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Turonian through Santonian deposits of the Central Polish Uplands; their facies development, inoceramid paleontology and stratigraphy

ABSTRACT: Stratigraphy, inoceramid paleontology and facies characteristics of the Turonian through Santonian deposits of the Central Polish Uplands are presented, on the basis of which 17 inoceramid zones are recognized and their position against the ammonite standard division is discussed. Apart from the Middle/Upper Santonian and Santonian/Campanian boundary all other stage and substage boundaries are well recognizable with the inoceramid fauna. Most of the inoceramids, comprising about 40 species, assigned to six genera, are monographed. Two species from the Turonian - Coniacian boundary interval are described as new: *Mytiloides turonicus* sp. n. and *Inoceramus vistulensis* sp. n. The *Mytiloides labiatus* group is thoroughly treated and particular members are discussed, to show that *M. submytiloides* (SEITZ) and *M. subhercynicus* (SEITZ), the widely cited species of this group, are invalid and thus should be rejected. The names *Mytiloides opalensis* sensu SEITZ (*non* BÖSE) and *M. duplicostatus* sensu KAUFFMAN (*non* ANDERSON) are younger synonyms of *M. kossmati* (HEINZ). A revision of the whole genus *Cremnoceramus* is also presented.

The stratigraphic scheme applied to the Turonian through Santonian deposits of the Central Polish Uplands allows to solve some regional problems, and to construct a unified chronostratigraphic facies scheme for the southern part of the epicontinental areas in Poland. The facies characteristics combined with the paleotectonic setting of the studied area is the base of the distinguishing of the four geotectonic-facies regions: the Circum-Sudetic Trap Basins, the Cracow Swell, the Danish Polish Trough, and the Russian Chalk Sea. The evolution of the studied areas during Turonian through Santonian time is assembled to indicate the primary role of tectonic movements of the Subhercynian phase of the Alpine orogeny.

INTRODUCTION

The time interval framed by the Albian-Cenomanian transgression and the Campanian calm, covers in the Cretaceous history of the Central Polish

Uplands a very vigorous and dynamic, though still poorly known phase. The recent advance in the recognition of the inoceramids, the only macrofossil group with appropriate stratigraphic value in the area, and the deciphering of the facies relations enable the more refined biostratigraphy, facies analysis and their regional evolution to be completed.

The presented material displays the results of the Author's studies on the Cretaceous of the Central Polish Uplands, initiated still in a frame of his M.Sc. thesis (WALASZCZYK 1984) and carried later in the years 1986-90, firstly at the Geological Survey of Poland, and since 1987 at the Geological Faculty of the University of Warsaw. Some results of these studie have already been published (WALASZCZYK 1987, 1988, 1989; MARCINOWSKI & WALASZCZYK 1985) and the present report extends the elaboration of the stratigraphy, with the paleontological analysis of the inoceramid fauna, facies characteristics and relations, and of the basin dynamics on the whole area of the Central Polish Uplands within the Turonian to Santonian time interval.

GENERAL SETTING OF THE STUDIED DEPOSITS

The present paper deals with the Turonian through Santonian deposits of the Central Polish Uplands (*see* Text-fig. 1). The Cretaceous cover of this area, being much reduced when compared to their presumed original extent, is now limited to the negative geostructural units and occurs only in the Border and the Miechów Synclinorium. In the whole area of the Holy Cross Mountains and the Lower San Anticlinorium, both forming a south-eastern part of the Mid-Polish Anticlinorium, due to subsequent erosion, the whole Cretaceous sequence is lacking (*see* Text-fig. 1). The Cretaceous deposits are also almost entirely removed from the area of the Great Monocline, adjoining the Miechów Synclinorium to the west. An outlier of the Cretaceous cover, separated from the continuous Cretaceous cover of the Polish Lowland during the Tertiary erosion, is represented by the Opole Cretaceous (*see* Text-fig. 1). Some minor occurrences in tectonical traps are noted inbetween these areas (*see* e.g. JASKOWIAK-SCHOENEICH 1981). Such architecture of the Upper Cretaceous strata limits their surface occurrences, being the base of the present study, to the marginal parts of the Synclinoria. Thus, passing from the east to the west, the four regions of the study are distinguished (*see* Text-fig. 1):

1. North-eastern margin of the Holy Cross Mountains (= the south-western part of the Border Synclinorium),
2. South-western margin of the Holy Cross Mountains (= the north-eastern border of the Miechów Synclinorium),
3. Polish Jura Chain (= south-western border of the Miechów Synclinorium),
4. The Opole Trough.

REVIEW ON THE STRATIGRAPHIC RECOGNITION OF THE STUDIED AREA

The first description of the Cretaceous deposits in the studied area was given in 1836 by Georg G. Pusch, in his monumental work "*Geognostische Beschreibung von Polen*". The studies of Pusch (1836, 1837) are all from before an advent of biostratigraphic revolution of d'Orbigny and Oppel, and thus he identified the Cretaceous on purely lithological grounds, as a system of carbonates, between the "*Grünsand Formation*" and the Tertiary clays and brown coals formation. Certainly, as we realize today, this led to many mistakes in details and in the general reconstruction of the Cretaceous sequence. For example, the Turonian limestones of the Polish Jura Chain or the limestones and opokas with flints of Turonian and Coniacian age of the south-western margin of

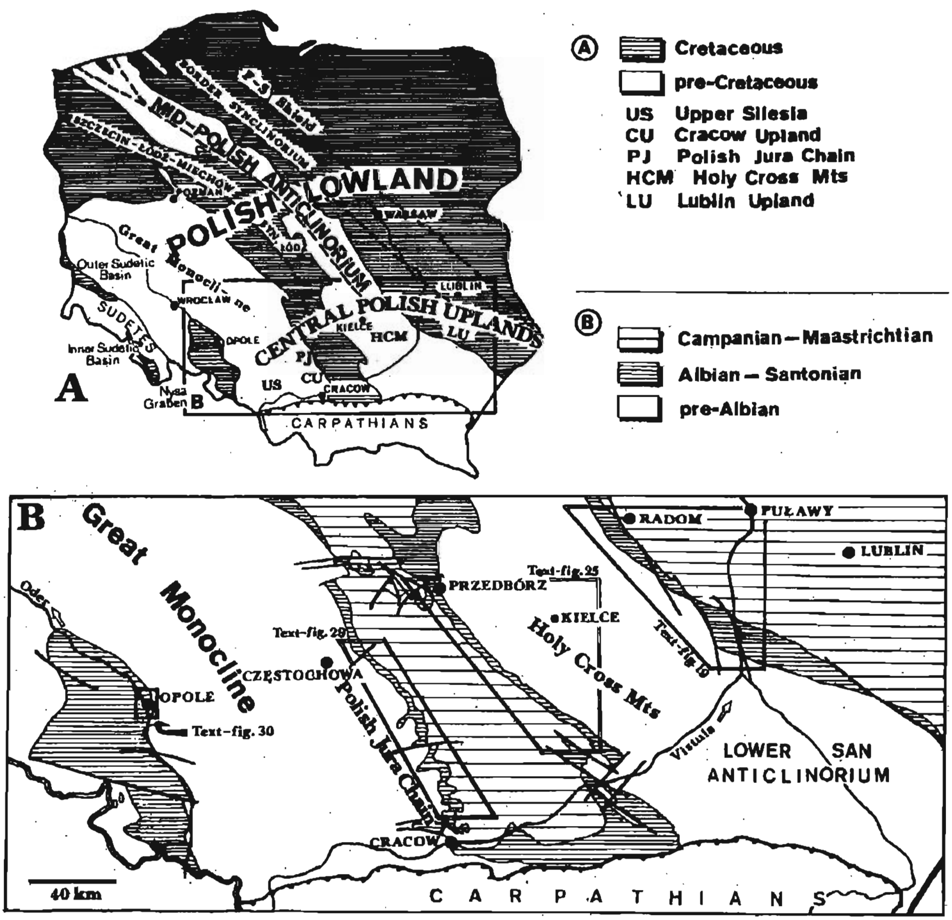


Fig. 1

A — Tectonic sketch-map of Poland, without Cenozoic deposits (*after* Marcinowski & Radwański 1983, *simplified)*;

B — Geologic sketch-map of the investigated region of the Central Polish Uplands and the Opole Trough the Holy Cross Mountains he included into his Jurassic Limestone Formation. Similarly, the two groups he distinguished within the Cretaceous Formation, it means, the "*Grube und Chloritische Kreide (= Polnische Opoka)*", covering the most part of the Central Polish Uplands and his "*Schreibende Kreide*" embracing the chalk deposits of the eastern part of the Lublin Upland, were regarded by him (PUSCH 1836) as the successive units, basing on such mutual relations of relative facies in France and England.

The d'ORBIGNY stages were very quickly adopted by geologists working on the Cretaceous strata of Poland, probably due to a lack of traditional local names anyhow existing in the Polish literature. And thus, as early as 1866, there appeared the paper of HOHENEGGER, completed and edited posthumously by FALLAUX, and which concerned the Cretaceous deposits of the Cracow area, with Cenomanian, Turonian and Senonian stages of d'ORBIGNY. Up to the First World War, such stage division of the Upper Cretaceous, indicating the Cenomanian, Turonian and Senonian stages was commonly used both in analytical reports (*see* e.g. KONTKIEWICZ 1882, MICHALSKI 1884, KRISCHTAFOVITSCH, 1899) and in the summaries on the regional geology, as given by SIEMIRADZKI (1909 and *in* SIEMIRADZKI & DUNIKOWSKI 1891). Only a few papers with serious stratigraphic discussion and zonal subdivision of the applied stages may be cited. Among them, worth of mention is the paper by ZARĘCZNY, published already in 1878, with given paleontological grounds for the Cenomanian, Turonian and Senonian stages and with zonal subdivision of the Turonian stages in the Cracow region. Much later, in 1906, there appeared the paper by SMOLEŃSKI concerning the low-Upper Cretaceous strata of Bonarka, now the outskirts of the city of Cracow, with extensive biostratigraphic discussion and paleontological elaboration of the stratigraphically important faunal groups; for the first time the Emscherian stage of SCHLÜTER (1864) was applied in the area.

In the 20-ties and 30-ties of our century, the careful stratigraphic elaboration was initiated for the low-Upper Cretaceous only. The adopted stage concept and the zonal subdivision based mainly on inoceramids, was worked out in Germany, partly still in the 19-th century by SCHLÜTER (1864, 1877) and STOLLEY (1897), and in our century by HEINZ (1926, 1928), HEINE (1929), RIEDEL (1930), and by STOLLEY again (1930). This part of the Cretaceous was divided into the Turonian, the Emscherian and the Senonian "*Granulaten Kreide*". The two latter stages were commonly correlated with the Coniacian and Santonian stages introduced by COQUAND (1852) in France, and used as a synonymy. Many well grounded biostratigraphic works then appeared to cover almost the whole area of the Central Polish Uplands, as the detailed studies by MAZUREK (*e.g.* 1923, 1925, 1948), SUJKOWSKI (1926, 1933), RÓŻYCKI (1937, 1938), and POŻARYSKI (1938, 1939).

The later works pertained to the Turonian through Santonian interval of the studied area, though being often very good examples of regional studies (e.g. POŻARYSKI 1948, 1956, 1966; CIEŚLIŃSKI & POŻARYSKI 1970) little improved the biostratigraphic framework. Worth of mention are the surveys on the Santonian/Campanian boundary by BŁASZKIEWICZ (1962, 1980) and the zonation of Turonian offered by MARCINOWSKI (1975), being the rare examples in the Polish literature of the discussions on the general problems of the Cretaceous stratigraphy.

STUDIES ON THE INOCERAMIDS IN POLAND

In the Upper Cretaceous deposits of the Central Polish Uplands the inoceramids are the most important group for their stratigraphic use, and most of the papers concerned with the biostratigraphy of the low-Upper Cretaceous are based upon them. In spite of this, however, a few papers may be cited which are devoted to the inoceramid fauna alone. Among early papers, the discussion of the inoceramid species and their occurrence was given already by PUSCH (1837). He ordered the species known in his time into two genera, *i.e.* "*Inoceramus*" and "*Catillus*", and from the studied area he reported: "*Catillus Brongniarti*", "*C. Cuvieri*", "*C. mytiloides*" and "*C. cordiformis*". Judging from the stratigraphic age of the localities referred by PUSCH (1837) to the cited species, the correctness of his determinations is rather doubtful. Similarly, as in the case of a single specimen illustrated by him, which hardly may be identified as an inoceramid at all. Certainly, the problem of the stratigraphic value of inoceramids did not exist for PUSCH (1837), but he noticed a need of careful studies on the vertical distribution of all fossils to recognize their possible validity in characteristics of particular lithologic units.

In most of the papers on stratigraphy and regional geology from the second half of the last century or the first decades of this century, the inoceramids were often cited in the characteristics of particular stages distinguished, but few forms only were used *per se* in the deposit timing. Moreover, basing on the given localities of the reported forms their determinations hardly may be regarded as correct.

Paleontological description of some new species, referred to as *Inoceramus robustus* and *I. cracoviensis*, was given by SMOLEŃSKI (1906) from the Senonian deposits of Bonarka. The collection of SMOLEŃSKI is lost and the present state of the section does not allow for the comparative studies to judge definitely his determinations. His *Inoceramus lobatus* var. *cancellata* GOLDFUSS (*see* SMOLEŃSKI 1906, Pl. 27, Fig. 19) may probably belong to *Inoceramus steenstrupi* but the rest of the specimens illustrated (SMOLEŃSKI 1906, Pl. 27, Figs 16-18) are too badly preserved to be identified, what was already indicated by SEITZ (1965).

In many subsequent papers in which the stratigraphic framework of the Upper Cretaceous deposits of the studied area is given, especially those by SUJKOWSKI (1926, 1933), SAMSONOWICZ (1934), RÓŻYCKI (1937, 1938), and particularly by MAZUREK (1923, 1925, 1948) and POŻARYSKI (1938, 1948, 1956) the inoceramids are extensively used in stratigraphic statements, however, without any paleontological documentation of the species.

In 1954, MITURA reported the inoceramid fauna, with discussion on their taxonomy, from the Turonian and Coniacian of a part of the SW margin of the Holy Cross Mountains. He published (MITURA 1957) a review on the metodology of inoceramid studies, as offered by HEINZ (1928a), HEINE (1929), FIEGE (1930), and SEITZ (1934), with a proposed Polish terminology applied to inoceramid description.

More recently the studies on inoceramid fauna were undertaken by CIEŚLIŃSKI (1960, 1963, 1966 and *in* CIEŚLIŃSKI & POŻARYSKI 1970, CIEŚLIŃSKI & TRÖGER 1964). These mostly concerned the stratigraphic distribution of inoceramid fauna with paleontological elaboration limited to the Albian and Cenomanian forms (CIEŚLIŃSKI 1987). Some Upper Cretaceous guide forms were illustrated by him in the Atlas of Cretaceous fossils of Poland (CIEŚLIŃSKI & BŁASZKIEWICZ 1989).

Single forms from the Turonian through Santonian deposits of the Vistula section were described and illustrated by KURLENDA (1965, 1966).

SYSTEMATIC DESCRIPTION OF INOCERAMIDS

The presented description is based on the material comprising about 3000 specimens, and collected by the Author in the years 1986-1990. In a case of poorly represented forms, a comparative material from Saxony, Sudetes, Crimea and Caucasus was also used. Very helpful were the vast collections of the Museum of the Geological Survey of Poland (abbreviated as GS) in Warsaw, and of the Museum of the Earth (abbreviated as ME) in Warsaw, particularly in the case of the well localized material and of the forms poorly and/or not represented in the Author's own collection.

Most of the studied material represents the Author's own collection, housed at the Institute of Geology, University of Warsaw. The specimens from this collection are affixed with 4-element code, allowing their univocal localization, which consists of (*see also* APPENDIX):

(i) Number of the studied region,
(ii) Letteral abbreviation of the locality [the elements (i) and (ii) form the *locality codes* and are to be found in the Appendix],
(iii) Number of the lithological unit within the section, marked at the left side of the referenced Text-figures ("O" indicates the lack of detailed position of the specimen within the section, irrespective of reason),
(iv) Serial number of the specimen.

The catalogued number of the specimens from the Museum of the Earth in Warsaw, and from the Museum of the Geological Survey of Poland are preceded with abbreviations ME and GS respectively.

The data within the Tables 1-16, marked with an asterisk indicate the incomplete measurements.

The described material does not form an even representation of the inoceramid fauna along the Turonian through Santonian strata in the studied area. While relatively adequate collections were obtained from the Turonian to Middle Coniacian part of the succession, the Santonian and particularly the Upper Coniacian fauna is not sufficiently represented. It is because of a low number of fossiliferous sections in that interval. In the Upper Coniacian deposits, in very limited numbers are known *e.g.* the genera *Inoceramus* and *Magadiceramus*, and many typical forms are completely missing. Similarly, from the Santonian, besides *Sphenoceramus*, the other genera, such as *e.g.* *Cordiceramus*, *Platyceramus*, or *Cladoceramus*, are known in single specimens, not sufficient to be reliably elaborated.

SUPRASPECIFIC CLASSIFICATION

In spite of the common agreement about generic differentiation of the inoceramids, none well founded system of their supraspecific classification exists. A revision of the generic and subgeneric systematics of inoceramids, currently undertaken by KAUFFMAN (*in* KAUFFMAN & *al.* 1977), and based on the complete set of internal shell-features, remained only announced as yet. The classification presented recently by POCHIALAINEN (1985) gives no clear criteria for supraspecific taxonomy of the species here concerned. The grouping of some other taxa as proposed by this author seems to be doubtful. In the present report, the supraspecific taxa applied: *Mytiloides* BRONGNIART, *Inoceramus* SOWERBY, *Cremnoceramus* COX (*non* HEINZ), *Volviceramus* STOLICZKA, *Magadiceramus* HEINZ, and *Sphenoceramus* BÖHM are used according to the concepts of SEITZ (1961, 1965, 1967, 1970), KAUFFMAN (*in* KAUFFMAN & *al.* 1977, and *in* HERM & *al.* 1979), COX (1969) and NODA (1988), and all are treated at the genus level.

DESCRIPTIVE TERMS

All measurements used in the present paper are those as applied in modern inoceramid studies (SEITZ 1934, 1961, 1965, 1967, 1970; TRÖGER 1967; NODA

1975; KELLER 1982), and the differences, if exist, concern the names of particular elements measured rather than their real concept (see comparison of measured elements and technics by EFREMOVA 1978b).

The basic measurements used are the same as commonly accepted (Text-fig. 2). Any extra characteristics applied to any specific taxa will be discussed at the head of the respective chapters.

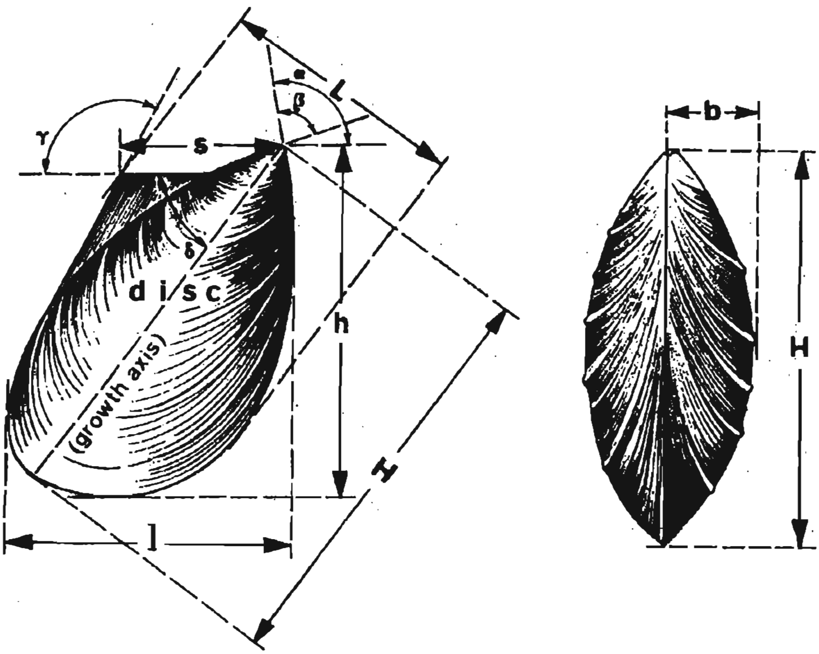


Fig. 2. Basic morphology for measurements of the inoceramids; explanation in the text

The letteral symbols to describe the dimensions and angles (*see* Text-fig. 2) are as follows:

h - height; **l** - length; H - maximum linear dimension from the beak to the ventral extremity of the shell; L - maximum dimension of the shell perpendicular to H; **b** - breadth; **α** - anterior hinge angle; **β** - angle of umbonal inflation; **γ** - posterior hinge angle; **δ** - obliquity (angle between growth axis and hinge line); **RV** - right valve; **LV** - left valve; **s** - length of hinge line.

Among the morphological elements often occurring in inoceramids are also the radial grooves placed at the contact of the disc and the posterior auricle (called here the auricular sulcus), and sometimes at the dorsoanterior part of the disc (as *e.g.* in *Mytiloides submytiloides* SEITZ) and called here simply the anterior sulcus.

The terminology used for description of concentric elements of the surface ornamentation is taken here after MATSUMOTO & NODA (1986) and comprises the following terms:

Concentric lines (or **lirae**): markings of the successive growth stops, usually seen only on the shell surface and not impressed on the internal mould;

Concentric ribs (or **ridges**): first order elevations; when they are broad and low, may be called the concentric undulations;

Concentric ribblets (or **subcostae**): second order elevations, well recognized on the internal moulds;

Concentric rings: third order, fine elevations, impressed on the internal mould, often corresponding to the concentric lines.

The radial ornaments, occurring among the studied material in the genus *Sphenoceramus* BÖHM and in some forms, the generic assignement of which (*Inoceramus fasciculatus* HEINE or *Inoceramus digitatus* HEINE *non* SOWERBY) is still unclear, may be subdivided as follows:

Radial rings: strong, continuous radial elevations, not disturbed by the concentric ornament elements;

Radial strings: radially arranged discontinuous elevations not passing through the first order concentric elevations; these correspond to the "*Rippeln*" as defined by SEITZ (1965);

"Spindel Rippen" (as defined by SEITZ 1965): fine radial rings, not passing through the first order concentric ornament elements and disturbed by the second order concentric ornaments; the distinguishing between the "*Spindel Rippen*" and the radial markings, which reflect the interior shell morphology is sometimes difficult (*see* SEITZ 1965).

In the case of the shell-possessing individuals, the reference to HEINZ' (1928b) terminology of the surface ornamentation is possible, and when it is advisable for comparative purposes his original terminology will be here applied.

Geniculation: radical slope change during ontogeny of the individuals, attaining even 90 degrees, the feature taken as one of the distinctive traits in the genus *Cremnoceramus* COX (*non* HEINZ) but well occurring also in the representatives of almost all other genera (*see* SEITZ 1967, TRÖGER 1981b; and discussion on the genus *Cremnoceramus* in the present report).

Genus *Mytiloides* BRONGNIART, 1822

TYPE SPECIES: By monotypy, *Ostracites labiatus* SCHLOTHEIM, 1813

DIAGNOSIS: Equivalve, inequilateral, strongly to moderately prosocline. Outline elongate, ovate, with the valves of moderate to weak convexity. Shell thin, hinge line of moderate length, thin. Anterior sulcus only rarely observed, posterior one of moderate size. Hinge area with small, closely spaced, multivincular resilifers. According to KAUFFMAN (*in* KAUFFMAN & *al.* 1977), musculature simple, insertion area consisting of entire or nearly entire pallial line, and narrow, laterally elongated posterior adductor area. No pedalbyssal musculature or appearent byssal gape in the shell.

OCCURRENCE: The genus is noted world-wide in the ?Jurassic and Cretaceous.

Group of *Mytiloides labiatus* (SCHLOTHEIM, 1813)

Wide geographic distribution, assumed high stratigraphic value, and not interpreted wide morphological variability of the group, makes it a very attractive object to study. Resolution of taxonomic problems within the group is of fundamental meaning for its use in stratigraphy and will allow to decide on reasons of divergent opinions concerning its stratigraphic significance.

The content and variability of this cosmopolitan, low-Turonian group, follows generally the results of SEITZ' (1934) study, who distinguished, basing on biometric methods 6 varieties and two forms within the group. Subsequently, SEITZ (1961) gave the status of subspecies to the former while uniting the latter with respective subspecies.

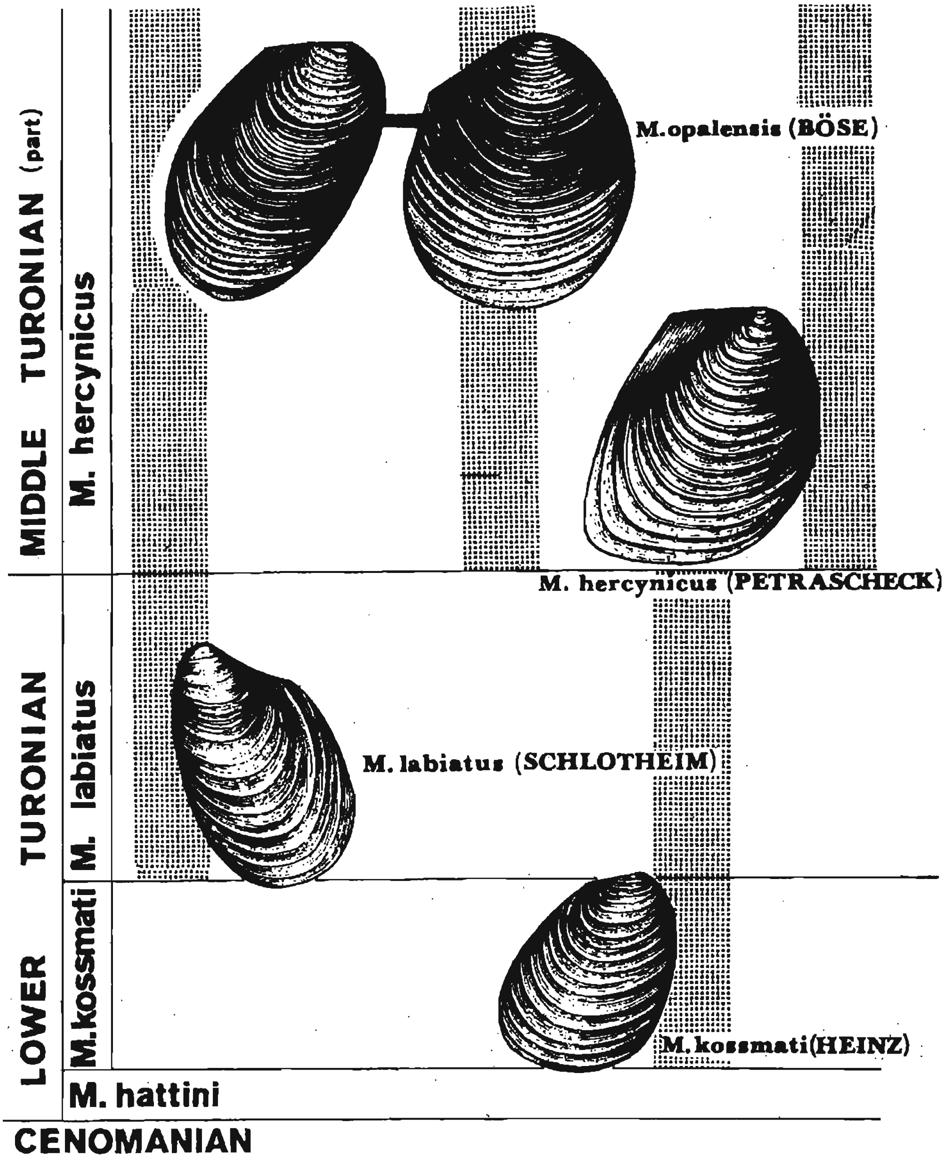


Fig. 3. Stratigraphic ranges of the low-Turonian *Mytiloides* species

Subsequent discussions have never questioned the subspecies division of the group as proposed by SEITZ (1934, 1961) being concerned rather with nomenclatorial problems (KAUFFMAN & *al.* 1977, TRÖGER 1967, BADILLET & SORNAY 1980, SORNAY 1981, KELLER 1982). In spite of this, however, serious divergencies exist in the concept, variability range, and consequently the stratigraphic value of particular species within the group. In part these discrepancies result from the basic disadvantage of SEITZ' (1934) study, namely a lack in his elaboration of the palentological material strictly fixed stratigraphically. This deprived SEITZ (1934) a possibility of the time control of the traits taken by him as specifically valid.

Basing on the material coming from the studied area and some outside localities (Saxony, Sudetes) plus the reexamination of the published material, the new taxonomic arrangement of the group *Mytiloides labiatus* is herein proposed (*see* Text-fig. 3), comprising the following forms:

The species *Mytiloides labiatus* (SCHLOTHEIM)

It comprises all the "*mytiloides*"-shaped forms, with typical representatives of *M. labiatus* (SCHLOTHEIM), and *M. mytiloides* (MANTELL), as interpreted by SEITZ (1934), which represent the extreme forms of one species, called here, according to the priority rule, *M. labiatus* (SCHLOTHEIM). Similarly, the species *M. submytiloides* (SEITZ), till the taxonomic value of the anterior sulcus will not be proved, belongs to *M. labiatus* (SCHLOTHEIM), as interpreted herein.

The species *Mytiloides kossmati* (HEINZ)

It comprises flat forms with circular or slightly longitudinally ovate trajectory of the ornament elements, and without well developed posterior auricle. The concentric rings may double at the crests of raised concentric ribs, and cross them obliquely, particularly at the anterior side of the disc. The species *M. opalensis* (sensu SEITZ, *non* BÖSE), *M. goppelnensis* (BADILLET & SORNAY), *M. modeliensis* (SORNAY), and *M. duplicostatus* sensu KAUFFMAN (*non* ANDERSON) fall into the synonymy of the species *M. kossmati* HEINZ. A very close form is represented by *M. columbianus* (HEINZ), as interpreted by KENNEDY & *al.* (1987, 1989).

The species *Mytiloides hercynicus* (PETRASCHECK)

It comprises the forms similar in their general shape to *M. kossmati* (HEINZ), but with distinct posterior auricle and another type of the surface ornament. The posterior auricle is delimited from the disc with a distinct step, and the shell possesses a markedly variable obliquity.

The species *Mytiloides opalensis* (BÖSE)

It comprises the forms similar to *M. hercynicus* (PETRASCHECK) except another surface ornamentation.

The species *Mytiloides hattini* ELDER

According to ELDER'S (1991) diagnosis it comprises medium sized, slightly inflated forms with poorly differentiated from the disc posterior wing and ornamented with evenly or subevenly spaced concentric rings. In the studied material not represented.

Mytiloides kossmati (HEINZ, 1930)
(Pl. 1, Figs 1-9)

1930. *Inoceramus naumanni* YOK. var. *kossmati* HEINZ; R. HEINZ *in* BESAIRIE, pp. 94 and 121.
1933. *Striatoceramus kossmati* HEINZ; R. HEINZ, p. 247, Pl. 18, Fig. 4.

1934. *Inoceramus labiatus* var. *opalensis* BÖSE; O. SEITZ, pp. 457-465, Text-figs 14, 15; Pl. 38, Figs 4-6, Pl. 39, Figs 1-4.
1934. *Inoceramus labiatus* n. var. *subhercynica*; O. SEITZ, pp. 465-469, Text-figs 18a-f; Pl. 40, Figs 2, 4, 5.
1974. *Inoceramus* cf. *crippsi* MANTELL; R. MARCINOWSKI, Pl. 25, Fig. 1.
1976. *Mytiloides opalensis elongata* (SEITZ); J. WIEDMANN & E.G. KAUFFMAN, Pl. 2, Figs 5, 11.
1976. *Inoceramus hercynicus* PETRASCHECK; F. ROBASZYNSKI, Pl. 2, Fig. 3.
1976. *Mytiloides opalensis* (BÖSE); E.G. KAUFFMAN & *al.*, Pl. 10, Fig. 10.
?1976. *Mytiloides* sp. aff. *M. duplicostatus* (ANDERSSON); E.G. KAUFFMAN & *al.*, Pl. 10, Fig. 11.
1977. *Mytiloides opalensis* (BÖSE); E.G. KAUFFMAN & J.D. POWELL *in* E.G. KAUFFMAN & *al.*, pp. 79- 81, Pl. 6, Figs 3, 6.
?1977. *Mytiloides* sp. aff. *M. duplicostatus* (ANDERSON); E.G. KAUFFMAN & J.D. POWELL *in* E.G. KAUFFMAN & *al.*, pp. 81-82, ?Pl. 6, Fig. 5, Pl. 7, Figs 2, 6.
1978a. *Inoceramus opalensis* BÖSE; V.I. EFREMOVA, p. 89, Pl. 3, Figs 2-5.
1980. *Inoceramus goppelnensis* nom. nov.; G. BADILLET & J. SORNAY, p. 324.
1981. *Inoceramus* (*Mytiloides*) *modeliensis* n. sp.; J. SORNAY, pp. 2-6, Pl. 1, Figs 1-4, Pl. 2, Figs 1, 3, 4.
1982. *Inoceramus goppelnensis* SORNAY; J. SORNAY *in* F. ROBASZYNSKI & *al.*, p. 139, Pl. 7, Fig. 4.
1982. *Inoceramus hercynicus* PETRASCHECK; J. SORNAY *in* F. ROBASZYNSKI & *al.*, p. 140, Pl. 8, Fig. 2.
1982. *Mytiloides transiens* (SEITZ); S. KELLER, pp. 133-135, Pl. 3, Fig. 5.
1987. *Mytiloides* cf. *columbianus* HEINZ; D.E. HATTIN, Fig. 11*B*.
1988. *Mytiloides modeliensis* (SORNAY); H.R. HESSEL, pp. 19-20, Text- fig. 30*C*.
1989. *Mytiloides* cf. *subhercynicus* (SEITZ); W.J. KENNEDY & *al.*, Fig. 34*I*.
1991. *Mytiloides* sp. aff. *duplicostatus* (ANDERSON); W.P. ELDER, Figs 1, 7-8.
1991. *Mytiloides columbianus* (HEINZ); W.P. ELDER, Figs 2, ?9.
1991. *Mytiloides opalensis* (sensu KAUFFMAN); W.P. ELDER, Figs 3-5.

HOLOTYPE: By original designation, the left valve of the specimen from Anontsy, Madagascar, illustrated by HEINZ (1933, Pl. 18, Fig. 4).

MATERIAL: 16 specimens preserved as internal moulds, occasionally with some shell fragments attached, representing one double-valved specimen, nine right and five left valves.

Lockwitz (Saxony, Germany): Specimens Nos 5.Lc.O.1 through 5.Lc.O.12, M. labiatus Zone.
Ożarów: Specimens Nos 1.Oz.2.1 and 1.Oz.2.2, M. labiatus Zone.
Glanów: Original of *Inoceramus* cf. *crippsi* MANTELL in MARCINOWSKI 1974, Pl. 25, Fig. 1, ?M. kossmati Zone.
Kozia Góra: Specimen No. 4.KG.O.15, ?M. labiatus Zone.

DESCRIPTION: The measurements and simple ratios are given in Table 1 and Text-fig. 4.
Shell attaining small to moderate size for the genus, inequilateral, ?equivalved, flat or slightly inflated. Outline subquadrate to obliquely ovate. Anterior and ventral margins convex, passing gradually into almost straight posterior margin. Hinge line straight, moderately long. Anterior side steep, low; ventral and posterior sides flattened. Posterior auricle small, subtriangular, continuous with a disc.

Ornamentation consisting, in the juvenile part, of closely and subevenly spaced concentric rings, slightly asymmetrical, with usually rounded trajectory, with both longitudinally and axially ovate forms occurring as well. The adult part with rounded, subevenly spaced concentric ribs with ventralward increase of interspaces. Double of the concentric ribs at the main part of the disc often observed. Ribs and interspaces covered with raised, sharp-edged concentric rings, often, particularly at the anterior part of the disc, crossing them obliquely. Concentric rings (? = growth lines) variable, ranging from indistinct, easily obliterated or completely unmarked through moderately raised to very distinct, raised, slightly lamellate.

Table 1

Measurements of selected specimens of *M. kossmati* (HEINZ); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
5.Lc.O.1	48	49	56	42	-	20	130	110	144	45	1.02	0.75	0.40
5.Lc.O.2	28	34	32	28	-	19	143	-	123	53	1.21	0.87	0.50
5.Lc.O.5	38	38	46	34	-	18	120	110	150	50	1.00	0.73	0.57
5.Lc.O.8	30	33	34	28	7	13	131	-	138	50	1.10	0.82	0.39
5.Lc.O.8									135	50			

REMARKS: In the studied area the species is very poorly represented, and its characteristics is based mainly on the sample from Lockwitz.

The discussed species shows a relatively high variability, concerning both the general shape and the characteristics of surface ornamentation (*see* Pl. 1, Figs 1-9). The latter includes the strength and spacing pattern of concentric ribs and strength of concentric rings in the adult part. The forms with weakly developed rings, possessing only well marked ribs have been hitherto commonly referred to as *M. opalensis* (sensu SEITZ, *non* BÖSE). The forms with characteristic doubling of concentric rings, were referred to as *Mytiloides duplicostatus* (sensu KAUFFMAN, *non* ANDERSON). It seems, however, that the concentric rings, as well as their doubling, occurs in every specimen with preserved details of surface ornamentation.

SEITZ (1934) was the first to describe the larger sample of the species *M. kossmati* (HEINZ), though he referred it incorrectly to as *M. opalensis* (BÖSE). Most of the SEITZ' specimens come from Kozia Góra. The part of the quarry, his collection was obtained from, is now poorly accessible, and getting a larger sample is impossible. Worth of mention is, however, that the inoceramids occurring here are preserved as moulds within medium- to coarse-grained quartz sandstones and this effectively deprives these inoceramids of the details of their surface ornament. What is preserved are only concentric ribs. The concentric rings, giving such a characteristic feature as doubling at the ribs edges, or oblique crossing of the ribs at the marginal parts of the disc, are missing. Such forms, however, have hitherto been the usual vision of what was called *M. opalensis* (sensu SEITZ, *non* BÖSE). SEITZ (1934) included to var. *opalensis* only the specimens which possessed approximately circular concentric ribs, while the specimens with longitudinally ovate trajectory he referred to his new variety (later raised to the subspecies rank), *subhercynica* (SEITZ 1934, Text-fig. 18, Pl. 40, Figs 2, 4, 5). Such specimens, however, in all other respects are identical

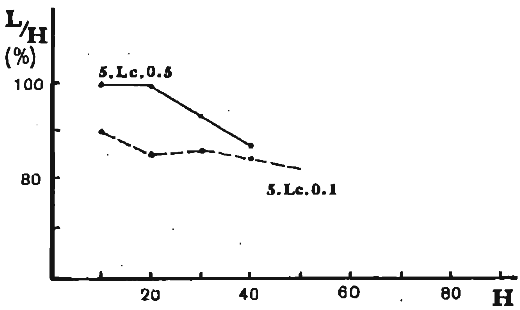


Fig. 4

Ontogenetic change of simple ratio L/H in *Mytiloides kossmati* (HEINZ)

to *M. opalensis* (sensu SEITZ, *non* BÖSE), and they markedly differ from the type of var. *subhercynica* SEITZ in the lack of distinct posterior auricle, and another type of ornamentation. These specimens fit well the variability range of the species concerned and thus they should be included into the intraspecific variability of *M. opalensis* (sensu SEITZ, *non* BÖSE), i.e. *M. kossmati* (HEINZ), as herein interpreted.

The holotype of the species, coming from the environs of Anontsy, Madagascar, was originally dated by BESAIRIE (1930) as of Turonian age. HEINZ (1933) comparing it with a form from Gabon suggested its low-Upper Turonian age (in the traditional German twofold division). SORNAY (1965), however, reported the forms close to *M. kossmati* (HEINZ) from Madagascar, coming from the Lower Turonian, thus questioning HEINZ' age attribution.

As the younger synonyms of *M. kossmati* (HEINZ), the species *M. goppelnensis* (BADILLET & SORNAY) and *Mytiloides modeliensis* (SORNAY), are here recognized. The latter species was described from the Lower Turonian La Frontera Formation of Colombia and reported also from Tárfaya, Morocco (SORNAY 1981, pp. 2-6, Pl. 1, Figs 1-4 and Pl. 2, Figs 1, 3, 4).

The species *Mytiloides kossmati* (HEINZ) differs from the other flat, possessing circular or almost circular surface ornament trajectory low-Turonian representatives of the genus *Mytiloides*, first of all in the lack of distinctly delimited posterior auricle, and in character of surface ornamentation. A very close form is represented by *Mytiloides columbianus* (HEINZ) as interpreted by KENNEDY & *al.* (1987, 1989).

The representatives of *Mytiloides kossmati* (HEINZ) were often mistaken with *Mytiloides hercynicus* (PETRASCHECK), e.g., the specimens ascribed to PETRASCHECK's species by SORNAY (*in* ROBASZYNSKI 1976, ROBASZYNSKI & *al.* 1982). It seems that such very reports were the base of questioning the stratigraphic value of the low-Turonian mytiloids.

OCCURRENCE: Cosmopolitan species, known from North and South America, Europe, Africa and Asia (Taymyr Peninsula, Japan). Where it is well stratigraphically labelled, the species is reported from the lowermost Turonian deposits, as indicated by the ammonite faunas, though it may range to the top of the Lower Turonian (as here defined). In the studied area, it possesses very scanty record (Ożarów, Glanów).

Mytiloides labiatus (SCHLOTHEIM, 1813)
(Pl.1, Fig.10; Pl. 2, Figs 1-6; Pl. 3, Figs 1-4; Pl. 4, Figs 1-6)

1813. *Ostracites labiatus*; E.T. SCHLOTHEIM, p. 93.
1822. *Inoceramus mytiloides*; G. MANTELL, pp. 215-216, Pl. 27, Fig. 3; Pl. 28, Fig. 2.
1822. *Mytiloides labiatus* A. Br.; A. BRONGNIART, pp. 81, 84; Pl. 3, Fig. 4.
1823. *Inoceramus mytiloides* MANTELL; J. SOWERBY, p. 62, Pl. 442, Figs 1-3.
1834-40. *Inoceramus mytiloides* MANTELL; A. GOLDFUSS, p. 118, Pl. 113, Fig. 4.
1843-47. *Inoceramus problematicus* d'ORBIGNY; A. d'ORBIGNY, p. 510-512, Pl. 40, Figs 6-7.
1871. *Inoceramus labiatus* SCHLOTHEIM; F. STOLICZKA, p. 408, Pl. 29, Fig. 1.
1871-75. *Inoceramus labiatus* SCHLOTH. sp.; H.B. GEINITZ, pp. 46-48, Pl. 12, Figs 1-3.
1893. *Inoceramus labiatus* SCHLOTHEIM; T.W. STANTON, pp. 77-78, Pl. 10, Fig. 4.
1911. *Inoceramus labiatus* (SCHLOTHEIM); H. WOODS, pp. 281-284, Text-fig. 37, Pl. 50, Figs 1-6.
1934. *Inoceramus labiatus* var. *labiata* SCHLOTHEIM; O. SEITZ, pp. 448-454, Text-fig. 9a-c, 11a-c, Pl. 38, Figs 1-3.
1934. *Inoceramus labiatus* var. *mytiloides* MANTELL; O. SEITZ, pp. 434-444, Text-fig. 2a-f, 3a-f, Pl. 36, Figs 1-4, Pl. 37, Figs 4-5.
1934. *Inoceramus labiatus* n. var. *submytiloides*; SEITZ, pp. 444-448, Text-fig. 8a-d, Pl. 37, Figs 1-3.
1939. *Inoceramus (Mytiloides) labiatus* (SCHLOTHEIM); E. DACQUÉ, pp. 103-104, Pl. 5, Figs 4-5; Pl. 6, Figs 12-13.
1954. *Inoceramus (Mytiloides) labiatus* (SCHLOTHEIM); R.F. RUTSCH & A. SALVADOR, pp. 419-420, Pl. 40, Fig. 1.
1965. *Inoceramus labiatus* von SCHLOTH. var. *antsaronaensis* n. var.; J. SORNAY, pp. 12-13, Pl. B, Fig. 1; Pl. C, Fig. 5.
1965. *Inoceramus paramytiloides* n. sp.; J. SORNAY, pp. 13-14, Pl. C, Figs 1-4, Text-figs 6-7.
1974. *Inoceramus labiatus* (SCHLOTHEIM); S.P. KOTSYUBINSKY, p. 76, Pl. 13, Fig. 1.
1975. *Mytiloides labiatus* (SCHLOTHEIM); D.E. HATTIN, Pl. 7, Fig. C.
1975. *Inoceramus labiatus* (SCHLOTHEIM); T. MATSUMOTO & M. NODA, pp. 197-206, Pl. 18, Figs 1, 3, 5.
1976. *Mytiloides submytiloides* (SEITZ); J. WIEDMANN & E.G. KAUFFMAN, Pl. 1, Fig. 19.
1976. *Mytiloides submytiloides* (SEITZ), new rugate subsp. transitional to early *M. mytiloides*; J. WIEDMANN & E.G. KAUFFMAN, Pl. 1, Fig. 23.
1976b. *Mytiloides labiatus labiatus* (SCHLOTHEIM); E.G. KAUFFMAN, Pl. 3, Figs 1, 6; Pl. 4, Fig. 9; Pl. 5, Fig. 14.
1976b. *Mytiloides submytiloides* (SEITZ); E.G. KAUFFMAN, Pl. 1, Figs 2, 7, 8.
1976b. *Mytiloides mytiloides mytiloides* (MANTELL) sensu SEITZ; E.G. KAUFFMAN, Pl. 1, Figs 4, 12.
1976b. *Mytiloides mytiloides* (MANTELL) n. subsp., late elongate form; E.G. KAUFFMAN, Pl. 1, Fig. 11.
1976b. *Mytiloides labiatus* (SCHLOTHEIM) n. subsp. (late, elongate, finely ribbed form); E.G. KAUFFMAN, Pl. 2, Fig. 6.
1976b. *Mytiloides mytiloides* (MANTELL) n. subsp. (late form, elongate shell); E.G. KAUFFMAN, Pl. 3, Fig. 2.
1976b. *Mytiloides labiatus* (SCHLOTHEIM) n. subsp. (elongated, finely ribbed, late form); E.G. KAUFFMAN, Pl. 2, Fig. 6; Pl. 3, Figs 4-5; Pl. 5, Figs 17-18.
1976b. *Mytiloides labiatus* (SCHLOTHEIM) n. subsp.; E.G. KAUFFMAN, Pl. 5, Figs 17-18.
1976. *Mytiloides labiatus labiatus* (SCHLOTHEIM); E.G. KAUFFMAN & *al.*, Pl. 6, Figs 3-6.
1976. *Mytilodies labiatus* (SCHLOTHEIM); sensu SEITZ (1934) n. subsp. (late form); E.G. KAUFFMAN & *al.*, Pl. 6, Fig. 14.
1976. *Mytiloides mytiloides arcuata* (SEITZ)?; E.G. KAUFFMAN & *al.*, Pl. 10, Fig. 9.
1976. *Mytiloides labiatus* (SCHLOTHEIM) s.l., transitional to *M. subhercynicus* (SEITZ); E.G. KAUFFMAN & *al.*, Pl. 10, Fig. 13.
1977. *Mytiloides labiatus labiatus* (SCHLOTHEIM); E.G. KAUFFMAN & J.D. POWELL *in* E.G. KAUFFMAN & *al.*, Pl. 7, Fig. 5.
1977. *Mytiloides mytiloides* (MANTELL); E.G. KAUFFMAN & J.D. POWELL *in* E.G. KAUFFMAN & *al.*, pp. 74 -78, Pl. 6, Figs 11-16.
1981. *Inoceramus (Mytiloides)* aff. *paramytiloides* SORNAY; J. SORNAY, pp. 6-7, Pl. 2, Fig. 2.
1982. *Mytiloides labiatus* (SCHLOTHEIM); S. KELLER, pp. 119-121, Pl. 3, Fig. 3.
1982. *Mytiloides mytiloides* (MANTELL); S. KELLER, pp. 121-125, Pl. 3, Figs 4, 6.
1982. *Mytiloides submytiloides* (SEITZ); S. KELLER, pp. 125-128, Pl. 3, Fig. 2.
1982. *Mytiloides goppelnensis* (BADILLET & SORNAY); S. KELLER, pp. 128-130, Pl. 3, Fig. 1.
1982. *Inoceramus labiatus* SCHLOTHEIM; J. SORNAY *in* F. ROBASZYNSKI & *al.*, p. 140, Pl. 8, Fig. 3.

1982. *Inoceramus mytiloides* MANTELL; J. SORNAY *in* F. ROBASZYNSKI *& al.*, p. 140, Pl. 7, Fig. 2; Pl. 8, Fig. 1b.
1982. *Inoceramus goppelnensis transiens* SEITZ; J. SORNAY *in* F. ROBASZYNSKI *& al.*, p. 140, Pl. 7, Fig. 1.
1982. *Inoceramus hercynicus* PETRASCHECK; J. SORNAY *in* F. ROBASZYNSKI *& al.*, p. 140, Pl. 8, Figs 1a, 1c.
1988. *Mytiloides mytiloides* (MANTELL); H.R. HESSEL, pp. 16-18, Text- fig. 30*A, B*.
1988. *Mytiloides* aff. *mytiloides* (MANTELL); H.R. HESSEL, pp. 18-19, Text-fig. 30*E*.
1988. *Mytiloides submytiloides* (SEITZ); H.R. HESSEL, p. 19, Text-fig. 30*D*.
1989. *Inoceramus labiatus* SCHLOTHEIM; S. CIEŚLIŃSKI & A. BŁASZKIEWICZ, p. 154, Pl. 156, Fig. 2.
1989. *Inoceramus (Mytiloides) mytiloides* (MANTELL); M.A. LAMOLDA *& al.*, Text-figs 3.7.
1989. *Inoceramus (Mytiloides) submytiloides* (SEITZ)?; M.A. LAMOLDA *& al.*, Text-fig. 4.1.
1990. *Mytiloides mytiloides* (MANTELL); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 1, Fig. 3.
1990. *Mytiloides* ex gr. *mytiloides - labiatus;* L.F. KOPAEVICH & I. WALASZCZYK, Pl. 1, Fig. 2.

HOLOTYPE: *Ostracites labiatus* of SCHLOTHEIM (1813, p. 93) illustrated by WALCH (1768, Pl. BIIb, Fig. 2).

MATERIAL: 115 specimens preserved mainly as internal moulds of single valves, rarely double-valved, with shelly fragments attached; usually, besides the material from Zalesice and Kozia Góra, more or less deformed.

Zalesice: Specimens Nos 3.Z.1.1; 3.Z.1.2; GS: 1401.II.376 through 1401.II.380; 1401.II.384; 1401.II.479 through 1401.II.494; 66/1 through 66/7; 199 and 200; M. labiatus Zone.
Ożarów: Specimens Nos 1.Oz.2.1 through 1.Oz.2.27; 1.Oz.4.1 through 1.Oz.4.32; and 1.Oz.5.1; M. labiatus Zone.
Lockwitz (Saxony, Germany): Specimens Nos 5.Lc.O.13 through 5.Lc.O.16; 5.Lc.O.18 and 5.Lc.O.19; M. labiatus Zone.
Kozia Góra: Specimens Nos 4.KG.O.1 through 4.KG.O.10; ?M. labiatus Zone.
Wielkanoc: Specimen No. ME: ML 1077; M. labiatus Zone.
Januszowice: Specimen No. 3.J.2.1; M. labiatus Zone.
Glanów: Specimen No. 3.G.1.1; M. labiatus Zone.
Przedbórz: Specimen No. 2.P.1.1; M. labiatus Zone.

DIAGNOSIS: Labiatoid-like forms, of moderate to large size for the genus, inequilateral, ?equivalved, with a linguoid shape and distinctly higher values of H than L (excluding the youngest parts), with usual values of L/H ratio exceeding 50% but being below 70%. The shape and the character of anterior side, the value of anterior hinge angle and inclination may vary to considerable extent.

The measurements and simple ratios are given in Table 2 and Text-fig. 5.

REMARKS: The species *Mytiloides labiatus* (SCHLOTHEIM) embraces the low-Turonian mytiloids with the traditionally defined (according to SEITZ 1934) *Mytiloides labiatus* (SCHLOTHEIM) and *Mytiloides mytiloides* (MANTELL) representing its extreme members. Contrary to the other species of the low-Turonian representatives of the genus, this species possesses clearly defined, axially elongated disc, the L/H ratio between 50% and 70%, and the more or less well developed posterior auricle. Inclination oscillates between 40° o and 50° (*see* Table 2). The shape of growth axis variable, changing between straight (*e.g.* Pl. 2, Figs 2, 4) to strongly inclined anteriorly (*see* Pl. 3, Figs 2, 4). Similarly, anterior margin varies between markedly curved anteriorly (*see e.g.* Pl. 3, Fig. 2 and Pl. 4, Fig. 2) to only slightly inclined, particularly in the juvenile parts, being later straight (*see e.g.* Pl. 2, Fig. 3). The anterior side, may be slightly concave below the umbo (*see* Pl 2, Fig. 2).

Before SEITZ' (1934) study, *M. labiatus* (SCHLOTHEIM) and *M. mytiloides* (MANTELL) were usually not discriminated, with *M. mytiloides* (MANTELL) being commonly included into the synonymy of *M. labiatus* (*see* GEINITZ 1872-75, SCHLÜTER 1877, WOODS 1911, SEITZ 1922). Basing on the statistical elaboration of the large material, SEITZ (1934) gave the characteristics of the two subgroups within the labiatoid-like low-Turonian mytiloids, and compared them with *M. labiatus* and *M. mytiloides,* respectively. Moreover, he distinguished the third species, *M. submytiloides,* the form almost identical to *M. mytiloides* but possessing an anterior sulcus (see discussion hereafter).

As differring traits between *M. labiatus* (SCHLOTHEIM) and *M. mytiloides* (MANTELL), SEITZ (1934) reports the higher values of L/H ratio (not dropping below 60%) and higher inclination in the former species when compared to the latter. The rest of characteristics (*e.g.* anterior hinge angle, character of the anterior side or ornamentation pattern) are undistinguishable in both species.

Table 2

Measurements of selected specimens of *M. labiatus* (SCHLOTHEIM); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	l/H	s/l
1401.II.380 [RV]	33	35	46	28	15	20	85	55	147	45	1.06	0.60	0.57
1401.II.378 [LV]	67	58	78	46	20	28	90	65	145	58	0.86	0.59	0.48
1401.II.379 [RV]	43	37	48	27	10	22	90	72	145	45	0.86	0.56	0.59
1401.II.376 [LV]	54	49	64	40	23	27	90	63	140	50	0.90	0.62	0.55
1401.II.377 [RV]	61	60	75	48	22	24*	90*	60*	145	40	0.98	0.64	0.40
1401.II.481 [LV]	44	41	51	34	17	21	90	58	135	50*	0.93	0.66	0.51
1401.II.482 [RV]	48	41	55	39	23	24	84	59	145	44	0.85	0.70	0.58
1401.II.484 [RV]	49	47	60	34	13	23	90	80	140	35	0.95	0.56	0.49
1401.II.487 [LV]	-	-	62	44	27	-	-	-	-	-	-	0.70	-
1401.II.491 [LV]	54	43	65	38	20	15	95*	55	125	35*	0.80	0.58	0.28
66/2 [RV]	48	46	59	41	21	25	90	65	142	50	0.97	0.70	0.54
66/3 [LV]	45	45	58	36	10	22*	90	-	125	46	1.00	0.62	0.48
66/4 [RV]	63	59	75	44	20	28	90	-	135	50	0.94	0.58	0.47
3/Z.D.1 [RV]	50	61	75	40	-	26	90	75	143	40	1.22	0.53	0.43
Holotype of *M. mytiloides*	62	49	72	40	12	26	90	60	148	50	0.80	0.55	0.53
1/Oz.3.1 [RV]	67	76	94	51	-	41	72	60*	143	37	1.13	0.54	0.54

In subsequent studies both species were differentiated, but the traits set which were to characterize them differed very much. KAUFFMAN (*in* KAUFFMAN & *al.* 1977) underlines first of all the sculpture pattern (stated by SEITZ 1934 to be undistinguishable in both species). KELLER (1982) stated the higher hinge angle, much shorter anterior margin, and much larger angle of umbonal inflation in *M. labiatus* (SCHLOTHEIM). He mentioned also the higher relative values of L/H ratio in *M. labiatus*, the main differing trait of SEITZ (1934).

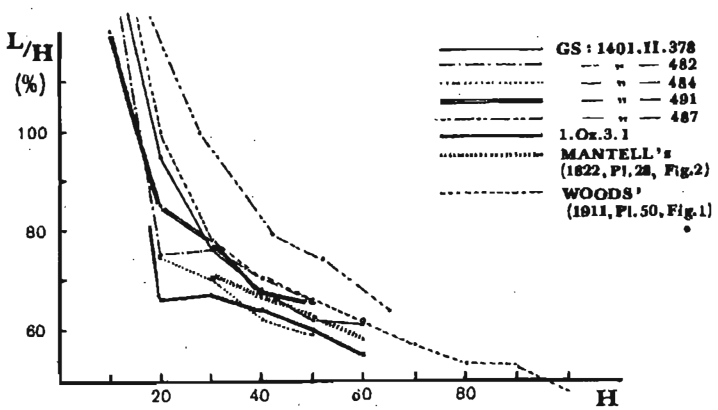


Fig. 5. Ontogenetic change of simple ratio L/H in *Mytiloides labiatus* (SCHLOTHEIM)

In the studied material the specimens close to the respective types of the MANTELL's and SCHLOTHEIM's species represent extremely rare forms, and the most common are intermidiate morphotypes (*see* Pls 2 and 3). The character of anterior side, curvature of the anterior margin, beak region inflation and the ornamentation characteristics are submitted to considerable variability. This concerns also the ontogenetic change of L/H ratio. No trait does give base to divide the sample into any distinct subgroups, which could have been identified with *M. labiatus* (SCHLOTHEIM) and *M. mytiloides* (MANTELL) respectively.

The presented material, and the lack of well-working concepts of the species *M. mytiloides* (MANTELL, 1822) and *M. labiatus* (SCHLOTHEIM, 1813), makes further distinction of both species questionable. In Author's opinion the names *labiatus* and *mytiloides* concern nothing more but extreme morphs of one species, which according to the priority rule must be referred to *Mytiloides labiatus* (SCHLOTHEIM). In such a concept, the species *Mytiloides labiatus* (SCHLOTHEIM), most probably comprises also the species *Mytiloides submytiloides* (SEITZ), discussed hereafter.

OCCURRENCE: Lower Turonian species common allover the world.

Mytiloides submytiloides (SEITZ, 1934)

REMARKS: This species underwent a great stratigraphic career in last years, being, on the other hand, one of the most confusing forms among the low-Turonian mytiloids. SEITZ (1934) distinguished this species from *M. mytiloides* (MANTELL), basing on the presence of the more or less distinct, anterior sulcus. Among the other characteristic traits of his new species, SEITZ (1934) mentioned also the parallel course of the ornament elements on the anteroventral side of the valves, and the slightly different course of the ontogenetical obliquity changes being in the species *submytiloides* higher in the juvenile part when compared to *M. mytiloides* (MANTELL). The given characteristics may be easily found in the type of the species (*see* SEITZ 1934, Text-fig. 8a; Pl. 37, Fig. 1) but besides the anterior sulcus, the other traits are already hardly to be found in other specimens referred to as *M. submytiloides* and illustrated by SEITZ himself (1934, Pl. 37, Fig. 2). Similarly in the material from Ożarów there occur specimens possessing the weakly developed anterior sulcus, but differing each other and being distinct also from the type of SEITZ' species. On the other hand, in the material from Lockwitz, as also from Kozia Góra, there occur specimens identical in their general shape to SEITZ' type but bearing no traces of the anterior sulcus (*see* Pl. 1, Fig. 10, and Pl. 4, Figs 1, 3).

The interpretations of *Mytiloides submytiloides* (SEITZ), as given by KAUFFMAN (1976 and *in*: KAUFFMAN & *al.* 1977) and KELLER (1982), are both quite distinct from the original concept of SEITZ (1934). Little may be said concerning KAUFFMAN's (*in*: KAUFFMAN & *al.* 1977, pp. 82-84, Pl. 86, Figs 7, 10) "*Mytiloides* sp. aff. *M. submytiloides*" as the two illustrated specimens are too poorly preserved to allow for any reliable discussion, but these are rather hardly similar to SEITZ' specimens. The forms reported by KAUFFMAN from Spain (*in*: WIEDMANN & KAUFFMAN 1976, Pl. 1, Fig. 19, and Pl. 1, Fig. 23, the latter specimen referred by him to as "*M. submytiloides* new rugate subsp. transitional to early *M. mytiloides*") and particularly the specimens from Bohemia (KAUFFMAN 1976b, Pl. 1, Figs 2 and 7-8) are undistinguishable from *M. mytiloides* (MANTELL)(= *M. labiatus* as here defined).

The species *Mytiloides submytiloides* (SEITZ) *sensu* KELLER (1982) also differs considerably from the type of the species, being much closer to the forms referred traditionally to *M. labiatus* (SCHLOTHEIM) while, according to SEITZ (1934), *M. submytiloides* approaches rather closely *M. mytiloides* (MANTELL). The distinction of KELLER's concept of the species is well visible *e.g.* in comparison of L/H characteristic of *M. submytiloides* as reported by KELLER (1982, Text-fig. 57) and given by SEITZ (1934, Text-figs 6-7). A remark of the former author that the difference resulted from various measuring method applied by him and SEITZ (1934), in the case of the species *submytiloides* is unfounded. Although SEITZ (1934) measured the L in some forms from the anterior margin and not from the beak, but in the case of *M. submytiloides*, both SEITZ (1934) and KELLER (1982) applied equivalent parameters.

KELLER (1982), as may be judged from his synonymy list, included into his concept of *M. submytiloides* (SEITZ) a wide range of forms being identical only in having a short, curved anterior side. This trait, however, is well represented in other species of the low-Turonian mytiloids, as *e.g. M. kossmati* (HEINZ) or *M. labiatus* (SCHLOTHEIM), and does not represent the characteristics distinctive for the species concerned, according to its original definition of SEITZ (1934).

Concluding, it may be stated that besides the anterior sulcus there is no special morphological characteristics reserved only for *M. submytiloides* (SEITZ) and allowing its distinguishing from *M. labiatus* (SCHLOTHEIM) as here defined. The anterior sulcus was stated till now in many specimens from Kozia Góra (SEITZ 1934), and in the studied material in two specimens from Ożarów. In both cases this trait was found only in specimens preserved as internal moulds, so it is hardly to state whether or not the anterior sulcus represents an original element of the shell. The other characteristics of the species concerned may be easily found in the representatives of *M. labiatus* (SCHLOTHEIM). The parallelism of the ornament elements on the anteroventral side of the valves, mentioned by SEITZ (1934) as characteristic for *M. submytiloides* (SEITZ), may simply be a result of posterolateral compression.

The hitherto illustrated forms and the two specimens found in the studied area and possessing the anterior sulcus, in other respects do not represent any distinct morphological pattern, and they evidently fall into a variability range of *M. labiatus* (SCHLOTHEIM) as here defined. Thus, the anterior sulcus represents the only characteristics typical of *M. submytiloides* (SEITZ), enabling its resonable identification. Therefore, as long as the taxonomical value of the anterior sulcus will not be proved, there is no reason to regard the specimens possesing it as representing distinct species, *M. submytiloides* (SEITZ).

Group of *Mytiloides hercynicus — opalensis*

The inoceramids of the *hercynicus — opalensis* group were found in the studied area only in the Tarłów Graben, precisely in Ożarów and Karsy sections (*see* Text-figs 20-21). The interval with these inoceramids overlies distinctly the interval with *labiatus*-like mytiloids, represented (*see* Text-fig. 3) by the species *M. labiatus* (SCHLOTHEIM) and *M. kossmati* (HEINZ). The studied material was collected in two distinct horizons, where the fossils are relatively frequent, while in the rest of the interval, though the fragments occur, the whole specimens are hardly to be obtained (horizons with frequent *M. hercynicus* and *M. opalensis* - *see* Text-fig. 21). As the specimens are usually more or less deformed, to illustrate the variability of the sample content the critical members of the relative samples are figured (*see* Pls 5-8).

Mytiloides hercynicus (PETRASCHECK, 1903)
(Pl. 5, Figs 1-5)

1903. *Inoceramus hercynicus* n. sp.; W. PETRASCHECK, pp. 156-15, Pl. 8, Figs 1-3, Text-fig. 1.
1928c. *Inoceramus plicatus* d'ORBIGNY, var. *hercynica* PETRASCHECK; R. HEINZ, pp. 65-68, Pl. 4, Fig. 5.
1934. *Inoceramus labiatus* var. *hercynica* PETRASCHECK; O. SEITZ, pp. 454-457.
1934. *Inoceramus labiatus* n. var. *subhercynica* n.f. *transiens*; O. SEITZ, p. 468, Pl. 40, Fig. 3.
1959. *Inoceramus hercynicus* PETRASCHECK; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, pp. 136-137. Pl. 2, Fig. 5.
1968. *Inoceramus hercynicus* PETRASCHECK; S.P. KOTSYUBINSKY, pp. 121-122, Pl. 17, Figs 2-3.
1976b. *Mytiloides subhercynicus transiens* (SEITZ); E.G. KAUFFMAN, Pl. 1, Fig. 6; Pl. 2, Figs 2, 7.
1976b. *Mytiloides ?hercynicus* (PETRASCHECK); E.G. KAUFFMAN, Pl. 1, Fig. 10.
1976b. *Mytiloides hercynicus* (PETRASCHECK); E.G. KAUFFMAN, Pl. 3, Fig. 7.
1976. *Mytiloides subhercynicus* (SEITZ) n.subsp. transitional to *M. mytiloides* (MANTELL); E.G. KAUFFMAN & *al.*, Pl. 11, Fig. 12.
1982. *Mytiloides hercynicus* (PETRASCHECK); S. KELLER, pp. 131-132, Pl. 4, Fig. 1.
1990. *Mytiloides hercynicus* (PETRASCHECK); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 1, Figs 3-4.

LECTOTYPE: *Inoceramus hercynicus* of PETRASCHECK (1903, Pl. 8, Fig. 3), designated by SEITZ (1934, p. 454). The lectotype comes from Bila Hora near Prague, Czecho-Slovakia. The second specimen from the same locality, as illustrated by PETRASCHECK (1903, Pl. 8, Fig. 2), represents the paralectotype.

MATERIAL: 28 specimens represented by internal moulds of single valves only.

Ożarów: Specimens Nos 1.Oz.7.1 through 1.Oz.7.18; 1.Oz.O.1; and 1.Oz.O.2; M. hercynicus Zone.
Karsy-1: Specimens Nos 1.K1.1.1 through 1.K1.1.6; 1.K1.2.1; and 1.K1.2.2; M. hercynicus Zone.

DESCRIPTION: The measurements and simple ratios are given in Table 3 and Text-fig. 6.

Shells of medium to large size for the genus; flat to weakly inclined, particularly in the umbonal region. Anterior margin strongly convex, rounded; hinge line and posterior margin straight. Ventral margin posteriorly ovate, regularly curved. Poterior auricle small to moderate in size, well delimited from the disc, particularly in the umbonal region with a distinct step ("*faltenartige Verdickung*" of PETRASCHECK 1903). Beak-umbo shifted poteriorly. Hinge line short to moderate in length. Anterior side steep, low. Obliquity varies to a considerable extent, with δ ranging from 45 (in strongly oblique forms) to about 60-70 degrees in forms regarded as typical representatives of the species (*see* Table 3 and Pl. 5, Figs 1-5).

Ornamentation on the disc and on the posterior auricle distinct. Disc sculpture in the juvenile part consists of closely spaced, narrow, sharp-edged concentric ribs, with raised rounded concentric rings at their edges ("*Anwachsringreifen*" of HEINZ 1928b) and, characteristic of the species, the doubling of concentric rings along the edges of the ribs. Posterior auricle with sharp, subregular concentric rings, parallel to the posterior margin. The doubling of the raised, sharp-edged concentric rings makes it very similar, particularly when the fragments are concerned, to *M. kossmati* (HEINZ), what in badly or frgmentarily preserved material may lead easily to misidentifications. In some specimens, the adult, concentric ribs are covered with more regularly developed concentric rings.

Table 3

Measurements of selected specimens of *M. hercynicus* (PETRASCHECK); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.Oz.O.1	93	87	108	77	-	35	138	120	140	62	0.93	0.71	0.40
1.Oz.7.6	66	67	73	55	-	24	135	125	130	60	1.01	0.75	0.36
1.Oz.7.1	62	62	75	50	-	25	130	110	134	50	1.00	0.66	0.40
1.Oz.7.4	-	-	-	-	-	-	-	-	-	40	-	-	-
1.K1.1.1	46	48	55	40	-	16	130	118	135	50	1.04	0.72	0.33
1.Oz.7.3	59	65	65	67	-	27	150	-	134	64	1.10	1.03	0.41
1.Oz.7.2	-	-	-	-	-	-	140	-	125	67	-	-	-

REMARKS: The forms referred usually to *Mytiloides hercynicus* (PETRASCHECK) comprise the specimens with low obliquity (*e.g.* KAUFFMAN 1976b, Pl. 3, Fig. 7 and KELLER 1982, Pl. 3, Fig. 1) while the more oblique forms (*e.g.* KAUFFMAN 1976b, Pl. 1, Fig. 6; Pl. 2, Figs 2, 7) are traditionally put into *Mytiloides subhercynicus* (SEITZ). These latter forms, however, are much closer to the holotype of *Mytiloides hercynicus* (PETRASCHECK) than the former, judging on the originals as illustrated by PETRASCHECK (1903, Pl. 8, Figs 2-3) and the measurements on this material as given by SEITZ (1934). Most probably, to *M. hercynicus* (PETRASCHECK) belongs also the type of SEITZ' "*Inoceramus labiatus* var. *subhercynica* forma *transiens*" (SEITZ 1934, Pl. 40, Fig. 3, *non* Fig. 4 which most probably represents *M. kossmati*), representing a more oblique form. Concluding, there are no resonable, natural limits between the weakly and the strongly oblique forms, and all these, being similar in respect of surface ornament, should be regarded as belonging to one species, variable in respect to its obliquity.

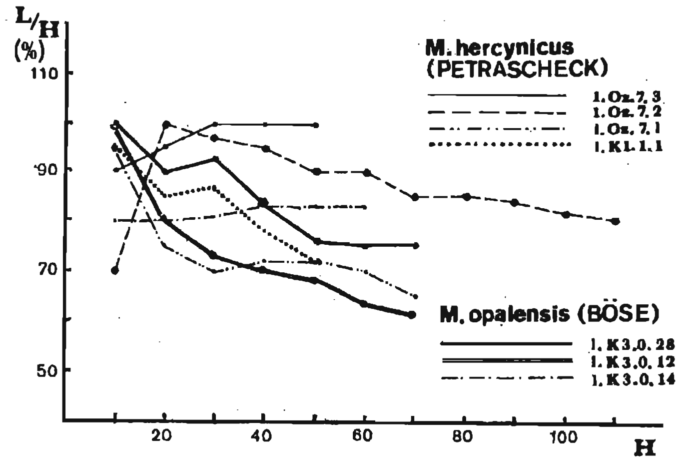


Fig. 6. Ontogenetic change of simple ratio L/H in *Mytiloides hercynicus* (PETRASCHECK) and *Mytiloides opalensis* (BÖSE)

OCCURRENCE: Low-Middle Turonian species (Mytiloides hercynicus and Inoceramus apicalis inoceramid Zones, corresponding, in ammonite standard to the lower part of the Collignoniceras woolgari Zone), widely distributed in Europe, North and South America. Its Lower Turonian reports, judging on the illustrated specimens (SORNAY *in* ROBASZYNSKI 1976, Pl. 2, Fig. 3; and *in* ROBASZYNSKI & *al.*, 1982, Pl. 8, Figs 1a,c, 2), represent rather the species *Mytiloides kossmati* (HEINZ).

Mytiloides opalensis (BÖSE, 1923)
(Text-fig. 3; Pl. 6, Figs 1-4; Pl. 7, Figs 1-3; Pl. 8, Figs 1-5)

?1913. *Inoceramus labiatus* SCHLOTHEIM; E. BÖSE, pp. 25-28, Pl. 2, Fig. 4.
1923. *Inoceramus opalensis* BÖSE, sp. n.; E. BÖSE, pp. 184-185, Pl. 13, Figs 2-3.
1923. *Inoceramus hercynicus* PETRASCHECK; E. BÖSE, pp. 181-183, Pl. 12, Figs 3-4.
part. 1934. *Inoceramus labiatus* n.var. *subhercynica;* O. SEITZ, pp. 465-469, Pl. 40, Fig. 1.
?1962. *Inoceramus labiatus* SCHLOTHEIM; D.E. HATTIN, Pl. 14, Figs D, G.
1976b. *Mytiloides subhercynicus subhercynicus* (SEITZ); E.G. KAUFFMAN, Pl. 1, Fig. 5; Pl. 3, Fig. 3.
1976. *Mytiloides subhercynicus translens* (SEITZ); E.G. KAUFFMAN & *al.*, Pl. 11, Figs 9, 13.
?1982. *Mytiloides transiens* (SEITZ); S. KELLER, pp. 133-135, Pl. 3, Fig. 5
1987. *Mytiloides opalensis* (BÖSE); W.J. KENNEDY & *al.*, Text-fig. 12*E*.

HOLOTYPE: By monotypy, the specimen illustrated by BÖSE (1923, Pl. 13, Figs 2-3), from Opal, Zacatecas, Mexico.

MATERIAL: 31 specimens represented by internal and external moulds of the single valves with shell fragments attached.

Karsy-1: Specimen No. 1.K1.O.1.
Karsy-2: Specimens Nos 1.K2.O.1 through 1.K2.O.15; I. apicalis Zone.
Karsy-3: Specimens Nos 1.K3.O.9; 1.K3.O.11; 1.K3.O.14
through 1.K3.O.19; and 1.K3.O.22 through 1.K3.O.28; I. apicalis Zone.

DESCRIPTION: Measurements and simple ratios are given in Table 4 and Text-fig. 6.

Shells of moderate size for the genus, weakly inclined, flat. Anterior margin convex; the posterior one and the hinge line straight. Anterior side steep, low, similarly as in *M. hercynicus* (PETRASCHECK); posterior and ventral sides flattened. Posterior auricle small, subtriangular, moderately well delimited from the disc, particularly in the umbonal region, The growth axis straight. Obliquity variable (*see* Table 4).

Ornamentation in the juvenile part consists of subrounded to longtidunally ovate concentric rings. In adults, the well developed concentric ribs appear, covered with regularly spaced, raised concentric rings (or growth lines). The third interval possesses irregular ornament, consisting of subevenly to irregularly spaced, flat, concentric ribs (passing into concentric undulations) with only slightly marked, unevenly spaced concentric rings.

REMARKS: The species *Mytiloides opalensis* (Böse) is similar in shape as also in the variability range of its obliquity to *M. hercynicus* (Petrascheck), from which it differs only in the surface sculpture pattern. In weakly oblige forms (with δ between 60-70°) the representatives of the concerned species seem to possess more circular ornament trajectory than the forms belonging to Petrascheck's species. Similarly as in *M. hercynicus* (Petrascheck), the whole range of forms with identical ornamentation but differring only in their obliquity are treated here as representing the infraspecific variablity rather than two distinct species (*see* Pls 6-8). Traditionally, the oblique representatives of *M. opalensis* (Böse), as here defined, were commonly referred, following Seitz' (1934) study, to as *M. subhercynicus* (Seitz). Consequently, to *M. opalensis* (Böse) most probably belongs also the type of *Inoceramus labiatus* var. *subhercynica* of Seitz (1934, Pl. 40, Fig. 1). It represents a deformed specimen comparable to the markedly oblique ones, illustrated in the present paper (*see* Pl. 7, Fig. 4; Pl. 8, Fig. 2), as also to the specimen coming from the type locality of *M. opalensis* (Böse) and reported by Böse (1923, Pl. 12, Fig, 3) under the name *Inoceramus hercynicus* Petrascheck.

Table 4

Measurements of selected specimens of *M. opalensis* (Böse); linear dimensions *in* mm

Specimen	h	l	H	L	b	a	α	β	γ	δ	l/h	L/H	a/l
1.K3.0.19	38	40	42	35	-	14	150	135	160	50	1.05	0.83	0.35
1.K3.0.28	52	65	60	73	-	27	134	-	152	33	1.25	1.21	0.41
1.K2.0.2	37	42	44	35	-	15	135	118	145	43	1.13	0.80	0.35
1.K2.0.7	-	-	-	-	-	-	-	-	-	42	-	-	-
1.K2.0.3	78	70	85	63	-	-	134	-	140	60	0.90	0.74	-
1.K2.0.4	-	-	-	-	-	-	-	-	-	50	-	-	-

OCCURRENCE: The real stratigraphic and geographic extent is poorly known as the name "*opalensis*" was, following the study of Seitz (1934), taken for forms completely different from the Böse's original concept, being commonly apllied to *M. opalensis* (sensu Seitz, *non* Böse) representing, according to here presented concept, *M. kossmati* (Heinz). The representatives of the species are to be found also among the forms referred traditionally to as *M. subhercynicus* (Seitz). The unquestionable records come from North America and Europe. In the studied area the species occurs in the M. hercynicus Zone and the I. apicalis Zone, corresponding in ammonite standard to the lower part of the Middle Turonian Collignoniceras woolgari Zone. The same stratigraphic position for the species was reported by Kennedy & *al.* (1987).

Mytiloides subhercynicus (Seitz, 1934)

Seitz (1934) established the variety "*subhercynica*" for all flat, markedly oblique (with δ between 30 to 50 degrees) forms, with longitudinally ovate trajectory of the ornament elements. In such concept of *M. subhercynicus* (Seitz) one can find the forms with variable surface ornamentation as also the forms variable in their posterior auricle, but still fitting the original definition. Taking into account more natural grouping of particular traits, as displayed by the one-level paleontological samples, it seems that such features as the presence of posterior auricle, or surface ornament pattern, at least in the case of low-Turonian mytiloids, are the more intrinsic for species definition than the obliquity or minor shifts in ornament shape trajectory. The species *M. subhercynicus* (Seitz) represents evidently a conglomerate of extreme forms belonging to different species. According to the interpretation of the *M. labiatus* group, presented herein, among the forms illustrated by SEITZ (1934) and referred by him to *M. subhercynicus* (SEITZ) one may find: (i) *Mytiloides kossmati* (HEINZ) (*see* SEITZ 1934, Text-figs 18a-f, and Pl. 40, Figs 2, 4-5); (ii) *Mytiloides hercynicus* (PETRASCHECK), to which belongs the type of *M. subhercynicus* forma *transiens* (*see* SEITZ 1934, Pl. 40, Fig. 3); and (iii) *Mytiloides opalensis* (BÖSE), to which belongs the type of var. *subhercynica* (*see* SEITZ 1934, Pl. 40, Fig. 1).

According to the here presented concepts of *M. kossmati* (HEINZ), *M. hercynicus* (PETRASCHECK) and *M. opalensis* (BÖSE), the species *M. subhercynicus* (SEITZ) does not represent any independent taxon, as it embraces the extreme forms, *i.e.* markedly oblique, belonging to three formerly mentioned species and thus this name should be rejected.

Mytiloides labiatoidiformis (TRÖGER, 1967)
(Pl. 12, Figs 1-2)

1967. *Inoceramus dresdensis? labiatoidiformis* n. sp.; K.-A. TRÖGER, pp. 125-127, Pl. 10, Figs 5-6.
1990. *Mytiloides labiatoidiformis* (TRÖGER); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 2, Fig. 4.

HOLOTYPE: By original designation, the specimen illustrated by TRÖGER (1967, Pl. 10, Fig. 5) from the Upper Turonian of Strehlen (Saxony, Germany).

MATERIAL: 5 specimens represented by internal moulds of single valves, with shell fragments attached.

Folwark Quarry: Specimens Nos 4.F.1.1 and 4.F.1.2; M. incertus Zone.
Bolko Quarry: Specimens Nos 4.B.3.1 and 4.B.3.2; I. costellatus Zone.
Aksu-Dere (Crimea, the Ukraine): Specimen No. 5.C.3 (*see* KOPAEVICH & WALASZCZYK 1990, Pl. 2, Fig. 4); C. waltersdorfensis Zone.

DESCRIPTION: Measurements and simple ratios are given in Table 5 and Text-fig. 7.

Shells of small to medium size for the genus, of a mytiloid shape, equivlaved (*after* TRÖGER 1967), inequilateral. Valves moderately convex with maximum inflation dorso-central. Anterior margin straight, short, with the length about a half of the respective height. Ventral and posterior margins rounded. Anterior side steep, almost perpendicular to the sagittal plane; other sides flattened. Hinge line short (about 0.4 of the respective H), straight. Umbonal region relatively well separated. Posterior auricle small, subtriangular not separated from the disc. Beak-umbo projecting slightly above the hinge line being incurved anterodorsally.

Ornamentation consists of concentric rings or simply growth lines, and later of concentric ribs, gradually increasing in their size and mutual interspaces, with the latter ranging maximally up to 5mm. Similarly, as mentioned by TRÖGER (1967), in adult parts the concentric ribs become slightly asymmetrical.

Table 5

Measurements of selected specimens of *M. labiatoidiformis* (TRÖGER); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
4.F.1.1	24	23	28	18	-	15	106	90	134	55	0.95	0.64	0.65
5.C. 3 (Crimea)	35	30	38	25	-	15	103	80	138	50	0.85	0.65	0.50

REMARKS: The specimens figured by KELLER (1982, Pl. 5, Figs 5, 7) and ascribed to the concerned species differ in another sculpture pattern, and the slightly outwardly inclined ornament elements on the posterior auricle, the feature not observed on the original of TRÖGER's species. Such forms are noted in the studied area in the M. incertus Zone (*see* Pl. 12, Figs 13-14). The number of specimens in Author's disposal is, however, too small to judge whether it is possible to accept such a great intraspecific variability of *M. labiatoidiformis* (TRÖGER), or to regard the forms reported by KELLER (1982) as a distinct species.

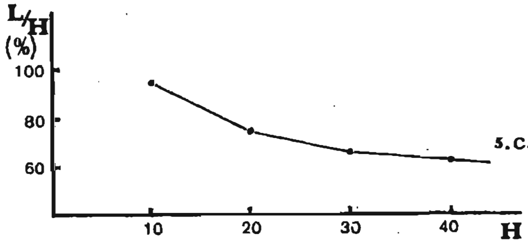


Fig. 7

Ontogenetic change of simple ratio L/H in *Mytiloides labiatoidiformis* (TRÖGER)

OCCURRENCE: Known from the Upper Turonian through lowermost Coniacian of Europe and the western Asia (Mangyshlak, Kazakhstan - *see* NAIDIN & *al.*, 1984).

Mytiloides incertus (JIMBO, 1894)
(Pl. 12, Figs 11-12)

part. 1872-75. *Inoceramus Cuvieri* SOWERBY; H.B. GEINITZ, Pl. 13, Fig. 6.
part. 1872-75. *Inoceramus striatus* MANTELL; H.B. GEINITZ, Pl. 13, Fig. 9.
1894. *Inoceramus incertus* n. sp.; K. JIMBO, p. 189, Pl. 24, Fig. 7.
part. 1930. *Inoceramus inconstans inconstans* WOODS; K. FIEGE, pp. 38-39, Pl. 5, Figs 16-17, Pl. 6, Fig. 18.
part. 1940. *Inoceramus incertus* JIMBO; T. NAGAO & T. MATSUMOTO, pp. 10-13, Pl.3, Figs 1-3; Pl. 10, Fig. 2.
1967. *Inoceramus fiegei fiegei* n. sp. n. ssp.; K.-A. TRÖGER, pp. 105-108, Pl. 11, Fig. 3; Pl. 13, Figs 14-15, 17, 20.
1974. *Inoceramus* cf. *fiegei* TRÖGER; J. SORNAY, p. 32, Pl. 2, Fig. 7.
1976. *Mytiloides fiegei fiegei* (TRÖGER); E.G. KAUFFMAN & *al.*, Pl. 15, Fig. 1; Pl. 16, Fig. 4.
1977b. *Mytiloides fiegei fiegei* (TRÖGER); E.G. KAUFFMAN, Pl. 11, Fig. 1; Pl. 12, Fig. 4.
1982. *Inoceramus fiegei fiegei* TRÖGER; S. KELLER, pp. 110-112, Pl. 7, Fig. 5.
1983. *Mytiloides incertus* (JIMBO); T. MATSUMOTO & M. NODA, pp. 109-112, Text-figs 2-5.
1984. *Mytiloides incertus* (JIMBO); M. NODA, pp. 458-467, Text-figs 7-8; Pl. 84, Figs 1-10; Pl. 85, Figs 1-2; Pl. 86, Figs 1-8.
1990. *Mytiloides incertus* (JIMBO); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 1, Fig. 5.

TYPES: As the loctotype of the species MATSUMOTO & NODA (1983; *see also* NODA 1984, Pl. 84, Fig. 1) designated one of the syntypes of JIMBO (1894); the second specimen from JIMBO's syntypes was designated by the same authors as the paralectotype (MATSUMOTO & NODA 1983, Text-fig. 4; *see also* NODA, 1984, Pl. 84, Fig. 2). The types come from the pebble in the River Pombets, Mikasa City, central Hokkaido, Japan.

MATERIAL: 5 specimens represented by internal moulds of single valves, fragmentarily preserved.

Folwark Quarry: Specimens Nos 4.F.1.3 through 4.F.1.6; M. incertus Zone.
Aksu-Dere (Crimea, the Ukraine): Specimen No. 5.C.2 (*see* KOPAEVICH & WALASZCZYK 1990, Pl. 1, Fig. 5); M. incertus Zone.

REMARKS: The specimens from Folwark Quarry are poorly and fragmentarily preserved, but all they display the main characteristics of JIMBO's species, and i.e. the subquadrate, mytiloid shape of the valves and very characteristic surface ornamentation, consisting of regular concentric ribs, covered with regularly spaced concentric rings (= growth lines). The nomenclatorical problems, biometry and the variability of the species are profoundly discussed by NODA (1984).

OCCURRENCE: In Japan, the species occurs in the Upper Turonian, and seemingly it does not pass the Turonian/Coniacian boundary (NODA 1984), though it ranges very close to it. Similar stratigraphic position, i.e. the upper part of the Upper Turonian is also given by KELLER (1982) for specimens from northern Germany and by KAUFFMAN (1977a, b) for these from the United States. TRÖGER (1967, 1981a) reports *M. incertus* (JIMBO)(= *Inoceramus fiegei fiegei* TRÖGER) still from the Lower Coniacian, up to the occurrence level of *Cremnoceramus schloenbachi* (BÖHM)(= *C. crassus* as here defined), so according to here accepted substage division it would range into the Middle Coniacian. SORNAY (1974) reports the species from Afghanistan where, judging on the accompanied fauna, it occurs within the lowermost Coniacian. In the studied area it was found in the upper part of the Upper Turonian.

The species is reported not only throughout the northern hemisphere, but also from South America (KAUFFMAN & BENGTSON, 1985).

Group of *Mytiloides striatoconcentricus* (GÜMBEL, 1868)

NEOTYPE: Due to a lack of the type of the species in the original collection of GÜMBEL (1868), DACQUÉ chosen one of the specimens, determined by GÜMBEL as *Inoceramus* aff. *striatus* MANTELL et *concentricus* PARKINSON as the neotype of the species (DACQUÉ 1939, Pl. 17, Fig. 5). The neotype comes from the Upper Turonian/?Lower Coniacian Grossbergschichten, southern Germany, from the environs of Thalmässing.

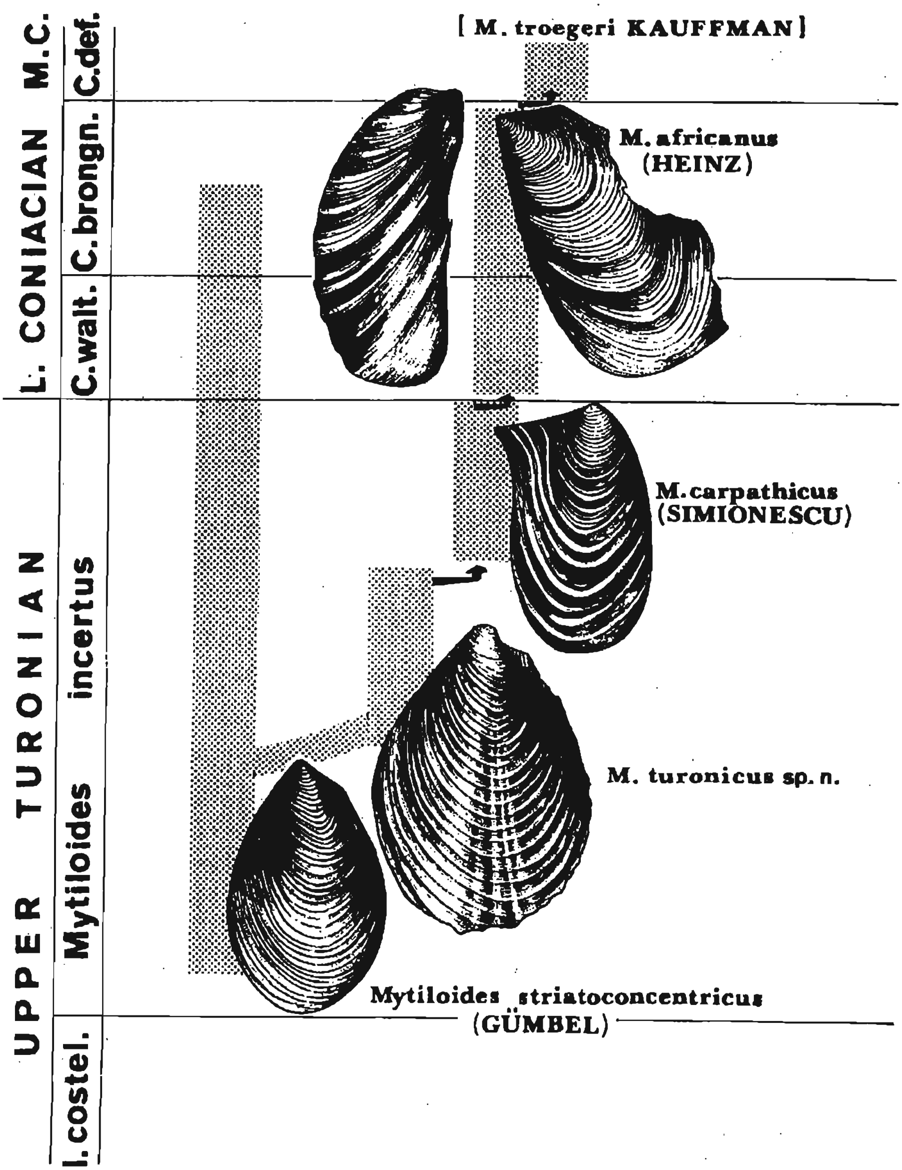


Fig. 8. Stratigraphic ranges and phylogeny of the *Mytiloides striatoconcentricus* (GÜMBEL) lineage

The group of *M. striatoconcentricus*, as here accepted, corresponds nearly to the diagnosis of the GÜMBEL's species as currently given by HEINZ (1928a) and TRÖGER (1967). Simply, the particular variants within the species *M. striatoconcentricus* of GÜMBEL, treated hitherto as of subspecific rank, are herein regarded as sufficiently differentiated to represent distinct species (*see* Text-fig. 8). The group of *Mytiloides striatoconcentricus* encompasses the Late Turonian - Early Coniacian "*labiatus*"-like forms, markedly convex, almost straight along growth axis and differing from the low-Turonian mytiloids by another surface ornamentation and the posteriorly curved ornament elements on the posterior auricle. The variability of the species concerns mainly the character of the surface ornamentation, which may be accompanied by the delicate shift of such other characteristics, as convexity, character of the umbonal part, L/H ontogentical change (Text-fig. 8; *see also* TRÖGER 1967, KELLER 1982). Besides the species *M. striatoconcentricus* (GÜMBEL), *M. turonicus* sp. n. [the name introduced hereafter for forms referred commonly to as *M. striatoconcentricus* aff. *carpathicus* (HEINZ)], and *M. troegeri* KAUFFMAN, the other species considered to belong to the group concerned (*see* Text-fig. 8) are *M. carpathicus* (SIMIONESCU) and *M. africanus* (HEINZ).

In the studied material the group of *M. striatoconcentricus* is relatively poorly represented quantitatively (about 30 specimens), though it displays, moderately high morphological variability (*see* Text-fig. 8 and Pls 13-15). The vertical distribution of particular species suggests the directional shift of their characteristics leading from the nominative species through species *turonicus*, and *carpathicus* to the species *troegeri*, implying them to be successive chronospecies (*see* Text-fig. 8). The discussion on the nomenclatorical problems confined to particular species are given at the species description.

Mytiloides striatoconcentricus (GÜMBEL, 1868)
(Text-fig. 8; Pl. 13, Figs 1-7)

1869. *Inoceramus striato-concentricus* GÜMBEL; C.W. GÜMBEL, p. 69, Pl. 2, Fig. 4.
1928c. *Inoceramus striatoconcentricus* GÜMBEL; R. HEINZ, pp. 68-70, Pl. 4, Fig. 3.
1960. *Inoceramus* sp. ex gr. *striato-concentricus* GÜMBEL; K.-A. TRÖGER & L. WOLF, p. 295, Text-fig. 4.
?1962. *Inoceramus striato-concentricus* GÜMBEL; F. BRÄUTIGAM, pp. 207-208, Pl. 4, Figs 2-3.
1967. *Inoceramus striatoconcentricus striatoconcentricus* GÜMBEL; K.-A. TRÖGER, pp. 84-86, Pl. 9, Figs 11-15, 17.
part. 1968. *Inoceramus carpathicus* SIMIONESCU; S. PAULIUC, pp. 89-91, Pl. 22, Fig. 1.
1971. *Inoceramus striatoconcentricus* GÜMBEL; M.A. PERGAMENT, pp. 59-60, Pl. 8, Figs 2-3.
?1976c. *Mytiloides* (?) *striatoconcentricus striatoconcentricus* (GÜMBEL); E.G. KAUFFMAN, Pl. 2, Figs 5-6.
1982. *Inoceramus striatoconcentricus striatoconcentricus* (GÜMBEL); S. KELLER, pp. 105-107, Pl. 7, Fig. 5.

NEOTYPE: The specimen illustrated by DACQUÉ (1939, Pl. 17, Fig. 5) from the Upper Turonian/?Lower Coniacian Grossbergschichten, southern Germany, from the environs of Thalmässing.

MATERIAL: 10 specimens represented by internal moulds of single valves, usually uncompletely preserved.

Folwark Quarry: Specimens Nos 4.F.3.1 through 4.F.3.3; and 4.F.1.5 through 4.F.1.7; M. incertus Zone.
Słupia Nadbrzeżna-Wesołówka: Specimen No. 1.SW.6.11; C. brongniarti Zone.
Kolonka-2: Specimen No. 1.K12.O.117; C. brongniarti Zone.
Miąsowa: Specimen No. 2.M.O.1; ?M. incertus Zone.

DESCRIPTION: Shells small, of a moderate size for the genus, inequilateral, equivalved. Valves elongate-ovate, prosocline with inclined umbonal part and with umbo slightly to moderately projecting above the hinge line. Growth axis straight or slightly inclined anteriorly. Anterior side steep, may be slightly concave at the umbonal part; the ventral and posterior sides flattened. Anterior margin straight, the others rounded. Posterior auricle of moderate size, usually well delimited from the disc, with marked posterior sulcus.

Ornamentation consists of regularly spaced, symmetrical concentric rings with sharp edges, and with interspaces only slightly increasing in ontogeny. In adults indistinct undulations may occur. Ornament elements pass onto the posterior auricle, with their marked posterodorsal curvation.

REMARKS: When passing to stratigraphically younger specimens the faint, closely spaced concentric rings, as observed in the mid-Upper Turonian representatives shift toward those more loosely spaced, with wider bases, but still keeping the symmetry. The latter specimens, occurring in the lowermost Coniacian strata, judging on the illustration in DACQUÉ (1939), fit the closest to the neotype of the species.

The juvenile specimens of the species are undistinguishable from *M. carpathicus* (SIMIONESCU).

OCCURRENCE: Known from mid-Upper Turonian to lowermost Coniacian of Europe, Asia, Africa and North and South America.

Mytiloides turonicus sp. n.
(Text-fig. 8)

part. 1872-75. *Inoceramus latus* MANTELL; H.B. GEINITZ, pp. 45-46, Pl. 13, Fig. 5.
?1928b. *Inoceramus striato-concentricus* GUMBEL aff. *carpathicus* SIMIONESCU; R. HEINZ, p. 34, Pl. 1, Fig. 3.
1967. *Inoceramus striatoconcentricus* GÜMBEL aff. *carpathicus* SIMIONESCU; K.-A. TRÖGER, pp. 87-88, Pl. 9, Figs 10?, 18.
1968. *Inoceramus carpathicus* SIMIONESCU; S. PAULIUC, pp. 89-91, Pl. 23, Fig. 1; Pl. 24, Fig. 1.
?1982. *Inoceramus striatoconcentricus* GUMBEL aff. *carpathicus* SIMIONESCU; S. KELLER, pp. 107-109, Pl. 5, Fig. 2.
non 1976c. *Mytiloides* (?) *striatoconcentricus carpathicus* (SIMIONESCU); E.G. KAUFFMAN, Pl. 2, Fig. 14.

HOLOTYPE: The specimen figured by GEINITZ (1872-75, Pl. 13, Fig. 5) under the name *Inoceramus latus* MANTELL; reillustrated later by TRÖGER (1967, Pl. 9, Fig. 18), from the Upper Turonian Plenerkalk of Strehlen, near Dresden, Germany.

TYPE LOCALITY: Dresden-Strehlen (Saxony, Germany).
TYPE HORIZON: Upper Turonian, ?M. incertus Zone.
DERIVATION OF THE NAME: After the name of the Turonian stage.

DIAGNOSIS: The species of the *M. striatoconcentricus* (GÜMBEL) lineage possessing regular, asymmetrical, lamellate concentric rings.

MATERIAL: One, poorly preserved specimen, represented by internal mould of the single valve, from the Upper Turonian of Folwark Quarry; M. incertus Zone.

REMARKS: The new species *Mytiloides turonicus* is introduced herein for the forms referred by HEINZ (1928b) to as "*Inoceramus striatoconcentricus* aff. *carpathicus* SIMIONESCU". HEINZ (op. cit.) referred in his original description to the specimen illustrated by GEINITZ (1872-75, Pl. 13, Fig. 5; reillustrated later by TRÖGER 1967, Pl. 9, Fig. 18), well corresponding to the specific characteristics of *Mytiloides striatoconcentricus* (GÜMBEL) except of the surface ornamentation. In the forms assigned here as *M. turonicus* sp. n., it is composed of asymmetrical, lamellate concentric rings, regularly spaced over the disc. In GÜMBEL's species, the surface ornamentation is composaed of evenly and closely spaced concentric rings, symmetrical in cross section. TRÖGER (1967) and KELLER (1982) remark, moreover, small differences in valves convexity, and development of the umbonal part, but these may be stated only when basing on the well preserved material.

The name *turonicus* is introduced because neither the specimen of GEINITZ (1872-75, Pl. 13, Fig. 5), being the holotype of the form, nor the specimen illustrated by HEINZ (1928b, Pl. 1, Fig. 3) correspond to the species *carpathicus* in a sense of SIMIONESCU (1899a). Moreover, the specimen of HEINZ (1928b) doubtfully belongs to the group of *M. striatoconcentricus* (GÜMBEL). This form, relatively flat, subquadrate in shape with indistinct posterior auricle (at least in the part preserved) from the Chalk of Kent seems to be much closer to lamellate, early representatives of the genus *Cremnoceramus*, particularly *Cremnoceramus denselamellatus* (KOTSYUBINSKY).

The affinity of HEINZ's "*M. striatoconcentricus* aff. *carpathicus*" to the species *M. carpathicus* (SIMIONESCU) was questioned lastly by KAUFFMAN (*in* HERM & *al.*, 1979), who included this form into a range of his new subspecies *troegeri*. However, judging on the holotype of *M. striatoconcentricus troegeri* KAUFFMAN (*see* HERM & *al.* 1979, Pl. 10*D*, *E*), his subspecies represents still another form, possessing wide, low concentric ribs, covered with subrounded, subevenly spaced concentric rings, what makes it easily distinguishable from *M. turonicus* sp. n. (= the subspecies aff. *carpathicus* sensu HEINZ).

The form *Mytiloides* (?) *striatoconcentricus carpathicus* (SIMIONESCU) illustrated by KAUFFMAN (1976c, Pl. 2, Fig. 14) from South Africa possesses distinct concentric ribs, with subrounded "massive" concentric rings and should be referred to as *M. troegeri* KAUFFMAN.

To the species *M. turonicus* sp. n. belong, on the other hand, the forms ascribed to *Inoceramus carpathicus* SIMIONESCU by PAULIUC (1968, Pl. 23, Fig. 1; Pl. 24, Fig. 1) from the Turonian of Romania.

OCCURRENCE: Known exclusively from Europe (Germany, Romania, ?England, Poland), from the upper part of the Upper Turonian to ?lowermost Coniacian strata.

Mytiloides troegeri KAUFFMAN, 1979
(Pl. 13, Fig. 8)

1976c. *Mytiloides* (?) *striatoconcentricus carpathicus* (SIMIONESCU); E.G. KAUFFMAN, Pl. 2, Fig. 14.
1979. *Mytiloides striatoconcentricus trögeri* n. subsp.; E.G. KAUFFMAN (*in* HERM & *al.*, pp. 65-67, Pl. 10, Figs D, E.

HOLOTYPE: By original designation, the specimen illustrated by KAUFFMAN (*in* HERM & *al.* 1979, Pl. 10, Figs D, E), from the ?Middle Coniacian of the Brandenberg Basin, Gosau, near Zoetbachgraben (bed d_4).

MATERIAL: One specimen represented by internal mould of the left valve, from the Middle Coniacian (Cremnoceramus deformis Zone) strata of Słupia Nadbrzeżna-3 (specimen No. 1.SN3.O.5).

REMARKS: The full description of the species was given by KAUFFMAN (*in* HERM & *al.* 1979, pp. 65-67). From the other representatives of the group *Mytiloides striatoconcentricus* (GÜMBEL), the species concerned differs in its surface ornament, consisting of widely spaced concentric ribs, covered by subrounded in cross section, raised, subevenly spaced, particularly well visible on the ribs edges concentric rings.

OCCURRENCE: Known from the Lower and Middle Coniacian of Europe and Africa.

Mytiloides carpathicus (SIMIONESCU, 1899)
(Text-fig. 8; Pl. 14, Figs 1-8; Pl. 15, Figs 1-8)

1899a. *Inoceramus labiatus* var. *carpathica* m.; J. SIMIONESCU, p. 261, Pl. 2, Fig. 1a, b.
1899a. *Inoceramus labiatus* SCHLOTHEIM; J. SIMIONESCU, pp. 259- 260, Pl. 2, Fig. 2.
1899a. *Inoceramus labiatus* SCHL. var. *regularis* m.; J. SIMIONESCU, pp. 260-261, Pl. 2, Fig.3
?1899a. *Inoceramus kiliani* n. sp.; J. SIMIONESCU, Pl. 2, Fig. 5.
?1963. *Inoceramus glatziae* FLEGEL; Z. RADWAŃSKA, Pl. 6, Fig. 1.
non 1968. *Inoceramus carpathicus* SIMIONESCU; S. PAULIUC, pp. 89-91, Pl. 22, Figs 1-4; Pl. 23, Figs 1-2; Pl. 24, Fig. 1.

1969. *Inoceramus herbichi* nom. nov.; A.A. ATABEKIAN, p. 11.
non 1976c. *Mytiloides* (?) *striatoconcentricus carpathicus* (SIMIONESCU); E.G. KAUFFMAN, Pl. 2, Fig. 14.
non 1985. *Inoceramus striatoconcentricus carpathicus* SIMIONESCU; L. SZASZ, p. 171, Pl. 33, Figs 4-5.
1988. *Mytiloides* aff. *labiatoidiformis* (TRÖGER); I. WALASZCZYK, Pl. 6, Figs 8-9.

HOLOTYPE: By monotypy, the specimen figured by SIMIONESCU (1899, Pl. 2, Fig. 1) from Ürmös (Transilvania, Romania), from the uppermost Turonian/lowermost Coniacian boundary beds.

MATERIAL: 18 complete or almost complete internal moulds of single and double-valved specimens, with shell fragments attached.

Słupia Nadbrzeżna - Wesołówka: Specimens Nos 1.SW.2.1 through 1.SW.2.14; and ME: ML 1195; M. incertus Zone.
Folwark Quarry: Specimens Nos 4.F.3.4 and 4.F.3.5; M. incertus Zone.
Brzeźno: Specimen No. GS: 1401.II.60; ?M. incertus Zone.

DESCRIPTION: Shells of a moderate size for the genus, with outline inclined, elongate-ovate, beak projected dorsally. Hinge line of moderate length (about 0.4 of respective H), straight. Dorsoanterior margin straight, ventral and posterior ones rounded. Valves moderately convex (though in most specimens the original convexity not preserved) with maximum inflation dorsocentral. Anterior flank steep, passing ventrally into the flattened ventral and posterior ones. Beak narrow, terminal, anterior, projecting slightly above the hinge line, slightly curved anteriorly. Posterior auricle, well separated from the disc by a more or less well developed posterior sulcus, displays a high range of variability concerning its shape and size, as it ranges from wide, well distincted from the disc to much smaller, subtriangular, with its posterior sulcus poorly developed. Anterior hinge angle averages 104°; the angle of umbonal inflation about 70°. The measurements and simple ratio L/H are given in Text-fig. 9 and Table 6. Ornamentation up to 20mm axial length consists of faint, raised concentric rings (= growth lines), evenly and closely spaced. Later, there appear low, slightly asymmetrical, irregular concentric ribs, covered with subevenly spaced concentric rings. On the wing, the ornament elements markedly incurved posterodorsally. The ornamentation pattern, particularly in the middle of the disc, displays high variability, in a shape and regularity of the concentric ribs.

Table 6

Measurements of selected specimens of *M. carpathicus* (SIMIONESCU); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.SW.2.8a	33	22	34	22	-	12	110	82	90	70	0.66	0.65	0.55
1.SW.2.5	35	26	38	23	-	19	105	70	90	65	0.74	0.60	0.73
1.SW.2.1	47	28	47	27	-	20	110	80	90	73	0.60	0.57	0.71
1.SW.2.20	41	28	45	27	-	19	103	75	90	75	0.68	0.60	0.67

REMARKS: In regard with the variability of the species as observed in the studied material, included into the synonymy are all specimens figured by SIMIONESCU (1899a) and designated by him to *Inoceramus labiatus* SCHLOTHEIM and its varieties. His *Inoceramus labiatus* SCHLOTHEIM, forma typica (SIMIONESCU, 1899a, Pl. 1, Fig. 9 and Pl. 2, Fig. 2) and *Inoceramus labiatus* SCHLOTHEIM var. *regularis* SIMIONESCU (1899a, Pl. 2, Fig. 3) differ from the holotype of the species *M. carpathicus* in the posterior auricle development only, and both of them may be well contained in the variability range of the species concerned. It can not be excluded that also *Inoceramus kiliani* SIMIONESCU (1899a, Pl. 2, Fig. 5) may represent highly deformed specimen of the species *carpathicus*, as it is appearant from an almost identical specimen in the studied material (Pl. 14, Fig. 4 and Pl. 15, Fig. 5).

As was already mentioned by TRÖGER (1967), SORNAY (1974) and KAUFFMAN (*in* HERM & *al.* 1979), the concept of HEINZ' subspecies *striatoconcentricus* aff. *carpathicus* markedly differs from the species *carpathicus* in a sense of SIMIONESCU (1899a). The latter is elongate-ovate, possesses much more extended and well separated posterior auricle (though this traits display relatively high variability), has much lower value of L/H , and another sculpture pattern.

No one of the hitherto published specimen, referable directly to SIMIONESCU's species can be here accepted (*see* synonymy). From Romania, relatively rich material was illustrated by PAULIUC (1968), but none of his figured forms, which he assigned to *Inoceramus carpathicus* SIMIONESCU, represent this species, being rather closer to the concept of *Mytiloides striatoconcentricus* aff. *carpathicus* of HEINZ (1928b). The specimens figured by SZASZ (1985, p. 171, Pl.33, Figs 4-5) and compared by him to *M. striatoconcentricus carpathicus* (SIMIONESCU) also do not belong evidently to SIMIONESCU's species. In the Author's opinion these forms represent *Mytiloides sabzakensis* (SORNAY).

The small representatives of *Mytiloides carpathicus* (SIMIONESCU) are indistinguishable from small specimens of *M. striatoconcentricus* (GÜMBEL).

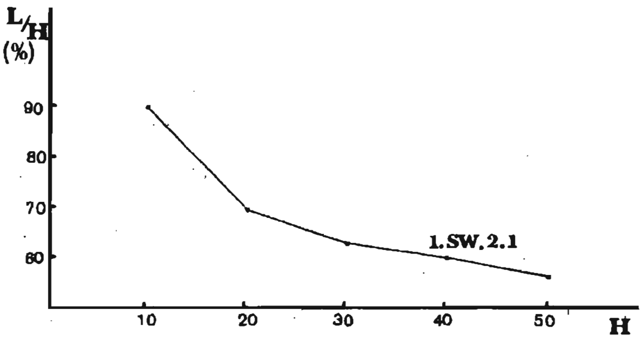


Fig. 9. Ontogenetic change of simple ratio L/H in *Mytiloides carpathicus* (SIMIONESCU)

OCCURRENCE: The material of SIMIONESCU (1899a, b), including the holotype of the species, comes from the classic section at Ormensis Village (near Ürmös), Romania, from 5m thick marly layer, which was dated by SZASZ (1985) for the Lower Coniacian. SZASZ (1986b) based his stratigraphic diagnosis on the occurrence of the bivalves of the genus *Didymotis* GEBHARDT, which, however, according to the data from Germany (ERNST & *al.* 1983), Spain (KÜCHLER & ERNST 1989) or Poland (this paper) may well occur far down within the Upper Turonian. In the studied area the representatives of *Mytiloides carpathicus* (SIMIONESCU) were found exclusively in the uppermost Turonian, and similarly they were found in the same stratigraphic position in the Sudetes (*see* RADWAŃSKA 1963).

Mytiloides africanus (HEINZ, 1930)
(Text-fig. 8; Pl. 29, Fig. 1)

1930. *Inoceramus africanus* HEINZ; H. BESAIRIE, p. 128

1933. *Mytiloides africanus* HEINZ; R. HEINZ, pp. 249-250, Pl. 21, Figs 3-4.

?1979. *Mytiloides africanus* (HEINZ); E.G. KAUFFMAN *in* D. HERM & *al.*, pp. 61-63, Pl. 9, Figs L, P.

HOLOTYPE: By original designation, the specimen from Andronovorikolo, Maintirano County, Madagascar, illustrated by HEINZ (1933, pp. 249-250, Pl. 21, Fig. 3).

MATERIAL: One double-valved specimen represented by internal mould from Maksymów (Specimen No. ME: ML 1140); C. brongniarti Zone.

DESCRIPTION: Shells of medium size, inequilateral, equivalved, moderately inflated, with maximum inflation dorsocentral. The valves subrectangular to elongate-ovate. Anterior margin straight, slightly concave below the beak, moderately short, less than a half of the respective axial length. It passes into the rounded ventral margin, markedly elongated axially. Anterior side steep, with the others gently sloping. Posterior auricle poorly preserved, but it seems to be of limited extension, poorly separated from the disc. Beak pointed, slightly projecting above the hinge line.

Ornamentation consists of subregular, round-edged, subevenly spaced concentric ribs, slightly asymmetrical, with ventral sides steeper. The ribs begin in about 10mm axial length from the beak. They are covered by regular, evenly spaced, raised, rounded concentric rings. The ornamentation does not seem to continue onto the posterior auricle.

REMARKS: From *Mytiloides mytiloidiformis* (Tröger) the species which is featured by a very similar shape and ornament (*see* Tröger 1967, Pl. 11, Fig. 4; Noda 1984, Pl. 86, Fig. 9), this species differs in its straight growth axis (instead of anteriorly curved as in the former species), the much shorter relative anterior margin, and the pointed beak.

The specimen illustrated by Heine (1929, Pl. 4, Figs 25-26) as *Inoceramus labiatus* (Schlotheim) is poorly preserved to judge definitely, but it seems to be closer to *M. mytiloidiformis* (Tröger than to *M. africanus (*Heinz).

The fragmentarily preserved or the juvenile specimens, possessing ornamentation pattern typical of the species concerned are frequent in the Lower Coniacian strata. However, any distinguishing in this material between *M. africanus* (Heinz), *Inoceramus annulatus* Goldfuss, or *I. lusatiae* Andert is hardly possible.

The species *Mytiloides africanus* (Heinz) represents the member of the Upper Turonian — Middle Coniacian lineage (*see* Text-fig. 8), that comprises *Mytiloides striatoconcentricus* (Gümbel) — *M. turonicus* sp. n. — *M. carpathicus* (Simionescu) — *M. africanus* Heinz and *Mytiloides troegeri* Kauffman.

OCCURRENCE: Heinz (1933) suggested a very extensive vertical distribution of this species, ranging from the Lower Coniacian till the Maastrichtian, although the Campanian - Maastrichtian interval he marked with a question mark. Kauffman (*in* Herm & *al.* 1979) reported the species from the Lower Coniacian of the Gosau Cretaceous. In the studied area it was found in the same stratigraphic position, i.e. in the C. brongniarti Zone.

Genus *Inoceramus* Sowerby, 1814

TYPE SPECIES: *Inoceramus cuvieri* Sowerby, 1814; *SD* Cox, 1969, p. *N*315.

[For synonymy *see* Cox 1969, and remarks *in* Kauffman (*in* Herm & *al.* 1979, and *in* Klinger & *al.* 1980)].

The genus has recently been treated very inconsistently, with different ("broad", "middle" and "restricted") meanings, as discussed by Kauffman (*in* Herm & *al.* 1979; and *in* Klinger & *al.* 1980). In the present report, it is used in accordance with the concept of Kauffman (*in* Herm & *al.* 1979) which approaches the best the status of the genus (in middle meaning), apparent from its internal shell features.

The genus comprises medium- to large-sized, equivalve to moderately inequivalved forms, slightly to strongly inflated, with height well exceeding their length. Obliquity is usually incosiderable. Anterior side is steep, the others are flattened. Posterior wing is well developed, usually well delimited from the disc, along the more or less developed auricular sulcus. Ornamentation is composed of weak to strong, subequaly spaced, subrounded ribs. Multivincular ligament, with ligamental plates is moderately to greatly thickened. Ressilifers numerous, subrectangular, well defined. Interior shell characteristics as defined by KAUFFMAN (*in* HERM & *al.* 1979; and *in* KLINGER & *al.* 1980).

Inoceramus apicalis WOODS, 1911
(Pl. 9, Figs 1-3)

1911. *Inoceramus Lamarcki* var. *apicalis*; H. WOODS, p. 319, Pl. 53, Figs 4-6.
1912. *Inoceramus lamarcki* var. *apicalis* WOODS; H. WOODS, p. 7, Figs 32-33.
1930. *Inoceramus inaequivalvis* SCHLÜTER, spec. juv. (=? *In. apicalis* WOODS); K. FIEGE, Pl. 5, Fig. 2.
1959. *Inoceramus apicalis* WOODS; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, p. 143, Fig. 4.
1962. *Inoceramus apicalis* WOODS; F. BRÄUTIGAM, pp. 194-195, Pl. 2, Figs 4-6.
1967. *Inoceramus apicalis* WOODS; K.-A. TRÖGER, pp. 76-79, Pl. 7, Figs 3-5.
part. 1975. *Inoceramus cuvieri* SOWERBY; D.E. HATTIN, Pl. 10, Fig. 1.
1976b. *Inoceramus (Inoceramus) apicalis* WOODS n.subsp. with equal rugae; E.G. KAUFFMAN, Pl. 1, Fig. 13.
1976. *Inoceramus (Inoceramus) apicalis* WOODS; E.G. KAUFFMAN & *al.*, Pl. 12, Figs 2-3.
1982. *Inoceramus apicalis* WOODS; S. KELLER, pp. 71-73, Pl. 5, Fig. 1.
1988. *Inoceramus apicalis* WOODS; I. WALASZCZYK, Pl. 3, Figs 2-3.

LECTOTYPE: By subsequent designation of KELLER (1982, p. 72), the specimen from Hitchim, England, illustrated by WOODS (1911, Pl. 52, Fig. 4A, B), from the Middle Turonian Rhynchonella cuvieri Zone.

MATERIAL: 40 specimens represented by internal moulds of single valves, with occasionally preserved shell fragments; all are more or less deformed.

Ożarów: Specimens Nos 1.Oz.O.10 through 1.Oz.O.20; I. apicalis and I. lamarcki Zone.
Karsy-1: Specimens Nos 1.K1.O.10 through 1.K1.O.28; I. apicalis and I. lamarcki Zone.
Karsy-2: Specimens Nos 1.K2.O.3; 1.K2.0.6, and 1.K2.07; I. apicalis Zone.
Karsy-3: Specimens Nos 1.K3.O.1 through 1.K3.O.7; I. apicalis Zone.
Odra Quarry: Specimens Nos 4.On.1.1 and 1.On.1.2; I. apicalis Zone.

DESCRIPTION: Specimens small, rarely attaining moderate size for the genus; biconvex, inequilateral, ?equivalve, with maximum convexity dorsocentral. Outline erect, subtriangular to subqadrate. Hinge line short, straight. Anterior face steep, truncated, with anterior margin slightly concave; ventral and ventroposterior margins evenly curved. Posterior auricle small, flat, usually not distinctly separated from the disc, rarely with shallow, indistinct auricular sulcus. Beak terminal, anterior, slightly incurved anterodorsally above the hinge line. Ornamentation composed of regularly and evenly spaced concentric rings with rarely observed, indistinct concentric ribs. In most of the specimens concentric rings raised, lamellate to rounded in shape with interspaces, not exceeding 1mm. Some specimens possess very fine, closely spaced, raised concentric rings (=?growth lines). One specimen displays well marked geniculation (about 80°) with confined ornament change.

REMARKS: Discriminating between three varieties as distinguished by BRÄUTIGAM (1962, p. 194) is unfounded in the studied material, although, two forms differing in their ornament type are stated, similar to those reported by TRÖGER (1967). Passage forms to small forms of *Inoceramus cuvieri* SOWERBY, and to early *Inoceramus lamarcki* PARKINSON, frequently occur.

OCCURRENCE: Known from the Middle (?low-Upper) Turonian of Europe and North America.

Inoceramus lamarcki PARKINSON, 1818
(Pl. 9, Figs 4-7; Pl. 10, Figs 1-3; Pl. 11, Figs 1-4)

REMARKS: The species as defined by TRÖGER (1967), is well represented in the Middle and low-Upper Turonian strata of the studied area. The detailed description of its particular subspecies was done already by TRÖGER (1967) and the here studied material does not introduce any improvement.

As the first, shortly after the entrance level of *Inoceramus apicalis* WOODS, appears *Inoceramus lamarcki lamarcki* PARKINSON accompanied by forms comparable to *Inoceramus lamarcki geinitzi* HEINZ and *Inoceramus cuvieri* SOWERBY. The understanding of *Inoceramus lamarcki geinitzi* HEINZ as a distinct taxon needs, however, a further study. According to TRÖGER (1967), the subspecies *geinitzi* is characterized by weak inflation, posteriorly curved growth axis, convex anterior side and poorly demarcated, though extended, posterior auricle. The so-defined forms are exactly in the middle between *Inoceramus lamarcki lamarcki* PARKINSON and *Inoceramus cuvieri* SOWERBY (*see* Pl. 9, Figs 5 and 7) and they show the curved posteriorly anterior side and growth axis, but simultaneously they are well inflated and possess clearly delimited posterior auricle. Similarly within flat forms with concave anterior side and growth axis, it is hardly to recognize the boundary between *Inoceramus cuvieri* SOWERBY and *Inoceramus lamarcki geinitzi* HEINZ.

Higher within the Middle Turonian there appears a large, relatively flat, distinctly ribbed form, *Inoceramus lamarcki stuemckei* HEINZ (*see* Pl. 9, Fig. 6). It is accompanied by such large, flat forms without distinct ribs, as *Inoceramus latus* MANTELL, *Inoceramus cuvieri* SOWERBY (*see* Pl. 11, Fig. 2) and still by the nominative subspecies *Inoceramus lamarcki lamarcki* PARKINSON (*see* Pl. 9, Fig.4; Pl. 10, Fig. 4; Pl. 11, Fig. 4). This assemblage is characteristic also of the low-Upper Turonian strata.

Further research is required to recognize the relations between Turonian representatives of *Inoceramus lamarcki* PARKINSON and the closely allied forms commonly noted within the Lower-Middle Coniacian transition beds. Rich assemblages of such forms were reported lastly by SORNAY (1980) and SZASZ (1985). The massive, relatively flat specimens, with regular, widely spaced concentric rings noted often within the "*schloenbachi*"-beds are commonly referred to as *Inoceramus annulatus* GOLDFUSS, although the species is still very poorly known. Some forms were referred here to as *Inoceramus* ex gr. *lamarcki* PARKISNOSN (*see* Pl. 33, Figs 1-2), *I. seitzi* ANDERT (*see* Pl. 31, Figs 1-3), or *I. madagascariensis* HEINZ (*see* Pl. 29, Fig. 3 *and* Pl. 30, Fig. 3). Unclear is also the phylogenetic relation to the common, particularly in SE Europe, species *I. wandereri* ANDERT (*see* Pl. 36, Fig. 2).

Inoceramus costellatus WOODS, 1911
(Pl. 12, Figs 3-9)

1834-40. *Inoceramus undulatus* MANTELL; A. GOLDFUSS, p. 115, Pl. 112, Fig. 1.
1897. *Inoceramus* sp.; H. WOODS, p. 381, Pl. 27, Figs 14-17.
1911. *Inoceramus costellatus* sp. nov.; H. WOODS, p. 336, Pl. 54, Figs 5-7.
part. 1930. *Inoceramus costellatus* WOODS; K. FIEGE, p. 35, Pl. 5, Figs 3-4, ?6, 7-9.
1962. *Inoceramus vancuverensis* SHUMARD; F. BRÄUTIGAM, p. 206, Pl. 3, Fig. 8.
1967. *Inoceramus vancuverensis vancuverensis* SHUMARD; K.-A. TRÖGER, pp. 89-92, Pl. 9, Figs 6-9.
1967. *Inoceramus vancuverensis parvus* n. ssp.; K.-A. TRÖGER, pp. 92-95, Pl. 9, Figs 1-5; Pl. 10, Fig. 3.
1976. *Inoceramus (Inoceramus) costellatus* WOODS; E.G. KAUFFMAN & *al.*, Pl. 12, Figs 1, 4. 8.
1981a. *Inoceramus costellatus pietzschi* n.nom.; K.-A. TRÖGER, p. 151.
1982. *Inoceramus costellatus costellatus* WOODS; S. KELLER, pp. 92-94, Pl. 7, Fig. 3.
1988. *Inoceramus costellatus* WOODS; I. WALASZCZYK, Pl. 5, Fig. 6.
1990. *Inoceramus* aff. *glatziae* FLEGEL (*sensu* ANDERT); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 2, Fig. 1.
1990. *Inoceramus costellatus* WOODS; L.F. KOPAEVICH & I. WALASZCZYK, Pl. 2, Fig. 2.
1991. *Inoceramus costellatus costellatus* WOODS; R. TARKOWSKI, p. 106, Pl. 12, Figs 3, 6, ?7, 10-11.
1991. *Inoceramus costellatus pietzschi* TRÖGER; R. TARKOWSKI, p. 106, Pl. 12, Fig. 9.

HOLOTYPE: By original designation, the specimen from Chalk Rock of Cuckhamsley, England, illustrated by WOODS (1911, Pl. 54, Fig. 5).

MATERIAL: 39 specimens represented by internal and external moulds of single valves, partly with shell fragments preserved.

Dębno - Lasocin: Specimens Nos 1.D.O.1 through 1.D.O.10; I. costellatus Zone.
Piotrowice: Specimens Nos 1.P.2.1 through 1.P.2.6; I. costellatus Zone.
Brzeźno: Specimens Nos GS: 1401.II.129; 1401.II.96; 1401.II.475; most probably I. costellatus Zone.
Odra Quarry: Specimens Nos 4.On.7.10 through 4.On.7.30; I. costellatus Zone.

DESCRIPTION: Specimens small to medium size for the genus; inequilateral, equivalved, subquadrate to subrounded in shape, moderately inflated, with maximum inflation centrally positioned. Beak pointed, slightly curved anteriorly, projecting above the hinge line. Anterior margin straight, convex, apart from a slightly concave part below the beak. Anterior side steepened, ventral and posterior ones flattened. Hinge line short to moderately long, straight. Posterior auricle poorly separated from the disc, small to moderately extended. Umbonal region usually well distinct from the posterior auricle.

Ornamentation consists of sharply edged concentric ribs, regularly increasing in size, with relatively wide, flat-floored interspaces. In phylogenetically older specimens the concentric ribs much closely spaced with interspaces of indistinct width. Concentric ribs continue onto posterior auricle without break or weakening; on the auricle they may curve posterodorsally.

REMARKS: TRÖGER (1967) distinguished the two subspecies within *Inoceramus costellatus* WOODS, i.e. the nominative one and the subspecies *parvus* (renamed in 1981 into the subspecies *pietzschi)*. Both subspecies differ only in general size and relative distances between concentric elements; according to TRÖGER's data, these would represent the successive subspecies (chronosubspecies). In the studied material, the specimens corresponding to one of these subspecies are found to be distributed more randomly, being most probably to some extent governed by ecological conditions. Thus, the nature of the variability taken by TRÖGER (1967) as the base of his subspecific division of *I. costellatus* WOODS does not seem to be clear, and consequently, these subspecies are not distinguished here.

OCCURRENCE: Common within the Upper Turonian (?Lower Coniacian) of Europe and North America.

Inoceramus lusatiae ANDERT, 1911
(Pl. 27, Figs 1-6)

1911. *Inoceramus lusatiae* n. sp.; H. ANDERT, pp. 54-56, Pl. 2, Fig. 1; Pl. 3, Fig. 3; Pl. 8, Figs 3-5.
1934. *Inoceramus lusatiae* ANDERT; H. ANDERT, pp. 126-128, Pl. 7, Figs 1-3 and Text-fig. 14.
part. 1959. *Inoceramus lamarcki* PARKINSON; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, pp. 142-143, Pl. 3, Fig. 1.
?1966. *Inoceramus lusatiae* ANDERT; Z. KURLENDA, pp. 519-520, Pl. 1, Fig. 1.
1967. *Inoceramus lusatiae* ANDERT; K.-A. TRÖGER, pp. 73-76, Pl. 8, Figs 2-3.
?1971. *Inoceramus lusatiae* ANDERT; M.A. PERGAMENT, pp. 94-95, Pl. 23, Fig. 1
1976b. *Mytiloides lusatiae* (ANDERT); E.G. KAUFFMAN, Pl. 2, Fig. 5; Pl. 4, Fig. 5.
?1985. *Inoceramus lusatiae* ANDERT; L. SZASZ, p. 172, Pl. 4, Figs 2-3.
1990. *Inoceramus lusatiae* ANDERT; L.F. KOPAEVICH & I. WALASZCZYK, Pl. 3, Fig. 1.
1991. *Inoceramus lusatiae* ANDERT; R. TARKOWSKI, p. 113, Pl. 7, Fig. 4.
1991. *Inoceramus lusatiae* ANDERT; K.-A. TRÖGER *in* K.-A. TRÖGER & W.K. CHRISTENSEN, p. 29, Pl. 3, Fig. 6.
?1991. *Inoceramus* cf. *annulatus* GOLDFUSS; K.-A. TRÖGER *in* K.-A. TRÖGER & W.K. CHRISTENSEN, p. 28, Pl. 4, Fig. 1.

LECTOTYPE: By subsequent designation of TRÖGER (1967, p. 73), the specimen illustrated by ANDERT (1911, Pl. 2, Fig. 1a, b). The lectotype comes from Sonnenberg near Waltersdorf, Saxony (Germany), from the Lowermost Coniacian (?uppermost Turonian) strata.

MATERIAL: 18 specimens, represented by internal moulds of single valves with usually poorly preserved posterior auricles.

Słupia Nadbrzeżna-Wesołówka: Specimens Nos 1.SW.1.3; 1.SW.1.4; and 1.SW.2.45 through 1.SW.2.51; M. incertus Zone; 1.SW.6.71 through 1.SW.6.74, and 1.SW.8.1; C. brongniarti Zone.
Maksymów: Specimens Nos ME: ML 1172; ML 1122; and ML 1216; C. brongniarti Zone.
Wielkanoc: Specimen No. 3.W.3.3; C. crassus Zone.

DESCRIPTION: The measurements and simple ratios are given in Table 7.

Specimens of medium size for the genus; inequilateral, slightly inequivalved (according to TRÖGER 1967). Valves poorly inflated, with maximum inflation dorsocentral. Umbonal region usually poorly defined with beak projecting slightly above the hinge line. Anterior side steep, the rest flatenned. Anterior margin straight, curving posteroventrally in its lower half. Posteroventral margin short, distinctly curved posteriorly. Posterior wing separated from the disc by a shallow, wide auricular sulcus.

Ornamentation in the juvenile part (up to first 20mm axial length from the beak) consists entirely of raised, closely spaced, subregular concentric rings. Ventralwardly the low to moderately raised concentric ribs appear. Concentric ribs subregularly to irregularly spaced, passing in part into concentric undulations, particularly in the axial part of the disc. Concentric ribs covered by distinctly raised concentric rings (?= growth lines), characterized by irregular increase of interspaces and their gradual disappearance toward the ventral margin. Concentric rings passing through the auricular sulcus onto the posterior wing, with concentric ribs usually indistinct or not discernible.

Table 7

Measurements of selected specimens of *I. lusatiae* ANDERT; linear dimensions *in* mm.

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
ME: ML 1172	72	52	75	49	-	-	120	85	-	80	0.77	0.80	-
ME: ML 1216	62	45	64	43	-	-	116	82	-	73	0.72	0.67	-
1.SW.6.40							100			65			

REMARKS: The species displays high variability of such its characteristics as the curvation of the growth axis, the development and strength of the ornament elements, the length and shape of the anterior side (*see* Pl. 26; *and* ANDERT 1911, 1934). The species represents the uppermost Turonian/Middle Coniacian member of the *Inoceramus lamarcki* group. The differences between *I. lusatiae* ANDERT and morphologically very close representatives of the group, i.e. *Inoceramus lamarcki lamarcki* PARKINSON and *I. lamarcki geinitzi* TRÖGER are fully discussed by TRÖGER (1967).

Four specimens referred to *Mytiloides lusatiae* (ANDERT) or to passage forms between *M. lusatiae* (ANDERT) and *M. kleini* (MÜLLER) and illustrated by KAUFFMAN *& al.* (1976, Pl, 13, Figs 17, 23 and Pl. 14, Figs 9, 15) from the Western Interior of the United States, seem to be closer to the genus *Mytiloides* and they represent other species. The specimens of *Inoceramus lusatiae* ANDERT, illustrated by SZASZ (1985, Pl. 4, Figs 2-3) are, except of their surface ornament, very close or even identical to the ANDERT's species.

OCCURRENCE: Known from the uppermost Turonian through Middle Coniacian strata, precisely from the Mytiloides incertus Zone up to the Cremnoceramus crassus Zone of Europe. No convincing reports are published from outside Europe. The report of *Inoceramus lusatiae* (ANDERT) from Kamtchatka, by PERGAMENT (1971, Pl, 23, Fig. 1), is based on a single, uncompletely preserved specimen of a rather doubtful recognition.

Inoceramus seitzi ANDERT, 1934
(Pl. 31, Figs 1-3)

1934. *Inoceramus seitzi* n. sp.; H. ANDERT, pp. 123-124, Pl. 16, Fig. 2.
1958. *Inoceramus septentrionalis* BODYLEVSKY *in* W.I. BODYLEVSKY & N.I. SCHULGINA, p. 76, Pl. 42, Fig. 1.
1969. *Inoceramus seitzi turgidus* subsp. nov.; R.A. CHALAFOVA, pp. 148-149, Pl. 4, Figs 8-11; Pl. 5, Figs 1-2.
1980. *Inoceramus frechi* FLEGEL; E.G. KAUFFMAN *in* H.C. KLINGER *& al.*, pp. 314-316, Figs 10*A-F*.
1980. *Inoceramus (Inoceramus) ernsti* HEINZ; E.G. KAUFFMAN *in* H.C. KLINGER *& al.*, pp. 310-314, Figs 10*G-P*.

HOLOTYPE: By monotypy, the specimen figured by ANDERT (1934, Pl. 16, Fig. 2) from Czaple (German *Hockenau*), North-Sudetic Trough, Poland, most probably Middle Coniacian, Cremnoceramus deformis - C. crassus Zone.

MATERIAL: 3 specimens represented by two double-valved internal moulds, from Słupia Nadbrzeżna-3 (Specimens Nos 1.SN3.O.6 and 1.SN3.O.3), C. deformis Zone, and one left valve from Maksymów (Specimen No. ME: ML 1153), ?C. brongniarti/C. deformis Zone.

DESCRIPTION: Specimens of medium size for the genus; inequilateral, inequivalved, with left valve higher and more inflated than the right one. Much higher than long (about one-half in figured specimens), strongly inflated, with maximum inflation central or dorsocentral. Umbonal region bluntly pointed, projecting markedly above the hinge line. Both anterior and posterior sides steep, perpendicular to the sagittal plane, with narrow main face of the disc. Ventral margin rounded, flattened. Anterior hinge angle about 90°. Posterior auricle clearly delimited from the disc, with a shallow auricular sulcus. Posterior wing subtriangular in shape, extended posterodorsally. Ligamental plate thick.

Ornamentation consists of sharp-edged concentric ribs, passing onto the posterior auricle, with poorly visible growth lines. The latter invisible on the surface of the internal moulds, where only indistinct concentric rings occur. In the juvenile part only concentric rings occur.

REMARKS: The Middle Coniacian *Inoceramus seitzi* ANDERT represents the forms very similar to Middle Turonian *Inoceramus lamarcki* PARKINSON, particularly to the nominative subspecies. Some slight differences, which may be stated between the types of both species, viz. slight inequivalvness and passing of the concentric ribs onto the posterior auricle in the species concerned, and the small differences in the ornament characteristics (*compare* Pl. 31, Fig. 1 *with* Text-fig. 63 in WOODS 1911) are falling well into the variability range of *Inoceramus lamarcki* PARKISNON (*compare e.g.* Pl. 31, Fig. 1 *and* Pl. 11, Fig. 4). On the other hand, there is an evident stratigraphic gap between the vertical range of both forms, as *I. lamarcki lamarcki* PARKINSON is limited to the Middle – low-Upper Turonian, and *I. seitzi* ANDERT has hitherto been stated in the Lower/Middle Coniacian. Certainly, it may be an appearant lack of records, but neverthless, it seems resonable to keep the Middle Coniacian forms distinct from mid-Turonian *Inoceramus lamarcki* PARKINSON [worths of mention is that most probably the holotype of *Inoceramus lamarcki* PARKINSON comes just from the Middle Coniacian, Micraster coranguinum Zone (*see* WOODS 1911)].

To the species concerned belong the forms described by KAUFFMAN (*in* KLINGER & *al.* 1980, Figs 10*A-P*) as *Inoceramus frechi* FLEGEL and *Inoceramus ernsti* HEINZ from South Africa. Neither the illustrations nor the given description justify the division of the figured sample.

BODYLEVSKY (*in* BODYLEVSKY & SCHULGINA 1958) described three new species, comparable to *Inoceramus seitzi* ANDERT, from the Lower (?Lower or Middle in the here applied scheme) Coniacian of the Taymyr Peninsula, i.e. *Inoceramus septentrionalis, Inoceramus tchaike,* and *Inoceramus troitsky.* All these three species are close each other, though only the first (i.e. *Inoceramus septentrionalis* may be directly compared to the species concerned.

Identical forms from the Coniacian of Caucasus referred to as "*Inoceramus seitzi turgidus* subsp nov." were reported by CHALAFOVA (1969, Pl. 4, Figs 8-11).

OCCURRENCE: Known from the Lower and Middle Coniacian of Europe and Asia (Taymyr, southern Caucasus).

Inoceramus germanobohemicus HEINZ, 1932 (Pl. 21, Figs 8-9)

part. 1911. *Inoceramus glatziae* FLEGEL; H. ANDERT, pp. 52-53, Pl. 1, Fig. 1.
1932b. *Inoceramus germano-bohemicus* nom. n.; R. HEINZ, p. 43.
1976. *Mytiloides*? *frechi* (FLEGEL); E.G. KAUFFMAN & *al.*, Pl. 13, Fig. 21.
?1976. *Inoceramus* n.sp. aff. *I. glatziae* FLEGEL; E.G. KAUFFMAN & *al.*, Pl. 14, Fig. 7.

HOLOTYPE: By the original designation of HEINZ (1932b), the specimen illustrated by ANDERT (1911, Pl. 1, Fig. 1) from Daschloch, Germany (uppermost Turonian or Lower/Middle Coniacian according to the scheme here applied).

MATERIAL: Two specimens represented by internal moulds of single valves from the Middle Vistula section; Specimens Nos 1.SW.4-5.68 (Słupia Nadbrzeżna-Wesołówka, C. brongniarti Zone), and ME: ML 1198/12 (Maksymów, C. brongniarti Zone).

DESCRIPTION: The measurements and simple ratios are given in Table 8 and Text-fig. 10. Specimens medium-sized, inequilateral, ?equivalved. Beak-umbo well defined, curved inward, projecting above the hinge line. Valves weakly convex, with maximum inflation dorsocentral. Anterior margin straight, slightly concave below the umbo; ventral margin evenly rounded, and posterior margin anteriorly curved. Hinge line long, straight. Anterior side steep, low, relatively long (about 70% of respective H). Posterior auricle, triangular in shape, well separated from the slim disc along the distinct auricular sulcus. Hinge line long, constituting over 50% of respective H in the studied material. Growth axis straight.

Table 8

Measurements of selected specimens of *I. germanobohemicus* HEINZ; linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
ML 1198/12	59	45	59	44	10	30	115	75	90	82	0.76	0.74	0.66
1.SW.4-5.68	58	51	55	45	10	29	120	80	90	90	0.92	0.81	0.56

Ornamentation consists of subregularly spaced, evenly developed small rounded concentric ribs, which pass continuously onto the posterior wing. Posteriorly of the auricular sulcus they distinctly curve posterodorsally, forming a sickle-shaped bend at the dorsal part of the wing.

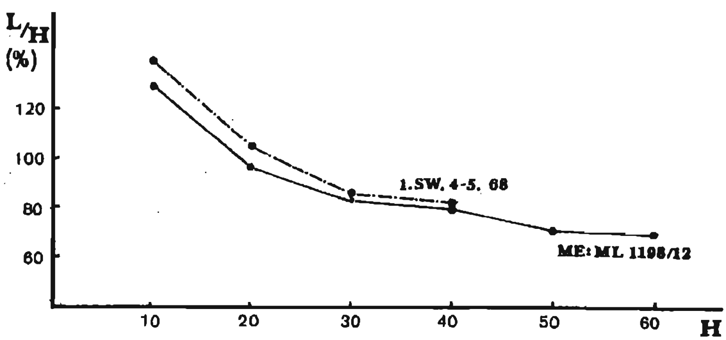


Fig. 10. Ontogenetic change of simple ratio L/H in *Inoceramus germanobohemicus* HEINZ

REMARKS: HEINZ (1932b) called as *Inoceramus germanobohemicus* one of the specimens illustrated by ANDERT (1911, Pl. 1, Fig. 1) and referred by the latter author to as *Inoceramus glatziae* FLEGEL. ANDERT (1911) underlined, that the concerned specimen fits the closest the forms which in FLEGEL's original collection were referred to as "*Inoceramus Cuvieri* var. *Geinitziana*", but which he regarded as falling well into the variability range of *Inoceramus glatziae* FLEGEL. Basing on the illustrations in ANDERT (1911), his uniting of both taxa is hardly acceptable. Moreover, the forms which were to be similar to var. *Geinitiana*, markedly differ from the concept of *Inoceramus glatziae*, arising from FLEGEL's original description.

Thus, because FLEGEL's text gives no idea concerning the form "*Inoceramus Cuvieri* var. *Geinitziana*", all the narrow, axially elongated forms with well extended posterior auricles, as represented by the specimen from Daschloch, are herein referred to *Inoceramus germanobohemicus* HEINZ.

OCCURRENCE: Known from the uppermost Turonian through Lower Coniacian strata of Central Europe, and Western Interior of the United States.

Inoceramus fasciculatus HEINE, 1929
(Pl. 37, Fig. 6)

1929. *Inoceramus fasciculatus*, sp. n.; F. HEINE, pp. 74-76, Pl. 9, Fig. 45 and Pl. 13, Fig. 56.
1974. *Inoceramus fasciculatus* HEINE; K.-A. TRÖGER, Pl. 9, Figs X4320 and X4321.

TYPES: The specimen illustrated by HEINE (1929) on Pl. 9, Fig. 45, from the mine Preussen 2, Westphalia, Germany, is here designated as the lectotype of the species; the second specimen from the same locality (HEINE, 1929, Pl. 13, Fig. 56) is the paralectotype.

MATERIAL: Single, uncomplete internal mould, lacking the umbonal part, and the external mould of the same specimen from Ludynia, near Włoszczowa (not catalogued specimen from the Geological Survey Museum). The measurements see Table 9.

REMARKS: The specimen well corresponds to the species characteristics as given by HEINE (1929, pp. 74-76). It shows the gradual ventralward increase of the concentric ribs, well delimited along the marked auricular sulcus posterior wing, radial groove in the posterior part of the disc, and indistinct, radial ribs appearing in the ventral part of the disc.

Table 9

Measurements of selected specimens of *I. fasciculatus* HEINE; linear dimensions *in* mm

Specimen	h	l	H	L	b	a	α	β	γ	δ	l/h	L/H	a/l
GS: 2.L.0	68	51	71	49	-	30	116	78	90	72	0.75	0.69	0.59

OCCURRENCE: HEINE (1929) reports the species from the Upper Coniacian to lowermost Santonian (undulatoplicatus Zone); RIEDEL (1931) notes its occurrence in the Grimberg IV mine in the Upper Coniacian (coocurring with *Magadiceramus subquadratus* SCHLÜTER). Similarly (Upper Coniacian, M. subquadratus Zone) stratigraphic position of the species is reported by TRÖGER (1974).

Inoceramus frechi FLEGEL, 1905; em. SCUPIN, 1912-13
(Pl. 38, Fig. 4)

1904. *Inoceramus Frechi* n. sp.; K. FLEGEL, p. 147.
non 1911. *Inoceramus frechi* FLEGEL; H. ANDERT, p. 51-52, Pl. 1, Fig. 8.
1912-13. *Inoceramus frechi* FLEGEL; H. SCUPIN, p. 208, Pl. 11, Fig. 10.
part. 1934. *Inoceramus frechi* FLEGEL; H. ANDERT, Pl. 6, Fig. 1; Pl. 5, Fig. 6.
non 1976. *Mytiloides? frechi* (FLEGEL); E.G. KAUFFMAN *& al.*, Pl. 13, Fig. 21.
non 1980. *Inoceramus frechi* FLEGEL; E.G. KAUFFMAN *in* H.C. KLINGER *& al.*, pp. 314-316, Figs 10*A-F*.
non 1982. *Inoceramus frechi* FLEGEL; S. KELLER, pp. 96-98, Pl. 7, Fig. 1.

LECTOTYPE: The specimen figured by SCUPIN (1912-13, Pl. 11, Fig. 10) from Czaple (German *Hockenau*), North-Sudetic Trough, Middle Coniacian (Cremnoceramus deformis - C. crassus Zone).

MATERIAL: One, uncompletely preserved (lacking ventral parts and posterodorsal parts of the posterior auricle) double-valved internal mould, with partly attached shell, from Kolonka-1 (Specimen No. 1.Kl1.2.3); C. deformis Zone.

DESCRIPTION: Specimen of medium-size for the genus; equivalve, inequilateral. Anterior margin straight, to slightly curved posteriorly; ventral margin rounded. Anterior side steep, the others flattened. Disc markedly higher than long, strongly inflated, with maximum inflation central. Posterior auricle only partly preserved, but judging on the trend of the ornamentation elements, it was typically developed as in the loctotype, and well delimited from the disc with shallow, wide, posterior auricular sulcus. Umbonal region pointed, markedly projecting above the hinge line, slightly curved anteriorly. Obliquity indistinct ($\delta = 90^{\circ}$).

Ornamentation consists, up to 10mm axial length from the beak, of growth lines only; later there appear subevenly spaced, subregular concentric ribs, with wide, flat-floored interspaces. Concentric ribs are sharp-edged, narrow, increasing gradually ventralward. Interspaces covered with evenly spaced growth lines, as may be observed on the shells, very poorly visible or completely invisible on the surface of internal moulds. Concentric ribs pass onto the surface of the posterior auricle, only slightly weakining at the passage through the auricular sulcus, curving posterodorsally at the wing surface.

REMARKS: Similarly as in the case of *Inoceramus glatziae*, FLEGEL (1905) did not illustrate any specimen creating the species concerned. He referred, however, to the specimen from Czaple (German *Hockenau*), North-Sudetic Trough, stating its identity to those from Batorów (German *Fridrichsgrunde*). Some years later, another specimen from Czaple, compared to the one referenced from that locality by FLEGEL, was illustrated by SCUPIN (1912-13, Pl. 11, Fig. 10) and said to be identical to that of FLEGEL (1905). That form is therefore, following also remarks in BRÄUTIGAM (1962), regarded herein as the lectotype of *Inoceramus frechi* FLEGEL (*see also* KELLER 1982). The name *Inoceramus frechi* FLEGEL was frequently used in the literature to encompass the Late Turonian - Early Coniacian alate forms, but only few (*see* synonymy) represent true *Inoceramus frechi* FLEGEL.

The species *Inoceramus frechi* FLEGEL is very similar to *Inoceramus kleini* MÜLLER, from which it differs in the larger posterior auricle, shorter anterior side, and continuity of the concentric ribs when passing onto the posterior auricle. The MÜLLER's species possesses also a weak, wide furrow in the posterior part of the disc, and often, particularly in the adult specimens, irregular radial elements on the axial parts of the disc, not observed in *Inoceramus frechi* FLEGEL.

OCCURRENCE: The lectotype comes from the Hockenauer Sandstones, from Czaple, (North-Sudetic Trough) which were dated by SCUPIN (1912-13) for the Emscherian. HEINZ (1932), however, reports from there *Cremnoceramus schloenbachi* (BÖHM) [=*Cremnoceramus crassus* (PETRASCHECK)], what may indicate the C. crassus Zone. In the marls below the sandstones, the Author found one specimen comparable to *Cremnoceramus brongniarti* (MANTELL) what well conforms with the data given by HEINZ (1932b). The specimen from the Vistula section comes from the Cremnoceramus deformis Zone.

Inoceramus kleini MÜLLER, 1887
(Pl. 37, Fig. 3)

1887. *Inoceramus kleini* n. sp.; G. MÜLLER, p. 415, Pl. 18, Fig. 1a-b.
part. ?1911. *Inoceramus kleini* MÜLLER; H. ANDERT, pp. 48-50, Pl. 2, Fig. 6 [non Pl. 1, Fig. 7; Pl. 2, Figs 3, 7-8].
non 1934. *Inoceramus kleini* MÜLLER; H. ANDERT, pp. 115-117, Text-figs 10-12. Pl. 4, Figs 9-10; Pl. 5, Figs 1-2.
1929. *Inoceramus kleini* MÜLLER; F. HEINE, pp. 44-46, Pl. 2, Figs 10-11; Pl. 3, Figs 12-13.
1969. *Inoceramus kleini* MÜLLER; Z. RADWAŃSKA, p. 709.
1979. *Inoceramus kleini* MÜLLER; A.V. IVANNIKOV, p. 62, Pl. 14, Fig. 4; Pl. 15, Figs 1-2; Pl. 16, Fig. 1; Pl. 17, Fig. 1.
1989. *Inoceramus koeneni* MÜLLER; S. CIEŚLIŃSKI & BŁASZKIEWICZ, p. 255, Pl. 160, Fig. 1.
part. 1991. *Inoceramus kleini* MÜLLER; R. TARKOWSKI, pp. 109-110, Pl. 13; Fig. 7; Pl. 14, Fig. 2 [*non* Pl. 14, Fig. 3].

HOLOTYPE: By monotypy, the specimen figured by MÜLLER (1887, Pl. 18, Fig. 1a-b) from Spiegelsbergen, near Halberstadt (Subhercynian Basin), Germany; Upper Coniacian, Volviceramus involutus Zone.

MATERIAL: One, left valve represented by internal mould from Jedlanka Nowa borehole (*see* CIEŚLIŃSKI 1959a *and* CIEŚLIŃSKI & BŁASZKIEWICZ 1989, Pl. 160, Fig. 1).

REMARKS: Adult representatives of the species are easily distinguishable. Equivalvness, strong inflation, well pointed, incurved anterodorsally umbonal region, and regular surface ornament, increasing gradually ventralwards, initial development of the radial ornament in the central part of the disc, and slight, wide furrow in the posterior part of the disc well characterize the species. Small forms are very similar to other representatives of the genus *Inoceramus*, for instance to *I. frechi* FLEGEL.

OCCURRENCE: Common form in the Upper Coniacian of Europe.

Inoceramus digitatus HEINE, 1929 (*non* SOWERBY, 1829) (Pl. 38, Fig. 5)

?1829(1842). *Inoceramus digitatus*; SOWERBY, p. 638, Pl. 392(604), Fig. 2.
1877. *Inoceramus radians* sp. n.; C. SCHLÜTER, pp. 270-271, Pl. 38, Fig. 2.
1928. *Inoceramus digitatus* SOWERBY; R. HEINZ, pp. 77-79.
1929. *Inoceramus digitatus* SOWERBY; F. HEINE, pp. 77-80, Pl. 9, Fig. 44; Pl. 10, Fig. 49; Pl. 11, Fig. 52.
1974. *Inoceramus digitatus* HEINE (*non* SOWERBY); K.-A. TRÖGER, pp. 118-121, Pl. 7, Fig. X4309.

MATERIAL: One, uncompletely preserved internal mould of the right valve, from Ossowa (Specimen No. GS: 1401.II.186); Upper Coniacian, Magadiceramus subquadratus Zone.

OCCURRENCE: Reported from the Upper Coniacian (Magadiceramus subquadratus Zone) of Europe.

Inoceramus hoepeni HEINZ, 1933 (Pl. 21, Figs 1-7)

1932. *Inoceramus (Striatoceramus) hoepeni* HEINZ; D. WOLANSKY, p. 27, Pl. 3, Fig. 30; Pl. 4, Fig. 3.
1933. *Striatoceramus hoepeni* HEINZ; R. HEINZ, pp. 246-247, Pl. 18, Figs 2-3.
1976b. *Inoceramus (Inoceramus)* n.sp. aff. "*I. costellatus* WOODS" of FIEGE 1930, Pl. 5, Fig. 10 and *I. uwajimensis* YEHARA, 1924, Pl. 3, Fig. 2; Pl. 4, Fig. 2; E.G. KAUFFMAN, Pl. 2, Figs 1, 4,?8.

HOLOTYPE; The specimen illustrated by HEINZ (1933, Pl. 18, Fig. 3), from Antsalova, Madagascar; Upper Turonian/Lower Coniacian.

MATERIAL: 9 specimens represented by internal moulds of single valves from Słupia Nadbrzeżna-Wesołówka section (Specimens Nos 1.SW.3.39 through 1.SW.3.47); C. waltersdorfensis Zone.

DESCRIPTION: Specimens of small to medium size for the genus; inequilateral, ?equivalved. Most of the specimens with well expressed geniculation, combined with changeable surface ornamentation. Anterior side moderately long, straight; ventral and posterior margins subquadrately rounded. Hinge line long, straight. Anterior side steep or even overhanged, sometimes slightly concave below the beak. The latter usually well pronounced, orthocline. Posterior auricle well developed, moderately well delimited from the disc.

Ornamentation consists of sharp-edged concentric ribs, usually loosely spaced, and with superimposed, raised concentric rings, well visible in the interspaces. Ventralward of the slope change the concentric ribs disappear or occur very irregularly, and then the shell surface bears only concentric rings. Concentric ornament elements pass onto the posterior auricle with its distinct posterodorsal curvation.

REMARKS: In the Upper Turonian/Lowermost Coniacian strata the small inoceramids with well developed concentric ribs, moderately well separated posterior auricle and posterodorsal curvation of ornament elements on its surface are relatively common. The specific assignment of such forms makes always a problem, particularly when single specimens are treated, and these are referred commonly to *Inoceramus costellatus* WOODS, *I. andersoni* ETHERIDGE, *I. frechi* FLEGEL, or *I. kleini* MÜLLER. A close form, as concerns its general shape is also the species *Inoceramus geinitzianus* STOLICZKA, 1871.

OCCURRENCE: Widely known from the Upper-(?most) Turonian to Lower Coniacian strata of Europe, Africa, North America.

Inoceramus vistulensis sp. n.
(Pl. 26, Figs 1-6)

part. ?1934. *Inoceramus glatziae* FLEGEL; H. ANDERT, 122-123, Pl. 6, Fig. 4.
?1982. *Inoceramus frechi* FLEGEL; S. KELLER, pp. 96-98, Pl. 7, Fig. 1
part. 1985. *Inoceramus* ex gr. *I. glatziae* FLEGEL - *I. uwajimensis* YEHARA; L. SZASZ, pp. 153-154, Pl. 6, Fig. 3.

HOLOTYPE: The specimen No. 1.SW.6.16 presented in Pl. 26, Fig. 1.

PARATYPES: The specimens Nos 1.SW.6.5; 1.SW.6.6; 1.SW.6.1; 1.SW.6.7; and 1.SW.6.14; presented in Pl. 26, Figs 2-6.

TYPE LOCALITY: Słupia Nadbrzeżna-Wesołówka, horizon No. 6 (*see* Text-fig. 23).
TYPE HORIZON: Lower Coniacian, C. brongniarti Zone.
DERIVATION OF THE NAME: After the river Vistula, Central Poland.

DIAGNOSIS: A medium-sized representatives of the genus, inequilateral, slightly inaequivalved, subrectangular to subquadrate; ornamentation consisting of sharp-edged, widely spaced concentric ribs, with flat-floored interspaces.

MATERIAL: Six specimens represented by one double-valved and five single-valved internal moulds with shell fragments preserved from Słupia Nadbrzeżna-Wesołówka section (Specimens Nos 1.SW.6.1; 1.SW.6.5 through 1.SW.6.7; 1.SW.6.14; and 1.SW.6.16); C. brongniarti Zone.

DESCRIPTION: Medium sized for genus, inequilateral, slightly inequivalved. Subrectangular to elongate ovate in shape, orthocline to only slightly oblique, moderately inflated, with the maximum inflation dorso-central (*see* Pl. 26, Fig. 4). Anterior margin straight, forming about 60% of the relative axial length, posterior and ventral margins rounded. Anterior margin steep, slightly concave below the beak. Ventral and posterior margins moderately sloping. Beak moderately pointed, incurved antero-dorsally, projecting above the hinge line. The latter straight, short to moderately long (about 40% of the relative axial length. Posterior auricle indistinct, small, not delimited from the disc.

Ornamentation in juvenile part (up to 10mm axial length from the beak) consists of sharp edged, raised concentric rings, gradually disappearing ventralwardly. Later, there appear the sharp-edged, irregular, unevenly to subevenly spaced concentric ribs, with usually wide, flat-floored interspaces. The character of the concentric ribbing displays wide range of variability. They change from round-topped, relatively closely spaced (*see* Pl. 26, Fig. 3) through moderately spaced, more or less regularly (*see* Pl. 26, Figs 2, 4) up to forms with widely spaced, sharp-edged concentric ribs (Pl. 26, Figs 5-6). Similarly varies the character of the concentric rings, which usually are poorly discernible on the surface of internal moulds.

REMARKS: The representatives of the species were already reported from the European Turonian - Coniacian passage beds, though referred to *Inoceramus glatziae* FLEGEL (*see* ANDERT 1934, Pl. 6, Fig. 4), *Inoceramus frechi* FLEGEL (*see* KELLER 1982, PL. 7, Fig. 1), or to *Inoceramus* ex gr. *glatziae* FLEGEL — *Inoceramus uwajimensis* YEHARA (*see* SZASZ 1985, PL. 6, Fig. 3). The species is similar to the commonly occurring in the North Pacific Region Coniacian species *Inoceramus uwajimensis* YEHARA [*see e.g.* NAGAO & MATSUMOTO, 1939-40, NODA 1975, ZONOVA 1970, PERGAMENT 1971 (under the name *Inoceramus stantoni* SOKOLOV)].

OCCURRENCE: In the studied area rarely noted within the Lower Coniacian strata. Known from Germany and Romania, from similarly dated horizons.

Genus *Cremnoceramus* Cox, 1969 (*non* HEINZ, 1932)

TYPE SPECIES: *Cremnoceramus inconstans* (WOODS), in WOODS (1911, Text-fig. 43); *SD* COX (1969, pp. *N*315, 317).

Diagnosis and discussion are given by KAUFFMAN (*in* HERM & *al.* 1979, pp. 58-59).

The main feature of this genus is the distinct slope change along the growth axis associated with the change of the ornamentation pattern. The geniculation, however, does not represent the feature confined to any distinct group of inoceramids, and is not limited to the inoceramids only (*see* TRÖGER 1981b). Within the family Inoceramidae, apart from the genus *Sphenoceramus* BÖHM, it was stated in all other groups (*see* TRÖGER 1981b, Table 2). In the studied material, besides the forms included into the genus *Cremnoceramus* the geniculation was stated in *Inoceramus lamarcki* PARKINSON, *Mytiloides kossmati* (HEINZ), *Inoceramus apicalis* WOODS, and "*Inoceramus*" ex gr. *balticus* BÖHM. The appearance of geniculated forms in groups where they form less than 1% of the population was interpreted as ecologically controlled (partly SEITZ 1965, and TRÖGER 1981b). The latter author suggested, moreover, a positive relationship between the occurrence of the geniculated forms and the high energy environment. This, however, can not be confirmed basing on the studied material. Moreover, as was shown by SEED (1980), the appearance of geniculation in the bivlave mollusks may be related to purely biological or ecological reasons having little chance to be recognized in the sediments.

While in many species geniculation appears occasionally, in the Lower Coniacian inoceramids traditionally forming the "*Inoceramus*" *inconstans* group, it seems to be typical and the forms without this trait may be interpreted as uncompletely preserved and/or representing young specimens. This group forms evident evolutionary lineage with the trait concerned most probably controlled genetically and thus representing a good base for taxonomical purposes.

The lower range interval of the cremnoceramids is well recorded in the Vistula section. The cremnoceramids occur here abundantly and, what is very important in the studies on that group, they are three dimensionally preserved (though often deformed).

In the description of the representatives of this genus the terms *the juvenile* and *the adult* stages, being the translation of the SEITZ' (1967) terms, "*Anfangs-Stadium*" and "*Alters-Stadium*", concerning the beakward and ventralward part of the valve from the geniculation point are here apllied.

Among Lower - Middle Coniacian *Cremnoceramus* two main lineages can be distinguished, which embrace most of the known representatives of the genus (*see* Text-fig. 17).

The first lineage comprises weakly oblique forms, originating at the Turonian/Coniacian boundary, and is represented by *Cremnoceramus waltersdorfensis* (ANDERT), *C. brongniarti* (MANTELL), *C. rotundatus* (FIEGE), and *C.*

deformis (MEEK). It was recognized and defined by KAUFFMAN (*in* HERM & *al.* 1979).

The second lineage comprises much more oblique forms and is represented by *Cremnoceramus waltersdorfensis/inconstans* passage forms, *C.inconstans* (WOODS) and *C.crassus* (PETRASCHECK)(= *C. schloenbachi*), originating also from *C. waltersdorfensis* (ANDERT), and recognized to large extent, and defined already by FIEGE (1930).

Cremnoceramus waltersdorfensis (ANDERT, 1911)
(Text-fig. 12; Pl. 16, Figs 1-11; Pl. 17, Figs 1-5; Pl. 18, Figs 1-7; Pl. 19, Figs 4-6)

1911. *Inoceramus Waltersdorfensis* n. sp.; H. ANDERT, p. 53, Pl. 5, Fig. 5.
1911. *Inoceramus sturmi* n. sp.; H. ANDERT, pp. 58-59, Pl. 2, Fig. 5.
part. ?1911. *Inoceramus inconstans* sp. nov.; H. WOODS, pp. 285-291, Text-fig. 43.
?1911. *Inoceramus inconstans* var. *striatus* MANTELL; H. WOODS, pp. 285-291, Pl. 52, Fig. 1.
1932b. *Alloceramus medius* n.g., n.sp.; R. HEINZ, p. 28.
?1932b. *Inoceramus subinconstans* (*Cremnoceramus?, Alloceramus?*); R. HEINZ, p. 28.
1934. *Inoceramus waltersdorfensis* ANDERT; H. ANDERT, pp. 112-113, Pl. 4, Figs 2-7.
1934. *Inoceramus protractus* SCUPIN; H. ANDERT, p. 114, Pl. 4, Fig. 8.
1962. *Inoceramus medius* HEINZ; F. BRÄUTIGAM, p. 223, Pl. 5, Figs 5-6.
1967. *Inoceramus waltersdorfensis waltersdorfensis* ANDERT; K.-A. TRÖGER, pp. 114-117, Pl. 12, Figs 1-2; Pl. 13, Figs 1-5.
1967. *Inoceramus waltersdorfensis hannovrensis* HEINZ; K.-A. TRÖGER pp. 117-120, Pl. 12, Figs 3-4; Pl. 13, Figs 6-9.
1968. *Inoceramus waltersdorfensis* ANDERT; S.P. KOTSYUBINSKY *in* S.I. PASTERNAK & *al.*, pp. 127-128, Pl. 18, Figs 2, ?3.
1971. *Inoceramus waltersdorfensis* ANDERT; M.A. PERGAMENT, pp. 108-111, Pl. 34, Fig. 4; Pl. 36, Fig. 3; Pl. 38, Figs 3-4; Pl. 46, Figs 3-4.
part. 1974. *Inoceramus* aff. *schloenbachi* BÖHM; J. SORNAY, p. 29, Pl. 1, Fig. 2.
1976b. *Inoceramus waltersdorfenis hannovrensis* HEINZ; E.G. KAUFFMAN, Pl. 5, Figs 3, 15.
1979. *Cremnoceramus? waltersdorfensis hannovrensis* (HEINZ); E.G. KAUFFMAN *in* HERM & *al.*, pp. 59-61, Pl. 9, Figs D, G.
1982. *Inoceramus waltersdorfensis hannovrensis* HEINZ; S. KELLER, pp. 112-114, Pl. 8, Fig. 3
part. 1985. *Inoceramus waltersdorfensis waltersdorfensis* ANDERT; L. SZASZ, pp. 166-167, Pl. 30, Fig. 11.
1985. *Inoceramus* ex gr. *inconstans* WOODS - *I. waltersdorfensis* ANDERT; L. SZASZ, Pl. 30, Fig. 10.
1985. *Inoceramus* aff. *striatus* MANTELL; L. SZASZ, p. 173, Pl. 30, Fig. 8.
1988. *Cremnoceramus? waltersdorfensis hannovrensis* (HEINZ); I. WALASZCZYK, Pl. 6, Figs 4-6.
1989. *Inoceramus* (*Cr.?*) *waltersdorfensis hannovrensis* (HEINZ); T. KÜCHLER & G. ERNST, Pl. 4, Figs 2-4.
1990. *Cremnoceramus?* ex gr. *waltersdorfensis* (ANDERT); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 3, Fig. 2.

LECTOTYPE: The specimen illustrated by ANDERT (1911, Pl. 5, Fig. 5) from Sonnenberge near Waltersdorf, Germany; most probably lowermost Coniacian (in the here applied stratigraphic scheme).

MATERIAL: 180 single- and double-valved specimens represented by internal moulds, rarerly possessing shell fragments.

Słupia Nadbrzeżna-Wesołówka section: Specimens Nos 1.SW.3.1 through 1.SW.3.38 and 1.SW.3.56 through 1.SW.3.102; C. waltersdorfensis Zone; Specimens Nos 1.SW.4-5.1 through 1.SW.4-5.11; 1.SW.6.49 through 1.SW.6.69; 1.SW.7.1 through 1.SW.7.5; and 1.SW.7.7 through 1.SW.7.34; C. brongniarti Zone.

Kolonka-2: Specimens Nos 11.K12.O.1 through 1.K12.O.41; C. brongniarti Zone.

Maksymów: Specimen No. ME: ML 1207; C. brongniarti Zone.

Folwark Quarry: Specimens Nos 4.F.3.10 through 4.F.3.20; C. waltersdorfensis Zone.

DESCRIPTION: The measurements and simple ratios are given in Tables 10-13 and Text-fig. 11. Specimens of small to moderate size for the genus; inequilateral, ?equivalve. Juvenile part flat to slightly convex, subrounded to subquadrate in shape, orthocline. Umbonal region usually slightly delimited from the posterior auricle. Hinge line and anterior margin straight; ventral and posterior margins rounded. Anterior side steep, the rest ones flattened. Posterior auricle poorly delimited from the disc; in completely preserved forms delineated by the posterodorsally curved ornament elements on its surface. In some specimens the more or less well distinct but shallow sulcus may occur. Slope change in different axial distance from the beak, and with values ranging up to 90°. Adult part usually small, though its length rarely preserved completely. In some specimens it is extremly long, and with the second geniculation stage (*see* Pl. 17, Fig. 4). In double-valved specimens the large and distinct posterior auricle visible (*see* Text-fig. 12 *and* Pl. 17, Fig. 1). Ornamentation varied in juvenile and adult stages. In juvenile stage it consists of slightly raised concentric rings (usually, the growth lines), with none or slightly irregular and indistinct concentric ribs. Adult stage smooth with only flat concentric rings and rarer irregular concentric ribs. In the completely preserved juvenile parts, the concentric ornament elements pass onto the posterior auricle where they curve posterodorsally toward the postrior end of the auricle.

The general shape, convexity, the kind of geniculation (rapid or more gradual passage) and the size of posterior auricle is subjected to a marked variability (*see* Text-fig. 12 *and* Pls 16-19).

Table 10

Measurements of selected specimens of *C. waltersdorfensis* (ANDERT); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.SW.3.1 [RV]	36	33	37	33	6.5	22.5	112	92	112	61	0.91	0.89	0.68
1.SW.3.2 [LV]	27	27	32	30	5	18	124	-	108	76	1.00	0.93	0.66
1.SW.3.3 [LV]	32	30*	34.5	31	6	22	111	90	-	69	0.94	0.90	0.73
1.SW.3.4 [LV]	32	31	33	34	7.5	20*	117	-	-	77	0.97	1.00	0.64
1.SW.3.5 [RV]	32	27	33	27.5	7	21	116	-	-	70	0.87	0.83	0.77
1.SW.3.6 [LV]	40.5	37	41	35.5	10	23.5	118	-	-	84	0.91	0.87	0.63
1.SW.3.7 [LV]	37	32	38	33	11	23	120	-	90	75	0.86	0.87	0.72
1.SW.3.8 [LV]	36	30	37.5	29.5	10.5	20.5	115	-	100	83	0.83	0.80	0.68
1.SW.3.9 [RV]	37	31	39	30.5	-	21	110	-	90	70	0.84	0.78	0.68
1.SW.3.10 [RV]	36	32	37*	33	8	22.5	118	-	90	78	0.88	0.89	0.70
1.SW.3.11 [RV]	32	29	33	29	7	19.5	122	95	65	74	0.90	0.88	0.67
1.SW.3.12 [RV]	34.5	31	37	32	8	23	116	90	90	70	0.90	0.86	0.74
1.SW.3.13 [RV]	38	33.5	38	31.5	9.5	26	119	90	70	74	0.88	0.83	0.77
1.SW.3.14 [RV]	31	30	31	18.5	9.5	19	125	95	75	80	0.97	0.92	0.63
1.SW.3.15 [LV]	40	35	41	35	8	23.5	118	-	90	72	0.87	0.85	0.67
1.SW.3.16 [LV]	33	29.5	34	30	8	22.5	112	90	82	78	0.89	0.88	0.88
1.SW.3.17 [RV]	36	31	38.5	33	8.5	22	113	90	82	73	0.86	0.86	0.71

Table 11

Measurements of selected specimens of *C. waltersdorfensis* (ANDERT); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.SW.4-5.1 [RV]	36	31	39	33	7	23	114	114	98	60	0.86	0.85	0.74
1.SW.4-5.2 [RV]	34	30	34	31	9	20*	118	118	-	77	0.88	0.89	0.66
1.SW.4-5.3 [LV]	31	27	31	28	7	19	120	-	90	75	0.87	0.88	0.70
1.SW.4-5.4 [LV]	39	34	41	36	-	25	118	-	-	75	0.88	0.87	0.72
1.SW.4-5.5 [RV]	31	30	32	31	10	22	120	-	-	77	0.95	0.97	0.75
1.SW.4-5.34 [RV]	28	25	30	26	-	17	121	-	-	78	0.91	0.89	0.66

This also concerns the details of the surface ornament, particularly in the juvenile stage (*see* Pl. 16, Figs 1-11). In a case of convexity it is often hardly to decide to what extent it is changed by secondary deformations. As concerns the geniculation type one may observe the forms with rapid slope change with perpendicularly lying juvenile and adult stages (*see* Text-fig. 12 *and* Pl. 17, Figs 1, 4), and the forms with uniform increase of convexity, with the geniculation point marked by the change of the surface ornament (*see* Text-fig. 12; *cf also* ANDERT 1934, Pl. 4, Fig. 3). Similar to the latter is the form referred to *Inoceramus inconstans* var. *striatus* MANTELL by WOODS (1911, Pl. 52, Fig. 1) and called *Inoceramus subinconstans* by HEINZ (1932a). The ornamentation, in the

Table 12

Measurements of selected specimens of *C. waltersdorfensis* (ANDERT); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.K12.0.1 [RV]	35	34	35	33	-	23	120	120	-	70	0.95	0.94	0.69
1.K12.0.2 [RV]	28	27	29	26	-	20	130	-	-	75	0.96	0.90	0.74
1.K12.0.3 [RV]	35	29	36	28	-	20	114	90	-	78	0.82	0.78	0.69
1.K12.0.5 [RV]	26	26	28	27	-	17	119	90	-	68	0.98	0.96	0.65
1.K12.0.6 [LV]	32	31	35	32	-	22	109	-	-	60	0.97	0.87	0.70
1.K12.0.7 [RV]	27	27	29	29	-	21	118	95	-	65	1.00	1.00	0.77
1.K12.0.8 [RV]	35	31	37	31	-	23	115	90	-	68	0.89	0.84	0.74
1.K12.0.9 [RV]	27	25	27	25	-	16	121	-	-	71	0.93	0.93	0.64

Table 13

Average values of selected characters in *C. waltersdorfensis* (ANDERT)

Kolonka 2 section

Characters	α	β	γ	δ	l/h	L/H	s/l
N	8	6	-	8	8	8	8
m	118.2	97.5	-	69.3	93.8	90.2	70.2

Słupia N. - Wesołówka composite section: 1.SW.3

Characters	α	β	γ	δ	l/h	L/H	s/l
N	17	-	12	17	17	17	17
m	117.5	-	95.3	74.3	89.8	82.5	69.6

Słupia N. - Wesołówka composite section: 1.SW. 4-5.

Characters	α	β	γ	δ	l/h	L/H	s/l
N	6	2	2	6	6	6	6
m	117.2	116.0	94.0	73.4	89.7	88.8	72.0

juvenile stage, highly variable ranging from the specimens with delicate, regular, evenly spaced concentric rings (= growth lines) through the specimens possessing, moreover, weakly developed concentric ribs to the specimens with subregular, subevenly spaced, concentric rings with relatively well developed, irregular and unevenly spaced concentric ribs (*see* Pls 16-19).

REMARKS: Within *Inoceramus waltersdorfensis* ANDERT, TRÖGER (1967) distinguished two subspecies, *viz.* the nominative one and the subspecies *hannovrensis* HEINZ. Among the differentiating traits he quoted the larger height and flatter form, and the presence of concentric ribs appearing in the 15-35 mm axial length and greater, average interrings distances in the subspecies *hannovrensis* HEINZ. Moreover, HEINZ' subspecies possesses a smaller anterior hinge angle than nominative subspecies, with reference to the total height. Basing on the studied material, the differing traits which concern the surface ornament do not give a base for distinguishing both

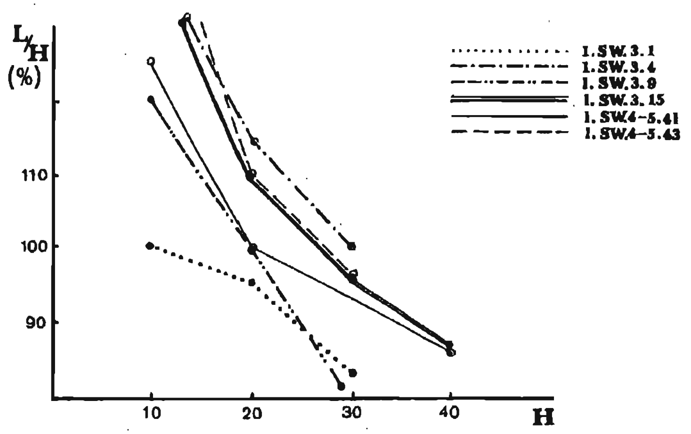


Fig. 11. Ontogenetic change of simple ratio L/H in *Cremnoceramus waltersdorfensis* (ANDERT)

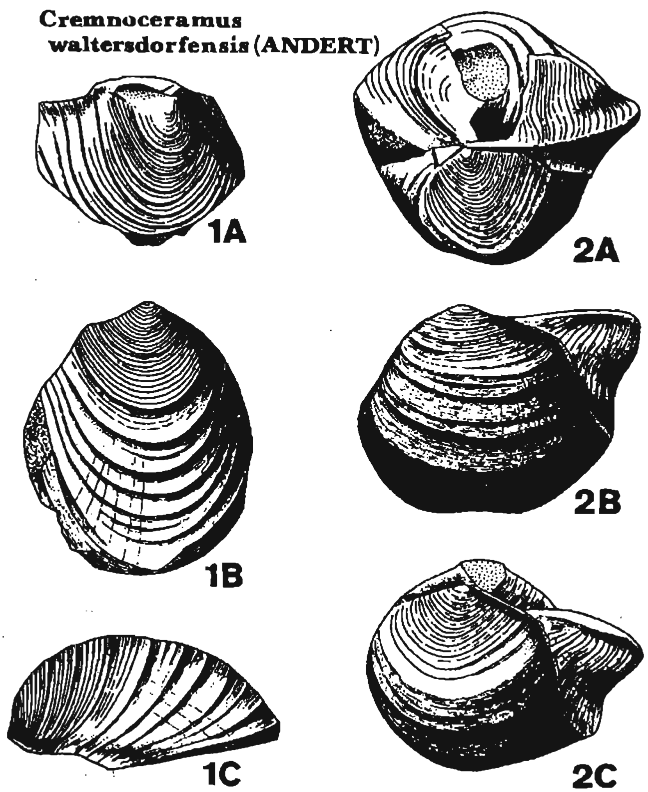


Fig. 12. Dependence of general shape of *Cremnoceramus waltersdorfensis* (ANDERT) on its geniculation types

1 — Specimen No. 1.SW.3.21: 1A dorsal, 1B lateral, 1C posterior view; 2 — Specimen No. 1.SW.3.2: 2A dorsal, 2B lateral, 2C latero-posterior view.

subspecies as the variability range in one sample is much greater than the differences indicated by TRÖGER (1967). Observable is a change between stratigraphically distinct samples, which concerns only the phylogenetic size increase. This alone, however, does not give a base for taxonomic subdivision of the species into subspecies *waltersdorfensis* and *hannovrensis*.

The specimen illustrated by ANDERT (1934, Pl. 4, Fig. 8) and referred to as *Inoceramus protractus* SCUPIN, represents a form belonging to *Cremnoceramus waltersdorfensis* (ANDERT), with irregular surface ornamentation, extended posterior auricle, and with the ornament elements markedly curved posterodorsally on its surface. Such forms fit the variability range of the ANDERT'S species (*compare* Pl. 16, Fig. 8 *and* Pl. 17, Fig. 1).

MATSUMOTO & NODA (1985) illustrated many forms, which judging on the illustrations, are identical with *Cremnoceramus waltersdorfensis* (ANDERT), what was underlined by these authors themselves. Regarding unnatural division of the studied population into two species, they included all specimens into a range of *Inoceramus rotundatus* FIEGE [sensu TRÖGER, *non* FIEGE = *Cremnoceramus brongniarti* (MANTELL)]. Basing on the studied material (*see* Text-fig. 17), the sample with coocurring *C. waltersdorfensis* (ANDERT) and *C. brongniarti* (MANTELL) (=*Inoceramus*

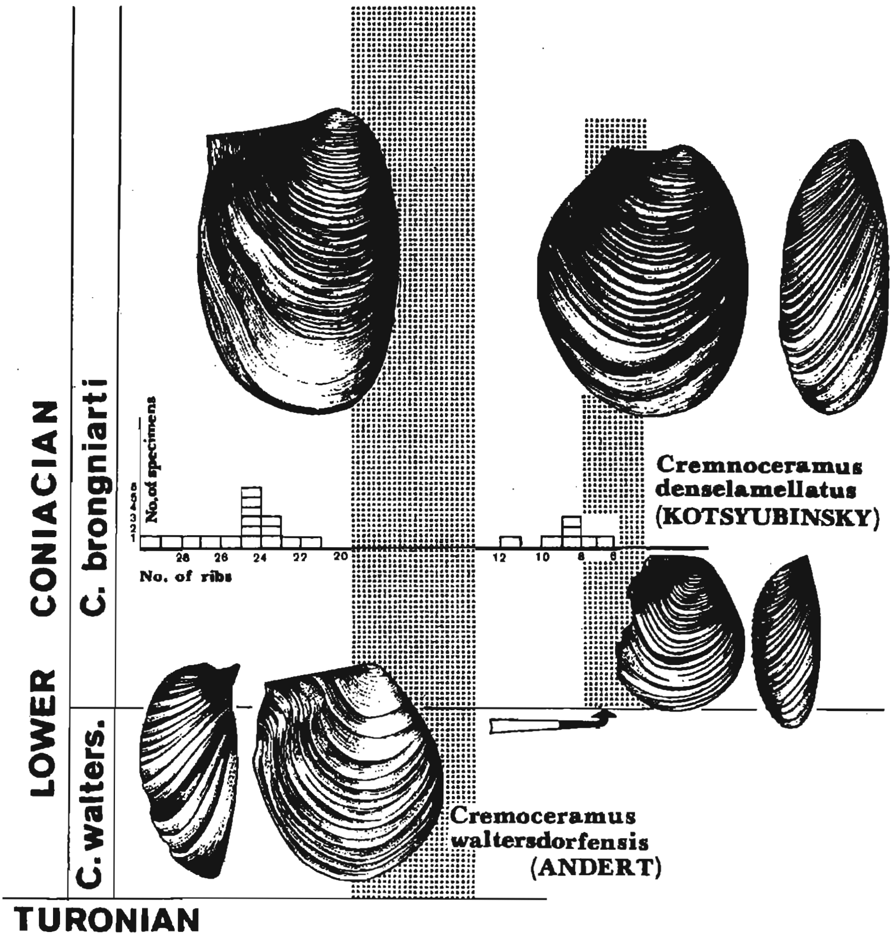


Fig. 13. Stratigraphic ranges and the phylogenetic link of *C. waltersdorfensis* (ANDERT) and *C. denselamellatus* (KOTSYUBINSKY); rib density for both species, measured in 10 to 30mm axial length from the beak, is also given

rotundatus sensu TRÖGER, *non* FIEGE) may well be represented [see specimens of *C. waltersdorfensis* (ANDERT) from the C. brongniarti Zone: Pl. 16, Figs 3, 5, 7], and thus it seems very probable that many of the specimens reported by MATSUMOTO & NODA (1985) represent ANDERT's species.

OCCURRENCE: World-wide in the Lower and Middle Coniacian. In the lowermost Coniacian of Europe often characterized by a mass occurrence.

Cremnoceramus denselamellatus (KOTSYUBINSKY, 1965) (Text-fig. 13 and Pl. 28, Figs 1-7)

1899. *Inoceramus Cuvieri* SOWERBY; J. SIMIONESCU, pp. 263-264, Pl. 2, Figs 8-9.
1958. *Inoceramus* sp.; S.P. KOTSYUBINSKY, p. 11, Pl. 2, Fig. 10.
1968. *Inoceramus denselamellatus* KOTSYUBINSKY; S.P. KOTSYUBINSKY *in* S.I. PASTERNAK & *al.*, p. 124, Pl. 18, Fig. 4.
1974. *Inoceramus waltersdorfensis afghanicus* ssp. nov.; J.SORNAY, pp. 5-6, Pl. 1, Figs 3-5; Pl. 2, Fig. 3.
part. 1974. *Inoceramus* aff. *schloenbachi* BÖHM; J. SORNAY, p. 29, Pl. 1, Fig. 1.
1976b. *Inoceramus waltersdorfensis waltersdorfensis* ANDERT; E.G. KAUFFMAN & *al.*, Pl. 13, Fig. 22, 726.

HOLOTYPE: By monotypy, the specimen figured by KOTSYUBINSKY (1958, Pl. 2, Fig. 10; refigured in KOTSYUBINSKY 1968, Pl. 18, Fig. 4), from Pidiscy, Western Ukraine, ?Lower Coniacian.

MATERIAL: 20 specimens represented by internal moulds, usually with shell fragments attached.

Słupia Nadbrzeżna-Wesołówka: Specimens Nos 1.SW.7.38 through 1.SW.7.43; 1.SW.6.99 through 1.SW.6.106; and 1.SW.4-5.53; C. brongniarti Zone.

Kolonka-2: Specimens Nos 1.K12.O.46 through 1.KL2.O.50; all from the C. brongniarti Zone.

DESCRIPTION: The variability range of general shape, and the shape of the posterior auricle are similar to the characteristics of these traits in *Cremnoceramus waltersdorfensis* (ANDERT). Similarly as in the latter species, there occurs also a phylogenetic size increase, from very small, noted at the base of the Coniacian stage (*see* Text-fig. 13 *and* Pl. 28, Figs 3-5) to moderately sized specimens at the top of the Lower Coniacian substage (*see* Text-fig. 13 *and* Pl. 28, Figs 1-2, 6-7).

The main difference against *Cremnoceramus waltersdorfensis* (ANDERT) is in the character of the surface ornamentation, consisting of regular, subevenly spaced concentric rings, lamellate in shape (*see* Text-fig. 13). Indistinct, low concentric ribs may appear in some distance from the beak (*see* Pl. 28, Fig. 1). Good illustration of the species is given by SORNAY (1974) from Afghanistan, under the name *Inoceramus waltersdorfensis afghanicus* (SORNAY). The specimens illustrated by SIMIONESCU (1899a) and KAUFFMAN & *al.* (1976) represent the juvenile stages of the species. The species possesses identical ornament pattern to that observed in *Mytiloides turonicus* sp. n.

OCCURRENCE: Known from the ?Upper Turonian through Lower Coniacin of Europe, North America and Asia (Afghanistan).

Cremnoceramus websteri (MANTELL, 1822) (Pl. 20, Figs 1-6)

1822. *Inoceramus Websteri*; G. MANTELL, pp. 216-217, Pl. 27, Fig. 2.
part. 1911. *Inoceramus Lamarcki* var. *Websteri* MANTELL; H. WOODS, p. 319, Text-fig. 71; Pl. 53, Fig. 2 [*non* Text-fig. 72 and Pl. 53, Fig. 1].
1959. *Inoceramus websteri* MANTELL; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, pp. 143-144, Pl. 6, Fig. 1.
1969. *Inoceramus websteri* MANTELL; R.A. CHALAFOVA, pp. 153-154, Pl. 5, Figs 10-13.
1990. *Inoceramus websteri* MANTELL; L.F. KOPAEVICH & I. WALASZCZYK, Pl. 3, Fig. 3.

HOLOTYPE: By monotypy, the specimen figured by MANTELL (1822, Pl. 27, Fig. 2) and reillustrated by WOODS (1911, Text-fig. 71).

MATERIAL: 8 specimens represented by internal moulds of the single valves, with occassionally small fragments of the shell attached, from Słupia Nadbrzeżna Wesołówka section (Specimens Nos 1.SW.3.48 through 1.SW.3.55); C. waltersdorfensis Zone.

DESCRIPTION: Measurements and simple ratios of the material are given in Table 14 and Text-fig. 14. Specimens of small to medium size for the genus; inequilateral, equivalved, with marked geniculation combined with distinct ornamentation change. Juvenile stage subrounded to subquadrate, with straight growth axis. Anterior margin straight; ventral and posterior ones rounded. Posterior auricle small, moderately well separated from the disc. Anterior side steep, ventral, and posterior one flattened. Hinge line moderately long, attaining up a half of the respective axial height. Geniculation moderately well to indistinctly marked, usually rounded.

Table 14

Measurements of selected specimens of *C. websteri* (MANTELL); linear dimensions *in* mm

Specimen	h	l	H	L	b	a	α	β	γ	δ	l/h	L/H	a/l
I.SW.3.49	45	39	46	42	-	-	118	100	-	69	0.86	0.91	-
I.SW.3.52	-	-	36	33	-	-	-	100	-	-	-	0.91	-
I.SW.3.55	39	34	39	33	16	20	140	110	-	80	0.87	0.85	0.59
I.SW.3.51	40	39	41	38	-	24	120	108	-	72	0.97	0.92	0.61
I.SW.3.54	40	37	40	37	10	26	110	100	-	70	0.92	0.92	0.65

Ornamentation consists of subregular, sharp-edged, widely spaced concentric ribs, with the interspaces attaining up to 15 mm, and of closely spaced, sometimes slightly lamellate concentric rings in the interspaces. The adult stage usually with only concentric rings. Rarely indistinct, irregular concentric ribs may occur.

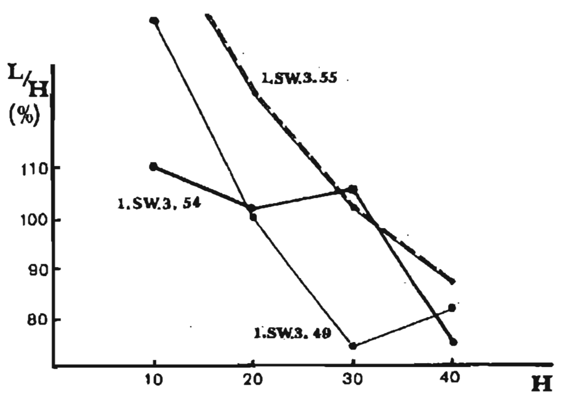


Fig. 14

Ontogenetic change of simple ratio L/H in *Cremnoceramus websteri* (MANTELL)

REMARKS: The species was commonly regarded as close to *Inoceramus lamarcki* PARKINSON and placed into the *lamarcki* group (WOODS 1911, DOBROV & PAVLOVA *in* MOSKVIN 1959, CHALAFOVA 1969, PERGAMENT 1971). On the other hand, SEITZ (1922) regarded it as being close to *Inoceramus costellatus* WOODS, and FIEGE (1930) placed it close to *Inoceramus striatus* MANTELL. The results obtained from the studies of relatively rich material from the Middle Vistula section, from the Cremnoceramus waltersdorfensis Zone, support the view of the latter author. It appears that the MANTELL's species possesses all the traits characteristic of *Cremnoceramus waltersdorfensis* (ANDERT), except of the surface ornament, consisting in the species discussed of irregularly spaced, distant, sharp-edged concentric ribs with wide, flat-floored interspaces. The latter bear indistint concentric rings, but weakly visible on the surface of internal moulds.

OCCURRENCE: Known from the Lower Coniacian (Micraster cortestudinarium Zone) of England, Lower Coniacian of Caucasus, lowermost Coniacian (Cremnoceramus waltersdorfensis Zone) of Poland (Middle Vistula section), ?uppermost Turonian (Inoceramus aff. frechi Zone) of Germany (*see* ERNST & *al.* 1983).

Cremnoceramus brongniarti (MANTELL, 1822)
(Text-figs 15-17; Pl. 22, Figs 1-3; Pl. 23, Figs 1-5; Pl. 24, Figs 1-5; Pl. 25, Figs 1-5; Pl. 30, Fig. 2)

1822. *Inoceramus Brongniarti* MANTELL; G. MANTELL pp. 214-215, Pl. 27, Fig. 8; Pl. 28, Fig. 3.
1822. *Catillus Cuvieri* A. BRONGNIART; A. BRONGNIART, p. 386, Pl. 4, Fig. 10*B*.
1877. *Inoceramus erectus* MEEK; F.B. MEEK, p. 145, Pl. 13, Fig. 1; Pl. 14, Fig. 3.
part. 1893. *Inoceramus deformis* MEEK; T.W. STANTON, p. 85, Pl. 15, Fig. 1 [non Fig. 2].
part. 1911. *Inoceramus inconstans* sp. n.; H. WOODS, pp. 285-291, Text-fig. 44.
part. 1911. *Inoceramus labiatus* var. *latus* SOWERBY; H. WOODS, p. 284, Text-fig. 40.
part. 1911. *Inoceramus Lamarcki* PARKINSON; H. WOODS, pp. 307-327, Text-fig. 68.
1911. *Inoceramus Daschlochensis* n.sp.; H. ANDERT, pp. 53-54, Pl. 1, Fig. 9; Pl. 7, Fig. 7.
1911. *Inoceramus Cuvieri* var. *planus* MÜNSTER (ELBERT); H. ANDERT, p. 45, Pl. 1, Fig. 2; Pl. 7, Fig. 8.
part. 1911. *Inoceramus kleini* MÜLLER; H. ANDERT, pp. 48-51, Pl. 1, Fig. 7.
1911. *Inoceramus subquadratus* SCHLÜTER; H. ANDERT, pp. 60, Pl. 5, Fig. 7.
part. 1930. *Inoceramus inconstans rotundatus* em.; K. FIEGE, p. 43-44, Pl. 8, Fig. 31.
part. 1934. *Inoceramus inconstans* WOODS em. ANDERT; H. ANDERT, pp. 102-106, Text-fig. 7*C*.
part. 1958. *Inoceramus labiatus* var. *latus* SOWERBY; S.P. KOTSYUBINSKY, p. 10, Pl. 1, Fig. 8.
1959. *Inoceramus inconstans* WOODS; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, pp. 137-138, Pl. 5, Fig. 1.
?1959. *Inoceramus weisei* ANDERT; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, p. 138, Pl. 7, Fig. 3.
1959. *Inocramus schloenbachi* BÖHM; S.A. DOBROV & M.M. PAVLOVA *in* MOSKVIN, p. 152, Pl. 8, Figs 1, ?2.
1962. *Inoceramus rotundatus* FIEGE; Z. RADWAŃSKA, pp. 147-149, Pl. 1-2, Figs 4-?5.
1967. *Inoceramus rotundatus* FIEGE; K.-A. TRÖGER, pp. 110-113, Pl. 12, Figs 5-6; Pl. 13, Figs 10-13.
1967. *Inoceramus inconstans hueckendorfensis* n. ssp.; K.-A. TRÖGER, pp. 102-105, Pl. 11, Figs 1-2.
1968. *Inoceramus brongniarti* MANTELL; KOTSYUBINSKY, pp. 124-125, Pl. 18, Figs 6-8.
1976b. *Inoceramus waltersdorfensis* ANDERT n.subsp. transitional to *I. rotundatus* FLEGE; E.G. KAUFFMAN, Pl. 5, Fig. 16.
1976. *Inoceramus erectus erectus* MEEK; E.G. KAUFFMAN & *al.*, Pl. 15, Figs 3-4.
1976. *Inoceramus erectus* MEEK n.subsp. (late from); E.G. KAUFFMAN & *al.*, Pl. 15, Fig. 6.
1979. *Cremnoceramus?* sp. aff. *C.? rotundatus* (FIEGE); E.G. KAUFFMAN *in* HERM & *al.*, Pl. 9, Fig. A.
1979. *Inoceramus* sp. aff. *I. ernsti* HEINZ; E.G. KAUFFMAN *in* HERM & *al.*, Pl. 9, Fig. B.
1979. *Cremnoceramus? rotundatus* (FIEGE); E.G. KAUFFMAN *in* HERM & *al.*, pp. 68-71, Pl. 9, Fig. C.
1982. *Inoceramus rotundatus* FIEGE; S. KELLER, pp. 114-116, Pl. 8, Fig. 2.
1985. *Inoceramus rotundatus* FIEGE; T. MATSUMOTO & M. NODA, pp. 264-271, Pl. 41, Figs 1-4; Pl. 42, Figs 4-6.
1985. *Inoceramus rotundatus* FIEGE; L. SZASZ, pp. 167, Pl. 10, Fig. 4.
1986. *Inoceramus erectus* MEEK; W.A. COBBAN, Fig. 6*B*.
1988. *Cremnoceramus rotundatus* (FIEGE); I. WALASZCZYK, Pl. 7, Figs 1-6.
1989. *Cremnoceramus* cf. *rotundatus* (FIEGE); W.J. KENNEDY & *al.*, p. 111, Figs. 34*J*, *K*.

HOLOTYPE: By original designation, the specimen from Lewes or Brighton (see a remark by WOODS 1911), most probably from the Micraster coranguinum Zone, illustrated by MANTELL (1822, Pl. 27, Fig. 8). Paratype represents the specimen illustrated by MANTELL (1822, Pl. 28, Fig. 3) from Southeram, probably Micraster coranguinum Zone.

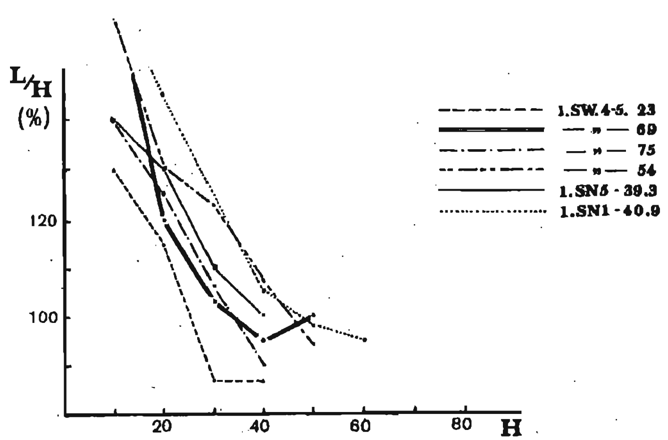


Fig. 15. Ontogenetic change of simple ratio L/H in *Cremnoceramus brongniarti* (MANTELL)

MATERIAL: 106 specimens represented by internal moulds, with shell fragments often attached, of usually single valves; double-valved specimens extremely rare.

Słupia Nadbrzeżna-Wesołówka section: Specimens Nos 1.SW.4-5.23 through 1.SW.4-5.25; 1.SW.4-5.54 through 1.SW.4-5.67; and 1.SW.4-5.69 through 1.SW.4-5.157; C. brongniarti Zone.
Kolonka-2: Specimens Nos 1.K12.O.53 through 1.K12.O.93; C. brongniarti Zone.
Staniewice: Specimens Nos 2.ST.O.1 through 2.ST.O.35; C. brongniarti Zone.
Brzeźno: Specimen No. GS: 1401.II.138; ?C. brongniarti Zone.
Folwark Quarry: Specimens Nos 4.F.3.21 through 4.F.3.30; C. brongniarti Zone.

DESCRIPTION: The measurements and simple ratios are given in Tables 15-16 and Text-fig. 15. Specimens attaining moderate to large size for the genus: inequilateral, ?equivalved. Juvenile stage subquadrate to subrounded, with straight anterior margin. Ventral and posterior margins rounded. Hinge line straight, long. Anterior side steep, sometimes slightly concave below the beak; the other sides flattened. Posterior wing poorly separated from the disc; in some specimens a shallow auricular sulcus occurs. The adult stage well distinct from the juvenile (*see* Pl. 23, Fig. 2) or marked

Table 15

Measurements of selected specimens in *C. brongniarti* (MANTELL); linear dimensions *in* mm

Specimen	h	l	H	L	b	s	α	β	γ	δ	l/h	L/H	s/l
1.SN.5.39.3 [LV]	40	38	44	42	9	23	122	105	-	78	0.95	0.95	0.60
1.SW.4-5.79 [LV]	40	41	42	42	13	21	110	-	140	74	1.00	1.01	0.51
1.SW.4-5.23 [LV]	38	35	40	35	6	26	118	-	-	71	0.92	0.87	0.74
1.SW.4-5.81 [LV]	35	34	39	35	5	26	117	102	-	70	0.97	0.91	0.76
1.SW.4-5.69 [LV]	50	50	52	49	-	26	121	-	124	78	1.00	0.93	0.52
1.SW.4-5.75 [LV]	40	37	44	38	8	28*	115	-	-	74	0.93	0.86	0.77
1.SW.4-5.72 [LV]	45	42*	50	46*	15	28	117	-	112	66	0.93	0.92	0.66
1.SW.4-5.70 [LV]	51	44	52	49	12	30*	112	-	-	72	0.87	0.94	0.67
1.SW.4-5.71 [RV]	34	28*	35	30*	8	18*	118	-	-	71	0.82	0.85	0.64
1.SW.4-5.67 [LV]	46	42	49	45	13	31	104	-	-	74	0.91	0.91	0.74
1.SW.4-5.80 [RV]	41	39	45	41	10	32	115	-	90	62	0.96	0.93	0.81
1.SW.4-5.54 [RV]	52	47	55	48	11	29	111	-	140	68	0.90	0.87	0.62
1.SW.4-5.65 [LV]	43	44	50	46	13	32	112	95	90*	70	1.00	0.92	0.73
1.SW.4-5.73 [RV]	62	59	65	61	18	-	110	-	-	70	0.95	0.94	-
1.SN.1.40.9 [LV]	61	61	65	62	-	34	124	-	115	78	1.00	0.95	0.56

Table 16

Average values of selected characters in *C. brongniarti* (MANTELL); linear dimensions in mm

Characters	α	β	γ	δ	l/h	L/H	s/l
N	16	-	9	16	16	16	15
m	114.6	-	115	71.4	94.0	91.6	67.4

only by the change in ornamentation (*see* Text-fig. 16), forming a continuation of the juvenile stage, with the longitudinal cross section of the valve being similar to typical one of the genus *Inoceramus* SOWERBY, with marked inflation, high and steep anterior side (*see* Pl. 22, Fig. 2; *cf. also* the holotype of the species Pl. 22, Fig. 3). In adult stage the posterior auricle, being in juveniles poorly separated from the disc, becomes distinct.

Ornamentation in the juvenile stage consists of distinct concentric ribs, while in adults it does of irregular flat concentric ribs or exclusively of concentric rings. Juvenile ornamentation is regular, with the trajectories of the ornament elements rounded to subquadrate. On the posterior auricle the ornament elements may markedly curve posterodorsally.

VARIABILITY: The species displays a relatively high morphological variability, with every trait varying in broad limits (*see* Text-fig. 16 *and* Pls 22-25). The forms with distinct slope change (*see* Text-fig. 16:2 *and* Pl. 23, Fig. 2) represent what may be referred to as classical image of "*Inoceramus inconstans*"; to such forms belongs also the paratype of the species. These have hitherto been commonly referred to as *Cremnoceramus rotundatus* (FIEGE) (*see* synonymy) and are relatively frequent in the studied material. However, in most cases the adult stage of such specimens is not preserved. Much rarely occur the forms close to the holotype (*see* Pl. 22, Figs 2-3), with almost uniform inflation of the valves, and with poorly defined juvenile and adult stages. Only in the specimens possessing the adult stage, the well separated posterior auricle is present. Such specimens with a relatively gradual slope change were referred commonly to *Cremnoceramus erectus* (MEEK) or *Cremnoceramus inconstans lueckendorfensis* (TROGER)[the probable identity of both these taxa was suggested by Dr. S. ČECH, Geological Survey of Czecho-Slovakia].

REMARKS: The type of MANTELL's *Inoceramus brongniarti* was already by SOWERBY (1828) referred to the inoceramid group fitting the applied here concept of the genus *Inoceramus*, approximating the concept of the *lamarcki* group. Most of the subsequent authors either shared

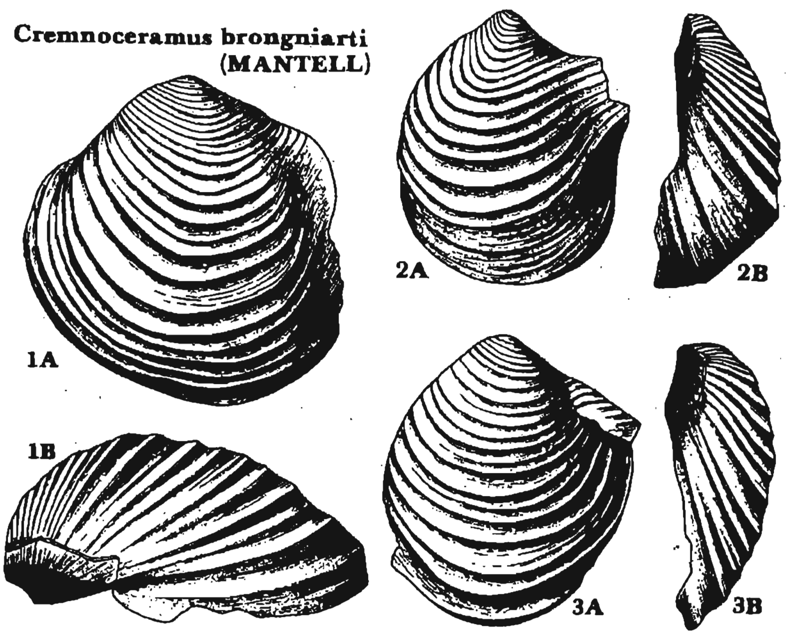


Fig. 16. Basic shape types in three specimens of *C. brongniarti* (MANTELL); 1 — Specimen No. 1.K12.O.71, 2 — No. 1.K12.O.85, 3 — No. 1.K12.O.92; 3A lateral, 3B anterior view

this view or simply compared the original of MANTELL (1822, Pl. 27, Fig. 8) to *Inoceramus lamarcki lamarcki* PARKINSON (*see* KELLER 1982). The latter species possesses, however, another sculpture pattern, namely round-topped concentric ribs covered with evenly spaced, and raised concentric rings against the sharp-edged occurring in *C. brongniarti*, the extended and well separated posterior auricle, with narrow, marked posterior sulcus, being small and indistinct in MANTELL's species. Moreover, the concentric ornamentation in *C. brongniarti* (MANTELL) continues onto the posterior auricle, while it does not in *I. lamarcki* PARKINSON. Also the L/H characteristics is apparently similar in the type of *C. brongniarti* (MANTELL) to that observed in the *lamarcki* group; in *C. brongnirti* much higher value of *H* in respect to *L* results from the anteroposterior compression of the original specimen combined with cracking of the left valve along the growth axis and pulling over of one

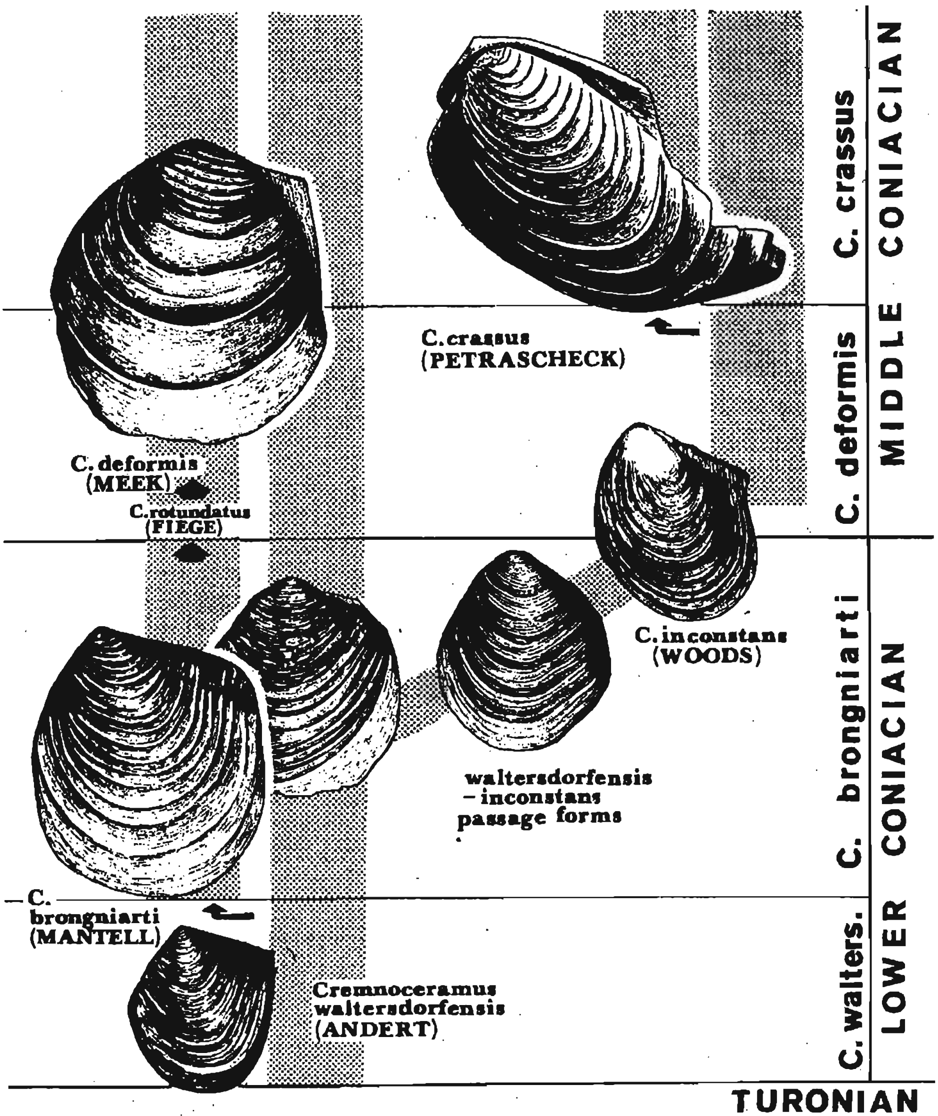


Fig. 17. Stratigraphic ranges and phylogeny within the Lower – Middle Coniacian cremnoceramids

half of the shell onto another, similarly as in the case of the specimen 1.SW.4-5.76 from studied collection (*compare* Pl. 22, Fig. 2 and Pl. 22, Fig. 3). The second specimen of MANTELL (1822, Pl. 28, Fig. 3), i.e. the paratype, was cited by WOODS (1911) as one of the types of his new species *Inoceramus inconstans*. Both specimens well compare to the Lower Coniacian forms represented in abundance in the studied collection (*see* Pls 22-25), and such forms have hitherto been referred to *Cremnoceramus rotundatus* (FIEGE), *C. inconstans lueckendorfensis* (TRÖGER), or *C. erectus* (MEEK)(*see* synonymy).

The species *Cremnoceramus rotundatus* (FIEGE), as represented by its lectotype designated by TRÖGER (1967), and to which, following TRÖGER's (1967) description the representatives of *C. brongniarti* (MANTELL) were commonly referred, represents most probably a distinct species, or the passage forms between *C. brongniarti* (MANTELL) and *C. deformis* (MEEK). It differs from *C. brongniarti* (MANTELL) in surface ornament characteristics, possessing round-edged, low, widely spaced concentric ribs with irregular concentric rings inbetween. This, as was mentioned already by FIEGE, makes its ornament more similar to the one occurring in the species *C. crassus* (PETRASCHECK) and *C. deformis* (MEEK). Very similar, if not identical form represents the species *"Inoceramus" stillei* of HEINZ (1928a, Pl. 2, Fig. 2). If the latter appears to be identical with *C. rotundatus* (FIEGE), the FIEGE's species would have become its younger synonym. In the studied area the forms comparable to *Cremnoceramus rotundatus* FIEGE/*stillei* HEINZ (*see* Pl. 29, Fig. 2) occur distinctly higher than *Cremnoceramus brongniarti* (MANTELL), in the C. deformis Zone (*see* Text-fig. 17). Two other specimens of *Inoceramus rotundatus* figured by FIEGE (1930, Pl. 8, Figs 31 and 33) represent, most probably, the species *C. brongniarti* (MANTELL) and *C. waltersdorfensis* (ANDERT) respectively.

OCCURRENCE: Common in the Lower Coniacian; world-wide.

Cremnoceramus deformis (MEEK, 1872)
(Text-fig. 17; Pl. 29, Fig. 4; Pl. 30, Fig. 4)

1877. *Inoceramus deformis* MEEK; F.B. MEEK, pp. 146-148, Pl. 14, Fig. 4.
part. 1893. *Inoceramus deformis* MEEK; T.W. STANTON, pp. 85-86, Pl. 15, Fig. 2.
1959. *Inoceramus deformis* MEEK; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, p. 138, Pl. 8, Fig. 3.
?1974. *Inoceramus crassus* PETRASCHECK; S.P. KOTSYUBINSKY, p. 80, Pl. 15, Fig. 3.
1976. *Inoceramus? deformis deformis* MEEK; E.G. KAUFFMAN & *al.*, Pl. 13, Fig. 3.
?1976. *Inoceramus? deformis* MEEK; E.G. KAUFFMAN & *al.*, Pl. 16, Fig. 2.
1988. *Cremnoceramus deformis* (MEEK); I. WALASZCZYK, Pl. 8, Figs 1-2.
1990. *Cremnoceramus deformis* (MEEK); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 4, Fig. 4.
1991. *Inoceramus deformis* MEEK; R. TARKOWSKI, p. 107, Pl. 15, Fig. 1.

HOLOTYPE: By monotypy, the specimen illustrated by MEEK (1877, Pl. 14, Fig. 4) from Colorado City, United States; Coniacian.

MATERIAL: Ten specimens represented by internal moulds of single valves.

Folwark Quarry: Specimens Nos 4.F.4.4; 4.F.4.14; 4.F.4.15; C. deformis/C. crassus Zone.
Pętkowice: Not catalogued specimen, Geological Survey Museum; C. crassus Zone.
Ossowa: Three, not catalogued specimens, Geological Survey Museum; ?C. deformis/C. crassus Zone.
Kostomlaty (Czecho-Slovakia): Specimen No. 5.K.O.2; C. crassus Zone.
Aksu-Dere (Crimea, the Ukraine): Specimens Nos 5.C.7 and 5.C.8; C. deformis/C. crassus Zone.

DESCRIPTION: Specimens attaining large size for the genus; inequilateral, ?equivalved, subquadrate, strongly inflated. Anterior, ventral and posterior margins convex; posterior auricle well delimitd from the disc, relatively small, elongated parallelly to the posterior margin of the disc. Valves slightly oblique, with δ varying between 70 and 80 degrees. Beak massive, prosocline, projecting above the hinge line.

Ornamentation consists of subquadrate concentric ribs, relatively closely spaced, in the juvenile stage, with quick, ventralward interspaces increasing in size. In the adult stage the concentric ribs sharp-edged, with very wide, flat-floored interspaces. Concentric rings on the surface of internal moulds very indistinct or missing.

REMARKS: This species is the end member of the *C. waltersdorfensis* (ANDERT) – *C. brongniarti* (MANTELL) – *C. deformis* (MEEK) lineage with an observed inner group size increase, and ornament change from the closely spaced concentric rings in the first member through sharp-edged, relatively closely spaced concentric ribs (*see* Text-fig. 17) in MANTELL's species, to widely spaced, with wide interspaces concentric ribs in *C. deformis* (MEEK).

OCCURRENCE: Common in the Middle Coniacian of Europe and North America.

Cremnoceramus inconstans (WOODS, 1911)
(PL. 35, Fig. 3; Pl. 36, Fig. 1)

1822. *Inoceramus* sp.; G. MANTELL, p. 217, Pl. 27, Fig. 9.
*part.*1911. *Inoceramus inconstans* sp. nov.; H. WOODS, pp. 285-291, Text-figs 42, ?43; ?Pl. 51, Fig. 2.
part. 1912. *Inoceramus inconstans* WOODS; H. WOODS, Text-figs ?67-68, ?71-73.
part. 1930. *Inoceramus inconstans Woodsi* em. FIEGE; K. FIEGE, pp. 39-40, Pl. 6, Figs 20-21, 23 [*non* Figs 22, 24].
1990. *Cremnoceramus inconstans inconstans* (WOODS); L.F. KOPAEVICH & I. WALASZCZYK, Pl. 4, Figs 1-2.

LECTOTYPE: The specimen from Lewes, Upper Chalk, figured by WOODS (1911, Text-fig. 42), and subsequently designated by TRÖGER (1967).

MATERIAL: 4 specimens represented by two internal moulds and two shell-possessing single valves.

Dzenguiay (Caucasus): Specimens Nos 5.Dz.Cn.3 and 5.Dz.Cn.4; C. deformis Zone.
Kostomlaty (Czecho-Slovakia): Specimen No. 5.K.O.1; C. crassus Zone.
Folwark Quarry: Specimen No. 4.F.4 16; C. crassus Zone.

DESCRIPTION: Specimens of small to medium size for the genus; inequilateral, ?equivalved. Juvenile stage elongated in posteroventral direction, flat to weakly inflated, with maximum inflation positioned centrally. Anterior side convex; ventral margin rounded, posterior margin straight. Beak pointed, slightly projecting above the hinge line. Posterior auricle elongated, subtriangular, narrow.

Ornamentation consists, in the juvenile stage, of subregular, subevenly spaced, rounded-edged concentric ribs, with indsitinct interspaces and covered with regular, slightly raised, in the central part of the disc slightly lamellate concentric rings (?growth lines). Adult stage, in the lectotype almost perpendicular to the juvenile one, with irregular concentric ribs.

REMARKS: The species *Inoceramus inconstans* in the content in which WOODS (1911) included many variable forms, but characterized by the presence of geniculation, was one of the most widely discussed inoceramid species, and one of the most inconsistently treated. Already in 1913, ANDERT gave a much restricted interpretation of the species, and of the forms illustrated by WOODS, he included in his concept only these coming from the Holaster planus Zone (WOODS 1911, Text-figs 39, 42, 43, 46 and Pl. 51, Fig. 2; Pl. 52, Fig. 1). FIEGE (1930) characterizing the nominative subspecies reffered only to Text-fig. 42 in WOODS (1911), the form which was later formally designated as the lectotype of the species *Inoceramus inconstans* WOODS by TRÖGER (1967), and which besides the specimen from Pl. 51, Fig. 2 in WOODS 1911, should be referred to *Cremnoceramus inconstans* (WOODS). The specimen illustrated by WOODS 1911, on Text-fig. 43 most probably represents the slightly deformed *Cremnoceramus waltersdorfensis* (ANDERT) and the specimen from Text-fig. 44 is one of the types of *Cremnoceramus brongniarti* (MANTELL), which as indicated above is a valid species.

The species *Cremnoceramus inconstans* (WOODS) in all respects but the surface ornamentation approaches *Cremnoceramus crassus* (PETRASCHECK). The latter possesses in the central and ventrally positioned part of the juvenile stage widely spaced, sharp-edged with wide, flat-floored interspaces concentric ribs not appearing in *Cremnoceramus inconstans* (WOODS).

The specimens assigned to *Inoceramus inconstans Woodsi* by FIEGE (1930, Pl. 6, Figs 20-21 and 23) represent *Cremnocermus inconstans* (WOODS). The concentric ribs with more sharp edges appearing in some distance from the beak, and which were to differentiate the subspecies *Woodsi* from the nominative subspecies occur in every, sufficiently large specimen.

OCCURRENCE: Known from the Middle Coniacian. Convincing reports are limited to Europe.

Cremnoceramus crassus (PETRASCHECK, 1903)
(Text-fig. 17; Pl. 34, Figs 1-4; Pl. 35, Figs 1-2; Pl. 36, Figs 3, 5)

1834-40. *Inoceramus Cuvieri* SOWERBY; A. GOLDFUSS, p. 114, Pl. 111, Fig. 1?a, b, c.
1903. *Inoceramus crassus* nov. spec.; W. PETRASCHECK, pp. 164-165, Pl. 8, Fig. 4.
1911. *Inoceramus crassus* PETRASCHECK; H. ANDERT, pp. 46-47, Pl. 3, Fig. 4; Pl. Figs 1-2.
1912. *Inoceramus schloenbachi* BÖHM; J. BÖHM, p. 570.
part. 1930. *Inoceramus inconstans Schloenbachi* BÖHM; K. FIEGE, pp. 40-42, Pl. 7, Figs 27?, 29; Pl. 8, Figs 28?, 29 [*non* Pl. 7, Fig. 26].
part. 1930. *Inoceramus inconstans Woodsi* em. FIEGE; K. FIEGE, pp. 39-40, Pl. 6, Fig. 24.
?1934. *Inoceramus schloenbachi* BÖHM; H. ANDERT, pp. 107-109, Text-fig. 8; Pl. 3, Fig. 2.
1934. *Inoceramus crassus* PETRASCHECK; H. ANDERT, pp. 109-111, Text-fig. 9; Pl. 3, Fig. 3.
1962. *Inoceramus schloenbachi* BÖHM; Z. RADWAŃSKA, pp. 142-145, Pl. 2, Figs 1, 4; Pl. 3, Fig. 1; Pl. 4, Fig. 2.
1967. *Inoceramus deformis* MEEK; K.-A. TRÖGER, pp. 130-132, Pl. 14, Fig. 7.
1974. *Inoceramus schloenbachi* BÖHM; K.-A. TRÖGER, pp. 114-118, Pls 1-3.
part. 1985. *Inoceramus schloenbachi* BÖHM; L. SZASZ, pp. 159-161, Pl. 3, Figs 1, ?2; Pl. 15, Fig. 2; Pl. 18, Fig. 3; Pl. 22 Fig. 3; ?Pl. 25, Fig. 3; ?Pl. 27, Fig. 2; ?Pl. 31, Fig. 2; Pl. 35, Fig. 1; ?Pl. 39, Fig. 2 [*non* Pl. 16, Fig. 2; Pl. 28, Fig. 1; Pl. 30, Fig. 1].
part. 1991. *Inoceramus schloenbachi* BÖHM; R. TARKOWSKI, pp. 114-115, Pl. 16, Fig. 1 [*non* Pl. 14, Fig. 1].

HOLOTYPE: By monotypy, the specimen figured by PETRASCHECK (1903, Pl. 8, Fig. 4) from Daschloch, Germany; Middle Coniacian.

MATERIAL: 14 specimens represented by internal moulds of single valves, rarely with shell fragments attached.

Folwark Quarry: Specimens Nos 4.F.4.1 through 4.F.4.3; and 4.F.4.6 through 4.F.4.12; C. crassus Zone.
Pętkowice: Two, not catalogued specimens, Geological Survey Museum; C. crassus Zone.
Ossowa: Specimen No. GS: 1401.II.171; ?C. crassus Zone. Słupia Nadbrzeżna-3: One, not catalogued specimen, Geological Survey Museum; passage form to *C. inconstans* (WOODS) (*see* Pl. 34, Fig. 3); C. deformis Zone.

DESCRIPTION: Specimens of medium to large size for the genus; inequilateral, ?equivalved. Juvenile stage weakly inflated, elongate ovate, with convex anterior side. Posterior auricle (rarely preserved) subtriangular, elongated, narrow. Angle between growth axis and posterior margin of the disc about 40°. Adult stage trapezoidal in shape, perpendicular or with angle 60 to 90° in reference to the juvenile stage.

Ornamentation in juvenile stage consists, up to 30-50mm axial length from the beak, of regular, rounded-edged, subevenly spaced concentric ribs, gradually increasing ventralwards and covered with regular, slightly lamellate, subevenly to evenly spaced concentric rings (*see* Pl. 33, Fig. 2; Pl. 34, Fig. 1), usually poorly visible on the surface of internal moulds. Ventralward the concentric ribs pass gradually into sharply edged, widely spaced, sub- to irregular ribs, with wide, flat-floored interspaces, which may bear one or two concentric riblets. Adult stage with irregular, widely spaced concentric ribs, or completely smooth. On the shelled specimens the concentric rings sometimes visible.

REMARKS: The study of the holotype of *Cremnoceramus crassus* (PETRASCHECK) shows that it represents a well preserved specimen, in respect to its general shape (it is represented by the sandstone internal mould), identical with forms which have hitherto been referred commonly to as *Cremnoceramus schloenbachi* (BÖHM 1912)(the latter species as currently defined by TRÖGER 1974). Thus, the specific name *C. schloenbachi* (BÖHM 1912) is a junior synonym of *Cremnoceramus crassus* (PETRASCHECK 1903).

The species concerned represents the final member of the evolutionary lineage (*see* Text-fig. 17), defined to large extent by FIEGE (1930), originating most probably from *Cremnoceramus waltersdorfensis* (ANDERT) and running through *Cremnoceramus inconstans* (WOODS). The forms which link the *Cremnoceramus inconstans* - *Cremnoceramus crassus* lineage with *Cremnoceramus waltersdorfensis* are well represented in the studied material (*see* Pl. 19, Figs 1-3). In the Middle Vistula section they were found in the topmost part of the Cremnoceramus brongniarti Zone. These, in their general characteristics are identical with *Cremnoceramus waltersdorfensis* (ANDERT) possessing, however, more or less well defined concentric ribs, superimposed on the ornamentation typical of ANDERT's species and usually composed of concentric rings only. On the other hand, such specimens may form extreme variants still within the range of *C. waltersdorfensis*. Moreover, these are similar also to *Mytiloides incertus* (JIMBO), though they possess much lower obliquity and slightly different trajectory of the ornament elements.

The species *Cremnoceramus crassus* (PETRASCHECK) is closely allied (*see* Text-fig. 17) to *Cremnoceramus inconstans* (WOODS) and *C. deformis* (MEEK). Concerning the latter species, following SEITZ' (1956) remark, *Cremnoceramus crassus* (=*schloenbachi*) has long been regarded as the subspecies of MEEK's species (*see e.g.* TRÖGER 1967). Some other authors distinguish both species, assuming the differences in the sculpture which, according to studies of HEINZ (1928), differentiate both forms. More recently TRÖGER (1974), studing the original of *Cremnoceramus deformis* (MEEK) and a rich material of *C. schloenbachi* (BÖHM), showed both species to be fairly well separatable, with the species of MEEK being subquadrate in shape (opposite to axially ovate in the case of *Cremnoceramus crassus*) and much less oblique.

The species *Cremnoceramus inconstans* (WOODS) differs from *C. crassus* (PETRASCHECK) only in surface ornamentation. The latter species possesses in the central and ventrally lying parts of the juvenile stage the widely spaced, sharp-edged concentric ribs, with flat-floored interspaces not occurring in the WOODS' species. In all other respects these two species are identical.

OCCURRENCE: Common in the Middle Coniacian of Europe and North America.

Cremnoceramus ernsti HEINZ, 1928
(Text-fig. 18; Pl. 32, Figs 1-3)

part. 1911. *Inoceramus Lamarcki* PARKINSON; H. WOODS, pp. 307-327, Text-fig. 85 [only].
1928. *Inoceramus ernsti* n.sp.; R. HEINZ, pp. 73-74.
?1967. *Inoceramus ernsti* HEINZ; K.-A. TRÖGER, pp. 128-130, Pl. 14, Figs 1-4, 6.
1979. *Inoceramus ernsti* HEINZ; A.V. IVANNIKOV, p. 51, Pl. 8, Figs 1-2.
non 1980. *Inoceramus (Inoceramus) ernsti* HEINZ; E.G. KAUFFMAN *in* KLINGER *& al*., pp. 310-314, Figs 10G-P.
1985. *Inoceramus paradeformis* n.sp.; L. SZASZ, pp. 165-166, ?Pl. 4, Fig. 1; Pl. 16, Fig. 1; Pl. 17, Fig. 1; Pl. 18, Fig. 1; Pl. 32, Fig. 1; Pl. 36, Fig. ?2; Pl. 37, Fig. 1.
non 1985. *Inoceramus ernsti* HEINZ; L. SZASZ, p. 172, Pl. 29, Fig. 3.
non 1991. *Inoceramus ernsti* HEINZ; R. TARKOWSKI, p. 108, Pl. 14, Fig. 5.

LECTOPTYPE: The specimen illustrated by WOODS (1911, Text-fig. 85; *see also* Text-fig. 18 and Pl. 32, Fig. 2 of the present paper) to which HEINZ (1928) referred when establishing his new species, by subsequent designation of TRÖGER (1967). The locality and the stratigraphic position unknown.

MATERIAL: 12 specimens represented by internal moulds of single valves with large shell fragments attached.

Wielkanoc: Specimen No. 3.W.3.1; C. crassus Zone.
Dzengutay (Caucasus): Specimen No. 5.Dz.Ca.1; C. deformis Zone
Kolonka-2: Specimens Nos 1.K2.3.10 through 1.K2.3.20; C. deformis Zone.

DESCRIPTION (based mainly on the lectotype): Specimens of medium to large size for the genus: inequilateral, ?equivalve. Valves subquadrate, massive, strongly inflated, with maximum inflation dorsocentral. Anterior margin concave, the others subrounded. Posterior auricle prominent, well delimited from the disc (not preserved in the lectotype). Umbonal region pointed, curved anteriorly, not projecting above the hinge line or only slightly so. Two distinct ontogenetic stages with different ornament pattern may be distinguished, passing gradually each other but with the main parts of them being almost perpendicular. The juvenile stage is weakly inflated, subquadrate, poorly ornamented, with only growth lines (or concentric rings on the surface of internal mould). Posterior auricle not distinctly delimited from the disc, though well extended. Anterior side straight to slightly convex, and delicately concave only below the beak. Obliquity ranges between 50 and 65°. Adult stage almost perpendicular to the juvenile part, evenly to subevenly ribbed, with deep and relatively wide interspaces, markedly inflated, and with the posterior auricle well delimited along the auricular sulcus. This stage, is almost perpendicular to the hinge line, with obliquity about 90° (*see* Text-fig. 18). Some forms possess an another sculpture pattern (*see* Pl. 32, Fig. 2 and the specimen illustrated by IVANNIKOV 1979, Pl. 8, Figs 1-2), consisting of sharply edged, widely spaced concentric ribs, with two or three concentric ribblets in between. Growth lines (or concentric rings) poorly visible.

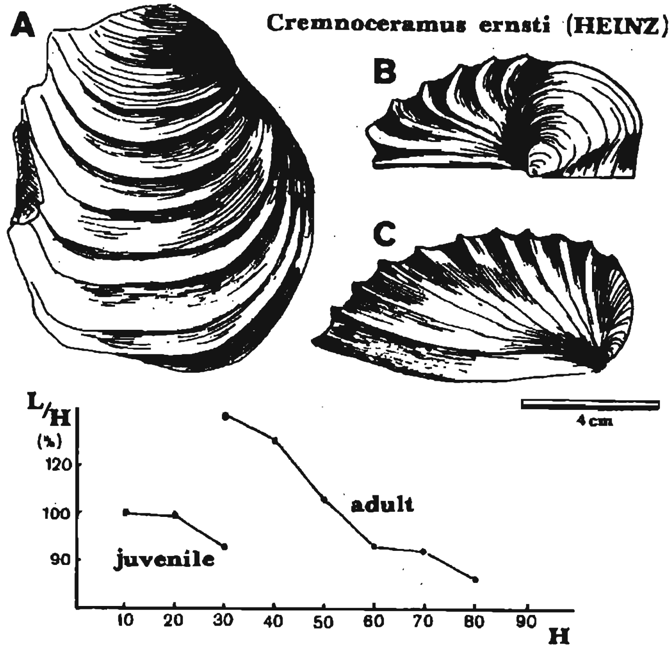


Fig. 18. General view (A lateral, B dorsal, C anterior) and some characteristics of *Cremnoceramus ernsti* (HEINZ), based on the plaster cast of the lectotype (*see* WOODS 1911, Text-fig. 85)

REMARKS: The species was interpreted very inconsistently and most of the figured forms do not represent this species (*see* synonymy). A good description of the species was given by SZASZ (1985) when characterizing his new species *Inoceramus paradeformis* SZASZ which, unfortunately to him, represents just typical *Cremnoceramus ernsti* HEINZ.

OCCURRENCE: The lectotype was not convincingly dated, with the Holaster planus Zone suggested by WOODS (1911) only with a question mark. The specimen from the Caucasus reported by INOSTRANZEFF (according to HEINZ 1928) comes from the Cremnoceramus crassus (=C. schloenbachi) Zone. From the Caucasus, from the same stratigraphic position comes the personally collected specimen (*see* Pl. 32, Fig. 1) in the Dzengutay section. Similarly, the specimen from Wielkanoc (*see* Pl. 32, Fig. 2) was found associated with *Cremnoceramus crassus* (PETRASCHECK). The credible reports of the species are limited to Europe (Caucasus, Romania, Poland, Germany, England).

Genus *Volviceramus* STOLICZKA, 1871

TYPE SPECIES: *Inoceramus involutus* SOWERBY (1828(1842), Pl. 583, Fig. 1), Upper Chalk, locality unknown; *OD* STOLICZKA 1871, p. 394.

Diagnosis and synonymy are given by Cox (1969, p. *N*321).

OCCURRENCE: Coniacian and Santonian of Europe and North America.

Volviceramus involutus (Sowerby, 1828)
(Pl. 37, Fig. 5)

1828(1842). *Inoceramus involutus* Sowerby; J. Sowerby, pp. 610-611, Pl. 583, Figs 1-2.
1843. *Inoceramus involutus* Sowerby; A. d'Orbigny, p. 520, Pl. 413, Figs 1-3.
1893. *Inoceramus umbonatus* Meek & Hayden; T.W. Stanton, pp. 81-82, Pl. 18, Figs 1-2.
1893. *Inoceramus exogyroides* Meek & Hayden; T.W. Stanton, p. 83, Pl. 17, Figs 1-2.
1959. *Inoceramus involutus* Sowerby; S.A. Dobrov & M.M. Pavlova *in* M.M. Moskvin, p. 153, Pl. 10, Fig. 1.
1971. *Inoceramus involutus* Sowerby; M.A. Pergament, pp. 130-131, Pl. 4, Fig. 2.
1974. *Inoceramus involutus* Sowerby; S.P. Kotsyubinsky, p. 81, Pl. 18, Fig. 1.

LECTOTYPE: The specimen figured by Sowerby (1828(1842), Pl. 583, Fig. 1), refigured by Woods (1911, Text-fig. 88) from the Upper Chalk; detailed locality unknown.

MATERIAL: The species is very poorly represented in the studied collection (three specimens), but it is simply due to an extremely limited number of accessible localities with Upper Coniacian fauna. Judging on the borehole materials, as deposited in the Geological Survey Museum, and on the well exposed *involutus*-beds in the western Ukraine and Caucasus, it is a very common form of the Upper Coniacian strata.

OCCURRENCE: Known from the Upper Coniacian; world-wide.

Genus *Magadiceramus* Heinz, 1932

TYPE SPECIES: *Inoceramus subquadratus* Schlüter, 1887; *SD* Seitz 1970, p. 16. The lectotype of the species designated by Seitz (1970, pp. 9-12, Pl. 1, Fig. 1), comes from the Coniacian Austin Group; Austin, Texas, United States.

Diagnosis and extensive discussion are given by Seitz (1970).

OCCURRENCE: Known in North America and Europe within the Upper Coniacian (?lowermost Santonian).

Magadiceramus ex gr. *subquadratus* (Schlüter, 1887)
(Pl. 37, Figs 1-2; Pl. 38, Figs 1-3)

LECTOTYPE: see remarks on the type species of the genus.

MATERIAL: 5 specimens represented by internal moulds of single valves.

Plusy: Two, uncatalogued specimens from depth 68 and 70m, Geological Survey Museum; M. subquadratus Zone.
Stefanów: One, uncatalogued specimen from depth 74m, Geological Survey Museum; M. subquadratus Zone.
Ossowa: Specimen No. GS: 1401.II.183; M. subquadratus Zone. Ludynia: uncatalogued specimen, Geological Survey Musem; detailed horizon unknown.

REMARKS: The species was extensively serveyed by Seitz (1970), so only short remarks on the studied material will be given.

Besides the specimen from Ludynia (Pl. 38, Fig. 3), which may represent the genus *Cordiceramus* Heinz, the other specimens well compare to the typical (*see* Schröder 1909, Heine 1929, Tröger 1974, Seitz 1970) representatives of *Magadiceramus subquadratus* (Schlüter). The specimens illustrated (Pl. 37, Figs 1-2 and Pl. 38, Fig. 1) fit well the diagnosis of the nominative subspecies, as defined by Seitz (1970), the other specimen, coming from Stefanów borehole (Pl.

38, Fig. 2) approaches in its characteristics *Magadiceramus subquadratus* cf. *crenistriatus* (ROEMER), according to SEITZ' (1970) definition.

Similar in character of the concentric ornamentation is also the specimen from Ossowa (Pl. 37, Fig. 4); its general shape is, however, distinct making it closer to *Inoceramus kleini* MÜLLER. It is also slightly similar to *Inoceramus stantoni* SOKOLOV (*compare* SCOTT & COBBAN 1964, Pl. 4, Fig. 2).

OCCURRENCE: The same as for the genus.

Genus *Sphenoceramus* BÖHM, 1915

TYPE SPECIES: *Inoceramus cardissoides* GOLDFUSS (1836, p. 112, Pl. 110, Fig. 2); *SD* VIALOV & *al.* 1960.

Diagnosis and extensive discussion are given by SEITZ (1965) and by COX (1969).

There is no agreement concerning the taxonomic rank of the genus *Sphenoceramus* BÖHM. In the present report, following COX (1969), KAUFFMAN (1977a) and NODA (1988), it is regarded as of a genus rank.

Within Santonian and Lower Campanian sphenoceramids, appearant dimorphism was recognized among the main representatives of the genus, that comprises the following pairs (*see* SEITZ 1965): *Sphenoceramus cardissoides* – *S. pachti*, *Sphenoceramus pinniformis* – *S. martini*, and *Sphenoceramus patootensiformis* – *S. angustus*. The members of the respective pairs differ (*see* SEITZ 1965) only in the length of the disc and the obliquity of the concentric undulations in relation to the growth axis, being in all other respects identical. SEITZ (1965) when discussing this problem put forward such possible explanations, as (*i*) sexual dimorphism, (*ii*) ecological variability or (*iii*) two independent lineages with homeomorphic members. In the present report, similarly as in SEITZ (1965), all these members are treated as independent species.

Sphenoceramus cardissoides (GOLDFUSS, 1835)
(Pl. 41, Fig. 4)

1835. *Inoceramus cardissoides* nobis; A. GOLDFUSS, p. 112, Pl. 110, Fig. 2.
1913. *Inoceramus cardissoides* GOLDFUSS; I.F. SINCOV, Fig. 21.
non 1929. *Inoceramus cardissoides* GOLDFUSS; F. HEINE, pp. 67-69, Pl. 7. Fig. 37; Pl. 8, Fig. 43.
?1931. *Inoceramus cardissoides* GOLDFUSS; L. RIEDEL, pp. 655-659, Pl. 74, Fig. 3.
?1959. *Inoceramus cardissoides* GOLDFUSS; S.A. DOBROV & M.M. PAVLOVA *in* M.M. MOSKVIN, p. 149, Pl. 12, Fig. 2.
1965. *Inoceramus* (*Sphenoceramus*) *cardissoides* GOLDFUSS; O. SEITZ, pp. 30-48, Pls 1-4.
non 1966. *Inoceramus cardissoides* GOLDFUSS; Z. KURLENDA, pp. 523-524, Pl. 2, Fig. 1.
non 1968. *Inoceramus cardissoides* GOLDFUSS; S.P. KOTSYUBINSKY, pp. 137-138, Pl. 25, Figs 1-2.
non 1974. *Inoceramus cardissoides* GOLDFUSS; S.P. KOTSYUBINSKY, pp. 81-82, Pl. 19, Figs 1-2.

HOLOTYPE: The specimen figured by GOLDFUSS (1835, Pl. 110, Fig. 2) from Salzberg, near Quedlinburg, Subhercynian Basin, Germany; lower part of the Santonian.

MATERIAL: 4 specimens represented by internal moulds of single valves.

Wesołówka-Sulejów: Specimen No. 1.WS.12.4; Sph. cardissoides Zone.
Lipnik: Specimens Nos GS: 1401.II.297 and 1401.II.299; Sph. cardissoides Zone.
Korzkiew: Specimen No. 3.KO.4.1; Sph. patootensiformis Zone, Upper Santonian.

DESCRIPTION: Specimens of small size for the genus; equivalved, inequilateral. Beak pointed, incurved anterodorsally, projecting above the hinge line. Anterior side straight, long, markedly delimited from the rounded ventral margin. Posterior margin straight. Anterior side steep, high, sometimes slightly concave below the beak; other sides flattened. Anterior side forming about 80-90% of repsective *H*. Posterior sulcus well developed, beginning almost at the umbonal region.

Ornamentation consists of concentric ribs, being markedly weakened in the area of the posterior sulcus, or interrupted. Interspaces with two to three concentric riblets. Ornamentation elements uaually do not continue onto the posterior auricle. Radial ornament indistinct.

REMARKS: The long anterior side with the length about 80-90% of the respective axial length, as also the values of the anterior hinge angle, angle of umbonal inflation and the angle between the anterior margin and the growth axis fall well within the characteristics of the species, as given by SEITZ (1965).

OCCURRENCE: Common in the European Santonian.

Sphenoceramus pachti (ARKHANGELSKY, 1912) (Pl. 41, Figs 5-7)

?1898. *Inoceramus cardissoides* GOLDFUSS; G. MÜLLER, p. 44, Text -fig. 11.
1911. *Inoceramus cardissoides* GOLDFUSS; H. WOODS, p. 301, Text- figs 57-(?)58.
1912. *Inoceramus pachti* sp. n.; A.D. ARKHANGELSKY, p. 171.
1913. *Inoceramus lobatus* MÜNSTER; I.F. SINCOV, Figs 22-24.
1916. *Inoceramus cardissoides* subsp. *pachti* ARKHANGELSKY; A.D. ARKHANGELSKY, pp. 18-21, Pl. 3, Figs 2-4.
part. 1929. *Inoceramus cardissoides* GOLDFUSS; F. HEINE, pp. 67-69, Pl. 8, Fig. 43 [*non* Pl. 7, Fig. 37].
1931. *Inoceramus pachti* ARKHANGELSKY; L. RIEDEL, pp. 654-655, Pl. 74, Fig. 2.
1958. *Inoceramus pachti* ARKHANGELSKY; W.I. BODYLEVSKY *in* W.I. BODYLEVSKY & N.I. SCHULGINA, pp. 81-82, Pl. 40, Fig. 4.
1965. *Inoceramus* (*Sphenoceramus*) *pachti* ARKHANGELSKY; O. SEITZ, pp. 48-66, Pls 5-9.
1966. *Inoceramus pachti* ARKHANGELSKY; Z. KURLENDA, pp. 520-521, Pl. 1, Fig. 2.
1968. *Inoceramus cardissoides* GOLDFUSS; S.P. KOTSYUBINSKY *in* S.I. PASTERNAK & *al.*, pp. 137-138, Pl. 25, Figs 1-2.
part. 1969. *Inoceramus pachti* ARKHANGELSKY; F. MITURA & *al.*, p. 175, Pl. 2, Fig. 2 [*non* 4].
1974. *Inoceramus* (*Sphenoceramus*) *pachti* ARKHANGELSKY; K.-A. TRÖGER, Pl. 9, Figs X4324-X4328.
1974. *Inoceramus cardissoides* GOLDFUSS; S.P. KOTSYUBINSKY, pp. 81-82, Pl. 19, Figs 1-2.
1989. *Inoceramus pachti* ARKHANGELSKY; S. CIEŚLIŃSKI & A. BLASZKIEWICZ, p. 256, Pl. 159, Fig. 4.

LECTOTYPE: The specimen from Tschembar in the Pensa Teritory, Turkestan, illustrated by ARKHANGELSKY (1916, Pl. 3, Fig. 2), by subsequent designation of SEITZ (1965).

MATERIAL: 16 specimens represented by internal moulds of single valves, with shell fragments attached.

Wesołówka-Sulejów section: Specimens Nos 1.SW.13.1 through 1.SW.13.3; Sph. cardissoides Zone.
Kije-1: Specimens Nos 2.Ki1.2.1 through 2.Ki1.2.6; Sph. cardissoides Zone.
Jedlanka Nowa: One, uncatalogued specimen from depth 100.95m, Geological Survey Museum; Sph. cardissoides Zone.
Płusy: One, uncatalogued specimen from depth 35m, Geological Survey Museum; stratigraphic position unknown.
Lipnik: Specimen No. 1401.II.496; ?Sph. cardissoides Zone.

DESCRIPTION: Specimens of small to medium size for the genus; equivalved, strongly inequilateral. Beak-umbo pointed, curved anterodorsally, slightly projecting above the hinge line. Anterior side straight to weakly curved anteriorly, with moderate length, usually between 50 to 60% of respective axial length. Posterior sulcus well to moderately well developed.

Ornamentation consists of concentric ribs with sharp edges, and with interspaces with two to three concentric ribblets, often discontinuous, well marked only at the anterior part of the disc and within the posterior sulcus. Radial ornament consisting usually of indistinct *"Rippeln"*, starting in the adults. Pattern of ornamentation almost identical to that observed in *Sphenoceramus cardissoides* (GOLDFUSS) and differing only in the anterodorsal curving of the concentric elements in the anterior part of the disc (between growth axis and anterior side).

REMARKS: Originally, ARKHANGELSKY (1912, 1916) distinguished *Inoceramus pachti* basing on its revealing the radial ornamentation still at the posterior part of the disc, not observable in the holotype of *Sphenoceramus cardissoides* (GOLDFUSS). However, BÖHM (1920), RIEDEL (1931) and SEITZ (1965) showed that the difference in sculpture should not be taken as the discriminating trait. Instead, they differ markedly in the growth pattern, expressed through the concentric element trajectories, being in *Sphenoceramus pachti* (ARKHANGELSKY) strongly oblique in relation to the growth axis, in the anterior part of the disc. This causes much shorter anterior side than in the representatives of *Sphenoceramus cardissoides* (GOLDFUSS), featured by a growth front almost perpendicular to the growth axis.

OCCURRENCE: Known from the whole Santonian of Europe and Asia.

Sphenoceramus pinniformis (WILLETT, 1871)
(Pl. 39, Fig. 1; Pl. 40, Fig. 1)

1911. *Inoceramus pinniformis* WILLETT; H. WOODS, p. 338, Text-fig. 96.
1929. *Inoceramus pinniformis* WILLETT; F. HEINE, pp. 91-93, Pl. 15, Fig. 64; Pl. 16, Fig. 65.
1931. *Inoceramus pinniformis* WILLETT; L. RIEDEL, pp. 658-660, Pl. 75, Fig. 1.
1959. *Inoceramus pinniformis* WILLETT var. *jenisseenis* nov.; W.I. BODYLEVSKY *in* W.I. BODYLEVSKY & N.I. SCHULGINA, pp. 82-83, Pl. 36, Fig. 1; Pl. 37, Fig. 1.
1966. *Inoceramus pinniformis* WILLETT; Z. KURLENDA, pp. 524-525, Pl. 2, Fig. 2.
1968. *Inoceramus pinniformis* WILLETT; S.P. KOTSYUBINSKY, pp. 140-141, Pl. 25, Figs 3-4.
1988. *Inocramus pinniformis* WILLETT; S. CIEŚLIŃSKI, p. 256, Pl. 160, Fig. 2.

HOLOTYPE: The specimen labelled by WILLETT (1871) and figured by WOODS (1911, Text-fig. 96), from the Upper Chalk, near Brighton, England.

MATERIAL: 10 specimens represented by internal moulds of single valves, rarely with shell fragments attached.

Wesołówka-Sulejów section: Specimens Nos 1.WS.13.2 through 1.WS.13.7; and 1.WS.13.9; Sph. pinniformis Zone.
Zychówki: Specimens Nos 1.Z.0.1 and 1.Z.0.2; ?Sph. pinniformis Zone.

DESCRIPTION: Specimens attaining large to very large size for the genus which, basing on the fragmentarily preserved largest individual, it reached approximately 70cm. Disc without marked axial crease ("*Schalenkante*" 2 of SEITZ 1965). Anterior side steep, moderately long attaining between 50 and 60% of the respective axial length. Growth axis straight to slightly curved anteriorly. Posterior sulcus well developed, subtriangular in shape, well delimited from the disc. Hinge line short, straight.

Ornamentation consists of concentric ribs, sparsely, but regularly spaced, with three to four concentric ribblets inbetween. Ribs start at about 20-25mm axial length from the beak. The most characteristic ornament elements are the radial ribs, appearing in the postumbonal region and increasing gradually in the ventral direction. They are limited to the main face of the disc, and thus disappear toward anterior and posterior slopes of the disc. The number of the radial ribs varies between 12 and 15. At the cross points with concentric ribs as also with riblets they may form more or less distinct tubercles. Concentric ribs, at the posterior margin of the disc, give often a radial row of massive tubercles. Concentric ornament elements pass onto the posterior auricle.

Full range of variability of the species is given by SEITZ (1965).

OCCURRENCE: Common within the upper part of the Santonian in Europe and Asia.

Sphenoceramus lingua (GOLDFUSS, 1835)
(Pl. 40, Fig. 4)

1834-40. *Inoceramus lingua* nobis; A. GOLDFUSS, p. 113, Pl. 110, Fig. 5.
1911. *Inoceramus lingua* GOLDFUSS; H. WOODS, p, 299, Text-fig. 56.
1958. *Inoceramus lingua* GOLDFUSS; W.I. BODYLEVSKY *in* W.I. BODYLEVSKY & N.I. SCHULGINA, p. 84, Pl. 39, Fig. 2.
1965. *Inoceramus (Sphenoceramus) lingua* GOLDFUSS; O. SEITZ, p. 90, Pl. 16, Fig. 4.

1965. *Inoceramus (Sphenoceramus)* cf. *lingua* GOLDFUSS; O. SEITZ, pp. 91-92, Pl. 18, Fig. 4; Pl. 19, Fig. 3.
1965. *Inoceramus (Sphenoceramus)* juv. cf. *lingua* GOLDFUSS; O. SEITZ, pp. 92-93, Pl. 18, Figs 3, 5.

HOLOTYPE: The original of GOLDFUSS (1835, Pl. 110, Fig. 5), from Dülmen, Germany; Lower Campanian.

MATERIAL: 2 specimens represented by internal moulds of single valves, from Kije-1 (Nos 2.Ki1.4.6 and 2.Ki1.2.7); Sph. patootensiformis Zone, Upper Santonian.

DESCRIPTION: Specimens attaining large size for the genus (the larger of the studied specimens is about 135mm high); inequilateral. equivalve. Anterior margin straight to slightly convex, long (above 75% of respective axial length). Growth axis anteriorly curved. Posterior sulcus poorly marked.

Ornamentation consists of uniform riblets, increasing gradually in size ventralward. Indistinct concentric undulations may be superimposed onto the riblets. Radial ornament absent, though sometimes weak "*Spindel Rippeln*" in adults, in the axial part of the disc may accur. Concentric ornament elements pass the shallow and indistinct posterior sulcus, almost without changing curvation or being only slightly curved dorsally. Angle of umbonal inflation about 60°, and between anterior margin and growth axis about 30°.

REMARKS: When compared to closely allied *Sphenoceramus angustus* (BEYENBURG) and *Sphenoceramus patootensiformis* (SEITZ),the concerned species differs only in the lack of concentric ornament differentiation into ribs and ribblets occurring in the two former species. In these two species the first order concentric ornament elements may, however, appaer even in 65mm axial length from the beak. It means, that up to this ontogenetic stage these two are undistinguishable from *Sphenoceramus lingua* (GOLDFUSS). Thus, many records of small forms with undifferentiated surface sculpture (*e.g.* KOTSYUBINSKY 1968, p. 141, Pl. 25, Fig. 5; ATABEKIAN 1979, pp. 51-53, Pl. 2, Fig. 5 and Pl. 3, Figs 4-7, 9, 10; CIEŚLIŃSKI & BŁASZKIEWICZ 1989, p. 155, Pl. 161, Fig. 3) can not be reasonably determined. Certainly, forms much higher than 65mm, with "lingua" ornament pattern exist. On the other hand, it is possible, taking into account the presence of wide spectrum of passage forms between *Sphenoceramus lingua* (GOLDFUSS) from one side, and *Sph. patootensiformis* (SEITZ) and *Sph. angustus* (BEYENBURG) from the other, that the forms lacking any divergency within concentric ornament elements represent only extreme forms of the latter species and should not be distinguished as distinct species.

OCCURRENCE: Upper Santonian Lower Campanian transition beds of Europe and Asia.

Sphenoceramus patootensiformis (SEITZ, 1965)
(Pl. 39, Figs 2-3; Pl. 40, Fig. 3)

part. 1877. *Inoceramus lobatus* MÜNSTER; C. SCHLÜTER, p. 275, Pl. 39, Fig. 1.
1898. *Inoceramus lobatus* MÜNSTER; G. MÜLLER, p. 43, Text-fig. 10.
1905. *Inoceramus lobatus* MÜNSTER; T. WEGNER, p. 164, Pl. 10, Fig. 1.
1911. *Inoceramus lobatus* GOLDFUSS; H. WOODS, p. 298, Text-fig. 55.
1965. *Inoceramus (Sphenoceramus) patootensiformis* sp. nov.; O. SEITZ, pp. 107-117, Pl. 20, Figs 1-2; Pl. 21, Fig. 2; Pl. 22, Fig. 2; Pl. 23, Figs 2-3; Pl. 24, Figs 1-2, 4; Pl. 25, Fig. 2.
1966. *Inoceramus cardissoides* GOLDFUSS; Z. KURLENDA, pp.523-524, Pl. 2, Fig. 1.

HOLOTYPE: By original designation, the specimen illustrated by SEITZ (1965, Pl. 25, Fig. 2), being the original of *Inoceramus lobatus* MÜNSTER of WEGNER (1905, Pl. 10, Fig. 1), from Haltern, Germany; the patootensiformis beds.

MATERIAL: 12 specimens represented by internal moulds of single valves.

Kije-1: Specimens Nos 2.Ki1.4.1; 2.Ki1.4.2; and 2.Ki1.4.5; all from the Sph. patootensiformis Zone, Upper Santonian; Nos2.Ki1.5.1 through 2.Ki1.5.5; Sph. patootensifomis Zone, Lower Campanian.

Wesołówka-Sulejów section: Specimens Nos 1.WS.14.10 through 1.WS.14.14; all from Sph. patootensiformis Zone, Lower Campanian.

REMARKS: The species was comprehensively treated by SEITZ (1965), who also discussud its nomenclatorical problems.

Similarly as in the case of *Sphenoceramus angustus* (BEYENBURG), the Upper Santonian representatives of *Sph. patootensiformis* (SEITZ) possess relatively strong radial ornamentation (*e.g.* Pl. 39, Fig. 2), which is not observed in Lower Campanian specimens.

OCCURRENCE: In the studied area the species occurs in the uppermost Santonian/Lower Campanian strata, being particularly common in the latter. Known from the same interval in Europe and Asia.

Sphenoceramus angustus (BEYENBURG, 1936)
(Pl. 39, Fig. 4; Pl. 40, Fig. 2)

part. 1877. *Inoceramus lobatus* MÜNSTER; C. SCHLÜTER, p. 275, Pl. 39, Fig. 2 [*non* Fig. 1].
part. 1905. *Inoceramus lobatus* MÜNSTER; T. WEGNER, pp. 164-167, Text-fig. 7.
1936. *Inoceramus patootensis* DE LORIOL, var. n. *angusta*; E. BEYENBURG, pp. 110-111, Pl. 25, Fig. 4.
part. 1958. *Inoceramus lobatus* MÜNSTER; S.P. KOTSYUBINSKY, p. 17, Pl. 8, Figs 27-28.
1965. *Inoceramus (Sphenoceramus) angustus* BEYENBURG; O. SEITZ, pp. 96-104, Pl. 17, Fig. 2; Pl. 18, Figs 1-2; Pl. 19, Fig. 1; Pl. 20, Fig. 4; Pl. 22, Figs 1, 3; Pl. 24, Fig. 3.
1974. *Inoceramus patootensis* LORIOL; S.P. KOTSYUBINSKY, p. 82, Pl. 16, Fig. 3.
1979. *Sphenoceramus angustus* (BEYENBURG); A.A. ATABEKIAN, pp. 43-47, Pl. 1, Figs 1-3.
1979. *Sphenoceramus* cf. *angustus* (BEYENBURG); A.A. ATABEKIAN, pp. 47-48, Pl. 1, Fig. 4; Pl. 2, Figs 1-3.
part. 1979. *Sphenoceramus* cf. juv. ex gr. *angustus* (BEYENBURG); A.A. ATABEKIAN, pp. 48-49, Pl. 3, Figs 1-2.

LECTOTYPE: The specimen from the Lower Campanian Dülmen Beds, illustrated by WEGNER (1905, p. 164, Text-fig. 7), designated subsequently by SEITZ (1965).

MATERIAL: 12 specimens represented by internal moulds of single valves.

Kije-1: Specimens Nos 2.Ki1.4.3; 2.Ki1.4.4; Sph patootensiformis Zone, Upper Santonian; 2.Ki1.5.6 through 2.Ki1.5.10; Sph. patootensiformis Zone, Lower Campanian.
Wesołówka-Sulejów section: Specimens Nos 1.WS.14.5 through 1.WS.14.9; Sph. patootensiformis Zone, Lower Campanian.

REMARKS: Diagnosis, full description, and discussion on the nomenclatorical problems are presented by SEITZ (1965).

While the forms coming from the Lower Campanian strata are typical representatives of the species, the two specimens coming from the Upper Santonian differ in the presence of the relatively well marked radial ornament (Pl. 39, Fig. 4 and Pl. 40, Fig. 2). This characteristics approaches them to forms described from the Taymyr Pennisula by BODYLEVSKY (*in* BODYLEVSKY & SCHULGINA 1958) and referred to as new variety *alexandrovi*. Such forms were found only within the Santonian, and they seem to disappear above the Santonian/Campanian boundary. Certainly, this needs further testing, but if confirmed the disappearance of the representatives of *Sph. patootensiformis* (SEITZ) and *Sph. angustus* (BEYENBURG) characterized by strong radial ornament would be a distinctive marker in placing the Santonian/Campanian boundary.

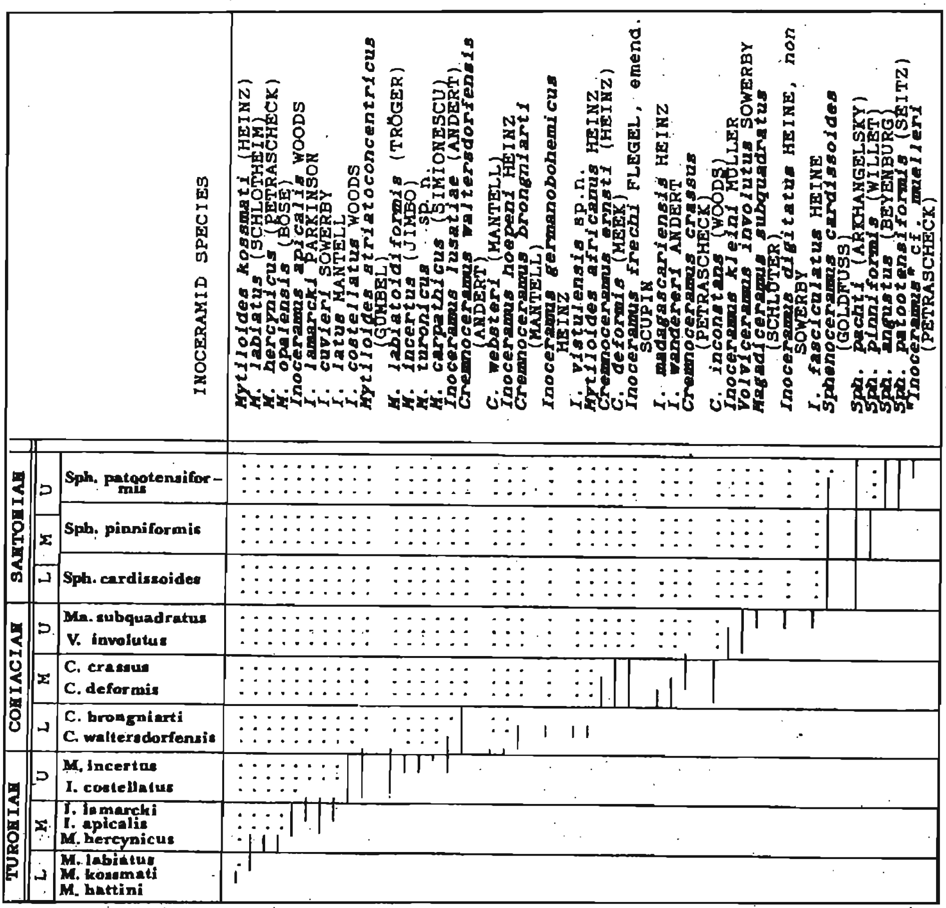
OCCURRENCE: Common in the Upper Santonian and lowermost Campanian of Europe and Asia.

INOCERAMID ZONATION

Within Central and Eastern Europe in the Turonian through Santonian interval the inoceramids are the only macrogroup allowing the refined zonation to be completed (*see* Tables 17-18). Other macrofossils as ammonites, belemnites or echinoids, commonly used in the Upper Cretaceous biostratigraphy are either rare (ammonites, belemnites) or their stratigraphic potential is poorly known (echinoids). The position of inoceramids as a good biostratigraphic tool is enhanced by their high degree of cosmopolitism (KAUFFMAN 1977) and mass occurrence in many areas. On the other hand, high biological plasticity of particular forms, as well as secondary deformations of the fossil material often combined with a poor recognition of the species variability causes many inconsistencies and misinterpretations of the cited taxa, and in consequence - biostratigraphic discrepancies. Far from being satisfactorily resolved is also the correlation of the inoceramid zonation with the ammonite standard division. It is due to a lack of a sufficient inoceramid record in the type areas of the Turonian, Coniacian and Santonian, and reversely a lack of good, ammonite-bearing sections in the area of the common occurrence of inoceramid fauna, i.e. in Central and Eastern Europe. The promising in this case seem to be the Sudetic and circum-Sudetic area where the Turonian and Coniacian inoceramid-rich deposits have yielded the ammonites, relatively frequent in many strata.

Table 17

Stratigraphic ditribution of the Turonian to Santonian inoceramid species in the epicontinental Cretaceous of southern Poland



Valuable data on the inoceramid-ammonite mutual vertical distribution were reported from the United States (KAUFFMAN 1977b, KAUFFMAN & *al.* 1976, 1977; HATTIN 1975; SCOTT & *al.* 1986; COBBAN 1986; KENNEDY & *al.* 1989; KENNEDY & COBBAN 1991). The inoceramid fauna from the American Cretaceous has, however, been rarely treated thouroughly and many species, particularly those firstly described from there are poorly known indeed. This, in parts of the studied interval markedly reduces significance of the American data.

CENOMANIAN/TURONIAN BOUNDARY

This level is still one of the most hotly discussed among the Cretaceous stage boundaries. The hitherto suggested proposals are based on different faunal groups and the boundary position placed within a relatively rough time interval (*see e.g.* BIRKELUND & *al.* 1984, KENNEDY & COBBAN 1991). In terms of inoceramid stratigraphy, either the first appearance of *Mytiloides* or the first flood occurrence of this genus were considered as a possible boundary marker (*see e.g.* BIRKELUND & *al.* 1984). In both cases, however, the acquired data on the respective levels are too meagre to allow their practical, univocal identification.

Following KENNEDY (1984a), the base of the Turonian stage in the ammonite standard division, the boundary level which is accepted here, is taken at the base level of the Watinoceras coloradoense Zone. Within the inoceramid zonation, as recognized lastly by KENNEDY & COBBAN (1991), this level lies within the Mytiloides hattini (= Mytiloides aff. sackensis of KENNEDY & COBBAN 1991) Zone. Moreover, according to ELDER (1991), with the so-defined lower boundary of the Turonian stage, corresponds well the first, flood occurrence of the species *Mytiloides hattini* ELDER.

TURONIAN INOCERAMID ZONATION

The inoceramid succession along the Turonian stage (*see* Table 17) allows for identification of eight interval zones (*see* Table 18) with all but one (M. hattini Zone) well represented and recognizable in the studied area. Their correlation with the ammonite standard division is based on the data presented by KELLER (1982), KENNEDY (1984a,b; 1985), KENNEDY & *al.* (1989), and KENNEDY & COBBAN (1991).

Undoubtedly, the most disputable Turonian interval, as concerns the inoceramid stratigraphy, are the traditional low-Turonian "*labiatus*"-beds, ranging from the appearance level of the genus *Mytiloides* to the first appearance of representatives of the *Inoceramus lamarcki* PARKINSON group. The subsequently applied zonations illustrate an extremely wide range of stratigraphic concepts worked out.

One extreme represents the highly refined scheme, as proposed by KAUFFMAN (1976b; and *in* KAUFFMAN & *al.* 1976, 1977) with five lineage zones spanning the topmost Cenomanian to the entrance of the *lamarcki* group. This

Table 18

Turonian to Santonian inoceramid zonation applied, and its comparison with the ammonite standard division

STAGE & SUBSTAGE		AMMONITE & BELEMNITE ZONATION	INOCERAMID ZONATION
CAMPANIAN	L	G. granulata-quadrata	Sph. patootensiformis
SANTONIAN	U	G. granulata	
	M	G. westfalica	Sph. pinniformis
	L	Texanites (Texanites)	Sph. cardissoides
CONIACIAN	U	Paratexanites serratomarginatus Gauthiericeras margae	Ma. subquadratus
			V. involutus
	M	Peroniceras tridorsatum	C. crassus
			C. deformis
	L	Forresteria petrocoriensis	C. brongniarti
			C. waltersdorfensis
TURONIAN	U	Subprionocyclus neptuni	M. incertus
			I. costellatus
	M	Collignoniceras woolgari	I. lamarcki
			I. apicalis
			M. hercynicus
	L	Mammites nodosoides	M. labiatus
		Watinoceras coloradoense	M. kossmati
			M. hattini
CENOMANIAN	U	Neocardioceras juddi	

author treated his scheme as world-wide applicable, but at least the "European" introduction of his zonation (Bohemia, Spain or England - *see* KAUFFMAN 1976a, b, *and* WIEDMANN & KAUFFMAN 1976) must be regarded as suggestions rather than evidenced data. Moreover, even in the U.S. Western Interior where the scheme was founded, the published data are not completely convincing. For instance, the traditionally treated *M. mytiloides* (MANTELL) and *M. labiatus* (SCHLOTHEIM) were to form two distinct successive zones, but basing on HATTIN's (1975) data, the forms undistinguishable in traditional terms from *M. labiatus* occur already in the M. mytiloides Zone (*see* HATTIN, 1975, Pl. 7, Fig. C).

The intermediate concepts assume a twofold division as possible with the two zones, i.e. the M. labiatus and the M. hercynicus Zone distinguishable (?TRÖGER 1967, KELLER 1982, KOPAEVICH & WALASZCZYK 1990).

The second extreme is the view according to which there is no recognizable time differentiation of the particular species within the *M. labiatus* group, and consequently no possibility of their use to a more refined subdivision of the traditional "*Inoceramus labiatus*" Zone (SEITZ 1934; SORNAY *in* ROBASZYNSKI *& al.* 1980, 1982; ROBASZYNSKI 1976; BADILLET & SORNAY 1980).

The reasons of these discrepancies are twofold. Firstly, the European boundary sections are mostly discontinuous what effectively hinders a possibility of tracing the complete low-Turonian *Mytiloides* succession. Secondly, being in part the result of the first reason, is the inconsistant taxonomic concept of the particular species within the *labiatus*-lineage.

A study of the own paleontological material, and its bearing on stratigraphic applicability of *M. labiatus* group may be summarized as follows:

(i). The species *M. labiatus* (SCHLOTHEIM), *M. mytiloides* (MANTELL), and most probably *M. submytiloides* (SEITZ) are not distinct, and they completely fall into the synonymy of *M. labiatus* (SCHLOTHEIM);
(ii). The species *Mytiloides opalensis* sensu SEITZ (*non* BÖSE), *M. goppelnensis* (BADILLET & SORNAY), *M. modeliensis* (SORNAY), and *M. aff. duplicostatus* sensu KAUFFMAN (*non* ANDERSON) are synonymous and should be called *M. kossmati* (HEINZ), the name of which has a priority;
(iii). The species *Mytiloides subhercynicus* (SEITZ) does not represent any distinct species, but it comprises the markedly oblique representatives of *M. hercynicus* (PETRASCHECK), *M. kossmati* (HEINZ), and *M. opalensis* (BÖSE), and thus it should be rejected;
(iv). The species *Mytiloides opalensis* (BÖSE) represents the Middle Turonian form (see also remark *in* KENNEDY 1985) occurring at the top of the traditional *labiatus*-range Zone.

Concluding, four zones may be distinguished within the traditional "Inoceramus labiatus" Zone (*see* Table 18). Further subdivision of M. labiatus and M. hercynicus Zones, based on these inoceramids is impossible. The reports of *M. hercynicus* (PETRASCHECK) from the lowermost part of the Turonian (*see e.g.* SORNAY *in* ROBASZYNSKI 1976), what were to prove the inapplicability for further subdivision of the "*labiatus*"-beds, were the result of different species concept, and including of the forms belonging to *M. kossmati* (HEINZ) to PETRASCHECK's species.

The zonation within the upper Middle Turonian is based on the *Inoceramus lamarcki* PARKINSON group. At the moment, two zones are recognized, namely the I. apicalis Zone and the I. lamarcki Zone (*see* Table 18), though the further subdivision of the latter, as supposed e.g. by TRÖGER (1989), seems very probable.

The base of the Upper Turonian is placed at the appearance level of *Inoceramus costellatus* WOODS (*see e.g.* KELLER 1982), the level which is assumed to correlate with the first occurrence of *Subprionocyclus neptuni* (GEINITZ), an ammonite marker of the base of the upper substage of the Turonian (KENNEDY 1984a, 1985). It is markedly lower than accepted by SEIBERTZ (1979) or TRÖGER (1981a, 1989), and in the case of TRÖGER's zonation it differs in one inoceramid Zone, i.e. the Inoceramus costellatus pietzchi Zone (unit *17* in his paper 1989, and unit *21* in his paper 1981a).

The **Mytiloides hattini** Interval Zone (=M. aff. sackensis Zone of KENNEDY & COBBAN 1991)

Interval from the first occurrence of the nominative species to the first occurrence of *Mytiloides kossmati* (HEINZ), thus spanning the topmost Cenomanian to the lowermost Turonian (*see* KENNEDY & COBBAN 1991, ELDER 1991). In the studied area not represented.

The **Mytiloides kossmati** Interval Zone (= M. columbianus Zone of KENNEDY & COBBAN 1991)

Interval from the first occurrence of the nominative species to the first occurrence of *Mytiloides labiatus* (SCHLOTHEIM), as here defined. In the ammonite standard division it corresponds to the middle and upper part of the Watinoceras coloradoense Zone, as recognized in Europe, or the Pseudaspidoceras flexuosum Zone and the Vascoceras birchbi Zone as reported from the U.S. Western Interior (*see* KENNEDY & *al.* 1989, KENNEDY & COBBAN 1991). Rarely recorded in most of the European sections, it is characterized by the boundary discontinuities. In the studied area it is most probably represented in the Glanów section, being absent in rest part of the area. From Germany, HILBRECHT (1986) reported the appearance of *M. labiatus* (SCHLOTHEIM) from the very beginning of the stage what would suggest that the M. kossmati Zone, and also the M. hattini Zone are unnecessary.

The **Mytiloides labiatus** Interval Zone

It ranges from the first occurrence of the index species (as here defined) to the first occurrence of *M. hercynicus* (PETRASCHECK), as here defined. The so-defined M. labiatus Zone corresponds to the M. labiatus and the M. mytiloides Zones *sensu* KAUFFMAN (1976a, b *and* KAUFFMAN & *al.* 1976).

The **Mytiloides hercynicus** Interval Zone

It embraces an interval from the appearance level of the index species, to the entrance level of representatives of the *Inoceramus lamarcki* PARKINSON group. The so-defined Zone corresponds in KAUFFMAN's zonation to the M. subhercynicus Zone and the M. hercynicus Zone. The reports of *M. hercynicus* (PETRASCHECK) from the levels far beneath the here postulated entrance level of this species (*see* SORNAY 1982, *and in* ROBASZYNSKI & *al.* 1980, 1982; *and* BADILLET & SORNAY 1980) are most probably the result of another concept of PETRASCHECK's species. Such a conclusion is based on the illustrated specimens coming from the Lower Turonian (*see* SORNAY *in* ROBASZYNSKI 1978, Pl. 2, Figs 2-3 and *in* ROBASZYNSKI & *al.* 1982, Pl. 8, Figs 1a, c and 2) which, in the Author's opinion, should be referred to *M. kossmati* (HEINZ)[see the systematic account of the present report].

The Mytiloides hercynicus Zone represents the lowest Middle Turonian inoceramid Zone (*see* KAUFFMAN & *al.* 1976; KENNEDY 1984, 1985; KENNEDY & *al.* 1989) as the base of the Zone corresponds to the appearance of the Middle Turonian index ammonite species *Collignoniceras woolgari* (MANTELL). In the studied area, the only ammonite specimen found, determined as *Lecointriceras* sp., comes from the topmost part of the Zone.

The **Inoceramus apicalis** Interval Zone

It ranges from the first occurrence of the index taxon to the first appearance of *Inoceramus lamarcki* PARKINSON.

The **Inoceramus lamarcki** Interval Zone

It ranges from the first occurrence of *Inoceramus lamarcki* PARKINSON to the first appearance of *Inoceramus costellatus* WOODS. The subdivision of the Zone, as suggested by TARKOWSKI (1991) cannot be effectively applied due to poor recognition both of taxonomy and of stratigraphic ranges of the forms involved by this author.

The **Inoceramus costellatus** Interval Zone

It ranges from the first occurrence of the index species to the first occurrence of *M. incertus* (JIMBO). In the upper part of the I. costellatus Zone there appear the species *Mytiloides striatoconcentricus* (GÜMBEL) and *M. labiatoidiformis* (TRÖGER). In the case of the former there are contradictory data on its stratigraphic range. TRÖGER (1981a) and SEIBERTZ (1979) report the species from the base of the interval included here into the I. costellatus Zone. According to KELLER (1982) and basing on the relations observed in the studied area it seems, however, to appear slightly higher than *Inoceramus costellatus* WOODS (*see* Table 17). The species *Mytiloides labiatoidiformis* (TRÖGER) is very inconsistently treated and most of the newly citations refer to this species rather in the concept of KELLER (1982), the relation of which to the species concerned in a sense of TRÖGER (1967) is at the moment unclear. Similarly, its relation to the forms assigned to as *M. carpathicus* (SIMIONESCU) requires further studies.

The **Mytiloides incertus** Interval Zone

It ranges from the appearance level of the index species to the entrance level of *Cremnoceramus waltersdorfensis* (ANDERT). The M. incertus Zone is nearly an equivalent of KELLER's (1982) Inoceramus labiatoidiformis Zone. In the upper part of this Zone the delicate, alate forms, assigned here to *M. carpathicus* (SIMIONESCU), are particularly well represented in the Vistula section (locality Słupia Nadbrzeżna), in the Folwark Quarry at Opole and also (ERNST & *al.* 1983, WOOD & *al.* 1984) in northern Germany. Similarly, the topmost Turonian assemblage composed of thin-shelled alate forms was reported from the U. S. Western Interior (COBBAN 1986). The vertical distribution of these forms is too poorly known and their relation to the species *M. labiatoidiformis* sensu KELLER, 1982, is too unclear to fix the distinct Zone.

TURONIAN/CONIACIAN BOUNDARY

The lower boundary of the Coniacian stage in the ammonite standard (*see* KENNEDY 1984a, b, 1985) is placed at the appearance level of *Forresteria petrocoriensis* (COQUAND). Its relation to the inoceramid scale is still, in details, slightly uncertain because of scanty reports on the relative ranges of the ammonite and inoceramid fauna. However, the gained data allow to place this level somewhere close to the appearance level of the first cremnoceramids (*see* ERNST & *al.* 1983, WOODS & *al.* 1984, MATSUMOTO 1984, BIRKELUND & *al.* 1984, KAUFFMAN 1979, CECH 1989, KÜCHLER & ERNST 1989). In this report, the boundary is placed at the base of the Cremnoceramus waltersdorfensis Zone (*see* Tables 17-18).

CONIACIAN INOCERAMID ZONATION

The substage division of the Coniacian stage accepted here is the one proposed by KENNEDY (1984b). Basing on the few data concerning the ammonite-inoceramid ranges (RADWAŃSKA 1962, 1963; JARVIS & *al.* 1982, JARVIS & GALE 1982, CECH 1989, KÜCHLER & ERNST 1989, SZASZ 1985), the reference of the inoceramid zones to the applied substage division markedly differs from the traditional; scheme. The Cremnoceramus deformis and the Cremnoceramus crassus Zone represent already the middle Coniacian substage, and the Lower Coniacian is represented only by the Cremnoceramus waltersdorfensis and the C. brongniarti Zone (*see* Table 18). The traditionally mid-Coniacian Volviceramus involutus Zone, together with the Magadiceramus subquadratus Zone represent the Upper Coniacian.

In descending order the zonal scheme and their substage distribution applied here is as follows:

Magadiceramus subquadratus Zone Volviceramus involutus Zone	**UPPER CONIACIAN**
Cremnoceramus crassus Zone Cremnoceramus deformis Zone	**MIDDLE CONIACIAN**
Cremnoceramus brongniarti Zone Cremnoceramus waltersdorfensis Zone	**LOWER CONIACIAN**

The **Cremnoceramus waltersdorfensis** Interval Zone

It ranges from the entrance level of the index species to the first appearance of *Cremnoceramus brongniarti* (MANTELL). The Zone is characterized by the flood occurrence of the small representatives of ANDERT's species. Subordinately, there also occur *Cremnoceramus websteri* (MANTELL), *Inoceramus hoepeni* HEINZ, and characteristic Upper Turonian mytiloids, such as e.g. *Mytiloides striatoconcentricus* (GÜMBEL) or *M. labiatoidiformis* (TRÖGER). Very characteristic element of the Zone is also the bivalve genus *Didymotis*.

The **Cremnoceramus brongniarti** Interval Zone

It ranges from the entrance level of the index species to the first occurrence of any form characterizing the successive Zone, C. deformis. The Zone is characterized by the common occurrence of the index species, however, only in the lower two thirds of the Zone, *plus* frequent representatives of *Cremnoceramus waltersdorfensis* (ANDERT), and *C. denselamellatus* (KOTSYUBINSKY). Almost to the top of the Zone there still occur bivalves of the genus *Didymotis* (*see* Text-fig. 23). At the top of the Zone the chronohorizon is noted with a flood occurrence of *Cremnoceramus waltersdorfensis* (ANDERT) represented by large forms. In similar position it was recognized in Germany by ERNST & *al.* (1983).

The **Cremnoceramus deformis** Assemblage Zone

It is characterized by wealth of *Cremnoceramus* [*C. deformis* (MEEK), *C. waltersdorfensis* (ANDERT), ?*C. rotundatus* (FIEGE), *C. ernsti* (HEINZ)] and *Inoceramus* [*I.* ex gr. *lamarcki* PARKINSON, *I.* cf. *madagascariensis* HEINZ, *I. frechi* FLEGEL, *I. wandereri* ANDERT]. The base of the Zone is marked either by the appearance of the index species or *C. rotundatus* (FIEGE) or cited representatives of the genus *Inoceramus*. The upper boundary is placed at the appearance level of *Cremnoceramus crassus* (PETRASCHECK) = *C. schloenbachi* (BÖHM).

The **Cremnoceramus crassus** Interval Zone

It embraces an interval from the first occurrence of the index species to the appearance of the representatives of the successive Zone. The Zone is characterized by the frequent occurrence of the index species, and of the associated species the commonest of which are *Cremnoceramus deformis* (MEEK) and *C. waltersdorfensis* (ANDERT).

The **Volviceramus involutus** Assemblage Zone

It is characterized by the involute species of the genus *Volviceramus* STOLICZKA, such as *V. involutus* (SOWERBY), *V. koeneni* (MÜLLER), as well as the representatives of the genus *Inoceramus* SOWERBY, primarily *I. kleini* MÜLLER, *I. percostatus* MÜLLER, *I. russiensis* NIKITIN. The characteristic element of the Zone, though not encountered in the studied area (the whole Upper Coniacian in the studied area is extremely poorly accessible) is also the species *Platyceramus mantelli* (De MERCEY). The lower boundary of the Zone is placed at the earliest appearance of any of the cited forms representing the characteristic assemblage. The upper boundary is placed at the appearance level of the species *Magadiceramus subquadratus* (SCHLÜTER).

The **Magadiceramus subquadratus** Interval Zone

It ranges from the first appearance of the index species to the entrance level of the genus *Sphenoceramus* Böhm. The index species is accompanied by *Inoceramus fasciculatus* Heine, *I. digitatus* Heine (*non* Sowerby), and involute inoceramids *Volviceramus involutus* (Sowerby), occurring almost to the top of the Zone.

CONIACIAN/SANTONIAN BOUNDARY

The base of the Santonian in ammonite terms is placed at the appearance level of the genus *Texanites* sensu stricto (*see* Kennedy 1984, 1985). It is generally accepted that this level is approximately coincident with the entrance level of the inoceramid genus *Cladoceramus* Heinz, though this was extremely rarely demonstrated (*see* Bailey & *al.* 1984). Seitz (1961, 1965) mentioned the record of *Texanites* about 10 m below the first occurrence of *Cladoceramus* (though these were poorly preserved, according to Bailey & *al.* 1984, and not definitely referable to *Texanites* s.s.) in northern Germany. As the lower boundary of the Santonian he accepted the appearance level of the genus *Sphenoceramus* Böhm. Moreover, Schultz & *al.* (1984) reported the same appearance level of the sphenoceramids ex gr. *pachti-cardissoides* and first representatives of *Cladoceramus undulatoplicatus* (Römer) in Lägerdorf, northern Germany. In the studied area, *Cladoceramus undulatoplicatus* was not found, and following Seitz (1965) and Tröger (1989) the Coniacian/Santonian boundary is placed here at the appearance level of the first sphenoceramids ex gr. *pachti-cardissoides*.

SANTONIAN INOCERAMID ZONATION

Ammonite standard division of the Santonian is far from being worked out, and Kennedy (1984a) pointed out the impossibility of its establishing in the stratotypic Santonian in Aquitaine. The substage division here applied is the one proposed by Ernst (1966, 1974; *also in* Ernst & Schmidt 1979) and based on the belemnite biozonation, worked out on the *Gonioteuthis westfalica - granulata* lineage (*see* Table 18). The Lower/Middle Santonian boundary is placed at the base of the upper westfalica Zone or at the base of the cordiformis/westfalica Zone, thus being determinable also with the inoceramid fauna. The Middle/Upper Santonian boundary is placed at the base of the *Gonioteuthis granulata* occurrence interval and it falls somewhere in the middle of the Sphenoceramus pinniformis Zone.

From base to the top of the stage the inoceramid zonation applied (*see* Table 18) comprises three zones, with the youngest spanning also the lowermost Campanian.

The **Sphenoceramus cardissoides** Interval Zone

It ranges from the appearance of the index taxon to the first occurrence of the representatives of *Sph. pinniformis* (WILLETT). In the studied area the Zone is characterized almost exclusively by forms representing the *Sphenoceramus pachti-cardissoides* group. No divergently ribbed forms of the genus *Cladoceramus*, and no complete specimens of the genus *Cordiceramus* were found. Rare, hardly determinable specimens of *Platyceramus* occur in the lower part of the Zone.

The **Sphenoceramus pinniformis** Interval Zone

It embraces an interval from the entrance level of the index taxon to the first appearance of *Sph. patootensiformis* (SEITZ). The associated forms are almost exclusively represented by rare forms of the group *Sph. pachti-cardissoides*.

The **Sphenoceramus patootensiformis** Range Zone

It embraces the range interval of the index species accompanied by *Sphenoceramus lingua* (GOLDFUSS), *Sphenoceramus angustus* (BEYENBURG), and rare representatives of the genus *Platyceramus*. Relatively frequent, particularly in the upper part of the Zone are the forms ascribed here to as "*Inoceramus*" ex gr. *balticus* (BÖHM). The taxonomy and stratigraphic ranges of the latter forms are rather poorly known at the moment but it is really a potential group for further subdivision of the Zone. In the middle part of the Zone the representatives of the free-living crinoid of the genus *Marsupites* occur, the extinction datum of which is commonly taken as approximating the Santonian/Campanian boundary.

The Sph. patootensiformis Zone spans the topmost Santonian and lowermost Campanian, till the end of the Gonioteuthis lingua/quadrata Subzone of the traditional G. quadrata Zone (*see* ERNST & *al.* 1979). In the range accepted here it corresponds to the Zone *29* of TRÖGER (1989).

SANTONIAN/CAMPANIAN BOUNDARY

The upper boundary of the Santonian stage also waits for the final decision (the historical review of the boundary broblem up to late 60s is given by NAIDIN 1978). In ammonite terms it corresponds to the classical definition of the boundary, i.e. the appearance level of *Placenticeras bidorsatum* (ROEMER), but this species it too rare to be practically used (*see* KENNEDY 1984a). In consequence, KENNEDY (1984a) proposed to fix the boundary with the appearance level of the ammonite genus *Submortoniceras* or to base the boundary discrimination on he representatives of the *Scaphites hippocrepis* (de KAY) group but both suggestions still need further researches.

In areas with regular belemnite occurrence the boundary is placed at the appearance level of the species *Gonioteuthis granulataquadrata* (STOLLEY), within the rapidly evolving Santonian-Campanian belemnite lineage (*see* ERNST 1964). The practical use of the belemnites need, however, a sample consisting at least of about 10 specimens (ERNST 1964) for reliable boundary placement what in many sections is rather hardly accessible.

Commonly used to fix the Santonian/Campanian boundary is also the extinction level of the free-living crinoid *Marsupites testudinarius* SCHLOTHEIM, which is demonstrated to coincide with the entrance level of the belemnite species *G. granulataquadrata* (STOLLEY) in many north German sections (*see* ERNST 1963, 1966, 1968; SCHULTZ & *al.* 1984). SEITZ' (1965) reports on the occurrence of these crinoids still within the Lower Campanian were not confirmed (*see e.g.* ERNST 1968, SCHULTZ & *al.* 1984).

In the present report, the *Marsupites* extinction datum is applied for boundary discrimination, due to a lack at the moment of the sufficent belemnite collections, as also of the ammonite records. These pelagic crinoids were reported fairly common from the studied area, though unevenly. Most of the reports come from the Polish Jura Chain (ROEMER 1870, SMOLEŃSKI 1906, PANOW 1934, KOWALSKI 1948, BARCZYK 1956). Outside the latter area, the Author found them only in one locality, namely in the railway cut Kije-1 (south-western margin of the Holy Cross Mountains).

The inoceramids practically do not give a base for the assessment of the boundary position, with the boundary itself falling within the Sphenoceramus patootensiformis Zone (*see* Table 18). In this case, however, interesting is a material obtained from the latter locality, Kije-1. Namely, the representatives of *Sphenoceramus patootensiformis* (SEITZ) and *Sph. angustus* (BEYENBURG) in the part of the section included into the Santonian, as dated by the *Marsupites* occurrence, are characterized by relatively strong radial ornament (*see* Pl. 39, Figs 2, 4; Pl. 40, Fig. 2) rather not typical of these species (*see* SEITZ 1965), and similar to *Sphenoceramus alexandrovi* (BODYLEVSKI). The typically ornamented *Sph. patootensiformis* (SEITZ) appear already in beds above the *Marsupites*-bearing strata and thus dated for the Campanian.

REGIONAL APPLICATION

The presented inoceramid zonation is used for recognition of the stratigraphy of the Turonian through Santonian deposits (*see* Text-fig. 1) in the four distinguished regions: (1) the north-eastern margin of the Holy Cross Mountains, (2) the south-western margin of the Holy Cross Mountains, (3) the eastern part the Polish Jura Chain, and(4) the Opole Trough. The location details on particular sections are given in the APPENDIX.

NORTH-EASTERN MARGIN OF THE HOLY CROSS MOUNTAINS

The area stretches between Annopol and Zawichost to the east, and the meridian of Radom to the west (*see* Text-figs 1 and 19). The Turonian through Santonian strata are a part of the Albian - Upper Cretaceous - Danian sequence, monoclinally arranged with a regional dip of about 4-5 degrees to NE (*see* Text-fig. 19). This whole succession is picturesquely exposed along the northwardly flowing Vistula river between Zawichost to the south up to Puławy in the north, giving the famous, standard Middle Vistula section of authors (SAMSONOWICZ 1925, 1934; POŻARYSKI 1938, 1948; KONGIEL 1962; BŁASZKIEWICZ 1980; MARCINOWSKI & RADWAŃSKI 1983). The simple monoclinal structure of the Cretaceous deposits in the region is disturbed by a system of strike perpendicular and parallel faults, and by the flexure zones slightly oblique to the strike, within which the dip increases locally even to 90 degrees (*see* POŻARYSKI 1948, 1956).

Both natural and artificial exposures of the Turonian to Santonian strata are limited to the southeastern part of the region, south-east of the Kamienna river (*see* Text-figs 19-20), while in the rest of the area the concerned Cretaceous deposits are covered by a more or less thick carpet of Quaternary sediments. The natural exposures are confined to the Kamienna and Vistula river valleys, while in the interriver area and east of the Vistula river, only artificial outcrops give an access into Cretaceous succession (*see* Text-figs 19-20).

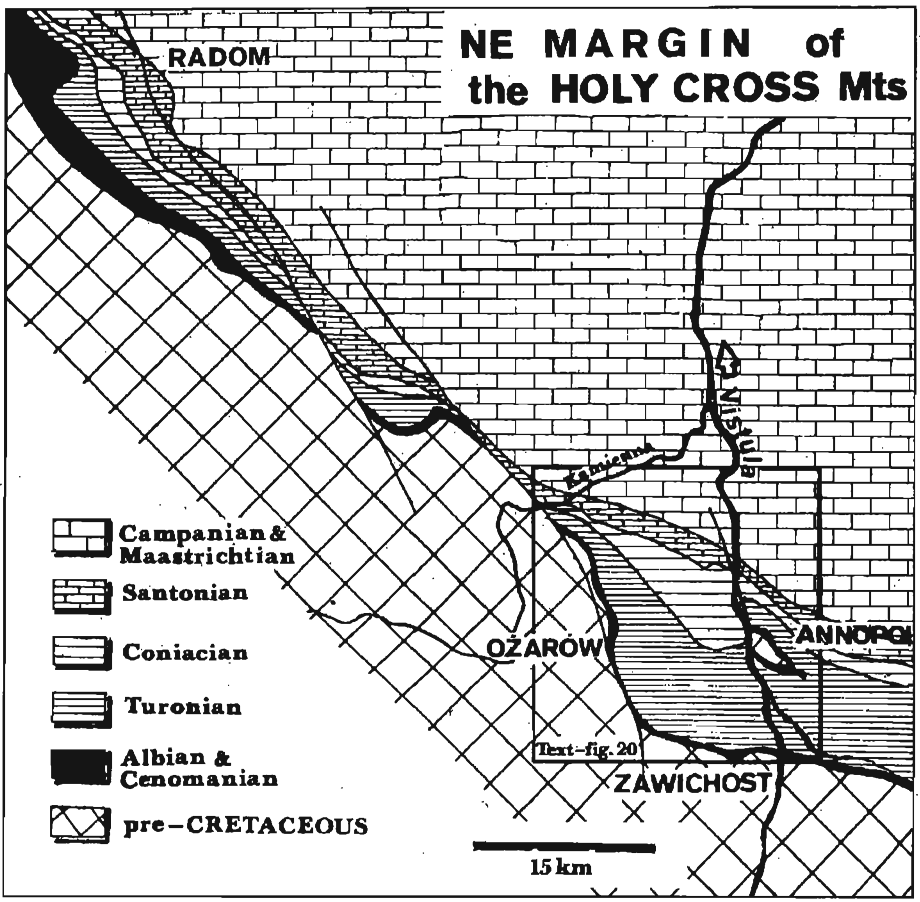


Fig. 19. Geologic sketch-map of the NE margin of the Holy Cross Mountains (*see* Text-fig. 1)

CENOMANIAN/TURONIAN BOUNDARY

The contact between the Cenomanian and the Turonian deposits in the area is readily defined as concordant with the discontinuity surface along which a stratigraphic gap of variable extent is noted (*see* Text-fig. 21). In the Annopol section, the gap comprises the upper part of the Upper Cenomanian, at least up of the Neocardioceras juddi Zone, while in the Ożarów section most probably the whole Upper Cenomanian as well as the Acanthoceras jukes-brownei Zone of the Middle Cenomanian (Professor R. MARCINOWSKI, *pers.*

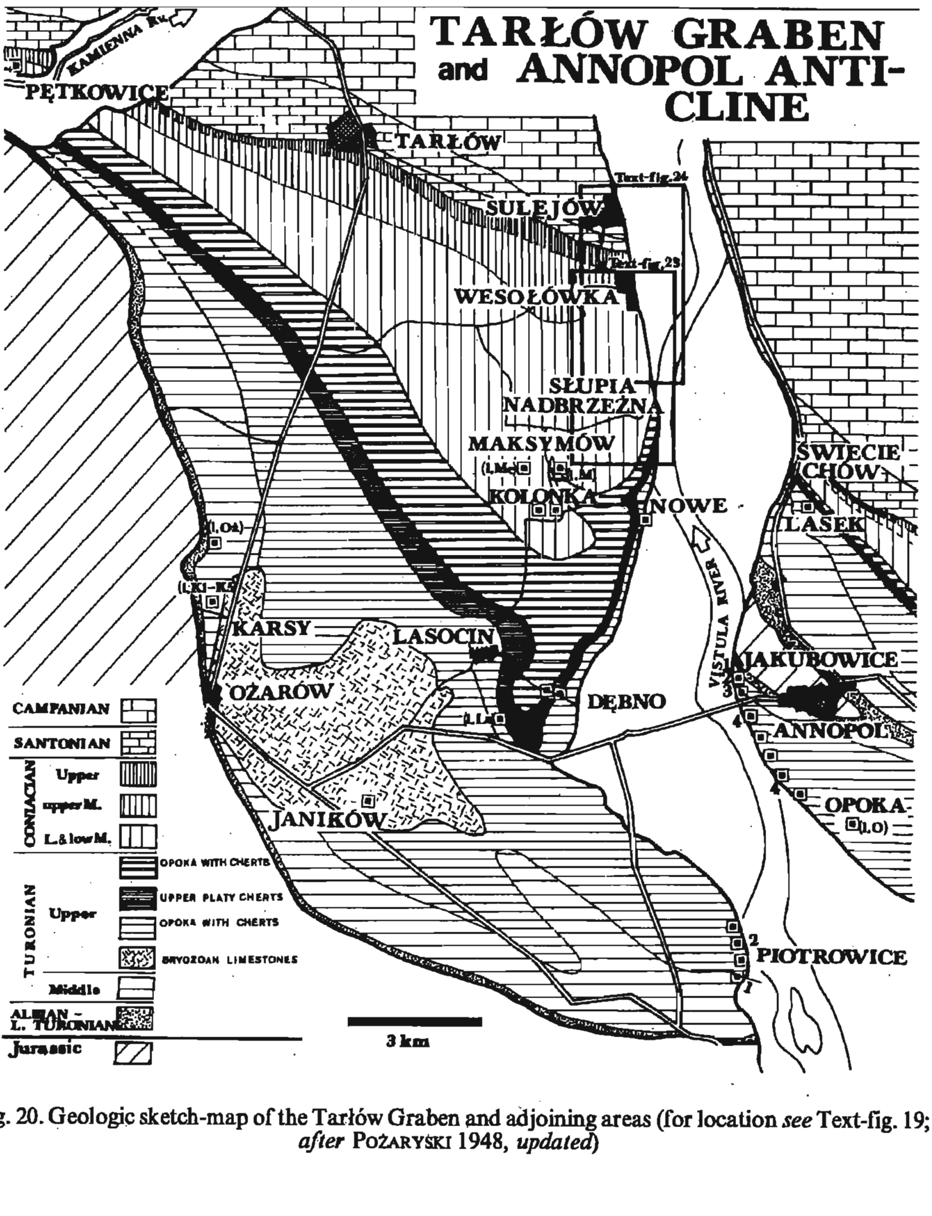


Fig. 20. Geologic sketch-map of the Tarłów Graben and adjoining areas (for location *see* Text-fig. 19; *after* POŻARYSKI 1948, *updated*)

communication). In both sections the gap extends further up, encompassing the lowermost Turonian (Mytiloides hattini Zone and M. kossmati Zone). The boundary discontinuity surface is developed as the initial hardground horizon

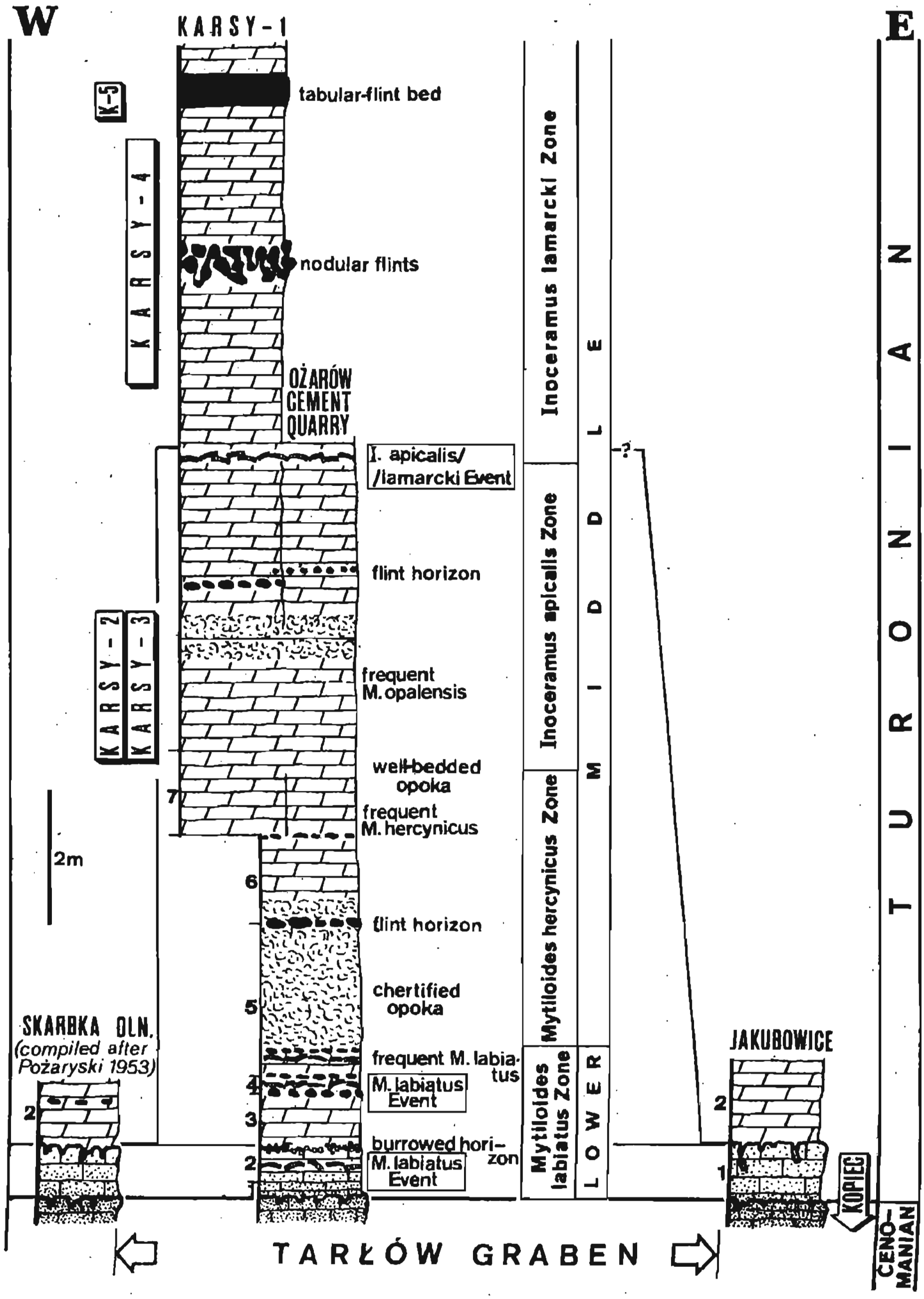


Fig. 21. Lithologic succession, marker horizons and zonation of the Lower and low-Middle Turonian deposits in the NE margin of the Holy Cross Mountains; explanations as for Text-fig. 22

(Ożarów Quarry - *see* Text-fig. 21 and Pl. 48, Fig. 2), or a well marked omission surface, the real nature of which can hardly be recognized, as in the case of Annopol (*see* Text-fig. 21; *cf. also* CIEŚLIŃSKI 1976, *and* WALASZCZYK 1987). In both cases, which are the only places where the boundary may be directly observed, the lithology of the rocks at the very contact does not change rapidly, though within the lowest Turonian in some tens of centimeters it evolves from the glauconitic at the base to the pure, almost devoid of glauconite limestone half a meter above.

LOWER TURONIAN (= M. LABIATUS ZONE)

The Lower Turonian substage, when completely developed, is represented by a bipartite lithological succession: the limestone unit at the bottom, and the opoka unit above. The limestones are composed of gray, rough, organodetrital mudstones with glauconite and, particularly at the bottom, phosphatic concretions. They form a constant unit within the whole NE margin of the Holy Cross Mountains with an average thickness about 1m. The main fossil component are the inoceramids, occurring as prism hash, larger shell fragments or intact shells. In Ożarów section, about 70 cm above the bottom, there occurs a 10 cm thick horizon with abundant inoceramids, represented by *M. labiatus* (SCHLOTHEIM), and an extremely rare form comparable to *M. kossmati* (HEINZ). This is the first *Mytiloides labiatus* Event (*see* Text-fig. 21). Rarely, the inoceramid shells bear epizoans, mainly serpulids. The other fossils are represented by relatively frequent brachiopods, oysters (rare), and extremely rare nautiloids and ammonites (some fragments of *Lewesiceras* sp.). Beyond the limits of the Tarłów Graben the limestones are capped by a hardground horizon, while within the graben an equivalent horizon is developed as a thin bed with burrows, but without any discontinuity surface (*see* Text-fig. 21).

The limestones belong to the lower part of the M. labiatus Zone, and the gap associated with the boundary discontinuity ranges far into the Lower Turonian comprising the M. hattini and the M. kossmati Zone.

In the Tarłów Graben, the Lower Turonian succession is completed by an about 1m thick bed of opokas with first flint horizons (*see* Text-fig. 21). Its topmost part consists of a complex flint horizon with associated mass accumulation of inoceramids, forming the second Lower Turonian *Mytiloides labiatus* Event (*see* Text-fig. 21). Beyond the graben, this unit is missing and it falls into a stratigraphic gap associated with the hardground horizon capping the limestones below (*see* Text-fig. 21).

MIDDLE TURONIAN

The substage is represented by flinty opokas (*see* Text-figs 21-22). Due to the flint content it is the unit being well delimited cartographically. The lower two zones, M. hercynicus and I. apicalis, are present only in the Tarłów Graben, where they may be observed in the Ożarów Quarry and in the abandoned quarries at Karsy (*see* Text-fig. 21). Off the graben, this stratigraphic interval is missing, and opokas of the Inoceramus lamarcki Zone overlie directly the Lower Turonian limestones, along the hardground horizon (*see* Text-fig. 21). Such relations in the studied region were firstly recognized by Pożaryski (1948). The complete succession of the Middle Turonian flinty opokas may be observed in the Jakubowice - Opoka section, still within the village Jakubowice (*see* Text-figs 20-22). Due to the presence of a strike-perpendicular faults and homogenity of the unit, a bed-by-bed insight into the unit is impossible. Its topmost part is accessible also in the lowermost part of the Piotrowice section (*see* Text-figs 20-22).The thickness of the unit, basing on the borehole data, was estimated for about 50m (*see* Pożaryski 1948).

The M. hercynicus and the I. apicalis Zone are represented mostly by pure opokas with local chert and flint horizons, while within the I. lamarcki Zone the rock is overloaded with both these types of silica concentrations. The flints are usually of nodular type, though the tabular flints with average thickness 10-20 cm and ranging even up to 1m (as in locality Karsy-*4*) also occur.

Similarly as in the Lower Turonian limestones the main faunal component of the Middle Turonian flinty opokas are the inoceramids. In the lower part of the substage they form three horizons with their flood appearance. The lower with *Mytiloides hercynicus* (Petrascheck), the middle with *M. opalensis* (Böse), and the upper with *Inoceramus lamarcki* Parkinson and *I. apicalis* Woods (*see* Text-fig. 21). The inoceramids are frequent also in the uppermost part of the unit, while in the main part of the substage they seem to be rather rare. Of the associated fossils the brachiopods, echinoids and ammonites are noted, all of them being rather an accessory element of the faunal assemblage.

UPPER TURONIAN

The substage forms the thickest and the most differentiated part of the Turonian succession in the region, being also fairly well exposed both in the Tarłów Graben and east of the Vistula River. The main outcrops are situated along the Vistula escarpments between Piotrowice and Słupia Nadbrzeżna at the western side, and between Jakubowice and Opoka in the eastern bank (*see* Text-figs 20 *and* 22-23). Inland outcrops are in the disused quarries in the vicinity of Janików, Lasocin, Słupia Nadbrzeżna, Rachów, Świeciechów and Pętkowice (*see* Text-fig. 20 *and* APPENDIX).

The background lithology within the whole Upper Turonian is uniformly the opoka, with the secondary accumulations of silica being predominantly of the chert type. Usually, the sequence is intensively chertified, but with some intervals devoid of cherts in the lower part of the substage, and with thin intercalations in the rest.

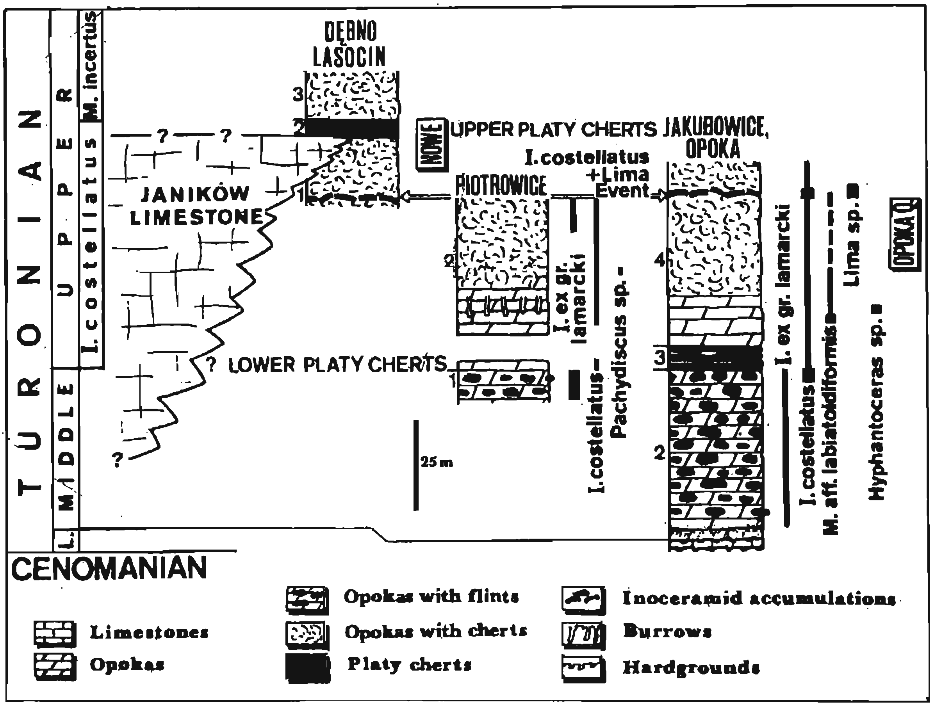


Fig. 22. Lithologic succession, marker horizons, inoceramid ranges and zonation of the Middle and low-Upper Turonian deposits in the NE margin of the Holy Cross Mountains

In the middle part of the Upper Turonian sequence, within the Tarłów Graben, there occurs a very characteristic unit of the opoka with platy cherts, distinguished originally by POŻARYSKI (1948), and called here the Upper Platy Chert (*see* Text-figs 22-23).

The unit seems to be isochronous within the limit of their extent and it is composed of the bands of opokas varying in thickness (from 0.5m to several meters) with laminated, bed-form type of cherts. Often accompaning there are thin beds of glauconite- and quartz-enriched opokas. The latter display a peculiar faunal characteristics, namely the inoceramid-echinoid dominated assemblage of the encompassing opoka is replaced by an assemblage composed mainly of the burrowing, non-inoceramid bivalves, and the gastropods uncommon in the Turonian succession of the area. Beyond the Tarłów Graben the glauconite-enriched opokas were found in an equivalent position within the waste material east of Świeciechów and north of Rachów Nowy. No platy cherts, however, were stated there. Partly, it could result from a lack of sufficient exposures comprising that part of the succession. On the other hand, a distinct layer with platy cherts occurs east of the Vistula River in the locality Jakubowice - Opoka and in the scree south of Świeciechów along the road Annopol - Opole (*see* Text-fig. 20), but much lower stratigraphically just above the Middle Turonian flinty opoka (*see* Text-fig. 22). Here the beds with platy cherts are interlayered with up to 10cm thick beds of calcarenitic/calciruditic organodetrital limestones, represented by crinoid and crinoid-inoceramid packstones, in the set of platy chert opokas/limestones couplets (*see* POŻARYSKI 1948). POŻARYSKI (1948) assuming one-time occurrence of the platy cherts within the Upper Turonian succession of the studied area, regarded these as time equivalent of the Upper Platy Chert occurring in the Tarłów Graben. Such an assumption he based on a similar position of the platy cherts on both sides of the Vistula River in respect to the general succession, and i.e. between the flinty opoka below and the opoka with frequent inoceramids above (*see*

Text-fig. 22). However, the beds with frequent inoceramids occurring in the Jakubowice-Opoka section represent the horizon with the flood appearance of *Inoceramus costellatus* WOODS and *Lima*, that is the *I. costellatus* + *Lima* Event, recognized also west of the river, and situated undoubtedly below the Upper Platy Chert (*see* Text-fig. 22). Thus, at least two horizons with platy cherts occur in the studied area, called here the Lower and the Upper Platy Chert beds (*see* Text-figs 22 and 23).

West of the Vistula River, within the Tarłów Graben, the equivalent of the Lower Platy Cherts bed is poorly evidenced.

In the SW edge of the Tarłów Graben there occurs a peculiar lithological unit, namely the bryozoan and/or bryozoan crinoidal limestones, called (ŁUNIEWSKI 1923, SAMSONOWICZ 1934, POŻARYSKI 1948) the Janików Limestone (*see* Text-figs 20, 22; *and* Pl. 47, Figs 1-2). The general structure of the unit suggests this to be a wedge-shaped, upward-coarsening body consisting of bryozoan/crinoidal detritus transported to here from behind the basin. An upward change from bryozoan to almost purely crinoidal limestones is observed. The chronostratigraphic position of the Janików Limestone may be estimated as ?topmost Middle Turonian - low-Upper Turonian (*see* Text-fig. 20).

A lateral interfringing of the Janików Limestone with the equivalent opokas facies may well be observed in the section south of Lasocin, NE of the Janików Quarry. Of interest are also the deposits cropped out in the Lasek Quarry, north of Annopol. There occur marly limestone representing lateral equivalent of the Janików Limestones, where the detrital, mainly crinoidal material is much diluted within the host rock.

In the lower part of opokas, representing the time equivalent of the Janików Limestone (*see* Text-fig. 22), there occur huge, up to 20cm in diameter and up to some meters in length vertically positioned burrows. The burrows bears no wall sculpture, and they often branch with changing diameter. The best they are observable in the Piotrowice section (*see* Text-fig. 22), where they form a distinct horizon in the quarries north of the main road in the village (*see* APPENDIX). POŻARYSKI (1948) distinguished these opokas, ranging up to the Upper Platy Chert as a distinct lithological unit and called the "Opoka with cylindricl concretions". The unit was regarded by him as limited to the Tarłów Graben, not continuing east of the Vistula River. Such interpretation resulted from the above discussed mistaken assumption of one-time occurrence of the beds with platy cherts in the studied area.

Above the Upper Platy Chert, the rest of the Upper Turonian succession is uniformly developed as a 40m sequence of the intensively chertified opoka. The cherts start to disappear close to the Turonian/Coniacian boundary, where the opoka with frequent inoceramids commences (*see* Text-fig. 23).

In general, the macrofauna is sparse throughout the Upper Turonian opoka facies, and dominated by inoceramids. The fossils are small, shell-possessing, usually badly preserved, with no preferred orientation to the bedding. The epizoans, represented mostly by small oysters are rarely noted. The two horizons with a flood appearance of fauna are herein distinguished: the *Inoceramus costellatus* + *Lima* Event in the lower part of the substage, and *Mytiloides carpathicus* Event at the top of the Upper Turonian. The latter marks the base of the overlying opoka, characterized by abundant inoceramid occurrence (*see* Text-fig. 23) and called by POŻARYSKI (1948) as "Opoka With Frequent Inoceramids". Besides inoceramids the Upper Turonian fauna in the region is represented by sparse brachiopods, echinoids, pectinids, spondylids and rarely cirripedes and ammonites (*see* Pl. 42). Among the latter up to now few specimens of the giant *Lewesiceras* sp. from the locality Jakubowice

- Opoka have hitherto been reported. The Author found single specimen of *Pachydiscus* sp. (locality Piotrowice), and two specimens of *Hyphantoceras* sp. (localities Jakubowice - Opoka and Słupia Nadbrzeżna - Wesołówka).

Another character possesses the fauna in the Janików Limestone. Here the inoceramid-echinoid assemblage disappears and, beside the bryozoans and crinoids forming the main grain component of the rock, the commonest are oysters, brachiopods and spondylids. The inoceramids are sporadic and only some "*lamarcki*"-comparable fragments and one specimen of *Mytiloides* cf. *striatoconcentricus* (GÜMBEL) have been collected.

Somewhere around the Upper Platy Chert the bivalves of the genus *Didymotis* start the regular occurrence in the section (*see* Text-fig. 23).

The both Upper Turonian inoceramid zones are well recognized in the area though it is not easy to place detailly their boundaries. Tentatively, the boundary between Inoceramus costellatus Zone and Mytiloides incertus Zone is placed at the base of Upper Platy Chert bed.

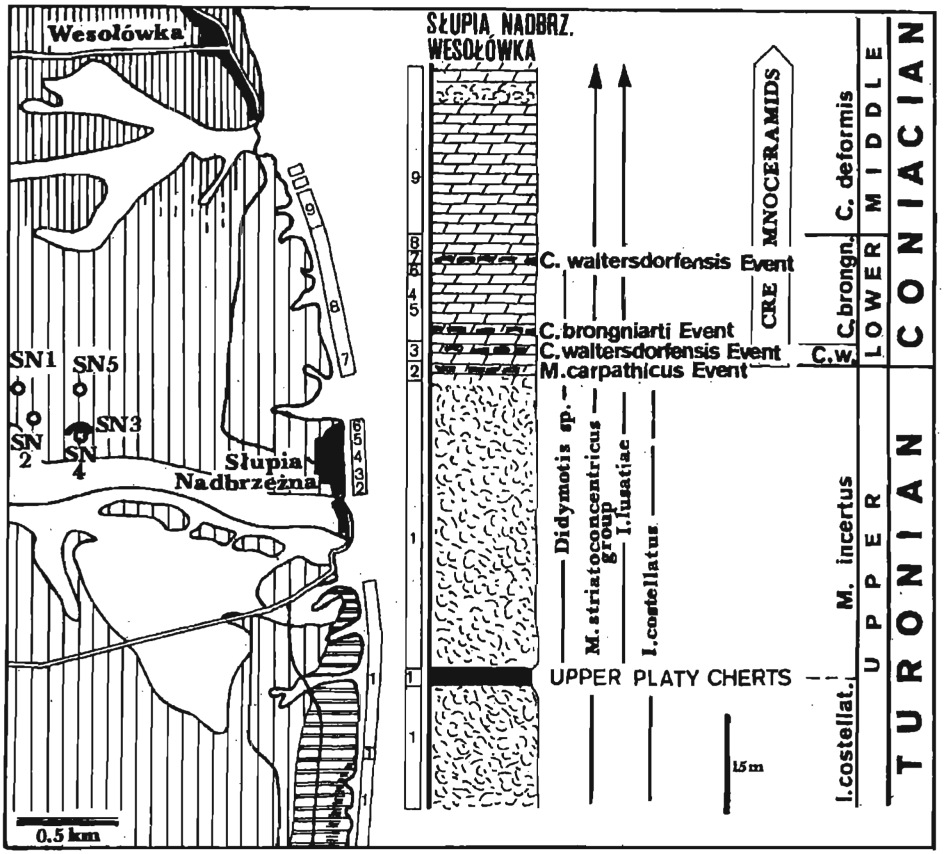


Fig. 23. Lithologic succession, marker horizons, inoceramid ranges and zonation of the Upper Turonian and Lower Coniacian deposits exposed between Słupia Nadbrzeżna and Wesołówka in the NE margin of the Holy Cross Mountains; explanations as for Text-figs 20 and 22

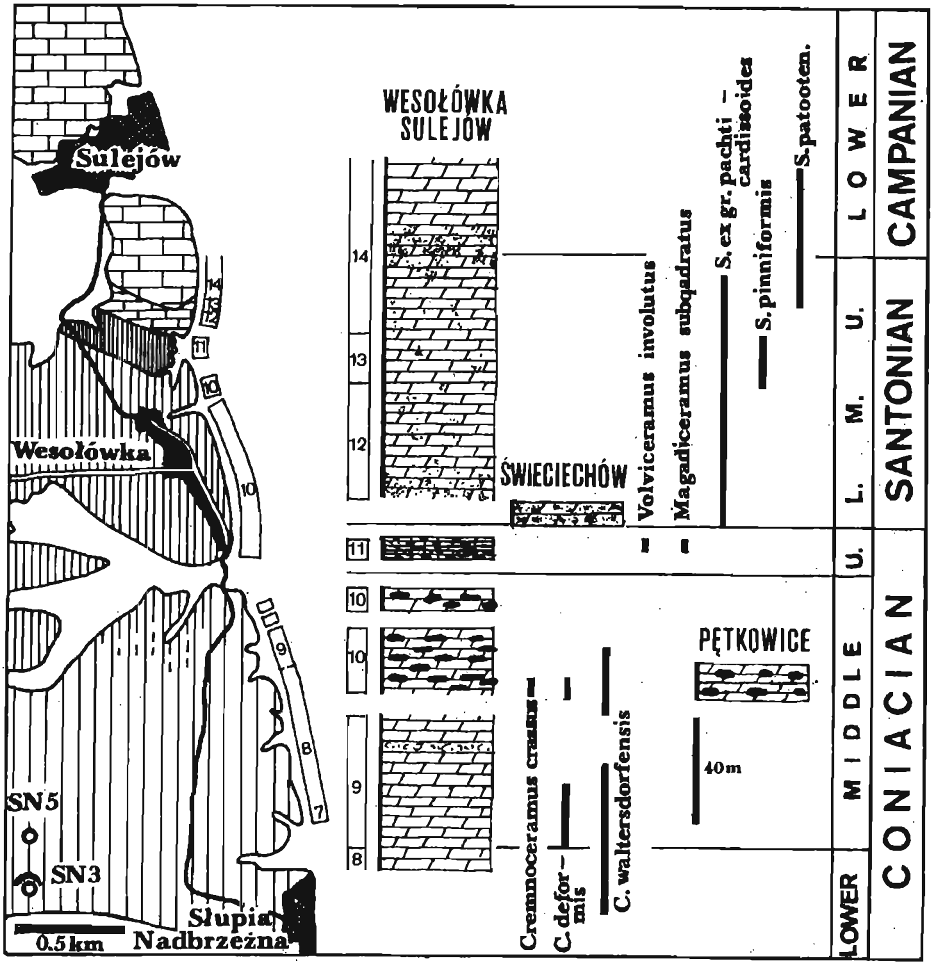


Fig. 24. Lithologic succession, inoceramid ranges and zonation of the Middle to Upper Coniacian and Santonian deposits exposed between Wesołówka and Sulejów in the NE margin of the Holy Cross Mountains; explanations as for Text-figs 20 and 22

The presented interpretation of the Turonian (in the content as used in the present report) markedly differs from the hitherto existing one presented by Požaryski (1948; *see also* Cieśliński & Požaryski 1970, Cieśliński & Jaskowiak 1976). The previous model assumed appreciable facies differentiation to exist between the area of the Tarłów Graben and the region east of the Vistula River till at least mid-Late Turonian time (according to here accepted substage division). However, proving the same biostratigraphic extent of the Opoka with flints in both areas, the occurrence of at least two horizons with platy cherts and stating the lateral continuitly of the opoka with cylindrical concretions far beyond the limits of the Tarłów Graben contest this view. The set forth arguments suggest that the discernible differences in behaviour of both areas existed in the Turonian only up to the Early/Middle Turonian boundary time.

Further on, the whole area behave as one sedimentary region with uniform depositional and paleotectonic conditions.

LOWER AND LOW-MIDDLE CONIACIAN

The lower part of the stage encompasses the pure opokas, with an upward-increasing content of cherts, and characterized by the exceptionally frequent inoceramid fauna. It is the unit distinguished by POŻARYSKI (1948) as the "Opoka With Frequent Inoceramids". Besides inoceramids, the other forms include pectinids, oysters, echinoids and representatives of the bivalve genus *Didymotis* (*see* Pl. 42, Figs 2-3). Occasionally, the ammonites [mainly heteromorphs (of the genera) *Sciponoceras* and *Scaphites*], nautiloids, fish scales and vertebrae and much sparsely plant remains are also noted. Around the lower stage boundary, the fauna is overdominated by inoceramids which form some individualized horizons with their flood appearance (*see* Text-fig. 23). These low-Coniacian inoceramid-bearing strata are the best accessible in the section Słupia Nadbrzeżna - Wesołówka, where the complete succession is present. The isolated fragments of the succession are accessible also in other localities (Kolonka-1, Kolonka-2, Maksymów, Słupia Nadbrzeżna-3; *see* Text-figs 20, 23).

Biostratigraphically, the "Opoka With Frequent Inoceramids" belongs to the Lower and low-Middle Coniacian till the top of the Cremnoceramus deformis Zone.

MIDDLE CONIACIAN

The opoka with frequent inoceramids grades upwardly into the second opoka unit, characterized by a common occurrence of nodular or tabular flints (*see* Text-fig. 24) The unit is best accessible in the localities Wesołówka - Sulejów and Pętkowice (Text-fig. 24). Both, the lower and upper boundary of the unit is not exposed, and its approximate thickness is about 50 m. The fauna collected comprises *Cremnoceramus deformis* (MEEK), *C. crassus* (PETRASCHECK), and *C. inconstans* (WOODS).

UPPER CONIACIAN

Overlying the flinty opoka of the Cremnoceramus crassus Zone there occur soft, gray marls, with cherts, forming most probably distinct layers. These are the most poorly exposed parts of the Turonian-Santonian succession in the studied area. The only exposure where direct observations are possible is the northern side of the roadcut north of Wesołówka (*see* Text-fig. 24). The faunal remains found are extremely rare and represented by fragmentarily preserved inoceramids. When large enough to be genetically assignable, they represent *Volviceramus* sp. POŻARYSKI (1938) reported from the marls also one specimen of *Magadiceramus subquadratus* (SCHLÜTER), but the specimen has been lost during 2nd World War. Up the section, the marls pass into opokas with a gradual increase of the glauconite and quartz content (POŻARYSKI 1938, KURLENDA 1967), the maximum of which is attained at the level approximating the Coniacian/Santonian boundary (the base of unit *e* of POŻARYSKI 1938).

The occurrence of *Volviceramus* sp. and the record of *Magadiceramus subquadratus* (SCHLÜTER) place the marls within the Upper Coniacian M. subquadratus Zone (*see* Tables 17-18).

SANTONIAN

The Santonian yellow-gray opokas with fluctuating amount of glauconite (*see* POŻARYSKI 1938 *and* KURLENDA 1967) similarly as the Upper Coniacian marls are accessible only in the section WesołówkaSulejów (*see* Text-fig. 24). At this moment, however, only the upper half of the Santonian stage is here visible.

The lowermost Santonian strata are glauconite-rich, intensively bioturbated opokas with frequent belemnites (*see* POŻARYSKI 1938), and with slump structures (RADWAŃSKI 1960). Moreover, it is the level of the remarkable faunal turnover. The inoceramid dominated assemblage with subordinate participation of echinoids, brachiopods, or pectinids is replaced by much more diverse assemblage composed of small non-inoceramid bivalves and gastropods, though the inoceramids are stiil relatively frequent. In perceptible number there start to appear also the ammonites and belemnites of which the latter were never reported from the underlying Turonian - Coniacian strata of the studied area. The fauna becomes much closer to the one occurring higher in the Campanian/Maastrichtian deposits of the studied area.

In the middle part of the Santonian succession there occur a horizon (or horizons?) with small concentrations of the oyster *Ostrea bucheroni*, usually overgrowing the surfaces of large (attaining up to 0.5m) fragments of the inoceramid species *Sphenoceramus pinniformis* (WILLETT).

The thickness of the deposits referred here to the Santonian stage in the region was estimated by POŻARYSKI (1938, only his units *e* and *f*) as 60m. However, in the boreholes, both SE and NW of the Middle Vistula section, allover the NE margin of the Holy Cross Mountains (*see e.g.* CIEŚLIŃSKI 1959a, WITWICKA & CIEŚLIŃSKI 1962) its thickness reaches 100m and this value seems to be accepted in the studied Middle Vistula section.

SOUTH-WESTERN MARGIN OF THE HOLY CROSS MOUNTAINS

Within the south-western margin of the Holy Cross Mountains the Turonian through Santonian deposits are exposed in a narrow belt, almost continuously stretching between Przedbórz to NW and the vicinity of Busko-Spa to SE (*see* Text-fig. 25). In spite of relatively large areal exposition of the Turonian, Coniacian and Santonian deposits, the outcrops enabling the detailed studies are very rare. This is particularly true in the case of the central and NW part of the area, whilst the most of exposures are located in the SE part, between Brzeźno and Busko-Spa (*see* Text-fig. 25)

The concerned strata, similarly as in the NE margin of the Holy Cross Mountains, form a part of the continuous mid- and Upper Cretaceous sequence (*see* Text-fig. 25) starting with the Albian siliciclastic and marly deposits (HAKENBERG 1969, 1978, 1984; MARCINOWSKI & RADWAŃSKI 1989), passing upwards into the limestones of the Lower-Middle Turonian, and almost exclusively opokas from the Upper Turonian to the Lower Maastrichtian (*see* CIEŚLIŃSKI & POŻARYSKI 1970).

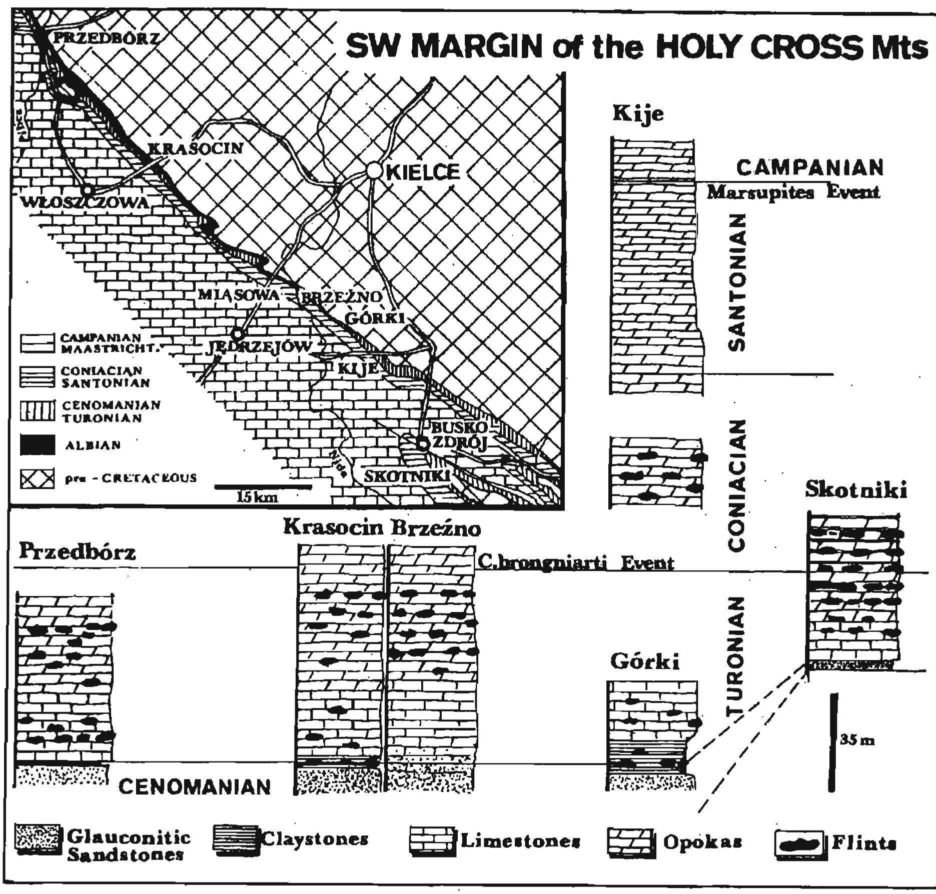


Fig. 25. Geologic sketch-map, and the general stratigraphic succession and its lithology in the SW margin of the Holy Cross Mountains (*see* Text-fig. 1)

CENOMANIAN/TURONIAN BOUNDARY

The most characteristic element of the Cenomanian-Turonian passage beds are the boundary clays (*see* Text-fig. 25), occurring between Przedbórz and Brzostek, Gruszczyn and almost to Miąsowa to SE, and at the most southesternmost part of the area between Pysk and Górki (*see* HAKENBERG 1969, 1978). Both, the thickness and vertical range of the boundary clays vary to a considerable extent throughout the whole area of the SW margin of the Holy Cross Mountains. Usually, its thickness varies between 10 and 20m, but the maximum thickness measured is 36m in the Pysk section (*see* HAKENBERG 1978, Text-fig. 3). In the northwestermost part, at Przedbórz and Brzostek, the thickness of the clays is much below 1m (*see* CIEŚLIŃSKI 1956, HAKENBERG 1978). Their stratigraphic position seems to change markedly, though the biostratigraphic data are very scanty. The only place where the clays were directly dated is the Przedbórz section from where the specimen of *Inoceramus pictus* SOWERBY was reported. The limestones overlying them contain *Mytiloides labiatus* (SCHLOLTHEIM) occurring in masses (*see* CIEŚLIŃSKI 1956). Thus, the clays belong here entirely to the Upper Cenomanian. These clays were partly dated also near Górki, in SE part of the area. From the limestone intercalation in the clays, MAZUREK (1948) reported *Mytiloides labiatus* (SCHLOTHEIM), what indicates the Lower Turonian age of at least a part of the clays. HAKENBERG (1978) reports some data, based on the foraminifers from samples directly over- or underlying the clay horizon. Though these data are rather only rough approximation of the real stratigraphic position, they seem to indicate differences in the vertical extent of the clays, with the overlying sediments representing the lower, or the upper part of the Turonian and in one sample (Wola Świdzińska section) they were dated for the Cenomanian.

The second type of the Cenomanian/Turonian boundary is represented in the area between Brzeźno and Korytnica (*see* Text-fig. 25), where the passage beds are developed as limy sands or sandy limestones (*see also* HAKENBERG 1969). At the moment, no outcrops allowing direct observations of this boundary are present. The organodetrital limestones with abundant inoceramid debris are well visible in the fields between Korytnica and Brzeźno (*see* Text-fig. 25). The inoceramid assemblage, composed of large representatives of *Inoceramus* ex gr. *lamarcki* PARKINSON, which are comparable to *I. lamarcki stumckei* HEINZ, *I. latus* MANTELL, and *I. cuvieri* SOWERBY, associated with *I. inaequivalvis* SCHLÜTER, is characteristic of the boundary interval between the Middle and Upper Turonian. In the uppermost part of the organodetrital limestones at the locality Staniewice one specimen of *Inoceramus costellatus* WOODS was found, indicating already a Late Turonian age of the uppermost part of this unit.

The only outcrop with the exposed Cenomanian/Turonian boundary is the Skotniki Quarry (*see* Text-fig. 26), where the Lower/low-Middle Cenomanian limy sands with glauconite are covered by thinly laminated, organodetrital limestones, dated with foraminifers (by Docent L. KOPAEVICH, Moscow University) as the Lower or low-Middle Turonian.

TURONIAN

The Lower, Middle and probably the lowest Upper Turonian are herein represented by the clay and the limestone lithofacies. The limestones are

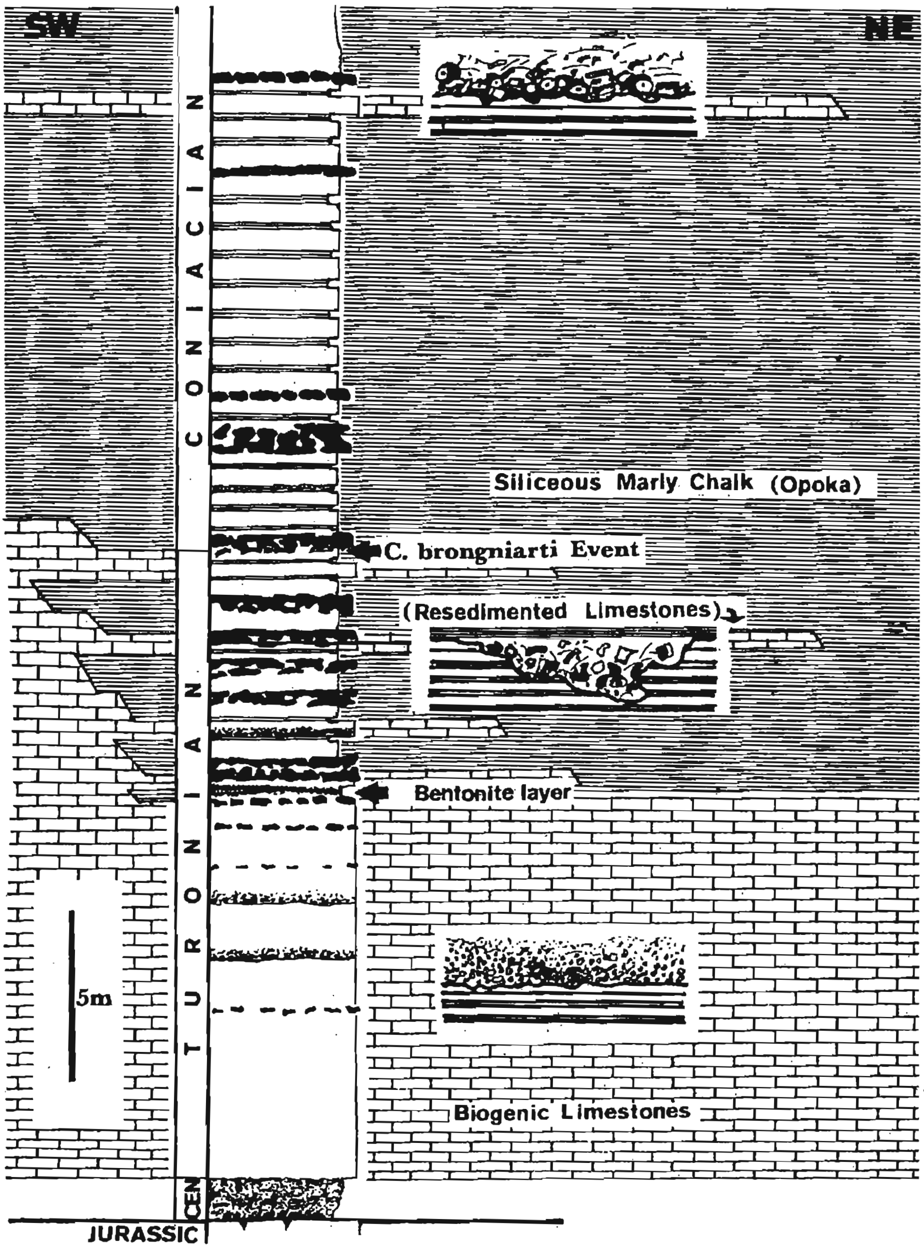
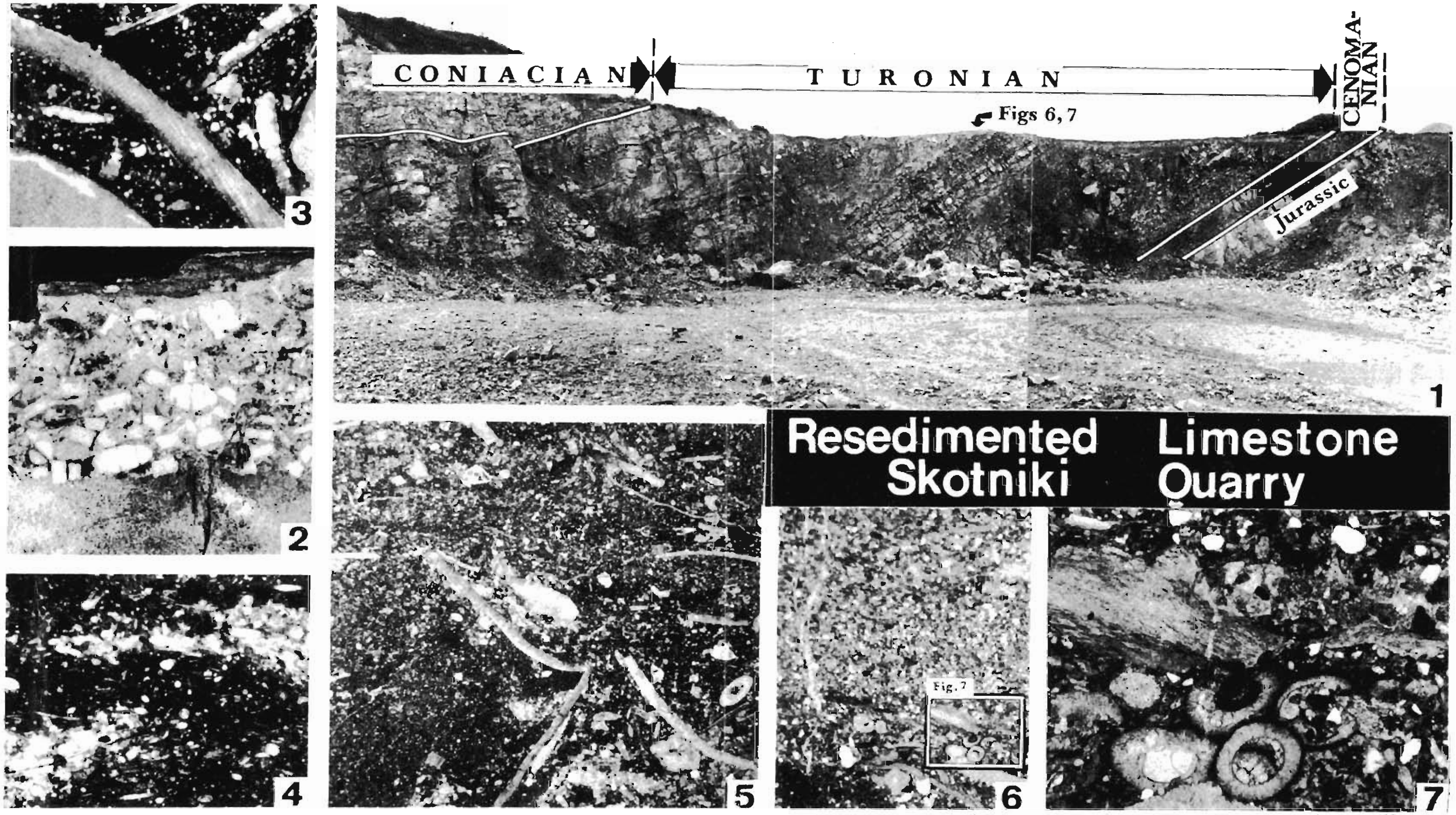


Fig. 26. Detailed lithologic and stratigraphic column of the Skotniki section in the SW margin of the Holy Cross Mountains (*compare* Text-fig. 25)

Resedimented Limestone Facies exposed at the Skotniki Quarry



1 — General view of the north-eastern wall of the Quarry; **2** — Polished slab of a crinoidal limestone (tempestite), nat. size; **3** — Photomicrograph of the crinoidal limestone from Fig. 2, taken × 10; **4** — Streaks of foraminiferal-detrital limestones within spiculitic/calcisphere wackstones, × 30; **5** — Inoceramid/echinoid microfacies, × 10; **6** — Echinoderm/bryozoan microfacies, × 10; **7** — Close-up view of the fragment rectangled in Fig. 6, taken × 30 represented by organodetrital, inoceramid calcarenites and calcirudites (*inoceramites* of HATTIN 1962) as seen in the Przedbórz section, between Korytnica and Brzeźno, and in the Skotniki section (*see* Text-figs 25-27). Partly, the limestones are represented by foraminiferal/calcisphere mudstones with black flints, well accessible in the Przedbórz section or in vicinity of Kije.

In every case the limestones pass gradually up the section, into opokas with flints, and with marly intercalations, of the Upper Turonian (*see* Text-figs 25-28). As may be observed in the Skotniki section (*see* Text-figs 26-27), the overlying opoka in its lowermost part comprises numerous interlayers of detrital inoceramid-crinoidal limestone beds, usually about 10 cm thick.

The upper stratigraphic limit of the limestones was stated between Korytnica and Brzeźno. In the fine-grained limestones at the locality Staniewice the Author found a specimen of *Inoceramus costellatus* WOODS, accompagnied by large representatives of *I.* ex gr. *lamarcki* PARKINSON. Such an assemblage is indicative for the lowermost Upper Turonian.

The Upper Turonian deposits succeeding the limestone-clay interval are composed of opokas with marls, and limestone intercalations (*see* Text-figs 25-28). The opokas are characterized by silica concentrations occurring as cherts and flints. This part of the Turonian succession, recognizable throughout the whole area of the SW margin of the Holy Cross Mountains, is very poorly exposed. In the Skotniki section, in the lower part of opokas, there occur two thin bentonite horizons (Text-figs 26-27). The fauna of the Upper Turonian in general is scarce but overdominanted by inoceramids. In the middle part of the succession, in the Brzeźno section, the level with frequent ammonites represented by *Hyphantoceras reussianum*, *Scaphites geinitzi* and *Sciponoceras* sp., accompanied by abundant *Inoceramus costellatus*, *Mytiloides striatoconcentricus*, and *M. labiatoidiformis* was found.

CONIACIAN

The Lower Coniacian strata are continuation of the Upper Turonian sequence in the region and are represented by a set of the marl/opoka bands. The bottom Coniacian strata, similarly as in the NE margin of the Holy Cross Mountains, are easily identified through the frequently occurring inoceramid fauna, which forms closely spaced and well individualized beds with the „event" accumulations (*see* Text-fig. 25). These are well exposed in the Skotniki section, and between Korytnica and Miąsowa (*see* Text-figs 25-26). The inoceramids are relatively frequent also in the Middle and Upper Coniacian. In the Lower and Middle Coniacian strata, in the Skotniki section, the skeletal limestone intercalations represented by crinoidal and inoceramid-crinoidal tempestites are noted.

The topmost part of the Coniacian is visible along the railroad-cut Kije-1, just close to the Coniacian/Santonian boundary (*see* Text-fig. 25). It is represented by soft marls and opokas with rare quartz and glauconite, and with fragmentarily preserved thick-shelled inoceramids. One specimen of *Volviceramus* cf. *involutus* (SOWERBY) and some specimens of *Magadiceramus subquadratus* (SCHLÜTER) were herein found.

SANTONIAN

The complete Santonian sequence is well cropped out in the railroad-cut at Kije-1 (*see* Text-fig. 25). The succession starts with hard, glauconite- and quartz-bearing opokas, with frequent inoceramid fauna represented mainly by *Sphenoceramus* ex gr. *pachti-cardissoides*. Much rarer, poorly preserved forms comparable to *Inoceramus cycloides* WEGNER, and *Cordiceramus cordiformis* (SOWERBY) were also found. Some thin beds are here overcrowded with current-oriented baculoid ammonites. Further upward, the rocks pass to more clayey marls, soft with almost no sand-sized glauconite and quartz admixture discernible. The fauna occur much more rarely, being represented by the same forms as in the lower parts of the stage. In the middle part of the succession the fragments of large inoceramids (probably of *Sphenoceramus pinniformis* WILLETT) with attached, numerous "*Ostrea bucheroni*" form small "oyster islands", in the similar way and identical stratigraphic position as in the northern margin of the Holy Cross Mountains. Close to the upper Santonian boundary the inoceramid frequency increases again. The lithological character of the deposits is the same as of the underlying beds. The inoceramids are represented by *Sphenoceramus* ex gr. *patootensiformis* (SEITZ), but still possessing relatively strong radial ornament [what makes them similar to the species *Sphenoceramus alexandrovi* (BODYLEVSKY) described from the Taymyr Peninsula by BODYLEVSKY (*in* BODYLEWSKY & SCHULGINA 1959)], *Sphenoceramus lingua* (GOLDFUSS), large representatives of the genus *Platyceramus*, and first representatives of "*Inoceramus*" ex gr. *balticus* BÖHM. Near the top of this level the inoceramids are accompanied by poorly preserved pelagic crinoids *Marsupites*, occurring in relatively high number of specimens, what may be called the *Marsupites* Event (*see* Text-fig. 25).

Above the upper limit of *Marsupites* occurrence, thus within the lowest Campanian deposits according to here accepted boundary definition, still occur the representatives of *Sphenoceramus patootensiformis* (SEITZ), *Sph. lingua* (GOLDFUSS), as well as the first typical "*Inoceramus*" *balticus* BÖHM.

THE INNER PART OF THE MIECHÓW SYNCLINORIUM

The Turonian to Santonian deposits of the inner part of the Miechów Synclinorium are known only from the borehole material. In the central and northern parts of the region the studied sequence continues through the younger Cretaceous (Campanian and Maastrichtian) strata, while in the southern part it is covered, moreover, by the Middle Miocene (Badenian) marine deposits.

The characteristics of the concerned strata in the central and northern part of the Synclinorium is demonstrated here in the three parallel cross sections perpendicular to the axis of the Structure (*see* Text-fig. 28), extended to the nearest surface sections in its border parts (*i.e.*, SW margin of the Holy Cross Mountains and the Polish Jura Chain - *see* Text-fig. 29). The data from the borehole sections are taken from unpublished reports of JURKIEWICZ & *al.* (1966-1971), but partly revised concerning their stratigraphy. The data concerning the south-easternmost part of the Miechów Synclinorium are based on the data recently published by HELLER & MORYC (1984).

The lower boundary of the Turonian through Santonian succession, *i.e.* the Cenomanian/Turonian boundary, is placed at the base of the carbonate part of the succession, overlying the basal, terrigenous part regarded as of Cenomanian age. In most cases the borehole material is lacking the direct biostratigraphic dating and the boundary is placed on purely lithological grounds, supported by the observations in the marginal parts of the Synclinorium.

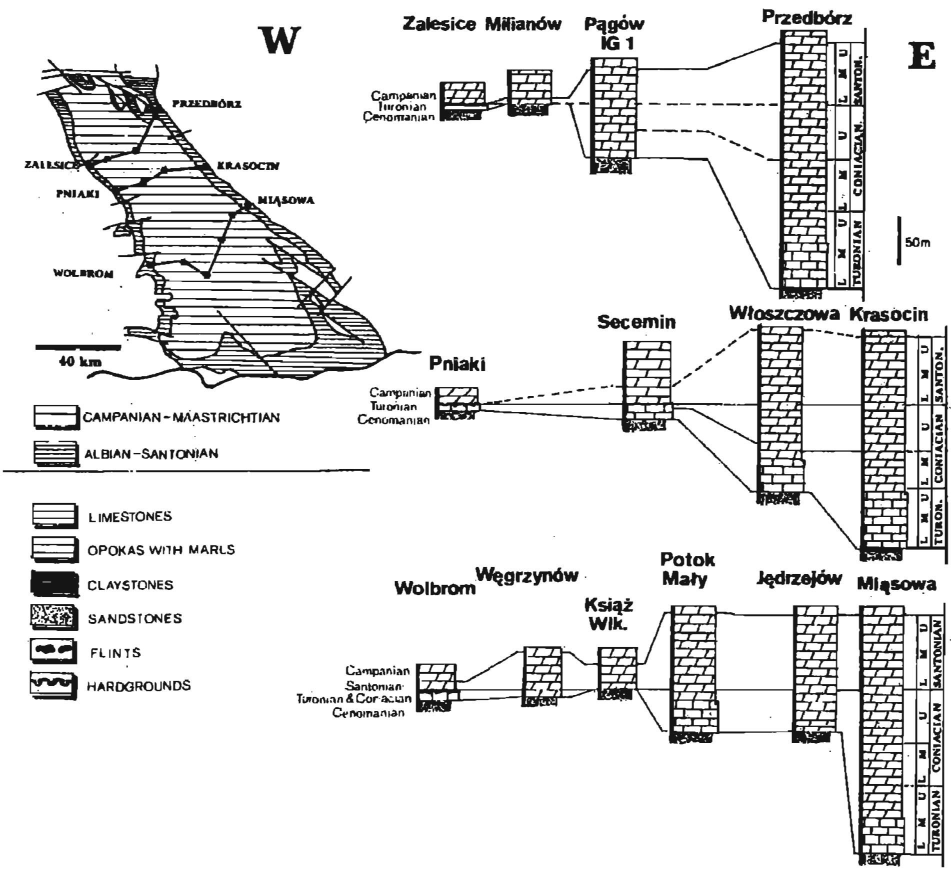


Fig. 28. Stratigraphic succession of the Turonian through Santonian deposits of the Miechów Trough (*compare* Text-fig. 1*B*; borehole columns compiled *after* JURKIEWICZ & *al.* 1966-1971)

The Turonian deposits are represented by limestones, marls, and opokas, rarely with lower or higher terrigenous influx (borehole Kazimierza Wielka 10; *see* HELLER & MORYC 1984). The limestones and marls often contain silica concentrations in the form of cherts or flints. In the Turonian of the south-western and southern parts of the area the infraformational breccia and discontinuity surfaces occur (HELLER & MORYC 1984). The Turonian deposits often rest directly on the Jurassic substrate.

The Coniacian deposits are developed mostly as marls and opokas with subordinate content of marly limestones. In places, the quartz and glauconite admixture, and rarer, thin layers of mudstones and sandstones, usually enriched with glauconite particularly in the southern part of the area are noted.

In the both stages the inoceramids, echinoids, sponges but in the Coniacian also ammonites occur.

The Turonian and Coniacian strata in the Miechów Synclinorium are characterized by small thickness (usually several meters) in its middle and south-western part, which increases rapidly up to about 100m in the NE part of the Synclinorium (*see* Text-fig. 27). The presence of the discontinuity surfaces in the south-western part within the Turonian and Coniacian, as well as the preserved sandstone and limestone pebbles of the older Turonian rocks, and the direct contact with the Jurassic substrate and small thickness of the sequence allows for the assumption that these deposits are developed similarly as those observed in the Polish Jura Chain. In contrary, the north-eastern part of the Synclinorium is characterized by the complete record (*see* Text-fig. 28). Most probably these differences result from an uncomplete record in the central and south-western part of the Miechów Synclinorium, where the sedimentation was limited to short time intervals and the rest of the Turonian-Coniacian time was hidden in stratigraphic hiatuses.

The base Santonian deposits are characterized by the relatively high admixture of quartz and glauconite. In some sections this part of the sequence is composed of marly sands. The rest of the succession is represented by marls and opokas, subordinately also by marly limestones. The basal and the topmost part of the stage are characterized by relatively frequent fauna, dominated by inoceramids, but also with ammonites, echinoids and sponges noted.

In the north-western part of the Miechów Synclinorium the Turonian and Coniacian deposits architecture was kept still within the Santonian (*see* Text-fig. 28). It underwent, however, a radical rearangement in the south-estern part of the Synclinorium (approximately SE of the Vistula river), due to depocentre migration from the most NE part of the Synclinorium to its central part (*see* HELLER & MORYC 1984).

POLISH JURA CHAIN

The Turonian through Santonian deposits of the Polish Jura Chain are exposed in a narrow belt along the SW border of the Miechów Synclinorium, between Zalesice to the north (close to Częstochowa) and Cracow to the south (*see* Text-fig. 29). The concerned deposits are well accessible in a set of natural and artificial outcrops, particularly numerous in the southern part of the area. Throughout the Polish Jura Chain, contrary to the previously characterized regions, the succession is very fragmentary with a stratigraphic gap comprising most of the Turonian to Santonian time (*see* Text-fig. 29), and with the particular units being well separated along the discontinuity surfaces of various kind.

The studied deposits gained a vast documentation due to the studies performed by ZARĘCZNY (1878), SMOLEŃSKI (1906), PANOW (1934), BUKOWY (1956), ALEXANDROWICZ (1954, 1960, 1969), BARCZYK (1956) and RUTKOWSKI (1965) in the Cracow Upland, and by SUJKOWSKI (1926, 1931), RÓŻYCKI (1937, 1938), KOWALSKI (1948), MARCINOWSKI (1970, 1974), MARCINOWSKI & SZULCZEWSKI (1972), and MARCINOWSKI & RADWAŃSKI (1983, 1989) in the rest of the area. The stratigraphic scheme and the general interpretation of the area is given by MARCINOWSKI (1974) and it may be concisely summarized as follows: thin, carbonate Turonian deposits, relatively uniformly developed over the whole area, are dated for the Inoceramus labiatus + I. lamarcki Zones in the northern part of the region, while in the southern part they range till the lower part of the Inoceramus costellatus Zone (the zonation used in traditional concept - *see* CIEŚLIŃSKI 1963, MARCINOWSKI 1975, MARCINOWSKI & RADWAŃSKI 1983). In the northern part of the area the Turonian deposits overlie in sedimentary continuity the Cenomanian ones. In the southern part (particularly the Cracow area) a multiphased block faulting casued a mosaic occurrence of particular Turonian members over particular blocks. The block mobility combined with constant relative elevation of the whole area manifested itself by interrupted sedimentation featured with associated hardgrounds, stromatolitic bands and/or condensation. The return of the sedimentary conditions is dated for the Santonian in the southern part of the area and for the Lower Campanian in the northern part. A lack of any evidence of the emersion suggest all breaks in sedimentation to be a record of the submarine breaks in sedimentation (*see* DŻUŁYŃSKI 1954, MARCINOWSKI 1974) rather than a set of the following transgressive-regressive pulses postulated by some authors (*e.g.* PANOW 1934, ALEXANDROWICZ 1954).

A restudy of the representative sections within the area (*see* Text-fig. 29) and the examination of their inoceramid content, coming also from old collections, allow to propose a new stratigraphic interpretation.

CENOMANIAN/TURONIAN BOUNDARY

The boundary is marked usually by a discontinuity surface. In many sections, moreover, an evident stratigraphic hiatus is recorded, particularly in the southern part of the area, i.e. in the Cracow Upland. There the Lower Turonian (Mytiloides labiatus Zone) limestones overlie an abrasion surface developed over the Jurassic limestones (*see e.g.* Januszowice Quarry, Pl. 45, Fig. 1). The locality postulated by MARCINOWSKI (1974) to record a continuous sedimentation accross the Cenomianian/Turonian boundary, i.e. the one of Glanów (*see* Text-fig. 29, the locality 108c *in* MARCINOWSKI 1974), also appears to be discontinuous. Simply, the specimen of *Inoceramus crippsi* MANTELL (*see* MARCINOWSKI 1974, Pl. 25, Fig. 1), which was to date the lower part of the unit 2d, overlying undoubtedly Upper Cenomanian conglomerates [well dated with *Inoceramus bohemicus* LEONHARD and with *Actinocamax plenus plenus* (BLAINVIL-

LE) and *Actinocamax primus primus* ARKHANGELSKY - *see* MARCINOWSKI (1972, 1974)] represents the Lower Turonian form *Mytiloides kossmati* (HEINZ). Thus, the boundary between the Cenomanian and the Turonian lies below the limestone unit at the discontinuous contact with the underlying conglomerates (*see* Text-fig. 29; *and* MARCINOWSKI 1974, Fig. 20).

STRATIGRAPHIC EXTENT OF THE TURONIAN

The main features of the Turonian deposits of the Polish Jura Chain are: (1) an almost uniform characteristics though with varying microfacies (*see* Pls 45-46) of limestones, (2) small thickness, not exceeding 10m, but usually with much lower values, and (3) composition of the Turonian succession of the thin, discontinuity bounded units. As it is evident from the own studies (*see* Text-fig. 29) on the representative sections of the Polish Jura Chain, the twofold division of the Turonian sections is valid over the whole area of the Polish Jura Chain. The lower member, dated directly with inoceramids in Zalesice, Poręba Dzierżna, Glanów, Ulina Wielka, Januszowice and Tyniec sections (*see* Text-fig. 29) represents invariably the Lower Turonian, precisely the Mytiloides labiatus Zone. In the case of Glanów section the lowermost part of the Turonian belongs most probably to the Mytiloides kossmati Zone. In none section as also in none older collections from the area, any representatives of the *Mytiloides hercynicus* - *opalensis* group were found. The dating of the upper member, directly with the newly collected inoceramids was made for the sections exposed at Zalesice, Wielkanoc, Pniaki, Przychody, Bocieniec, Januszowice, and Ząbierzów. The occurrence, within the upper member, of large representatives of the *Inoceramus lamarcki* group as also of *Inoceramus costellatus* WOODS, well dates this part of the Turonian section for the lowermost part of the Upper Turonian, precisely the Inoceramus costellatus Zone. The nominative species *Inoceramus costellatus* WOODS is rarely found. However, a similar age, i.e. the upper part of the Middle Turonian and/or the lowermost part of the Upper is suggested by the representatives of the *I. lamarcki* group.

PRESENCE OF THE CONIACIAN

The Coniacian deposits were evidenced (with inoceramid fauna) by the Author in the Wielkanoc Quarry, near Wolbrom (*see* Text-fig. 29). They are represented by the sandy glauconitic limestone occurring in a form of breccia (?karstic in origin) infilling an erosional hole within the Jurassic limestone in the northern wall of the quarry, and covered by the layered marls of the Santonian age. The fauna within the limestone blocks, sufficiently preserved to be determined to the species level is not frequent, but it comprises *Cremnoceramus crassus* (PETRASCHECK) (*see* Pl. 34, Fig. 4), *C. ernsti* (HEINZ)(*see* Pl. 32, Fig. 3), *Inoceramus* cf. *madagascariensis* HEINZ, *I. lusatiae* ANDERT, *Cremnoceramus* cf. *deformis* (MEEK), and *Micraster* cf. *cortestudinarium* (the echinoid species determined by Dr. S. MĄCZYŃSKA, Museum of the Earth,

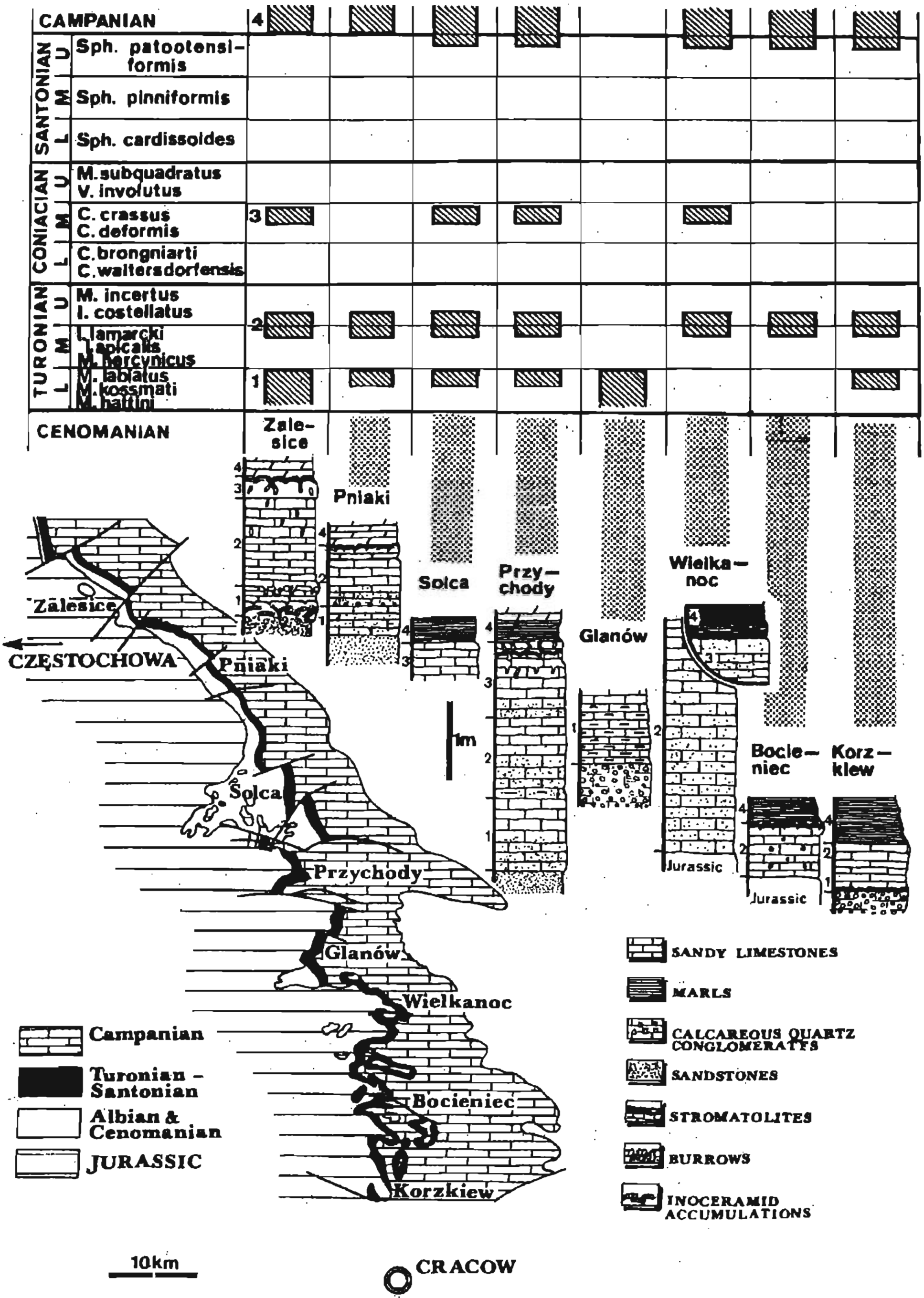


Fig. 29

Representative sections of the Upper Cretaceous deposits in the Polish Jura Chain, and their geochronological interpretation

Warsaw). The whole assemblage indicates the Middle Coniacian Cremnoceramus crassus Zone. The mode of occurrence of the Coniacian deposits do not allow for any direct reading of the original succession in the Wielkanoc section, but some remarks may be made. The whole succession was probably uniform in facies, judging on the breccia composition and developed as sandy-glauconitic limestone. The fragments of hardground with the stromatolite cover at their top suggest that the Coniacian unit was deposited under conditions similar to those prevailing within the Turonian time, leading to very noncontinuous sedimentation. The brecciated Middle Coniacian limestones represent, most probably, the youngest deposits below the Middle/Upper boundary Santonian marls (the age of the latter determined on the foraminiferal fauna by Docent L.F. Kopaevich, Moscow University).

A restudy of the inoceramids from the original collection of Professor R. Marcinowski, which were to characterize his third Turonian horizon, i.e. the Inoceramus costellatus Zone (*see* Marcinowski 1974, *and also* Marcinowski & Radwański 1983, 1989) showed these to be identical to the one as found in the Middle Coniacian deposits of the Cremnoceramus crassus Zone in Wielkanoc. The identifiable specimens from the collection comprise: *Cremnoceramus crassus* (Petrascheck), *I.* cf. *ernsti* Heinz, and *C.* cf. *waltersdorfensis* (Andert). At this moment, it is also easy to comment on the data presented by Sujkowski (1926), who reported from the environs of Wolbrom the sandy-glauconitic limestones with *Inoceramus lamarcki, I.* cf. *inconstans,* the passage forms between *I. lamarcki* and *I. involutus* (most probably *Cremnoceramus ernsti* - Author's suggestion) as also *Micraster cortestudinarium.* Sujkowski (1926) suggested a continuity of the sequence from the Turonian up to the Santonian. In this statement he was wrong, but the occurrence of the Middle Coniacian deposits in the environs of Wielkanoc, Przychody, Solca, and Ulina Wielka, and dated previously for the low-Upper Turonian (Inoceramus costallatus Zone) by Marcinowski (1974) is well evidenced.

THE AGE OF THE OVERLYING "SENONIAN"

Allover the studied area, the Turonian or Middle Coniacian deposits are covered by a more or less uniform marly and "opoka" facies of the "Senonian" age. In the southern and middle parts of the area they were dated for the Santonian, while in the northern part of the area already for the Campanian (*see e.g.* Różycki 1937, 1938; Marcinowski & Szulczewski 1972; Marcinowski 1974; Marcinowski & Radwański 1983, 1989). The real stratigraphic spantime within the basal Senonian cover between the southern and northern parts of the Polish Jura Chain is, however, indistinct approximating allover the area the Santonian/Campanian boundary level (*see* Text-fig. 29). Few groups of fossils can be used for detailed biostratigraphy of these deposits. The critical ones, i.e. ammonites and belemnites need the new, strictly labelled collections to be made. Among the other fossils the most useful are the pelagic crinoids of the genus *Marsupites*, whose isolated plates are commonly cited from the Polish Jura Chain. They are known from the Cracow environs (localities Bonarka, Zabierzów, Sudół, Narama, Iwanowice; *see* SMOLEŃSKI 1906, PANOW 1934, BARCZYK 1954), from the area of Wolbrom (KOWALSKI 1948), and a single plate was cited also from the most northern part of the Polish Jura Chain (environs of Zalesice), by ROEMER (1870). From the latter region the Santonian deposits were not reported, but it seems probable that in places the Santonian glauconitic marls underlying the Campanian opokas could have been preserved (see discussion in RÓŻYCKI 1937). The inoceramids in the Santonian/Campanian boundary interval do not represent the group with the marked stratigraphic utility, and moreover the identifiable specimens in the deposits discussed are extremely rare.

SUMMARY ON THE STRATIGRAPHY

Following the studies on the inoceramid fauna from the Polish Jura Chain, a new stratigraphic interpretation of the sequence is here offered (*see* Text-fig. 29). It involves the presence in the whole area of the Polish Jura Chain of a thin, short-ranged, discontinuity-bounded isochronous units, separated each other by the more or less extended stratigraphic gaps. The two lower units, dated for the Mytiloides labiatus Zone of the Lower Turonian and for the boundary interval between Inoceramus lamarcki and Inoceramus costellatus Zones occur in the whole area between Cracow and Zalesice. The third unit, belonging to the Middle Coniacian Cremnoceramus crassus (= C. schloenbachi) Zone (dated previously as being of low Upper Turonian Inoceramus costellatus Zone) is up to now recognized only in the south-central part of the region, but most probably it may be represented also in other regions as well. The base of the "Senonian" cover may be dated allover the area as being close to the Santonian/Campanian boundary (the Sph. patootensiformis Zone). In such a stratigraphic sequence there is no more place for the statements about the directional change of the vertical range of the main stratigraphic gap in the area, between the Turonian and Coniacian from below and the Santonian/Campanian from above as postulated by RÓŻYCKI (1938). Allover the studied area the Cenomanian/Turonian boundary is discontinuous and underlined by hardgrounds, stromatolite layers, distinct lithological changes, or the lowermost Turonian deposits overlie directly the Jurassic basement, as it is particularly apparent in the Cracow region, just within and around the city of Cracow.

OPOLE TROUGH

The Turonian and Coniacian deposits of the Opole Trough are herein characterized basing on their superficial occurrences near the city of Opole. It is the only region within the Trough, which gives a direct insight into the Cretaceous succession in the area. Since the general characteristics of the

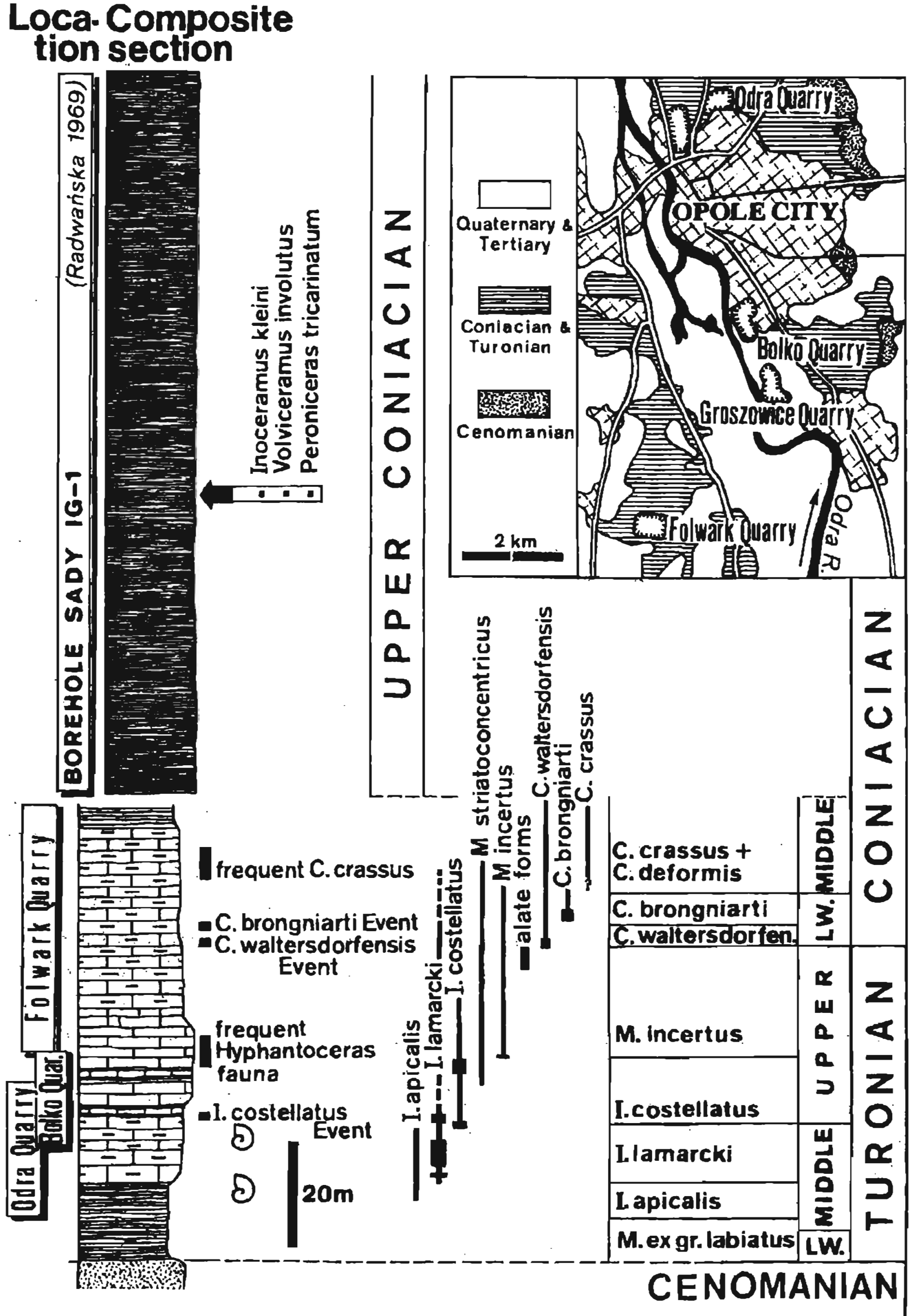


Fig. 30. Stratigraphic and lithologic column, to show the ranges of the selected inoceramid species, marker horizons and biostratigraphy of the Cretaceous deposits in the Opole Trough

succession and its basic biostratigraphic scheme have recently been given by the Author (WALASZCZYK 1988), only a short summary, supplemented with new data, and a revised biostratigraphic scheme of the sequence is offered (*see* Text-fig. 30).

Meanwhile, the survey on the stratigraphy and paleontology of the Opole Cretaceous was published by TARKOWSKI (1991). However, neither the litho- nor biostratigraphy presented by this author improve the existing schemes. Concerning the biostratigraphic scheme, based on inoceramids, his newly introduced zones are not satisfactorily defined, and their extents are not readible from the referenced graphs.

FIELD RELATIONS

The Cretaceous deposits of the Opole Trough are an outlier of the originally much more extensive cover, embracing the entire area of the Great Monocline (*see* Text-fig. 1). The Cenomanian through Coniacian, mainly subsurface succession is quite well exposed in the environs of Opole, with only minor occurrences in the central and southern part of the Trough. In the rest of the Trough, stretching from around Brzeg to the north, and to the south, along the Oder river, as far as the territory of Czecho-Slovakia, the Cretaceous strata are covered by a thick cover of Tertiary deposits.

The tectonic structure of the Opole Trough, still poorly known, is interpreted as a system of WNW-ESE trending parallel synclines and anticlines, disturbed by a system of superimposing faults (OBERC 1978). The studied Turonian-Coniacian succession of the Opole Trough would be, according to this interpretation, a part of the NE limb of the Brzeg Syncline.

In the environs of Opole the accessible part of the sequence includes the Middle Turonian up to the Middle Coniacian strata. They are well exposed in the numerous Cement Industry quarries all but one being situated east of the Oder River, immediately in the city (*see* Text-fig. 30). In these quarries the lower part of the succession encompasses the interval from the Inoceramus apicalis Zone up to the I. costellatus Zone. In the only quarry situated west of the Oder River, near Folwark (*see* Text-fig. 30), the upper part of the succession is exposed, and it is composed of limestones and marls of the Mytiloides incertus Zone of the Upper Turonian up to the Cremnoceramus crassus Zone of the Middle Coniacian. In the former report a rather large observational gap (estimated for about 15m) between the part of the succession visible in the Folwark Quarry and the part exposed in the quarries east of the Oder River was assumed. In the following years, the exploitation in the Folwark Quarry went further down to the topmost part of the Marly Limestones Unit (*see* Pl. 44, Figs 1-3, *and* WALASZCZYK 1988, Text-fig. 2) what allows to complete the sections, and to measure the thickness of the successive zones.

SUCCESSION CHARACTERISTICS

The lowermost strata of the succession are not exposed in the environs of Opole, but basing on the former data (ALEXANDROWICZ 1974a, b) this part, comprising the Lower and the low-Middle (M. hercynicus Zone) Turonian, is composed of 8-14m thick set of argillaceous marls, the uppermost part of which is exposed in the Odra Quarry (*see* Pl. 43, Fig. 1). The latter belongs already to the Inoceramus apicalis Zone of the Middle Turonian (*see* Text-fig. 30). According to ALEXANDROWICZ (1974a), in their lower part the marls contain the low-Turonian fauna with *Mytiloides* ex gr. *labiatus* (SCHLOTHEIM).

Following the Clayey Marls Unit there occurs an about 15m thick unit of gray, layered marls of the Lower Marls Unit, with characteristic two thin clay layers (Cl-1 and Cl-2; *see* WALASZCZYK 1988, Text-fig. 2) at their top, with small brachiopods *Terebratulina gracilis*, as recognized already by GÜRICH (1890). Besides their uppermost part, the marls belong to the Middle Turonian Inoceramus lamarcki Zone (*see also* WALASZCZYK 1988).

About 2m below the top of the Lower Marls Unit, there is a flood appearance of small inoceramids of the species *Inoceramus costellatus* WOODS, marking the base of the Upper Turonian substage (*see* Text-fig. 30).

Judging on the graphs presented by TARKOWSKI (1991, Text-fig. 7), this part of the section was included still into the Middle Turonian, and the base of the Upper Turonian placed at the bottom of the Marly Limestone Unit, i.e. about 2m higher than here accepted.

In the lower part of the substage, small representatives of the WOODS' species are accompanied by the large forms assigned here as *Inoceramus* ex gr. *lamarcki*, whose state of preservation do not allow, in most cases, for their more detailed identification. They often occur only as a bed of layered shell debris accumulations, probably of a tempestitic origin (*see* WALASZCZYK 1988, Pl. 2, Fig. 2). The low-Upper Turonian is composed mainly of the yellow-gray, thin-layered limestones, with thin marly intercalations, and in the middle part with distinst two clay horizons (Cl-3 and Cl-4), commonly used as marker horizons.

In the previous report, the Author distinguished, about 1m above the Clay horizon *4* within the Marly Limestone Unit, an interval with frequently occurring ammonites and regarded it as an equivalent of the *Hyphantoceras* Event (*see* WALASZCZYK 1988, Text-fig. 2). A new possibility of collecting within the uppermost part of this unit showed, however, that this ammonite fauna is quite frequent up to the top of the unit and thus it should not be called an event.

The lower part of the Marly Limestone Unit belongs evidently to the Inoceramus costellatus Zone, while its uppermost part belongs already to the Mytiloides incertus Zone (*see* Text-fig. 30).

Overlying the limestones of the Marly Limestones Unit is a 35m thick part of the succession, composed of gray, rhythmically bedded marls, exposed in the Folwark Quarry (*see* Text-fig. 30 and Pl. 44). Almost at the base of the unit, a radical decrease of the faunal frequency and its diversity is observed.

Such "poor" interval comprises the lower, about 16m thick part of the Upper Marls, up to the Turonian/Coniacian boundary passage featured with an associated faunal acme (*see* Text-fig. 30). In this interval a poor fauna of ammonites (*Hyphantoceras* sp.), inoceramids (one specimen of *Mytiloides incertus* JIMBO), pectenids, and sponges is yielded. Close to the Coniacian boundary, an increase of the faunal frequency is noted, and it is particularly due to the occurrence of inoceramids. The whole interval from the first occurrence of *Mytiloides incertus* (JIMBO) up to the first occurrence of cremnoceramids, is herein assigned to the Mytiloides incertus Zone, which includes the zone Mytiloides aff. labiatoidiformis, distinguished in the uppermost part of the Turonian formerly (*see* WALASZCZYK 1988, Fig. 2).

The cremnoceramids, with their first representative *C. waltersdorfensis*, appear suddenly in mass, well marking the Turonian/Coniacian boundary (Text-fig. 30). About 1.2m above the Coniacian base there occurs already *Cremnoceramus brongniarti* (MANTELL).

In the upper part of the Folwark Quarry there occur about 12m thick unit of hard, thinly layered, slightly siliceous marls; these marls are overlain by soft, clayey marls of the Upper Clayey Marls Unit (*see* Text-fig. 30).

Above the Cremnoceramus brongniarti Zone two other zones are recognized in the Folwark Quarry, namely the Cremnoceramus deformis Zone and the Cremnoceramus crassus (=C. schloenbachi) Zone of the Middle Coniacian (*see* Text-fig. 30). The here postulated presence of the Middle Coniacian in the area has nothing in common with that reported by TARKOWSKI (1991) who concerned this substage in the traditional sense (=lower part of the *involutus* beds) which was to be documented here by the presence of the species *Inoceramus kleini* MÜLLER. However, the specimen illustrated by TARKOWSKI (1991, Pl. 14, Fig. 3) from the Folwark Quarry does not represent MÜLLER's species, because it belongs to the *Cremnoceramus inconstans - crassus* group, which, when occurring without the former, is indicative of the C. crassus Zone.

The youngest deposits of the Opole Trough are documented in numerous boreholes. The best evidenced paleontologically they were in the Sady borehole, described by RADWAŃSKA (1969) who, from the upper part of the succession reported *Inoceramus kleini* MÜLLER, *I. involutus* SOWERBY, and the ammonite *Peroniceras tricarinatum* (d'ORBIGNY), the assemblage of which indicates the lower part of the Upper Coniacian (as here defined), Volviceramus involutus Zone. This part of the sequence is composed of the clayey marls and mudstones and possesses a great thickness, attaining about 150m in the referenced borehole.

GEOTECTONIC-FACIES UNITS OF THE POLISH CRETACEOUS

The thickness of deposits and their facies relations allow to distinguish five, distinct geotectonic-facies units within the epicontinental Polish Cretaceous, existing at least in the early-Late Cretaceous, and characterized by their specific evolutionary behavior. From SW to NE these are: (i) the Inner Sudetic Area, corresponding to the area of the present-day Sudetes, (ii) the Circum-Sudetic Trap Basins, embracing in Poland the area of the present-day Opole Trough and the North-Sudetic Trough, (iii) the Cracow Swell, approximating the area of the present-day Great Monocline, (iv) the Danish-Polish Trough, and (v) the most easterly lying unit, stretching over the East-European Platform, and called here the Russian Chalk Sea.

INNER SUDETIC AREA

The unit comprises the landmasses of the Sudetic Islands (the West and the East Sudetic Island; *see* Scupin 1936), with the Inner Sudetic Basin amongst them. The major part of this unit represented an area with dominating positive movements, being the main supplier of the terrigenic material for the surrounding basins, and also for the Inner Sudetic Basin. The Sudetic Islands were continuously and steadily uplifting, being in balance with the rate of subsidence in the surrounding Trap Basins, while their uplift is estimated for about 750m (*see* Skocek & Valecka 1983).

CIRCUM-SUDETIC TRAP BASINS

The unit comprises the tectonically distinct structures surrounding the Inner Sudetic Area, characterized by similar facies and thickness relations and an almost identical evolutionary behavior in the time concerned.

Within the studied area this unit encompasses the Opole Trough only. The other basins belonging to the unit are: the North Sudetic Basin, the Saxonian Basin, and the Bohemian Basin.

The unit displays a clear facies pattern. At the inner part, i.e. close to the boundary with the Inner Sudetic Area the sandy sedimentation predominates, in *e.g.* Łużyce area in NW part of the Bohemian Basin, the Elbsandstein Gebirge in the Saxonian Basin or in the SE part of the North-Sudetic Basin (*see* Scupin 1912-13, Milewicz 1966, Tröger 1969a, Valečka 1979). This part of the unit marks the main subsidence zone in particular basins. Off the above indicated boundary zone the deposits are characterized by a gradual decrease of the size and content of the terrigenic influx, with change to more and more carbonate sedimentation. Such outer margin facies of the unit, referred here to as "Bedded Marly Chalk", is demonstrated by the succession observed in the Opole Trough.

This facies is represented by light to dark gray, well-bedded marls (*see* Pls 43-44), with ten to some tens of centimeters thick individual beds, exhibiting long-distance, constant, lateral characteristics. The succession exhibits a one-cycle, centrally decreasing fluctuation of the terrigenic influx, reaching the minimum in the early-Late Turonian (*see* Alexandrowicz 1974a). This trend is superimposed on the most prominent feature of the sequence, namely the regular to subregular record of rhythmic alternation of the carbonate richer (light-gray beds) and carbonate poorer (dark-gray) beds, assumed here to be the primary rhythmicity (*periodite facies* of Kennedy 1987).

Almost identical facies-stratigraphic relationships may be recognized also in the central part of the North-Sudetic Trough (*see* Milewicz 1988). They are compatible with the development pattern of the Bohemian Basin, especially its off-marginal parts, not induced by any peculiar features of the basin (*see* Klein & *al.* 1979, Čech & *al.* 1980).

The whole area of the Circum Sudetic Trap Basins displays a simple sedimentary succession composed of one transgressive-regressive cycle, with a much thicker regressive member of the cycle.

The succession is characterized by great thickness, in the Turonian to Middle Coniacian part comparable to the respective sequence in the most subsiding unit in extra-Carpathian Poland, i.e. the Danish-Polish Trough, and in the Upper Coniacian - Lower Santonian still attaining higher values, some times exceeding those of that Trough. In the North-Sudetic Trough the maximum thickness reported approximates one kilometer (*see* MILEWICZ 1988). In the marginal parts of the Bohemian Basin with the psammitic sedimentation, the measured sequences reach 1200m (*see* VALEČKA 1979).

The stratigraphic range of the marine sedimentation in the Circum-Sudetic Trap Basins is embraced between the Middle Cenomanian and Early Santonian. Whereas, however, the lower time limit is recognizable throughout the whole unit, its upper boundary has hitherto been proved only in the North-Sudetic Trough (MITURA & *al.* 1969) and in the Bohemian Basin (ČECH & *al.* 1980). In both cases the youngest marine deposits are followed by the non-marine facies clearly indicating the demise of marine conditions. Concerning the Opole succession, the youngest deposits reported here are of Late Coniacian age. However, taking into accout an identical facies-stratigraphic succession in this area, as compared to the North-Sudetic Trough, the same upper time limit (*i.e.* the Early Santonian) of the marine sedimentation in both areas is herein considered as the most probable (*see also* JERZYKIEWICZ 1971, MARCINOWSKI 1974). This may be an explanation of WEGNER's (1913) reports of the Santonian belemnites from the kart deposits in the Bolko Quarry.

CRACOW SWELL

The unit adjoining the Circum-Sudetic Trap Basins to the North is characterized by positive tendencies almost throughout the whole Turonian to Santonian interval. A part of the Swell represented, at least in the Turonian and Coniacian, a considerable fragment of the present-day Miechów Synclinorium, re-aranged later and included into the frames of the Danish-Polish Trough, somewhen close to the Coniacian/Santonian boundary (*see* Text-fig. 32).

Most of the area of the Swell was stripped of the Cretaceous cover due to subsequent erosion, and the Cretaceous deposits are now accessible only in the area of the Polish Jura Chain.

During the Turonian through Santonian interval, following the mid-Cretaceous initial transgressive onlap, the unit was characterized by a very limited record with most of the time hidden within regional stratigraphic gaps. According to the newly presented biostratigraphic scheme, this part of the succession comprises the record of Mytiloides labiatus Chrone, the boundary interval between the Middle and Late Turonian, the Middle Coniacian Cremnoceramus crassus Chrone, and the latest Santonian Sph. patootensiformis Chrone (*see* Text-fig. 29). Similar results were also reported from the NW part of the Swell (*see* JASKOWIAK-SCHOENEICH 1981), based on the rough dating from the borehole material.

As concerns the facies, the unit is characterized by limestones, variable in their microfacies, and referred here to as Biogeniec Limestone Facies. These limestones form a discontinuous, sheet-like sediment bodies, with thickness not exceeding about ten meters and divided by discontinuities of various kind (*see* Text-figs 31-32). The most spectacular of these discontinuities are the abrasion surfaces, occurring in the southern part of the Polish Jura Chain, i.e. in the Cracow Upland (*see* Pl. 45, Fig. 1). These surfaces are developed directly on the carbonate Jurassic substrate (often featured with the borings of the basement) and/or over the succeeding Turonian carbonate slices. Due to tectonic block movements the successive abrasion surfaces cut often each other, with the angular unconformity reaching maximum several degrees (*see* ALEXANDROWICZ 1954). Toward the north, the abrasion surfaces pass into the time correlatable discontinuities of other types, such as hardgrounds or omission surfaces, commonly associated with the stromatolitic bands (*see* MARCINOWSKI & SZULCZEWSKI 1972, GOLONKA & REICHEL 1972).

The limestones were formed in the open marine environment, well off the regular supply of the terrigenic input. Such environment is suggested by the microfacies characteristics of the limestones, being dominated by the foraminiferal/calcisphere wackstones with foraminifers represented almost entirely by the planktic forms. The sand-sized quartz (and even gravel), the admixture of which is found in places to form a considerable content of the rock, was probably supplied from local underlying beds, mostly of Albian and Cenomanian age (*see* MARCINOWSKI 1974). Besides the south-eastern part of the Cracow Swell, which at least periodically was reached by effective wave base responsible for the formation of successive abrasion surfaces, the rest of the area was probably situated well below this level.

DANISH-POLISH TROUGH

This unit borders the Cracow Swell to SW and represents the structure with the maximum subsidence rate within the Late Cretaceous (*see* KUTEK & GŁAZEK 1972). Such geotectonic behavior resulted in monotonous facies development almost throughout the Turonian through Santonian interval. Except the earliest Turonian facies unification, with the Biogenic Limestone Facies dominating almost the whole area (*see* Text-figs 31-32), the unit is invariably characterized by the Siliceous Marly Chalk (= Opoka) Facies. Close to the Cracow Swell the background opoka facies is interlayered by the detrital, biogenic limestones transported into the Trough from the Swell, referred here to as the Resedimented Limestone Facies (*see* Text-figs 27, 31-32 and Pl. 47). The limestones are often represented by tempestite beds (Text-fig. 27).

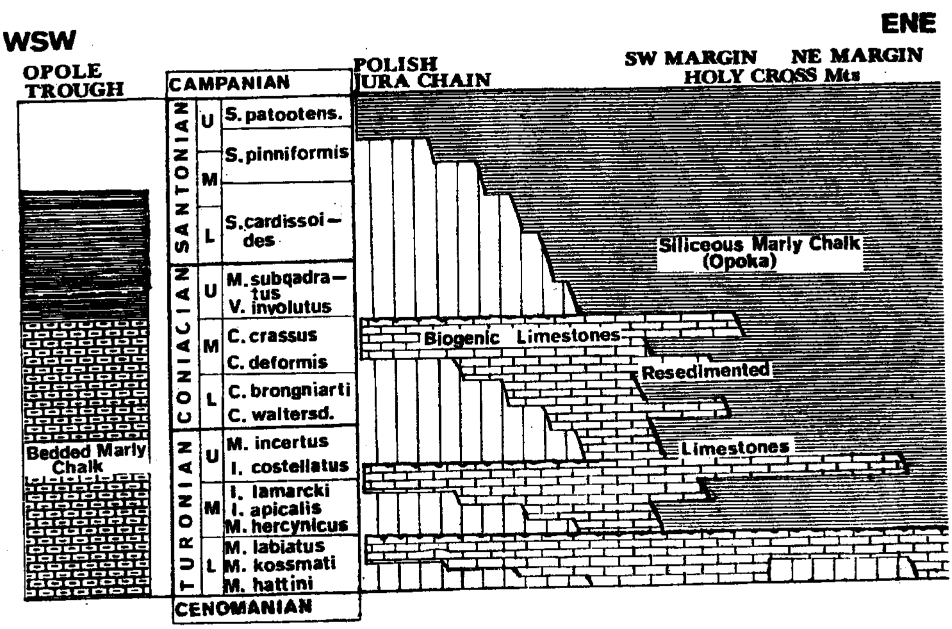


Fig. 31. Chronostratigraphic scheme of facies distribution across southern Poland; for location of the regions and their general stratigraphic successions *see* Text-figs 1, 21-25, 29, and 30

The background opoka facies diplays, at least in parts, clearly identifiable rhythmicity underlined by the silica concentrations in a form of nodular and/or bedded cherts and flints. Certainly, both cherts and flints are clearly diagenetical structures as they are always superimposed on the trace fossils (*see* VOIGT 1979, KENNEDY & JUIGNET 1974). However, they are assumed to repeat the primary fluctuations of the silica content in the sediment, resulting from the primary variation in the productivity of siliceous organisms in the Late Cretaceous sea (*see* EHRMANN 1986). This productivity, on the other hand, is interpreted to be dependant mostly on the amount of silica supplied from the land areas around. In such a case, the rhythmicity recorded in the opokas should well correspond to the rhythmicity observed in the marls of the Circum-Sudetic Trap Basins, and it thus should be ascribed to the pan-regional climatic changes.

The Danish-Polish Trough, in the light of the Author's data which, however, concern the early Late Cretaceous time only, did not behave as constantly subsiding structure throughout its area. The paleotectonic re-arangement of the Miechów Synclinorium, and the facies data from the Lvov region (PASTERNAK & *al.* 1987) seem to indicate that the most of the SE part of the Danish-Polish Trough was markedly influenced by the infra-Late Cretaceous movements, referred to the Subhercynian phase of the Alpine orogeny. During Late Coniacian-Santonian this phase caused an uplift of the area of the present-day Lower San Anticlinorium. Whether it led to an emersion is hardly to judge, though this is postulated by some Ukrainian authors (*see* KOTSYUBINSKY 1987). On the other hand, this confirms an older view of POŻARYSKI (1962, 1964) on the Late Cretaceous evolution of the Danish-Polish Trough, though in contrary to this author the assumed uplift did not reach the area of the present-day Holy Cross Mountains.

RUSSIAN CHALK SEA

This unit streches upon the Precambrian East European Platform, bordering the Danish Polish Trough somewhere in the middle of the present-day Lublin Upland. The deep-seated faults in the basement caused some thickness variations of the sedimentary cover due to different subsidence rates of particular blocks but, in general, the area was relatively stable as concerns the facies and tectonics. The regional differentiation pertains only to a SW-trending thickness increase, following the south-western basement plunging at the platform margin. The stable tectonic conditions and insignificant terrigenic input resulted in development of monotonous facies of the pure chalk, and a fairly complete stratigraphic record.

GENERAL REMARKS

All geotectonic-facies units display the NW-SE trend parallelling the SW border of the East-European Platform, and this is the most clearly visible direction within the Early Late Cretaceous of the studied area. Upon this pattern, however, the perpendicular changes directed toward the Carpathians are superimposed. In the Polish Jura Chain and in the Miechów Synclinorium these are readable in the facies change and the thickness decrease of the studied successions southwardly and in the increased amount of data suggesting more and more energetive environment in the same direction (KUTEK & GŁAZEK 1972, MARCINOWSKI 1974). This southward trend clearly indicates the existence of latidunal, circum Carpathian submarine rise, separating the studied area from the Carpathian Basin to the south (KUTEK & GŁAZEK 1972).

SUMMARIZING CONCLUSIONS

The Turonian through Santonian development of the studied sequence is the common effect of the eustatic sea-level fluctuations and the local paleotectonics confined to the Subhercynian phase of the Alpine movements. The latter is a particularly well readible agent in the Inner Sudetic unit, the Circum-Sudetic Trap Basins, and in the SE part of the Cracow Swell. Certainly the local tectonic activity in these areas could not have remained without response in the adjoning regions as *e.g.* Danish-Polish Trough.

With the end of the Cenomanian, almost the whole area of the extra-Carpathian Poland was invaded by the sea. It was an "end product" of the continuous eustatic transgression which commenced in epicontinental Poland earlier, in the mid-Albian time (SAMSONOWICZ 1925; POŻARYSKI 1962; CIEŚLIŃSKI 1960, 1976; MARCINOWSKI & RADWAŃSKI 1983, 1989).

The Cenomanian/Turonian passage strata are very poorly represented in the studied area, and are furnished with the stratigraphic gaps commonly spanning the topmost Cenomanian and lowermost Turonian. This effectively hinders a recognition of many details of the transgressive-regressive course and the associated phenomena around the boundary.

Within the Early Turonian Mytiloides labiatus Chrone, almost the whole studied area exhibits short-spanned facies unification (*see* Text-figs 31-32). The carbonates, extending almost throughout the whole area of the present-day Central Polish Uplands show no shift of their characteristics in-between distant regions. More prominent sedimentation rate was displayed only in the regions confined to the tectonically active Inner Sudetic unit, i.e. the Circum Sudetic Trap Basins, where the terrigenic influx was higher (*see* Text-fig. 32).

This Early Turonian facies unification was followed quickly by the facies differentation, with the involved pattern clearly confined to particular geotectonic units and being kept till the Late Coniacian (*see* Text-figs 31-32). The limestone facies was restricted to the Cracow Swell area while in adjoining regions the opoka/marly facies stabilizes. The Cracow Swell was an active alimentary area for the outer regions, what is well seen in its border zone with the Danish-Polish Trough (till Late Coniacian this zone laid approximately in the line of the present-day SW margin of the Holy Cross Mountains), supplying a considerable amount of detrital calcareous material (the facies of Resedimented Limestone). In times of markedly lowered sea level, *e.g.* during Late Turonian eustatic fall, the detrital limestones could prograde much further to NE, into the area of Opoka Facies, being accompanied there by the current-winnowed opoka beds (= Platy Chert Beds).

South-west of the Cracow Swell, within the Circum-Sudetic Trap Basins, the Upper Cretaceous succession seems to reflect one transgressive-regressive cycle (ALEXANDROWICZ 1974a). The transgressive peak of the cycle was, however, differently placed in particular basins. It happened in the early-Late Turonian in the Opole region (ALEXANDROWICZ 1974a) but it is dated for the Middle

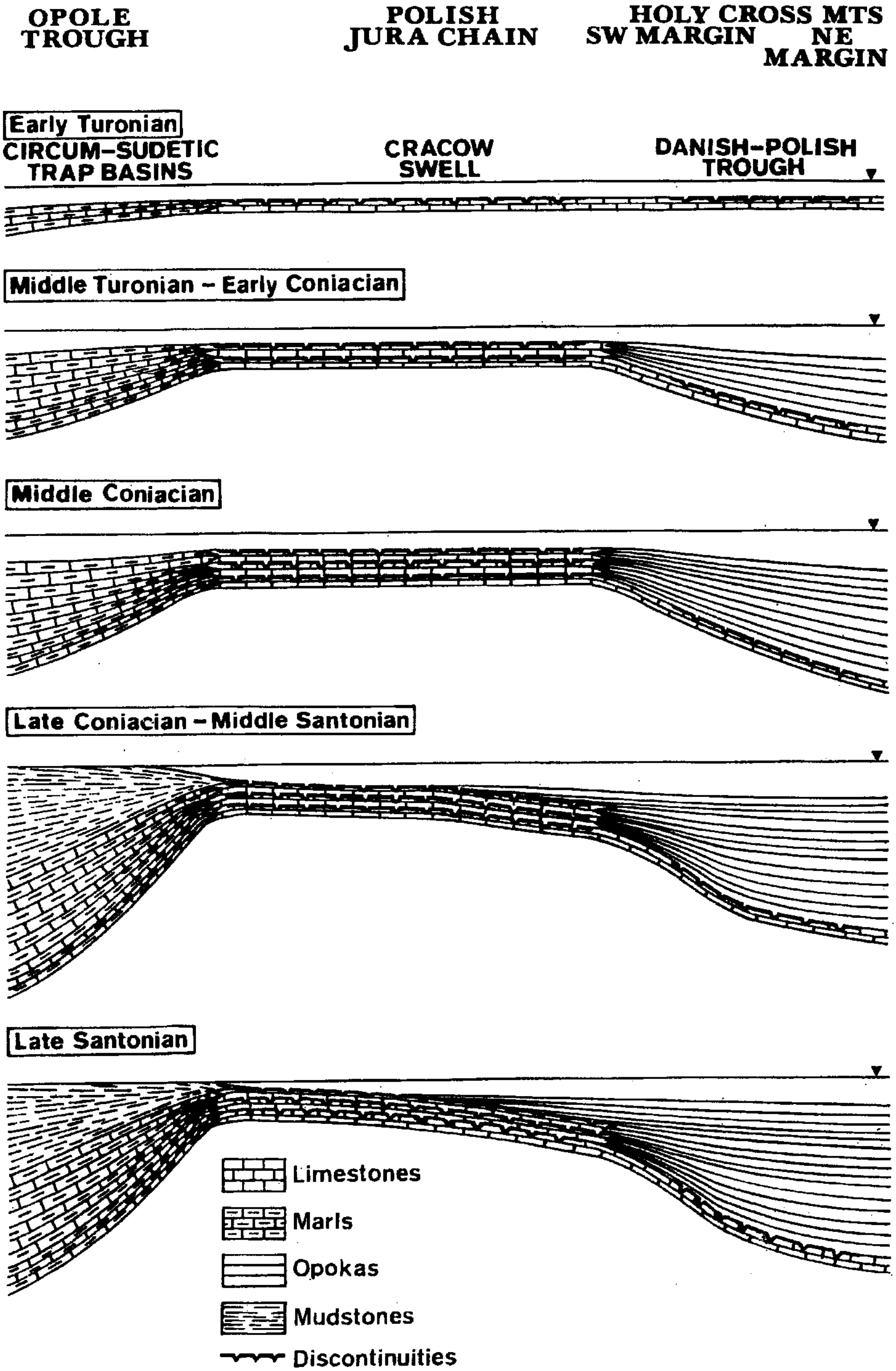


Fig. 32

Facies and geotectonic development of the Central Polish Uplands and the Opole Trough in the Turonian through Santonian time

Coniacian in the Bohemian Basin (VALEČKA 1988 *and* VALEČKA & SKOČEK 1990). These authors placed the transgressive peak at the interval with relatively weakest influence of the alimentary area. However, in areas like this, closely confined to the tectonically active landmass, the amount of terrigenic influx might have resulted also from its changing uplift rate, with no transgressive/regressive background.

The relatively constant subsidence rate during Turonian - Middle Coniacian in the Circum-Sudetic Trap Basins underwent marked acceleration in the Late Coniacian, and particularly during the Early Santonian (*see* Text-fig. 32). It was due to beginning of the final emersion of the Inner Sudetic unit and due to a supply of a large amount of terrigenic material to the surrounding basins. Simultaneously, the Late Coniacian and Early Santonian represent the time of the regional stratigraphic gap allover the Cracow Swell, what is thought to have been an effect of isostatic response of the latter area to the highly increased subsidence in the Circum-Sudetic Trap Basins (*see* Text-fig. 32). Further to north-east, at the same time, in the Late Coniacian, starts also the SW progradation of the increased subsidence of the Danish-Polish Trough (*see* Text-fig. 32), "consuming" at first the NE part of the Cracow Swell (the area of the present-day Miechów Synclinorium), and followed by the south-west expansion of the opoka facies (*see* Text-figs 31-32).

The Subhercynian phase, probably, caused also an uplift of the south-eastern part of the Danish-Polish Trough, approximating the area of the present-day Lower San Anticlinorium ("Kukernitz" island of PASTERNAK & *al.* 1987). This is indicated by the south-western migration of the depocenter in the south-eastern part of the present-day Miechów Synclinorium (*see* HELLER & MORYC 1984), and the facies pattern of the Coniacian and Santonian strata in the Lvov region.

Around the Early/Middle Santonian time the sea retreated from the Inner Sudetic area and also from the Circum Sudetic Trap Basins. The emersion of the latter area had to imply the negative isostatic response within the Cracow Swell, and consequently the cessation of the "swell" conditions and encroachment of the marly/opoka facies in the Late Santonian (*see* Text-figs 31-32).

The recognized tectonic movements of the Subherynian phase have significantly influenced the evolution of the studied area within Turonian through Santonian time, and both sedimentary-body geometry and facies distribution were to a large extent under their control. Only the most prominent of the global eustatic events were capable to leave the univocal signs on the course of evolution of the studied sequence. Among these the eustatic events from around the Cenomanian/Turonian boundary and the early-Late Turonian regressive pulse represent the most effective cases. The former, though possessing important influence on the area, usually yield serious disopportunities for detailed studies due to the presence of stratigraphic gaps in the sequence. More clearly readable is only the record of the early-Late Turonian eustatic fall (*see* HANCOCK 1975, 1989; HANCOCK & KAUFFMAN 1979; HAQ & *al.* 1988).

The presented data show that the evolutionary pattern of the distinguished geotectonic-facies units in the epicontinental areas of Poland was so persistent within Turonian through Santonian time that it may be well compared to that which is commonly known from the coeval oceanic realm of the Tethys provenience.

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APPENDIX

This APPENDIX contains a short characteristics of localities, grouped alphabetically, anyhow existing in this report.

The number of the Text-figure referrs to the locality graphs in the chapter on locality details (for locations see the maps *in* Text-figs 1, 19-20, 25, 28 and 29).

The **locality code**, given in brackets immediately after the locality name, comprises:

(*i*) the number of the studied area, as follows:

1 – North-eastern margin of the Holy Cross Mountains,
2 – South-western margin of the Holy Cross Mountains,
3 – Polish Jura Chain,
4 – Opole and North Sudetic Trough,
5 – Locations outside Poland;

(*ii*) the letteral abbreviation of the locality.

The locality codes are used in numbering the inoceramid specimens, both in the text and captions to Text-figs and Plates, what allow their direct localization. The main references to the localities are given at the end of descriptions.

The numbers are omitted only in a case of discussing specimens borrowed from other institutions, and not catalogued there.

Bocieniec (3.Bo): Abandoned quarries in the southern part of the village, at the eastern side of the main road, where the Cretaceous deposits overlie the Jurassic limestones topped by an abrasion surface (*see* Text-fig. 29; *and* RUTKOWSKI 1965, MARCINOWSKI & SZULCZEWSKI 1972).

Bolko Quarry (4.B): Large, working quarry of the Groszowice Cement Plant, in the southern outskirts of Opole, east of the Oder River (*see* Text-fig. 30; *and* BIERNAT 1960, WALASZCZYK 1988, TARKOWSKI 1991).

Borczyn (2.B): Abandoned rural quarries, north of the village, 3.5 km NW of Kije (*see* MITURA 1954).

Brzeźno (2.Bn): Section completed on the outcrop area close to the western part of the village (*see* Text-fig. 25; *and* SENKOWICZ 1959, HAKENBERG 1969, 1978).

Dębno – Lasocin (1.D): Section in the northern side of the country road Dębno – Lasocin, beginning about 500m NW of Dębno, and continuing up to the top of the hill between the villages (*see* Text-figs 20 and 22).

Dzengutay (5.Dz): Exposures along the Dzengutay River, comprising the whole Upper Cretaceous succession, Dagestan, NE Caucasus.

Folwark Quarry (4.F): Large, working quarry of the Górażdże Cement Plant, SW of Opole, between the villages Folwark and Chrząszczyce, west of the Oder River (*see* Text-fig. 30 and Pl. 44; *and* WALASZCZYK 1988, TARKOWSKI 1991).

Glanów (3.G): Overgrown escarpment of the Dłubnia valley in the westernmost part of the village (*see* Text-fig. 29; *and* locality *108c* of MARCINOWSKI 1974).

Groszowice Quarry (4.Gr): Large, working quarry of the Groszowice Cement Plant in the southern outskirts of Opole (*see* Text-fig. 30; *and* BIERNAT 1960, WALASZCZYK 1988, TARKOWSKI 1991).

Jakubowice – Opoka (1.Ja): Exposures in the Vistula escarpment, between Jakubowice to the north (about 800m north of the bridge over Vistula) and the first houses of the Opoka village to the south (*see* Text-figs 20, 22; *and* POŻARYSKI 1948).

Janików (1.J): Abandoned quarries about 1 km NE of the village, NE of the road Ożarów – Zawichost; type locality of the Janików Limestones (*see* Text-figs 20, 22; *and* ŁUNIEWSKI 1923, SUJKOWSKI 1931, SAMSONOWICZ 1934, POŻARYSKI 1948, ALEXANDROWICZ 1978).

Januszowice (3.Ja): Abandoned quarry in the southern part of the village, at the eastern side of the road Kraków – Skała (*see* Pl. 45; *and* BUKOWY 1956, Text-fig. 8).

Jedlanka Nowa (1.JN): Borehole in the NE margin of the Holy Cross Mountains, about 25 km SE of Radom (*see* CIEŚLIŃSKI 1959a).

Karsy-1 (1.K1): Abandoned quarry, about 500m west of the road Ożarów – Tarłów, and about 250m north of the main road in the village (*see* Text-figs 20-21; Pl. 47, Fig. 1; *and* POŻARYSKI 1948).

Karsy-2 (1.K2): Abandoned rural quarry, about 200m west of Karsy-1 (*see* Text-figs 20-21).

Karsy-3 (1.K3): Rural quarry, 50m SE of Karsy-2 (*see* Text-figs 20-21).

Karsy-4 (1.K4): Abandoned rural quarry, about 800m north of Karsy-1, with a thick, tabular flint bed (*see* Text-fig. 21).

Karsy-5 (1.K5): Abandoned rural quarry at the main road in the village, about 500m west of the road Ożarów – Tarłów (*see* Text-figs 20-21).

Kije-1 (2.Ki1): Section along the "Staszów" railway, south of Kije, between Stawiany to SE and the road Kije – Pińczów; at the moment, the best exposure of the Santonian deposits in the whole SW margin of the Holy Cross Mountains (*see* Text-fig. 25).

Kije-2 (2.Ki2): Railroad-cut along the Kielce – Busko line, northwest of Kije, starting at the NW part of the town and continuing about 1 km to NW (*see* Text-fig. 25).

Kolonka-1 (1.Kl1): Abandoned rural quarry in the southern wall of the southern arm of the ravine reaching the Vistula River in the Nowe village, about 100m east of the western tip of that arm (*see* Text-fig. 20).

Kolonka-2 (1.Kl2): Abandoned rural quarry in the same wall of the ravine as Kolonka-1, but about 250m east of the latter (*see* Text-fig. 20).

Korzkiew (3.KO): Abandoned rural quarry (*"U Krzywdy"*), north of the road leading to the ruins of the castle (*see* KUDREWICZ 1992).

Kostomlaty (5.K): Large, working quarry near the village, about 50 km NNW of Prague, Czecho-Slovakia.

Kozia Góra (German *Ziegenberge*)(4.KG): Abandoned, large quarry at the southern side of the Kozia hill, in the village Wilków, 4 km SE of Złotoryja, North Sudetic Trough; the locality (*see* SCUPIN 1912-13) from where the most of SEITZ' (1934) collection was coming from.

Krasocin (2.Kr): Section completed on the outcrop area between Krasocin and Gruszczyn (*see* Text-figs 25, 28; *and* POŻARYSKI 1966, HAKENBERG 1978).

Langenstein (5.L): Section along the road, SE of the town, Subhercynian Basin, Germany (*see* TRÖGER 1968).

Lasek (1.L): Rural quarry, about 500m SE of the southern part of the village Świeciechów (*see* Text-fig. 20).

Lasocin (1.La): Abandoned, and overgrown to large extent, quarry at the eastern, steep side of the valley, south of Lasocin, about 1.3 km south of the center of the village (*see* Text-fig. 20).

Ligota (2.Li): Test-pit in the village, about 90 km NW of Przedbórz; SW margin of the Łódź Synclinorium (*see* KOWALSKI 1956, CIEŚLIŃSKI 1958).

Lockwitz (5.Lo): Working quarry in the town, south of Dresden, Saxony, Germany.

Ludynia (2.Lu): Environs of the village, without detailed location; SE margin of the Holy Cross Mountains, NE of Włoszczowa (*see* Text-fig. 25).

Maksymów (1.M): Abandoned rural quarry, about 500m south of the village in the eastern side of the road descending to the ravine leading to the village Nowe (*see* Text-fig. 20).

Miąsowa (2.M): Environs of the village, without detailed location (*see* Text-figs 25, 28; *and* SENKOWICZ 1959).

Mieczysławów (1.Me): Abandoned rural quarry about 1 km west of the village Maksymów (*see* Text-fig. 20).

Nowe (1.N): Abandoned quarry in the Vistula escarpment close to the southern margin of the village; the observable succession topped by the Upper Platy Cherts (*see* Text-figs 20 and 22).

Odra Quarry (4.On): Large, working, new quarry of the Cement Plant "Odra", in the northern side of the town Opole (*see* Text-fig. 30; *and* WALASZCZYK 1988, TARKOWSKI 1991).

Opoka (1.O): Large, abandoned quarry in the NW part of the village (*see* Text-fig. 20).

Ossowa (2.Os): Environs of the village, without detailed location; SW margin of the Holy Cross Mountains, 1 km SE of Miąsowa.

Ożarów (1.Oz): Section along the access road to the quarry of the "Ożarów" Cement Plant, 3 km north of the town, at the western side of the road Ożarów — Tarłów (*see* Text-figs 20-21; *and* Pl. 47, Fig. 2).

Pętkowice (1.P): Abandoned rural quarry at the northern side of the Kamienna valley, close to the western part of the village (*see* Text-fig. 20).

Piotrowice (1.Po): Quarries and exposures in the Vistula valley escarpment in the village, starting about 200m south of the main cross-road in the village (in the topmost part of the lower flinty opokas) and continuing about 1 km to the north (*see* Text-figs 20, 22; *and* POŻARYSKI 1948).

Płusy (1.Ps): Borehole in the NE margin of the Holy Corss Mountains, about 35 km SE of Radom.

Pniaki (3.Pn): Poorly exposed section in the eastern side of the village, about 2 km SE of Lelów (*see* Text-fig. 29; *and* locality *121* of MARCINOWSKI 1974; *see also* RÓŻYCKI 1938, MARCINOWSKI & SZULCZEWSKI 1972).

Poręba Dzierżna (3.PD): Section in the cutting of the main road in the southern part of the village, overgrown (locality *110* of MARCINOWSKI 1974).

Przedbórz (2.B): Outcrop area in the fields around the road Przedbórz—Korytno, about 1 km SE of the latter (*see* Text-figs 25, 28; *and* CIEŚLIŃSKI 1956).

Przychody (3.Pd): Exposure in the village path in the western face of the cuesta 2 km south of Siadcza, near Solca (locality *115* of MARCINOWSKI 1974).

Skotniki (2.Sk): Large, working quarry, 6 km SE of Busko-Spa, at the eastern margin of the village Skotniki-Duże (*see* Text-figs 25-27).

Skrajniwa (3.Sj): Exposure in the western face of the cuesta in the southernmost part of the village, 6 km NW of Lelów (*see* Text-fig. 29; *and* locality *122* of MARCINOWSKI 1974; *see also* RÓŻYCKI 1938, MARCINOWSKI & SZULCZEWSKI 1972).

Słupia Nadbrzeżna-1, -2, -4, -5 (1.SN1, 1.SN2, 1.SN4, 1.SN5): four, shallow (to about 40m) boreholes, about 1 km west of the village (*see* Text-fig. 23).

Słupia Nadbrzeżna-3 (1.SN3): Rural quarry in the northern side of the ravine, reaching the Vistula valley at Słupia Nadbrzeżna, about 1 km west of the mouth of the ravine (*see* Text-fig. 23; *and* POŻARYSKI 1938, 1948).

Słupia Nadbrzeżna — Wesołówka (1.SN): Section along the Vistula valley escarpment between Słupia Nadbrzeżna and Wesołówka (*see* Text-figs 20, 23; *and* POŻARYSKI 1938, 1948).

Staniewice (2.St): Section completed in the outcrop area on the hills south of the village, and continuing SE to the village Korytnica; SW margin of the Holy Cross Mountains, about 6 km SE of Brzeźno (*see* Text-fig. 25; *and* MITURA 1954).

Stefanów (1.St): Borehole in the NE margin of the Holy Cross Mountains, about 30 km NE of Radom (*see* WITWICKA & CIEŚLIŃSKI 1962)

Szczepanów (2.Sz): Environs of the village, without detailed location; SW margin of the Holy Cross Mountains, 2 km NW of Miąsowa.

Ulina Wielka (3.UW): Large, working quarry in the southern part of the village, exploiting Jurassic limestones with the overlying Cretaceous deposits (*see* MARCINOWSKI 1974 for description of the area).

Wesołówka — Sulejów (1.WS): Section along the Vistula valley escarpment between the southern tips of the Wesołówka village north to the Sulejów village (*see* Text-figs 20, 24; *and* POŻARYSKI 1938, 1948; BŁASZKIEWICZ 1962, KURLENDA 1967).

Wielkanoc (3.W): Large, working quarry in the SW part of the village (*see* Text-fig. 29; *and* locality *123* of MARCINOWSKI 1974).

Zalesice (3.Za): Section in the southern side of the railroad-cut of the Kielce—Częstochowa line, in the village (*see* Text-fig. 29; *and* locality *74* of MARCINOWSKI 1970, 1974; *see also* RÓŻYCKI 1937, MARCINOWSKI & SZULCZEWSKI 1972).

Zychówki (1.Z): Temporary excavation in the eastern part of the village, about 1 km east of Świeciechów; NE margin of the Holy Cross Mountains.

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I. WALASZCZYK

STRATYGRAFIA INOCERAMOWA I ROZWÓJ FACJALNY UTWORÓW TURONU, KONIAKU I SANTONU WYŻYN POLSKI ŚRODKOWEJ

(Streszczenie)

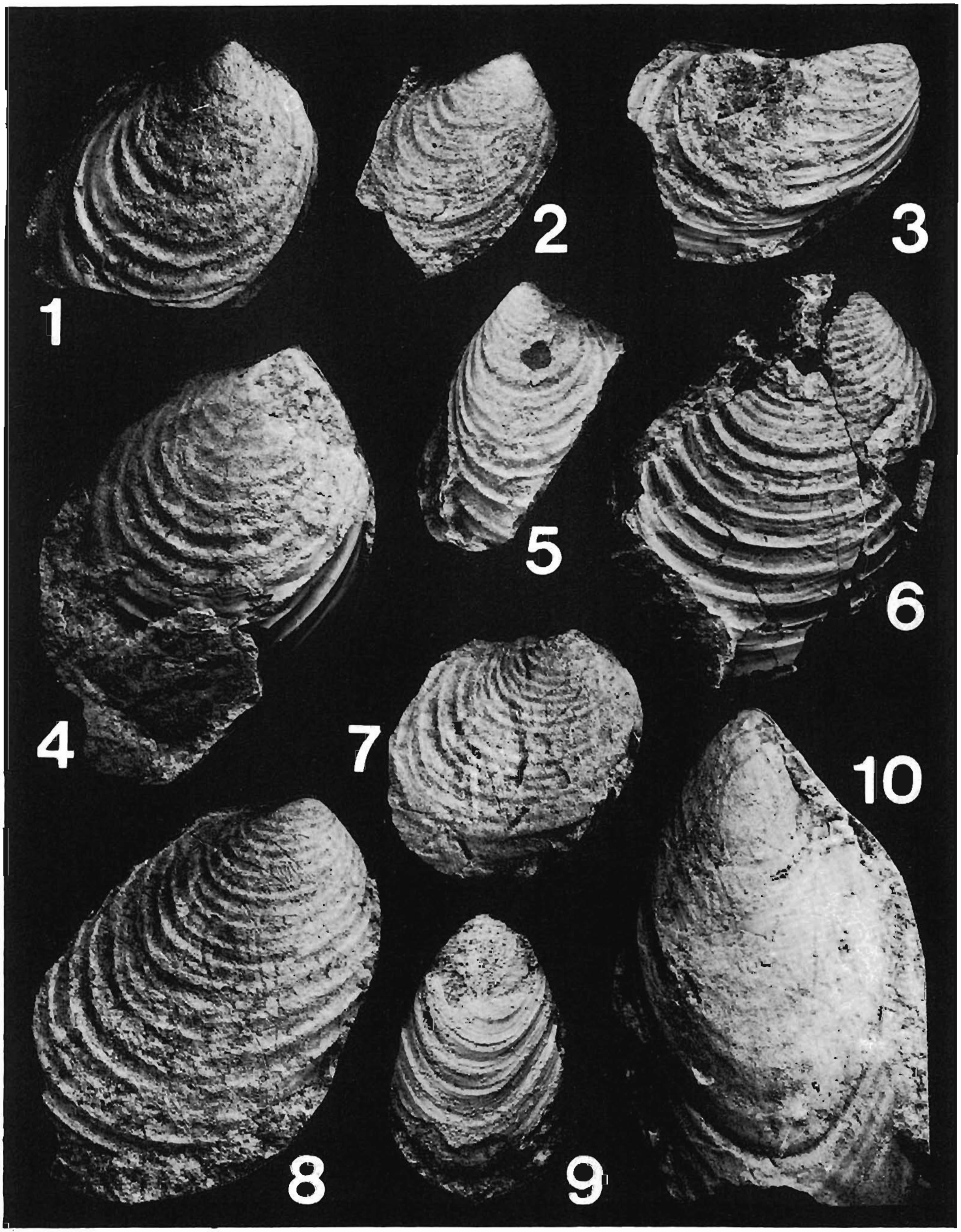
Przedmiotem pracy jest stratygrafia inoceramowa i rozwój facjalny utworów turonu, koniaku i santonu oraz ewolucja we wczesnej późnej kredzie obszaru dzisiejszych Wyżyn Polski Środkowej (*patrz* fig. 1).

Analiza biostratygraficzna tych utworów poprzedzona została monograficznym opracowaniem fauny inoceramowej, obejmującym 40 gatunków (*patrz* fig. 2-18, tab. 1-16 oraz pl. 1-42), w tym dwu nowych: *Mytiloides turonicus* sp. n. oraz *Inoceramus vistulensis* sp. n. Szczególną uwagę zwrócono na wczesnoturońską grupę *Mytiloides labiatus* (Schlotheim) oraz dolno- i środkowokoniackie formy z rodzaju *Cremnoceramus* Cox, 1969 (*non* Heinz 1932). Obie grupy reprezentują szeroko rozpowszechnione inoceramy, których interpretacja taksonomiczna, mająca istotny wpływ na ich aplikację stratygraficzną była dotychczas przedmiotem bardzo rozbieżnych opinii.

Rozprzestrzenienie stratygraficzne poszczególnych gatunków stwierdzone na badanym obszarze (*patrz* tab. 17) odpowiada następstwu faun inoceramowych w całym obszarze ich występowania. Pozwoliło to na rozpoznanie 17 poziomów inoceramowych, w większości tradycyjnie wyróżnianych w kredzie Europy, jak również skorelowanie zastosowanego podziału ze standardowym podziałem amonitowym niższej górnej kredy (*patrz* tab. 18). Poza dwoma przypadkami (środkowy/górny santon, oraz santon/kampan) wszystkie granice pięter i podpięter w rozważanym przedziale stratygraficznym są dobrze rozpoznawalne na podstawie fauny inoceramowej (*patrz* tab. 18).

Analiza rozprzestrzenienia inoceramów w badanym obszarze pozwoliła na skorygowanie pozycji stratygraficznej utworów turonu, koniaku i santonu Wyżyn Polski Środkowej (*patrz* fig. 19-29) oraz okolic Opola (*patrz* fig. 30). Stan rozpoznania następstwa faun inoceramowych pozwolił na podział biostratygraficzny badanych utworów znacznie bardziej szczegółowy niż dotychczas stosowany (*patrz* Cieśliński & Pożaryski 1970; Marcinowski 1974, 1975; Cieśliński & Jaskowiak 1976; Cieśliński & Błaszkiewicz 1989).

Czasowo-przestrzenne rozmieszczenie wyróżnionych facji (*patrz* fig. 31 oraz pl. 43-48), a także ich analiza miąższościowa i środowiskowa wskazuje na istnienie szeregu odrębnych regionów paleotektoniczno-facjalnych. Ich turońsko-koniacki plan, powstały zapewne jeszcze w cenomanie, z końcem koniaku i w santonie ulega powolnej przebudowie. Początkowo (najwyższy koniak niższy santon) znacznie wzrasta tempo sedymentacji i subsydencji na obszarze basenów wokółsudeckich, które następnie, w środkowym santonie ulegają wypiętrzeniu, stając się lądem (*patrz* fig. 32). Izostatyczną odpowiedzią na to wydarzenie było pogrążanie się obszaru progu krakowskiego (*patrz* fig. 32), zanik dominującej tu facji wapieni biogenicznych i wkroczenie "senońskiej" facji opok i margli (*patrz* fig. 32). Santońska przebudowa południowo-zachodniej części badanego obszaru była wynikiem ruchów fazy subhercyńskiej orogenezy alpejskiej. Efektem tych ruchów było najprawdopodobniej również wydźwignięcie (?emersja) południowo-wschodniej części bruzdy duńsko-polskiej, tzn. obszaru odpowiadającego dzisiejszemu antyklinorium dolnego Sanu. Ruchy te nie objęły natomiast części bruzdy leżącej dalej ku północnemu-zachodowi, tj. obszaru dzisiejszych Gór Świętokrzyskich (*patrz* Kutek & Głazek 1972). Pan-regionalne trendy batymetryczne w przedziale turon – santon, poza nielicznymi (zdarzenia eustatyczne z pogranicza cenomanu i turonu, oraz późnoturońska regresja), sa bardzo trudno identyfikowalne w badanych sekwencjach. W dużej mierze może to być wynikiem zatarcia zapisu tych zmian w wyniku ruchów związanych z fazą subhercyńską, które stanowiły w tym czasie niewątpliwie główny element kontrolujący ewolucję całego obszaru dzisiejszych Wyżyn Polski Środkowej.

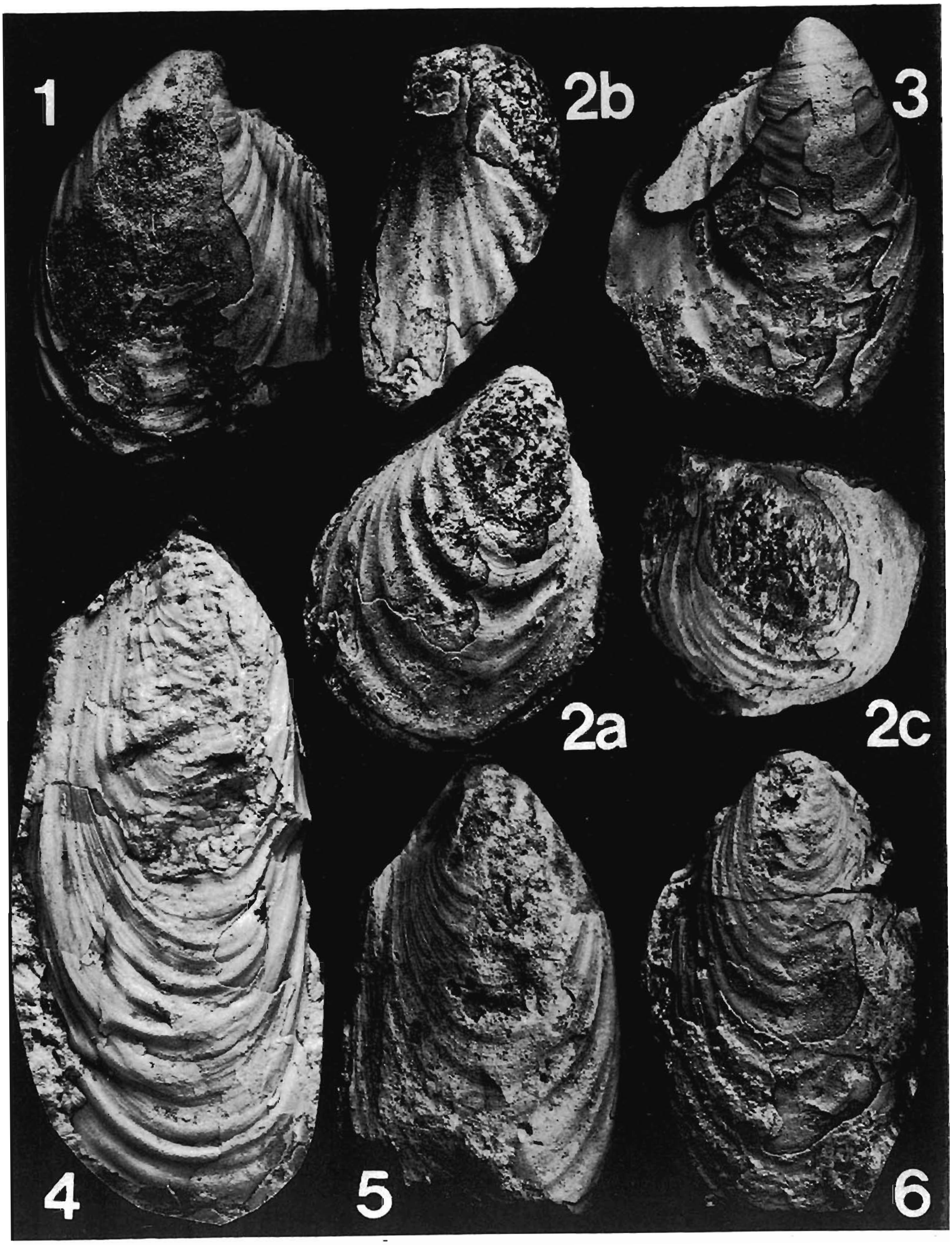


1-9 — *Mytiloides kossmati* (HEINZ); 1-8 — M. labiatus Zone, Lockwitz, Germany; 9 — Ożarów, M. labiatus Zone

1 — Specimen No. 5.Lc.O.6, RV; 2 — No. 5.Lc.O.8, RV; 3 — No. 5.Lc.O.7, RV; 4 — No. 5.Lc.O.5, RV; 5 — No. 5.Lc.O.9, LV; 6 — No. 5.Lc.O.3, RV; 7 — No. 5.Lc.O.2, RV; 8 — No. 5.Lc.O.1, RV; 9 — No. 1.Oz.1.1, LV

10 — *Mytiloides labiatus* (SCHLOTHEIM); Specimen No. 5.Lc.O.19, LV, M. labiatus Zone, Lockwitz, Germany

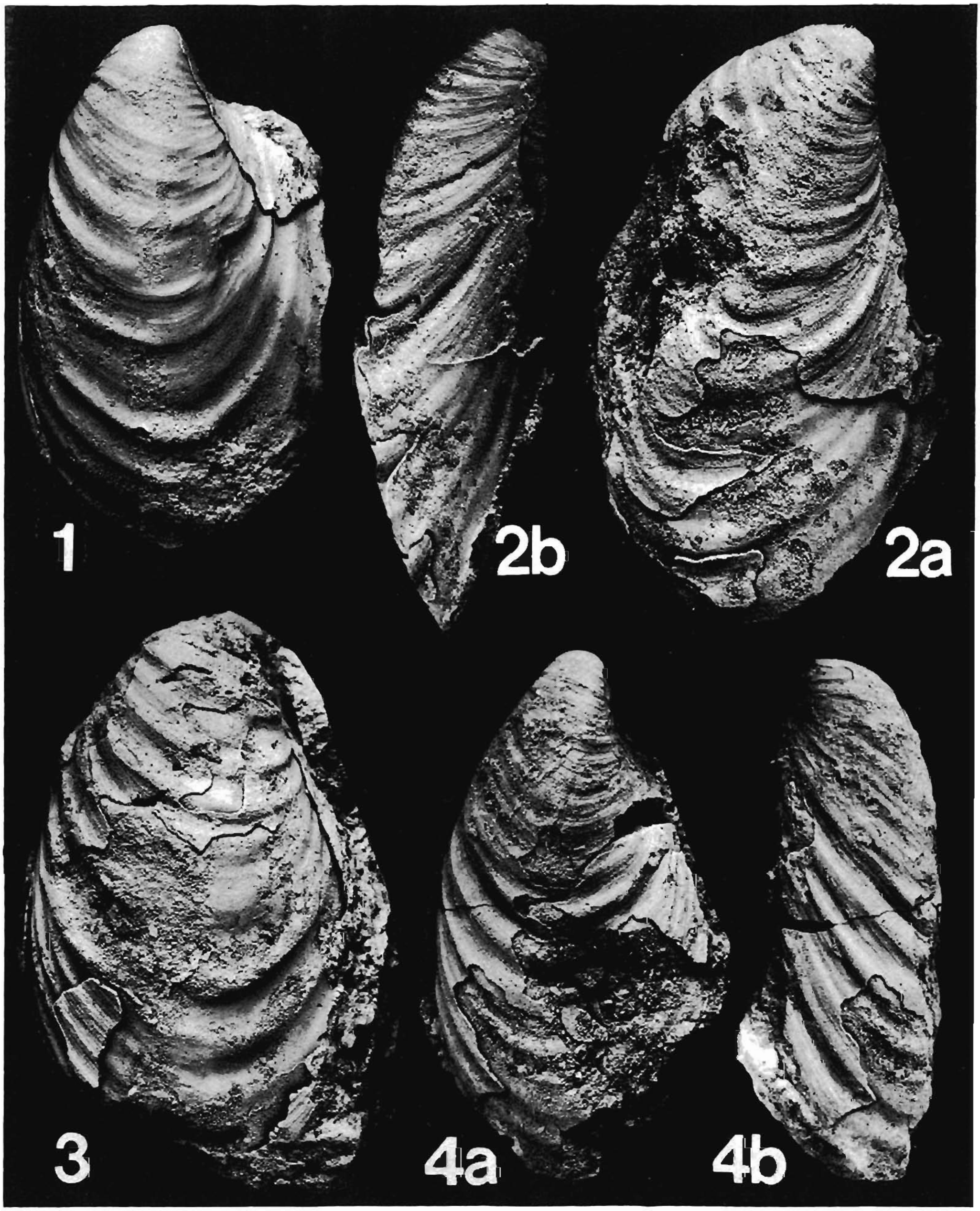
All figures in natural size



Mytiloides labiatus (SCHLOTHEIM); M. labiatus Zone; 1 — Poręba Dzierżna, 2-3, 5-6 — Zalesice, 4 — Przedbórz

1 — Specimen No. GS: 1401.II.328, LV; 2 — No. GS: 1401.II.481, LV, 2a lateral, 2b anterior, 2c dorsal view; 3 — No. GS: 1401.II.482, RV; 4 — No. 2.P.1.1, RV; 5 — No. GS: 1401.II.484, RV; 6 — No. GS: 66/3, LV

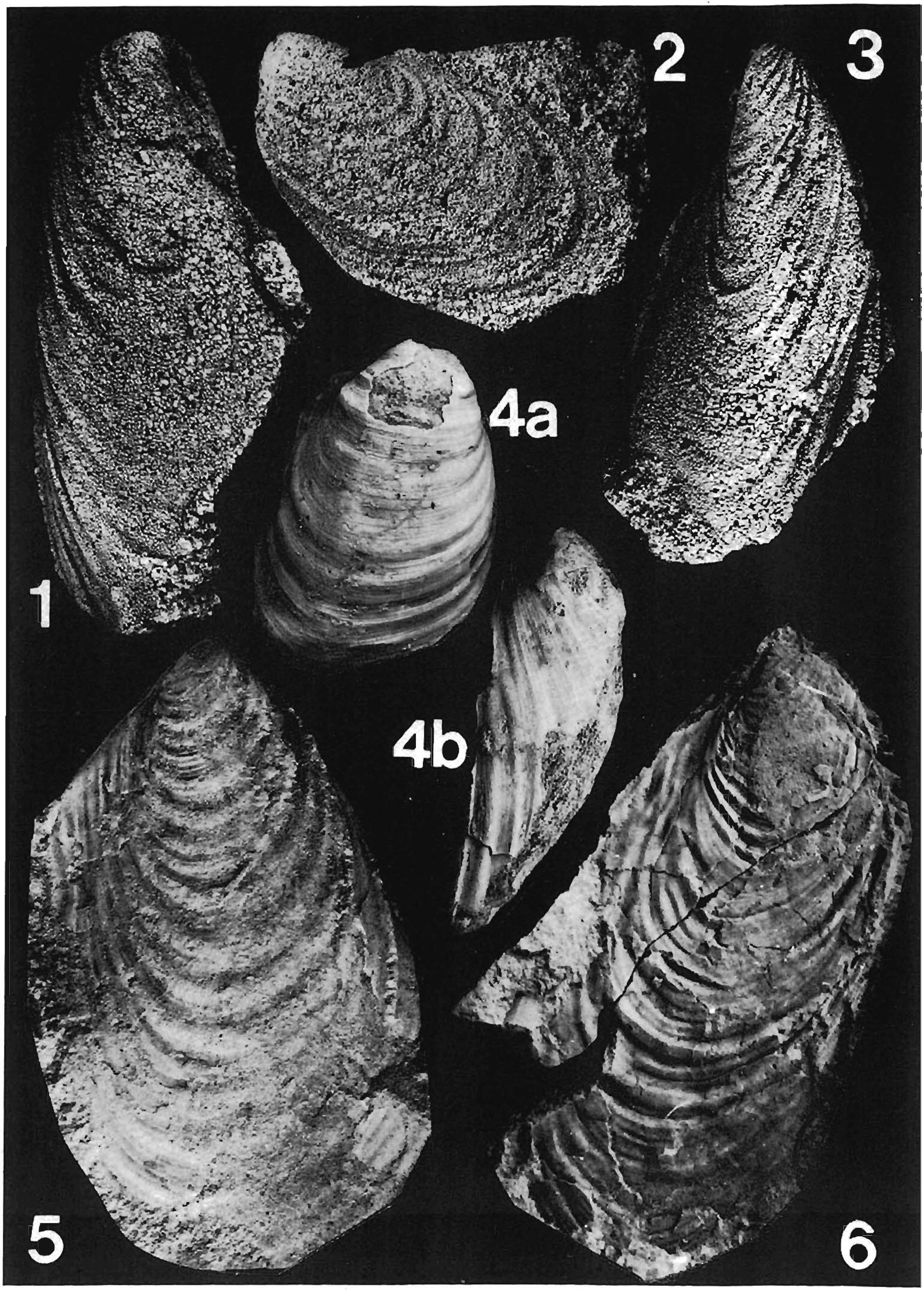
All figures in natural size



Mytiloides labiatus (SCHLOTHEIM); M. labiatus Zone, Zalesice

1 – Specimen No. GS: 1401.II.376, LV; 2 – No. GS: 1401.II.494, LV, 2a lateral, 2b posterior view; 3 – No. GS: 1401.II.487, LV; 4 – No. GS: 1401.II.491, LV, 4a lateral, 4b anterior view

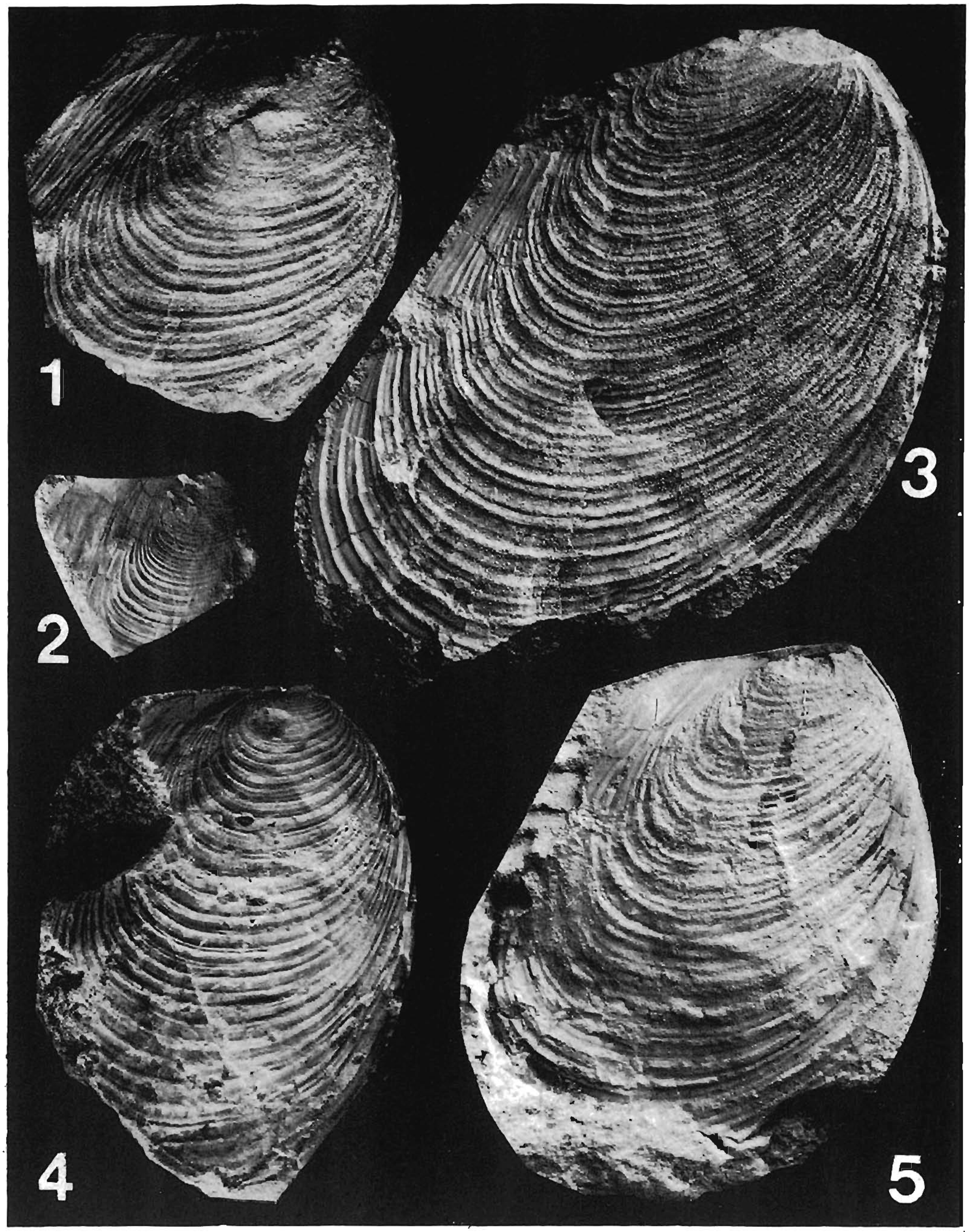
All figures in natural size



Mytiloides labiatus (SCHLOTHEIM)

1 — Specimen No. 4.KG.O.1, LV; **2** — No. 4.KG.O.10, LV; **3** — No. 4.KG.O.2, RV, M. labiatus Zone, Kozia Góra near Wilków (German *Ziegenberge bei Wolfsdorf*); **4** — No. 3.G.3.1, RV, 4a lateral, 4b posterior view, M. labiatus Zone, Glanów; **5** — No. 1.K3.O.12, RV, M. hercynicus Zone, Karsy-3; **6** — No. 1.Oz.4.1, RV, M. labiatus Zone, Ożarów

All figures in natural size



Mytiloides hercynicus (PETRASCHECK); 1 – Karsy-1, 2-5 – Ożarów, M. hercynicus Zone (*M. hercynicus* Event)

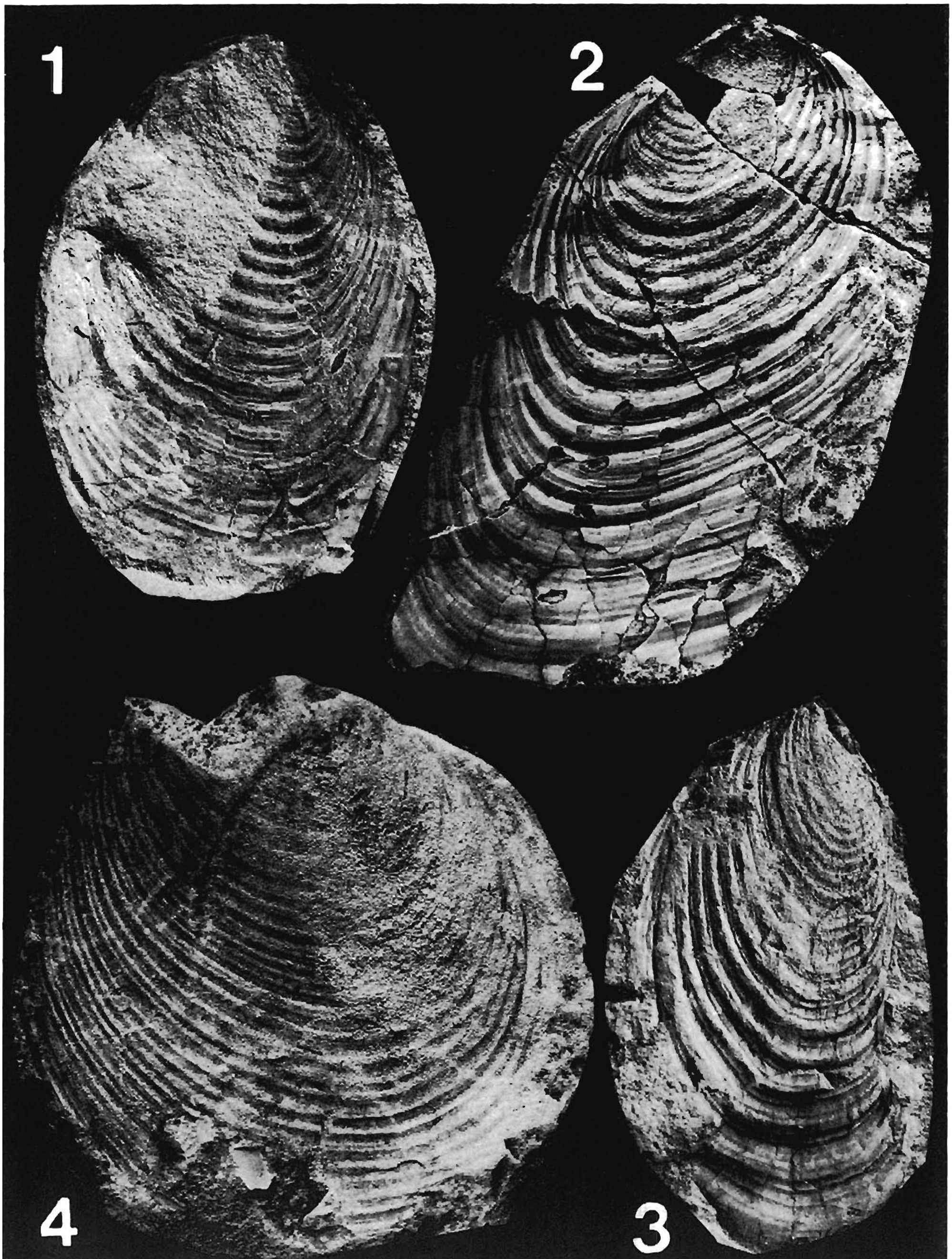
1 – Specimen No. I.K1.1.1, RV; **2** – No. I.Oz.7.4, RV; **3** – No. I.Oz.7.7, RV; **4** – No. I.Oz.O.1, RV; **5** – No. I.Oz.7.1, RV

Figs 3-4 taken × 0.6; the others in natural size

Mytiloides opalensis (BÖSE); I. apicalis Zone

1 — Specimen No. 1.K3.O.19, RV, Karsy-3; **2** — No. 1.K2.O.5, RV, Karsy-2; **3** — No. 1.K1.O.1, LV, Karsy-1; **4** — No. 1.K2.O.2, RV, Karsy-2

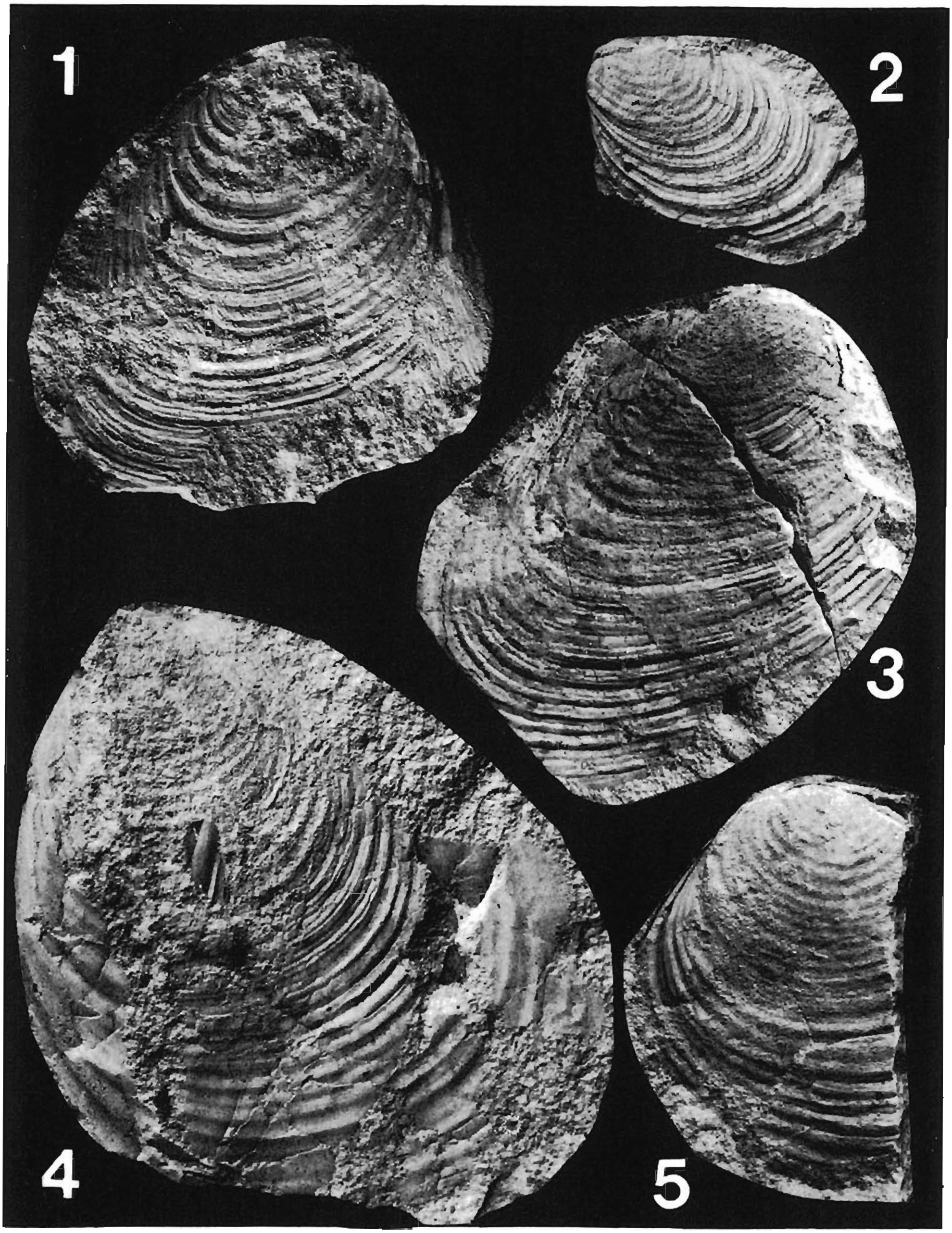
All figures in natural size



1-3 — *Mytiloides opalensis* (BÖSE); I. apicalis Zone; 1 — Specimen No. 1.K2.O.3, LV, Karsy-2; 2 — No. 1.K3.O.28, external mould of LV, Karsy-3; 3 — No. 1.K2.O.8, LV, Karsy-2

4 — *Mytiloides* sp.; Specimen No. 1.Oz.7.5, LV, ?M. hercynicus Zone, Ożarów

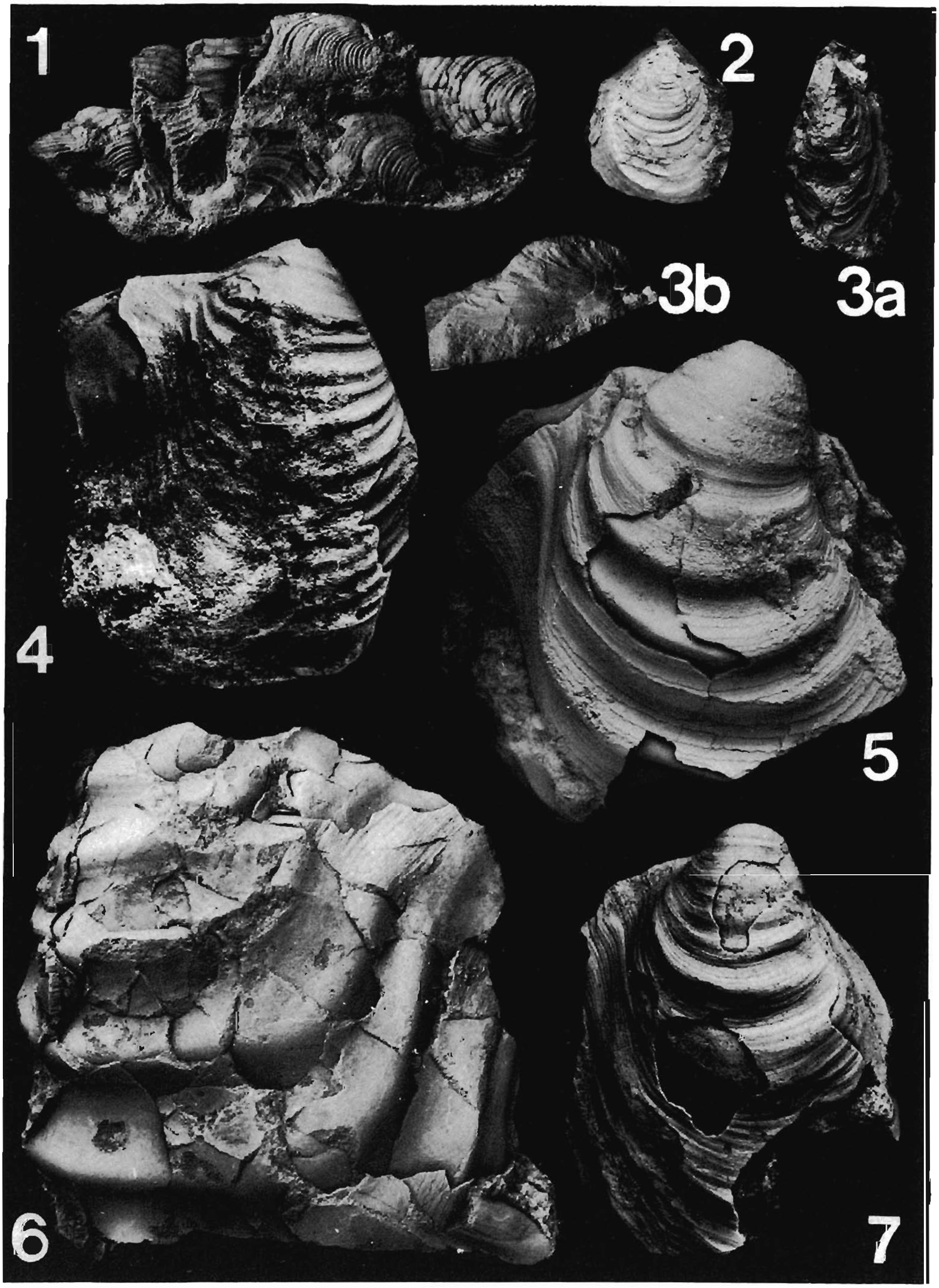
Fig. 1 taken × 0.8; the others in natural size



Mytiloides opalensis (BÖSE); I. apicalis Zone; 1-2 — Karsy-2, 3-5 — Karsy-3

1 — Specimen No. I.K2.O.4, RV; **2** — No. I.K2.O.7, LV; **3** — No. I.K3.O.14, RV; **4** — No. I.K3.O.22, LV; **5** — No. I.K3.O.16, LV

Fig. 1 taken × 0.8; the others in natural size



1-3 — *Inoceramus apicalis* WOODS; I. apicalis Zone; 1 — Specimen No. 1.K1.O.10, Karsy-1; 2 — No. 4.On.1.1, RV, Odra Quarry; 3 — No. 1.K3.O.2, LV, 3a lateral, 3b posterior view, Karsy-3

4 — *Inoceramus lamarcki lamarcki* PARKINSON; Double-valved specimen No. ME: ML 1105, RV (LV *see* Pl. 10, Fig. 3), I. lamarcki Zone, Wielkanoc

5 — *Inoceramus lamarcki lamarcki* PARKINSON/*geinitzi* HEINZ, passage form; Specimen No. 2.St.O.1, RV; I. lamarcki/?I. costellatus Zone, Staniewice

6 — *Inoceramus lamarcki stuemckei* HEINZ; Specimen No. 2.St.O.2, LV, I. lamarcki/?I. costellatus Zone, Staniewice

7 — *Inoceramus lamarcki* PARKINSON, RV (Geological Survey Museum; not catalogued specimen), I. lamarcki Zone, Ligota

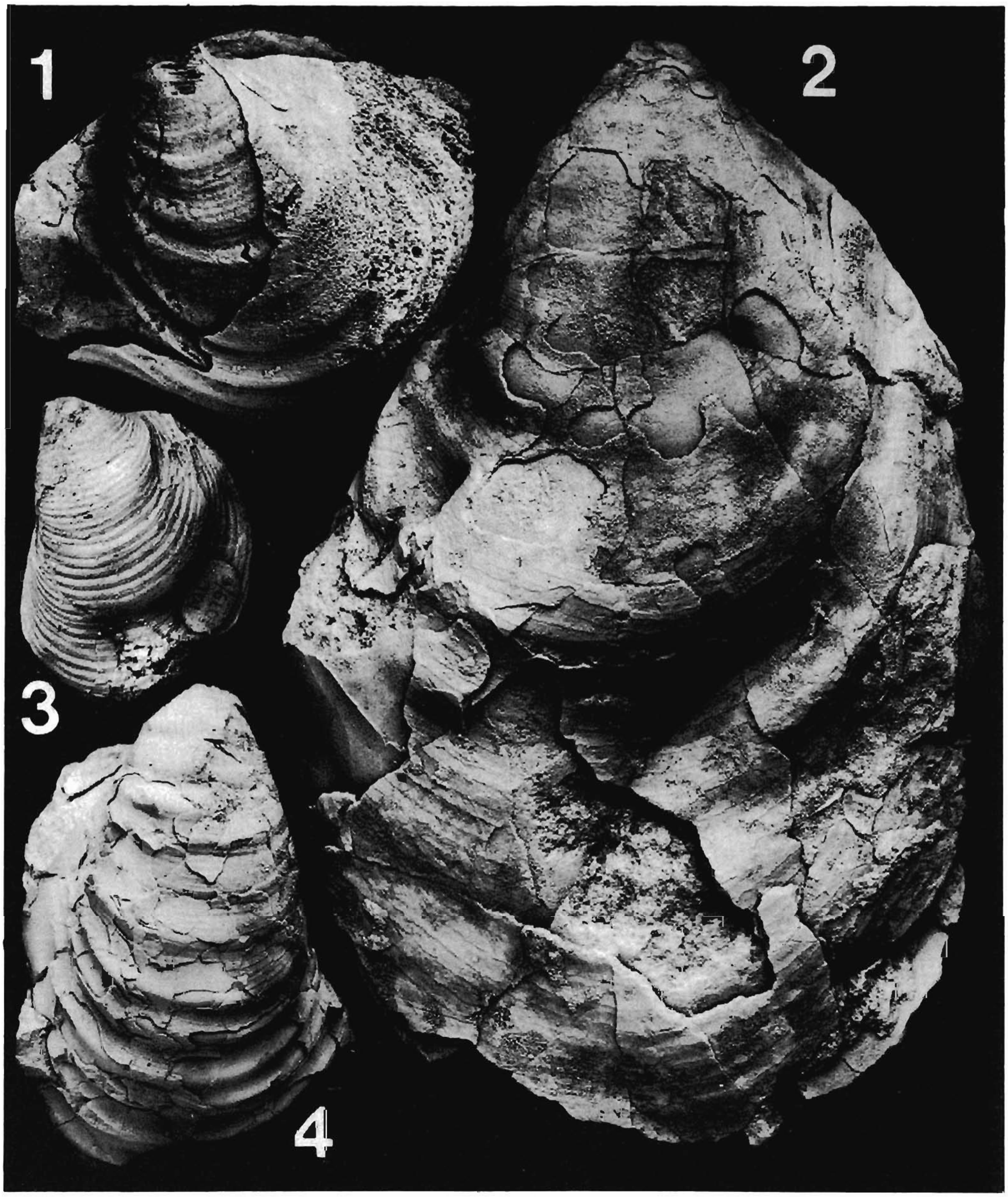
Fig. 6 taken × 0.5; the others in natural size

1 — *Inoceramus lamarcki* PARKINSON; Specimen No. ME: ML 1098, RV, 2a lateral, 2b posterior view (*see* Pl. 11, Fig. 1 for dorsal view), Inoceramus lamarcki Zone, Wielkanoc

2 — *Inoceramus lamarcki ?geinitzi* HEINZ; Specimen No. 4.On.2.2, RV, I. lamarcki Zone, Odra Quarry

3 — *Inoceramus lamarcki lamarcki* PARKINSON; Double-valved specimen No. ME: ML 1105 LV (RV *see* Pl. 9, Fig. 4), I. lamarcki Zone, Wielkanoc

All figures in natural size



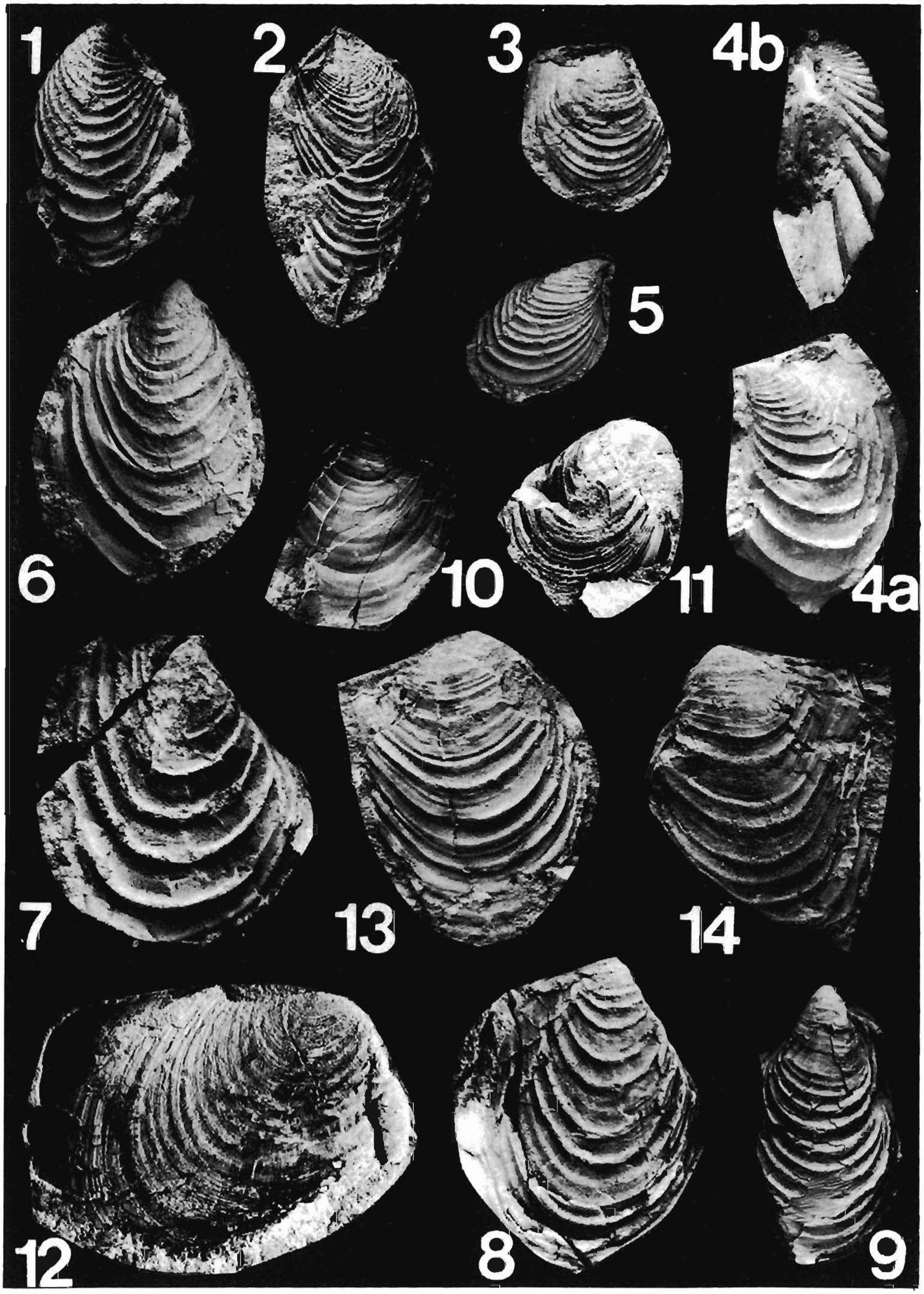
1 — *Inoceramus lamarcki* PARKINSON; Specimen No. ME: ML 1098, RV, dorsal view (*see* Pl. 10, Fig. 1 for other views), I. lamarcki Zone, Wielkanoc

2 — *Inoceramus cuvieri* SOWERBY; Specimen No. 2.St.O.3, LV, I. lamarcki/?I. costellatus Zone, Staniewice

3 — *Inoceramus cuvieri* SOWERBY; Specimen No. ME: ML 1079/6, LV, I. lamarcki Zone, Wielkanoc

4 — *Inoceramus lamarcki lamarcki* PARKINSON; Specimen No. 5.L.O.1, RV, I. lamarcki Zone, Langenstein, Subhercynian Basin, Germany

All figures in natural size



1-2 — *Mytiloides labiatoidiformis* (TRÖGER); 1 — Specimen No. 4.F.1.1, LV; 2 — No. 4.F.1.2, RV; M. incertus Zone, Folwark Quarry

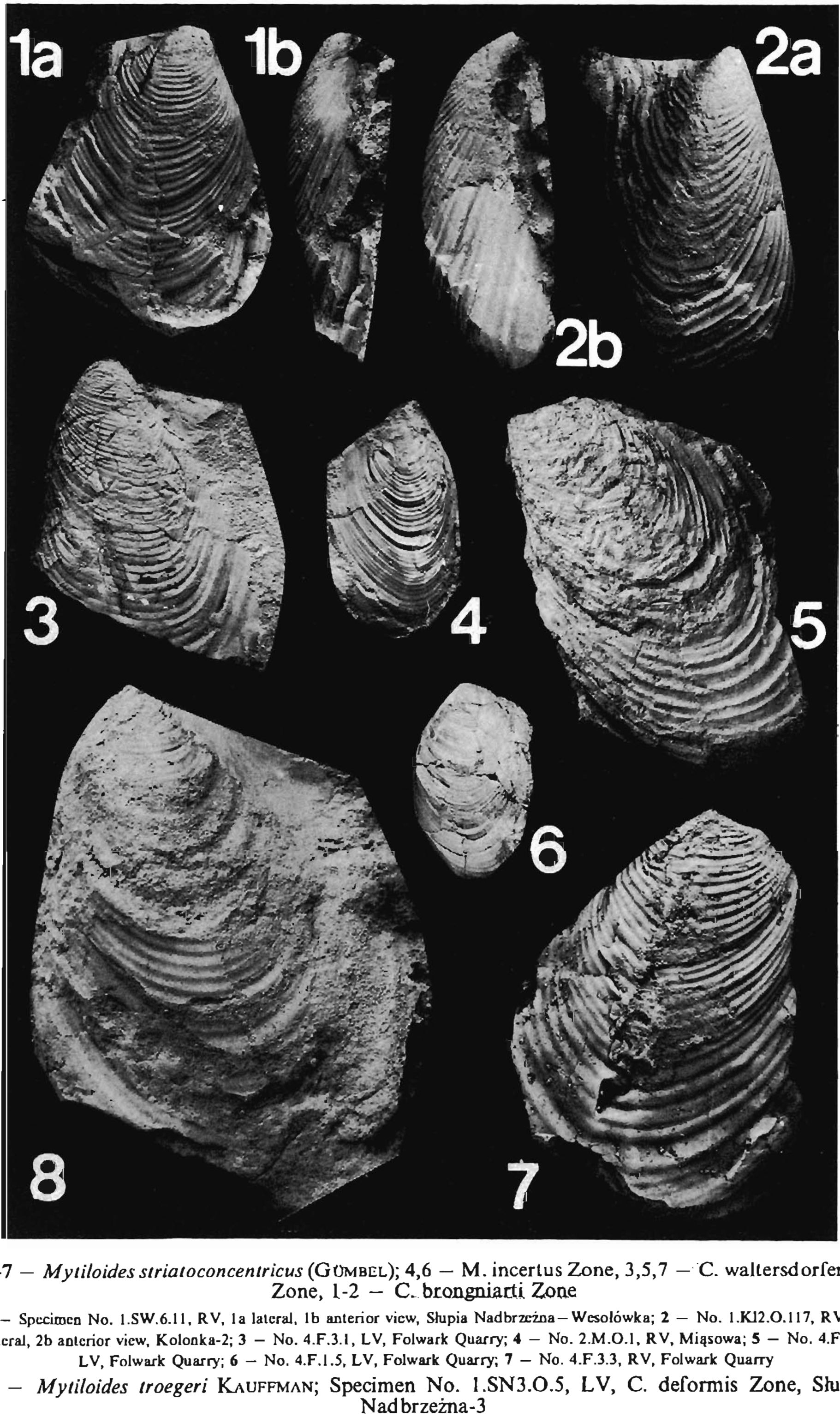
3-9 — *Inoceramus costellatus* WOODS; 3 — Specimen No. 1.D.O.1, RV; 4 — No. 1.D.O.2, LV, 4a lateral, 4b anterior view; 5 — No. 4.On.7.10, RV, I. costellatus Zone, Odra Quarry; 6 — No. 1.D.O.3, RV; I. costellatus Zone, Dębno—Lasocin; 7 — No. GS: 1401.II.129, RV; 8 — No. GS: 1401.II.96, RV; 9 — No. GS: 1401.II.475, LV; I. costellatus Zone, Brzeźno

10 — *Inoceramus* sp.; Specimen No. 1.N.O.1, LV, M. incertus Zone, Nowe

11-12 — *Mytiloides incertus* (JIMBO); 11 — Specimen No. 4.F.1.3, RV; 12 — No. 4.F.1.4, external mould, LV; M. incertus Zone, Folwark Quarry

13-14 — *Inoceramus* sp. aff. *M. labiatoidiformis* (TRÖGER) *sensu* KELLER, 1982; 13 — Specimen No. 1.SW.1.1, RV; 14 — No. 1.SW.1.2, LV; M. incertus Zone, Słupia Nadbrzeżna—Wesołówka

All figures in natural size

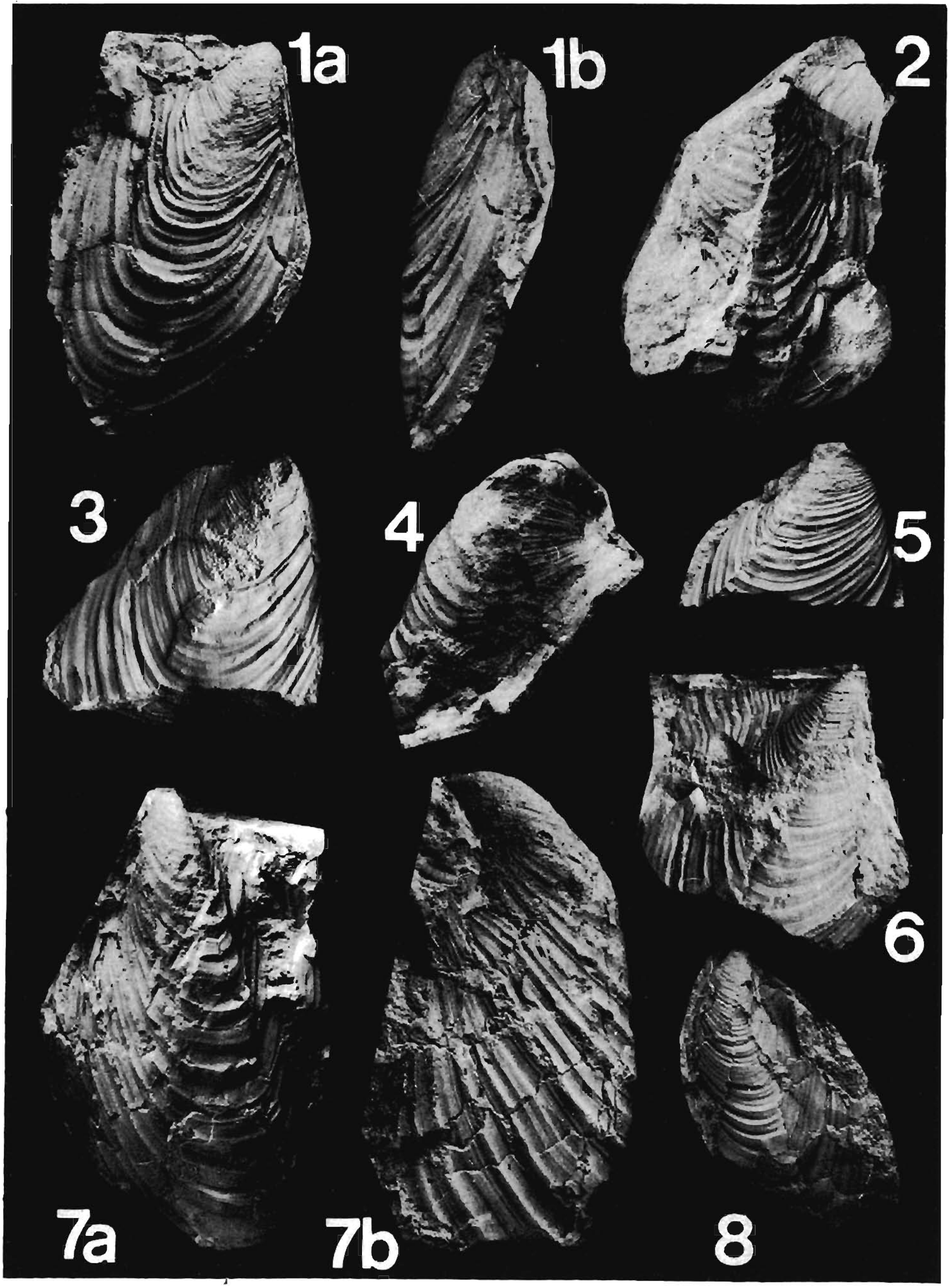


1-7 — *Mytiloides striatoconcentricus* (GÜMBEL); 4,6 — M. incertus Zone, 3,5,7 — C. waltersdorfensis Zone, 1-2 — C. brongniarti Zone

1 — Specimen No. 1.SW.6.11, RV, 1a lateral, 1b anterior view, Słupia Nadbrzeżna—Wesołówka; 2 — No. 1.Kl2.O.117, RV, 2a lateral, 2b anterior view, Kolonka-2; 3 — No. 4.F.3.1, LV, Folwark Quarry; 4 — No. 2.M.O.1, RV, Miąsowa; 5 — No. 4.F.3.2, LV, Folwark Quarry; 6 — No. 4.F.1.5, LV, Folwark Quarry; 7 — No. 4.F.3.3, RV, Folwark Quarry

8 — *Mytiloides troegeri* KAUFFMAN; Specimen No. 1.SN3.O.5, LV, C. deformis Zone, Słupia Nadbrzeżna-3

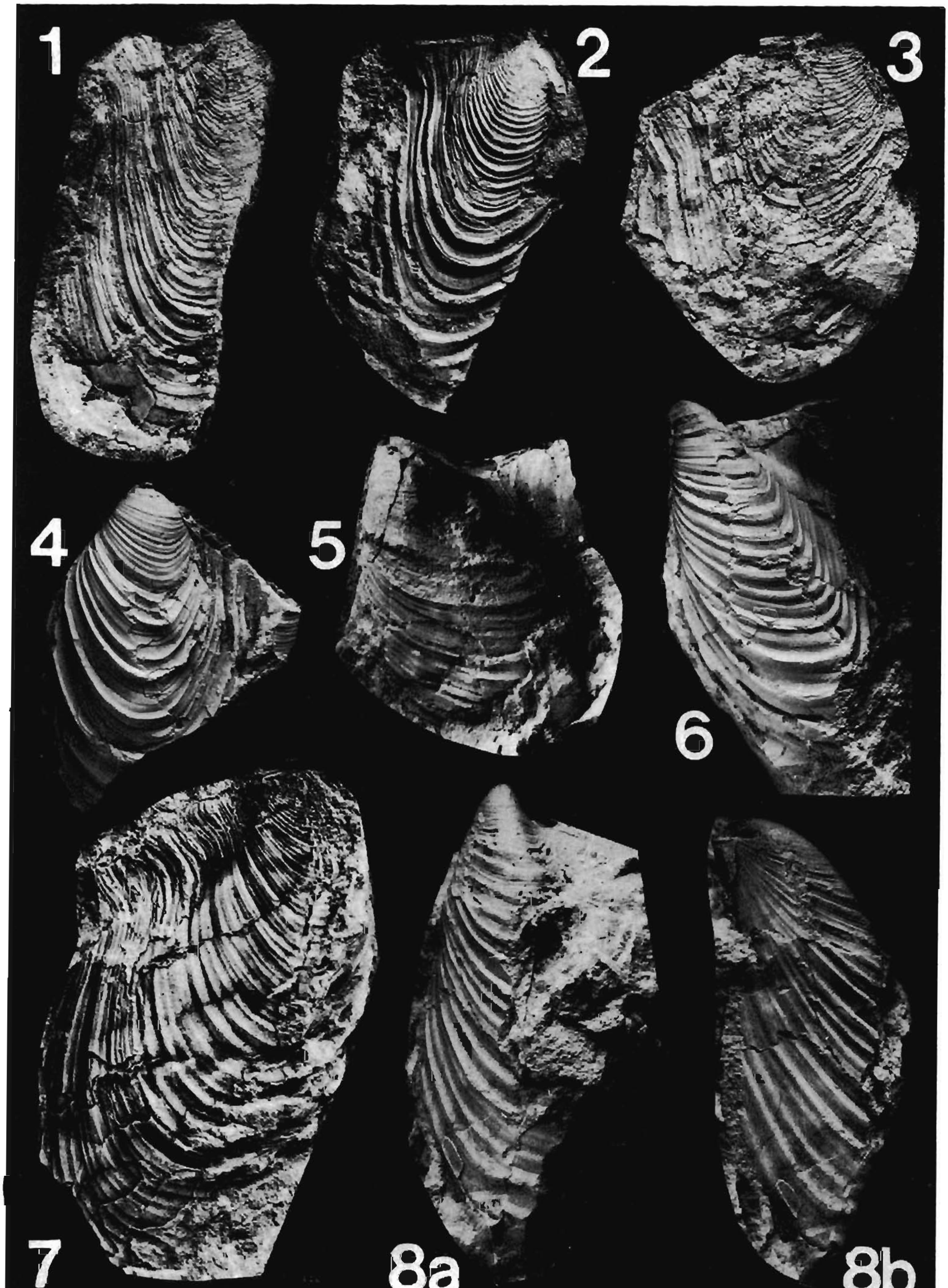
All figures in natural size



Mytiloides carpathicus (SIMIONESCU); M. incertus Zone (*M. carpathicus* Event), Słupia Nadbrzeżna – Wesołówka

1 — Specimen No. I.SW.2.1, RV, 1a lateral, 1b anterior view; **2** — No. I.SW.2.12, LV; **3** — No. I.SW.2.8a, RV; **4** — No. I.SW.2.6, LV; **5** — No. I.SW.2.8b, RV; **6** — No. I.SW.2.5, RV; **7** — No. I.SW.2.4, LV, 7a lateral, 7b anterior view; **8** — No. I.SW.2.3, LV

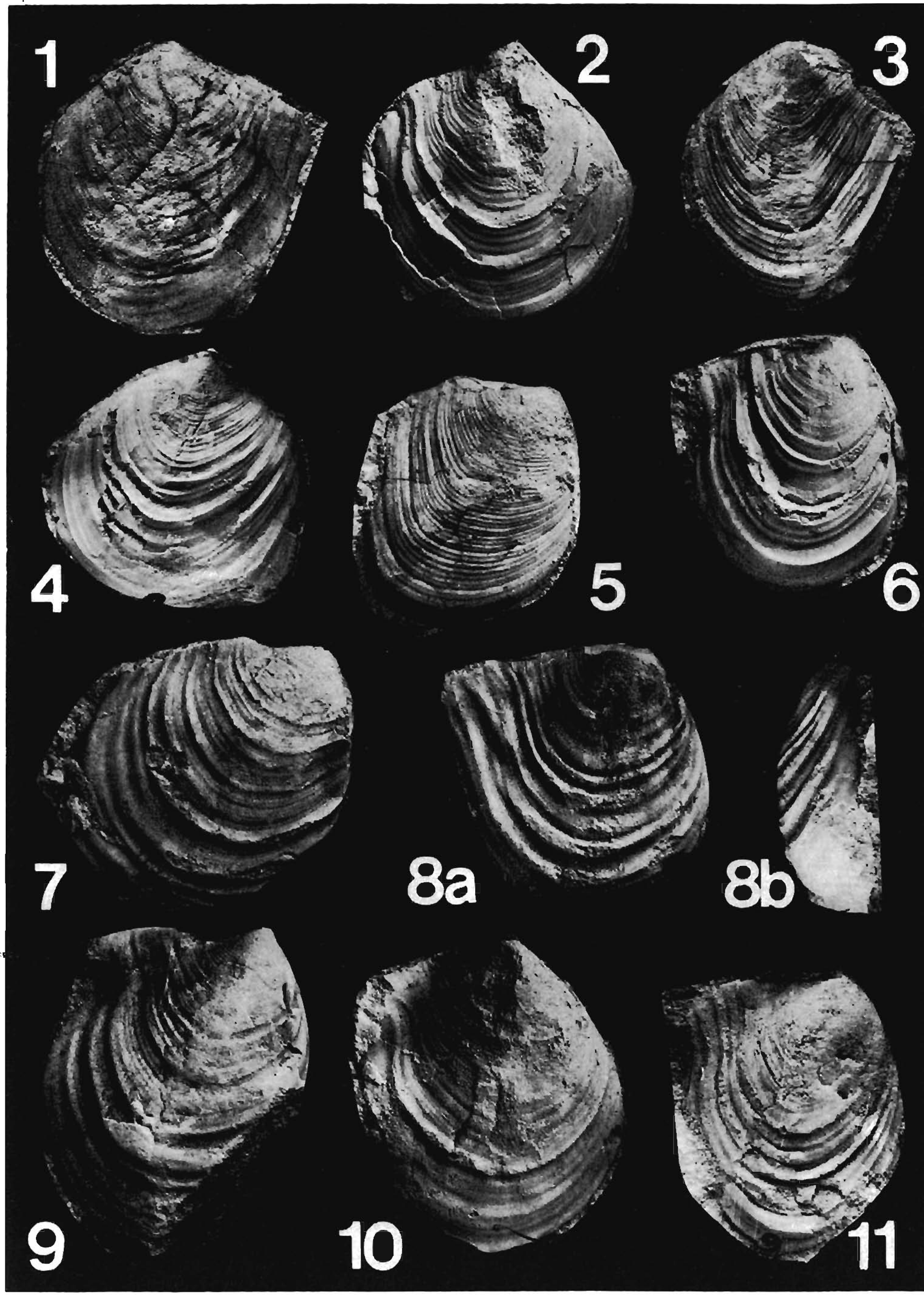
All figures in natural size



Mytiloides carpathicus (SIMIONESCU); M. incertus Zone (M. *carpathicus* Event); 1,3 – Folwark Quarry, 2-6, 8 – Słupia Nadbrzeżna – Wesołówka, 7 – Brzeźno

1 – Specimen No. 4.F.3.4, RV; 2 – No. ME: ML 1195, RV; 3 – No. 4.F.3.5, RV; 4 – No. 1.SW.2.9, LV; 5 – No. 1.SW.2.6, LV; 6 – No. 1.SW.2.2, LV; 7 – No. GS: 1401.II.60, RV; 8 – No. 1.SW.2.7, LV, 8a lateral, 8b anterior view

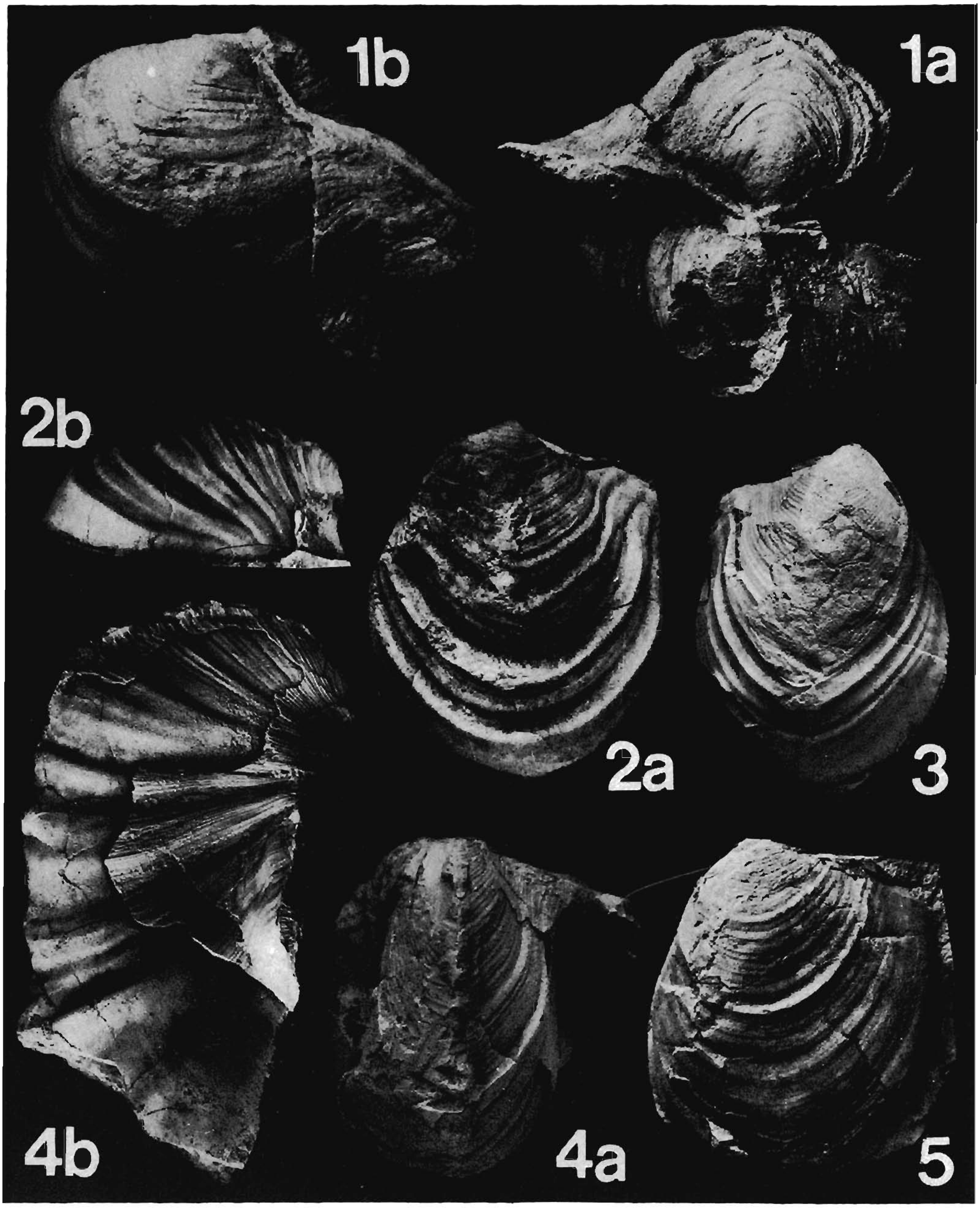
All figures in natural size



Cremnoceramus waltersdorfensis (ANDERT); 1-2, 4, 6, 8-10 — C. waltersdorfensis Zone (*C. waltersdorfensis* Event), Słupia Nadbrzeżna — Wesołówka; 3,5,7 — C. brongniarti Zone, Słupia Nadbrzeżna — Wesołówka, 11 — C. brongniarti Zone, Kolonka-2

1 — Specimen No. I.SW.3.7, LV; **2** — No. I.SW.3.1, RV; **3** — No. I.SW.4-5.3, LV; **4** — No. I.SW.3.26, LV; **5** — No. I.SW.4-5.2, RV; **6** — No. I.SW.3.57, RV; **7** — No. I.SW.4-5.40, RV; **8** — No. I.SW.3.37, RV, 8a lateral, 8b anterior view; **9** — No. I.SW.3.13, RV; **10** — No. I.SW.3.11, RV; **11** — No. I.KI2.0.13, RV

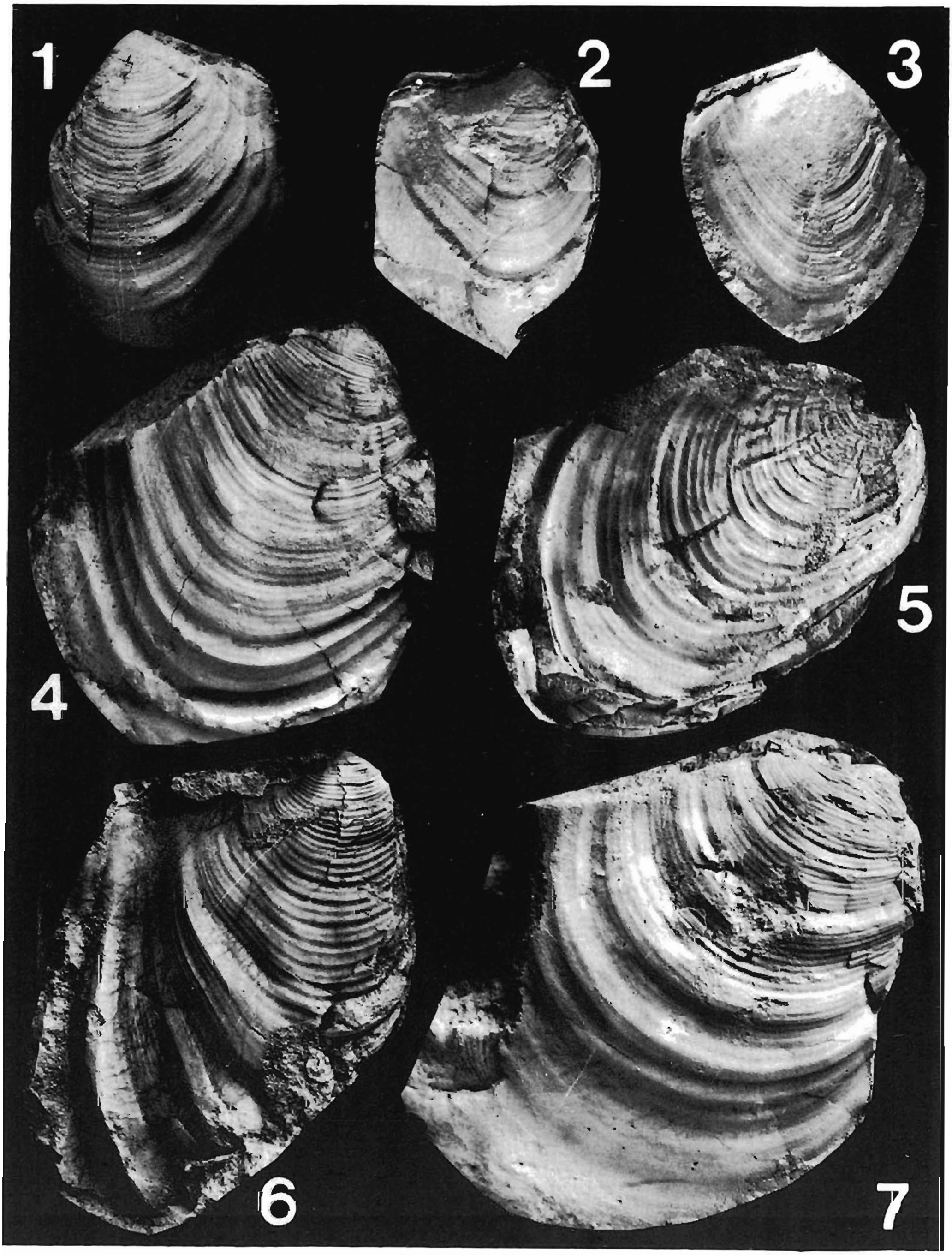
All figures in natural size



Cremnoceramus waltersdorfensis (ANDERT); 1-4 — C. waltersdorfensis Zone (*C. waltersdorfensis* Event), 5 — C. brongniarti Zone; Słupia Nadbrzeżna — Wesołówka

1 — Specimen No. 1.SW.3.2, double-valved specimen, 1a dorsal, 1b posterolateral view; **2** — No. 1.SW.3.40, LV, 2a lateral, 2b posterior view; **3** — No. 1.SW.3.9, RV; **4** — No. 1.SW.3.20, LV, 4a lateral, 4b posterior view; **5** — No. 1.SW.4-5.6, LV

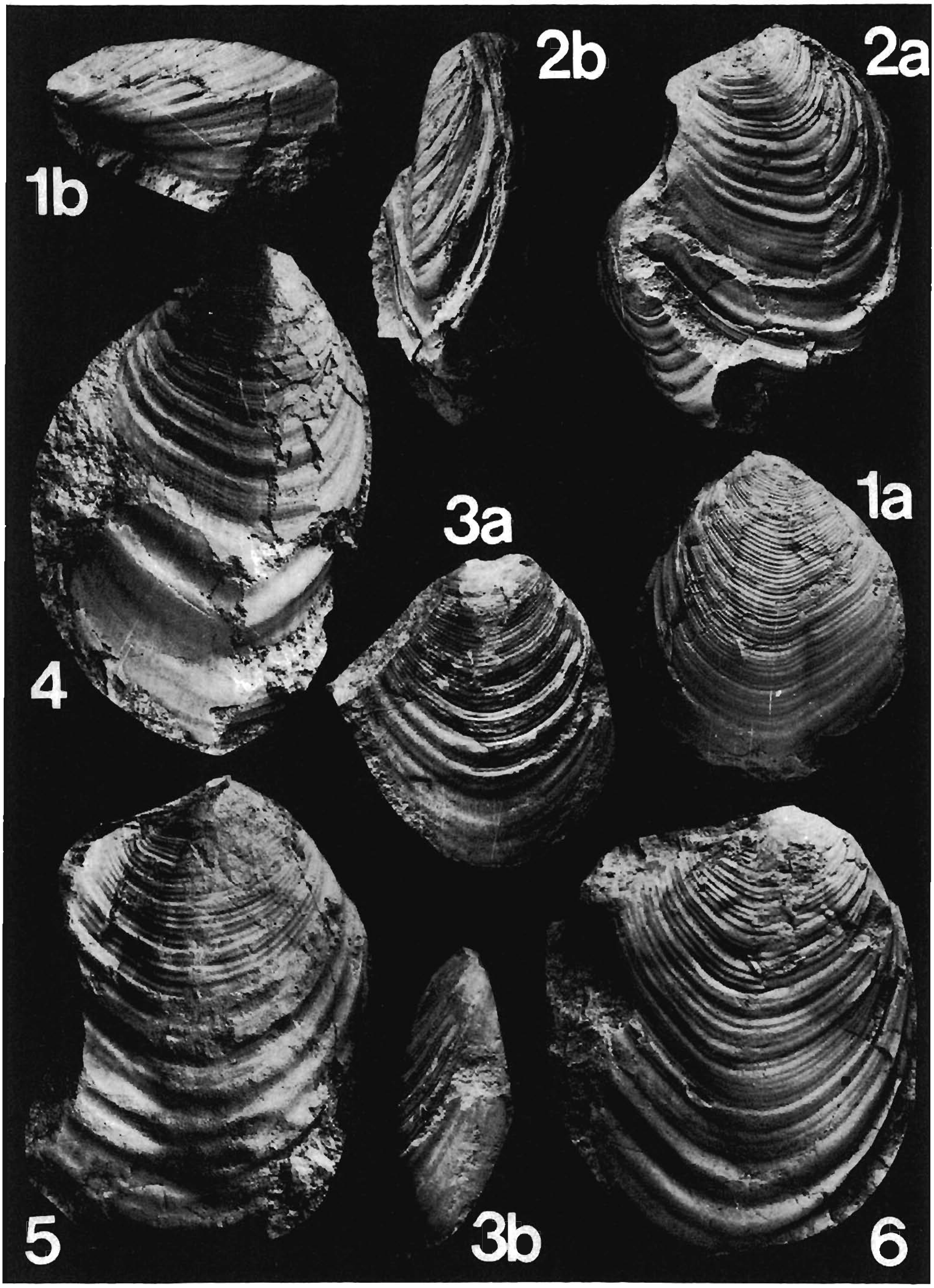
All figures in natural size



Cremnoceramus waltersdorfensis (ANDERT); 1-3 — C. waltersdorfensis Zone (*C. waltersdorfensis* Event), 4-7 — C. brongniarti Zone; 1-4, 7 — Słupia Nadbrzeżna — Wesołówka, 5 — Folwark Quarry, 6 — Maksymów

1 — Specimen No. I.SW.3.38, LV; **2** — No. I.SW.3.5a, RV; **3** — No. I.SW.3.5b, RV; **4** — No. I.SW.6.55, RV; **5** — No. 4.F.3.10, RV; **6** — No. ME: ML 1207, RV; **7** — No. I.SW.7.1, RV

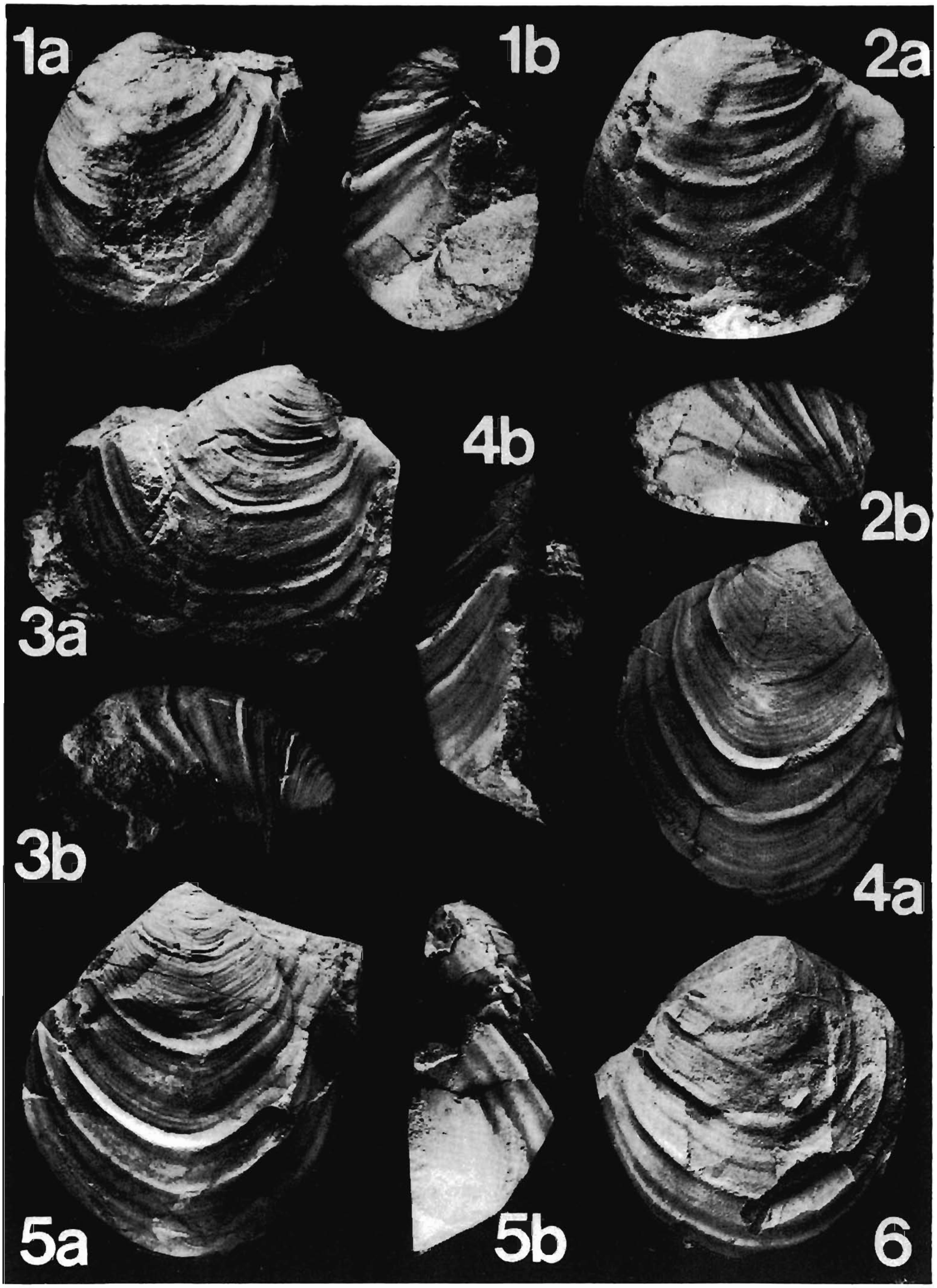
All figures in natural size



1-3 — *Cremnoceramus waltersdorfensis* (ANDERT), form transitional to *C. inconstans* (WOODS); 1 — Specimen No. 1.SW.6.4, LV, 1a lateral, 1b anterior view; 2 — No. 1.SW.6.2, RV, 2a lateral, 2b anterior view; 3 — No. 1.SW.6.3, RV, 3a lateral, 3b anterior view; C. brongniarti Zone, Słupia Nadbrzeżna — Wesołówka

4-6 — *Cremnoceramus waltersdorfensis* (ANDERT); 4 — Specimen No. 1.SW.6.12, RV; 5 — No. 1.SW.6.10, RV; 6 — No. 1.SW.6.9, RV; C. brongniarti Zone, Słupia Nadbrzeżna — Wesołówka

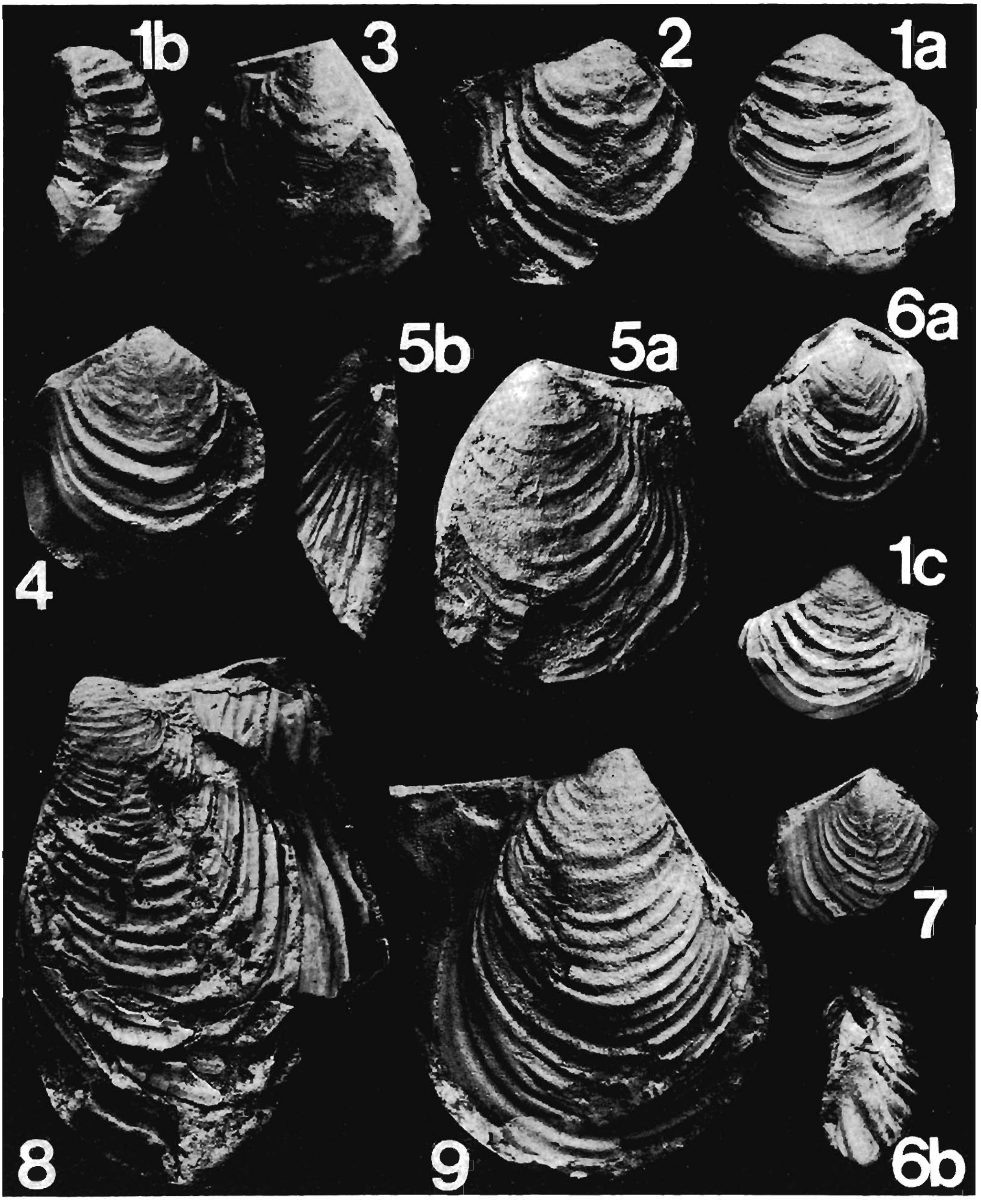
All figures in natural size



Cremnoceramus websteri (MANTELL); C. waltersdorfensis Zone (*C. waltersdorfensis* Event), Słupia Nadbrzeżna – Wesołówka

1 – Specimen No. I.SW.3.55, LV, 1a lateral, 1b posterior view; 2 – No. I.SW.3.53, LV, 2a lateral, 2b posterior view; 3 – No. I.SW.3.52, LV, 3a lateral, 3b posterior view; 4 – No. I.SW.3.49, RV, 4a lateral, 4b anterior view; 5 – No. I.SW.3.54, LV, 5a lateral, 5b anterior view; 6 – No. I.SW.3.50, RV

All figures in natural size



1-7 — *Inoceramus hoepeni* HEINZ; C. waltersdorfensis Zone (*C. waltersdorfensis* Event), Słupia Nadbrzeżna — Wesołówka

1 — Specimen No. I.SW.3.42, LV, 1a lateral, 1b anterior, 1c dorsal view; 2 — No. I.SW.3.39, RV; 3 — No. I.SW.3.40, RV; 4 — No. I.SW.3.45, RV; 5 — No. I.SW.3.46, LV, 5a lateral, 5b posterior view; 6 — No. I.SW.3.41, LV, 6a lateral, 6b anterior view; 7 — No. I.SW.3.47, RV

8-9 — *Inoceramus germanobohemicus* HEINZ; Lower Coniacian, C. brongniarti Zone

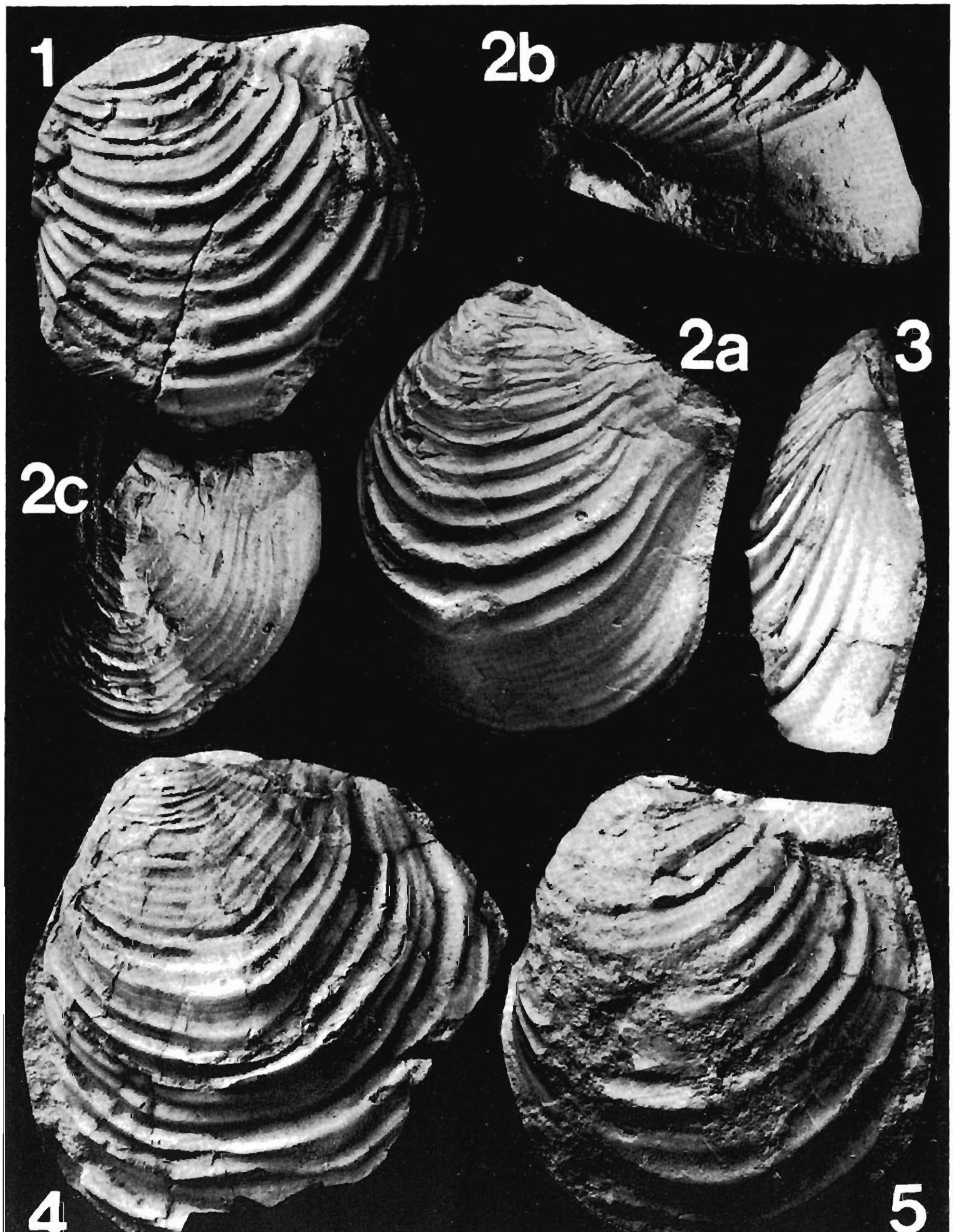
8 — Specimen No. ME: ML 1198/12, LV, Maksymów; 9 — No. I.SW.4-5.68, RV, Słupia Nadbrzeżna — Wesołówka

All figures in natural size

Cremnoceramus brongniarti (MANTELL)

1 — Specimen No. I.SW.4-5.110, RV; **2** — No. I.SW.4-5.76, LV, 2a lateral, 2b anterior view; C. brongniarti Zone, Słupia Nadbrzeżna — Wesołówka; **3** — Plaster cast of the holotype (*see* MANTELL 1822, Pl. 27, Fig. 8), 3a lateral view of the left valve, 3b-3c anterior views of the right and left valves respectively

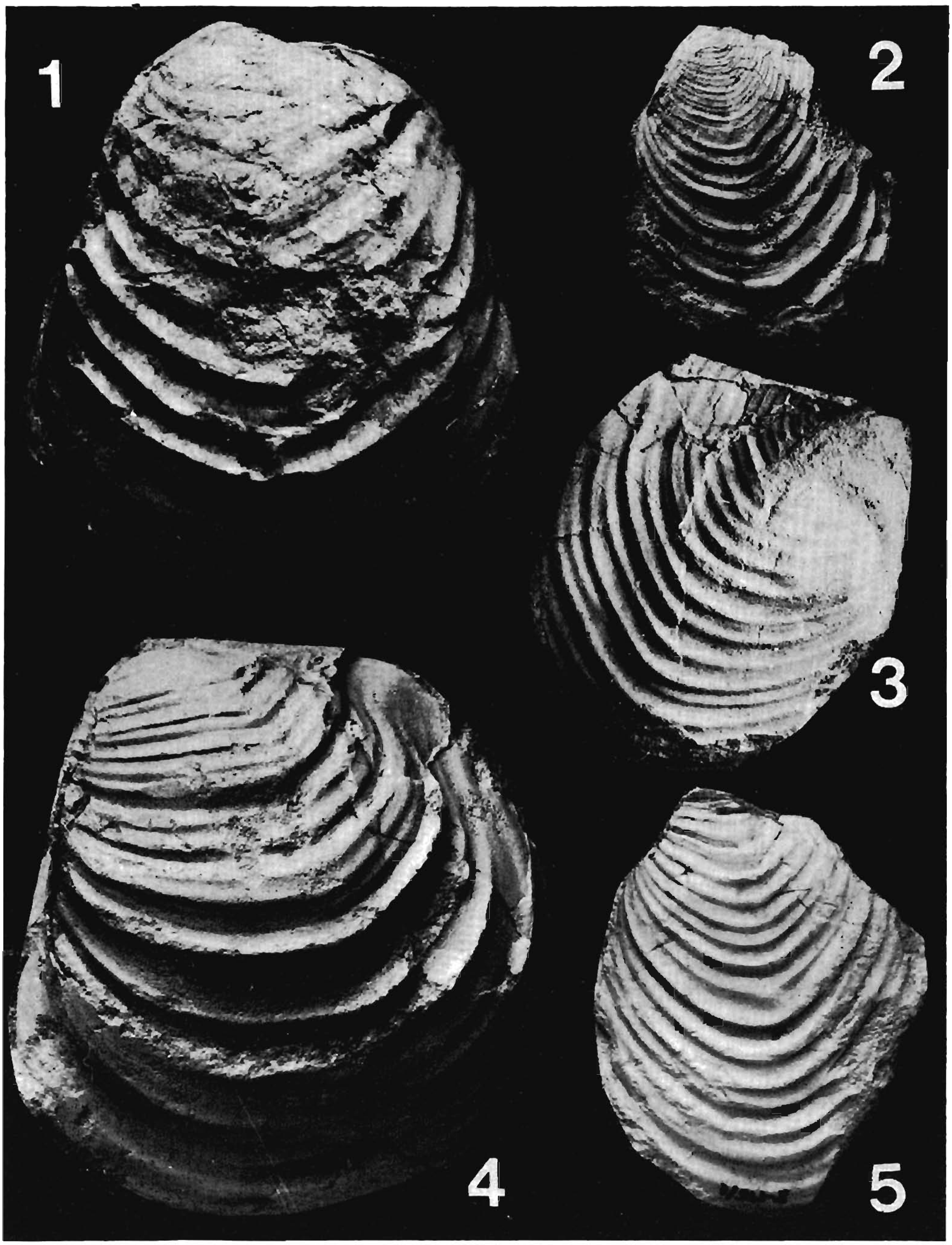
All figures in natural size



Cremnoceramus brongniarti (MANTELL); C. brongniarti Zone

1 — Specimen No. I.SW.4-5.136, LV, Słupia Nadbrzeżna – Wesołówka; **2** — No. I.KI2.O.85, LV, 2a lateral, 2b anterior, 2c dorsal view, Kolonka-2; **3** — No. I.KI2.O.89, LV, anterior view (lateral view *see* Pl. 25, Fig. 5), Kolonka-2; **4** — No. I.SW.4-5.97, LV, Słupia Nadbrzeżna – Wesołówka; **5** — No. I.KI2.O.92, LV, Kolonka-2

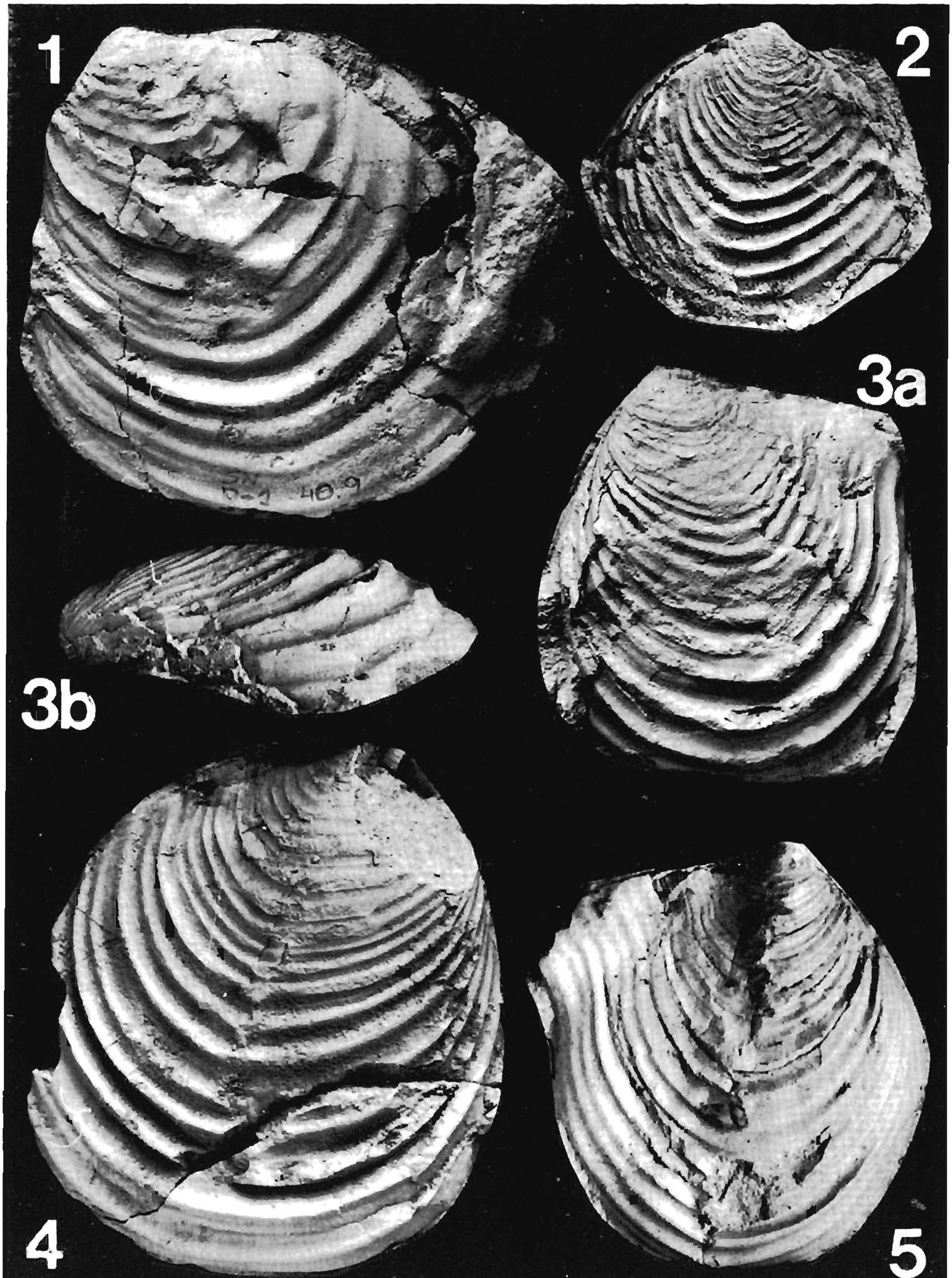
All figures in natural size



Cremnoceramus brongniarti (MANTELL); C. brongniarti Zone; 1-2, 5 — Słupia Nadbrzeżna — Wesołówka; 3-4 — Kolonka-2

1 — Specimen No. I.SW.4-5.62, LV; **2** — No. I.SW.4-5.25, LV; **3** — No. I.K12.O.80, RV; **4** — No. I.K12.O.71, LV; **5** — No. I.SW.4-5.64, LV

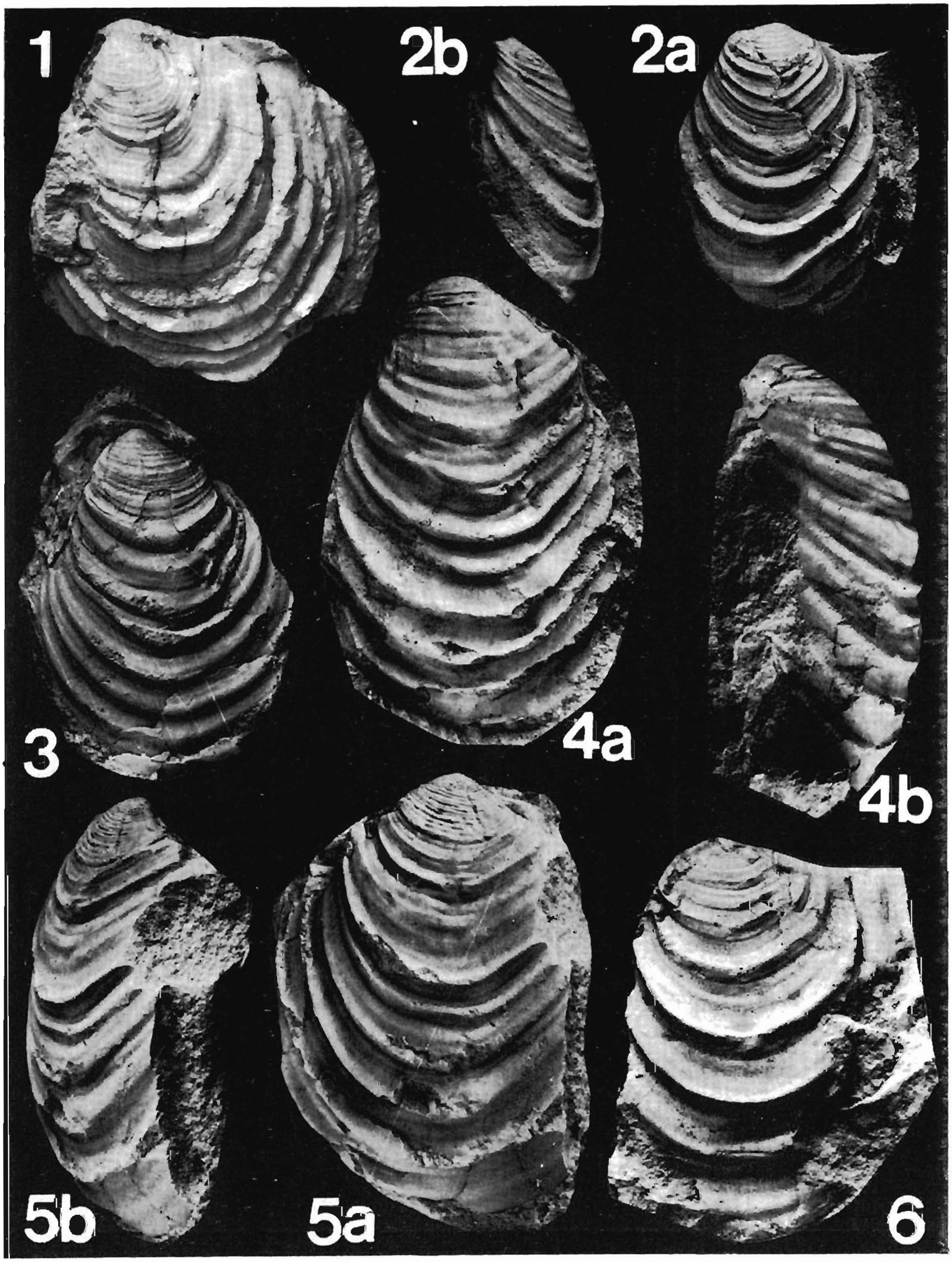
All figures in natural size



Cremnoceramus brongniarti (MANTELL); C. brongniarti Zone

1 — Specimen No. I.SN1.40.9, LV, Słupia Nadbrzeżna-1; 2 — No. GS: 1401.II.138, LV, Brzeźno; 3 — No. I.SW.4-5.54, LV, 3a lateral, 3b anterior view, Słupia Nadbrzeżna – Wesołówka; 4 — No. I.SW.4-5.73, RV, Słupia Nadbrzeżna — Wesołówka; 5 — No. I.KJ2.O.89, lateral view, RV (anterior view *see* Pl. 23, Fig. 3), Kolonka-2

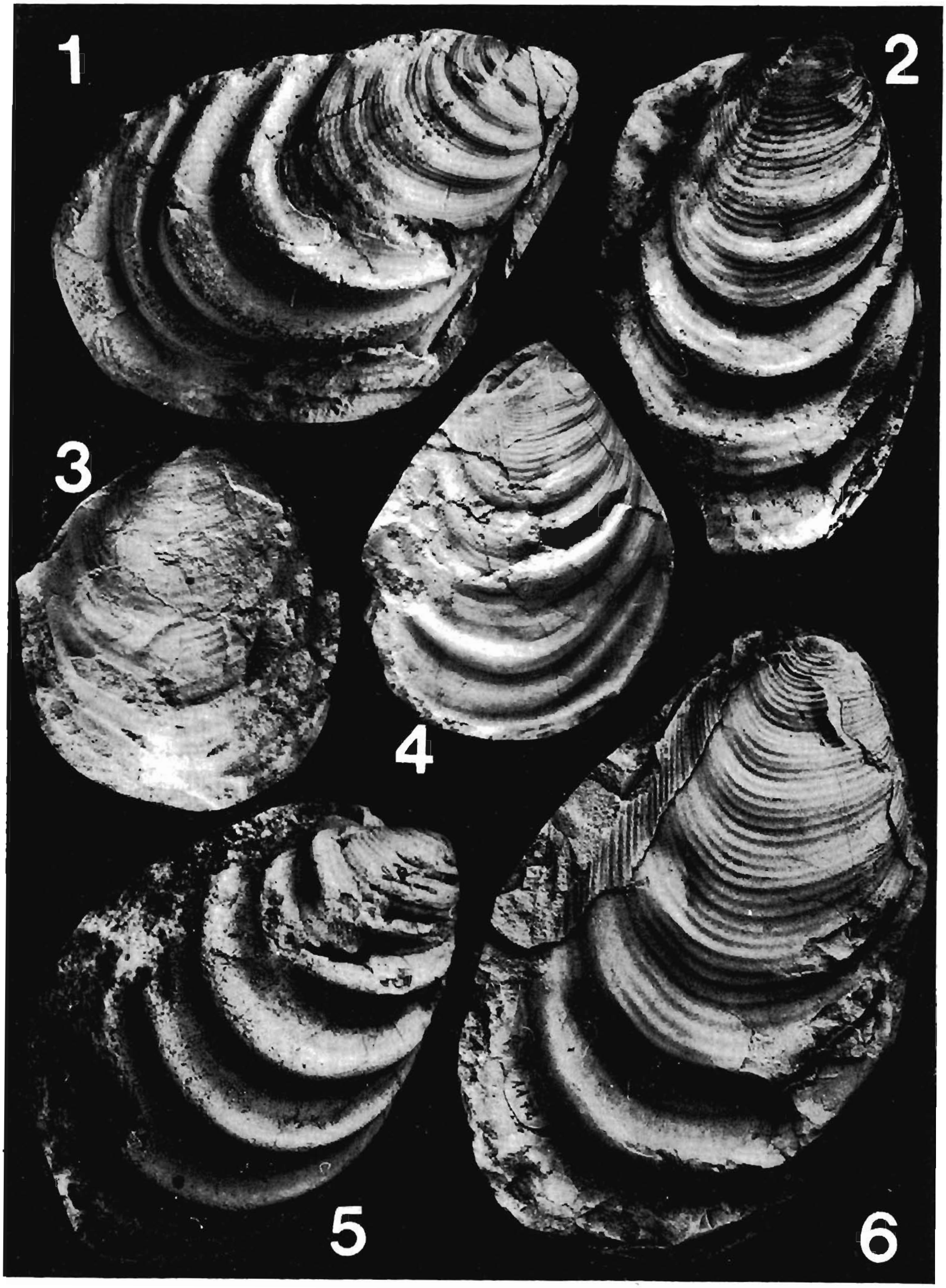
All figures in natural size



Inoceramus vistulensis sp. n.; C. brongniarti Zone; Słupia Nadbrzeżna — Wesołówka

1 — Specimen No. I.SW.6.16, LV; **2** — No. I.SW.6.6, LV, 2a lateral, 2b anterior view; **3** — No. I.SW.6.1, LV; **4** — No. I.SW.6.5, LV, 4a lateral, 4b anterior view; **5** — No. I.SW.6.7, LV, 5a lateral, 5b posterolateral view; **6** — No. I.SW.6.14, LV

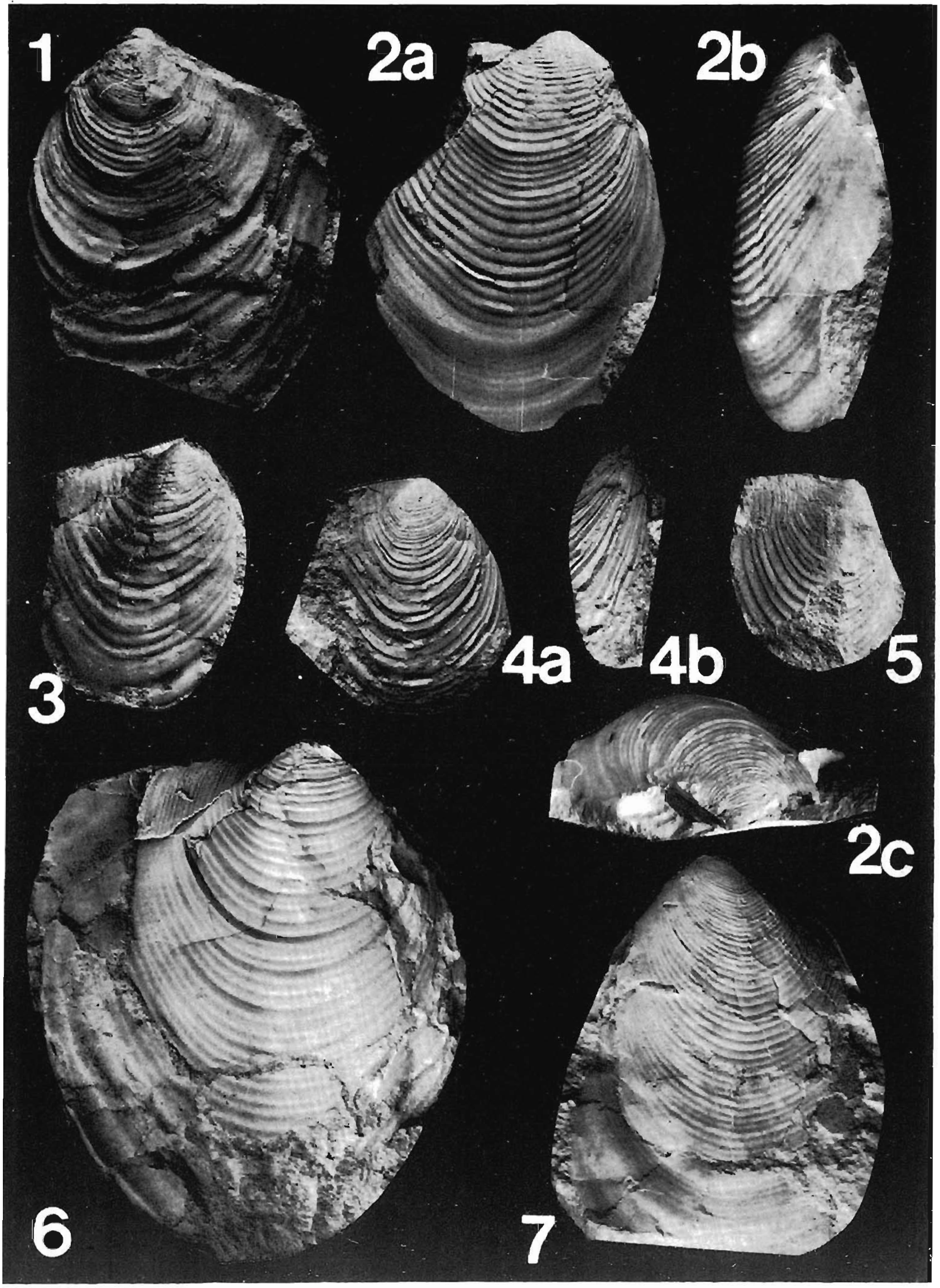
All figures in natural size



Inoceramus lusatiae ANDERT; 1-3, 5-6 — C. brongniarti Zone, 4 — C. waltersdorfensis Zone; 1, 3-4 — Słupia Nadbrzeżna—Wesołówka, 2, 5-6 — Maksymów

1 — Specimen No. 1.SW.6.74, RV; **2** — No. ME: ML 1216, RV; **3** — No. 1.SW.6.72, RV; **4** — No. 1.SW.2.45, RV; **5** — No. ME: ML 1122, RV; **6** — No. ME: ML 1172, RV

All figures in natural size



Cremnoceramus denselamellatus (KOTSYUBINSKY); C. brongniarti Zone; 1-2, 4, 6-7 — Słupia Nadbrzeżna—Wesołówka, 3,5 — Kolonka-2

1 — Specimen No. I.SW.6.103, LV; **2** — No. I.SW.7.39, RV, 2a lateral, 2b anterior, 2c dorsal view; **3** — No. I.KI2.O.46, RV; **4** — No. I.SW.4-5.53, RV, 4a lateral, 4b anterior view; **5** — No. I.KI2.O.47, RV; **6** — No. I.SW.7.38, RV; **7** — No. I.SW.7.43, LV

All figures in natural size

1 — *Mytiloides africanus* (HEINZ); Specimen No. ME: ML 1140, double-valved, 1a lateral, 1b anterior view, C. brongniarti Zone, Maksymów

2 — *Cremnoceramus? rotundatus* (FIEGE)/*stillei* HEINZ; Specimen No. I.SW.9.1, LV; C. deformis Zone, Słupia Nadbrzeżna — Wesołówka

3 — *Inoceramus madagascariensis* HEINZ; Specimen No. I.KJ1.3.5, LV (*see* Pl. 30, Fig. 3 for posterior view), C. deformis Zone, Kolonka-I

4 — *Cremnoceramus deformis* (MEEK); Specimen No. 4.F.4.15; C. deformis/C. crassus Zone, Folwark Quarry

All figures in natural size

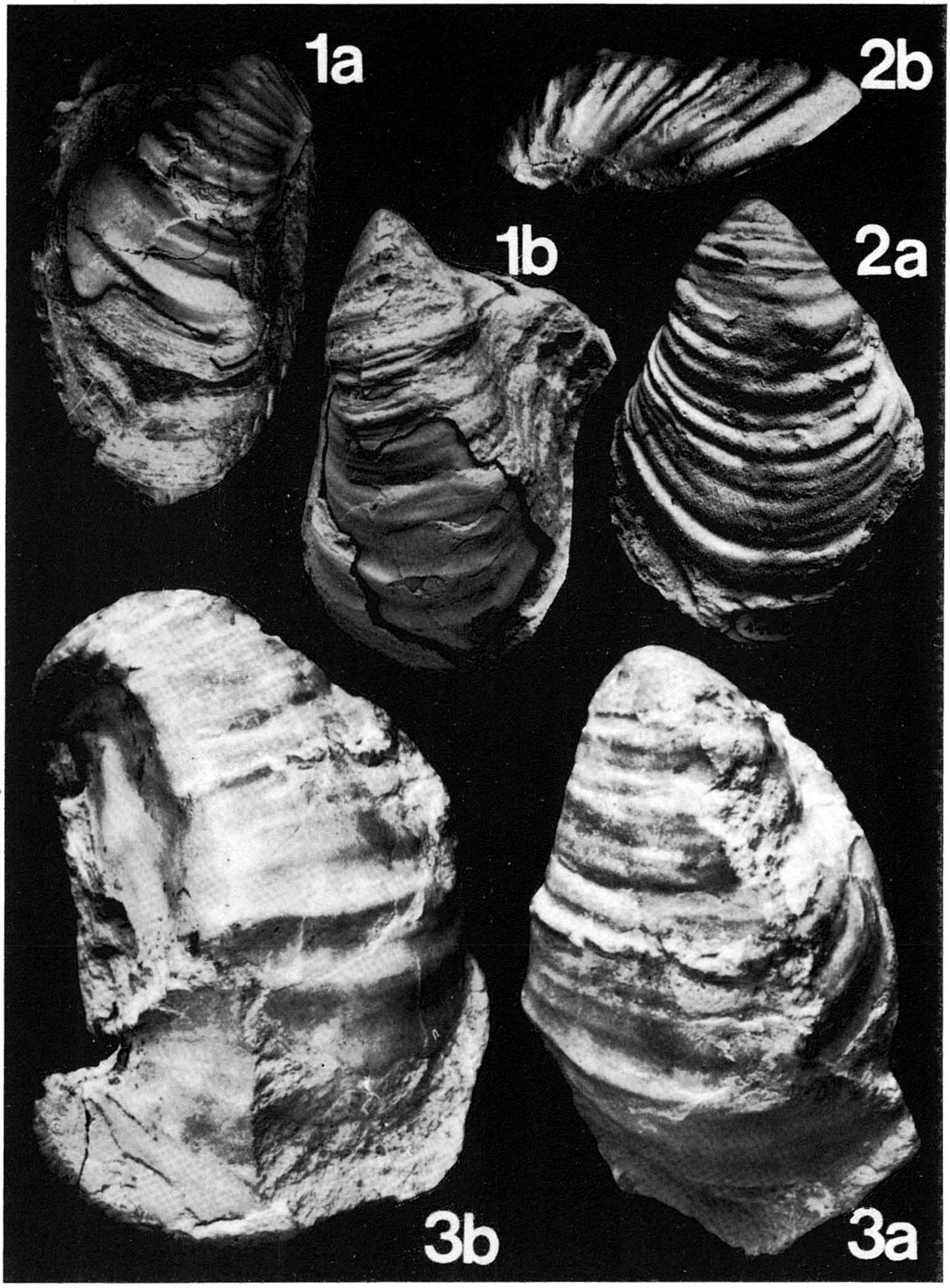
1 — *Cremnoceramus waltersdorfensis* (ANDERT) transitional to *C*? *rotundatus* (FIEGE); Specimen No. 4.F.4.5, LV, C. brongniarti/?C. deformis Zone, Folwark Quarry

2 — *Cremnoceramus brongniarti* (MANTELL); Specimen No. 1.SN5.93.9, LV, C. brongniarti Zone, Słupia Nadbrzeżna-5

3 — *Inoceramus madagascariensis* HEINZ; Specimen No. 1.KJ1.3. 5, LV, posterior view (*see* Pl. 29, Fig. 3 for lateral view); C. deformis Zone, Kolonka-1

4 — *Cremnoceramus deformis* (MEEK); LV, Geological Survey Museum, not catalogued specimen; C. crassus Zone, Pętkowice

All figures in natural size



Inoceramus seitzi ANDERT

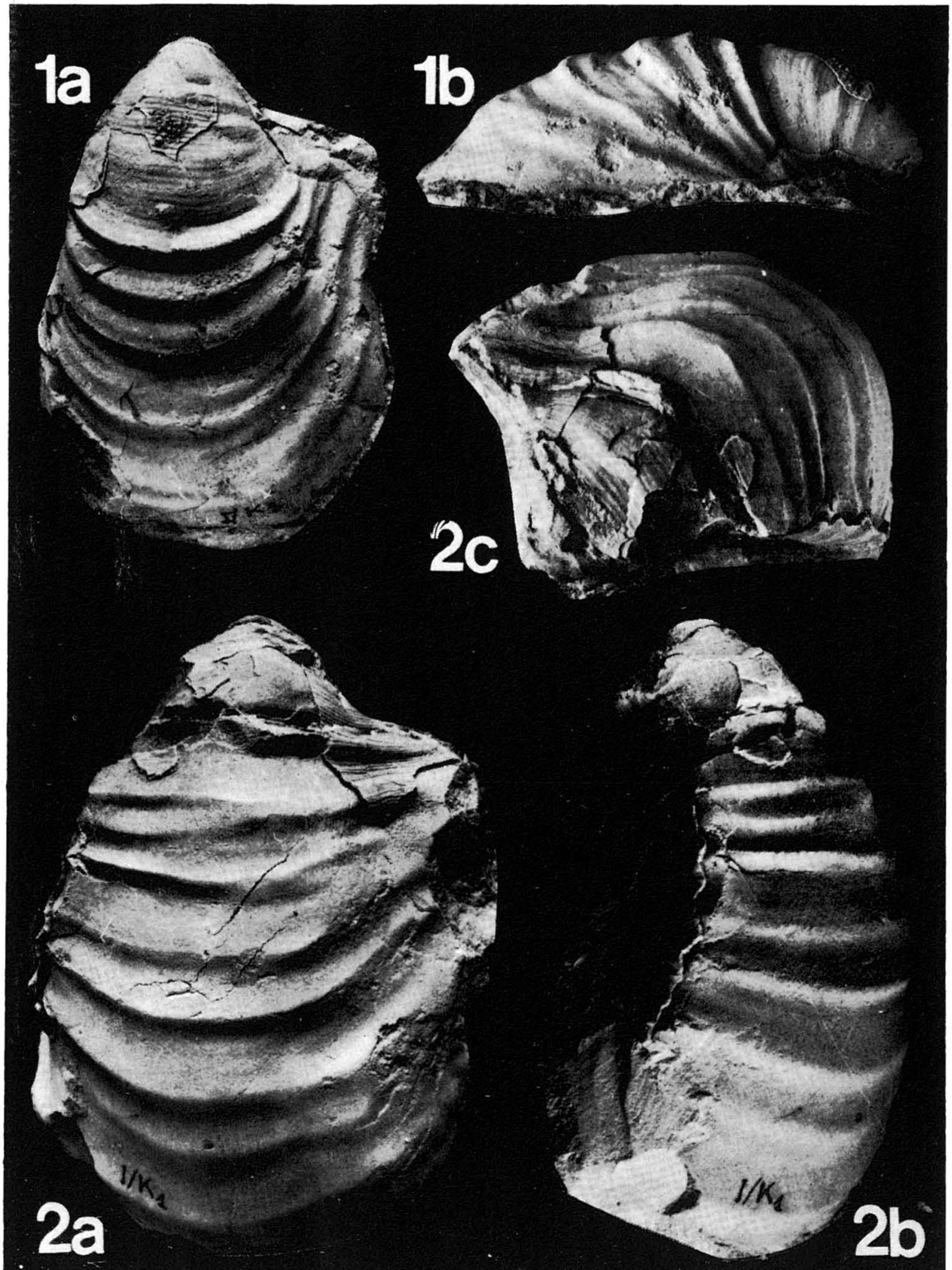
1 — Specimen No. 1.SN 3.O.6, double-valved, 1a lateral view of RV, 1b lateral view of LV, C. deformis Zone, Słupia Nadbrzeżna-3; 2 — No. ME: ML 1153, LV, 2a lateral, 2b anterior view, C. brongniarti Zone, Maksymów; 3 — No. 1.SN3.O.3, double-valved specimen, 3a lateral view of LV, 3b anterior view of the whole specimen, C. deformis Zone, Słupia Nadbrzeżna-3

All figures in natural size

Cremnoceramus ernsti (HEINZ)

1 — Specimen No. 5.Dz.Cn.1, RV, 1a lateral, 1b dorsolateral view, C. crassus Zone, Dzengutay, Dagestan, Caucasus; **2** — Plaster cast of the lectotype (*see* WOODS 1911, Text-fig. 85), RV, 2a lateral, 2b dorsal view; **3** — No. 3.W.3.1, RV, C. crassus Zone, Wielkanoc

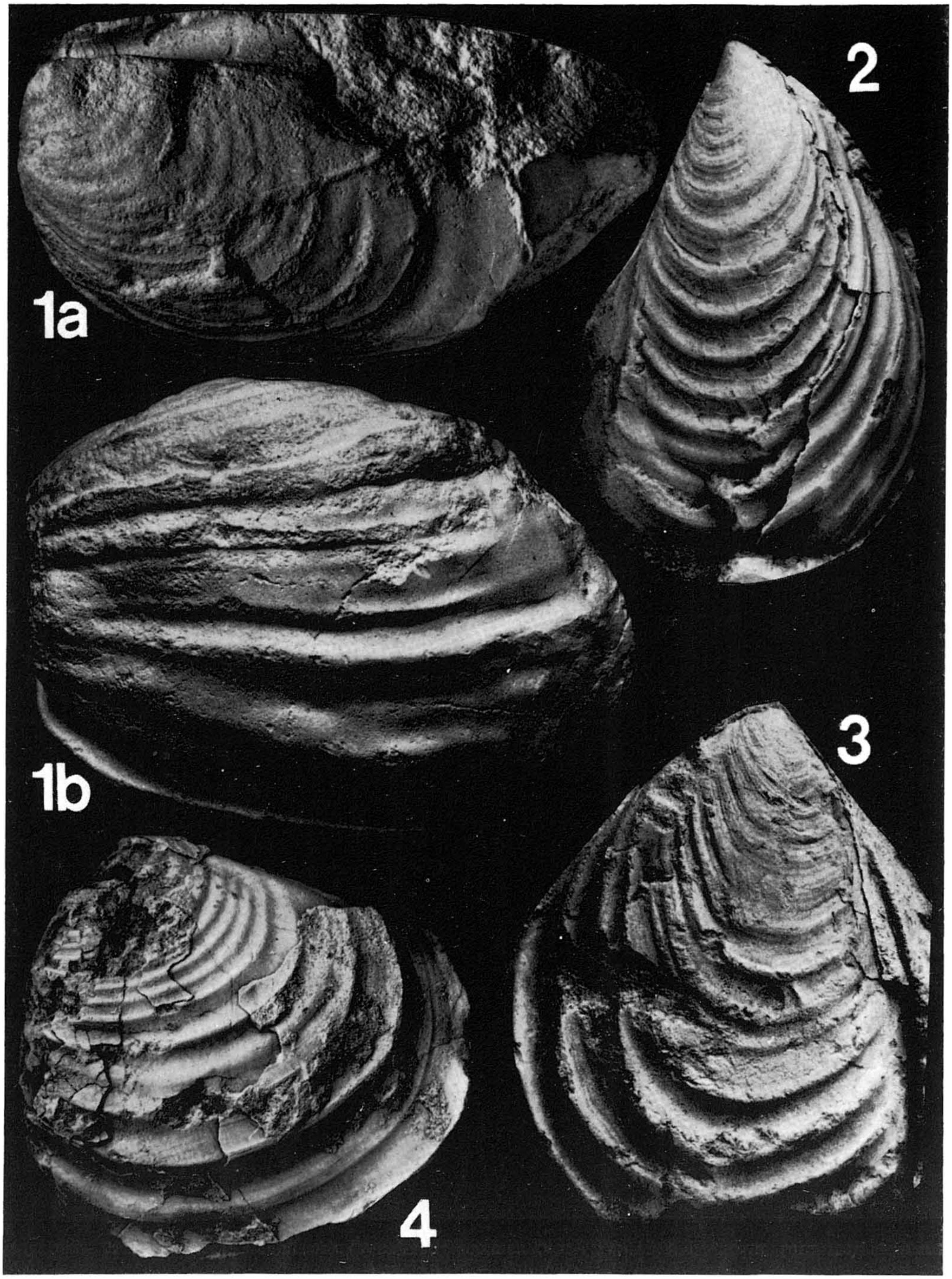
Fig. 3 taken × 0.75; the others in natural size



Inoceramus ex gr. *lamarcki* PARKINSON; C. deformis Zone, Kolonka-1

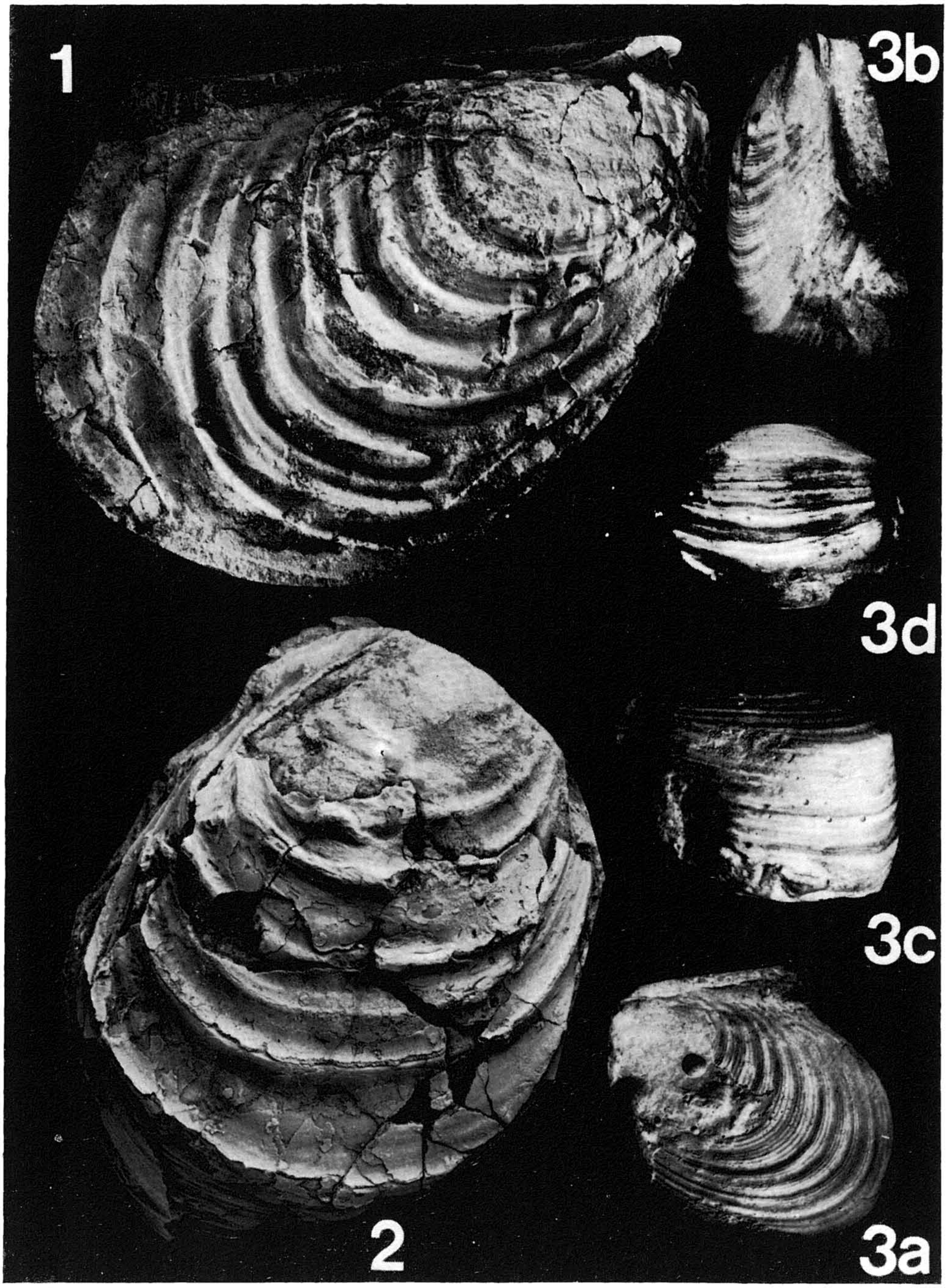
1 – Specimen No. 1.Kl1.3.1, LV, 1a lateral, 1b posterior, 1c dorsal view; **2** – No. 1.Kl1.3.2, LV, 2a lateral, 2b anterior view

All figures in natural size



Cremnoceramus crassus (PETRASCHECK)

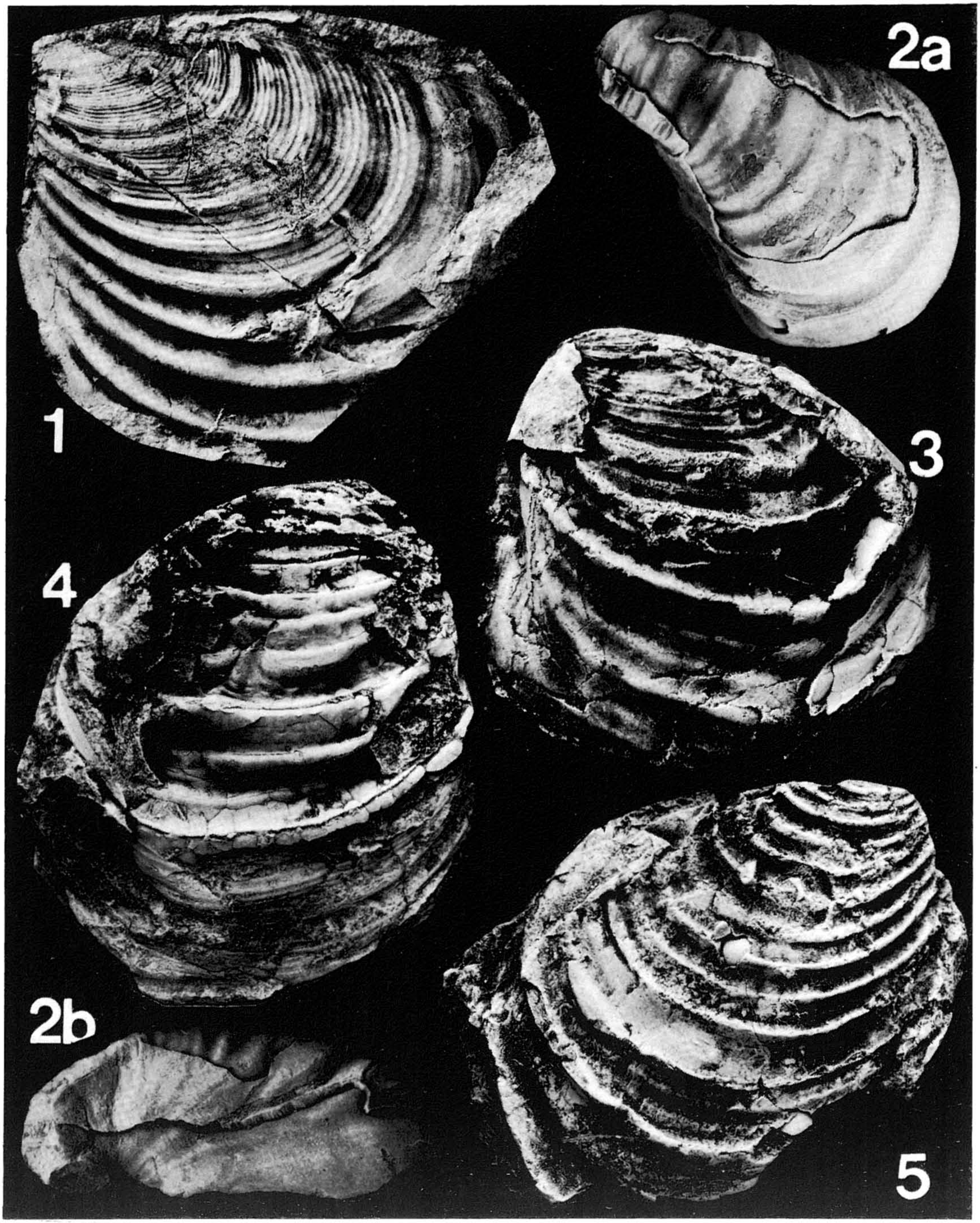
1 — Plaster cast of the holotype (*see* PETRASCHECK 1903, Pl. 8, Fig. 4), 1a lateral view of the juvenile part, 1b lateral view of the adult, × 0.75; 2 — Form transitional to *C. inconstans* (WOODS), Geological Survey Museum, not catalogued specimen, RV, C. crassus Zone, Pętkowice, × 0.7; 3 — Form transitional to *C. inconstans* (WOODS), Geological Survey Museum, not catalogued specimen, LV, C. deformis Zone, Słupia Nadbrzeżna-3, × 1; 4 — No. 3.W:3.2, LV, C. crassus Zone, Wielkanoc, × 0.75



1-2 — *Cremnoceramus crassus* (PETRASCHECK); 1 — Specimen No. 4.F.4.1, RV, lateral view of the juvenile part, C. crassus Zone, Folwark Quarry; 2 — No. GS: 1401.II.171, RV, lateral view of the juvenile part, C. crassus Zone, Ossowa

3 — *Cremnoceramus inconstans* (WOODS); Plaster cast of the lectotype (*see* WOODS 1911, Text-fig. 42), RV, 3a lateral view of the juvenile part, 3b posterior view, 3c anteroventral view, 3d ventral view (=lateral view of the adult part)

Fig. 3 taken × 0.65; the others in natural size



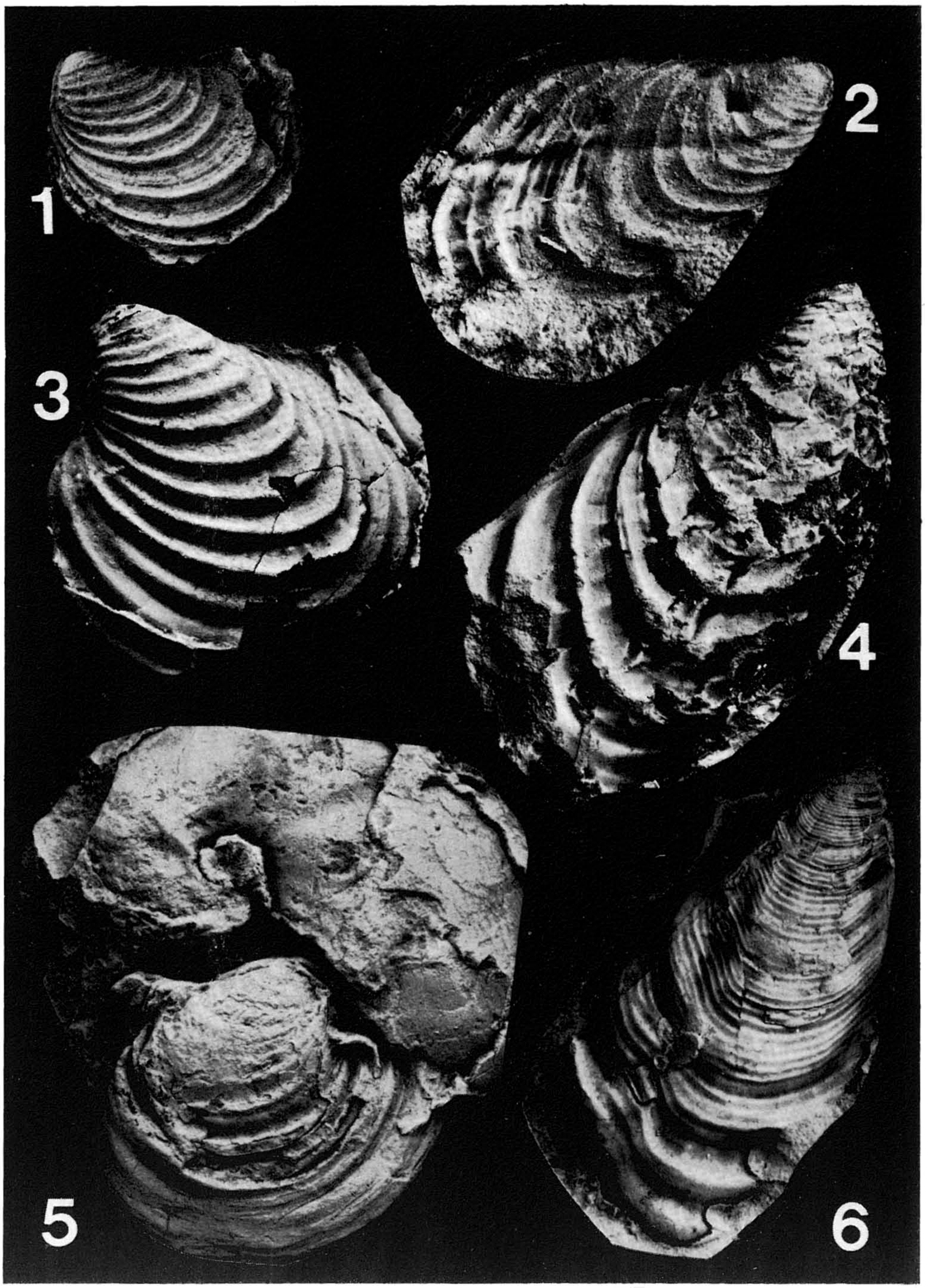
1 — *Cremnoceramus inconstans* (WOODS); Specimen No. 5.K.O.1, LV, Cremnoceramus crassus Zone, Kostomlaty, České středohoři, Czecho-Slovakia, × 1

2 — *Inoceramus wandereri* ANDERT; Specimen No. 5.Dz.Cn.2, LV, 2a lateral, 2b anterior view, C. crassus Zone, Dzengutay, Dagestan, Caucasus, × 1

3 — *Cremnoceramus crassus* (PETRASCHECK); Specimen No. 4.F.4.3, LV, C. crassus Zone, Folwark Quarry, × 1

4 — *Cremnoceramus ?deformis* (MEEK); Specimen No. 4.F.4.4, RV, C. crassus Zone, Folwark Quarry, × 0.65

5 — *Cremnoceramus crassus* (PETRASCHECK); Specimen No. 4.F.4.2, RV, C. crassus Zone, Folwark Quarry, × 0.7



1 — *Magadiceramus subquadratus* (SCHLÜTER); Geological Survey Museum, not catalogued specimen, LV, Plusy borehole (depth 70m)

2 — *Magadiceramus subqudratus* (SCHLÜTER); Specimen No. GS: 1401.II.183, RV, Ma. subquadratus Zone, Ossowa

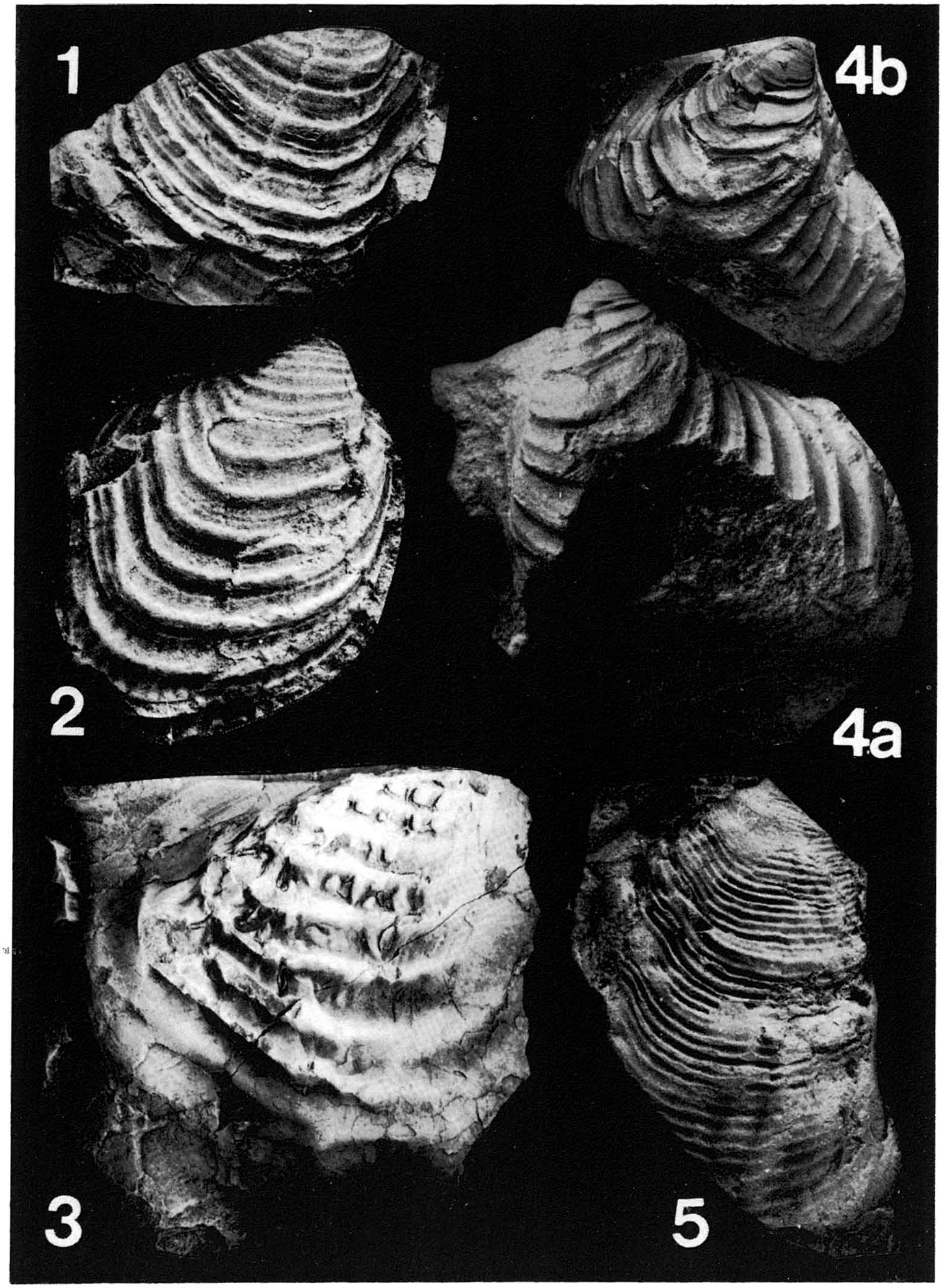
3 — *Inoceramus kleini* MÜLLER; Geological Survey Museum, not catalogued specimen, LV, Jedlanka Nowa borehole (depth 189.2m)

4 — *Inoceramus* sp.; Specimen No. GS: 1401.II.182, ?Ma. subquadratus Zone, Ossowa

5 — *Volviceramus involutus* (SOWERBY); No. GS: 1401.II.196, double-valved, ?V. involutus Zone, Szczepanów

6 — *Inoceramus* (?*Sphenoceramus*) *fasciculatus* HEINE; RV, ?Ma. subquadratus Zone, Ludynia

All figures in natural size



1-3 — *Magadiceramus subquadratus* (SCHLÜTER); 1 — LV, Płusy borehole (depth 68m); 2 — RV, Stefanów borehole (depth 74m); 3 — RV, Ludynia; all three specimens from the Geological Survey Museum, not catalogued

4 — *Inoceramus frechi* FLEGEL emend. SCUPIN; Specimen No. 1.Kl1.2.3, RV, 2a lateral, 2b dorsolateral view, C. deformis Zone, Kolonka-1

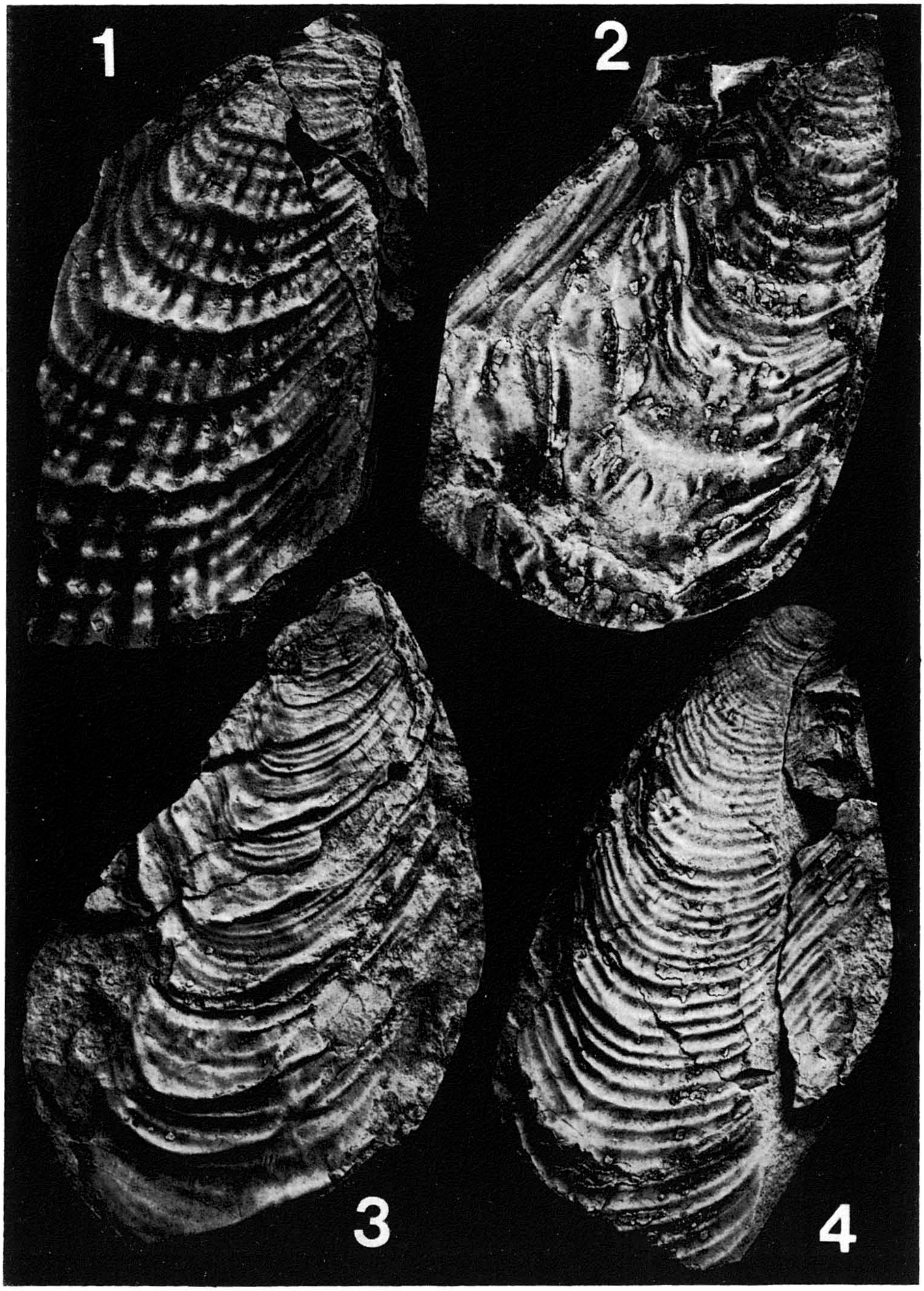
5 — *Inoceramus digitatus* HEINE (*non* SOWERBY); No. GS: 1401.II.186, RV, ?Ma. subquadratus Zone, Ossowa

All figures in natural size

1 — *Sphenoceramus pinnifomis* (WILLET); Specimen No. 1.WS.13.7, LV, Sph. pinniformis Zone, Wesołówka — Sulejów, × 0.9

2-3 — *Sphenoceramus patootensiformis* (SEITZ); Upper Santonian, Sph. patootensiformis Zone, Kije-1; 2 — Specimen No. 2.Ki1.4.1, LV, × 0.8; 3 — No. 2.Ki1.4.2, LV, × 1.4

4 — *Sphenoceramus angustus* (BEYENBURG) aff. *alexandrovi* BODYLEVSKY; Specimen No. 2.Ki1.4.3, RV, × 1, Upper Santonian, Sph. patootensiformis Zone, Kije-1



1 — *Sphenoceramus pinniformis* (Willet); Specimen No. 1.WS.13.3, RV, × 0.6, Sph. pinniformis Zone, Wesołówka — Sulejów

2 — *Sphenoceramus angustus* (Beyenburg); Specimen No. 2.Ki1.4.4, RV, × 1, Upper Santonian, Sph. patootensiformis Zone, Kije-1

3 — *Sphenoceramus patootensiformis* (Seitz); Specimen No. 2.Ki1.4.5, RV, × 0.85, Upper Santonian, Sph. patootensiformis Zone, Kije-1

4 — *Sphenoceramus lingua* (Goldfuss); Specimen No. 2.Ki1.4.6, LV, × 0.8, Upper Santonian, Sph. patootensiformis Zone, Kije-1