of the epicontinental Polish basin) from the Carpathian flysch geosyncline (Głazek & Kutek 1970, Kutek & Głazek 1972). During the Middle (Hoplites dentatus Zone) and Upper Albian, the northern slope of this zone was flooded by the sea gradually advancing from the German-Polish syneclise (*cf.* Samsonowicz 1925; Cieśliński 1959a; Pożaryski 1960, 1962). Most likely, the meta-Carpathian zone had not been completely invaded by the sea so that the epicontinental basin in the north had no direct communication throughout the Cracow Upland with the flysch geosynclinal basin in the south (Pożaryski 1960, 1962). At the beginning of the Albian, the southern part of the meta-Carpathian zone was uplifted resulting in the inflow of coarse clastic material (Lgota sandstones) from the south into the flysch geosyncline (*cf.* Książkiewicz 1962). Very probably, quartz material was also being transported northwards from the alimentary area, resulting in sandy sedimentation in the Upper Albian basin of the Cracow Upland and the other parts of the Polish Jura Chain (Docent J. Kutek — oral communication, *cf.* also Sujkowski 1929). In the Cracow Upland, the sandy Upper Albian deposits are neither very widespread nor very thick and they fill in only the major denivelations in the Upper Jurassic substrate (*cf.* Panow 1934, Bukowy 1960); hence, this had been an elevated area where, in principle, the conditions were non-depositional, the quartz material being transported from here farther north, *i.e.* into the investigated area (*cf.* Fig. 29*A*).

During the Cenomanian, the sea made advances throughout the epicontinental Polish area (*cf.* Samsonowicz 1925; Cieśliński 1959a; Pożaryski 1960, 1962) and, through the meta-Carpathian zone, a direct communication was available with the Carpathian geosyncline (Pożaryski 1960, Książkiewicz 1962). The Cenomanian progress of the transgression is responsible for a considerable reduction of the alimentary area lying south of the Cracow Upland (*cf.* Książkiewicz 1962), and therefore — of the amounts of clastic material brought into the Cenomanian basin of the Polish Jura Chain.

In the early Cenomanian, the basin floor of the Polish Jura Chain was lowered to an extent not too deep but indicated over the entire area (*cf.* Fig. 29*B*). This led to the sedimentation both on local hummocks and probably throughout the Cracow Upland (*cf.* Fig. 29*B*). During the Lower and Middle Cenomanian, sandy sedimentation predominates in the northern part, while in the southern part gravels are the main sedimentary material, and in most cases they are deposited directly on the Upper Jurassic substrate (*cf.* Zaręczny 1878, 1894; Panow 1934; Bukowy 1956; Alexandrowicz 1960; Głazek, Marcinowski & Wierzbowski 1971). The presence in the Cracow Upland of numerous abrasion surfaces, sometimes associated with rich assemblages of borings (*cf.* Głazek, Marcinowski & Wierzbowski 1971), reliably indicates that similarly as in the Upper Albian, so in the Cenomanian, too, this area represented the shallowest part of the Polish Jura Chain basin [22]. During the Upper Cenomanian, owing to the synsedimentary block-faulting, the floor of sedimentary basin is here uplifted in relation to the other parts of the Polish Jura Chain and non-depositional conditions prevailed on some of the individual blocks (*cf.* Fig. 29*C*). A differentiated uplifting of these blocks is often accompanied by their leaning or tilting that resulted in a varying degree of the their abrasion, as in some places Upper Albian or Lower and Middle Cenomanian deposits had been preserved and were overlaid by the Turonian ones (*cf.* Fig. 29*D*). The gravelous deposits of the Upper Albian, but chiefly those of the Lower and Middle Cenomanian, affected by abrasion within the Cracow Upland, were, partly, a source of material for Upper Cenomanian sediments in the vicinity of Glanów, Wolbrom and Poręba Dzierżna. Hence, the Upper Cenomanian conglomerates from Glanów strongly resemble the Lower and Middle Cenomanian conglomerates from the vicinity of Cracow. Farther to the north of Glanów (Poręba Dzierżna — Zalesice) the effect of all these processes is not indicated at all. It therefore may be concluded that postulated by some authors (*cf.* Bukowy 1956, Alexandrowicz 1960) a regression in the Upper Cenomanian from the whole area of the Cracow Upland, does not seem reliably justifiable.

Within the Polish Jura Chain, all the Cenomanian profiles are characteristic by their rather small thickness and relatively highest per cent content of phosphatic nodules and glauconite, as compared with the other

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[22] South of Glanów, within the Cracow Upland, Upper Cenomanian deposits are absent (*cf.* Głazek, Marcinowski & Wierzbowski 1971), while the Cenomanian rocks described by the former authors, after a stratigraphic subdivision used in the present paper (*cf.* Table 6), represent only the Lower and the major part of the Middle Cenomanian.

Cretaceous members here discussed. Moreover, they bear an abundance of faunal remains (particularly in the Lower and Middle Cenomanian), and in some profiles the ammonite horizons are mixed (*cf.* chapter on stratigraphy). The rate of sedimentation may, therefore be supposed to have been a slow one at that time, leading to faunal condensation, similarly as in the transgresive Albian-Cenomanian deposits in the Holy Cross margins (*cf.* Samsonowicz 1925, 1934; Pożaryski 1947; Cieśliński 1959; Uberna 1967; Hakenberg 1969). Similarly as in the Holy Cross Mts, so in the Polish Jura Chain, too, the concentration of the fauna and phosphatic nodules, also the extent of stratigraphic condensation are most distinctly indicated on elevations of the bottom within the sedimentary Cenomanian basin.

During the Turonian, the sedimentation zones expanded and this is the span-time of maximum transgression in epicontinental Poland which, beginning with the Middle Albian, was gradually involving successive areas (Pożaryski 1960, 1962). Then, the direct communication of the epicontinental basin of Central Poland with the Carpathian geosyncline, through the meta-Carpathian zone, grew wider as compared with the Cenomanian (*cf.* Książkiewicz 1962). Within the Polish Jura Chain, the Turonian sedimentary basin was still slighly subsiding and it was filled in chiefly by carbonate (limestone) deposits and, similarly as in the Cenomanian, differentiated into two parts — the northern (region of Zalesice--Solca), and the southern in the area of Poręba Dzierżna — Cracow Upland.

The sedimentation of Turonian deposits in the southern part of the Polish Jura Chain was accompanied by synsedimentary movements leading to the inclusion of the part of the blocks in the zone of abrasion. The abrasion removed older deposits (chiefly Lower and Middle Cenomanian) supplying material for the gravelous deposits encountered within the Turonian carbonates (*cf.* Panow 1934; Alexandrowicz 1954, 1960; Bukowy 1956; Marcinowski & Szulczewski 1972). Farther north, in the area Glanów — Poręba Dzierżna, gravelous material is represented only by isolated pebbles in the lower parts of the Turonian profiles. The scouring of older deposits is the cause why, in the absence of fauna, it is hardly possible to determine — basing only on lithology — whether the conglomerates in some profiles of the Cracow Upland are confined to the Turonian or to the Cenomanian (*cf.* Alexandrowicz 1960; Rutkowski 1965, 1971; and also discussion on the age of gravelstones at Bocieniec by Marcinowski & Szulczewski 1972).

The profile of the Turonian deposits in the northern part of the Polish Jura Chain in the Solca region (Przychody), as compared with contemporaneous sediments from Glanów and Poręba Dzierżna, are characterized by a big admixture of finer grained quartz material. The transport of this material was rhythmic and its maximum supplies occurred in the median parts of the Inoceramus labiatus and I. lamarcki Zones (*cf.* microfacial analysis). This seems to be connected with the intensity of erosion in the southern regions, *i.e.* Poręba Dzierżna — Cracow Upland, and with a periodical inflow of sandy material farther north than the coarser gravel could subjected. The markedly lower quartz content in the contemporaneous Turonian deposits north of Solca would seemingly confirm this supposition (*cf.* Fig. 29*C*—*D*).

Nevertheless, during the Turonian a carbonate sedimentation begun in the entire area of the Polish Jura Chain, accompanied by development of the organogenic facies in which planktic material makes also its appearance, being represented by foraminifers and *Pithonella ovalis* (Kaufmann). Owing to the facial unification, the contemporaneous carbonates of the Turonian from various regions of the Polish Jura Chain do not much differ in microfacies (*cf.* microfacial analysis and Sujkowski 1934; Alexandrowicz 1954, 1960; Barczyk 1956; Marcinowski & Szulczewski 1972). The differentiated floor of the sedimentary basin in the southern part of the Polish Jura Chain, *i.e.* in the Cracow Upland resulted in changed hydrodynamic conditions, the same stratigraphic members of the Turonian being developed either in carbonate or clastic facies (*cf.* Alexandrowicz 1954, Table 1; *cf.* also microfacial analysis). The Turonian stromatolites, occurring at Mydlniki and Zabierzów in the Cracow Upland, developed in the sublittoral zone, under exceptionally weak water turbulence (Golonka & Rajchel 1972), while the formation of those from Bocieniec was accompanied by high water energy, up to 120 cm/sec at current velocities (Marcinowski & Szulczewski 1972). Though the stromatolites here discussed probably vary in age (those from Bocieniec most likely representing the I. costellatus Zone), yet the depths of their formation did not differ much. Therefore, various hydrodynamic conditions prevailed at similar depths in the Turonian basin of the Cracow Upland, depending on the local configuration of the sea bottom. In the southern part of the Polish Jura Chain (Poręba Dzierżna — Cracow Upland), Turonian sedimentation ends in the Inoceramus costellatus Zone (*cf.* Panow 1934); the synsedimentary movements are responsible for the occurrence of Turonian deposits sometimes directly on the Upper Jurassic substrate, in some places on the older Cretaceous deposits, or, the particular Turonian members are truncated by abrasion surfaces and rest on each other with a sedimentary gap (*cf.* Figs 27—29*D*; Panow 1934; Dżułyński 1953; Alexandrowicz 1954, 1960; Barczyk 1956; Bukowy 1956; Marcinowski & Szulczewski 1972).

Non-depositional conditions set in after the Turonian sedimentation in the Polish Jura Chain, owing to substrate movements with a wide regional range (*cf.* Pożaryski 1960, 1962; Marcinowski & Szulczewski 1972). The range of the stratigraphic gap connected with these movements varies: in the northern part of the basin (Zalesice-Lelów) the gap comprises the whole Upper Turonian till the Santonian (Różycki 1937, 1938), while more to the south (Solca — Cracow Upland) it is narrowed at the top and bottom and comprises only the last zone of the Turonian and the Coniacian (*cf.* Panow 1934, Różycki 1938, Kowalski 1948). The tectonic movements during the lasting of the discussed gap, may have resulted in local emersions, but not in a complete regression (*cf.* Alexandrowicz 1969 and the relevant literature), as indicated by the absence of land erosion (Dżułyński 1953, p. 393), and in some places (Bocieniec) by the Santonian deposits being not of a transgressive character (Marcinowski & Szulczewski 1972). The above-presented processes are responsible in the Cracow Upland for complications in the mutual relation of particular Cretaceous members, as well as in their relation to the Jurassic substrate. This intricate spatial distribution of the Cretaceous deposits has suggested opinions current in the Polish regional papers postulating that repeating oscillations of the shoreline, as well as sedimentary breaks connected with successive emersions and new transgressions, occurred during Cenomanian, Turonian, Coniacian and Santonian in the Cracow Upland (*cf.* Panow 1934; Alexandrowicz 1954, 1960, 1969; Barczyk 1956; Bukowy 1956, 1968; Golonka & Rajchel 1972). These opinions do not seem reliable in the light of the herein presented reconstruction of sedimentary conditions.

Within the Polish Jura Chain, the presence of sedimentary gaps in the transgressive Upper Albian through the Turonian sequence, and the rather strong stratigraphic condensation in these deposits, distinguishes this area within the southern parts of the epicontinental Polish basin. Beginning with the Cenomanian, to the west (Opole region) and the east (SW margin of the Holy Cross Mts[23]) of the Polish Jura Chain, the subsidence in the epicontinental basin was stronger, leading to an increase in thickness of the deposits (Fig. 30). Most probably, the subsidence in the adjacent areas was compensated by an uplift in the Polish Jura Chain. In the latest Turonian and Coniacian, owing to movements of the basin floor, the area of the Polish Jura Chain was the most elevated zone in the southern part of the epicontinental Polish basin and the conditions there prevailing were non-depositional (*cf.* Fig. 30). Such non-depositional conditions over a great part of the Polish Jura Chain were also indicated in the Santonian. The above observations suggest that during the Cenomanian, Turonian, Coniacian and Santonian, the Polish Jura Chain area was — in the epicontinental sedimentary basin here discussed — elevated with the character of a submarine swell (*cf.* also Alexandrowicz 1969,

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[23] Here, the transgression occurred earlier, *viz.* in the Middle Albian, resulting in deposits of various depth, with a maximum as great as 180 m in the Tomaszów syncline in the western margin of the Holy Cross Mts (Raczyńska & Cieśliński 1960; *cf.* also Witkowski 1969).

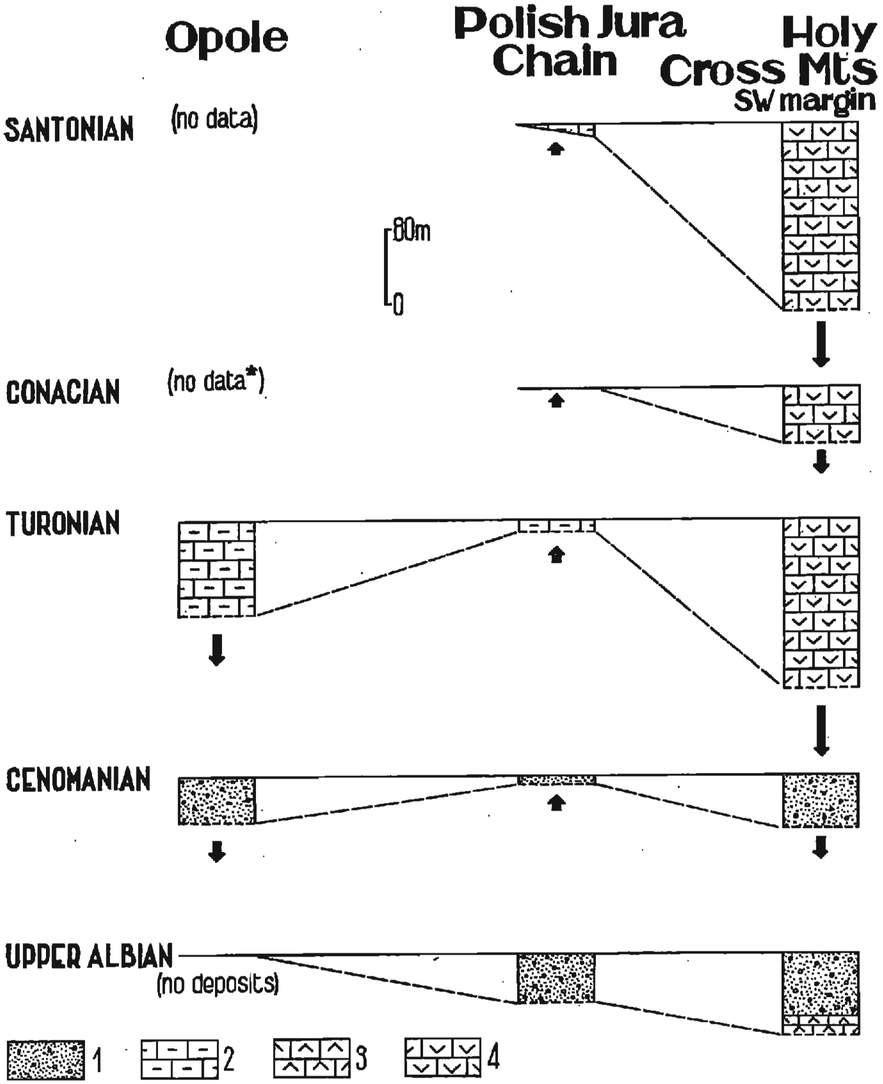

Fig. 30

Comparative diagram of subsidence and uplift during the successive Cretaceous stages (Upper Albian through Santonian) in the Polish Jura Chain and neighbouring regions of the Opole basin * in Lower Silesia and of the south-western part of the Holy Cross Mts (*cf.* Text-fig. 1*A*—*B*)

The arrows correspond to the synsedimentary movements of the basin floor; compiled on author's own data from the Polish Jura Chain, and referenced papers (Witkowski 1969, Cieśliński & Pożaryski 1970, Alexandrowicz & Radwan 1973)

1 stands and sandstones, *2* limestones and marls, *3* spongiolites and gaizes, *4* siliceous marls (*opoka*)

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* In the Opole area, the deposits younger than Turonian are now lacking. According to sedimentological and paleogeographical analysis of the Sudetic Cretaceous by Jerzykiewicz (1971), this area was included in the sedimentary regime till the Coniacian or lowermost Santonian (*cf.* also Alexandrowicz & Radwan 1973). In a nearest region in the Sudetes, the Coniacian deposits are represented in the Nysa graben by a local, taphrogeosynclinal, c. 900 m thick flysch sequence (Jerzykiewicz 1971)

Marcinowski & Szulczewski 1972). This swell was not, however, a homogenous element, being along its axis (NW-SE, *cf.* Fig. 1) broken up into blocks and, in connection with their movements, the timeinterval of the post-Turonian sedimentary gap varies along the Polish Jura Chain (*cf.* Panow 1934, Różycki 1938). In the Upper Albian through the Turonian, the Cracow Upland was the most elevated part of that swell, and the facial analysis and distribution of the Cretaceous deposits reliably indicates that the disintegration into individual blocks was much stronger here than in the remaining area of the Polish Jura Chain.

After the period of non-deposition, the sedimentation in the Polish Jura Chain returned in the Santonian and continued until the Laramide movements in the Maestrichtian. In result of these movements the investigated area became the SW limb of the Miechów synclinorium, while the Albian through Turonian sequence here discussed acquired a sligh dip of the order of 4—5° in the regional scale, being responsible for its belt occurrence along the NW-SE direction (*cf.* Fig. 1C).

COMPARATIVE REMARKS

The transgressive Albian, Cenomanian and Turonian deposits of the Polish Jura Chain may be compared to the deposists of the same age occurring in a few epicontinental areas of Europe (*cf.* Fig. 31). The comparisons mostly concern the relation of the transgressive deposits to their substrate, their facial development and sedimentary conditions. Part of remarks on the stratigraphy of these deposits and organic assemblages they contain have already been given in previous chapters.

A considerable extension of the epicontinental marine basin in Europe begins in the Albian and, in this connection, in many places the Albian, Cenomanian and sometimes even Turonian deposits are transgressive in character (*cf.* Samsonowicz 1925; Kokoszyńska 1931; Najdin 1959; Brinkmann 1960; Pożaryski 1960; Senkovski 1963; Tröger 1963; Arnold 1964; Cieśliński & Tröger 1964; Larsen 1966; Pasternak & *al.* 1968; Hancock 1969; Christensen 1970; Owen 1971a; Soukup 1971; Hancock, Kennedy & Klaumann 1972; Bergström 1973). It may be noticed that the extension of the sea range also in the Albian locally takes place in the northern (external) outskirts of the European part of the Alpine geosyncline (*cf.* Passendorfer 1930, Renz 1968).

As compared with the area of the Polish Jura Chain, the trangressive Cretaceous deposits of the Münster Basin and Rhine Massif, Sub-Hercynian Basin, Saxony, Bohemian Massif, Sudetes Mts and Podolia, display certain analogies. Namely, the Cenomanian deposits are mostly developed in clastic facies. It is also in the Cenomanian that the bottom relief in sedimentary basins becomes considerably levelled. In the Turonian, the predominant type od sedimentation is the carbonate one, which closes the entire (Albian through Turonian) sedimentation of transgressive deposits. During sedimentation of these deposits the distribution of facies and thickness of particular stratigraphic members were affected by synsedimentary tectonic movements (the so-called Sub-Hercynian epeirogeny). These areas formed marginal, latitudinal parts of the German-Polish Cretaceous sedimentary basin, or the Central European Basin *sensu* Kölbel (1968) as used beneath, which were successively invaded by transgression from the axial parts of the Basin. The facial development of the Cretaceous deposits on Bornholm Island, in Scania and on the west coast of Sweden indicates that this area constituted, the northern, marginal parts of the Central European Basin. It seems, however, that, as compared with other of here discussed regions, it formed the outermost part of this basin, since the Sub-Hercynian movements led in this region to subsequent transgressions and regressions (*cf.* Bergström 1973).

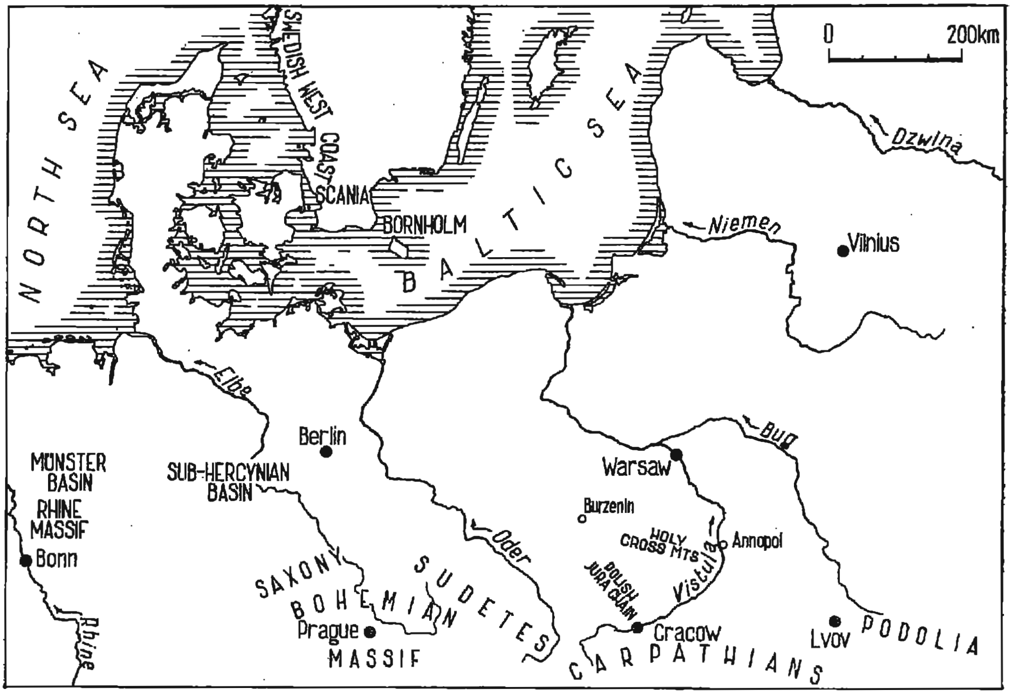

Fig. 31

Location of the regions consisting in marginal parts of the Central European Basin during the Albian-Cenomanian transgression

The transgressive Cretaceous deposits occurring in Southern England are also comparable with those of the Polish Jura Chain, although the phenomena which accompanied their formation occurred earlier, since this region was situated outside of the sedimentary basin under study and the transgression started in it as early as the Aptian.

A more detailed comparison of the transgressive deposits (Albian through Turonian) of the Polish Jura Chain with those of other regions (*cf.* Fig. 31) may be presented as below.

Münster Basin and Rhine Massif

In the area of the Münster Basin and Rhine Massif, the Cenomanian clastic deposits lie transgressively on the Albian ones (*cf.* Arnold 1964; Wirth 1964, Fig. 1) and, in many localities, directly overlie the Paleozoic substrate, filling more extensive depresions (*cf.* Kahrs 1927; Hancock, Kennedy & Klaumann 1972). The transgression entered this area successively from the north, beginning as early as the Albian, and reaching the Rhine Massif only in the Cenomanian (*cf.* Arnold 1964, Pl. 1; Wirth 1964). Thus, there were similar conditions as in the Cenomanian of the Polish Jura Chain, where the continuation of transgression is marked which enabled the beginning of sedimentation on the substratal hummocks (*cf.* Fig. 29*B*). In the Turonian, carbonate facies are predominant in the area of the Münster Basin, while clastic facies (*cf.* Arnold 1964) appear towards the Rhine Massif (in this direction, particular Cretaceous stratigraphic members decrease their thickness). Of interest is that turbidites, formed as a result of the suspension currents running to the Turonian basin from the *"Nordwestfälisch-Lippischen Schwelle,"* occur within the carbonate deposits of the Münster Basin (*cf.* Voigt & Häntzschel 1964).

Sub-Hercynian Basin

In the western part of this area, the Cretaceous transgression begins in the Uppermost Albian and gradually extends eastwards in the Cenomanian (Cieśliński & Tröger 1964). In the Cenomanian, the carbonate sedimentation (limestones and marls) takes place in the localities in which the sedimentation is continued from the Upper Albian, while the clastic sedimentation (glauconite sands) is observed in the remaining areas. In the Turonian, the predominant type of sedimentation is the carbonate one (limestones), while the bottom subsidence of the basin enables the accumulation of considerably thicker deposits than those in the Polish Jura Chain (*cf.* Tröger 1969).

Saxony

The transgression entered this area in the Middle or Upper Cenomanian (*cf.* Geinitz 1850, 1875; Cieśliński & Tröger 1964) and at first coarse-clastic deposits (conglomerates) and then marly glauconite sands with phosphorites were deposited in the basin formed. At first, the sedimentation occurs in larger depressions of substrate and a considerable degree of levelling the relief of bottom (*cf.* Tröger 1963, Fig. 4) is observed on the boundary of the Cenomanian and Turonian (Actinocamax plenus Zone). In the Turonian, there takes place the clastic-carbonate sedimentation (sandstones, marls, limestones) and the subsidence of the bottom enables the accumulation of deposits (Inoceramus labiatus — I. costellatus Zones) with a considerably larger thickness (300 to 400 m) than those in the Polish Jura Chain (*cf.* Tröger 1963, 1969).

Bohemian Massif

The transgression extending southwards and south-eastwards from the Central European Basin, entered the Bohemian Massif in the Cenomanian (*cf.* Krejči 1877, Dvořák 1958, Soukup 1971). In thus formed basin, mostly the clastic sedimentation (sands and sandstones) occurs, the parts of massifs surrounding the basin and not flooded by sea being the source of material (*cf.* Klein & Soukup 1966). In the Turonian, the clastic (sandy and marly-sandy) facies persist only in the peripheral parts of the basin, carbonate (limestones and marls) and organodetrital (spongiolites) facies predominate in the remaining areas. The sedimentation of these deposits is accompanied by synsedimentary bottom movements, which cause differences in their facial development and thickness. In the Turonian, the thickness of the deposits is much larger than that in the Polish Jura Chain. In the Upper Turonian (Inoceramus schloenbachi Zone), the intensity of movements increases and in the Coniacian and Santonian they locally cause the emersion of marginal parts of the basin and redeposition of earlier sediments (Klein & Soukup 1966). During the same period, as a result of synsedimentary movements, the non-depositional conditions occurred in also the Polish Jura Chain.

Sudetes Mts

The area of the Sudetes, marking up the northern part of Bohemian Massif, was entered by the transgression also in the Cenomanian (*cf.* Scupin 1912—1913, Häntzschel 1933, Milewicz 1963, Jerzykiewicz 1971a). In this region, the shallow-water marine sedimentation of the Cenomanian clastic deposits (conglomerates and mostly sandstones) at first takes place in depressions surrounded by old, crystalline massifs. Then, as a result of a far-reaching gradation of alimentary areas, a fine-clastic (mudstones) and organogenic (gaizes, spongiolites) sedimentation takes place in some localities. The differences in the morphology of basin bottom result in a variable thickness (at most about 50 m) of deposits here accumulated (*cf.* Milewicz 1963, Jerzykiewicz 1971a). In the Turonian, the extent of sea progresses and the clastic sedimentation (sandstones) takes place in principle near the alimentary areas, while a more or less carbonate sedimentation is observed in the rest of this region. The distribution of facies is, however, disturbed (*cf.* Milewicz 1963, Jerzykiewicz 1968) by differences in the morphology of basin bottom and synsedimentary movements within the basin itself and in the surrounding alimentary areas. At the turn of the Turonian to Coniacian, the intensity of these movements increases to such an extent that they even cause local remodelling of the area; *e.g.* in the region of the Nysa Graben, during the sedimentation of the Cenomanian and Turonian deposits, the subsidence was marked only to a very small extent, while the sedimentation of flysch deposits, reaching about 900 m in thickness (Jerzykiewicz 1971), started in this region in the Coniacian. In contrast to the area of the Polish Jura Chain, in the Sudetes, a considerable influence was exerted on the sedimentation of the Cenomanian and Turonian deposits, as well as on younger Cretaceous members by directly adjoining alimentary areas, while the accumulation of deposits with a considerably larger thickness (*cf.* Milewicz 1963; Jerzykiewicz 1968, 1971, 1971a) was enabled by the synsedimentary, Sub-Hercynian tectonic movements.

Podolia

Much the same as in Central Poland, the Albian-Cenomanian transgression entered Podolia in the Middle Albian (Hoplites dentatus Zone), when a clastic sedimentation (conglomerates, sands, sandstones) and the phosphatization processes of organic remains started in the depressions of substrate (*cf.* Pasternak & *al.* 1968, Fig. 10). The extension of the sea and the mostly carbonate and organogenic sedimentation (various limestones, spongiolites, opoka), with the clastic sedimentation limited to small areas, took place in the Upper Albian. In the Cenomanian, like in the Polish Jura Chain, the subsidence of the bottom and the extension of sea range, connected with, enabled the beginning of sedimentation also on the local hummocks of the substrate and, thus, a considerable levelling of the bottom took place in the sedimentary basin (*cf.* Senkovski 1963). In the areas in which the sedimentation began in the Cenomanian, the differences in bottom morphology, frequently resulting from synsedimentary tectonic movements, cause considerable differences in facies (*cf.* Kokoszyńska 1931, p. 683). In the Turonian, much the same as in the remaining area of the Russian Platform, there takes place a unification of facies and carbonate sedimentation (chalk with flints, limestones, marls), which terminates the sedimentation of transgressive deposits (*cf.* Najdin 1959, 1969; Pasternak & *al.* 1968).

Bornholm

On Bornholm Island [24], the Upper Cretaceous transgressive deposits begin with Cenomanian basal conglomerate (18—55 cm thick) containing phosphatic nodules and reworked Albian fauna, i.a. *Hoplites (Leymeriella) regularis* (Bruguière) and *H. auritus* (Sowerby), mixed with various species of *Schloenbachia* [25] (*cf.* Ravn 1925, Wienberg Rasmussen 1970). The transgressive deposits overlie here a freshwater series of the Lower Cretaceous (Neocomian). The main Cenomanian member, the Arnager Greensand (70—130 m thick), is developed as loose sands with thin and few interbeddings of calcite-cemented sandstones that contain diversified fossils, i.a. *Schloenbachia varians* (Sowerby), *S. coupei* (Brongniart), *Acanthoceras* aff. *sherborni* Spath and *Actinocamax primus* Arkhangelsky (*cf.* Ravn 1916; Rosenkrantz 1944; Birkelund 1957; Wienberg Rasmussen 1970; Christensen 1970, 1973). Successive in the profile, but with a sedimentary gap and phosphatic conglomerates at the bottom (*cf.* Ravn 1918, Stolley 1930, Stenestad 1972) is the Arnager Limestone (12—20 m thick) with *Scaphites geinitzi* d'Orbigny and *Gonioteuthis lundgreni* (Stolley) (= *Actinocamax bornholmensis* sensu Stolley; *cf.* Ravn 1918, Stolley 1930, Birkelund 1957, Christensen 1973). This limestone member, being previously regarded as Upper Turonian (Ravn 1918, Birkelund 1957), has recently been interpreted as pelagic and embedding the Upper Turonian macrofauna possibly reworked, and its age been documented by planktonic foraminifers as Coniacian (Douglas & Rankin 1969). The sedimentological character of these limestones does not, however, support their "pelagic" interpretation (Thiede & Larsen 1971). Mentioned may be here that macrofaunistic data on Upper Turonian age of the Arnager Limestone

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[24] The data for the subchapter on the Upper Cretaceous of Bornholm were contributed by Docent A. Radwański during his visit to the discussed localities (October 1973) under the guidance of Professor G. Larsen, University of Aarhus, Denmark.

[25] Ravn (1925) under the name *Schloenbachia varians* (Sowerby) and *S. coupei* (Brongniart) described various varieties that are referred to separate species or varieties in the present paper (*S. subtuberculata, subplana, ventriosa* and *varians* var. *tetrammata* or *varians* var. *trituberculata* — *cf.* also Marcinowski 1970); of the only two illustrated specimens, the correct identification should be as follows:

Ravn's "*S. coupei*" (Ravn 1925, Pl. 3, Fig. 5a—b) → *S. ventriosa* Stieler
"*S. varians*" (Ravn 1925, Pl. 4, Fig. 5a—b) → *S. subtuberculata* (Sharpe)

were also not obvious in former time (*cf.* discussion *in*: Birkelund 1957, Stenestad 1972, Christensen 1973) and it was already Stolley (1930 and earlier papers) who regarded the here-found macrofossils as indicative of Lower & Middle Emscherian (= Coniacian) age.

With a next sedimentary gap, the preserved Cretaceous sequence is completed on Bornholm with the fossiliferous Bavnodde Greensand of Lower Santonian age (*cf.* Ravn 1921, Birkelund 1957, Wienberg Rasmussen 1970). The total sequence of the Bornholm Cretaceous (Cenomanian greensand with reworked Albian fauna, fragmentary carbonate facies of the Turonian-Coniacian, and Santonian greensand) bears a great resemblance to that of some parts of the Polish Jura Chain, especially of the Cracow Upland. The differences are not important here and mostly consist in greater thickness of the deposits on Bornholm Island. It may therefore be concluded that similar succession of endo- and exogenic processes and resulting sedimentary phenomena have developed on both (SW — Cracow Upland, NE — Bornholm) margins of the Danish-Polish Trough (*cf.* Kutek & Głazek 1972, Bergström 1973) or in paleogeographical sense — in marginal zones of the Central European Basin (*cf.* also Larsen 1966, Stenested 1972).

Scania and Swedish west coast

The occurrence of the Cretaceous deposits are here recorded on the Fennoscandian border southeast of the Tornquist line (Bergström 1973). In Scania, an assemblage of sands with an intercalation of conglomerates of indefinite age (Christensen 1970) occurs below the faunally determined Cenomanian deposits (sands and limestones) and over the crystalline substrate. This area was entered by the Cretaceous transgression in the Middle or Upper Cenomanian, while the region of Kristianstad and Båstad was probably the border of the sea (Christensen 1970).

In the region of Särdal, late Cenomanian phosphatized rock fragments, indirectly indicative of the presence of the Cenomanian transgression in this area (*cf.* Bergström & Johansson 1973, Christensen 1973), occur within the transgressive Santonian deposits. In the Turonian and Coniacian a regression of the sea took place in this region, which is responsible for a lack of deposits of this age (Bergström 1973). The sedimentation returns in the Santonian with a new transgression (Bergström 1973), similarly as in the Polish Jura where, however, only non-depositonal conditions prevailed. It seems, therefore, that the greatest intensification of the tectonic movements in the two regions discussed falls in the Coniacian, although they are manifested in different ways. These analogies, and a similar sequence on Bornholm Island, indicate that the synsedimentary tectonic movements occurred more or less simultaneously in fairly extensive areas of the marginal zones of the Danish-Polish Trough (*cf.* Kutek & Głazek 1972, Bergström 1973).

Southern England

The Cretaceous deposits (Aptian — Lower Albian through Cenomanian) occurring in Southern England, locally display certain analogies to the transgressive Upper Albian and Cenomanian deposits of the Polish Jura Chain. Comparing the structural features (type of bedding) and general facial development of the Upper Albian sandy deposits from Glanów (outcrop *109*) with the Lower Albian deposits of the Isle of Wight, one gets the impression that the sedimentation of both these deposits took place under similar shallow-marine conditions, although those from the Isle of Wight (*cf.* Dike 1972) differ in the abundant occurrence of burrows *Ophiomorpha nodosa* Lundgren. On the boundary of the Albian and Cenomanian (Chalk Basement Bed), the appearance of an abundant fauna and phosphatic nodules, as well as a stratigraphic condensation (*cf.* Hancock 1969, Kennedy 1970) are observed in many localities, but on the regional scale this it is a diachronic phenomenon (*cf.* Kennedy 1970, Fig. 18). During sedimentation of the Albian and Cenomanian deposits, subaqueous swells and depresions formed as a result of synsedimentary movements of the bottom, resulting in turn in a considerable variability of facies and thickness of the deposits (*cf.* Drummond 1970; Kennedy 1970; Owen 1971b, 1972).

The comparisons reviewed above indicate analogies which occur within the transgressive deposits of the marginal parts of the Central European Basin, while Southern England, with its continuous marine sedimentation from the Aptian, belongs to a different zone within the time of the Albian-Turonian sequence, which in the area of the Polish Jura Chain is expressed in the transgressive deposits presented in this paper.

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REFERENCES

ADKINS W. S. 1928. Handbook of Texas Cretaceous fossils. — Texas Univ. Bull., no. 2838. Austin.

ALEXANDROWICZ S. 1954. Turonian of the southern part of the Cracow Upland. — Acta Geol. Pol., vol. 4, no. 3. Warszawa.

— 1956. Globotruncana assemblages in the Turonian of the Cracow region. — *Ibidem*, vol. 6, no. 1.

— 1960. Geological structure of the vicinity of Tyniec, Cracow region. — Biul. Inst. Geol. 152. Warszawa.

— 1969. Les dépôts transgressifs du Santonien aux environs de Cracovie. — Zesz. Nauk. AGH, nr 211, Geologia z. 11. Kraków.

— & RADWAN. D. 1973. The Opole Cretaceous; stratigraphical problems and deposits. — Przegląd Geol., no. 4. Warszawa.

ARNOLD H. 1964. Fazies und Mächtigkeit der Kreidestufen im Münsterländer Oberkreidegebiet. — Fortschr. Geol. Rheinld. u. Westf., Bd. 7. Krefeld.

BAŁUK W. & RADWAŃSKI A. 1968. Lower Tortonian sands at Nawodzice, southern slopes of the Holy Cross Mts., their fauna and facial development. — Acta Geol. Pol., vol. 18, no. 2. Warszawa.

BANDEL K. 1973. Trace fossils from the Upper Devonian Nehden Siltstone of Wuppertal-Barmen (Nordrhein-Westfalen, Germany). — Palaeontographica, Bd. 142, Abt. A. Stuttgart.

BARCZYK W. 1956. On the Upper Chalk deposits on Bonarka near Cracow. — Studia Soc. Sci. Torunensis, sect. C, vol. 3, no. 2. Toruń.

BEDNAREK J. 1974. Budowa geologiczna w strefie wychodni górnojurajskich między Łazami, Zawierciem i Pilicą [*in preparation*].

BENAVIDES-CÁCERES V. E. 1956. Cretaceous system in Northern Peru. — Bull. Amer. Mus. Nat. Hist., vol. 108, art. 4. New York.

BERGSTRÖM J. 1973. An extension of Upper Cretaceous rocks to the Swedish west coast at Särdal. General geological framework. — Bull. Geol. Soc. Denmark, vol. 22, part 2. Copenhagen.

— & JOHANSSON C. 1973. An extension of Upper Cretaceous rocks to the Swedish west coast at Särdal. The geology at Särdal. — *Ibidem.*

BIRKELUND T. 1957. Upper Cretaceous belemnites from Denmark. — Biol. Skrifter Kong. Danske Vidensk. Selskab, vol. 9, no. 1. København.

BORZA K. 1961. Výskyt rodu *Stomiosphaera* Wanner, *Cadosina* Wanner a *Pithonella* Lorenz v Západných Karpatoch. — Geol. Sborn., vol. 12, no. 1. Bratislava.

BRINKMANN R. 1960. Geologic evolution of Europe. *Hafner*. New York.

[BRITISH MESOZOIC FOSSILS]. 1964. Trustees of the British Museum (Natural History). London.

BUKOWY S. 1956. Geology of the area between Cracow and Korzkwia. — Biul. Inst. Geol. 108. Warszawa.

— 1960. Notes on sedimentation and diagenesis of the Albian in Cracow region. — *Ibidem*, 152.

— 1968. Wolbrom (objaśnienia do szczegółowej mapy geologicznej Polski). Warszawa.

BURZEWSKI W. 1969. Les conditions structurales du Jurassique de la région d'Olkusz et de Wolbrom comme bordières pour les gisements pétrolifères du Bassin de Nida. — Prace Geol. PAN, Oddz. w Krakowie (Geol. Transact.), no. 61. Warszawa.

CAROZZI A. V. 1958. Micro-mechanisms of sedimentation in the epicontinental environment. — J. Sedim. Petrol., vol. 28, no. 2. Menasha.

CHRISTENSEN W. K. 1970. *Actinocamax primus* Arkhangelsky from Scania, Sweden. — Stockh. Contr. Geol., vol. 21, no. 6. Stockholm.

— 1973. An extension of Upper Cretaceous rocks to the Swedish west coast at Särdal. The belemnites and their stratigraphical significance. — Bull. Geol. Soc. Denmark, vol. 22, part 2. Copenhagen.

CIEŚLIŃSKI S. 1958. New data on stratigraphy of Albian, Cenomanian and Lower Turonian sediments in region of Burzenin on Warta river (Central Poland). — Kwartalnik Geol. (Quart. J. Inst. Geol.), vol. 2, no. 4. Warszawa.

— 1959. The Albian and Cenomanian in the northern periphery of the Holy Cross Mts. — Prace IG (Trav. Inst. Geol.), vol. 28. Warszawa.

— 1959a. Commencement of Upper Cretaceous transgression in Poland. — Kwartalnik Geol. (Quart. J. Inst. Geol.), vol. 3, no. 4. Warszawa.

— 1960a. Biostratigraphy and fauna of the Albian in Poland, without the Albian of the Alpine geosyncline. — Prace IG (Trav. Inst. Geol.), vol. 30, no. 2. Warszawa.

— 1960b. Biostratigraphy and Extent of Index Forms of the Upper Cretaceous in Poland. — Kwartalnik Geol. (Quart. J. Inst. Geol.), vol. 4, no. 2. Warszawa.

— 1963. Die Grundlagen der Biostratigraphie der Oberkreide in Polen. — Ber. Geol. Ges. DDR, Bd. 8, H. 2. Berlin.

— 1965. Stratigraphy and fauna of the Cenomanian in Poland, excluding the Carpathians and Silesia. — Biul. Inst. Geol. 192. Warszawa.

— & POŻARYSKI W. 1970. Cretaceous. *In:* The stratigraphy of the Mesozoic in the margin of the Holy Cross Mts. — Prace IG (Trav. Inst. Geol.), vol. 56. Warszawa.

— & TRÖGER K. A. 1964. The epicontinental Upper Cretaceous of the Middle Europe; Albian — Coniacian in Poland, Czechoslovakia and Germany. — Kwartalnik Geol. (Quart. J. Inst. Geol.), vol. 8, no. 4. Warszawa.

CLARK D. L. 1965. Heteromorph ammonoids from the Albian and Cenomanian of Texas and adjacent areas. — Mem. Geol. Soc. Amer., 95. New York.

COBBAN W. A. & SCOTT G. R. 1972. Stratigraphy and ammonite fauna of the Graneros Shale and Greenhorn Limestone near Pueblo, Colorado. — U. S. Geol. Surv. Prof. Paper 645. Washington.

COLLIGNON M. 1928—1929. Paléontologie de Madagascar. XV. Les Céphalopodes du Cénomanien pyriteux de Diego-Suarez. — Ann. Paléont. Mus. Hist. Nat., vol. 17, 18. Paris.

— 1963. Atlas des fossiles caractéristiques de Madagascar (Ammonites). Albien. — Serv. Géol. Tananarive, Fasc. 10. Tananarive.

— 1964. Atlas des fossiles caractéristiques de Madagascar (Ammonites). Cenomanien. — *Ibidem,* Fasc. 11.

— 1966. Les Céphalopodes crétacés du bassin côtier de Tarfaya. — Notes et Mém. Serv. Géol. Maroc, no. 175. Rabat.

DIKE E. F. 1972. *Ophiomorpha nodosa* Lundgren: environmental implications in the Lower Greensand of the Isle of Wight. — Proc. Geol. Assoc., vol. 83, part 2. London.

DOBROV S. A. & PAVLOVA M. M. 1959. *In:* MOSKVIN M. M., Atlas verkhnemelovoy fauny severnovo Kavkaza i Krima. Moskva.

DOUGLAS R. G. & RANKIN C. 1969. Cretaceous planktonic foraminifera from Bornholm and their zoogeographic significance. — Lethaia, vol. 2, no. 3. Oslo.

DRUMMOND P. V. O. 1970. The Mid-Dorset Swell. Evidence of Albian-Cenomanian movements in Wessex. — Proc. Geol. Assoc., vol. 81, part 4. London.

DUBOURDIEU G. 1953. Ammonites nouvelles des Monts du Mellègue. — Bull. Serv. Carte Géol. Algér., 1e sér. Paléontologie, no. 16. Alger.

DVOŘÁK J. 1958. Vývoj stratigrafie Křídového útvaru v oblasti Českého Masivu. — Ústř. Úst. Geol., sv. 30. Praha.

DŻUŁYŃSKI S. 1953. Tectonics of the southern part of the Cracovian Upland. — Acta Geol. Pol., vol. 3, no. 3. Warszawa.

FRITSCH A. 1878. Die Reptilien und Fische der böhmischen Kreideformation. Prag.

— (= FRIČ). 1911. Studien im Gebiete der böhmischen Kreideformation. — Arch. Naturwiss. Landesdurchfor. Böhmen, Bd. 15, H. 1. Prag.

GEINITZ H. B. 1850. Das Quadergebirge oder die Kreideformation in Sachsen mit besonderer Berücksichtigung der glaukonitischen Schichten. Leipzig.

— 1875. Das Elbthalgebirge in Sachsen. Erster Teil. Der untere Quader. — Palaeontographica, Bd. 20. Cassel.

GŁAZEK J. & KUTEK J. 1970. The Holy Cross Mts area in the Alpine diastrophic cycle. — Bull. Acad. Pol. Sci., Sér. Sci. Géol. Géogr., vol. 18, no. 4. Varsovie.

— , MARCINOWSKI R. & WIERZBOWSKI A. 1971. Lower Cenomanian trace fossils and transgressive deposits in the Cracow Upland. — Acta Geol. Pol., vol. 21, no. 3. Warszawa.

GOLONKA J. & RAJCHEL J. 1972. Upper Cretaceous stromatolites in the vicinity of Cracow. — Kwartalnik Geol. (Quart. J. Inst. Geol.), vol. 16, no. 3. Warszawa.

GREGORY M. R. 1969. Trace fossils from the turbidite facies of the Waitemata group, Whangaparaoa Peninsula, Auckland. — Trans. Roy. Soc. New Zealand, Earth Sciences, vol. 7, no. 1. Wellington.

HAKENBERG M. 1967. On the diagonal cross bedding and organic structures (*Chondrites*) in the Cenomanian sandstones near Brzeźno. — Acta Geol. Pol., vol. 17, no. 1. Warszawa.

— 1969. Albian and Cenomanian between Małogoszcz and Staniewice, SW border of the Holy Cross Mountains. — Studia Geol. Pol., vol. 26. Warszawa.

HANCOCK J. M. 1959. Les Ammonites du Cénomanien de la Sarthe. Colloque sur le crétacé supérieur français. — C. R. Congr. Savantes-Dijon 1959. Paris.

— 1969. Transgression of the Cretaceous sea in south-west England. — Proc. Ussher Soc., vol. 2, part 2. Redruth.

— , KENNEDY W. J. & KLAUMANN H. 1972. Ammonites from the transgressive Cretaceous on the Rhenish Massif, Germany. — Palaeontology, vol. 15, part 3. London.

HÄNTZSCHEL W. 1933. Das Cenoman und die Plenuszone in der sudetischen Kreide. — Abh. Preuss. Geol. Landesanst., N. F., H. 150. Berlin.

— 1952. Die Lebensspur *Ophiomorpha* Lundgren im Miozän bei Hamburg, ihre weltweite Verbreitung und Synonymie. — Mitt. Geol. Staatsinst. Hambg., H. 21. Hamburg.

— 1962. Trace fossils and problematica. *In:* MOORE R. C. (*Ed.*), Treatise on Invertebrate Paleontology, Part *W* (Miscellanea). Lawrence.

— & REINECK H. E. 1968. Fazies-Untersuchungen im Hettangium von Helmstedt (Niedersachsen). — Mitt. Geol. Staatsinst. Hambg., H. 37. Hamburg.

HILLMER G. 1971. Bryozoen (Cyclostomata) aus dem Unter-Hauterive von Nordwestdeutschland. — Mitt. Geol.-Paläont. Inst. Univ. Hamburg, H. 40. Hamburg.

JAWOR E. 1970. The structure of the deep substratum in the region east of Cracow. — Acta Geol. Pol., vol. 20, no. 4. Warszawa.

JELETZKY J. A. 1971. Marine Cretaceous biotic provinces and paleogeography of Western and Arctic Canada: Illustrated by a detailed study of ammonites. — Geol. Surv. of Canada, paper 70—22. Ottawa.

JERZYKIEWICZ T. 1968. Sedimentation of the youngest sandstones of the Intrasudetic Cretaceous Basin. — Geologia Sudetica, vol. 4. Warszawa.

— 1971. A flysch/littoral succession in the Sudetic Upper Cretaceous. — Acta Geol. Pol., vol. 21, no. 2. Warszawa.

— 1971a. Cretaceous in the vicinity of Krzeszów. — Geologia Sudetica, vol. 5. Warszawa.

JUX U., KEMPF E. K. & MANZE U. 1971. Schichtenfolge der marinen Oberkreide bei Bande Amir (Zentral-Afghanistan). — N. Jb. Geol. Paläont. Mh., Jg. 1971, H. 12. Stuttgart.

KAHRS E. 1927. Zur Paläogeographie der Oberkreide in Rheinland Westfalen. — N. Jb. Miner. Geol. Paläont., Bd. 58, Abt. B. Stuttgart.

KAMIEŃSKI M. & PIĄTKOWSKI A. 1950. Quelques remarques sur le Cénomanien des environs de Cracovie. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), vol. 19, no. 3. Kraków.

KENNEDY W. J. 1967. Burrows and surface traces from the Lower Chalk of Southern England. — Bull. Brit. Mus. Nat. Hist. (Geology), vol. 15, no. 3. London.

— 1969. The correlation of the Lower Chalk of south-east England. — Proc. Geol. Assoc., vol. 80, part 4. London.

— 1970. A correlation of the Uppermost Albian and the Cenomanian of south-west England. — *Ibidem*, vol. 81, part 4.

— 1971. Cenomanian ammonites from Southern England. — Special Papers in Palaeontology, no. 8. London.

— & HANCOCK J. M. 1970. Ammonites of the genus *Acanthoceras* from the Cenomanian of Rouen, France. — Palaeontology, vol. 13, part 3. London.

— & — 1971. *Mantelliceras saxbii*, and the horizon of the Martimpreyi Zone in the Cenomanian of England. — *Ibidem*, vol. 14, part. 3.

— & MACDOUGALL J. D. S. 1969. Crustacean burrows in the Weald Clay (Lower Cretaceous) of south-eastern England and their environmental significance. — *Ibidem*, vol. 12, no. 3.

KLEIN V. & SOUKUP J. 1966. *In:* Regional Geology of Czechoslovakia. Part I — The Bohemian Massif. Prague.

KOKOSZYŃSKA B. 1931. Sur la faune, les faciès et la stratigraphie du Cénomanien de la Podolie. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 6, no. 3. Warszawa.

KÖLBEL H. 1968. Regionalgeologische Stellung der DDR im Rahmen Mitteleuropas. *In:* Grundriss der Geologie der Deutschen Demokratischen Republik, Bd. 1. Berlin.

KONGIEL R. 1939. Notes pour servir à l'étude des Échinides crétacés de Pologne. — Prace Tow. Przyj. Nauk w Wilnie, Wydz. nauk mat.-przyr. (Trav. Soc. Sci. Lett. Wilno, Cl. sci. math.-nat.), vol. 13, no. 8. Wilno.

KORONIEWICZ P. & REHBINDER B. 1913. Geologicheske issledovanya vdol linii Gerby-Keleckoy zheleznoy dorogi na utchastke Gerby-Konecpol v 1909—1911 gg. — Izv. Geol. Komit., vol. 32, no. 10. Petersburg.

KOWALSKI W. C. 1948. Geological outline of Cretaceous deposits in the environs of Solca. — Biul. Państw. Inst. Geol. 51. Warszawa.

KREJČÍ J. 1877. Geologie čili nauka o útvarech zemských se zvláštním ohledem na krajiny československé. Praha.

KSIĄŻKIEWICZ M. 1927. Les poissons fossiles du crétacé supérieur des environs de Cracovie. — Bull. Acad. Pol. Sci. Lett., Cl. Sci. Math. Nath., sér. B. Kraków.

— 1956. The Jurassic and Cretaceous of Bachowice. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), vol. 24, no. 2/3. Kraków.

— 1962. (*Ed.*). Geological Atlas of Poland, 13 — Cretaceous and Early Tertiary in the Polish External Carpathians. Warszawa.

KUTEK J. & GŁAZEK J. 1972. The Holy Cross area, Central Poland, in the Alpine cycle. — Acta Geol. Pol., vol. 22, no. 4. Warszawa.

LARSEN G. 1966. Rhaetic-Jurassic-Lower Cretaceous sediments in the Danish Embayment. — Geol. Survey of Denmark, II Series, No. 91. København.

MĄCZYŃSKA S. 1958. Cenomanian and Turonian Echinoids of genus *Discoidea* from the vicinity of Kraków, Miechów and Wolbrom. — Prace Muzeum Ziemi (Trav. du Musée de la Terre), no. 2. Warszawa.

— 1962. On echinoids of the genus *Pyrina* from the Cenomanian in the vicinity of Kraków, Miechów and Wolbrom. — *Ibidem*, no. 5.

— 1972. On some representatives of the genus *Catopygus* L. Agassiz (Echinoidea) from the Upper Cretaceous. — *Ibidem*, no. 20.

MANTELL G. 1822. Fossils of the South Downs. London.

MARCINOWSKI R. 1969. Transgresywne utwory kredy i podścielające utwory jury na wschód od Mostowa i Janowa (graduate paper, Institute of Geology of the Warsaw University — *unpublished*). Warszawa.

— 1970. The Cretaceous transgressive deposits east of Częstochowa (Polish Jura Chain). — Acta Geol. Pol., vol. 20, no. 3. Warszawa.

— 1972. Belemnites of the genus *Actinocamax* Miller, 1823, from the Cenomanian of Poland. — *Ibidem*, vol. 22, no. 2.

— & SZULCZEWSKI M. 1972. Condensed Cretaceous sequence with stromatolites in the Polish Jura Chain. — *Ibidem*, vol. 22, no. 3.

MARYAŃSKA T. 1968. On new subspecies of *Multicrescis variabilis* d'Orb., a Bryozoan from the Cenomanian of Korzkiew near Cracow. — Prace Muzeum Ziemi (Trav. du Musée de la Terre), no. 12. Warszawa.

MAZUREK A. 1923. Nouvelles données sur le Cénomanien et le Turonien dans le bassin de la Nida. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 2, no. 1/2. Warszawa.

MICHALSKI A. 1888. Zarys geologiczny południowo-zachodniej części gubernii Piotrkowskiej. — Pam. Fizjogr., vol. 8. Warszawa.

MILEWICZ J. 1963. Die faziellen Verhältnisse in der Nordsudetischen Kreide. — Ber. Geol. Ges. DDR, Bd. 8, H. 2. Berlin.

MOSKVIN M. M. 1962. Upper Cretaceous sediments of the North Caucasus and Subcaucasia. — Acta Geol. Pol., vol. 12, no. 2. Warszawa.

MUROMCEVA T. L. & JANIN B. T. 1960. *In:* DRUSHTCHIC V. V. & KUDRIAVTSEV M. P., Atlas nizhnomelovoy fauny severnovo Kavkaza i Krima. Moskva.

NAJDIN D. P. 1959. On the paleogeography of the Russian platform during the Upper Cretaceous epoch. — Stockh. Contr. Geol., vol. 3, no. 6. Stockholm.

— 1960. The stratigraphy of the Upper Cretaceous of the Russian platform. — *Ibidem*, vol. 6, no. 4.

— 1969. Biostratigraphie und Paläogeographie der Oberen Kreide der Russischen Tafel. — Geol. Jb., Bd. 87. Hannover.

NOETLING G. 1885. Die Fauna der Baltischen Cenoman-Geschiebe. — Paläont. Abh., Bd. 2, H. 4. Berlin.

NOWAK J. 1915. Über die bifiden Loben der oberkretazischen Ammoniten und ihre Bedeutung für die Systematik. — Bull. Intern. Acad. Sci. Cracovie, sér. B, no. 1/2. Kraków.

— 1916. Zur Bedeutung von *Scaphites* für die Gliederung der Oberkreide. — Verh. K. K. Geol. Reichsanst., no. 3. Wien.

NOWAK W. 1963. *Pithonella ovalis* (Kaufmann) dans les Karpates de Flysch occidentales. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), vol. 33, no. 3. Kraków.

d'ORBIGNY A. 1840—1842. Paléontologie française. Terrains crétacés. *I. Céphalopodes.* Paris.

OSGOOD R. G. 1970. Trace fossils of the Cincinnati area. — Palaeontographica Americana, vol. 6, no. 41. New York.

OWEN E. F. 1962. The Brachiopod genus *Cyclothyris*. — Bull. Brit. Mus. Nat. Hist. (Geology), vol. 7, no. 2. London.

OWEN H. G. 1971a. Middle Albian stratigraphy in the Anglo-Paris Basin. — Bull. Brit. Mus. Nat. Hist. (Geology), Suppl. 8. London.

— 1971b. The stratigraphy of the Gault in the Thames Estuary and its bearing on the Mesozoic tectonic history of the area. — Proc. Geol. Assoc., vol. 82, part 2. London.

— 1972. The Gault and its junction with the Woburn sands in the Leighton Buzzard Area, Bedfordshire and Buckinghamshire. — *Ibidem*, vol. 83, part 3.

PANOW E. 1934. Sur la stratigraphie du Crétacé des environs de Cracovie. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), vol. 10. Kraków.

— (*posthumous edition*) 1969. Contribution to the knowledge of the Brachiopods from the Upper Cretaceous of the Kraków district. — *Ibidem*, vol. 39, no. 4.

PASSENDORFER E. 1930. Étude stratigraphique et paléontologique du Crétacé de la série hauttatrique dans les Tatras. — Prace PIG (Trav. Serv. Géol. Pol.), vol. 2, no. 4. Warszawa.

PASTERNAK S. I., GAVRILISHIN V. I., GINDA V. A., KOTSUBINSKII S. P. & SENKOVSKII J. M. 1968. Stratigraphia i fauna kreidovih vidkladiv zahodu Ukrainy (bes Karpat). Kiev.

PEAKE N. B. & HANCOCK J. M. 1961. The Upper Cretaceous of Norfolk — Trans. Norfolk Norwich Nat. Soc., vol. 19, part 6. Norwich.

PERVINQUIÈRE L. 1910. Sur quelques ammonites du Crétacé algérien. — Mém. Soc. Géol. France, no. 42. Paris.

PICTET F. J. & CAMPICHE G. 1858—1864. Description des fossiles du terrain crétacé des environs de Sainte-Croix. — Mat. Paléont. Suisse *1* (1858—1860), *2* (1861—1864). Genève.

POPIEL-BARCZYK E. 1958. The Echinoid of genus *Conulus* from the Turonian in the vicinity of Kraków, Miechów and Wolbrom. — Prace Muzeum Ziemi (Trav. du Musée de la Terre), no. 2. Warszawa.

— 1972. Albian-Cenomanian brachiopods from the environs of Annopol on the Vistula with some remarks on related species from Cracow Region. — *Ibidem*, no. 26.

PORTHAULT B., THOMEL G. & VILLOUTREYS O. 1966. Étude biostratigraphique du Cénomanien du bassin supérieur de l'Estéron (Alpes-Martitimes). Le problème de la limite Cénomanien-Turonien dans le Sud-Est de la France. — Bull. Soc. Géol. France, sér. 7, vol. 8. Paris.

POSLAVSKAYA N. A. & MOSKVIN M. M. 1959. *In*: MOSKVIN M. M., Atlas verkhnomelovoy fauny severnovo Kavkaza i Krima. Moskva.

POŻARYSKI W. 1938. Senonsstratigraphie im Durchbruch der Weichsel zwischen Rachów und Puławy in Mittelpolen. — Bull Serv. Géol. Pol. 6. Warszawa.

— 1947. A phosphate deposit of the north-eastern periphery of the Holy Cross Mts. — *Ibidem*, 27.

— 1948. Jurassic and Cretaceous between Radom, Zawichost and Kraśnik (Central Poland). — *Ibidem*, 46.

— 1956. Regionalna geologia Polski. Region Lubelski, t. 2. Warszawa.

— 1960. An outline of stratigraphy and palaeogeography of the Cretaceous in the Polish Lowland. — Prace IG (Trav. Inst. Geol), vol. 30, no. 2. Warszawa.

— 1962. Geological Atlas of Poland, 10 — Cretaceous. Warszawa.

PRESCHER H. 1963. Die Scaphitenzone und ihre Problematik. — Ber. Geol. Ges. DDR, Bd. 8, H. 2. Berlin.

PRIEM F. 1907. Note sur les poissons fossiles de Madagascar. — Bull. Soc. Géol. France, sér. 4, vol. 7, fasc. 7/8. Paris.

PUSCH G. 1836. Geognostische Beschreibung von Polen so wie der übringen Nordkarpathen-Länder. Stuttgart-Tübingen.

— (*posthumous edition*) 1883. Nowe przyczynki do gieognozyi Polski. — Pam. Fizjogr., vol. 3. Warszawa.

RACZYŃSKA A. & CIEŚLIŃSKI S. 1960. The Lower Cretaceous terrestrial strata NW from Holy Cross Mts. — Przegląd Geol., no. 10. Warszawa.

RADWAŃSKI A. 1967. Remarks on some Lower Tortonian brown-coal bearing sediments on the southern and eastern slopes of the Holy Cross Mts. — Bull. Acad. Pol. Sci., Sér. Sci. Géol. Géogr., vol. 15, no. 1. Varsovie.

— 1968. *Ischyodus thurmanni* Pictet & Campiche and other Chimaeroid fishes from the Albian-Cenomanian of the Holy Cross Mountains (Poland). — Acta Palaeont. Pol., vol. 13, no. 2. Warszawa.

— 1969. *In*: HAKENBERG M., Albian and Cenomanian between Małogoszcz and Staniewice, SW border of the Holy Cross Mountains. — Studia Geol. Pol., vol. 26. Warszawa.

— 1970. Dependence of rock-borers and burrowers on the environmental conditions within the Tortonian littoral zone of Southern Poland. *In*: CRIMES T. P. & HARPER J. C. (*Eds.*), Trace Fossils (Geol. J. Special Issues, No. 3). Liverpool.

— 1973. Lower Tortonian transgression onto the south-eastern and eastern slopes of the Holy Cross Mts. — Acta Geol. Pol., vol. 23, no. 2. Warszawa.

RADWAŃSKI S. 1966. Upper Cretaceous facies and faunas in the central part of the Sudety Mts. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.) vol. 36, no. 2. Kraków.

RAVN J. P. J. 1916. Kridtaflejringerne paa Bornholms Sydvestkyst og deres Fauna; I, Cenomanet. — Danmarks Geol. Undersøg., II Raekke, Nr. 30. Kjøbenhavn.

— 1918. Kridtaflejringerne paa Bornholms Sydvestkyst og deres Fauna; II, Turonet. — *Ibidem*, Nr. 31.

— 1921. Kridtaflejringerne paa Bornholms Sydvestkyst og deres fauna; III, Senonet. — *Ibidem*, Nr. 32.

— 1925. Det cenomane Basalkonglomerat paa Bornholm. — *Ibidem*, Nr. 42.

RENZ O. 1963. *In*: RENZ O., LUTERBACHER H. & SCHNEIDER A., Stratigraphisch-paläontologische Untersuchungen im Albien und Cenomanien des Neuenburger Jura. — Ecl. Geol. Helv., vol. 56, no. 2. Basel.

— 1968. Die Ammonoidea im Stratotyp des Vraconnien bei Sainte-Croix (Kanton Waadt). — Schweiz. Paläont. Abh. (Mém. Suisse Paléont.), vol. 87. Basel.

— 1972. Die Gattungen *Puzosia* Bayle, *Bhimaites* Matsumoto und *Desmoceras* Zittel (Ammonoidea) im oberen Albien Venezuelas. — Ecl. Geol. Helv., vol. 65, no. 3. Basel.

ROEMER F. 1870. Geologie von Oberschlesien. Wrocław.

ROSENKRANTZ A. 1944. Nye Ammonitfund i Kridtformationen paa Bornholm. — Meddel. Dansk Geol. Foren., Bind 10, Hefte 4. København.

RÓŻYCKI S. Z. 1937. Alb, Cenoman und Turon in der Umgebung der Eisenbahnstation Złoty Potok. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 9, no. 1. Warszawa.

— 1938. Stratigraphie und Tektonik der Kreideablagerungen der Umgebung von Lelów — Südöstlich von Częstochowa. — *Ibidem*, vol. 9, no. 2.

RUTKOWSKI J. 1965. Senonian in the area of Miechów, Southern Poland. — Rocz. P. T. Geol. (Ann. Soc. Géol. Pol.), vol. 35, no. 1. Kraków.

— 1971. Wycieczka B-3. *In*: Przewodnik 43 Zjazdu Pols. Tow. Geol. [Guide to the 43*th* Meeting of the Geological Society of Poland]. Warszawa.

SAMSONOWICZ J. 1925. Esquisse géologique des environs de Rachów sur la Vistule et les transgressions de l'Albien du Cénomanien dans le sillon nord-européen. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 3, no. 1/2. Warszawa.

— 1934. Explication de la feuille Opatów. Warszawa.

— 1948. Cretaceous deposits in bore-holes in Łódź and the structure of the Łódź Basin (Central Poland). — Biul. Inst. Geol. 50. Warszawa.

SCHLÜTER C. 1871—1876. Die Cephalopoden der oberen deutschen Kreide. — Palaeontographica, Bd. 21—24. Stuttgart.

SCUPIN H. 1912—1913. Die Löwenberger Kreide und ihre Fauna. — Palaeontographica, Suppl.-Bd. 6. Stuttgart.

SENKOVSKII J. M. 1963. Litologia verkhnokredovykh vidkladiv serednovo Pridnistrova. Kiev.

SHARPE D. 1853—1857. Description of the fossil remains of Mollusca found in the Chalk of England. — Palaeontogr. Soc. (Monogr.). London.

SIEMIRADZKI J. 1909. Geologia Ziem Polskich. Formacye młodsze (kreda — dyluwium), vol. 2. Lwów.

— 1926. Sur les coraliaires du Crétacé Supérieur de Pologne. — Kosmos, vol. 51, no. 1—4. Lwów.

SIMPSON S. 1957. On the trace-fossil *Chondrites*. — Quart. J. Geol. Soc. London, vol. 112, part 4. London.

SORNAY J. 1966. Idées actuelles sur les Inocérames d'après divers travaux récents. — Ann. Paléont. Invért., T. 52, Fasc. 1. Paris.

SOUKUP J. 1971. Ein Fund von *Schloenbachia varians trituberculata* Spath (Mollusca, Ammonoidea) im mittelböhmischen Cenoman. — Věstn. Ústř. Úst. Geol., Roč. 46, Č. 2. Praha.

SPATH L. F. 1923—1943. A monograph of the Ammonoidea of the Gault. — Palaeontogr. Soc. (Monogr.), parts: *1* (1923), *2* (1925), *4* (1926), *12* (1937), *15* (1942). London.

— 1926a. On the zones of the Cenomanian and the Uppermost Albian. — Proc. Geol. Assoc., vol. 37. London.

STENESTAD E. 1972. Traek af det danske bassins udvikling i Øvre Kridt. — Dansk Geol. Foren., Aarsskrift for 1971. København.

STOLLEY E. 1930. Einige Bemerkungen über die Kreide Südskandinaviens. — Geol. Fören. Stockh. Förhandl., Bd. 52, H. 2. Stockholm.

SUJKOWSKI Z. 1926. Sur le Jurassique, le Crétacé et le Quaternaire des environs de Wolbrom. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 3, no. 3/4. Warszawa.

— 1929. Recherches sur la roche-mère des dépôts clastiques du Cénomanien sup. de la Solca et Wolbrom. — Spraw. Tow. Nauk. Warsz., Wydz. III (C.-R. Séanc. Soc. Sci. Varsovie, Cl. III), vol. 21 (1928), no. 7—9. Warszawa.

— 1931. Étude pétrographique du Crétacé de Pologne. La série de Lublin et sa comparaison avec la craie blanche. — Spraw. PIG (Bull. Serv. Géol. Pol.), vol. 6, no. 3. Warszawa.

— 1934. Roches crétacées entre les villes Pilica et Szczekociny. — *Ibidem*, vol. 8, no. 1.

THIEDE J. & LARSEN G. 1971. Radiographies of consolidated calcareous sediments from Denmark. — Bull. Geol. Soc. Denmark, vol. 20, no. 3. Copenhagen.

TRÖGER K. A. 1963. Stratigraphisch-paläontologische und fazielle Probleme der sächsischen Kreide. — Ber. Geol. Ges. DDR, Bd. 8, H. 2. Berlin.

— 1967—1969. Zur Paläontologie, Biostratigraphie und faziellen Ausbildung der unteren Oberkreide (Cenoman bis Turon). Teil I (1967). Paläontologie und Biostratigraphie der Inoceramen des Cenomans bis Turon Mitteleuropas. — Abh. Staatl. Mus. Miner. Geol., Bd. 12. Dresden, Teil II (1969). Stratigraphie und fazielle Ausbildung des Cenomans und Turons in Sachsen, dem nördlichen Harzvorland (subherzyne Kreide) und dem Ohm-Gebirge. — *Ibidem*, Bd. 13.

UBERNA J. 1967. Development of the phosphorite-bearing series of the northern margin of the Holy Cross Mountains, in the light of the sedimentology of the Albian and Cenomanian. — Biul. Inst. Geol. 206. Warszawa.

VAN ANDEL T. 1954. *In*: VAN ANDEL T. & POSTMA H., Recent sediments of the Gulf of Paria (Reports of the Orinoco shelf expedition), vol. I. — Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurkunde, Eerste Reeks, Deel 20, No. 5. Amsterdam.

VOIGT E. & HÄNTZSCHEL W. 1964. Gradierte Schichtung in der Oberkreide Westfalens. — Fortschr. Geol. Rheinld. u. Westf., Bd. 7. Krefeld.

WAAGE K. M. 1968. The type Fox Hills Formation, Cretaceous (Maestrichtian), South Dakota; Part 1. Stratigraphy and paleoenvironments. — Peabody Mus. Natur. Hist., Yale University, Bull. 27. New Haven.

WANDERER K. 1909. Die wichtigsten Tierversteinerungen aus der Kreide Königreiches Sachsen. Jena.

WEIMER R. J. & HOYT J. H. 1964. Burrows of *Callianassa major* Say, geologic indicators of littoral and shallow neritic environments. — J. Paleont., vol. 38, no. 4. Tulsa.

WENDT J. 1970. Stratigraphische Kondensation in triadischen und jurassischen Cephalopodenkalk der Tethys. — N. Jb. Paläont. Mh., Jg. 1970, H. 7. Stuttgart.

WIEDMANN J. 1959. Le Crétacé supérieur de l'Espagne et du Portugal et ses Céphalopodes. Colloque sur le crétacé supérieur français. — C. R. Congr. Soc. Savantes-Dijon 1959, Sect. Sci. Paris.

— 1962. Ammoniten aus der Vascogotischen Kreide (Nordspanien). *I.* Phylloceratina, Lytoceratina. — Palaeontographica, Bd. 118, Abt. A. Stuttgart.

— 1964a. Unterkreide-Ammoniten von Mallorca. 2. Liefrg.: Phylloceratina. — Abh. Akad. Wiss. Lit. Mainz, Math.-Naturw. Kl., no. 4. Wiesbaden.

— 1964b. Le Crétacé supérieur de l'Espagne et du Portugal et ses Céphalopodes. — Estudios Geol., vol. 20. Madrid.

— & DIENI I. 1968. Die Kreide Sardiniens und ihre Cephalopoden. — Palaeontogr. Italica, vol. 64 (n. ser., vol. 34). Pisa.

WIENBERG RASMUSSEN H. 1970. Danmarks geologi. *Gjellerup*. København.

WIERZBOWSKI A. 1966. L'Oxfordien supérieur et le Kimméridgien inférieur du Plateau de Wieluń. — Acta Geol. Pol., vol. 16, no. 2. Warszawa.

WIRTH W. 1964. Über zwei Unterkreiderelikte im nördlichen Sauerland. — Fortschr. Geol. Rheinld. u. Westf., Bd. 7, Krefeld.

WITKOWSKI A. 1969. Geological structure of the Tomaszów syncline. — Prace IG (Trav. Inst. Geol.), vol. 53. Warszawa.

WOODS H. 1899—1911. A monograph of the Cretaceous Lamellibranchiata of England. — Palaeontogr. Soc. (Monogr.), vol. 1/2. London.

— 1912. The evolution of Inoceramus in the Cretaceous period. — Quart. J. Geol. Soc. London, vol. 68, part 1. London.

WOODWARD A. S. 1911—1912. The fossil Fishes of the English Chalk. — Palaeontogr. Soc. (Monogr.), parts: *6* (1911), 7 (1912). London.

WRIGHT C. W. 1957. *In*: MOORE R. C. (*Ed.*), Treatise on Invertebrate Paleontology, Part *L* (Mollusca *4*). Lawrence.

— 1963. Cretaceous ammonites from Bathurst Island, Northern Australia. — Palaeontology, vol. 6, part 4. London.

— & WRIGHT E. V. 1949. The Cretaceous ammonites genera *Discohoplites* Spath and *Hyphoplites* Spath. — Quart. J. Geol. Soc. London, vol. 104, part 4. London.

— & — 1951. A survey of the fossil Cephalopoda of the Chalk of Great Britain. — Palaeontogr. Soc., vol. 104, no. 3. London.

WRIGHT T. 1864—1882. Monograph on the British fossil. Echinodermata from the Cretaceous Formations. The Echinoidea. — Palaeontogr. Soc. (Monogr.), vol. 1. London.

WULF G. R. 1962. Trough cross-bedding. — J. Sedim. Petrol., vol. 32, no. 3. Menasha.

ZAPAŚNIK T. 1974. Budowa geologiczna w strefie wychodni górnojurajskich między Olkuszem, Wolbromiem i Glanowem (*in preparation*).

ZARĘCZNY S. 1874. O średnim ogniwie warstw cenomańskich w Galicyi Wschodniej. — Spraw. Komis. Fizjogr. Akad. Um., vol. 8. Kraków.

— 1878. O średnich warstwach kredowych w krakowskim okręgu. — *Ibidem*, vol. 12.

— 1894. Atlas geologiczny Galicyi (tekst do zeszytu trzeciego). Kraków.

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TRANSGRESYWNE UTWORY KREDY (ALB-TURON) NA OBSZARZE JURY POLSKIEJ

(Streszczenie)

Przedmiotem pracy są transgresywne utwory kredy na obszarze Jury Polskiej, odsłaniające się między Częstochową a Glanowem (*por.* fig. 1, 3—4, 9 oraz 12). Utwory te (*por.* fig. 2, 5—8, 10—11, 13—28 oraz pl. 1—11) leżą na erozyjnie rozciętej powierzchni wapieni górnojurajskich, a wiek ich zamyka się w granicach górny alb (ewentualnie najwyższy środkowy alb) — niższa część górnego turonu (poziom Inoceramus costellatus). Stwierdzone zespoły faunistyczne (*por.* tab. 1—5 oraz pl. 17—34) scharakteryzowano w nawiązaniu do zespołów znanych z obszarów sąsiednich oraz innych części Europy, a także kilku regionów pozaeuropejskich. Szczególnie liczne zespoły występują w cenomanie, co przynajmniej częściowo spowodowane było powolnym tempem sedymentacji (kondensacja faun amonitowych z poszczególnych poziomów, wzrost ilości glaukonitu, obecność różnorodnych konkrecji fosforytowych). Ogólnie scharakteryzowano również ślady działalności życiowej organizmów grzebiących i drążących (*por.* pl. 12—16; pl. 17, fig. 9). W części paleontologicznej pracy, spośród bogatej fauny cenomanu, szczegółowo opracowane zostały amonity (pl. 31—34). Reprezentują one poziomy amonitowe znane z południowej Anglii i Francji (*por.* Hancock 1959; Kennedy 1969, 1971), co uzasadnia przyjęcie także i w Polsce podziału cenomanu na trzy części (*por.* tab. 6). Podział ten skorelowano ze stosowanym dotychczas w Polsce dwudzielnym podziałem cenomanu (*por.* Cieśliński 1959, 1965; Cieśliński & Pożaryski 1970; Marcinowski 1970; Głazek, Marcinowski & Wierzbowski 1971). W związku z tym, iż *Scaphites geinitzi* d'Orbigny występuje w całym turonie (*por.* Prescher 1963) i nie może być wskaźnikiem dla zony niższej części górnego turonu (*tzw.* poziom T_3 *sensu* Cieśliński 1960b, 1963), dokonano redefinicji tego poziomu. Zaproponowano, aby dawny poziom Scaphites geinitzi nazwać poziomem Inoceramus costellatus i ten właśnie gatunek uznać za wskaźni-

kowy; za dolną granicę poziomu należy uznać pojawienie się gatunków *Inoceramus costellatus* Woods i *I. inconstans* Woods, natomiast za górną — pojawienie się *I. schloenbachi* Böhm (*por.* Cieśliński 1960b, 1963; Cieśliński & Pożaryski 1970). Analizując wykształcenie facjalne badanych utworów i ich stosunek do górnojurajskiego podłoża oraz porównując je z równowiekowymi osadami na obszarze Wyżyny Krakowskiej, odtworzono warunki sedymentacji osadów transgresywnych na obszarze całej Jury Polskiej (*por.* fig. 29). Scharakteryzowano również pozycję paleogeograficzną regionu wykazując m. in., że na przełomie albu i cenomanu doszło tutaj do utworzenia podmorskiego progu, który oddzielał morze kredowe obszaru Opola i Głubczyc od morza Polski Centralnej (*por.* fig. 30; a także Alexandrowicz 1969). Próg ten zaznaczył się również w trakcie sedymentacji młodszych osadów kredy (*por.* fig. 30), a jego powstanie wiązać należy z subhercyńskimi ruchami tektonicznymi. W zakończeniu pracy przedstawiono porównanie transgresywnych utworów albu, cenomanu i turonu Jury Polskiej z równowiekowymi utworami epikontynentalnymi innych obszarów Europy.

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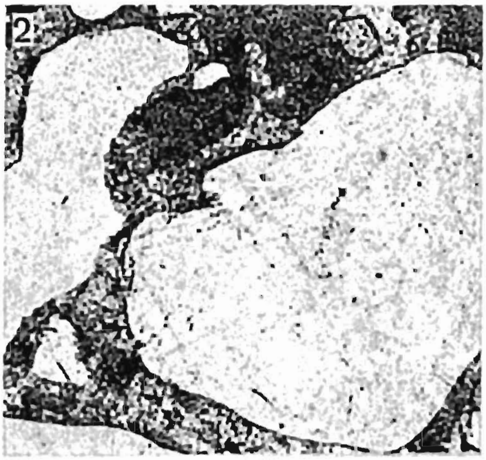
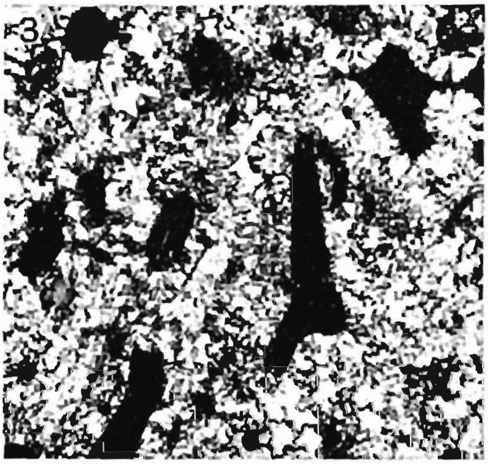
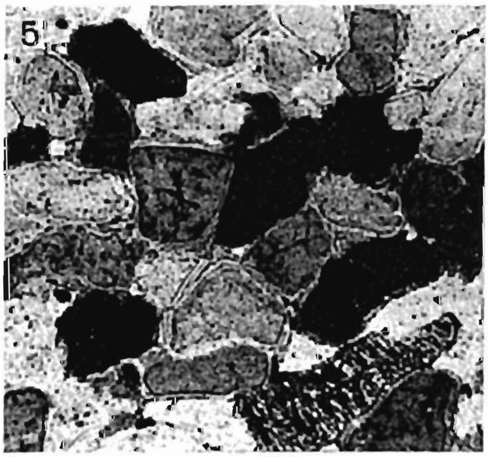
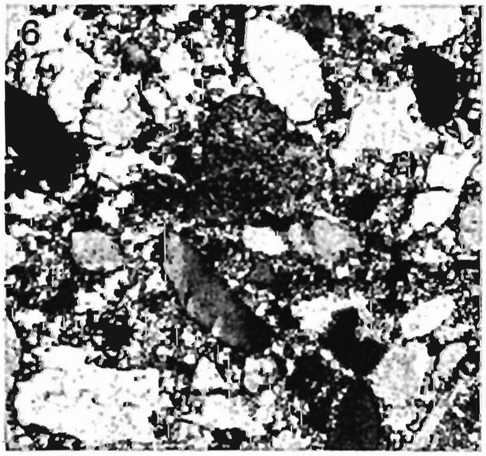








1 — Coarse-grained, marly sandstone: inoceram prisms in matrix; Cenomanian, Mokrzesz (unit 3 in Fig. 2*A*).

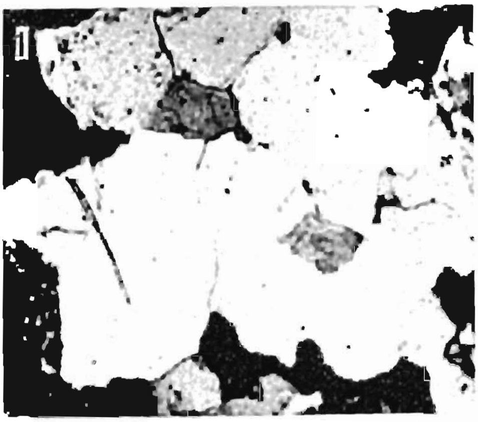
2 — Marly, phosphatic conglomerate; Cenomanian, Julianka (unit 2 in Fig. 2*E*).

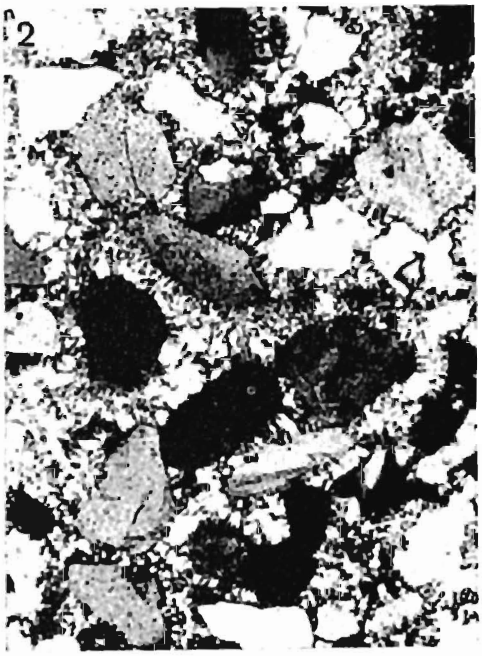
3, 4 — Chalcedonite: voids after sponge spicules (3) and unrecognizable organic debris (4); Upper Albian, Łusławice (unit 3 in Fig. 2*D*); nicols crossed.

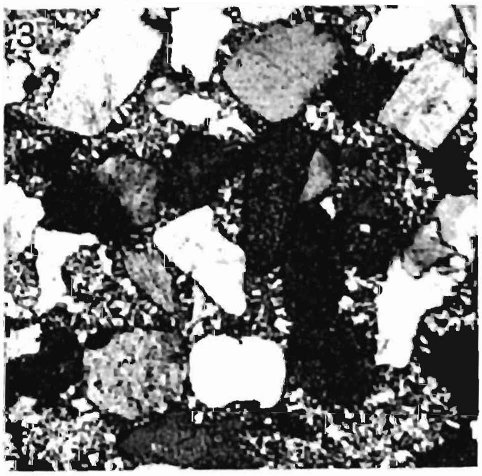
5 — Quartzitic sandstone: secondary rims around quartz grains; Upper Albian, Staropole (unit 2 in Fig. 2*F*); nicols oblique.

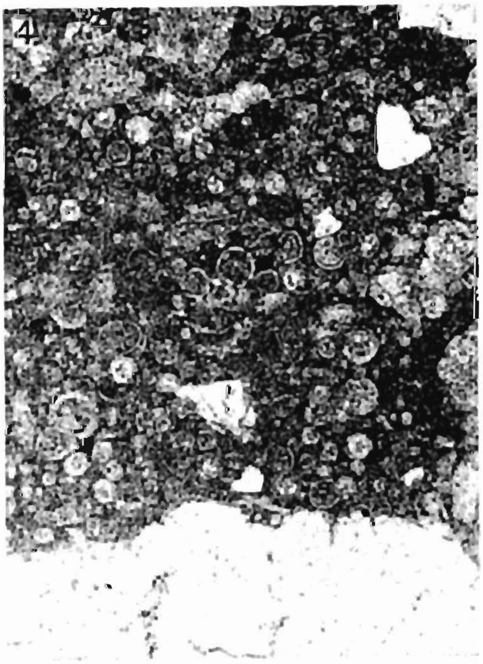
6 — Chalcedony-cemented sandstone; Upper Albian, Solca (outcrop *IIIc* in Fig. 4); nicols crossed.

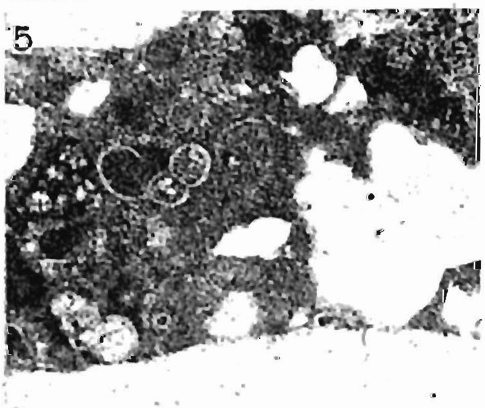
All figures × 50











1 — Strongly cemented quartzitic sandstone with pressure-solution contacts; Upper Albian, Solea (outcrop *111a* in Fig. 4); nicols crossed.

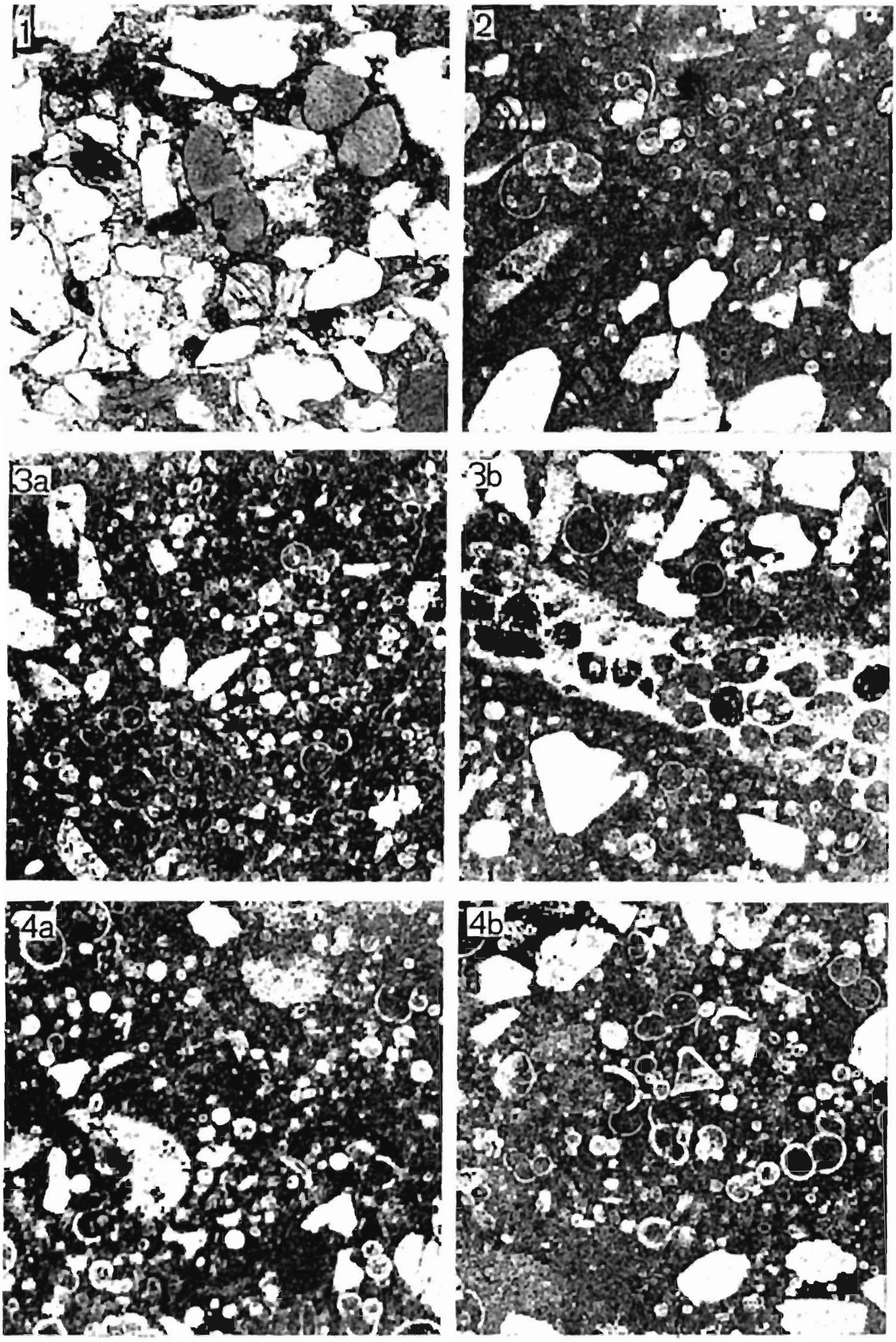
2 — Chalcedony-cemented sandstone; Upper Albian, Wolbrom (outcrop *103* in Fig. 9); nicols crossed.

3 — Chalcedony-cemented sandstone with altered glauconite grains; Upper Albian, Sucha (unit 3 in Fig. 13); nicols crossed.

4 — Foraminifer limestone being the cement of quartz conglomerate (quartz pebble at bottom of photo); Middle Cenomanian, Glanów (upper part of unit *2a* in Fig. 22).

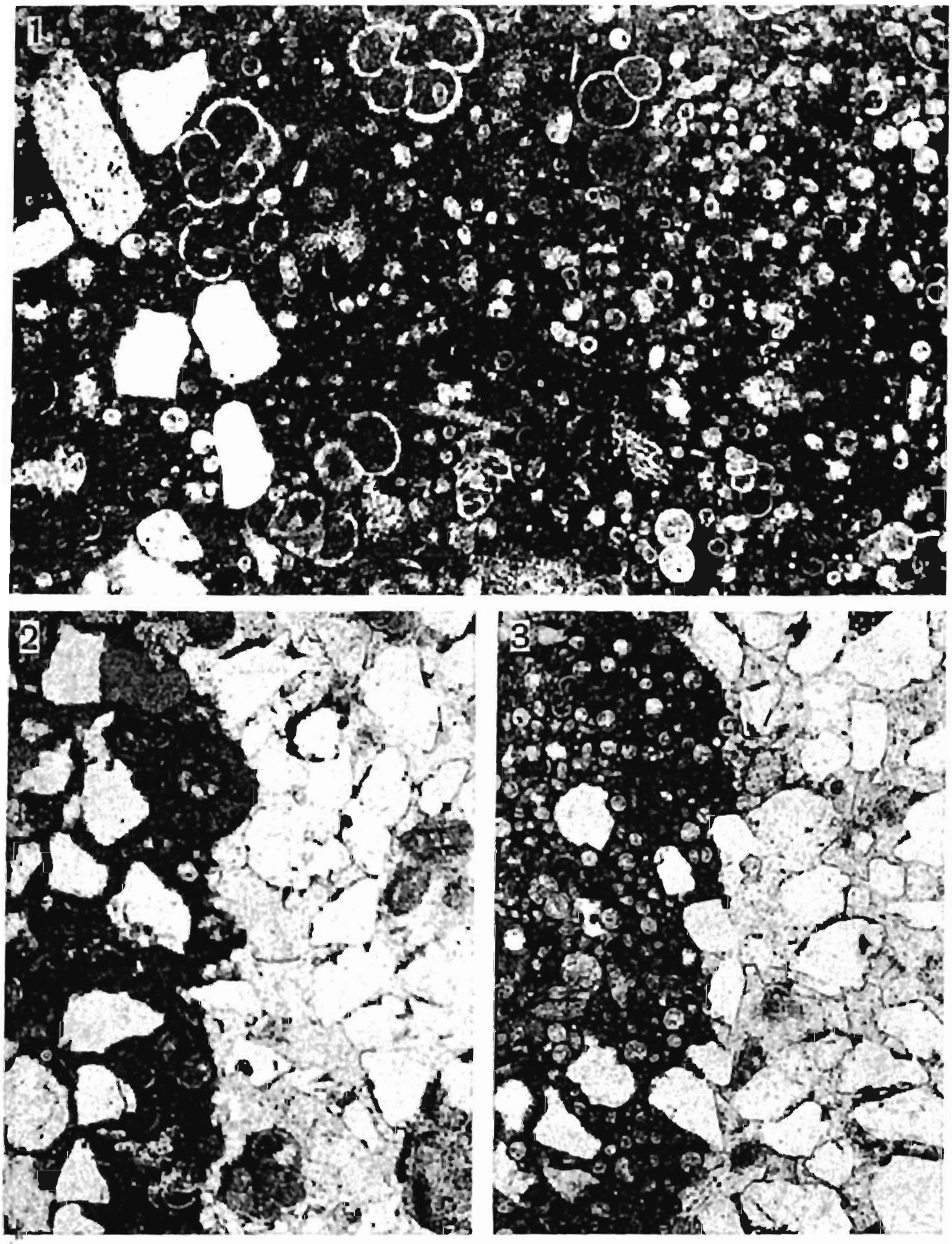
5 — Organodetrital limestone with foraminifers and quartz grains; Lower Turonian, Ulina Wielka (outcrop *1.5* in Fig. 9).

All figures × 50



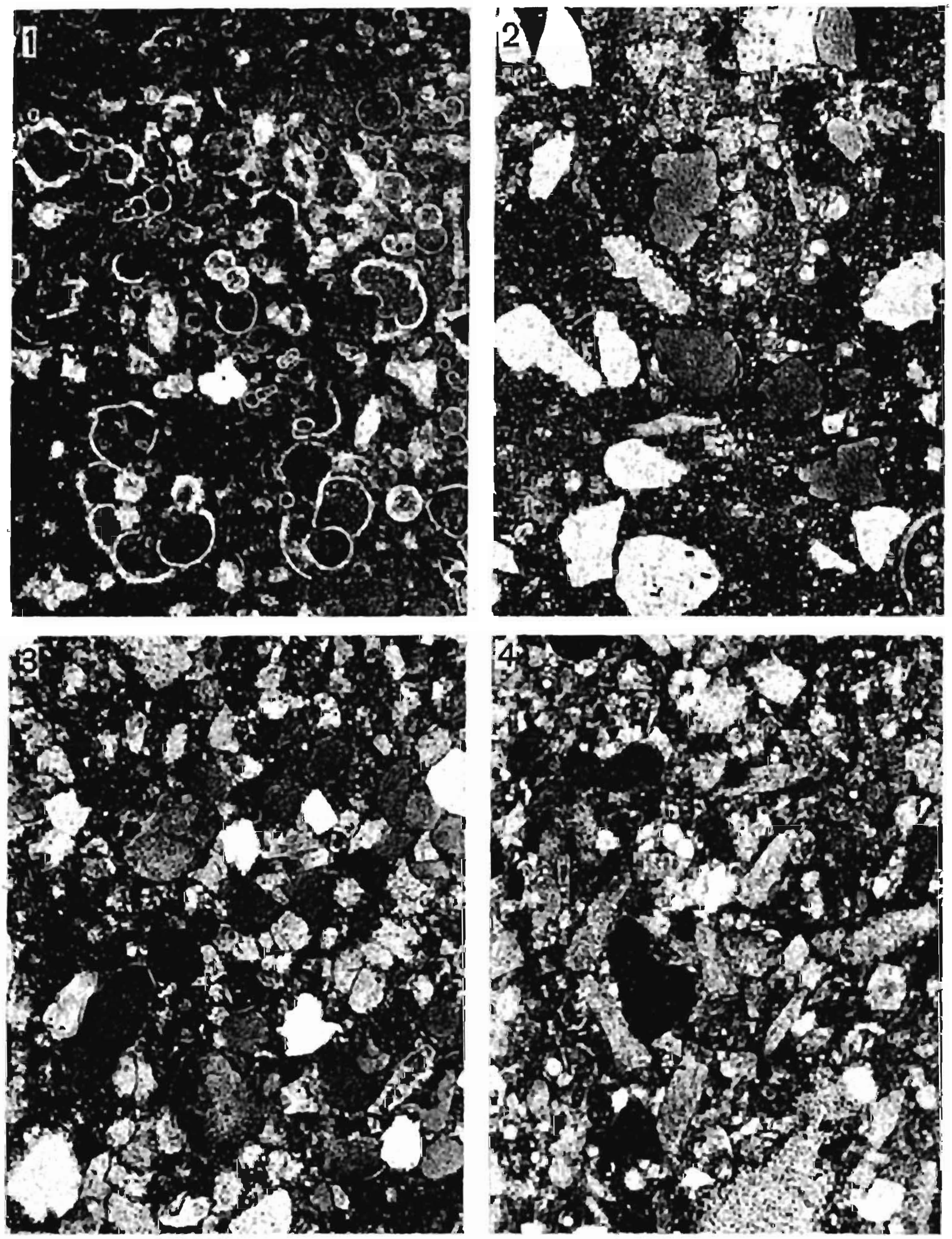
Cenomanian-Santonian microfacies at Przychody
(outcrop *115* in Fig. 4; location of samples in Figs 7 and 8*A*); all figures × 30

1 microfacies of maximal frequency of quartz and glauconite (sample *1*, Cenomanian); *2* *Pithonella* microfacies with foraminifers, and quartz and glauconite admixture (sample *3*, Lower Turonian); *3a—b* *Pithonella*-foraminifer microfacies with quartz admixture and bryozoan debris (*3b*) — sample *7*, Lower Turonian; *4a—b* the same microfacies (sample *12*, Upper Turonian)



Cenomanian-Santonian microfacies at Przychody (*cnt'd*)

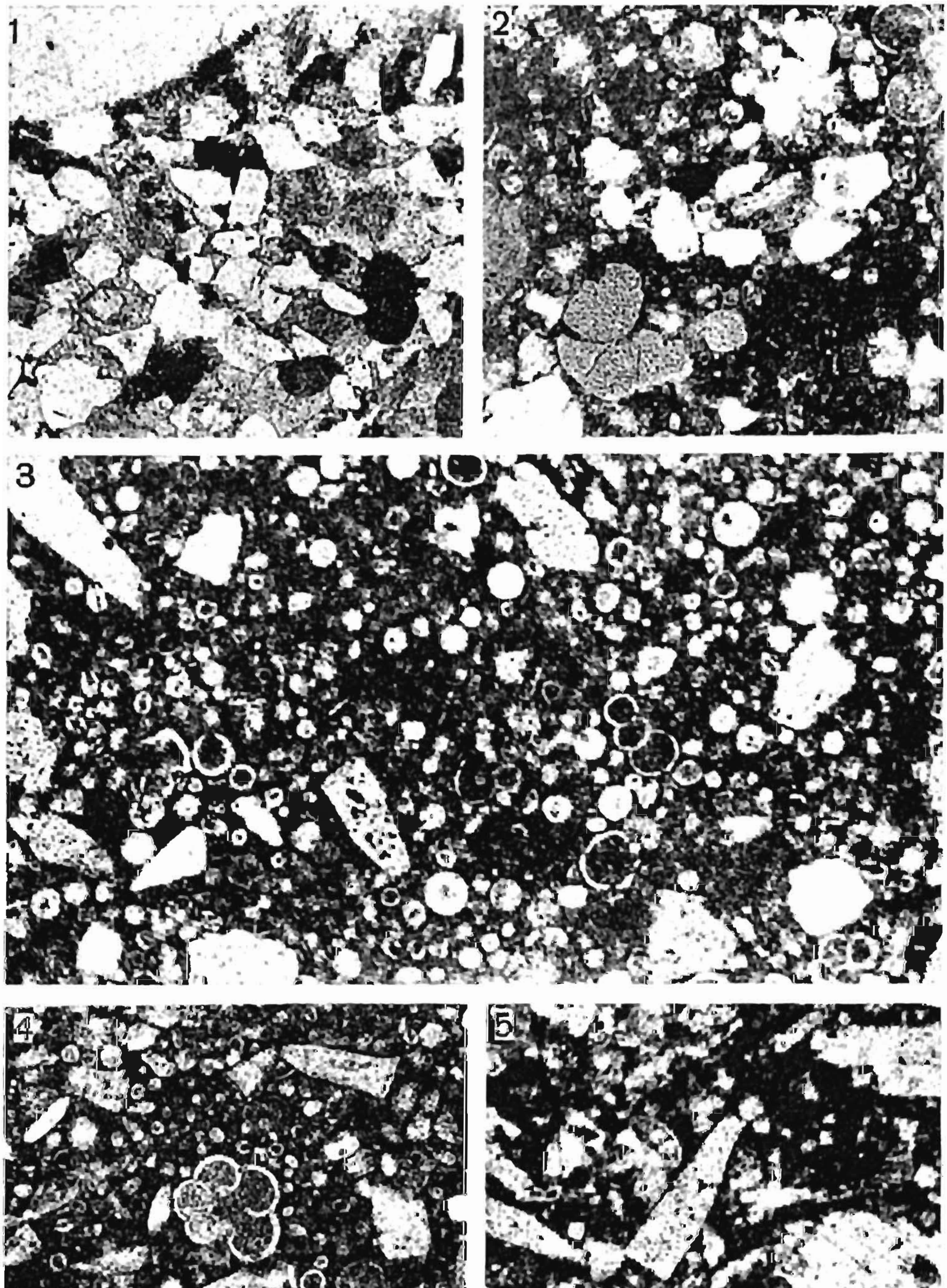
1 foraminifer-*Pithonella* microfacies (sample *14*), Upper Turonian, × 70; 2 contact of sandy limestone (sample *14* — left side of photo) with a dyke enriched with quartz (sample *14a*), Upper Turonian, × 50; 3 contact of foraminifer-*Pithonella* limestone (sample *15* — left side of photo) with a similar dyke (sample *15a*), Upper Turonian, × 50



Cenomanian-Santonian microfacies at Przychody (*cnt'd*)

1 foraminifer microfacies (sample *16*, Upper Turonian); 2 Santonian sandy marl from a dyke in Turonian deposits (cf. Fig. *8B*): foraminifer microfacies abundant in glauconite and quartz (sample *16a*); 3 microfacies of maximal frequency of glauconite and abundant inoceram prisms (sample *17*, Santonian); 4 inoceram microfacies (sample *19*, Santonian)

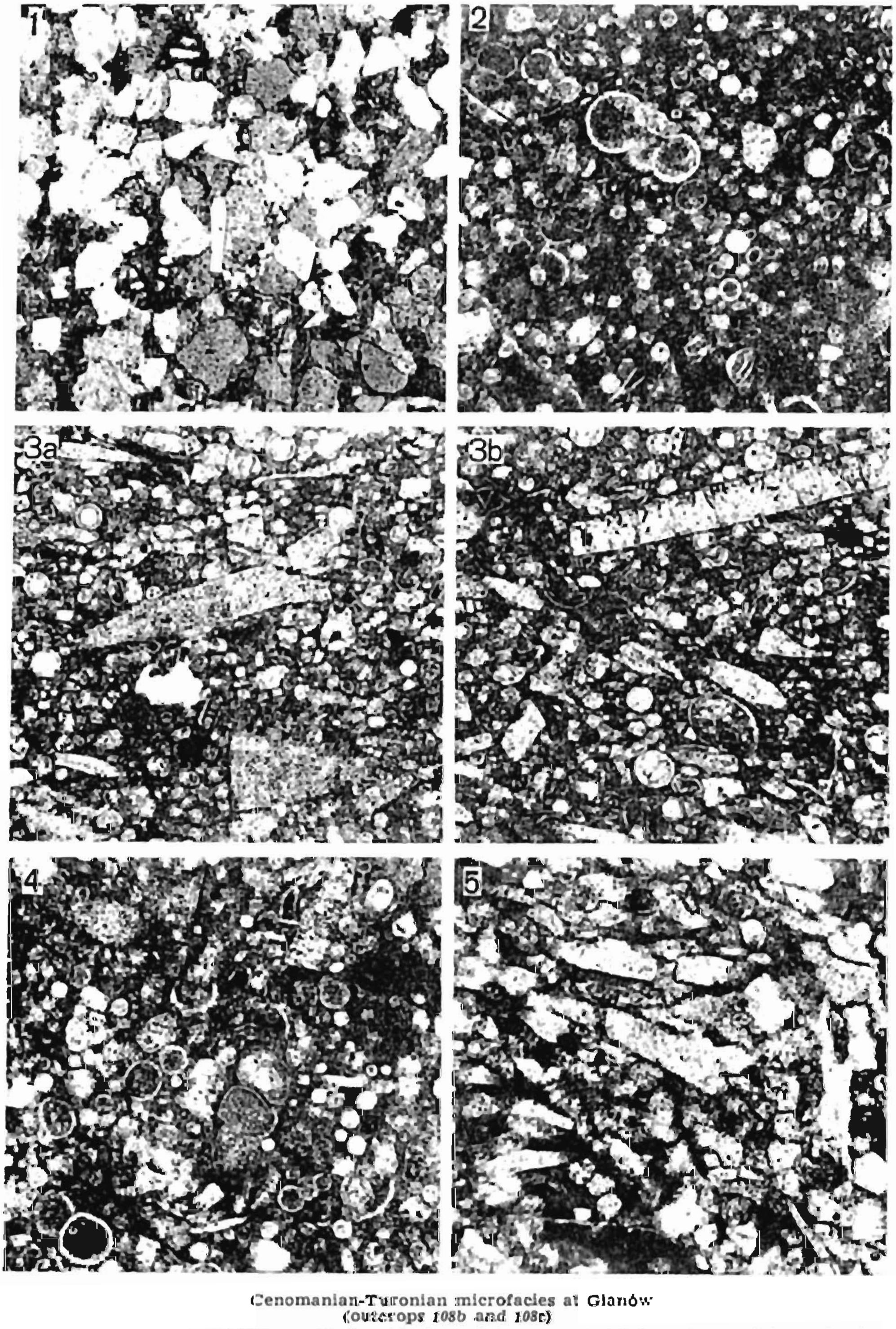
All figures × 50



Cenomanian/Turonian microfacies at Poręba Dzierżna
(outcrop *110* in Fig. 9, location of samples in Fig. 10)

1 marl-sandy matrix of quartz conglomerate (quartz pebble at upper left), sample *1*, Upper Cenomanian; 2 foraminifer microfacies with quartz and glauconite admixture (sample *2*, Cenomanian — Turonian junction); 3 *Pithonella* microfacies with abundant foraminifers and inoceram prisms (sample *3*, Lower Turonian, × 70); 4 inoceram-foraminifer-*Pithonella* microfacies (sample *4*, Lower Turonian); 5 inoceram microfacies (sample *5*, Lower Turonian)

All figures × 50, except Fig. 3

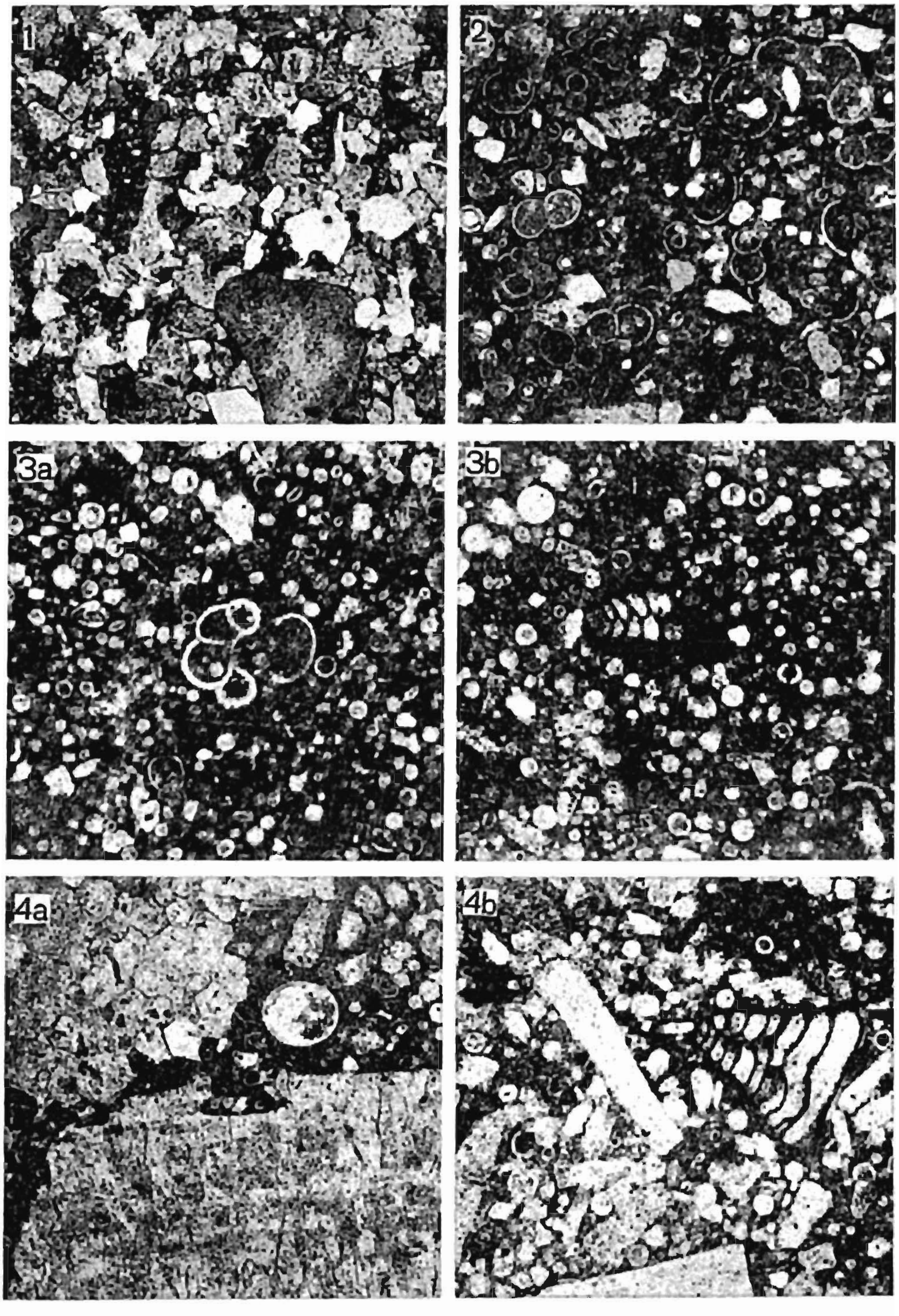


Cenomanian-Turonian microfacies at Glanów
(outcrops *108b* and *108c*)

1 marly, glauconitic sandstone with benthic foraminifers (sample *6* in outcrop *108b* — cf. Fig. 13, Lower Cenomanian)

Remaining samples from outcrop *108c* (their location — in Fig. 22): 2 foraminifer-*Pithonella* microfacies (sample *6*, Upper Cenomanian); 3a—b foraminifer-inoceram microfacies (sample *7*, Upper Cenomanian); 4 foraminifer-inoceram-*Pithonella* microfacies (sample *10*, Lower Turonian); 5 inoceram microfacies (sample *14*, Lower Turonian)

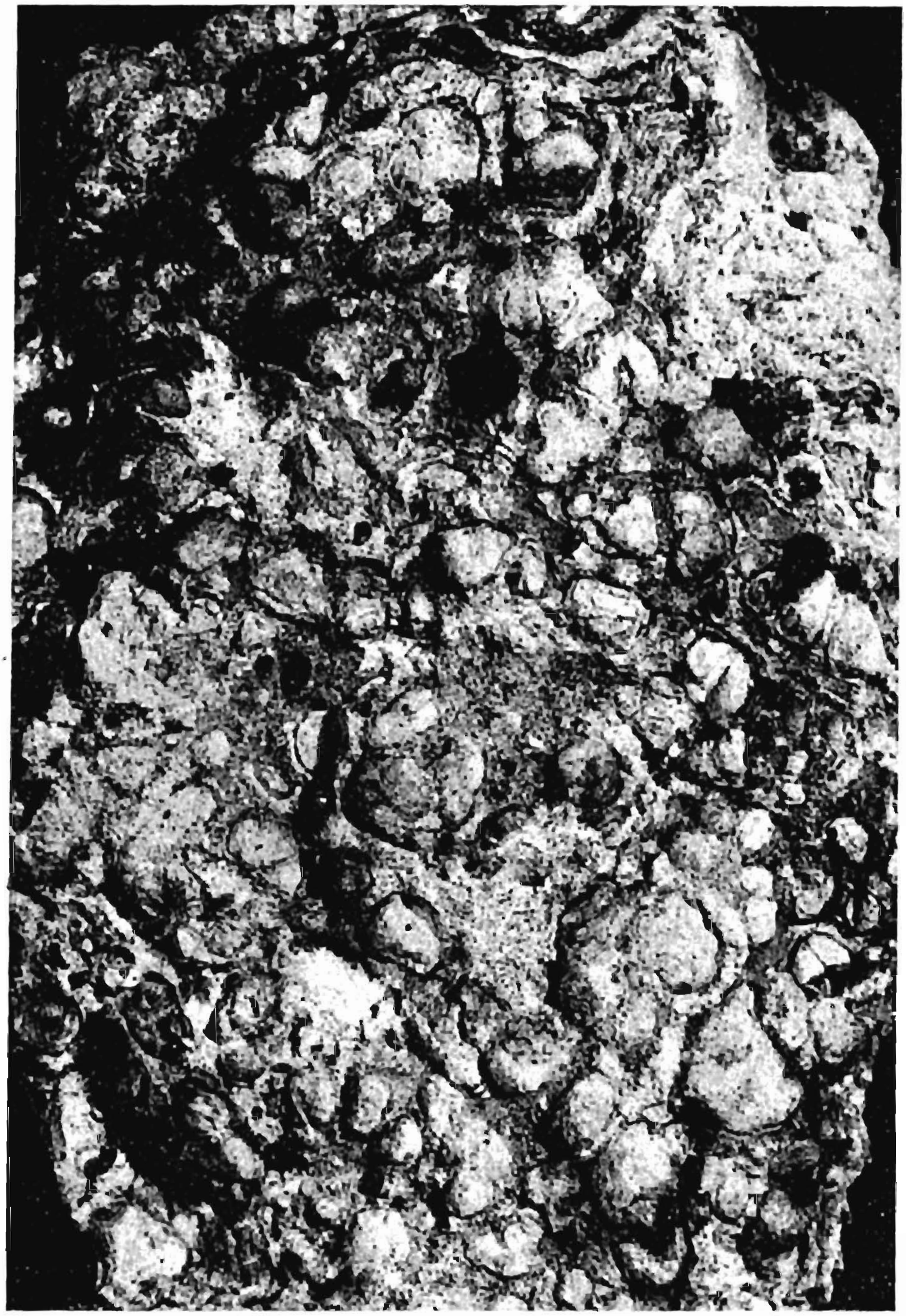
All figures × 50



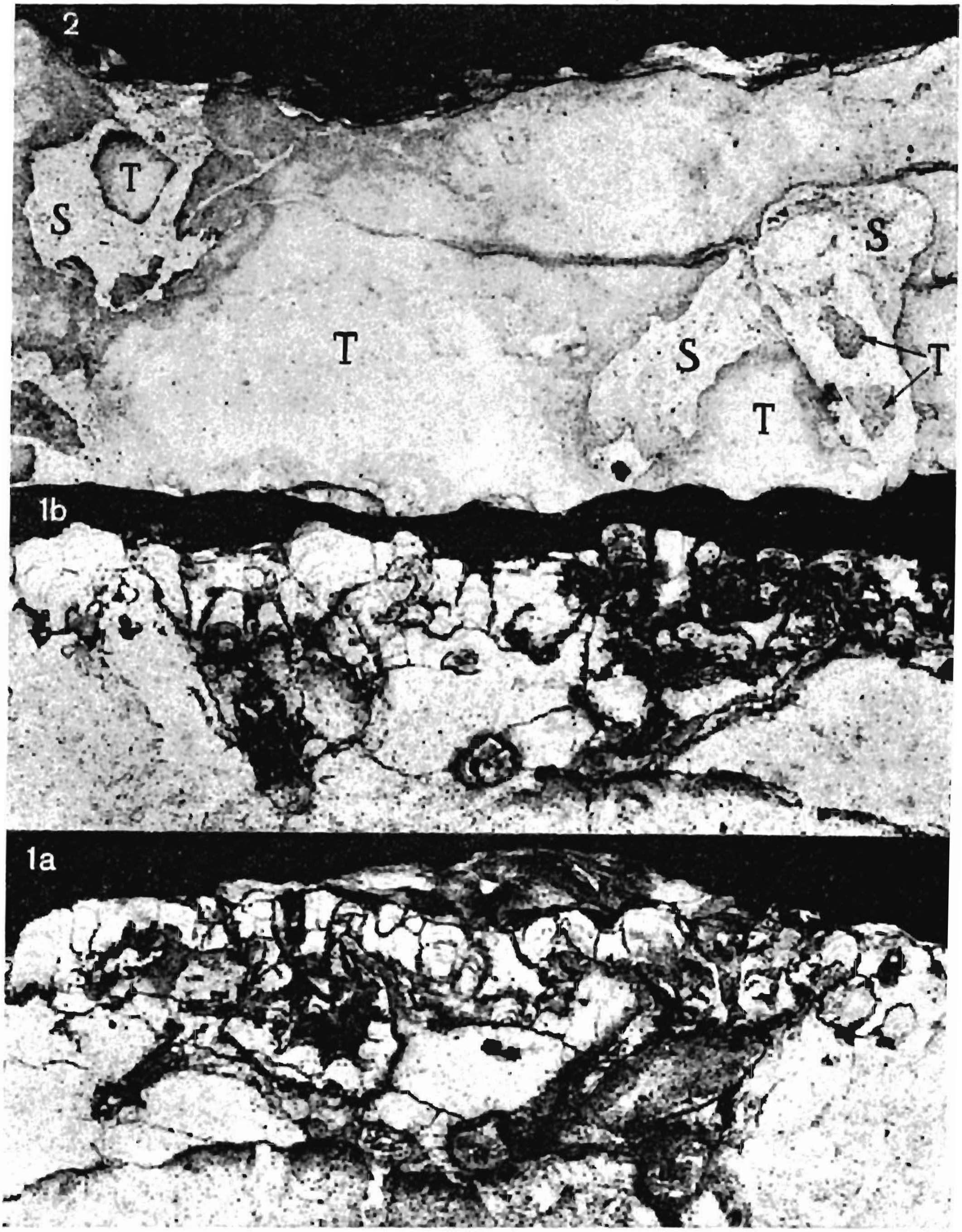
Lower Turonian microfacies at Wielkanoc
(outcrop *123* in Fig. 9, location of samples in Fig. 26)

1 microfacies of maximal frequency of quartz and glauconite (sample *2*); 2 foraminifer microfacies with scattered quartz and glauconite (sample *5*); 3a—b *Pithonella* microfacies with foraminifers (sample *7*); 4a—b inoceram microfacies with foraminifers (sample *11*): *a* inoceram valve fragments, *b* inoceram prisms and their fine detritus

All figures × 50



Upper view of the stromatolite at Przychody (unit *4* in Figs 7—8*A*); Upper Turonian, *Inoceramus costellatus* Zone; nat size

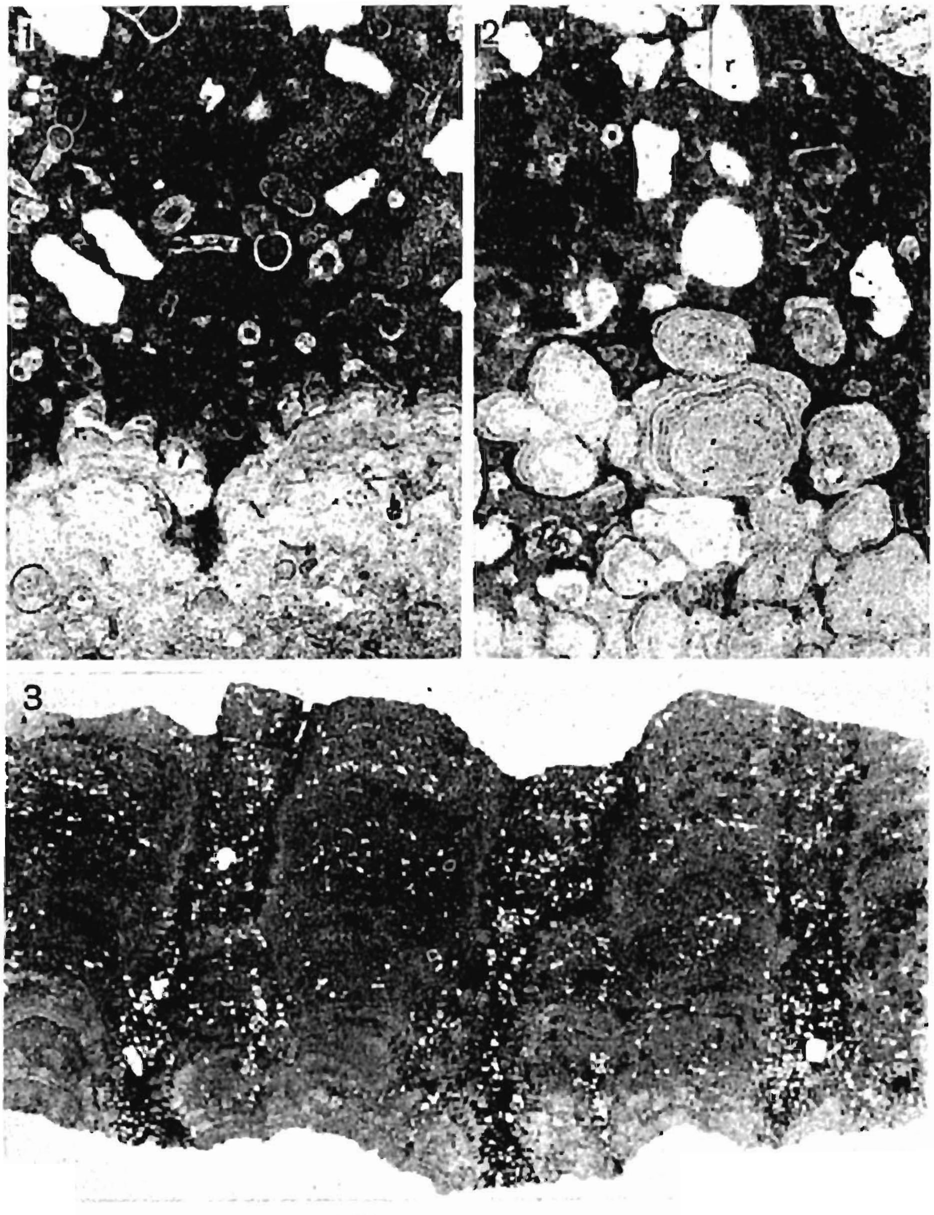


Upper Turonian and Santonian deposits at Przychody

1a—b stromatolite (cf. Pl. 9) developed on eroded surface of sandy limestone; Upper Turonian, Inoceramus costellatus Zone

2 sandy limestone of the topmost layer of the Turonian (*T*, Upper Turonian, Inoceramus costellatus Zone) cut by dykes of sandy glauconitic marls of the Santonian (*S*)

All figures in natural size



Stromatolitic structures at Przychody

1 transverse section of a stromatolite column: preserved corrugated lamination at the edges of an interstice; × 50

2 colloform phosphate encrustings around a stromatolite column (not visible in photo), × 30

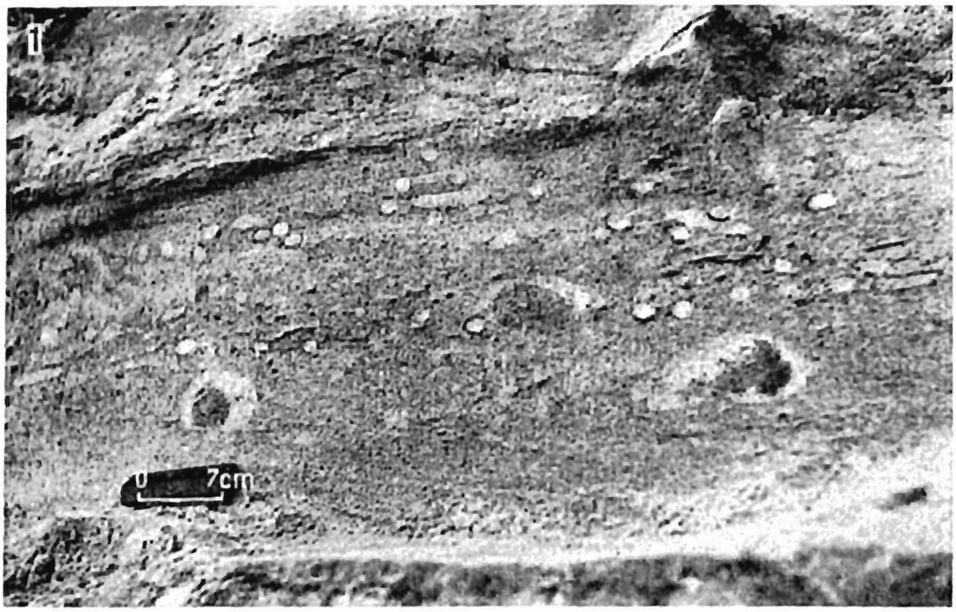
3 distribution of quartz in the stromatolite: variable frequency in particular laminae of columns, greater amount and concentration at bottom of interstices; × 4

1—2 Lower Turonian abrasion surface (on Upper Jurassic butten limestones) with "*Potamilla*" borings (type *C* as *in:* Głazek, Marcinowski & Wierzbowski 1971); Wielkanoc, outcrop *123* (*cf.* Figs 9 and 24—26)

3 borings "*Potamilla*" type *C* (longitudinal sections; the same specimen as presented in *1*)

Both figures in nat. size; taken by B. Drozd, M. Sc.

Chondrites sp. in a sandstone layer (section parallel to bedding); Upper Albian, Sucha (outcrop *109* in Fig. 12), × 0.7

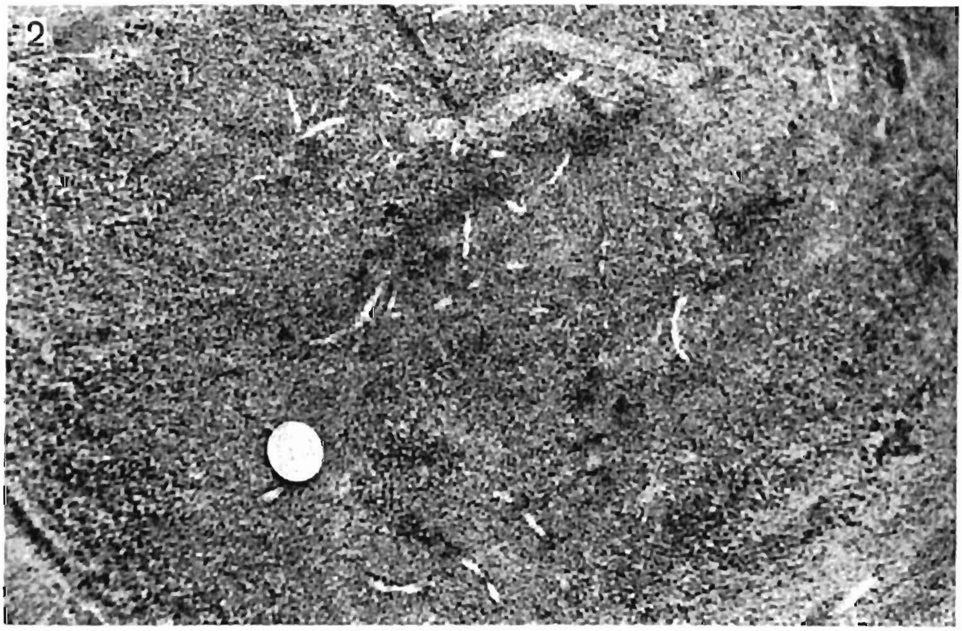


1 *Chondrites* sp. in section perpendicular to the bedding; Upper Albian, Sucha (unit 4 in Fig. 13)

2 *Chondrites* sp.: burrows covered by oblique-bedded sands (section perpendicular to bedding); Upper Albian, Sucha (unit 2 in Fig. 13)

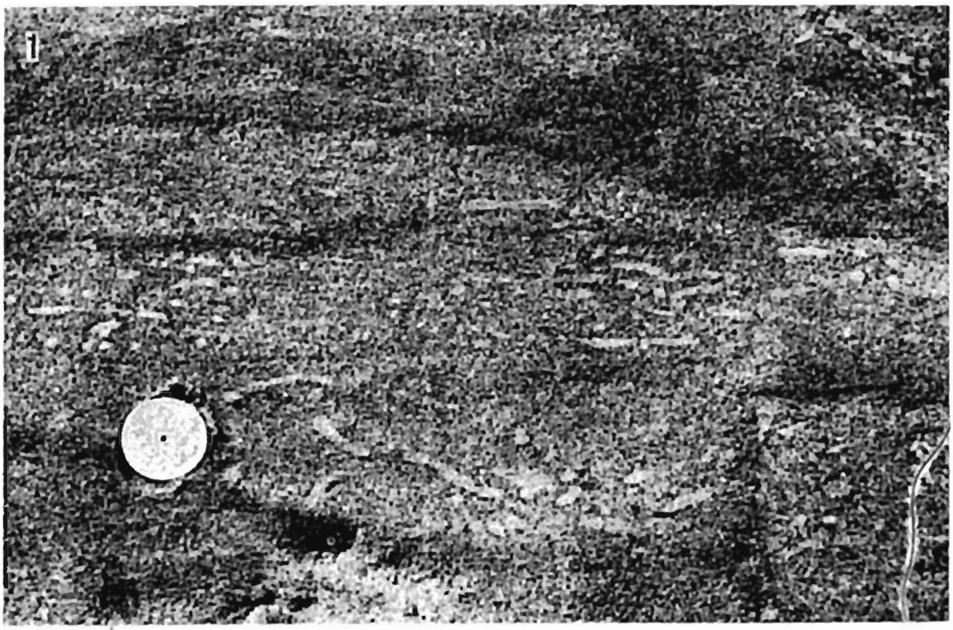
1

2



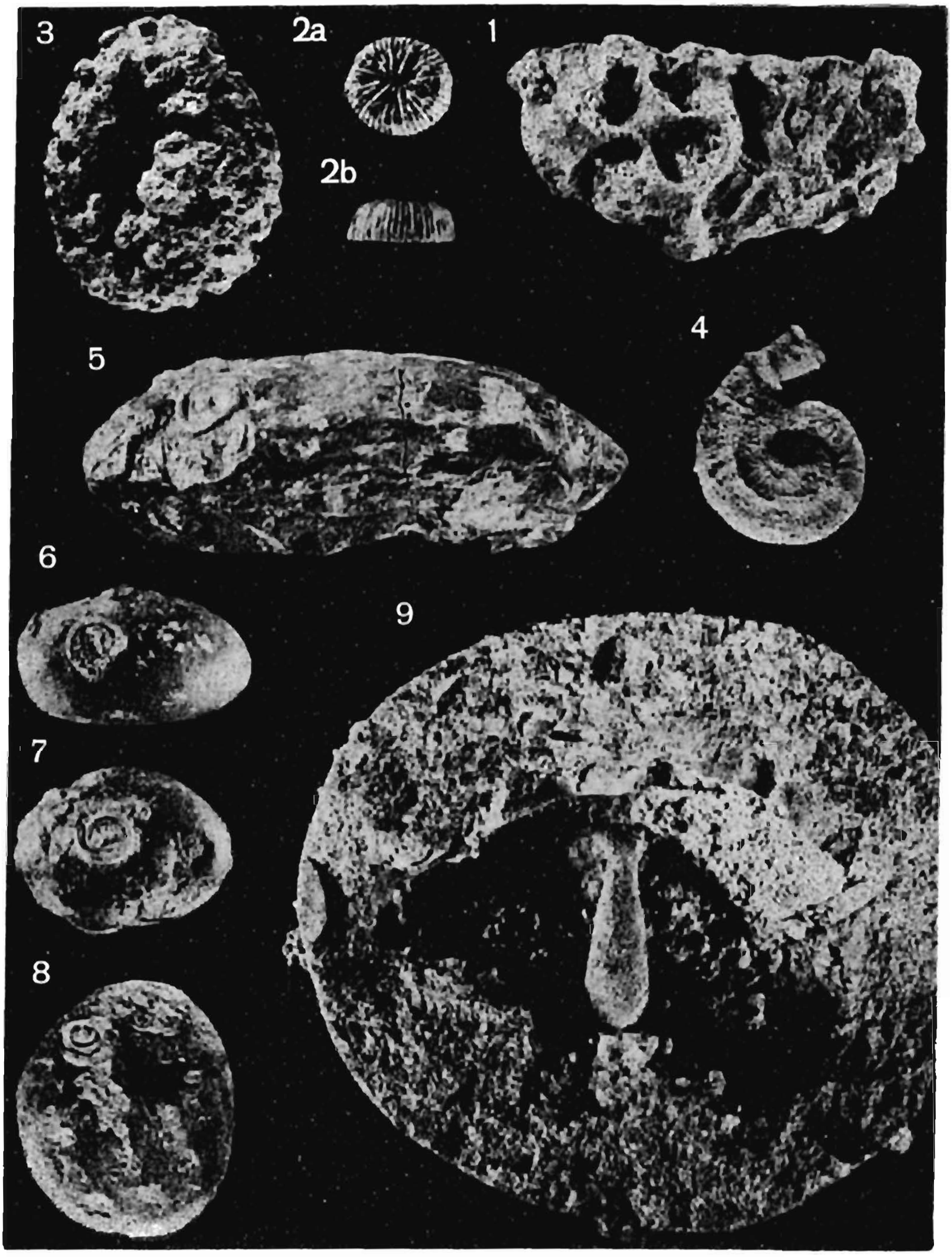
1 *Chondrites* sp. — burrows visible in section perpendicular to the bedding; Upper Albian, Sucha (lower part of unit 4 in Fig. 13)

2 the same in section parallel to the bedding



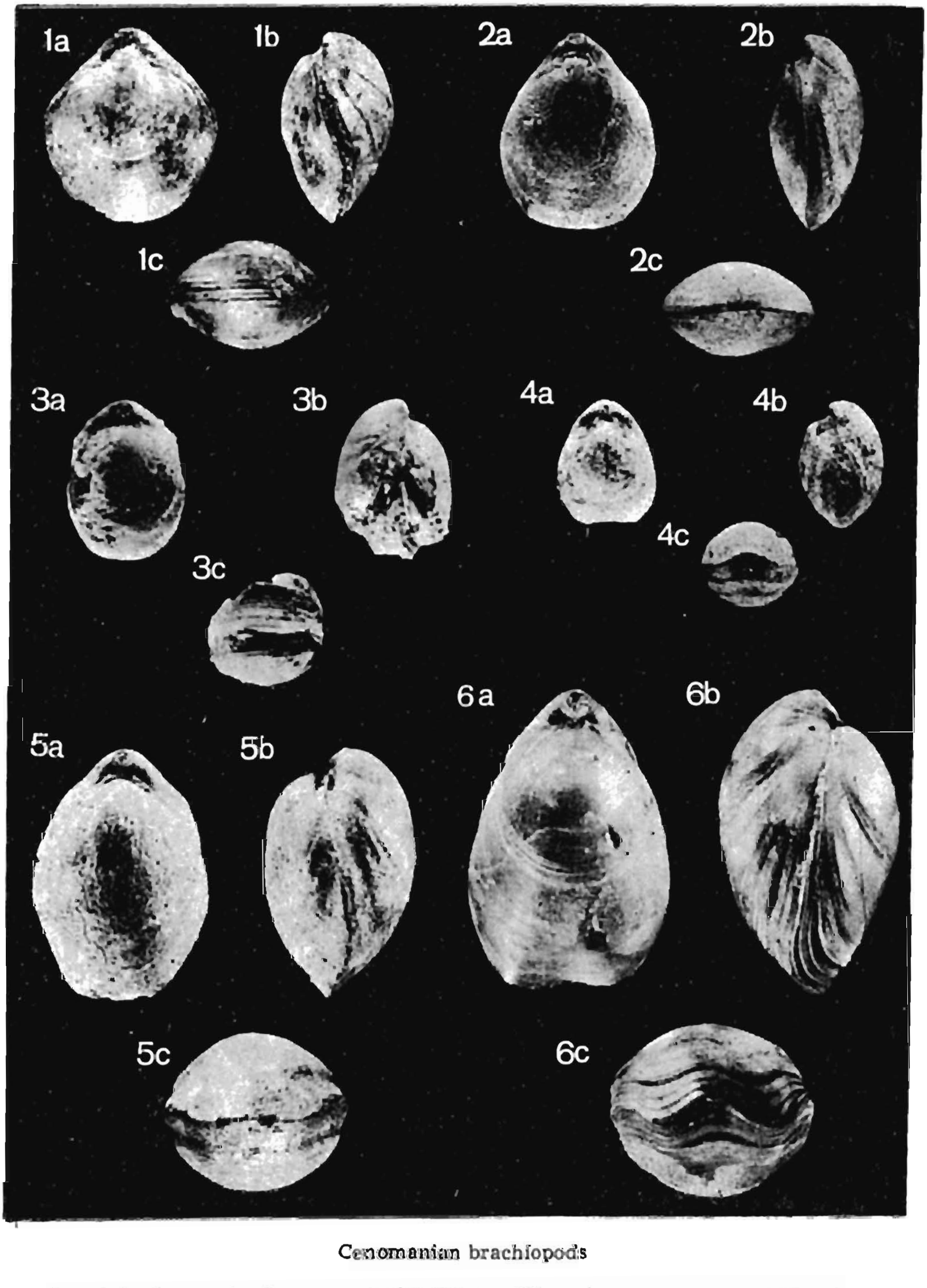
1 *Chondrites* sp. — burrows visible in section perpendicular to the bedding; Upper Albian, Wolbrom (outcrop *103* in Fig. 9, *cf. also* Fig. 11)

2 the same in section parallel to the bedding



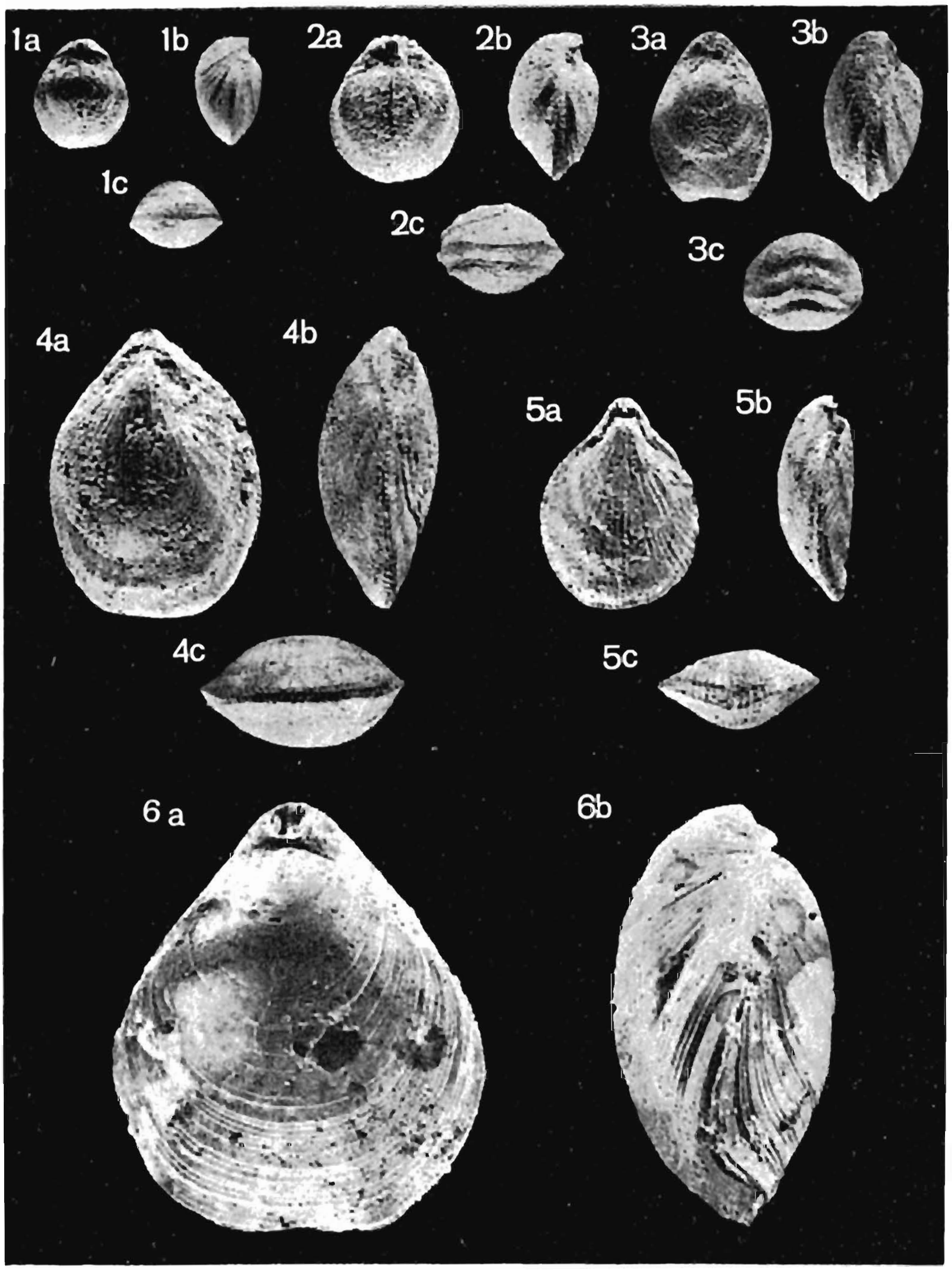
1 *Exanthesis* cf. *labrosus* (Smith); Cenomanian, Mokrzesz (outcrop 46), × 1.5
2a—b *Micrabacia coronula* (Goldfuss), top (*a*) and side (*b*) views; ibidem, × 1.5
3 *Multicrescis variabilis cracoviensis* Maryańska; ibidem, × 1.5
4 *Serpula proteus* J. de C. Sowerby; ibidem, × 1.5
5 pebble of Upper Jurassic limestone, encrusted by a serpulid; Middle Cenomanian, Glanów (*108c*, unit *2a*), × 2
6—8 quartz pebbles encrusted by serpulids; ibidem, × 2
9 sandy, siliceous concretion with a void after a limestone pebble: visible is a mould of the boring by *Gastrochaena* sp.; Upper Albian, Sucha (*109a*); nat. size

All photos taken by B. Drozd, M. Sc



Cenomanian brachiopods

1 *Arcuatothyris arcuata* (Roemer), Glanów (outcrop *108c*, unit *2c*); *2* the same Mokrzesz (*46*, unit *3*); *3—4 Platythyris rugulosa* (Morris), *ibidem*; *5 Concinnithyris(?) subundata* (J. de C. Sowerby), *ibidem*; *6 "Terebratula" dutemplei* d'Orbigny, Glanów (*108c*, unit *2a*)
a — dorsal view, *b* — side view, *c* — anterior view
All photos × 2; taken by B. Drozd, M. Sc.

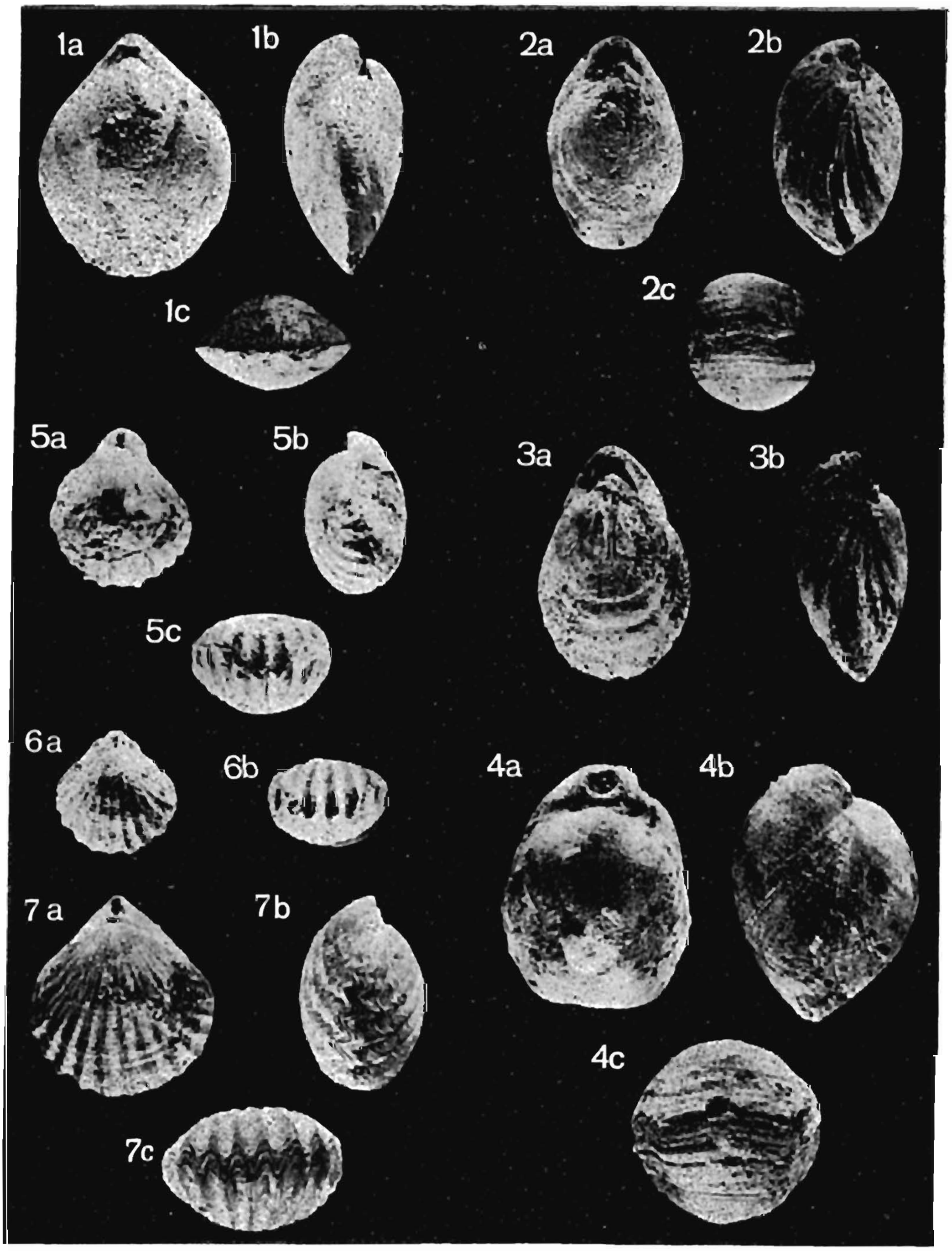


Cenomanian brachiopods

1—2 *Kingena arenosa* (d'Archiac), Jaźwiny (outcrop 53, unit 3); 3 *Praelongithyris* sp., Mokrzesz (46, unit 3); 4—5 *Terebratulina chrysalis* (Schlotheim), *ibidem*; 6 *Sellithyris(?)* sp., Glanów (*108c*, unit *2a*)

a — dorsal view, *b* — side view, c — anterior view

All photos X 2; taken by B. Drozd, M. Sc.

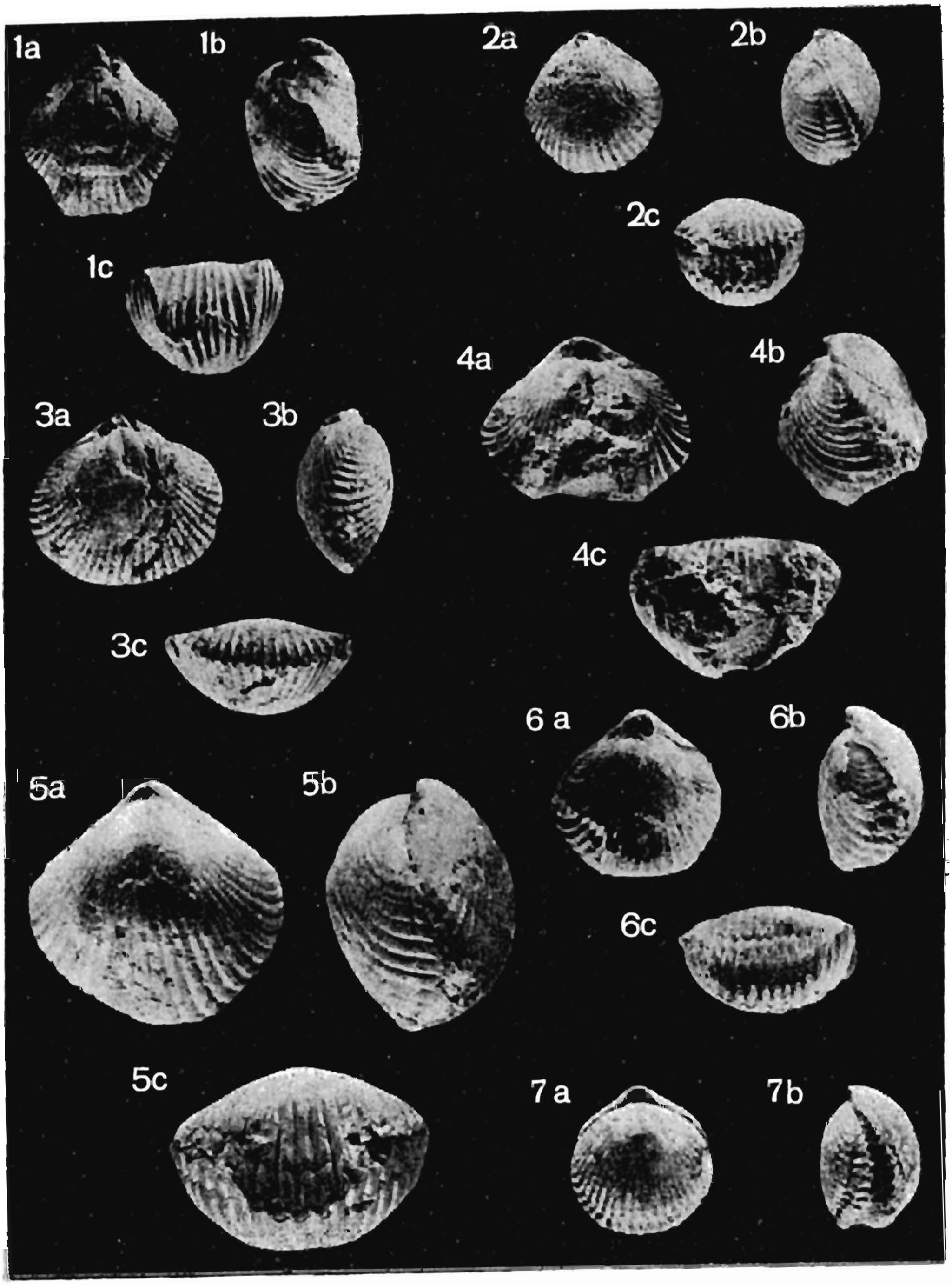


Cenomanian brachiopods

1 *Gibbithyris* sp., Mokrzesz (outcrop *46*, unit *3*); 2 *Ornatothyris* sp., Krasice (*51*); 3 *Praelongithyris* sp., Mokrzesz (*46*, unit *3*); 4 *Ornatothyris* sp., Glanów (*108c*, unit *2c*); 5—6 *Orbirhynchia mantelliana* (J. de C. Sowerby), Mokrzesz (*46*, unit *3*); 7 *Orbirhynchia parkinsoni* Owen, Glanów (*108c*, unit *2a*)

a — dorsal view, *b* — side view, *c* — anterior view

All photos X 2; taken by B. Drozd, M. Sc.

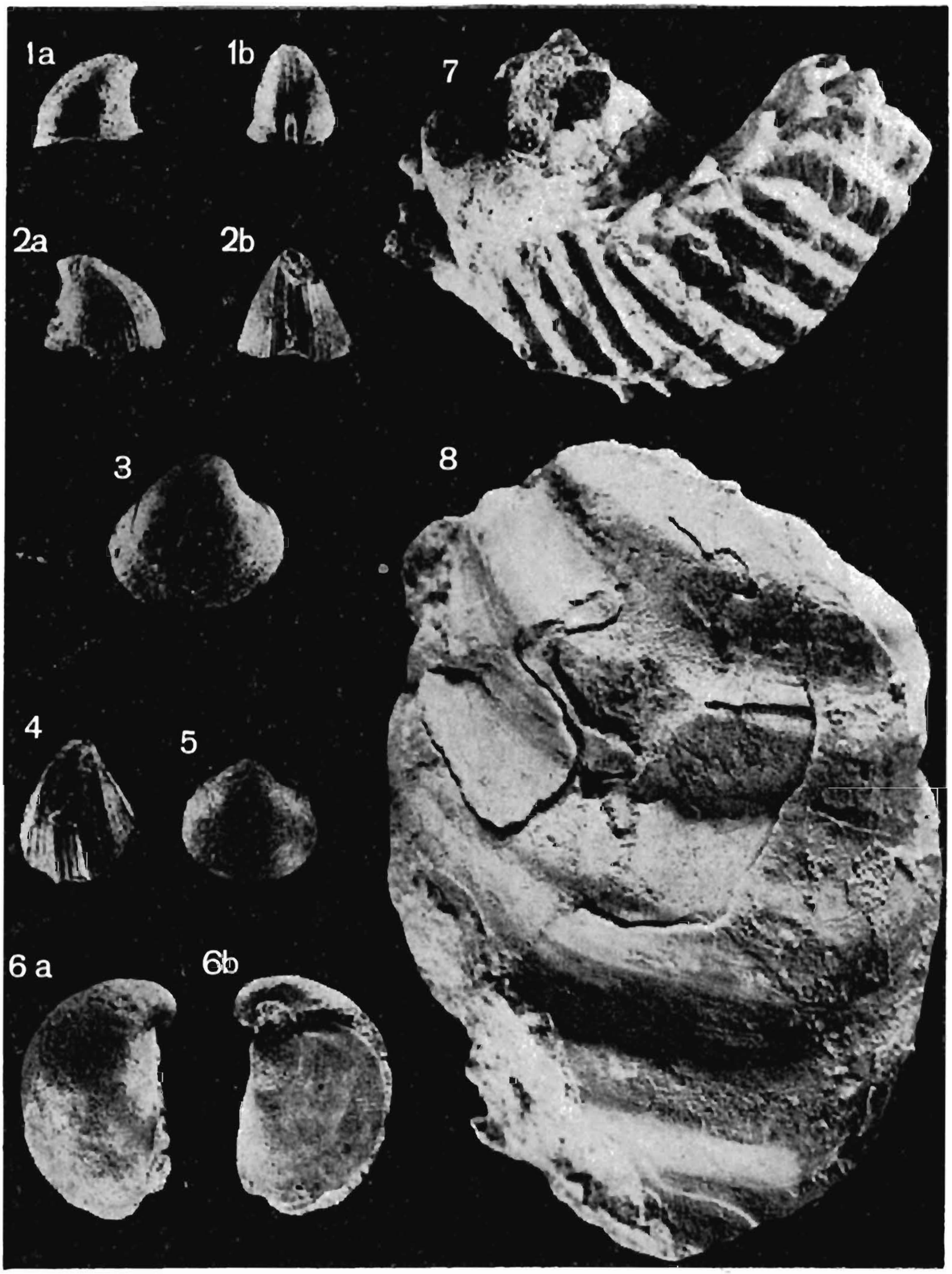


Cenomanian brachiopods

1 *Lepidorhynchia sigma* (Schloenbach), Julianka (outcrop *69*, unit *4*); 2 *Grasirhynchia martini* (Mantell), Mokrzesz (*46*, unit *3*); 3 *Cyclothyris* cf. *difformis* (Valenciennes in Lamarck), *ibidem*; 4 *Lamellaerhynchia caseyi* Owen, Glanów (*108c*, unit *2a*); 5 *Cretirhynchia* sp., Glanów (*108c*, unit 2c); 6 *Cyclothyris(?) schloenbachi* (Davidson), Mokrzesz (*46*, unit 3); 7 *Cretirhynchia minor* (Pettitt), *ibidem*

a — dorsal view, *b* — side view, c — anterior view

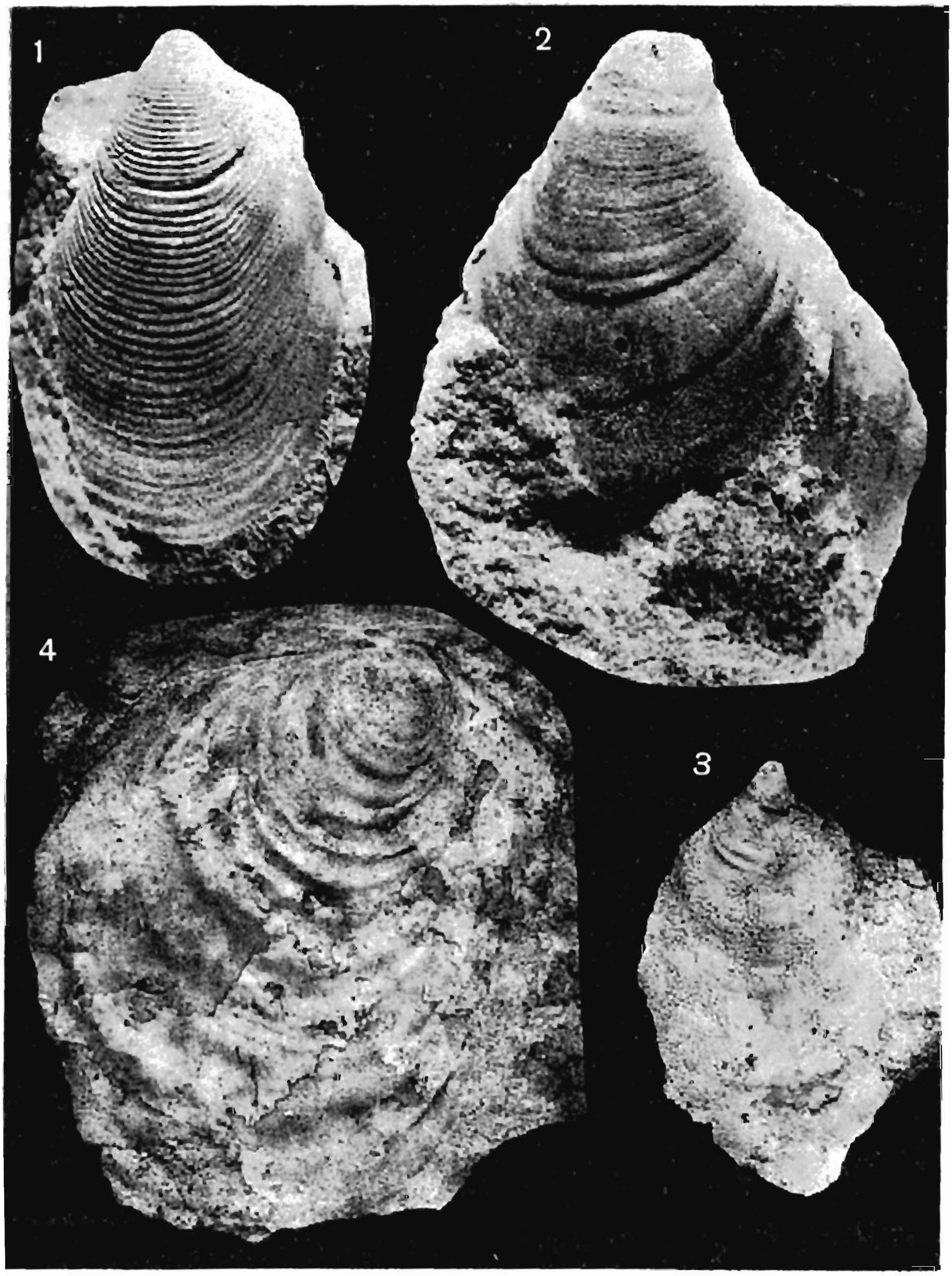
All photos × 2; taken by B. Drozd, M. Sc.



Albian-Turonian gastropods and pelecypods

1 *Emarginula althi* Zaręczny, *a* side view, *b* anterior view, Cenomanian, Mokrzesz (outcrop *46*, unit *3*), × 1.5; **2** the same, Cenomanian, Jaźwiny (*53*, unit *3*), × 1.5; **3** *Venilicardia ligeriensis* (d'Orbigny), *ibidem*, × 1.5; **4** *Neithea quinquecostata* (J. de C. Sowerby), Cenomanian, Mokrzesz (*46*, unit *3*), × 1.5; **5** *Unicardium* cf. *tumidum* Briart & Cornet, *ibidem*, × 1.5; **6** *Aucellina gryphaeoides* (J. de C. Sowerby), *a* left valve, *b* right valve, Upper Albian, Lusławice (*84*, bottom part of unit *2*), × 1.5; **7** *Lopha colubrina* (Lamarck) [= *Alectryonia diluviana* Linnaeus] Cenomanian, Jaźwiny (*53*, unit *3*), × 1.5; **8** *Inoceramus annulatus* Goldfuss, Lower Turonian, Wielkanoc (*123*, unit *6*), nat. size

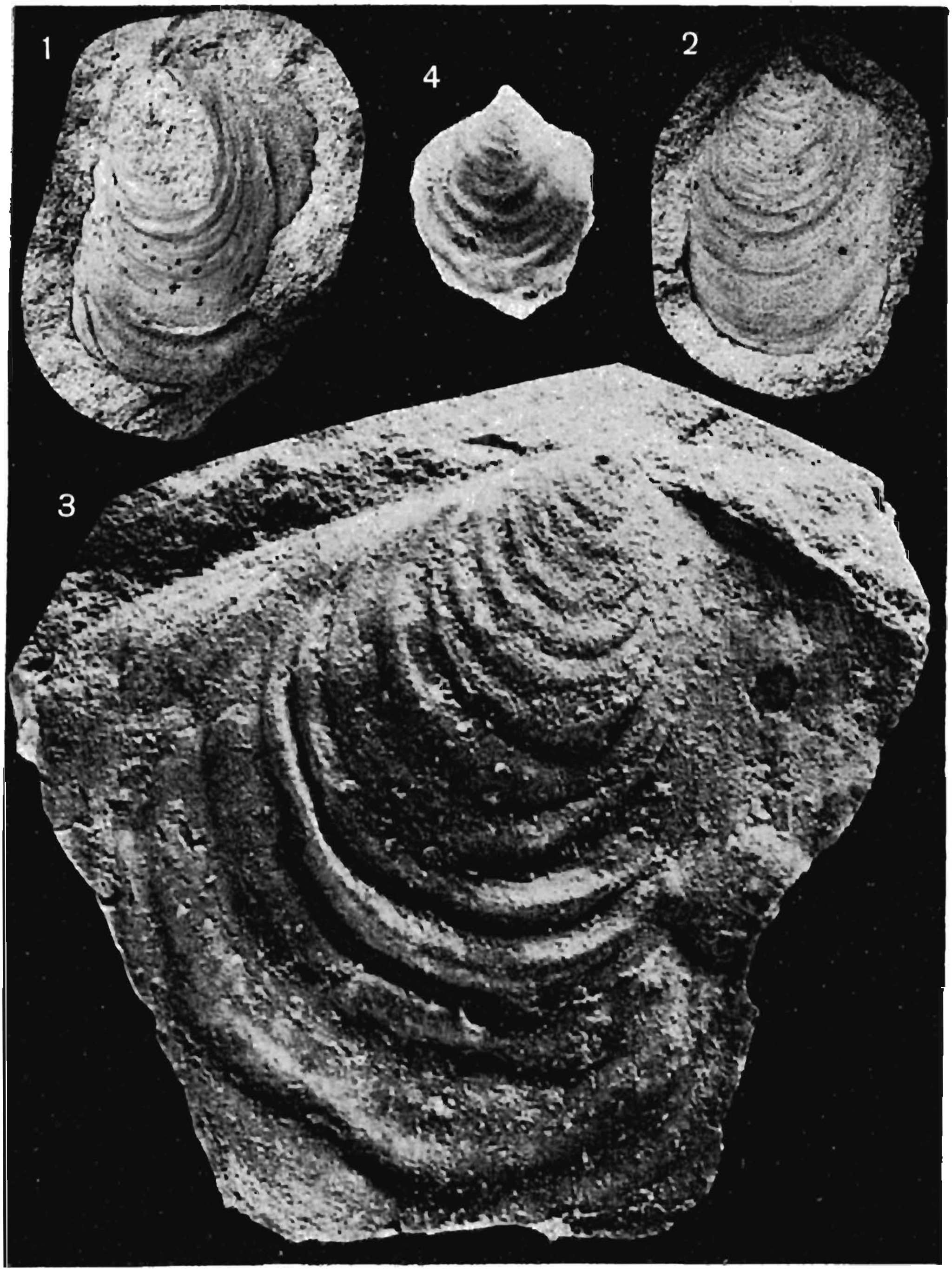
All photos taken by B. Drozd, M. Sc.



Upper Albian inocerams

1 *Inoceramus concentricus* Parkinson, Staropole (outcrop 63, unit 5), nat. size; 2 *Inoceramus anglicus* Woods, Staropole (63, unit 2), nat. size; 3 the same, Solca (*111a*), nat. size; 4 *Inoceramus anglicus — crippsi* m. f. (specimen transitional from *I. anglicus* Woods to *I. crippsi* Mantell), *ibidem*, X 0.5

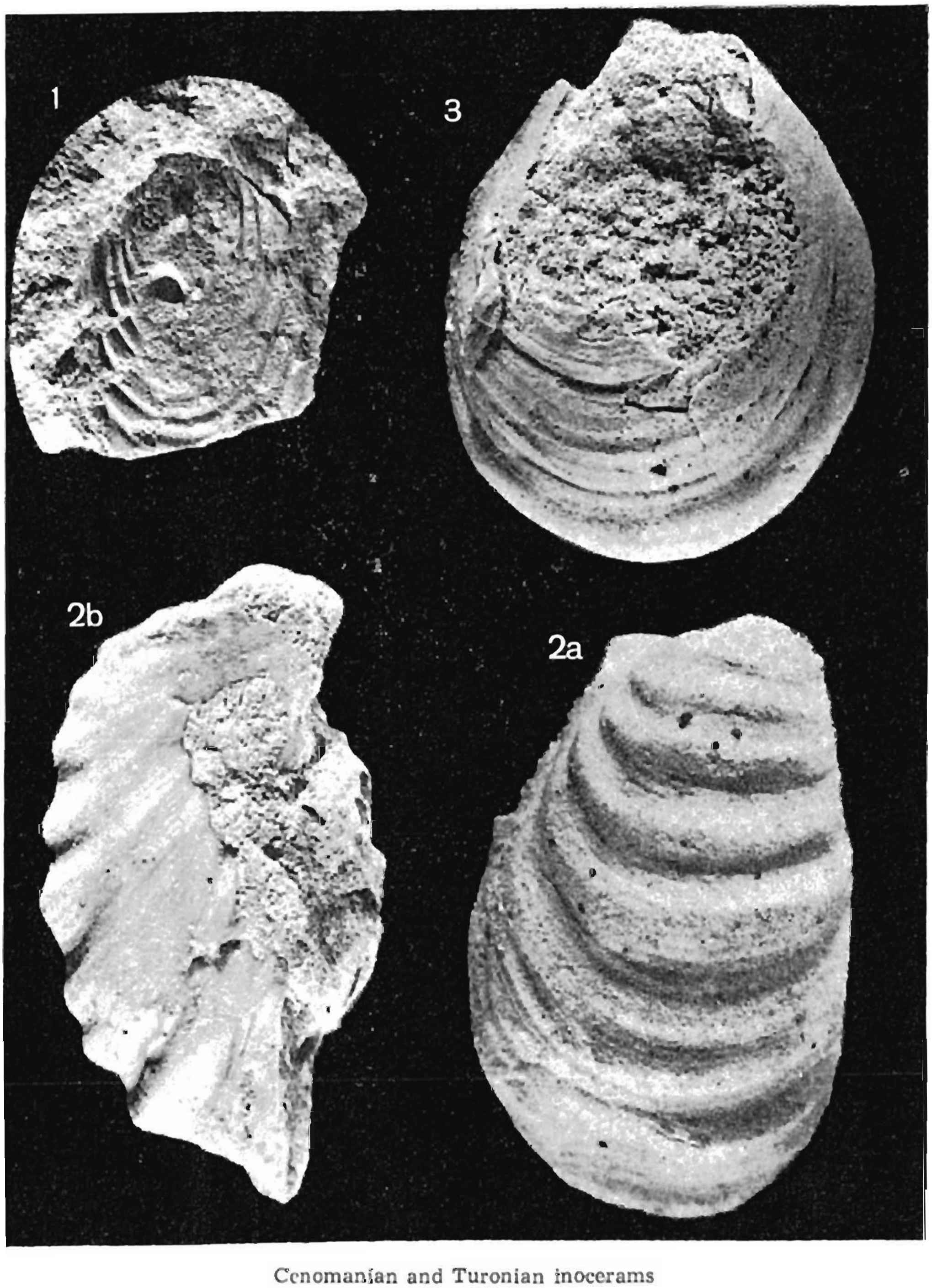
All photos taken by B. Drozd, M. Sc.



Upper Albian and Cenomanian Inocerams

1—2 *Inoceramus anglicus* Woods, Upper Albian, Solca (outcrop *IIIa*); 3 *Inoceramus anglicus — crippsi* m. f. (for explanations see Pl. 23, Fig. 4), *ibidem*; 4 *Inoceramus bohemicus* Leonhard, Cenomanian, Jaźwiny (*53*, unit 3)

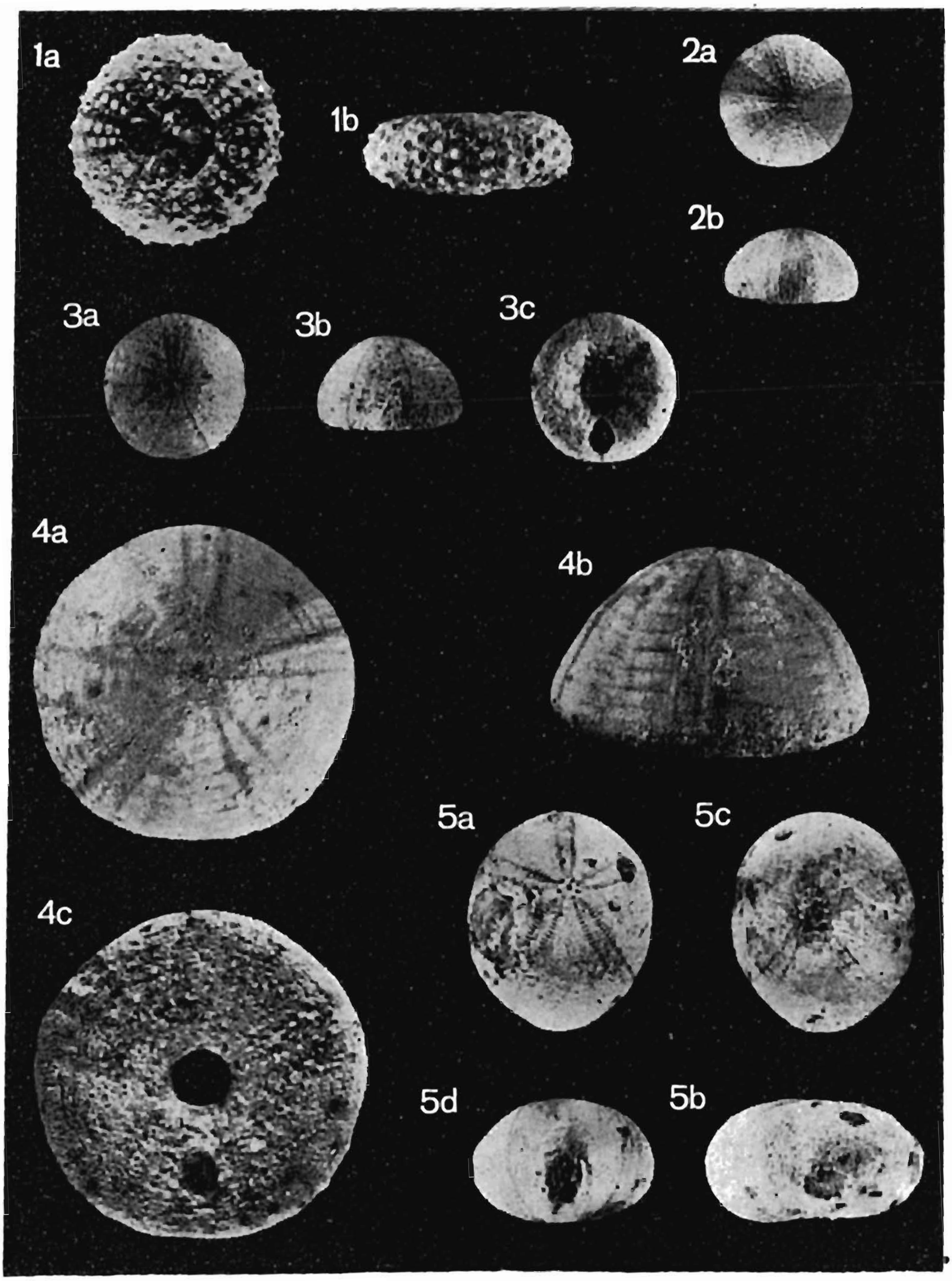
All photos in nat. size; taken by B. Drozd, M. Sc.



Cenomanian and Turonian inocerams

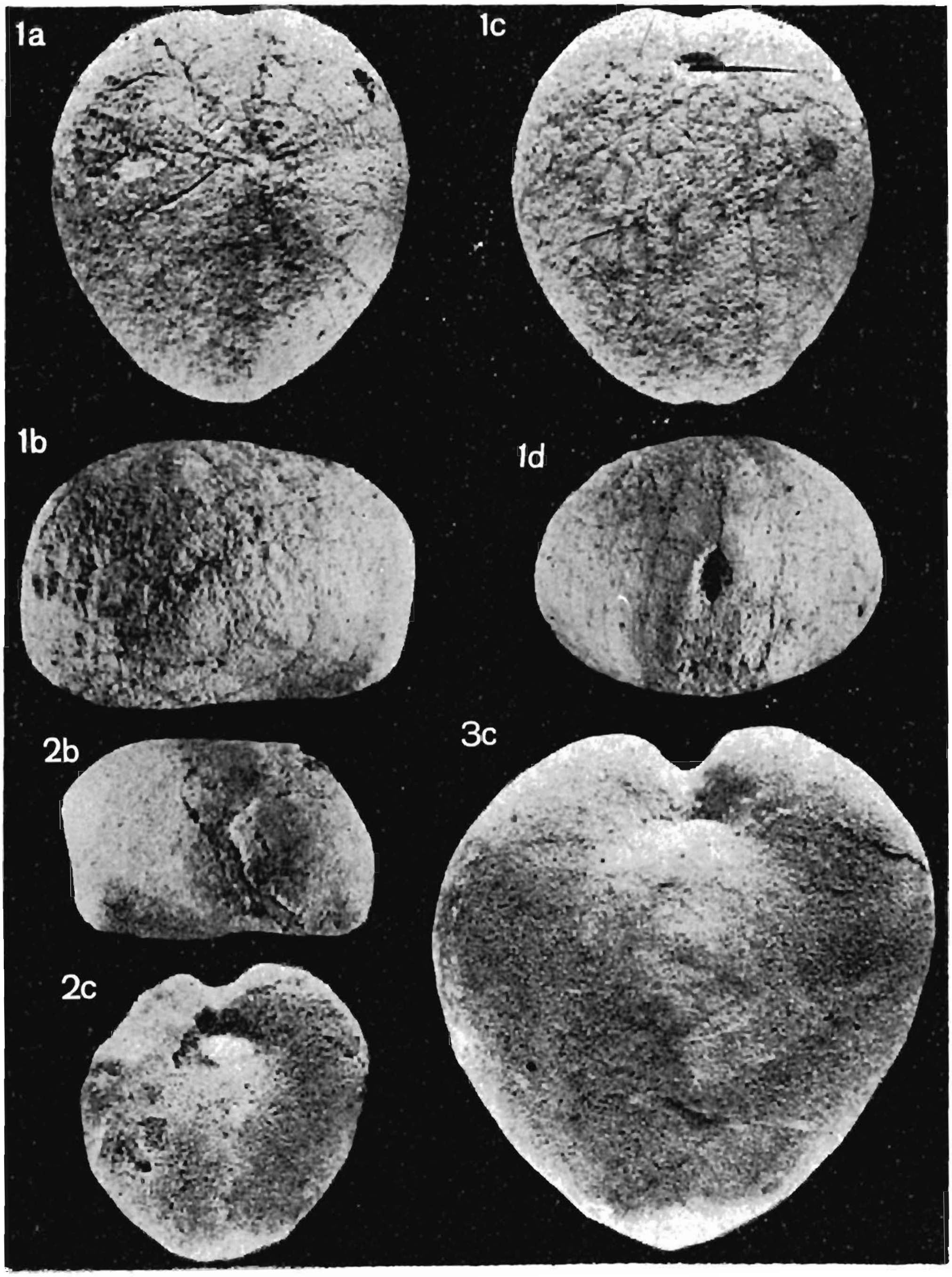
1 *Inoceramus crippsi* Mantell, Upper Cenomanian, Glanów (outcrop *108c*, unit *2d*); 2 *Inoceramus lamarcki* Parkinson — *a* right valve, *b* anterior margin view, Lower Turonian, Solca (*126*); 3 *Inoceramus inconstans* Woods, Upper Turonian, Solca (*126*)

All photos in nat. size; taken by B. Drozd, M. Sc



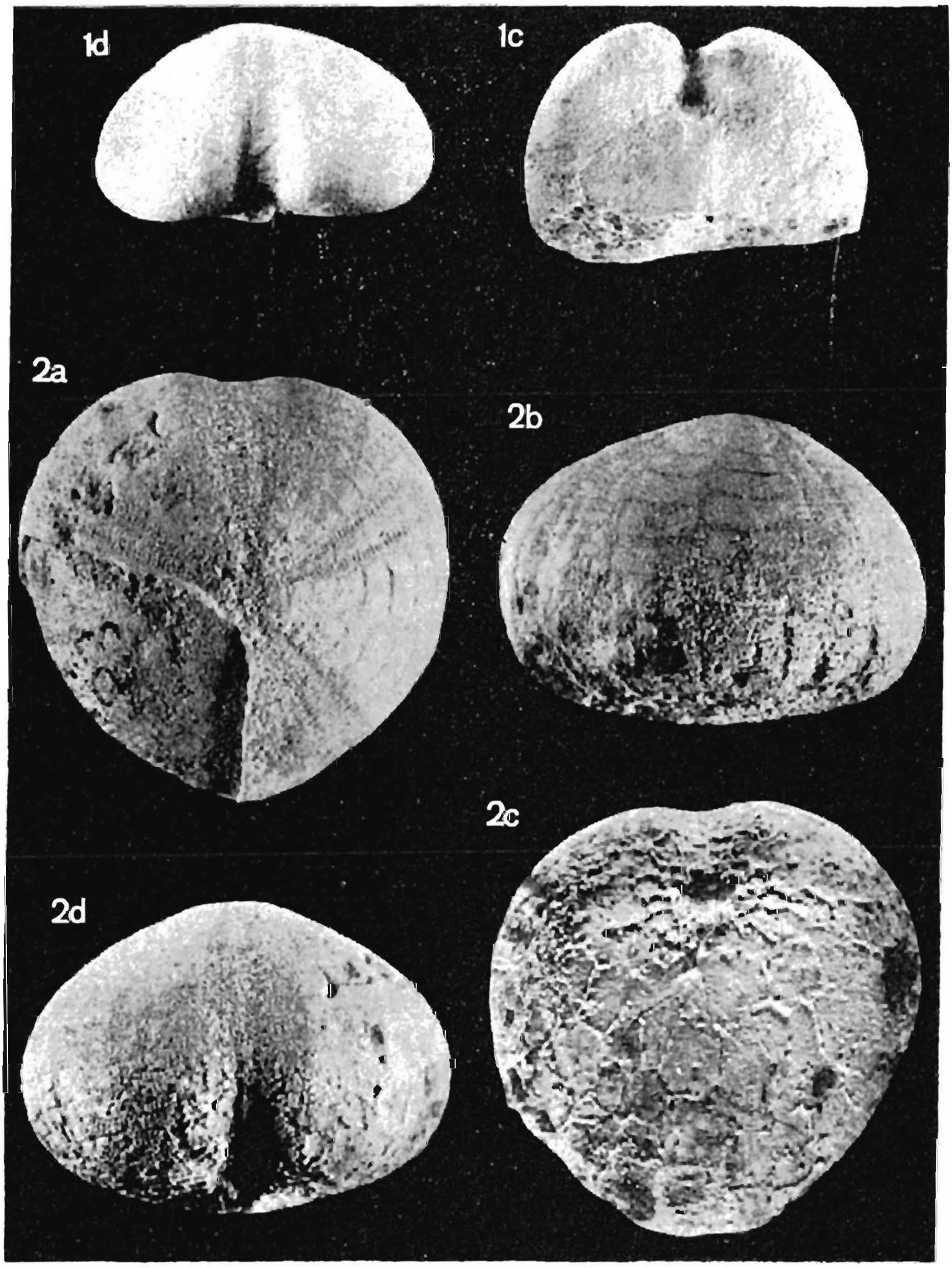
Cenomanian echinoids

1 *Phymosoma cenomanense* Cotteau, Mokrzesz (outcrop *46*, unit 3); 2 *Discoides subuculus* (Klein), Jaźwiny (*53*, unit 3); 3 the same, Mokrzesz (*46*, unit 3); 4 *Camerogalerus cylindricus* (Lamarck), *ibidem*; 5 *Pygaulus pulvinatus* d'Archiac, Glanów (*105c*, unit *2a*)
a — top view, *b* — side view, *c* — bottom view, *d* — posterior view
All photos X 1.5; taken by B. Drozd, M. Sc.



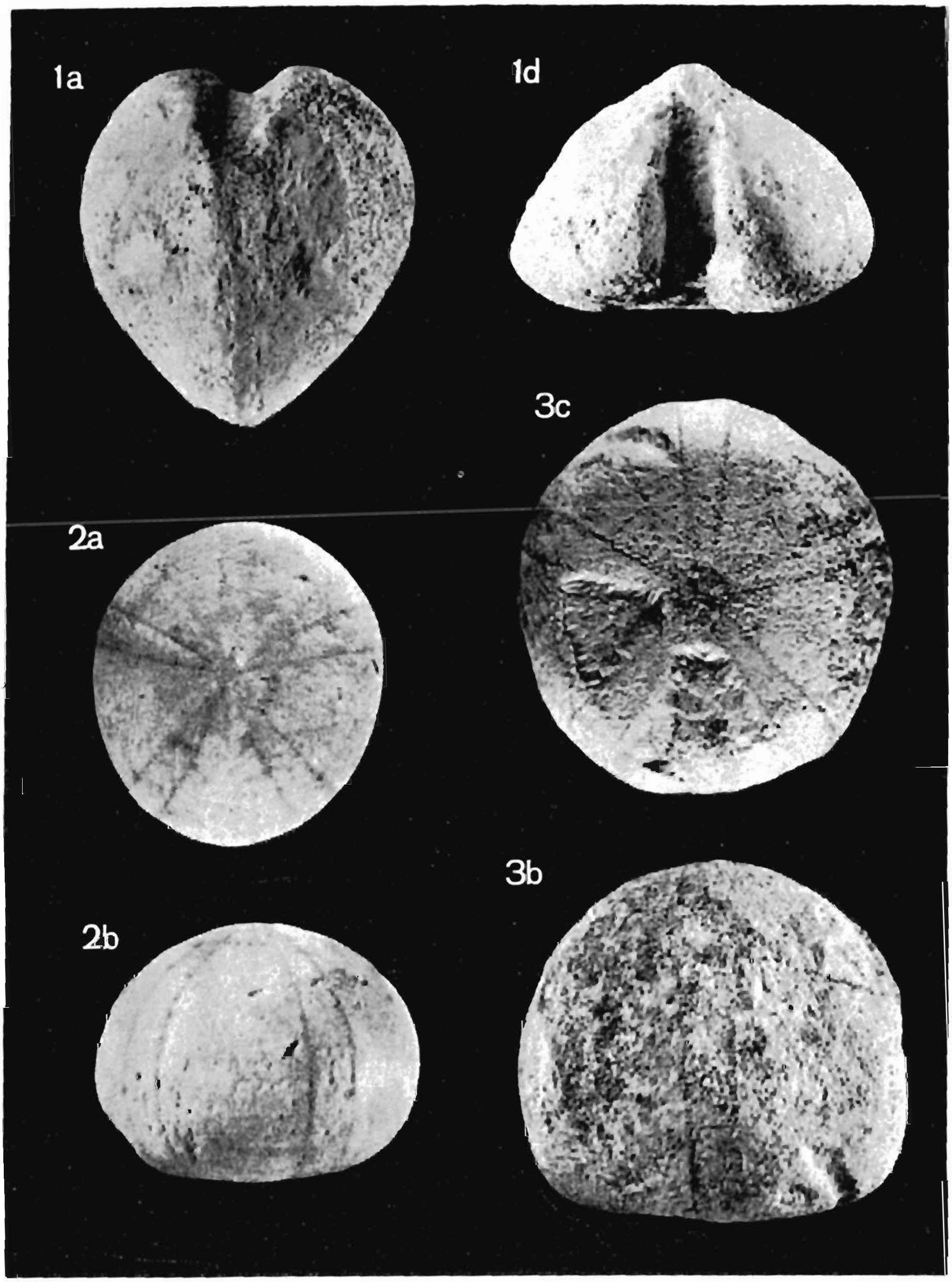
Albian and Cenomanian echinoids

1 *Holaster poloniae* Lambert, Cenomanian, Jaźwiny (outcrop 53, unit 3); 2—3 *Pseudholaster*(?) sp., Upper Albian, Staropole (63, unit 2)
a — top view, *b* — side view, *c* — bottom view, *d* — posterior view
All photos × 1.5; taken by B. Drozd, M. Sc.



Cenomanian and Turonian echinoids

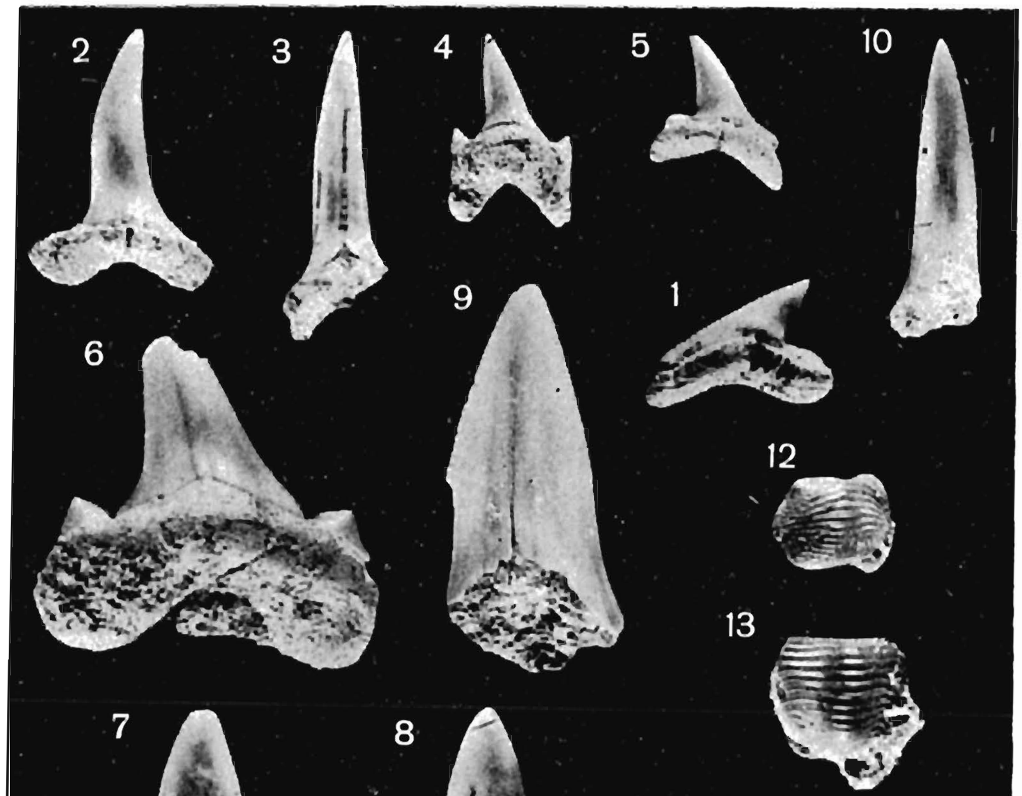
1 *Cardiaster* sp., Upper Turonian, Solca (outcrop *117*); 2 *Holaster subglobosus* Leske, Cenomanian, Jaźwiny (*53*, unit *3*)
a — top view, *b* — side view, *c* — bottom view, *d* — anterior view
All photos X 1.5; taken by B. Drozd, M. Sc.



Turonian echinoids

1 *Infulaster* sp., Upper Turonian, Solca (outcrop *116*); **2** *Conulus ellipticus* (Zaręczny), Lower Turonian, Glanów (*108c*, unit *3b*); **3** *Conulus subrotundus* (Mantell), Lower Turonian, Solca (*117*)
a — top view, *b* — side view, *c* — bottom view, *d* — anterior view

All photos × 1.5; taken by B. Drozd, M. Sc.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11b

PLATE 30

Cenomanian and Turonian elasmobranch teeth

1 — *Corax falcatus* Agassiz, inner view; Cenomanian, Mokrzesz (outcrop *46*, unit *3*).

2 — *Oxyrhina angustidens* Reuss, inner view; Cenomanian, Julianka (*69*, unit *6*).

3 — The same; Cenomanian, Mokrzesz (*46*, unit 3).

4, 5 — *Otodus appendiculatus* (Agassiz), inner view; Cenomanian, Julianka (*69*, units *4* and *6*).

6 — The same; Cenomanian, Julianka (*70*, *cf.* Marcinowski 1970, Fig. 1).

7, 8 — The same; Cenomanian, Mokrzesz (*46*, unit *3*).

9 — ?*Oxyrhina mantelli* Agassiz, fragment of the crown; Cenomanian, Jaźwiny (*53*, unit *3*).

10 — *Scapanorhynchus rhaphiodon* (Agassiz), inner view; Upper Cenomanian, Glanów (*108c*, unit *2c*).

11 — *Ptychodus mammillaris* Agassiz, *a* oblique-crown (front) view, *b* hind view; Lowermost Turonian, Skrajniwa (*122*).

12-15 — *Ptychodus decurrens* Agassiz — crown view of the teeth from: *12* — lateral (*III* or *IV*) row of the upper jaw, *14* — lateral (*II* or *III*) row of the upper jaw, *13* and *15* — lateral (*I* or *II*) row of the lower jaw; Upper Cenomanian, Glanów (*108c*, unit *2c*).

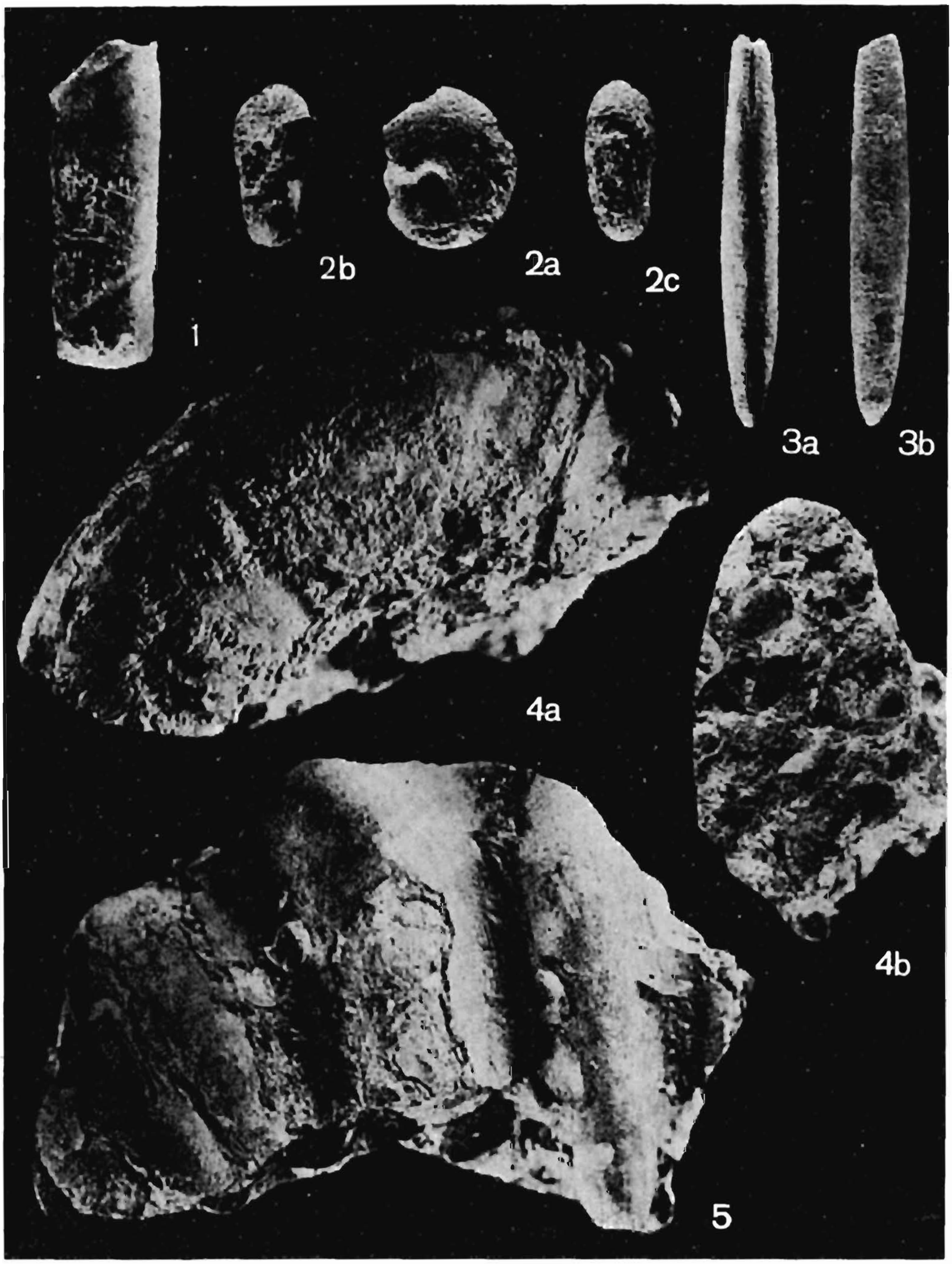
All photos X 2; taken by B. Drozd, M. Sc.

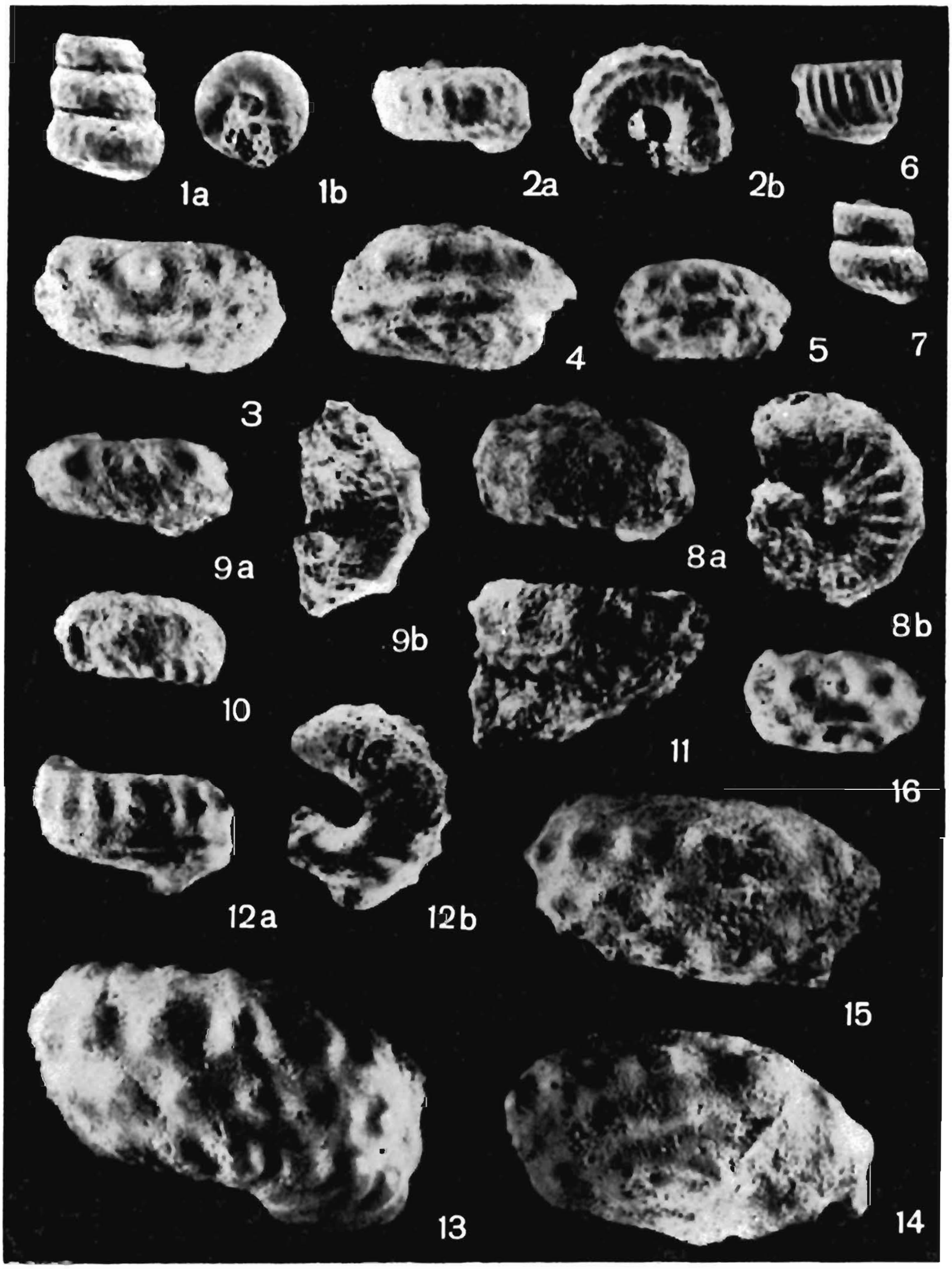
PLATE 31

Cenomanian belemnites and ammonites

1 *Sciponoceras subbaculoides* (Geinitz), Middle Cenomanian, Glanów (outcrop *108c*, unit *2a*), × 1.5; **2** *Phylloceras (Hypophylloceras) seresitense seresitense* Pervinquière, Cenomanian, Mokrzesz (46, unit 3), × 1.5; **3** *Neohibolites ultimus* (d'Orbigny), *ibidem*, × 1.5; **4** *Puzosia (Puzosia) subplanulata* (Schlüter), Middle Cenomanian, Glanów (*108c*, unit *2a*), nat. size; **5** *Acanthoceras* sp., *ibidem*, nat. size

All photos taken by B. Drozd, M. Sc.


1
2b
2a
2c
3a
3b
4a
4b
5



Cenomanian ammonites

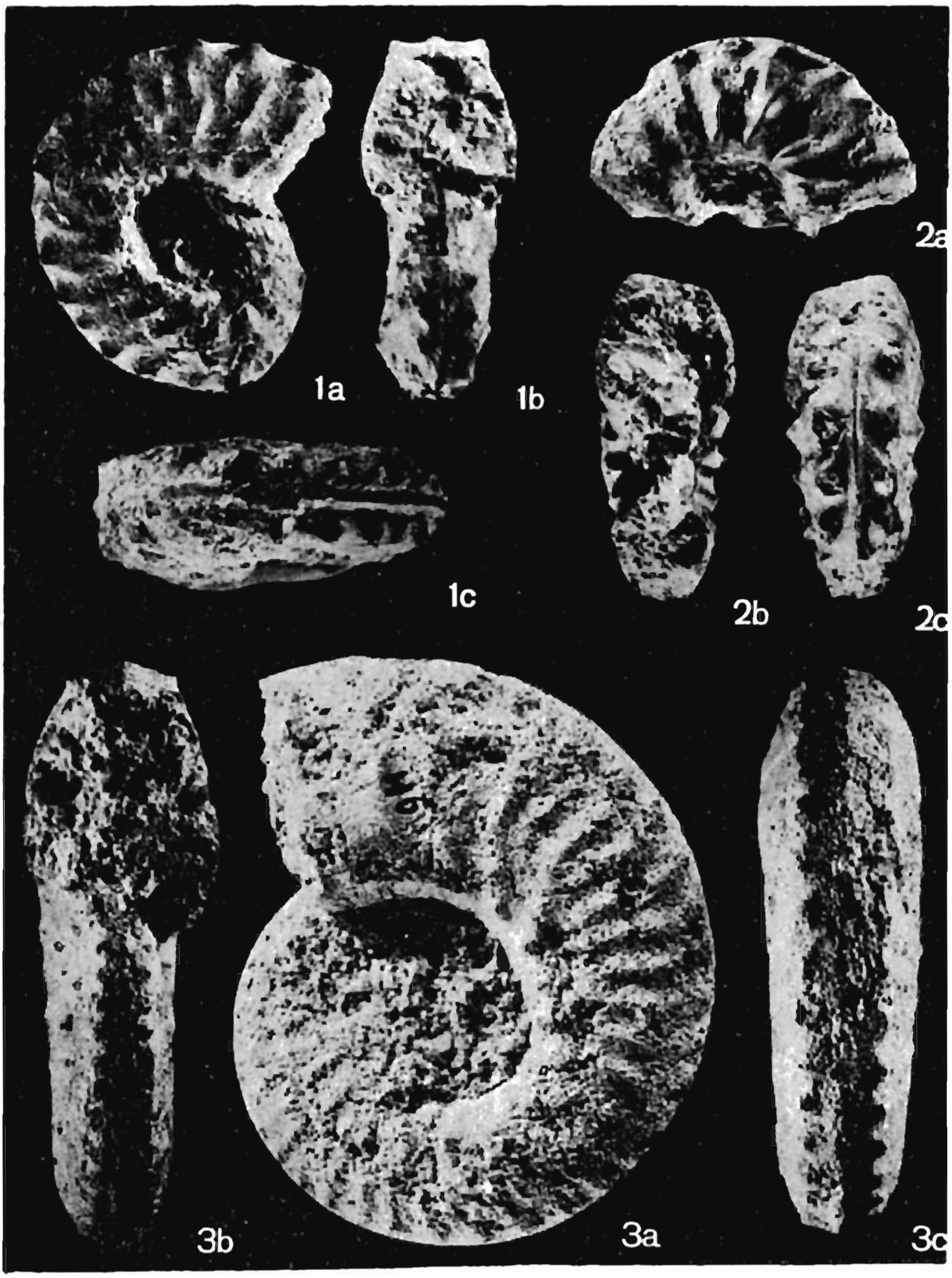
1—3 *Hypoturrilites tuberculatus* (Bosc), Mokrzesz (outcrop 46, unit 3); 4—5 *Hypoturrilites* aff. *tuberculatus* (Bosc), *ibidem*; 6 *Ostlingoceras (Ostlingoceras) puzosianum* (d'Orbigny), *ibidem*; 7 *Mariella (Mariella)* sp., *ibidem*; 8 *Hypoturrilites gravesianus* (d'Orbigny), Luslawice (84, unit 4); 9 *Hypoturrilites* aff. *gravesianus* (d'Orbigny), Mokrzesz (46, unit 3); 10 *Hypoturrilites gravesianus* (d'Orbigny), Jaźwiny (57, unit 3); 11 *Hypoturrilites* sp., Mokrzesz (46, unit 3); 12 *Turrilites (Turrilites) boerssumensis* Schlüter, *ibidem*; 13 *Mariella (Mariella) lewesiensis* (Spath), *ibidem*; 14—15 *Mariella (Mariella) cenomanensis* (Schlüter), *ibidem*; 16 *Mariella (Mariella)* cf. *cenomanensis* (Schlüter), *ibidem*

All photos × 1.5; taken by B. Drozd, M. Sc.

Cenomanian ammonites

1 *Hyphoplites campichei campichei* Spath, Mokrzesz (outcrop 46, unit 3); 2 *Hyphoplites falcatus aurora* Wright & Wright, *ibidem*; 3 *Mantelliceras saxbii* (Sharpe), *ibidem*; 4 *Mantelliceras tuberculatum* (Mantell), Jaźwiny (53, unit 3); 5 *Mantelliceras* gr. *dixoni* Spath, Mokrzesz (46, unit 3); 6 *Calycoceras* (*Lotzeites*) aff. *lotzei* Wiedmann, Jaźwiny (53, upper part of unit 3)

All photos × 1.5; taken by B. Drozd, M. Sc.



Cenomanian ammonites

1—2 *Schloenbachia subtuberculata* (Sharpe), Middle Cenomanian, Glanów (outcrop *108c*, unit *2a*);
3 *Schloenbachia subvarians* Spath, Cenomanian, Mokrzesz (*18*, unit 3)
All photos × 1.5; taken by B. Drozd, M. Sc.