



**PRACE
INSTYTUTU GEOLOGICZNEGO
XCII**

ANDRZEJ BŁASZKIEWICZ

**CAMPANIAN AND MAASTRICHTIAN AMMONITES
OF THE MIDDLE VISTULA RIVER VALLEY, POLAND:
A STRATIGRAPHIC-PALEONTOLOGICAL STUDY**

**STUDIUM STRATYGRAFICZNO-PALEONTOLOGICZNE AMONITÓW
KAMPANU I MASTRYCHTU (DOLINA ŚRODKOWEJ WISŁY)**

**СТРАТИГРАФО-ПАЛЕОНТОЛОГИЧЕСКОЕ ИЗУЧЕНИЕ АММОНИТОВ
КАМПАНА И МААСТРИХТА (ДОЛИНА СРЕДНЕГО ТЕЧЕНИЯ ВИСЛЫ)**

WARSZAWA 1980



**PRACE
INSTYTUTU GEOLOGICZNEGO
XCII**

ANDRZEJ BŁASZKIEWICZ

**CAMPANIAN AND MAASTRICHTIAN AMMONITES
OF THE MIDDLE VISTULA RIVER VALLEY, POLAND:
A STRATIGRAPHIC-PALEONTOLOGICAL STUDY**

**STUDIUM STRATYGRAFICZNO-PALEONTOLOGICZNE AMONITÓW
KAMPANU I MASTRYCHTU (DOLINA ŚRODKOWEJ WISŁY)**

**СТРАТИГРАФО-ПАЛЕОНТОЛОГИЧЕСКОЕ ИЗУЧЕНИЕ АММОНИТОВ
КАМПАНА И МААСТРИХТА (ДОЛИНА СРЕДНЕГО ТЕЧЕНИЯ ВИСЛЫ)**

(with 2 Figs. and 56 Pls.)

**WARSZAWA 1980
WYDAWNICTWA GEOLOGICZNE**

Redaktor wydawnictwa: mgr Kamilla TUTAK

ISBN 83-220-0071-5

Akceptował do druku dnia 25 X 1977 r.
dyrektor Instytutu Geologicznego
prof. dr hab. Jan MALINOWSKI

UKD 564.53 + 564.581 : 551.763.333.022.2(438:282.243.61 – 191.2)

Tłumacze:
Tekst angielski: Jerzy DŁUTEK
Tekst rosyjski: mgr Stanisław CZYŻEWSKI

© Copyright by Wydawnictwa Geologiczne, Warszawa, 1980

Redaktor techniczny: B. Modzelewska
Korektor: M. Świątlik

WYDAWNICTWA GEOLOGICZNE – WARSZAWA 1980 r.

Wydanie I. Nakład 400 + 70 egz. Ark. wyd. 22. Ark. druk. 15.5. Format A4. Papier offsetowy kl. III 80 g. Oddano do składania 26.XI.1979 r. Podpisano do druku 3.XI.1980 r. Druk ukończono w listopadzie 1980 r.

Druk Wydawnictwa Geologiczne. Zlec. 1173/79.

CONTENTS

General Part		page
Introduction		5
An outline history of studies on the Campanian and Maastrichtian of the Middle Vistula river valley		6
Tectonics		7
Stratigraphy		7
Introductory and methodological remarks		7
Campanian		9
Lower Campanian		9
Upper Campanian		12
Maastrichtian		14
Lower Maastrichtian		14
Upper Maastrichtian		16
Paleontological Part		
Material, methodological remarks, terminology		18
Explanations of symbols		18
Descriptions of taxons		19
Class Cephalopoda Cuvier, 1797		19
Order Ammonitida Zittel, 1884		19
Family Tetragonitidae Hyatt, 1900		19
Genus Gaudryceras Grossouvre, 1894		19
Genus Pseudophyllites Kossmat, 1895		19
Family Nostoceratidae Hyatt, 1894		19
Genus Bostrychoceras Hyatt, 1900		19
Genus Didymoceras Hyatt, 1894		21
Genus Nostoceras Hyatt, 1894		26
Family Diplomoceratidae Spath, 1926		28
Genus Glyptoxoceras Spath, 1925		28
Genus Neancyloceras Spath, 1926		28
Genus Diplomoceras Hyatt, 1900		30
Family Scaphitidae Meek, 1876		30
Genus Trachyscaphites Cobban and Scott, 1964		30
Genus Hoploscaphites Nowak, 1911		33
Genus Acanthoscaphites Nowak, 1911		37
Family Desmoceratidae Zittel, 1895		41
Genus Hauericeras Grossouvre, 1894		41
Family Kossmaticeratidae Spath, 1922		41
Genus Pseudokossmaticeras Spath, 1922		41
Family Pachydiscidae Spath, 1922		41
Genus Eupachydiscus Spath, 1922		41
Genus Pachydiscus Zittel, 1884		42
Genus Menuites Spath, 1922		47
Genus Anapachydiscus Yabe and Shimizu, 1926		49
Family Placenticeratidae Hyatt, 1900		51
Genus Placenticerias Meek, 1870		51
Family Sphenodiscidae Hyatt, 1900		51
Genus Sphenodiscus Meek, 1871		51
References		52
Streszczenie		56
Резюме		56
Explanations of plates		57

Summary

A monographic elaboration of the Campanian and Maastrichtian ammonites of the Middle Vistula river valley is presented in the paleontological part.

The stratigraphic part contains a revision of so far described sequences of that area's Campanian and Maastrichtian ammonites and an updating of biostratigraphic units from the viewpoint of their suitability for chronostratigraphic divisions.

The biostratigraphic zones distinguished in this paper are interpreted as a basis for chronostratigraphic units for the extra-Car-

pathian area of Poland. The applicability of these zones exceeds, of course, the boundaries of this region, in particular the *Bostrychoceras polyplacum*, *Didymoceras donezianum* and *Nostoceras* sp. nov. zones of the upper part of the Upper Campanian. Contemporary European standard stratigraphic schemata suggested for the upper part of the Upper Campanian are here interpreted as too general ones, which should be replaced by a diagram based on biostratigraphic units of the Middle Vistula river valley. Concepts of the standards of boundaries of stages and substages have also been presented and discussed in this paper.

GENERAL PART

INTRODUCTION

Revising the sequence of the Campanian and Maastrichtian ammonites and belemnites of the Middle Vistula river valley, presented so far in literature and updating biostratigraphic units from the viewpoint of their suitability to more extensively understood chronostratigraphic divisions were among the aims set himself by the present writer. The results of studies, presented in this paper, also include a monographic paleontological description of ammonites, the knowledge of which has hitherto been based on contributory taxonomic publications. Some part of paleontological descriptions is also based on materials coming from the Rostocze Region and the Miechów trough, indispensable for a more complete documentation of the taxonomic conceptions here presented.

The selection of the region of studies was induced by a classical position of the Campanian and Maastrichtian outcrops of the Middle Vistula river valley in relation not only to other profiles in the extra-Carpathian parts of Poland, but also to most Boreal regions in Europe.

The paleontological materials from the area of studies, made use of here, also include specimens collected by other persons: Professor R. Kongiel, Dr. A. Mazurek, Dr. S. Mączyńska, Dr. Z. Modliński, Dr. E. Popiel-Barczyk, Professor K. Pożaryska, Professor W. Pożaryski, Mr. A. Sokołowski M.Sc., and Dr. I. Żnińska. These materials are housed at the Geological Institute, at the Polish Academy of Sciences' Museum of the Earth and at the University of Warsaw's Center of Micropaleontology. In addition, the present writer has made use of the specimens collected by Assnt.

Professor S. Cieśliński, Professor H. Makowski, Dr. R. Marcinkowski, Assnt. Professor H. Pugaczewska and Dr. J. Stochlak.

Besides, the writer had at his disposal a comparative material from various extra-Carpathian areas of Poland, composed primarily of specimens collected by Assnt. Professor B. Areń, Dr. Z. Górzyński, Dr. M. Jaskowiak, Mrs. A. Krassowska M.Sc., Assnt. Professor J. Łyczewska, Mr. S. Popiel M.Sc., Assnt. Professor J. Rutkowski, Dr. E. Senkowicz and, finally, himself. The last-named group of materials also includes materials coming from Greenland, the U.S.A. and the Soviet Union, lent to the writer by Professor Towe Birkelund from the University of Copenhagen's Mineralogical-geological Institute and Dr. Mikhail Abramovich Pergament from the Geological Institute of the U.S.S.R.'s Academy of Sciences.

Professors Jan Samsonowicz and Władysław Pożaryski were the initiators of undertaking these studies, to whom the writer feels strongly indebted for their kind and helpful scientific guidance. His thanks are due to the reviewers of the present paper, Professor Jan Kutek and Assnt. Professor Stefan Cieśliński, whose penetrating opinions and remarks undoubtedly enhanced the quality of the work. The writer's heartfelt gratitude is also extended to his colleagues from the Paleozoological Laboratory of the Geological Institute's Center of Stratigraphy, in particular to Assnt. Professor Lidia Malinowska and Dr. Janusz Kopik, for their valuable remarks and discussions, concerning the subjects dealt with in the paper.

The writer is also grateful to all persons mentioned above who kindly allowed him to make use of their collections, as well as to Mrs. Danuta Oleksiak for

taking photographs of the specimens described and to Mrs. Stanisława Pacuszka for technical aid during his studies.

AN OUTLINE HISTORY OF STUDIES ON THE CAMPANIAN AND MAASTRICHTIAN OF THE MIDDLE VISTULA RIVER VALLEY

The first publications devoted to these studies included those by J.B. Pusch (1836, 1837), K. Jurkiewicz (1872), J. Siemiradzki (1886), J. Trejdosiwicz (1893), as well as by J. Siemiradzki and E. Dunikowski (1891).

N. Krishtafovich's studies (1897, 1899) introduced a radical change in the views on the tectonic structure and age of strata. In conformity with present-day views, this investigator proved the existence of a gentle north-eastern inclination of beds and separated several stratigraphic units varying faunally. The priority in finding several species of cephalopods, characteristic of the Upper Campanian such as: *Bostrychoceras polylocum* (Roemer), *Trachyscaphites spiniger* (Schlüter), *T. pulcherrimus* (Roemer) and of the Lower Maastrichtian such as the group of *Acanthoscaphites tridens* (Kner) should be ascribed to N. Krishtafovich.

J. Siemiradzki's later views (1905, 1909) remained to a considerable extent in conformity with the results obtained by N. Krishtafovich.

C. Łopuski's publications (1911, 1912) contain a paleontological documentation, concerning stratigraphically significant species of cephalopods, part of which are taxons erected by this investigator, that is, *Pachydiscus perfidus* Grossouvre, *Anapachydiscus wittekindi* (Schlüter), *Hoploscaphites constrictus crassus* (Łopuski), *H. angulatus* (Łopuski) and *Acanthoscaphites varians* (Łopuski). A correlation of the Upper Campanian beds with Western European profiles, the first ever to be in conformity with that now accepted has also been C. Łopuski's contribution.

The occurrence of the few cephalopods mentioned above in the Campanian beds is confirmed in A. Mazurek's (1915) paper. The list of the cephalopods has been extended by the studies of J. Nowak (1913a, 1913b, 1917), who added to it such species as: *Belemnella lanceolata* (Schlotheim), *Belemnitella junior* Nowak, *Acanthoscaphites? roemeri* (d'Orbigny) = *A. ? tuberculatus* (Giebel), "*Anisoceras? elegans* Moberg (= ? *Neancyloceras phaleratum* (Griepenkerl)) and *Pachydiscus kaliszanensis* Nowak.

J. Samsonowicz's publications (1932a, 1932b, 1934) constitute a significant stage in studying the range of particular species of the genus *Gonioleuthis* that is, *G. quadrata* (Blainville) and *G. granulata* (Blainville).

W. Krach's publication (1931) is a paleontological contribution to the knowledge of bivalves and gastropods from the upper beds of the profile.

In his paper, based, among other things, on materials from the Vistula river valley, Z. Sujkowski (1931) was the first to employ petrographical studies as a method of the paleogeographical analysis.

The occurrence of a new species, *Belemnella kazimiroviensis* (Skolodrówna), a taxon of considerable importance to the division of the Upper Maastrichtian, was proved in 1932 by Z. Skolodrówna.

New bases for discussing the age of the uppermost beds of this profile were supplied in L. Matwiejówna's and R. Kongiel's publications (1935–1937).

A new, fundamental stage of learning the Senonian stratigraphy and tectonics of the Vistula river valley was opened by W. Pożaryski's works (W. Pożaryski, 1938, 1948, 1956; K. Pożaryska and W. Pożaryski, 1951). This was connected, among other things, with an introduction of relatively numerous newly recorded cephalopods (see Table 1) to the existing list of fauna.

K. Pożaryska's publication (1952) is a monographic, sedimentological elaboration of the uppermost beds of the Upper Cretaceous and overlying Tertiary beds.

In her next work, K. Pożaryska (1953) gives a paleontological documentation of *Sphenodiscus binckhorsti* Böhm and *Placentoceras whitfieldi* Hyatt (= *P. meeki* Böhm), ammonite species first discovered in this profile.

K. Pożaryska's later publications (1954, 1957) open studies devoted to microorganisms of the Upper Cretaceous of the Vistula river valley. The results of her studies include correlations of the ranges of the foraminifers with the ranges of diagnostic macrofauna, which essentially affects the problem of a general stratigraphic scheme. This group of publications also includes W. Pożaryski's and E. Witwicka's (1956) and H. Górka's (1967) works.

R. Kongiel's last works (1949, 1958, 1962) contain the first paleontological synthesis devoted to the Campanian and Maastrichtian belemnites and presenting numerous species first discovered in this profile including some newly erected ones, as well as that author's stratigraphic conclusions (see Table 1).

A. Radwański's work (1960) is devoted to the genesis of sedimentary structures of the Lower Senonian glauconitic zone.

W.C. Kowalski's publication (1961) makes up a study on the physico-mechanical properties of the Senonian rocks in the Vistula river valley as shown against the background of their lithological properties.

The presence of a newly recorded taxon, that is, *Belemnitella praecursor mucronatiformis* Jeletzky is proved by M. Jamiolkowski (1961). Z. Modliński's and A.B. Sokołowski's unpublished graduation dissertations of 1963, are based on fairly numerous materials of Campanian and Maastrichtian cephalopods. Z. Kurlenda's studies (1966, 1967) are aimed at updating the results obtained so far in the domains of the lithology, biostratigraphy and tectonics of the Turonian and the lower part of the Senonian. K. Pożaryska's studies on the foraminifers, occurring in the transitional stages between the Cretaceous and Tertiary (W. Pożaryski and K. Pożaryska, 1960; K. Pożaryska, 1965), introduce fundamental changes to the interpretation of the stratigraphic position of the liminary lithological members of these units in the Vistula river valley. The present

writer's articles (A. Błaszkiwicz, 1962, 1965, 1966) contain a preliminary communication on stratigraphic solutions already closely approaching those contained in the present paper. W. Pożaryski's work (1966) gives revisions of that investigator's former findings as compared with contemporary interpretations of index cephalopods. Comprehensive paleontological works, concerning brachiopods (E. Popiel-Barczyk, 1968) and bryozoans (T. Maryńska, 1969), appeared in 1968–1969. So far obtained results of studies in lithology, sedimentation and biostratigraphy were summed up

in S. Cieśliński's and W. Pożaryski's (S. Cieśliński and W. Pożaryski, 1970), K. Pożaryska's (W. Pożaryski and K. Pożaryska, 1970) and K. Wyrwicka's (S. Cieśliński and K. Wyrwicka, 1970) papers. Regional structural elaborations concerning the Vistula river valley, based on data from several borings and on detailed geophysical studies (S. Pawłowski, 1961; A. Krassowska, 1969; A. Żelichowski, 1972; E. Senkowicz, 1973; W. Pożaryski, 1974) have also appeared in recent years.

TECTONICS

The complexes under study are contained within limits of the western part of the Lublin synclinorium. The inclination of strata seems on the whole mild and general dips display NE and NNE directions. Zones of more distinct dislocations, unsettling the mild, monoclinical arrangement of strata have been recorded in few cases only. On the southern border of the area under study, we have presumably to do with a considerable flexure of strata (the flexure of Wesolówka, W. Pożaryski, 1948), intersected by the right bank of the Vistula river valley in the northern part of Świeciechów and – by the left bank – between Wesolówka and Sulejów.

A zone of dislocation lowering the strata in the area west of the Vistula's banks between Pawłowice and Kamiń (W. Pożaryski, 1948, 1956, 1974) is another, distinctly outlined, secondary element which unsettles the monoclinical arrangement of strata. The presence of this zone is indicated by, among other things, so far recorded data on the direction and magnitude of the dip of strata.

A fairly conspicuous northern displacement of the

outcrops of particular stratigraphic members of the right bank, between Wałowice and Józefów, as compared with the outcrops of these members on the left bank is a fact that should be also emphasized. These conditions are indicative, according to the views presented (W. Pożaryski, 1938, 1974), of the existence of the zones of dislocation, which lower the left-bank strata in relation to the right-bank ones.

The area stretching between Kłudzie and Dobre is a sector of profile, which did not supply any direct, detailed tectonic data. Only marls and a marly chalk are known from this area and the occurrence of only one biostratigraphic zone is indicated by faunal data coming from it. This area, making up considerable part of the entire profile, is, however, overlain as a rule by thick Quaternary deposits. The relations observed in this region do not preclude, therefore, the possibility of accepting the idea of the Cretaceous deposits occurring here as folded elements with a general NW–SE direction and low-magnitude amplitudes (A. Krassowska, 1969; A. Żelichowski, 1972; E. Senkowicz, 1973; W. Pożaryski, 1974).

STRATIGRAPHY

INTRODUCTORY AND METHODOLOGICAL REMARKS

Modifications introduced to contemporary stratigraphic solutions (W. Pożaryski, 1938, 1948, 1956, 1966; R. Kongiel, 1958, 1962; A. Błaszkiwicz, 1962, 1966) are connected with a change in the accepted principles of the classification, terminology and nomenclature of stratigraphic units, a change in the concept of true ranges and an introduction of new paleontological taxons, including those newly erected. The comparison with contemporary divisions is shown in Table 1.

The biostratigraphic units distinguished represent as a rule a variety termed in the draft of "Principles of the Polish Stratigraphic Classification, Terminology and Nomenclature" (1975) as a zone, whose lower boundary has been settled on the basis of these same features on which the upper boundary of an underlying zone is based.

A designated stratotype of the zone or a reference profile (in the case of a zone established by another investigator) is a profile with a whole assemblage of forms, accepted in the definition of the unit as diagnostic

ones, as well as with at least one taxon of those made use of for the definition of the lower boundary of the overlying unit. At the same time, it is a profile, in which the recognition of the lower boundary of the unit is one of the most accurate ones.

Recording at least one of the taxons used in the definition of the zone for determining each of its boundaries is in principle assumed as a condition for distinguishing a unit outside of the type (or reference) profile. The boundaries traced incompatibly with this principle are marked on the map of the distribution of zones by dashed lines (Fig. 1).

In the present writer's view, the role of the index taxon in the case of the variety of the zone discussed above is not limited mostly to nomenclature. An index taxon is interpreted as being at the same time among the best separated, most widely distributed and most frequently occurring species, whose range is enclosed exclusively or, at least, to the greatest extent, within limits of a zone.

The sectors of profiles including the boundaries of true ranges of particular taxons used for defining

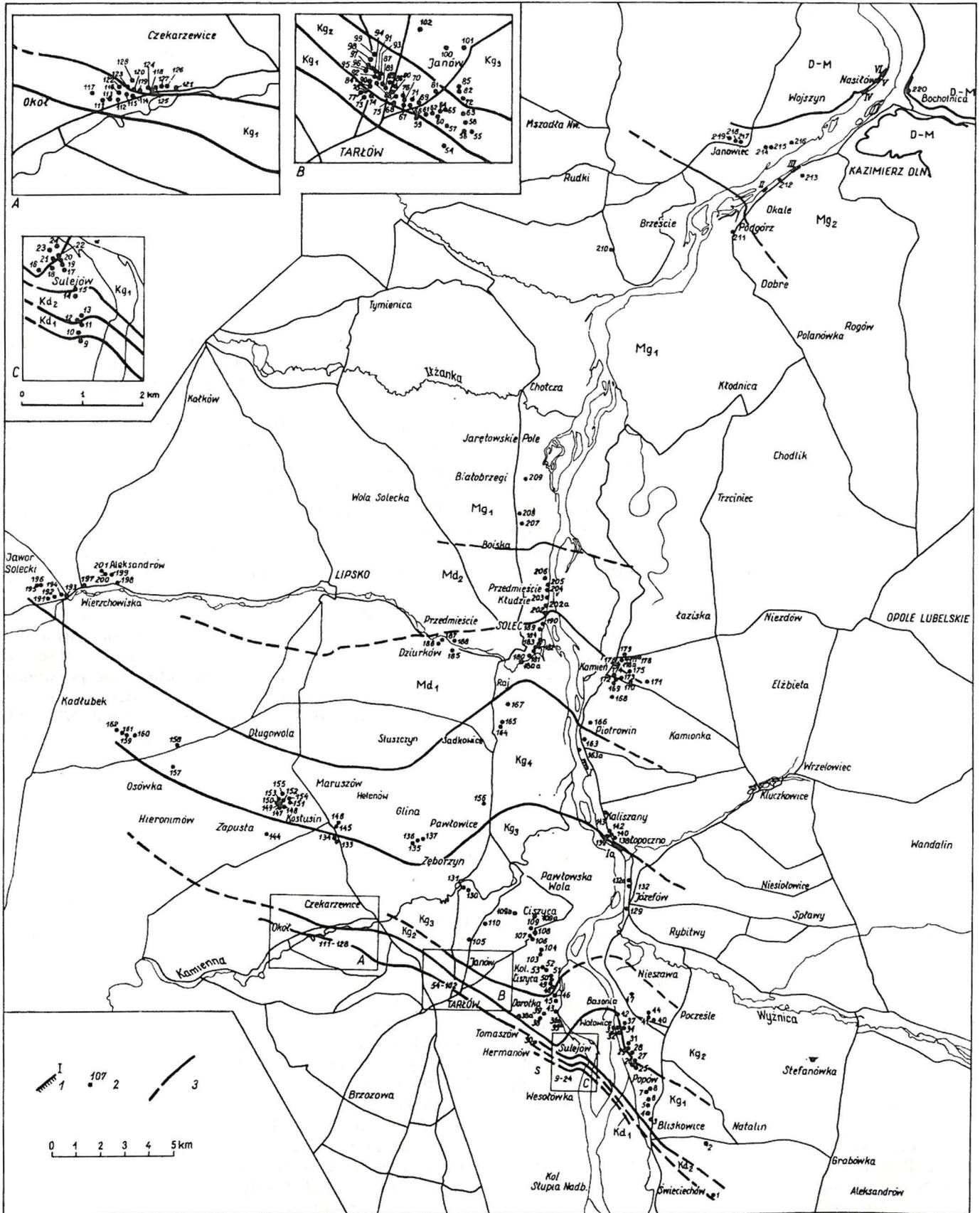


Fig. 1. Ranges of the Campanian and Maastrichtian biostratigraphic zones

1 – large consecutively numbered outcrops. 2 – small consecutively numbered outcrops. 3 – boundaries of ranges of stratigraphic zones. T to S – Turonian to Santonian. Lower Campanian: Kd₁ – *Goniatites granulata granulata* Zone. Kd₂ – *Goniatites quadrata* Zone. Upper Campanian: Kg₁ – *Neancyloceras phalaratum* Zone; Kg₂ – *Bostrychoceras polyplocum* Zone, Kg₃ – *Didymoceras donezanum* Zone, Kg₄ – *Nostoceras pozaryskii* Zone. Lower Maastrichtian: Md₁ – *Belemnella lanceolata lanceolata* Zone; Md₂ – *Belemnella occidentalis* Zone. Upper Maastrichtian: Mg₁ – *Belemnitella junior* Zone. Mg₂ – *Hoploscaphites constrictus crassus* Zone. Tertiary: D to M – Danian to Montian

A comparative presentation of contemporary stratigraphic schemes of the Campanian and Maastrichtian strata

W. Pożaryski, 1938, 1948		W. Pożaryski, K. Pożaryska, 1960; K. Pożaryska 1965; W. Pożaryski 1966		R. Kongiel, 1958, 1962		A. Błaszczewicz, 1966		A. Błaszczewicz	
DANTIAN-MONTANIAN		DANTIAN-MONTANIAN		DANTIAN-MONTANIAN		DANTIAN-MONTANIAN		DANTIAN-MONTANIAN	
UPPER		UPPER		UPPER		UPPER		UPPER	
LOWER		LOWER		LOWER		LOWER		LOWER	
<p>Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Baculites sp. Hoploscaphtes constrictus v. vulgaris Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Baculites sp. Hoploscaphtes constrictus v. vulgaris Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Baculites anceps Hoploscaphtes constrictus v. vulgaris Kossmaticeras galicianum Hauericeras gardeni Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Baculites anceps Baculites sp. Bostryhoceras schloenbachi Hamites cylindraceus Hoploscaphtes constrictus v. tenuistriatus Hoploscaphtes constrictus v. vulgaris Acanthoscaphites roemeri Acanthoscaphites tridens Pachydiscus aff. colligatus Pachydiscus egertoni neubergicus/ Hauericeras gardeni Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Hamites sp. nov. Baculites anceps Baculites sp. Hoploscaphtes constrictus v. tenuistriatus Acanthoscaphites roemeri Acanthoscaphites tridens Pachydiscus perfidus Pachydiscus colligatus Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Acanthoscaphites roemeri Pachydiscus perfidus Pachydiscus colligatus Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Anacyloceras bipunctatum Hoploscaphtes constrictus v. tenuistriatus Acanthoscaphites roemeri Belemnitella mucronata v. senior Belemnitella mucronata v. junior</p> <p>Ancylloceras bipunctatum Helicoceras aff. ellipticum Hamites wormi Baculites anceps Baculites sp. Bostryhoceras polyplacum Acanthoscaphites roemeri Hoploscaphtes constrictus v. tenuistriatus Belemnitella mucronata v. senior Belemnitella mucronata v. junior Belemnitella lanceolata</p> <p>Anacyloceras bipunctatum Baculites sp. Bostryhoceras polyplacum Acanthoscaphites pulcherrimus Acanthoscaphites roemeri Pachydiscus wittekindi Pachydiscus portlocki Belemnitella mucronata v. senior Belemnitella mucronata v. junior</p> <p>Baculites sp. Bostryhoceras polyplacum Acanthoscaphites pulcherrimus Acanthoscaphites roemeri Pachydiscus portlocki Pachydiscus wittekindi Belemnitella mucronata v. senior Belemnitella mucronata v. junior</p> <p>Baculites sp. Bostryhoceras polyplacum Acanthoscaphites spiniger Pachydiscus oldhami Belemnitella mucronata v. senior</p> <p>Hamites phaleratus Baculites sp. Bostryhoceras polyplacum Acanthoscaphites spiniger Pachydiscus oldhami Belemnitella mucronata v. senior</p> <p>Anacyloceras sp. Hamites phaleratus Baculites anceps Baculites sp. Acanthoscaphites gibbus Acanthoscaphites spiniger Belemnitella mucronata v. senior</p> <p>Baculites sp. Pachydiscus levyi Actinocamax quadratus</p> <p>Baculites anceps Baculites sp. Actinocamax quadrato-granulatus Actinocamax quadratus</p> <p>Crioceras cf. sarta Baculites sp. Actinocamax quadrato-granulatus</p> <p>Baculites sp. Actinocamax verus Actinocamax granulatus Actinocamax quadrato-granulatus</p>		<p>The Maastrichtian reworked fauna / Belemnites of the higher zone of the Upper Maastrichtian/</p> <p>Sphenodiscus binckhorsti Belemnella kazimiroviensis</p> <p>Hoploscaphtes constrictus vulgaris Belemnella lanceolata</p> <p>Belemnitella langei</p>		<p>Discoscaphites constrictus vulgaris</p> <p>Sphenodiscus binckhorsti Belemnitella junior Belemnitella nowaki Belemnitella pensansensis Belemnitella archangelakyi Belemnitella kazimiroviensis Belemnitella skolodromnae Fusiteuthis polonica</p> <p>Discoscaphites constrictus vulgaris Belemnitella junior Belemnitella nowaki</p> <p>Discoscaphites constrictus tenuistriatus Acanthoscaphites tridens Pachydiscus colligatus Belemnitella mucronata Belemnitella posterior Belemnitella minor Belemnitella langei Belemnitella najdini Belemnitella junior Belemnitella nowaki Belemnitella lanceolata</p> <p>Belemnitella lanceolata sumensis Belemnitella gracilis vistulensis Belemnitella lanceolata accidentalis</p> <p>Acanthoscaphites roemeri Pachydiscus perfidus Pachydiscus colligatus Placenticeras whitefieldi Belemnitella mucronata Belemnitella posterior Belemnitella minor Belemnitella langei Belemnitella najdini</p> <p>Bostryhoceras polyplacum Acanthoscaphites spiniger Acanthoscaphites pulcherrimus Pachydiscus wittekindi Belemnitella mucronata Belemnitella minor Belemnitella langei Pachydiscus oldhami</p> <p>"Hamites" phaleratus Acanthoscaphites gibbus Acanthoscaphites spiniger Pachydiscus oldhami Belemnitella minor Belemnitella langei Gontoteuthis quadrata quadrata</p> <p>Gontoteuthis quadrata quadrata Gontoteuthis quadrata ampullacea Gontoteuthis quadrata gracilis</p> <p>Actinocamax verus verus Actinocamax verus dnestrensis Gontoteuthis pseudopropinqua Gontoteuthis granulata</p> <p>Actinocamax verus verus and other forms as above</p>		<p>The Maastrichtian reworked fauna / Belemnites of the higher zone of the Upper Maastrichtian/</p> <p>Hoploscaphtes constrictus crassus Belemnella kazimiroviensis Belemnella kazimiroviensis subsp. nov.</p> <p>Hoploscaphtes constrictus constrictus Hauericeras sulcatum Belemnitella junior</p> <p>Acanthoscaphites bispinosus Pachydiscus neubergicus neubergicus Pachydiscus gollevillensis nowaki Neophylloceras velledaeforme Belemnella occidentalis</p> <p>Nostoceras [?]/ schloenbachi Nostoceras sp. nov. Diplomoceras cylindraceum lwovense Hoploscaphtes angulatus Hoploscaphtes aff. constrictus Hoploscaphtes constrictus subsp. nov. Acanthoscaphites quadrispinosus Acanthoscaphites bispinosus Pachydiscus colligatus subsp. nov. Pachydiscus neubergicus subsp. nov. Pseudokossmaticeras galicianum Hauericeras sulcatum Belemnella lanceolata lanceolata</p> <p>Nostoceras vistulae Neancyloceras aff. bipunctatum Hoploscaphtes sp. nov. Hoploscaphtes angulatus Acanthoscaphites sp. nov. Pachydiscus perfidus Pachydiscus colligatus subsp. nov. Pseudophyllites ndra Hauericeras aff. sulcatum Placenticeras meeki Belemnitella langei</p> <p>Cirroceras donezianum et subsp. Cirroceras donezianum Cirroceras donezianum densecostatum Cirroceras sp. nov. Neancyloceras bipunctatum Trachyscaphtes pulcherrimus pulcherrimus Trachyscaphtes pulcherrimus subsp. nov. Trachyscaphtes greenlandicus Hoploscaphtes aff. greenlandicus Acanthoscaphites tuberculatus Anapachydiscus wittekindi Munites portlocki subsp. nov. Munites sp. nov. Pachydiscus oldhami Gaudryoceras mite Belemnitella langei</p> <p>Bostryhoceras polyplacum Bostryhoceras sp. nov. Empoceras aff. beecheri Empoceras sp. nov. Cirroceras [?]/ sp. nov. Neancyloceras varium sp. nov. Trachyscaphtes spiniger Trachyscaphtes pulcherrimus pulcherrimus Hoploscaphtes greenlandicus Trachyscaphtes wittekindi Anapachydiscus sp. nov. Munites portlocki portlocki Pachydiscus koeneni Belemnitella mucronata</p> <p>Neancyloceras phaleratum phaleratum Neancyloceras phaleratum subsp. nov. Trachyscaphtes [?]/ gibbus Trachyscaphtes spiniger spiniger Trachyscaphtes spiniger subsp. nov. Pachydiscus koeneni Pachydiscus aff. koeneni Belemnitella mucronata</p> <p>Glyptoceras [?]/ retrorsum Eupachydiscus levyi Gontoteuthis quadrata Belemnitella praecursor mucronatiformis</p> <p>Actinocamax verus Gontoteuthis granulata Gontoteuthis ex gr. granulata Gontoteuthis granulato-quadrata</p>		<p>The Maastrichtian reworked fauna / Belemnites of the higher zone of the Upper Maastrichtian/</p> <p>Baculites sp. div. Diplomoceras cylindraceum cylindraceum Hoploscaphtes constrictus crassus Acanthoscaphites varians Sphenodiscus binckhorsti Belemnella kazimiroviensis kazimiroviensis Belemnella kazimiroviensis skolodromnae Belemnitella junior ?</p> <p>Baculites sp. div. Belemnitella junior</p> <p>Baculites sp. div. Hoploscaphtes constrictus anterior subsp. nov. Acanthoscaphites bispinosus Acanthoscaphites neubergicus Pachydiscus neubergicus neubergicus Pachydiscus gollevillensis nowaki Hauericeras sulcatum Belemnella occidentalis</p> <p>Baculites sp. div. Nostoceras [?]/ schloenbachi Nostoceras sp. Nostoceras [?]/ schloenbachi Diplomoceras cylindraceum lwovense Hoploscaphtes minimus sp. nov. Acanthoscaphites quadrispinosus Acanthoscaphites bispinosus Pachydiscus neubergicus variocostatus subsp. nov. Pachydiscus colligatus latumbilicatus subsp. nov. Pseudokossmaticeras galicianum nov. Belemnella lanceolata lanceolata</p> <p>Baculites sp. div. Nostoceras pozaryskii sp. nov. Neancyloceras aff. bipunctatum Hoploscaphtes vistulensis sp. nov. Hoploscaphtes minimus sp. nov. Hoploscaphtes angulatus Acanthoscaphites prequadrispinosus sp. nov. Pachydiscus perfidus Pachydiscus cf. colligatus latumbilicatus subsp. nov. Pseudokossmaticeras galicianum Pseudophyllites ndra, Placenticeras meeki Hauericeras aff. sulcatum Belemnitella langei</p> <p>Baculites sp. div. Didymoceras donezianum Didymoceras densecostatum Didymoceras postremum sp. nov. Neancyloceras bipunctatum Hoploscaphtes greenlandicus Hoploscaphtes [?]/ sp. Trachyscaphtes pulcherrimus Acanthoscaphites [?]/ tuberculatus Pachydiscus cf. oldhami Munites portlocki posterior subsp. nov. Anapachydiscus wittekindi Gaudryoceras cf. mite Belemnitella langei</p> <p>Baculites sp. div. Bostryhoceras polyplacum polyplacum Bostryhoceras polyplacum schlueteri subsp. nov. Bostryhoceras unituberculatum sp. nov. Didymoceras sp. nov. [?] Didymoceras cf. beecheri Didymoceras cf. secense Neancyloceras sp. Hoploscaphtes greenlandicus Trachyscaphtes spiniger Trachyscaphtes spiniger posterior subsp. nov. Pachydiscus koeneni Munites portlocki portlocki Anapachydiscus wittekindi Anapachydiscus vistulensis sp. nov. Belemnitella minor</p> <p>Baculites sp. div. Trachyscaphtes spiniger spiniger Trachyscaphtes spiniger posterior subsp. nov. Trachyscaphtes [?]/ gibbus Neancyloceras phaleratum Pachydiscus koeneni Belemnitella mucronata s. l.</p> <p>Baculites sp. div. Glyptoceras retrorsum Eupachydiscus levyi Gontoteuthis quadrata Belemnitella praecursor mucronatiformis Belemnitella ex gr. mucronata</p> <p>Baculites sp. div. "Crioceras" sarta [?] Gontoteuthis granulata granulata Gontoteuthis granulata quadrata Gontoteuthis pseudopropinqua Actinocamax verus</p>	

zones, which have been determined on the basis of available data varying in the degree of probability, display distinct differences in size. This differentiation is also conspicuous when we compare the sectors of type profiles which include the boundaries of true ranges of taxons made use of for defining the boundaries of zones. The size of these sectors is, however, mostly not large as compared with the thickness of zones. The boundaries of zones have been drawn in an interpolative manner within the limits of the determined sectors, which include the boundaries of true ranges of taxons. Outside type profiles, the boundaries of zones have, however, been recognized in some cases also on the basis of other data such as tectonic and lithological ones.

The biostratigraphic zones, distinguished at present in the Middle Vistula river valley, are regarded as a basis for chronostratigraphic units for extra-Carpatian areas of Poland (R. Kongiel, 1962; A. Błaszkiwicz and S. Cieśliński, 1973). The biostratigraphic zones, presented in this paper, are also treated as a basis for chronostratigraphic units for this region. The applicability of these zones exceeds, of course, the boundaries of this region, in particular the *Bostrychoceras polyplacum*, *Didymoceras donezianum* and *Nostoceras* sp. nov. zones of the upper part of the Upper Campanian. The zones mentioned above are based on the ammonites of the groups, which are best known and most widely distributed (the families Nostoceratidae, Scaphitidae and Pachydiscidae). On the other hand, a current knowledge of classical European sequences, representing the same time interval, is undoubtedly considerably smaller and these sequences may supposedly belong as a whole to less favorably developed ones. In the light of the present writer's studies conducted in the Middle Vistula river valley, the stratigraphic patterns, proposed for this time interval as general European schemata (J.A. Jeletzky, 1958, 1968; T. Birkelund, 1965; W.D. Ilin, 1969), are too general in character and should be, at least in the case of the central European Boreal paleogeographical zone, replaced by another scheme based on subdivisions in the Middle Vistula river valley.

Differences in formulations are connected with a different concept of the species *Bostrychoceras polyplacum* (Roemer), which in all stratigraphic diagrams occurs as an index species, while in the European schemata mentioned above its name includes various species and genera of the Nostoceratidae Hyatt, which display considerable differences in their vertical range.

In conformity with contemporary propositions concerning the principle of a formal stratigraphic classification¹, the problem of the standards of general chronostratigraphic units, that is, substages and units of the higher rank, have been reduced by the present writer exclusively to the problem of the standards of lower boundaries of these units. In other words, the

standard of a lower boundary of a given substage automatically defines the upper boundary of the preceding substage. Also, correspondingly to part of these formulations, the accepted standard of the lower boundary of a basal substage is, at the same time, a standard for the lower boundary of a stage.

CAMPANIAN

Lower Campanian

Lower boundary. The lower boundary of the *Diplacmoceras bidorsatum* Zone² (F.A. Roemer, 1841), based on the complete range of the index taxon, is accepted as a standard of the Santonian-Campanian boundary.

The solution presented above is based on both historical and factual premises, which include the following ones:

1 – *Diplacmoceras bidorsatum* (Roemer) is an index species of the lowermost zone of the Campanian in the type area in the case of divisions, which accurately refer to the original range of a stage and which are based on the cephalopods (H. Coquand, 1856, 1857; A. Grossouvre, 1894, 1901; R. Abrard, 1948; E. Basse de Ménerval and J. Sornay, 1959).

2 – In A. Grossouvre's division (1901), the first ever division of the Campanian proposed explicitly as a general, standard scheme, *Diplacmoceras bidorsatum* (Roemer) is an index species of the lowermost zone of the Campanian.

3 – F.A. Roemer's species has at present been generally accepted as an index species of the lowermost zone or subzone of the Campanian, considered as standards for European areas (N.P. Mikhailov, 1951; J.A. Jeletzky, 1955, 1958, 1968; C.W. Wright, 1957; R. Dalbiez, 1959; F. Schmid, 1959b; T. Birkelund, 1965; V.D. Ilin, 1969).

4 – F.A. Roemer's species includes in its range of distribution the areas of both the Tethyan and Boreal zoogeographical zones and, under the conditions of present-day knowledge, there is no foundation for assuming its diachronous appearance in these areas.

5 – In the light of currently available data, the lower boundary of the total range of F.A. Roemer's species can be correlated with the boundaries of total ranges of other cephalopods, which display a wider geographical distribution.

6 – Current concepts concerning the situation of the lower boundary of the true range of F.A. Roemer's species in classical European profiles do not arouse substantial doubts.

Taking into account a standard area of the lower boundary of a total range of F.A. Roemer's species, this boundary, under the conditions of the present state of studies, seems to be best and most accurately defined in the region of Brunswick, the Federal Re-

¹ Cf., among other works: H.D. Hedberg, 1972; J.H. Callomon and D.T. Donovan, 1966; L. Störmer, 1966; T.N. George et al., 1969; N.F. Hughes et al., 1967; J. Wiedmann, 1970; Projekt stratigraficheskovo kodeksa S.S.S.R. (collective work), 1970; J. Kutek, 1971; G. Thomel, 1973; Zasady polskiej klasyfikacji, terminologii i nomenklatury stratygraficznej (Principles of the Polish Stratigraphic Classification, Terminology and Nomenclature; a collective work).

² F.A. Roemer, 1841, Pl. 13, Fig. 5a–b; C. Schlüter, 1867, Pl. 4, Figs. 1–2; 1871–1876, Pl. 15, Figs. 6–8; A. Grossouvre, 1894, p. 137; G. Müller and A. Wollemann, 1906, Pl. 3, Figs. 1–3, Pl. 9, Fig. 2.

public of Germany (E. Stolley, 1897; G. Müller and A. Wolleemann, 1906; J.A. Jeletzky, 1958; F. Schmid, 1959b).

In the Middle Vistula river valley, the lower boundary of the Campanian has been traced by the present writer on the basis of taxons of the genus *Goniotoothis* Bayle. More or less in conformity with the existing solutions, this writer assumes that the lower boundary of a total range of *Diplacmoceras bidorsatum* (Roemer) is synchronous with the lower boundary of a corresponding range of *Goniotoothis granulata granulata* (Blainville) — J.A. Jeletzky, 1955, 1958, 1968; F. Schmid, 1959b; A. Błaszkiwicz, 1966. This correlation is based on data published from the area of the Federal Republic of Germany, where specimens of *Diplacmoceras bidorsatum* (Roemer) and *Goniotoothis granulata granulata* (Blainville) have been found in these same sections (C. Schlüter, 1871–1876; E. Stolley, 1897; T. Wegner, 1905; G. Müller and A. Wolleemann, 1906; L. Riedel, 1931; J.A. Jeletzky, 1958; F. Schmid, 1959b). The region of the Middle Vistula river valley seems to be situated outside the area of a regular occurrence of *Diplacmoceras bidorsatum* (Roemer). We can also suppose that this is an area of the Boreal zoogeographical zone, marked by lower water temperatures than those in Brunswick.

In so far published works (W. Pożaryski, 1938, 1948; R. Kongiel, 1962; Z. Kurlenda, 1966, 1967) on the Middle Vistula river valley, the lower boundary of the Campanian is placed higher in the stratigraphic profile as compared with this author's previous formulations and those adopted in the present paper. In some cases, this is undoubtedly connected with a different correlation between the range of *Diplacmoceras bidorsatum* (Roemer) and those of forms of the genus *Goniotoothis* Bayle.

The *Goniotoothis granulata granulata* Zone. In addition to the index species, *G. granulataquadrata* (Stolley)

and *Actinocamax verus* Miller are among the taxons on which the concept of the zone is based primarily (Table 2). In the assumed concept of the zone, the appearance of the index taxon marks its lower boundary, while the upper boundary of this taxon's range is situated in the roof part of the zone.

The appearance of *Goniotoothis granulataquadrata* (Stolley) is also interpreted as concordant or almost concordant with the lower boundary of the zone, while the upper boundary of this species' vertical range is placed within an interval contained between the uppermost part of the unit under study and the lower part of the next unit.

The true appearance of *Actinocamax verus* Miller is undoubtedly decidedly earlier as compared with that of the remaining taxons, while the upper boundary of this species' range has been placed in beds of the unit under study.

The reference profile of the lower zone of the Lower Campanian is situated in the area of the left-hand scarp of the Vistula valley south of Sulejów (Fig. 1).

Except for a rather thin glauconitic bed (Fig. 2), occurring in its lower part, the beds of the unit under study are composed of opoka rocks, frequently containing cherts (the classification of rocks is in conformity with W. Pożaryski's formulation of 1938 and 1948 and K. Pożaryska's of 1952).

The formation of the glauconitic bed, containing several sedimentary structures (cf. A. Błaszkiwicz, 1962), was connected with essential changes in the sedimentary regimen.

In the light of the results of contemporary studies, devoted to fossil surfaces of underwater breaks in sedimentation (K. Pożaryska, 1952; E. Voigt, 1959; V. Jaanusson, 1961; W. Pożaryski, 1960a; J. Rutkowski, 1965; J. Kutek and A. Radwański, 1967; J. Kazimierzczak and A. Pszczółkowski, 1968; J. Kutek, 1969), a surface separating the glauconitic bed from underlying

* Occurrence

g to j — zones established by W. Pożaryski (1938); I to VI — large outcrops; 1 to 220 — small outcrops

I — I. IV-zone j: 63, 88, 92, 107, 173, 181, 185, 186, 215; zones g–j: 2 — 22, 27, 34, 38a, 61, 83, 94, 96, 125, 128; S of Dorotka: 3 — 39, 45, 46; Dorotka: zone o, general localization: Janów-zone determined by outcrops 55, 56 and 58; 4 — 22, 28, 29, 31, 34, 36, 38a, 42, 83, 84, 90, 120, 123, 124, 125, 127, 128; Wałowice: zone k, zone m, general local. Sulejów — general local.: S of Dorotka: Okól — general local.: 5 — 22, 125; 6 — 67; 7 — 39–41, 43, 45, 46, 71, 86, 92–94; Dorotka: zone n, general local: Basonia — E part: 8 — 63; Kol. Ciszycza — zone p: 9 — 50–52; Kol. Ciszycza: zone p, general local.: Ciszycza (in general); 10 — Kol. Ciszycza — general local.: 11 — 107–110; Ciszycza Górna: zone s, general local.: Józefów (area of the slope); 12 — I: Helenów (E of the village); 13 — 197; 14 — Kamień — zone u; 15 — 13; 16 — 4–8, 17, 19, 20, 26, 32, 42, 59, 74, 77, 78, 111, 112; Wałowice — general local.: Sulejów — general local.: Janów — general local.: Okól — general local.: 17 — 22; 18 — 103; 19 — 144; 20 — Solec — zone v; 21 — 213; Kazimierz — zone v; 22 — 113; 23 — 4–6, 15 (?); Okól — general local.: 24 — 8, 18, 22, 23, 26, 27, 29, 32, 34, 41, 42, 44, 57, 74, 76, 77, 83, 88, 89, 92, 96, 112, 124, 126, 128; Dorotka — general local.: Janów — general local.: Okól — general local.: 25 — 39, 43–45, 47, 51, 58, 97, 103; Dorotka: zone o, zone u, general local.: Kol. Ciszycza — zone p: Ciszycza (in general); 26 — 47, 49, 81, 92; Basonia — E part: Dorotka: zone p, general local.: Ciszycza (in general); 27 — 50; 28 — I: Piotrawin — zone t; 29 — Kaliszany — general local.: 30 — 163, 166, 167; Piotrawin — zone t: Sadowice — general local.: 31 — Kludzie — zone determined by outcrops 202 and 202a; Aleksandrów — general local.: 32 — II, III, VI: 212, 215, 216, 219, 220 — zones x and y; Kazimierz — zone x; Bochońnica — zone x; Janowiec — zone x; Nasilów — zone x; 33 — 103, 107, 132; Ciszycza Górna — general local.: Ciszycza (in general); Józefów — general local.: 34 — I, 136, 138, 139, 143, 145–147, 149–151, 153, 162; Kaliszany — general local.: Piotrawin — zone t; Pawłowice — N part: Sadowice — N part: Maruszów–Kostusina area (general local.): 35 — 166, 185, 190, 194; Kamień — zone u; Raj — NW part: Solec — zone v; Solec (Przedmieście Bliższe — Nearer Suburb) — zone u; environs of Solec: 36 — 172, 183, 186, 194, 202a; Solec — zone v; Solec (Przedmieście Bliższe — Nearer Suburb) — general local.: Solec (Przedmieście Dalsze — Further Suburb) — zone u; environs of Solec; environs of Dąbrówka Daniszewska: Jawor Solec: Aleksandrów — W part: 37 — III: 38 — I: 39 — 39, 47, 49, 50, 52, 56, 58, 63, 99; Kol. Ciszycza — zone p: 40 — 41, 44, 60, 61, 91, 94; Dorotka — S part: 41 — 46, 47, 63, 81, 99; Basonia — E part: Dorotka — zone o; environs of Janów: 42 — 48–50, 72; Kol. Ciszycza: zone p, general local.: Ciszycza (in general); 43 — 4, 20, 22, 34, 59, 60, 62, 70, 77, 87, 88, 96, 112, 115, 117, 122, 126–128; Sulejów — general local.: 44 — 48, 50, 103, 108, 109; 45 — I, 136, 147; 46 — 172; Kamień — zone u; 47 — Kludzie — zone v; 48 — Kludzie — zone v; 49 — I; 50 — 172, 173, 182; 51 — I: Dziurków — zone u; 52 — 107; 53 — I; 54 — 153; 55 — Kludzie — zone u; 56 — I; 57 — Nasilów — zone y; 58 — 9, 10; 59 — 10; S of Sulejów: 60 — 10, 11; Sulejów — zone l; 61 — S of Sulejów (zones g and h ?); 62 — I, 12, 14 (?); Sulejów: zones i and j: 63 — Sulejów — zone i; 64 — 13; 65 — 7, 14 (?); 113; 66 — 89; 67 — I, Ia: 107, 109, 130, 133, 134, 139, 140, 147, 150, 151, 153, 155, 163, 163a, 167; Helenów — S part: Maruszów — W part: Piotrawin — S part: 68 — 211, 213 (?); Boiska: zone determined by outcrops 107 and 208 (?); Kazimierz (?): zone v; Bochońnica (?): zones x to z; Nasilów (?): zones x to z; 69 — 166, 168, 170, 172, 180a, 181, 183–185, 189, 191, 194; Kamień — zone u; Raj — zone u; Solec — zones u and v; Solec (general local.): 70 — 175, 202, 202a, 203, 204; Kludzie — zone v; Kludzie (general local.): 71 — VI — zone z; Kazimierz: zones x to z; Bochońnica: zones x to z; Nasilów: zones x to z; 72 — IV — zone x; 73 — Kazimierz: zones x to z; Bochońnica: zones x to z; Nasilów: zones x and z; 73 — Bochońnica — zone z; Nasilów — zone z;

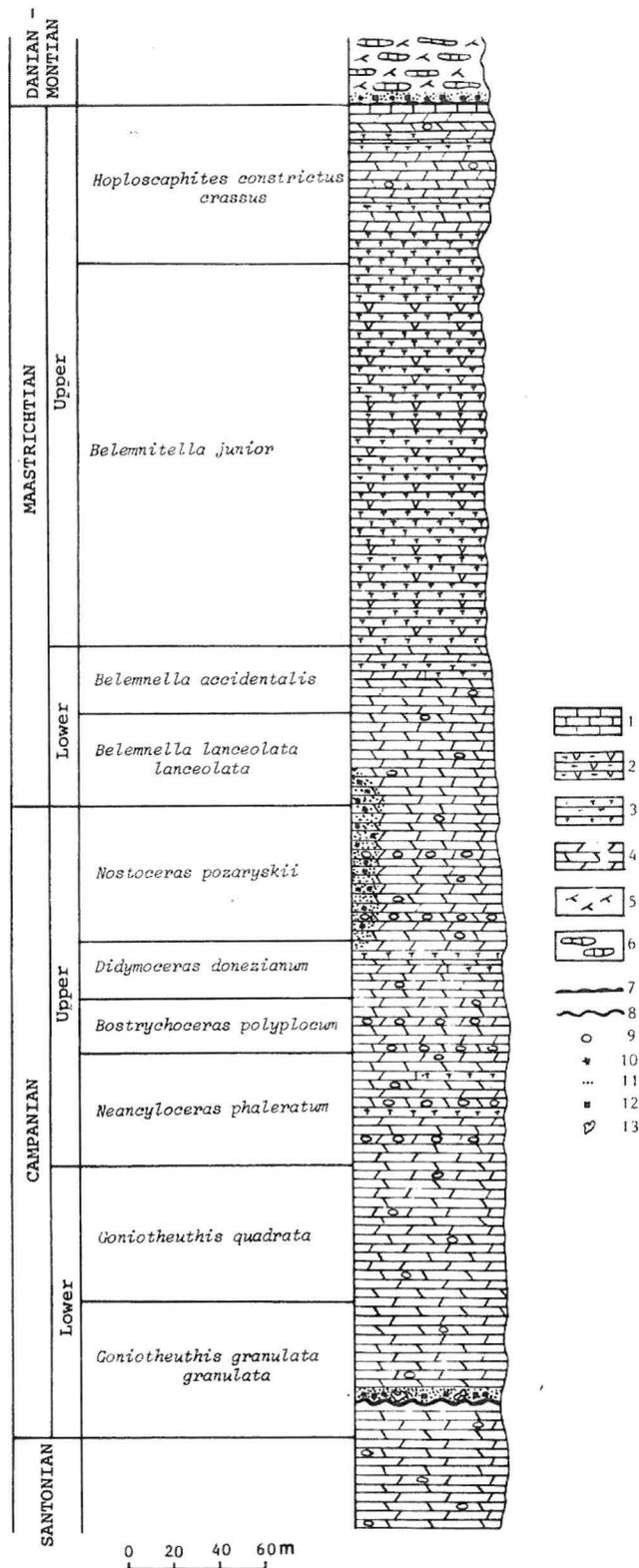


Fig. 2. A schematic lithostratigraphic profile of the Campanian and Maastrichtian

1 - limestones. 2 - marly chalk. 3 - marls. 4 - opokas. 5 - gaizes. 6 - calcareous intercalations. 7 - hard bottom. 8 - sedimentary discontinuity surface. 9 - cherts. 10 - glauconite. 11 - quartz. 12 - phosphorites. 13 - fragmentary opokas on a secondary deposit

rocks, seems to be an example of the surfaces of this type, whose genesis is generally ascribed to the activity of currents.

The phenomena recorded reflect general paleogeographical changes, which occurred in the extra-Carpathian areas of Poland during the period of the sub-Hercynian orogeny (W. Pożaryski, 1960, 1962; M. Jaskowiak, 1966; S. Cieśliński and W. Pożaryski, 1970; S. Milewicz, 1973; S. Radwański, 1973; A. Błaszkiwicz et al. 1970; S. Cieśliński and M. Jaskowiak, 1973).

The *Goniotheuthis quadrata* Zone. In addition to the index species, several other cephalopods, such as *Eupachydiscus levyi* (Grossouvre), *Glyptoxoceras retrorsum* (Schlüter), and *Belemnitella praecursor* (?) *mucronatiformis* Jeletzky were recorded in the strata of the unit under study. Determining accurate boundaries of their ranges poses, however, more difficult problems. In the accepted concept of the zone, the true range of the index species is contained between the floor and ceiling of the zone. The area of the scarp of the Vistula valley in the environs of Sulejów is a reference profile. The unit under study is composed of opoka rocks with cherts.

Upper Campanian

Lower boundary. In contemporary elaborations, making use of standard European ammonitic units, the *Hoplitoplacenticeras coesfeldiense* or the *Hoplitoplacenticeras marroti* zones (cf. T. Birkelund, 1957, 1965; C.W. Wright, 1957; J.A. Jeletzky, 1958, 1968³; V.D. Ilin, 1969) have been considered as a basal unit of the Upper Campanian.

In the present paper, the lower boundary of a zone based on the total range of C. Schlüter's species⁴ has been adopted as referential to the lower boundary of the Upper Campanian. Despite the fact that it is rather H. Coquand's⁵ species which would be recommended on the basis of historical data, the predominance of C. Schlüter's species, resulting from a possibility of using it for stratigraphic correlations, makes the latter taxon more important. C. Schlüter's species, better known in European areas, allows one for a more certain correlation of the lower boundary of its stratigraphic range with the boundaries of ranges of other diagnostic taxons.

In the present state of knowledge, the position of the lower boundary of the total range of *Hoplitoplacenticeras coesfeldiense* (Schlüter), seems to be most precisely determined in the area of the Münster trough, the Federal Republic of Germany (C. Schlüter, 1871-1876; R. Giers, 1934, 1958; J.A. Jeletzky, 1951).

H. coesfeldiense (Schlüter) has never been recorded in the Middle Vistula river valley. However, the pre-

³ In J.A. Jeletzky's papers, the species *Hamites phaleratus* Griepenkerl (= *Neancyloceras*) was made use of in addition to *Hoplitoplacenticeras coesfeldiense* (Schlüter).

⁴ C. Schlüter, 1867, Pl. 1, Figs 1 and 4, Pl. 2, Fig. 3; 1871-1876, Pl. 20, Figs. 5-6, Pl. 44, Figs. 5-7; N.P. Mikhailov, 1951, Pl. 14, Fig. 57, Pl. 15, Fig. 60, Pl. 17, Fig. 72, Pl. 13, Figs. 53 and 54, Pl. 18, Fig. 89.

⁵ A. Grossouvre, 1894, Pl. 8, Fig. 3, Pl. 9, Figs. 1-3. This species is in fact an index taxon of the lowermost zone of the Upper Campanian in A. Grossouvre's division of 1894 and 1901 - in the stratotype area.

sence of a species was found, the lower boundary of whose total range may, in the light of currently available data, be correlated with the lower boundary of the total range of *H. coesfeldiense* (Schlüter). This taxon is *Trachyscaphites spiniger* (Schlüter).

This correlation, assumed by the present writer, is based primarily on an analysis of data from the sections, in which the two taxons were found and which concern both the southernmost area of extra-Carpathian Poland (A. Błaszkiwicz, 1969) and other European areas of the Boreal zoogeographical zone (Westphalia, the Federal Republic of Germany, C. Schlüter, 1871–1876; R. Giers, 1934, 1958; Donbass, the U.S.S.R. – N.P. Mikhailov, 1951; D.P. Naydin, 1959, 1960).

It seems that in the Middle Vistula river valley we have to do, if not with a complete lack then at least with an incomparably less frequent occurrence of *Hopliotoplacentceras coesfeldiense* (Schlüter) as compared with that in Donbass and Westphalia. As opposed to those areas of the Boreal zoogeographical zone, the region of the Vistula valley was not, in all likelihood, part of an area, in which this species appeared regularly.

In other contemporary authors' publications, dealing with the Middle Vistula river valley (W. Pożaryski, 1938, 1948, 1956; R. Kongiel, 1962), the lower boundary of the Upper Campanian has been traced primarily on the basis of the appearance of forms connected either with *Belemnitella mucronata* (Schlotheim), or *B. langei* Jeletzky, or *B. minor* Jeletzky. In these elaborations, the lower boundary of the Upper Campanian is placed in the profile somewhat lower than in the this writer's presentation (Table 1).

The *Neancyloceras phaleratum* Zone. In the assumed concept of the zone, its lower boundary is determined by the lower boundary of the range of *Trachyscaphites spiniger spiniger* (Schlüter). On the other hand, the appearance of the index species is interpreted as rather conspicuously later one than that of C. Schlüter's taxon. The upper boundary of the range of *T. spiniger spiniger* (Schlüter) is assumed as being located within the upper part of the zone, while in the case of the index species, the possibility is assumed of only a very small difference between the upper boundary of its range and the upper boundary of the zone. *T. spiniger posterior* subsp. nov. and *Pachydiscus koeneni* Grossouvre are among the remaining taxons recorded in this zone and allowing one for a fairly accurate delimitation of the boundaries of true ranges. The appearance of the former is a character determining the upper members of the zone and, of the latter, the lower members. The two taxons pass, however, to the next unit.

The area of the scarp of the Vistula valley at Sulejów is also a reference profile.

The strata of the unit under study are composed of opoka rocks, which rather rarely contain cherts. In the eastern area, small (a dozen or so cm. in diameter) inclusions of the marly type (Z. Modliński, 1963) were sporadically recorded at Bliskowice, while in the western one the occurrence of opoka rocks, with an admixture of glauconite distinctly visible macroscopically (W. Pożaryski, 1948) was stated at Okół in certain sectors of the profile.

The *Bostrychoceras polyplocum* Zone. *Bostrychoceras polyplocum* (Roemer), an index species of this zone is

represented in the Middle Vistula river valley by two formally erected subspecies, that is, the nominal subspecies and the newly erected *Bostrychoceras polyplocum schlueterri* subsp. nov.

F.A. Roemer's species is a taxon generally distinguished in most elaborations of the Middle Vistula river valley. In other authors' works, the same as in several contemporary European publications, the concept of F.A. Roemer's species is, however, wider as compared with that of the present writer. The name *Bostrychoceras polyplocum* (Roemer) includes various species and genera of the Nostoceratidae Hyatt. The assumption by the present writer of a narrower scope of F.A. Roemer's species in relation to other presentations is connected with the limitation of its total range and separation of several species, which represent the genera *Bostrychoceras* Hyatt, *Didymoceras* Hyatt and *Nostoceras* Hyatt.

In the accepted concept of the zone, its lower boundary is determined, in addition to the lower boundary of the range of index species, by a corresponding boundary of the species *Bostrychoceras unituberculatum* sp. nov. In regard to the upper boundary of the range of index species, that is, *B. polyplocum* (Roemer), it is assumed to occur within an interval which includes a small ceiling part of the unit under study and a corresponding floor part of the next unit. In the case of the other species, that is, *B. unituberculatum* sp. nov., this boundary is placed in the middle part of the zone.

The remaining taxons, recorded in the strata of the unit under study and on which its concept is based primarily, include: *Didymoceras varium* sp. nov., *Pachydiscus koeneni* Grossouvre, *Menuites portlocki portlocki* (Sharpe), *Anapachydiscus wittekindi* (Schlüter), *A. vistulensis* sp. nov., *Trachyscaphites spiniger posterior* subsp. nov., *T. pulcherrimus* (Roemer) and *Hoploscaphites greenlandicus* (Donovan). *Didymoceras varium* sp. nov., *A. wittekindi* (Schlüter), *A. vistulensis* sp. nov. and *T. pulcherrimus* (Roemer) are species whose appearance was assumed in the middle part of the unit, while the beginning of the occurrence of *Menuites portlocki portlocki* (Sharpe) and *Hoploscaphites greenlandicus* (Donovan) is believed to be rather higher up, that is, in the upper part of the unit. The upper boundary of the range of particular taxons is decidedly assumed above the upper boundary of the zone only in the case of three of them, *A. wittekindi* (Schlüter), *T. pulcherrimus* (Roemer) and *Hoploscaphites greenlandicus* (Donovan). The range of *A. vistulensis* sp. nov. is related with the middle part of the zone. The upper boundary of the occurrence of *Menuites portlocki portlocki* (Sharpe) is assumed in the roof of the zone. In the case of *Didymoceras varium* sp. nov., the possibility has been assumed of a slight deviation of the upper boundary of its range from the upper boundary of the unit. The upper boundaries of the ranges of *Pachydiscus koeneni* Grossouvre and *Trachyscaphites spiniger posterior* subsp. nov., taxons which pass from the underlying unit, are related with the upper part of the zone.

The stratotype of the unit is contained between Sulejów and the northern part of Dorotka.

The strata of the unit under study are composed of opoka rocks with silica concentrations, locally displaying the tendency to occur in the form of thin beds.

The *Didymoceras donezianum* Zone. In the concept assumed, its lower boundary is determined by the appearance of *Menuites portlocki posterior* subsp. nov., whose total range is related with the lower part of the zone. The assumed vertical range of the index species occurs exclusively in the lower sector of the zone. The remaining taxons, primarily forming a characteristic assemblage, are: *Didymoceras postremum* sp. nov., *Acanthoscaphites* (?) *tuberculatus* (Giebel), *Trachyscaphites pulcherrimus* (Roemer), *Hoploscaphites greenlandicus* (Donovan), *Pachydiscus* cf. *oldhami* Grossouvre, *Anapachydiscus wittekindi* (Schlüter) and *Belemnitella langei* Jeletzky. The vertical range of the species passing from the former unit is interpreted as reaching either the middle part of the zone (*Trachyscaphites pulcherrimus* (Roemer), *Acanthoscaphites* (?) *tuberculatus* (Giebel) and *Hoploscaphites greenlandicus* (Donovan)), or its lower part (*Anapachydiscus wittekindi* (Schlüter)). Of the remaining taxons, the range of *Didymoceras postremum* sp. nov. is assumed rather only in the middle and that of *Pachydiscus* cf. *oldhami* (Sharpe) – in the lower and middle part of the zone. *Belemnitella langei* Jeletzky is interpreted as a species which appears in the middle part of the zone and passes to the next zone.

The stratotype runs from a point north of Dorotka, through Kolonia Ciszycza and Ciszycza Górna, to the environs of Pawłowice.

The strata of the unit under study are composed of opoka rocks. There also occur opoka beds rich in cherts. Small inclusions of rocks of the marly type (W.C. Kowalski, 1961) were also recorded in the upper part of the lower sector of type profile. The rocks of the upper part of the zone, outcropped in the westernmost area (near Kostusin), display macroscopically an increase in the content of glauconite and in porosity.

The *Nostoceras pozaryskii* Zone. In the assumed concept of the zone, its lower boundary is determined by the appearance of *Acanthoscaphites praequadriscopinosus* sp. nov., while the first occurrence of the index species is considered as pronouncedly later. In the case of upper boundaries of true ranges of the two taxons, the possibility was assumed of an only insignificant departure from the upper boundary of the unit. The remaining taxons here occurring and having more closely determined true ranges include *Pachydiscus perfidus* Grossouvre, *Hoploscaphites minimus* sp. nov. and *Belemnitella langei* Jeletzky.

The true range of *Pachydiscus perfidus* Grossouvre is seen as approaching that of *Acanthoscaphites praequadriscopinosus* sp. nov. The position in the roof part or only slightly above the upper boundary of the zone is also assumed in the case of the upper boundary of the true range passing from the former unit of *Belemnitella langei* Jeletzky. *Hoploscaphites minimus* sp. nov. is a species decidedly passing to the next unit and whose appearance is related with the upper part of the zone.

The stratotype runs from Kaliszany to Piotrawin. The strata of the unit under study are composed of opoka rocks, as well as those of the type of opoka with cherts. The opoka rocks with cherts form sometime more distinct complexes. The above characteristics concern the areas directly connected with the banks of the Vistula valley. In the area situated in the western part of the region (the environs of Maruszów, Kostusin and Głina), the strata of this unit and those connected,

with a certain reservation, with the unit under study (the environs of Ludwików) are composed of rocks similar to those of the gaize type (W. Pożaryski, 1948).

MAASTRICHTIAN

Lower Maastrichtian

Lower boundary. In most contemporary elaborations, dealing with the Campanian – Maastrichtian boundary, this boundary is determined by a simultaneous appearance of *Hoploscaphites constrictus* (Sowerby), *Belemnella lanceolata* (Schlotheim) and, probably, also of the group of *Acanthoscaphites tridens* (Kner)⁶, which, similarly as *Belemnella lanceolata* (Schlotheim), is widely distributed in the European Boreal region (J.A. Jeletzky, 1951, 1958, 1968; F. Schmid, 1955, 1967; E. Voigt, 1956; T. Birkelund, 1957, 1965; E. Calembert, 1957; D.P. Naydin, 1958, 1960, 1969; F. Hofker, 1962; W.A. Berggren, 1964; A. Błaszczewicz, 1966; W. Pożaryski, 1966; C.J. Wood, 1967; J.V. Gorsel, 1973).

The materials, available to the present writer, primarily the data from the territory of Poland coming from classical sections of the transitional sequence between the Campanian and Maastrichtian, induce one, however, to drawing the conclusion that the lower boundary of the total range of *Belemnella lanceolata* (Schlotheim) and of the group of *Acanthoscaphites tridens* (Kner), is situated conspicuously below the corresponding boundary of the species *Hoploscaphites constrictus* (Sowerby).

In the light of these materials, the lower boundary of the total range of these forms is more unquestionably comparable with the corresponding boundary of *Pachydiscus neubergicus* (Hauer), which, in some contemporary presentations (including a resolution passed during a scientific conference in Dijon, France), is primarily made use of for determining the Campanian – Maastrichtian boundary (C.W. Wright, 1957; M. Collignon, 1959; F. Dalbiez, 1959; V.D. Ilin, 1969).

The available data do not induce one, at the same time, to revise lower boundaries of true ranges of *Belemnella lanceolata* (Schlotheim) and taxons of the group of *Acanthoscaphites tridens* (Kner) currently assumed in classical Boreal profiles.

In the light of these facts and taking into account, in adopting standards of boundaries of stages, primarily their concordance with essential faunal changes, on the one hand, and with currently accepted boundaries in classical European profiles, on the other, the present writer has adopted the lower boundary of the zone based on the total range of *Pachydiscus neubergicus* (Hauer) as a reference point for the Campanian – Maastrichtian boundary.

Noteworthy is, however, the fact that it is J. Sowerby's species, whose selection is recommended by the results of an analysis of historical data. The lower boundary of the total range of the two taxons under study is presumably situated within an interval contained

⁶ The taxons of this group, found in the Middle Vistula river valley include *Acanthoscaphites bispinosus* Nowak, *A. quadriscopinosus* (Geinitz) and *A. varians* (Łopuski). In contemporary elaborations by other authors, these taxons are connected to form one taxon of the specific rank.

between the upper boundary of the range of a complex of strata, primarily made use of in the original definition of the Campanian and the lower boundary of the range of a corresponding complex of strata, concerning the Maastrichtian⁷. J. Sowerby's species has, however, been accepted earlier as an index taxon in standard divisions.

The lower boundary of the Maastrichtian in the Middle Vistula region has been traced by the present writer primarily on the basis of the range of *Belemnella lanceolata lanceolata* (Schlotheim).

The nominative subspecies of *Belemnella lanceolata* (Schlotheim) is undoubtedly among the most frequent cephalopods occurring in the lowermost strata of the Maastrichtian of the Middle Vistula river valley. The concordance of the lower boundary of its total range of occurrence with the lower boundary of the corresponding range of the species is assumed by the present writer, which seems to be in conformity with the existing elaborations (*l.c.*).

The material analyzed, identified with *Pachydiscus neubergicus* (Hauer) from the Middle Vistula river valley, comes from an upper part of the beds, containing *Belemnella lanceolata lanceolata* (Schlotheim) and from an overlying unit. Specimens from the unit under study represent only the new subspecies *Pachydiscus neubergicus raricostatus* subsp. nov. The nominative subspecies, on the other hand, is known exclusively from the higher zone.

The correlation of the lower boundary of the total range of *Pachydiscus neubergicus* (Hauer) and *Belemnella lanceolata lanceolata* (Schlotheim), assumed in the present paper, is based primarily on the data from the environs of Miechów available to its author. In the environs of Miechów, *P. neubergicus raricostatus* subsp. nov. and *Belemnella lanceolata lanceolata* (Schlotheim), found in the best studied profile (cf. also A. Błaszkiwicz, 1969), appear simultaneously, and the determined sector of profile, including the lower boundary of the total range of the latter form does not seem to represent a period longer than that of a corresponding sector in the Middle Vistula river valley. At the same time, relations between the lower boundary of the range of *B. lanceolata lanceolata* (Schlotheim) and the boundaries of the ranges of other taxons, including those of the group of *Acanthoscaphites tridens* (Kner), are markedly similar to the relations recorded in the Middle Vistula river valley.

The published data, along with W. Pożaryski's oral communication, do not indicate that the material, related so far with the species *Pachydiscus neubergicus* (Hauer), was found in the lower part of strata, containing *Belemnella lanceolata lanceolata* (Schlotheim) in the Middle Vistula river valley. In the light of the available data, the fact that the species *Pachydiscus*

neubergicus (Hauer) has never been recorded in the lower part of the unit under study, is interpreted by the present writer as resulting either from a markedly rarer occurrence of this species in this part of beds, or from its later appearance in the Middle Vistula river valley as compared with that in the Miechów through.

In the case of the group of *Acanthoscaphites tridens* (Kner), its appearance in the Middle Vistula river valley, in a profile in which the Campanian–Maastrichtian boundary was traced most accurately, was recorded in the same outcrop in which *Belemnella lanceolata lanceolata* (Schlotheim) was found.

No materials from the Middle Vistula river valley including the species *Hoploscaphites constrictus* (Sowerby), coming from the strata with *Belemnella lanceolata lanceolata* (Schlotheim), were available to the present writer. Specimens of *Hoploscaphites minimus* sp. nov., a taxon closely related to J. Sowerby's species come from these strata and from an underlying unit. Some of these specimens, included in the collections of former investigators, were assigned by them to *H. constrictus* (Sowerby).

A material, which, according to the present writer's opinion, may be assigned to J. Sowerby's species, comes only from the strata overlying those with *Belemnella lanceolata lanceolata* (Schlotheim). As revealed also by data concerning the material directly analyzed, containing J. Sowerby's species from the Miechów trough, the lower boundary of the total range of this taxon is situated above the strata with *B. lanceolata lanceolata* (Schlotheim).

In last publications, concerning the Middle Vistula river valley the lower boundary of the Maastrichtian is coincident, like in the present paper, with the appearance of *B. lanceolata* (Schlotheim) (R. Kongiel, 1962; W. Pożaryski, 1966; A. Błaszkiwicz, 1966). The lower boundary of the true range of *B. lanceolata* (Schlotheim), determined in those elaborations, may be accepted as being in conformity with its presentation in this paper (Table 1).

The *Belemnella lanceolata lanceolata* Zone. In the assumed concept of the zone, its lower boundary is determined by the appearance of the index taxon. In the case of the upper boundary of the true range of the index taxon, the possibility was assumed of its only insignificant departure from the upper boundary of the zone. The remaining taxons, recorded in this zone and playing an essential role in its concept are as follows: *Pachydiscus neubergicus raricostatus* subsp. nov., *P. colligatus latumbilicatus* subsp. nov., *Acanthoscaphites quadrispinosus* (Geinitz), *A. hispinosus* Nowak and *Hoploscaphites minimus* sp. nov.

The concept of the lower boundary of the true range of *Pachydiscus neubergicus raricostatus* subsp. nov. in the Middle Vistula river valley has been presented in the subchapter Remarks. In regard to the upper boundary, it was assumed that the range of this species may only slightly overlap the strata of the next unit.

The appearance of *Acanthoscaphites quadrispinosus* (Geinitz) is interpreted, if not exactly concordantly with the lower boundary of the range of index taxon, at least as only insignificantly departing from it.

The lower boundary of the range of *Pachydiscus colligatus latumbilicatus* subsp. nov. is assumed within

⁷ The data concerning type areas have been taken mostly:
a – for the Campanian, from the works of H. Coquand (1856, 1857), M. Arnaud (1877), A. de Grossouvre (1894, 1901), R. Abrard (1948), E. Basse de Ménorval and J. Sornay (1959), M. Séronie-Vivien (1959), J.E. van Hinte (1965, 1966, 1967), F. Goharian (1971) and J.T. van Gorsel (1973);
b – for the Maastrichtian – from J.T. Binkhorst (1861), A. de Grossouvre (1901, 1908), M. Leriche (1929), J.A. Jeletzky (1951), S. van Heide (1954), E. Voight (1956), E. Calembert (1957), F. Schmid (1959a, 1967), J. Hofker (1962), B.J. Romein (1963) and D. Richter (1967).

an interval, determined by a small part of a given, discussed zone and an insignificant roof part of the preceding zone. An analogous situation is also assumed for the lower boundary of the range of *Acanthoscaphites bispinosus* Nowak. In regard to the upper boundary of the last-named taxon, its situation is assumed well above the upper boundary of the zone.

In the case of the last taxon, *Hoploscaphites minimus* sp. nov., known also from the strata related with the former unit, discussed extensively in the previous chapter due to its considerable similarity to *H. constrictus* (Sowerby), a species, which was made use of for defining the Campanian–Maastrichtian boundary, an upper boundary of its true range, is related with the lower part of the zone under study.

Of the forms of cephalopods, found here, noteworthy is *Nostoceras* sp., recorded in the upper sector of an outcrop of the reference profile (running through the localities Piotrawin and Kamień on the right-hand bank of the Vistula), and in the overlying beds. Together with data concerning *Nostoceras pozaryskii* sp. nov., those on *Nostoceras* sp. allow one to assume a distinctly similar stratigraphic range of *Nostoceras* Hyatt in the Middle Vistula river valley and in the south-eastern areas of the U.S.A. (L.W. Stephenson, 1941; K. Young, 1960).

The species *Nostoceras* (?) *schloenbachi* (Favre) was recorded in the environs of Aleksandrów (outcrop 197) in the strata, which can be correlated with transitional members occurring between the unit under study and the next one. This species, originally based on the Lower Maastrichtian materials, is also noteworthy due to the fact that, in contemporary elaborations (cf. i.a.: N.P. Mikhailov, 1951; T. Birkelung, 1957; D.P. Naydin, 1959, D.P. Naidin, 1960), it is assigned to *Bostrychoceras polyplacum* (Roemer), an index species of the middle zone of the Upper Campanian.

The strata of the unit under study are composed of rocks of the opoka type, locally enriched conspicuously with silica.

In the environs of Jawor Solecki, the strata correlated with members of the unit discussed, consist of rocks with considerable content of the detrital quartz. However, intercalations with a lower content of this material, but more compact and richer in calcium carbonate, have also been recorded in this locality (W. Pożaryski, 1948).

The *Belemmella occidentalis* Zone. In the concept assumed for this zone, its lower boundary is determined by the appearance of its index species, while the possibility of a small difference in relation to the situation of its upper boundary has been assumed in the case of the upper boundary of the range of the index species. A characteristic assemblage of this zone is formed by the remaining taxons, that is, *Pachydiscus neubergicus neubergicus* (Hauer), *Hoploscaphites constrictus anterior* subsp. nov. and *Acanthoscaphites bispinosus* Nowak. The concepts of the situation of boundaries of their true ranges are, however, among the most debatable (within the limits of ammonites which define particular zones) and based to a considerable extent on data concerning the faunal sequence from other Boreal European areas (as follows from the present writer's former remarks, these taxons represent widely distributed groups, used as a basis for divisions, to which considerable importance

was attached). The situation of the lower boundary of the true range of *Pachydiscus neubergicus neubergicus* (Hauer) is assumed as if not exactly coincident with, at least only slightly departing from the situation of the corresponding boundary of the index species. In regard to the appearance of *Hoploscaphites constrictus anterior* subsp. nov., this interval has been extended, as compared with the interval including the former taxon, by considerable part of the lower sector of the zone. In the case of the situation of the upper boundaries of the ranges of all diagnostic forms (including *Acanthoscaphites bispinosus* Nowak, recorded in the strata of the former unit), the possibility was precluded of their distinct situation above the upper boundary of the zone.

The occurrence of *Pachydiscus gollevillensis nowaki* Mikhailov has also been found in the strata of the unit discussed. The true appearance of this taxon, despite the fact that only one specimen of it has been recorded in the Middle Vistula river valley, may also be related with the unit under study. This taxon is also known from a faunal assemblage containing *Hoploscaphites constrictus anterior* subsp. nov. from Wólka Maziariska (a locality situated west of the area of our studies) and from the environs of Lvov, U.S.S.R., where its true appearance has been marked in the upper part of the Lower Maastrichtian strata (N.P. Mikhailov, 1951; cf. also D.P. Najdin, 1969).

The reference profile runs from the area, situated north of Solec, to that, situated south of Boiska. The strata of this unit consist of rocks of the opoka type.

Upper Maastrichtian

Lower and upper boundaries. In the stratigraphic divisions proposed as standard ones for European areas, the lower boundary of the Upper Maastrichtian is determined by the appearance of the species *Sphenodiscus binckhorsti* Böhm (J.A. Jeletzky, 1958, 1968). The knowledge of this ammonite is, however, considerably more limited than that of *Belemmitella junior* Nowak,⁸ whose appearance is also used for determining the lower boundary of the Upper Maastrichtian in the divisions proposed as standard ones for European areas (J.A. Jeletzky, 1958, 1962, 1968; F. Schmid, 1967).

On the basis of the above findings, the lower boundary of the *B. junior* Zone, based on the total range of this form, has been adopted by the present writer as a point of reference of the boundary discussed above. The lower boundary of the total range of J. Nowak's taxon seems to be fairly well defined in several European areas outside the Middle Vistula river valley, that is, in the Lower Elbe region (J.A. Jeletzky, 1951; F. Schmid, 1967) and in the Lvov Region, U.S.S.R. (J. Nowak, 1913a–b, 1917); D.P. Naydin, 1952; D.P. Naidin, 1960; S.I. Pasternak et al., 1968).

The interpretation of J. Nowak's species, adopted

⁸ J. Nowak (1913a): Pl. 42, Figs. 18, 21, 25; J.A. Jeletzky (1951): Pl. 2, Figs. 2, 6, 7, Pl. 3, Figs. 1–3, Pl. 4, Figs. 1–2; D.P. Naydin (1952): Text-fig. 30, Pl. 14, Pl. 15, Figs. 1, 3, Pl. 16, Figs. 2–3, Pl. 19, Fig. 2; T. Birkelund (1957): Pl. 3, Fig. 2a–c and 3a–c; R. Kongiel (1962): Pl. 12, Figs. 7–8; Pl. 13, Figs. 1–3 (?) and 10–12 (?), Pl. 14, Figs. 1–3 (?).

by the present writer, undoubtedly departs from its concept in some publications concerning the Middle Vistula river valley (R. Kongiel, 1962). The assumed situation of the lower boundary of the Upper Maastrichtian in the profile does not, however, display any major differences as compared to that so far presented by other authors (W. Pożaryski, 1938, 1948, 1956; R. Kongiel, 1962). This is related with the coincidence of the assumed positions of the upper boundary of the true range of some forms recorded in the Lower Maastrichtian (Table 1).

The upper boundary of the unit under study is understood, according to a generally accepted formulation, as corresponding to the extinction of the species of ammonites and *sensu stricto* belemnites. As shown by the results of recent studies on the foraminifers and on the development of strata on the boundary between the Cretaceous and Tertiary of extra-Carpathian Poland (W. Pożaryski and K. Pożaryska, 1960; K. Pożaryska, 1965, 1967), the time of this extinction is coincident with the appearance of a numerous assemblage of the foraminifers. The results of these studies also indicate that the stratigraphic diastem in the Middle Vistula river valley occurred during the period of extinction of the ammonites and belemnites.

The *Belemnitella junior* Zone. *Belemnitella junior* Nowak is an only taxon characteristic of this zone. The true range of J. Nowak's species is assumed, if only with a certain reservation, to pass to the next unit. The reservation mentioned above results from a debatable systematic position of the material analyzed, which comes from the strata of the last-named unit.

The *Belemnitella junior* Zone was distinguished in the sector of the profile stretching from Boiska on the left-hand to Okal on the right-hand bank of the Middle Vistula river valley. This is the only instance of the division of a reference profile by the Vistula valley which – in regard to a stratotype – has never been observed so far. However, due to an exceptionally large stretch of outcrops and a configuration of those, in which the index species is recorded, it does not seem that the existence of even a distinct dislocation, determined by the Vistula valley might affect the assumed sequence of this species' specimens. The zone under study contains marls with intercalations of marly chalk and places in which it turns into rocks of the opoka type.

The *Hoploscaphites constrictus crassus* Zone. This zone differs from all former units in the definition of its upper boundary, which is determined by the time of the extinction of the ammonites and belemnites. The problem of demarcating so understood boundary in the Middle Vistula river valley is connected with evaluating the nature of the occurrence of the belemnites in a sandy-glaucconitic bed overlying the surface of the sedimentary break and constituting the uppermost bed of the profile, in which representatives of the group formed by the ammonites and belemnites have been recorded. On the basis of the results of analysis of a foraminiferal sequence and on a correlative diagram of the ranges of the foraminifers with those of the ammonites and belemnites, presented in K. Pożaryska's works (W. Pożaryski and K. Pożaryska, 1960; K. Pożaryska, 1965), the present writer has assumed that

the belemnites occurred in the sandy-glaucconitic bed, mentioned above, as reworked fossils. The upper boundary of the *H. constrictus crassus* Zone occurs, therefore, in the same place as the surface of the sedimentary break.

The lower boundary of the *H. constrictus crassus* Zone is determined by the appearance of its index taxon. The uppermost ever recorded point of the occurrence of the index taxon is connected with a stratum terminating in the surface of sedimentary break, which allows us to suppose that the moment of its extinction falls in the stratigraphic diastem. The remaining, distinctly separated taxons, whose true appearance is assumed unequivocally within limits of the zone's boundaries, are: *Belemnella kazimiroviensis kazimiroviensis* (Skolozdrówna) and *Belemnella kazimiroviensis skolozdrownae* Jeletzky. The appearance of the two taxons is, however, interpreted as pronouncedly later as compared with that of the index taxon. In regard to the upper boundary of true ranges of the belemnites mentioned above, it should be emphasized that they were recorded in the sandy-glaucconitic bed overlying the surface of a sedimentary break. In addition, there is a group of forms, sporadically recorded, or uncertainly identified specifically, or determined only generically, which also provide a basis for the concept of the zone, since they occur in the uppermost part of the profile. They include *Sphenodiscus binckhorsti* Böhm, *Baculites* sp., *Belemnella pensaensis* Kongiel, 1962 and *Belemnitella junior* (?) Nowak.

The only directly analyzed specimen of *Acanthoscaphites varians* (Łopuski) comes from the middle sector of the stratotype of the unit under study. This species, formerly known from the Middle Vistula river valley only on the basis of C. Łopuski's specimen, coming in all likelihood from this same sector of the type profile, is especially noteworthy due to its being assigned nowadays to the species *Acanthoscaphites tridens* (Kner), whose range is limited to the Lower Maastrichtian only (J.A. Jeletzky, 1958, 1969).

The stratotype of the zone stretches on the right-hand bank of the Vistula valley between Podgórze and Bochoznica (Fig. 1).

The strata of the lower part of the unit under study are composed of rocks of the marly type turning locally into those of the opoka type. The upper part consists of the opoka rocks with rare intercalations of marl and, in its roof, a bed of a compact limestone already described in detail by other authors (K. Pożaryska, 1952; W. Pożaryski, 1956).

The upper surface of the bed should be treated, according to the existing interpretations, as discontinuity surfaces of the "hard bottom" type (R. Kongiel, 1935, 1936, 1958; W. Pożaryski, 1938, 1956; K. Pożaryska, 1952; cf. also the description of a surface of the sedimentary break recorded in the Lower Campanian).

The data, published so far on boundary beds between the Cretaceous and Tertiary of European areas, indicate that the phenomena, recorded in the Middle Vistula river valley, are related with universal regressive processes, that is, with a general shallowing of the sedimentary basin and narrowing of its boundaries (W. Pożaryski, 1960, 1962; K. Pożaryska, 1965, 1967; S. Cieśliński and W. Pożaryski, 1970; A. Błaszkiwicz et al., 1970; S. Cieśliński and M. Jaskowiak, 1973).

PALEONTOLOGICAL PART

MATERIAL, METHODOLOGICAL REMARKS, TERMINOLOGY

The collection of the ammonites described consists of several hundred specimens, preserved mostly in the form of internal molds and only rarely as external impressions, the latter examined as latex casts. The specimens on the whole display secondary deformations, considerably varying in degree and quality. Secondary asymmetrical changes, that is, disorders in the biconvex symmetry of a coil, are among frequent deformations. In normally coiled ammonites, these disorders are manifested by differences in the size of umbilicus and lateral height of whorl sections on particular sides of specimens. In the case of aberrant turrilite-like forms, a lateral compression of the coil resulting in ellipsoidal shapes of particular whorls and changes in the height and thickness of sections are among the most frequent deformations. Symmetrical ventral deformations, causing an ellipsoidal shape of the entire coil in normally coiled ammonites, are easily observable, although less frequently recorded. On the other hand, lateral compressions, which, on account of their small degree of flattening and an only fragmentary preservation of the material, cannot be, however, stated with a complete certainty, may be also among frequent deformations of symmetry.

The tables of dimensions, presented by the writer, contain results also concerning specimens with secondary deformations and the methods employed for measuring deformed specimens require a certain explanation. In the case of symmetrical lateral deformations, the tables contain actually found values. Thus, the results presented are of course only approximate in character.

In the case of asymmetrical deformations of a nor-

mally coiled spiral, the value given for umbilicus is a mean value of measurements taken on both sides of a specimen. It seems that the percentage relation of this mean value of umbilicus to the diameter of an entire specimen on the whole corresponds very accurately to the original percentage relation between these elements. Next, the proportion of the size of umbilicus to that of the diameter of laterally compressed turrilite-like whorls, based on measurements taken both along the shortest and longest axis of the whorls, seems also to correspond exactly to the original relation of the two elements. The values of the height and thickness of whorls, given for asymmetrical deformations also make up attempts at reconstructing original relations. The values presented in this case arouse, however, considerable reservations and should also be treated as approximate only.

No sutures are observed in considerable part of the material, which undoubtedly represents septate parts of shell. The rest of this material on the whole displays only very indistinct or partially preserved sutures. These facts, as well as secondary deformations of the coil and a corrosion of its surface constitute the reason why the suture has not been described in the present paper.

The nomenclature of morphological elements has been taken from various existing elaborations. The less known terms are explained either by a direct description in the text, or by references to other publications. The symbols used in the tables of dimensions for quantitative characters are explained below.

EXPLANATION OF SYMBOLS

D	— diameter of specimen	L	— length of specimen
DP	— diameter of phragmocone	LS	— length of specimen determined by the direction of the shaft
U	— diameter of umbilicus	WS	— width of specimen
U/D	— U to D percentage ratio	R	— ribs occurring on a sector equalling the height of whorl section
H	— height of last whorl section	RE	— external ribs
H ₁	— height of last whorl section in a normally coiled part of shell	RI	— internal ribs
H ₂	— height of section at midlength of the shaft	RW ₁	— internal ribs occurring on a sector devoid of internal elements of the tuberculation
H ₃	— height of aperture	RW ₂	— internal ribs in the stages of the reappearance of ornamentation
W	— width of last section	TF	— external tubercles
W ₁	— width of last whorl section in a normally coiled part of shell	TI	— internal tubercles
W ₂	— width of section at midlength of the shaft	TI ₁	— internal tubercles connected with pairs of ribs
W ₃	— width of aperture	TI ₂	— internal tubercles connected with simple ribs and tubercular swellings of ribs
Th	— thickness of specimen		
W/H	— W to H percentage ratio		
W ₁ /H ₁	— W ₁ to H ₁ percentage ratio		
W ₂ /H ₂	— W ₂ to H ₂ percentage ratio		
W ₃ /H ₃	— W ₃ to H ₃ percentage ratio		

DESCRIPTIONS OF TAXONS

Class CEPHALOPODA Cuvier, 1797
 Order AMMONITIDA Zittel, 1884
 Family TETRAGONITIDAE Hyatt, 1900

Genus *Gaudryceras* Grossouvre, 1894

Type species *Ammonites mitis* Hauer, 1866

Diagnosis. See C.W. Wright, 1957, p. L 200.

Gaudryceras cf. *mite* (Hauer, 1866)

(Pl. LIV, Fig. 1)

1966 *Gaudryceras mite* (Hauer); Blaszkiewicz A., table.

Material: IG 1, 310.II.486⁹.

Remarks. An impression of a fragmentary shell (a latex cast presented in the illustration) which in the form of coil and development of ornamentation seems to be most similar to the type of *Gaudryceras mite* (Hauer) (F. Hauer, 1866, p. 300, Pl. 2, Figs. 3-4). The stratigraphic position of F. Hauer's species, accepted at present, is however, conspicuously lower than that of the form described (M. Collignon, 1956, p. 67). As compared with a form from Lüneburg, F.R.G., related by A. Wolleemann with F. Hauer's species (A. Wolleemann, 1902, p. 93, Pl. 4, Fig. 6, Pl. 6, Fig. 1) and displaying a similar, if not identical, stratigraphic position, the specimen described differs undoubtedly in a distinctly more widely-spaced costulation.

Distribution: Upper Campanian, *Didymoceras donezianum* Zone, the Middle Vistula river valley.

Genus *Pseudophyllites* Kossmat, 1895

Type species *Ammonites indra* Forbes, 1846

Diagnosis. See C.W. Wright, 1957, p. L 203.

Pseudophyllites indra (Forbes, 1846)

(Pl. LVI, Figs. 4-5)

1846 *Ammonites indra* Forbes; Forbes E., p. 105, Pl. 11, Fig. 7a-c.
 1963 *Pseudophyllites indra* (Forbes); Jones D I., p. 25, Pl. 7, Figs. 6-7, Pl. 8, Pl. 29, Figs. 7-12, Text-fig. 10 (cum synonymica).
 1966 *Pseudophyllites indra* (Forbes); Blaszkiewicz A., table.

Material: IG 1, 310.II.27.

Dimensions in mm. (Table 3)

Table 3

Specimen	D	DP	U	U/D	H	W	W/H	Remarks
Pl. LVI, Figs 4 and 5	143.8	-	22.7	15	83.5	51.7	60	The specimen displays secondary disorders in bilateral symmetry
	184.5	-	27.0	14	106.0	-	-	

⁹ Explanation of collection symbols:

IG - collection of the Geological Institute's Museum in Warsaw
 MZ - collection of the Polish Academy of Sciences' Museum of the Earth

Remarks. In the development of morphological elements the specimen presented distinctly corresponds to those given in the synonymy. Certain reservations concern only the height-to-thickness ratio of whorls which in the form described is larger than in the specimens mentioned in the synonymy. This may, however, result from secondary deformations of the specimen described.

Part of so far illustrated materials (H. Woods, 1906, Pl. 41, Fig. 6; M. Boule, P. Lemoine and A. Thevenin, 1906, Pl. 1, Fig. 1b; D.L. Jones, 1963, Pl. 7, Fig. 6, Pl. 8, Fig. 2) reveal, in *Pseudophyllites indra* (Forbes), the presence of a dorsal septal lobe (called so after W.J. Arkell, 1957), which may be also observed in the material from Poland.

Distribution: Upper Campanian, *Nostoceras pozaryskii* Zone, the middle Vistula river valley, Poland; Upper Campanian (?) of Alaska and Canada; Campanian and Santonian (?) of South Africa; Maastrichtian (?) of India.

Family NOSTOCERATIDAE Hyatt, 1894

Genus *Bostrychoceras* Hyatt, 1900

Type species *Turrilites polyplocum* Roemer, 1841

Diagnosis. See C.W. Wright, 1957, p. L 224 and remarks.

Remarks. The genus *Bostrychoceras* Hyatt is treated by the present writer as an evolutionary group transitional between the stratigraphically underlying genus *Eubostrychoceras* Matsumoto (T. Matsumoto, 1967) and the stratigraphically overlying genus *Didymoceras* Hyatt. Despite giving it a lower taxonomic rank, that is, that of a subgenus of the genus *Didymoceras* Hyatt (T. Matsumoto, 1967), in some contemporary elaborations *Bostrychoceras* Hyatt is interpreted in a similar way.

In part of contemporary works, the *Bostrychoceras* Hyatt is related with the *Didymoceras* Hyatt and sometimes even with *Nostoceras* Hyatt (J. Wiedmann, 1962; M.K. Howarth, 1965; Z. Lewy, 1967). These conspicuous differences in interpretation are connected with a distinctly different evaluation of the taxonomic importance of the character of ornamentation in the Campanian and Maastrichtian turrilite-like forms.

As compared with the genus *Eubostrychoceras* Matsumoto, the *Bostrychoceras* Hyatt differs in the occurrence of a downturn of body chamber (or at least of its most part) from the preceding sector of coil and in the dimensions of a coil, which are, on the whole, larger. In addition, it differs in the possibility of the occurrence of tuberculation.

The differences between the genera *Didymoceras* Hyatt and *Bostrychoceras* Hyatt consist in a permanent lack of the bituberculation in the early and middle ontogenetic stages and in an exceptionally rare occurrence of both one- and two-row tuberculation in the case of the last-named genus. At the same time, tuberculate forms of the *Bostrychoceras* Hyatt display a massive tuberculation as compared with the thickness of ribs and an unreduced costulation between the rows

of tubercles, that is, characters which are only very rarely recorded in *Didymoceras* Hyatt (in the latter genus, the costulation is reduced in this area). Besides, *Bostrychoceras* Hyatt is frequently marked by a tight coiling of phragmocone, which, on the other hand, is rarely observed in forms of the genus *Didymoceras* Hyatt.

Bostrychoceras polyplacum schlueteri subsp. nov.

(Pl. II, Figs. 1, 4, 9–11)

1871–1876 *Heteroceras polyplacum* Roemer; Schlüter C. p. 112 (pars). Pl. 33, Figs. 3–4, 5 ?

1900 *Bostrychoceras polyplacum* Roemer; Hyatt A., p. 588, Fig. 1231.

1957 *Bostrychoceras polyplacum* Roemer; Wright C.W., p. L 224, Fig. 250, 4.

1966 *Bostrychoceras* sp. nov. Błaszkiwicz; Błaszkiwicz A., p. 1063.

Holotypus. Pl. II, Figs. 9–11, (IG 1,310. II. 1).

Stratum typicum. Upper Campanian. *Bostrychoceras polyplacum* Zone.

Locus typicus. The Middle Vistula river valley, Sulejów, outcrop 22.

Derivatio nominis. After Clemens Schlüter's name.

Diagnosis. Coil large. Apical angle small. Whorls normal, in contact. Contact impressions deep. Umbilicus narrow. The deflected part of coil makes up about a half of a whorl. Its plane forms a considerable angle with the axis of a normal spiral. Normal whorls thicker than high. Simple ribs, fairly thick, about 50 of them occurring over a complete whorl.

Material: IG 234. II. 18, 22; IG 889. II. 30, 40; IG 890. II. 63, 73; IG 1,310. II. 1, 26–30.

Description. Holotype composed of a tightly coiled helicoidal part, including one whorl and a quarter and a downturned part of coil with its aperture preserved. Coil secondarily compressed laterally. Contact impressions visible along the whole upper surface of the helicoidal part preserved. The deflected part of coil, about a half of a whorl, is situated in a plane inclined at an angle of about 40° to the axis of preceding whorl. The umbilicus of whorls in a normal spiral does not exceed 15 per cent of the diameter. The height of whorl sections in a normal spiral and of the initial part of the deflected part is smaller than their thickness (the height and thickness of the last whorl section of a normal spiral are respectively 23 and 48 mm.). Quite opposite proportions occur in a further sector of the deflected part. Aperture (incompletely preserved) is 43 (?) mm. high and 23 mm. thick. The entire specimen is 156 mm. high. Ornamentation in the form of simple, rounded fairly thick ribs, about 25 of them to a half of whorl. A constriction emphasized by a more strongly developed element of costulation, is visible on the first half of the first whorl. Aperture marked by a wider costular element.

The specimen, presented in Pl. II, Fig. 1, presumably makes up a portion of the last whorl of the helicoidal part of coil and initial sector of the deflected part. Coil secondarily compressed laterally. Helicoidal part displays traces of the contact of whorls. Whorl sections thicker than high (the thickness and height of the whorl section at the end of a normal spiral amount respectively 41 and 19 mm.). At the end of a coil, this difference is, however, insignificant only: 36 and 32 mm. Simple ribs rounded, fairly thick, about 25 of them occurring over a half of a whorl. A poorly

visible constriction occurs at the beginning of the spiral.

Remarks. Differences between the holotype and one of C. Schlüter's (1871–1876, Pl. 33, Fig. 4) specimens, that is, smaller dimensions, varying distribution and development of constrictions, are analogous to those found in the material from the Middle Vistula river valley. C. Schlüter's (Pl. 33, Fig. 3) another specimen differs from the whole material from Poland in its more closely spaced costulation. In the development of its costulation, it is most similar to specimens of the nominative subspecies (cf. the comparison of the two taxons in the remarks on the nominative subspecies). The third of C. Schlüter's specimens, identified, with a reservation, with the taxon described, is marked by the occurrence of tuberculation on body chamber, a slight downturn of this chamber with a loose coiling of the septate part of shell and a fairly narrow umbilicus of whorls. The loose coiling seems, however, to result from a secondary deformation, at least in regard to the later part of normal spiral, where contact impressions probably occur. Nevertheless, as indicated by the remaining differences, this specimen is a transitional form between that here described and the nominative subspecies.

Distribution: Upper Campanian. *Bostrychoceras polyplacum* Zone, the Vistula river valley. Upper Campanian of the Federal Republic of Germany.

Bostrychoceras polyplacum polyplacum (Roemer, 1841)

(Pl. I, Figs. 1–9; Pl. II, Figs. 2–3 and 5–6)

1841 *Turrilites polyplacum* Roemer; Roemer F.A., p. 92, Pl. 14, fig. 1 (lektotyp – J. Wiedman, 1962, p. 198), non Fig. 2.

1966 *Bostrychoceras polyplacum* Roemer; Błaszkiwicz A., p. 1063.

Material: IG 1,310. II. 31–44; MZ VIII Mc 417. Roztocze: IG 1,407. II. 1–2¹⁰.

Remarks. *Bostrychoceras polyplacum polyplacum* (Roemer) differs from the stratigraphically underlying *B. polyplacum schlueteri* subsp. nov. in a more closely spaced costulation and a wider umbilicus of whorls. In addition, the new subspecies is marked by the lack of tuberculation and a tight coiling of the helicoidal part.

In the shape of coil and character of costulation, the best preserved specimen, shown in Pl. I, Figs. 3, 4 and 7, is most similar to specimens of *B. polyplacum schlueteri* subsp. nov.

The specimen, presented in Pl. I, Figs. 8–9, is transitional between the two subspecies described. In its ornamentation and stratigraphic position, it corresponds to specimens of *B. polyplacum schlueteri* subsp. nov., while its shape relates it to the nominative subspecies.

Among formally erected species, *B. depressum* (Wiedmann) (C. Schlüter, 1871–1876, Pl. 34, Figs. 2–3 and 4–5) is distinctly related to F.A. Roemer's taxon. As compared with the two subspecies, it differs in a lateral compression of the whorl sections of phragmocone and a closer costulation. In regard to *B. polyplacum schlueteri* subsp. nov., it also differs in a wider umbilicus of whorls.

¹⁰ The regionalization is given only for specimens which come from areas outside the Middle Vistula river valley.

Considerable affinities have also been found with F.A. Roemer's taxon in the case of the species *B. unituberculatum* sp. nov.

A comparable species, *B. elongatum* (Whiteaves) (J.F. Whiteaves, 1879, Pl. 12, Figs. 1–3; J.L. Usher, 1952, Pl. 28, Figs. 3 and 4), which presumably takes quite a different stratigraphic position (Lower Campanian), differs from F.A. Roemer's species in having a less close costulation and a smaller deflection of body chamber from phragmocone.

Devoid of tuberculation and constituting apical parts of a coil, a specimen from Iwanowice, related by J. Nowak (1913a, Pl. 4, Fig. 6) with F.A. Roemer's species, displays the distinct morphological similarity to J.F. Whiteaves' species and perhaps has also a similar stratigraphic position.

Distribution: Upper Campanian, *Bostrychoceras polyplacum* Zone, the Vistula river valley, Upper Campanian of the Federal Republic of Germany.

Bostrychoceras unituberculatum sp. nov.

(Pl. III, Figs. 1–8; Pl. IV, Figs. 3–6)

1899 *Turrilites polyplacum* Roemer; Simionescu J., p. 253, Pl. 1, Fig. 2.

Holotypus. Pl. III, Figs. 3, 6 (IG 1,310. II. 3).

Stratum typicum. Upper Campanian, *Bostrychoceras polyplacum* Zone. **Locus typicus.** The Middle Vistula river valley, Sulejów, outcrop 22. **Derivatio nominis.** *Unus* (Lat.) – one, *tuberculatus* (Lat.) – tuberculate.

Diagnosis. Apical angle small. Normal spiral tightly coiled. The plane of the deflected part of coil forms a considerable angle with the axis of normal spiral. The deflected part constitutes not more than a half of a whorl. The umbilicus of whorls narrow. Simple ribs fairly thick, about 50 to 60 to a complete whorl. Tubercles form a single row in the middle zone of the ventral area. One or two free ribs occur on the whole.

Material: IG 13. II. 1–4; IG 234, II. 20; IG 889. II. 55; IG 890. II. 57–60, 64, 81, 87–88; IG 1,310. II. 3, 45–77; MZ VIII Mc 287–289, 425, 430–431, 674, 1,381.

Description. Specimens representing all developmental stages, except for the earliest. Normal spiral tightly coiled (Pl. III, Figs. 1–8; Pl. IV, Figs. 4–6). Body chamber, or at least its larger sector, downturned from the normal spiral and situated in a plane, which, together with the axis of normal spiral, forms an angle of about 40° (Pl. III, Figs. 5, 7, 8; Pl. IV, Figs. 3, 4, 6). The deflected part of coil makes up not more than a half of a whorl. The umbilicus of septate whorls does not seem on the whole to exceed 15 per cent of the diameter of whorls (all coils display a more or less distinct secondary lateral compression). In one case, a deflected part displays a distinct increase in umbilical index as compared with the preceding whorl, which, however, may be a result of secondary deformation (Pl. IV, Fig. 3). The height of whorls of normal spiral and of initial sector of the deflected part of coil is smaller than their thickness. The height of a further sector of the deflected part is either larger (Pl. IV, Figs. 4 and 6) or somewhat smaller (Pl. III, Figs. 7 and 8) than the thickness. Ornamentation composed of ribs and tubercles. As compared with the thickness of ribs, tubercles reach considerable dimensions and form a row, running through the middle

of siphonal area. Two or, less frequently, one rib runs from each tubercle both downwards and upwards. In later development stages of some specimens' (presented on Pl. III, Figs. 7 and 8; Pl. IV, Figs. 4 and 6), sometimes three ribs each become detached and run upwards. The number of free ribs, unattached to tubercles, fluctuates between 1 to 2 (Pl. III, Figs. 3 and 6) and 2 to 4 (sporadically even 6 to 7) (Pl. III, Fig. 5). Ribs rounded, fairly thick, about 50 (Pl. III, Figs. 2–4 and 6) to about 60 (Pl. III, Figs. 7 and 8) of them to a full whorl. Some specimens (Pl. III, Fig. 1) display 1 to 2 constrictions, related with a more strongly developed costular element, which constantly occur on each of their whorls. At the same time, a certain irregularity is observed in the costulation of these specimens, that is, some ribs are thinner. In some cases, a partly preserved aperture (Pl. IV, Fig. 3) has a somewhat swollen margin. The thickness and height of whorl section on the boundary between a normal spiral and deflected part of coil fluctuate within limits of 41 to 52 and 20 to 41 mm, respectively.

Remarks. The occurrence of only one row of tubercles in both early and late development stages is a character, which differs *Bostrychoceras unituberculatum* sp. nov. from all other taxons of the genus *Bostrychoceras* Hyatt.

A possibility of very close phylogenetic relationships between the new species and *B. polyplacum schlueteri* subsp. nov. is indicated by features concerning the shape of coil, development of costulation and stratigraphic position.

In the character of its tubercles alone, the species under study displays a close analogy to *B. polyplacum polyplacum* (Roemer). Certain relationships have also been observed in the case of *Didymoceras* sp., found in the Vistula river valley. The characters of the new species are exactly displayed by a fragmentary specimen from Ūrmös, Rumania (J. Simionescu, 1899, Pl. 1, Fig. 2).

Distribution: Upper Campanian, *Bostrychoceras polyplacum* Zone, the Vistula river valley. The Senonian of Rumania.

Genus *Didymoceras* Hyatt, 1894

Type species *Ancycloceras* (?) *nebrascensis* Meek and Hayden, 1856

Synonym *Emperoceras* Hyatt, 1894

Diagnosis. Shells on the whole large. Apical angle of coil variable. Septate part usually loosely coiled. Apical part variable in shape: straight, hamitoidal or helicoidal. Body chamber, or at least its considerable part, more or less downturned, corresponding in shape to that of the genus *Bostrychoceras* Hyatt, but sometimes tending to take a U-shaped form. Tuberculation of the two-row type only, including, in all cases, the early and middle and, on the whole, also late developmental stages. As compared with the thickness of ribs, tubercles are usually small. Costulation formed by primary and secondary ribs. Between the rows of tubercles, ribs are on the whole distinctly less strongly developed.

Remarks. The *Didymoceras* Hyatt is interpreted by the present writer as a stratigraphically underlying taxon as compared with the *Nostoceras* Hyatt.

Generally occurring morphological differences

between *Nostoceras* Hyatt and *Didymoceras* Hyatt include, in the former genus: smaller dimensions of a coil, in particular of a phragmocone, occurrence of an exactly U-shaped body chamber, situated in the plane of phragmoconic axis, and a turrilite-like phragmocone.

As follows from the illustration and description of a holotype of the type species of the *Didymoceras* Hyatt (F.B. Meek, 1876, p. 480, Pl. 22, Fig. 1), it is a septate part of a whorl marked by a fairly large diameter and whorl sections and having two rows of tubercles rather indefinite in shape and manner of connecting with ribs (the data on its tuberculation have been taken from the description, since the siphonal area is not illustrated). The facts cited could not be a sufficient basis for an unquestionable generic classification. In the light of all available information on the type species of *Didymoceras* Hyatt (R.P. Whitfield, 1880; A. Hyatt, 1894; G.R. Scott and W.A. Cobban, 1965; W.A. Cobban, 1970), its generic separation from those of *Nostoceras* Hyatt and *Bostrychoceras* Hyatt does not, however, arouse any major doubt.

In conformity with part of recent presentations, the *Emperoceras* Hyatt (A. Hyatt, 1894) is considered by the present writer as a junior synonym of the generic name *Didymoceras* Hyatt. At the same time, in all likelihood, there occurs a conspecificity of the type *Didymoceras* Hyatt with the type *Emperoceras* Hyatt (A. Hyatt, 1894, p. 575, Pl. 14, Figs. 16 and 17), which is accepted at present (W.A. Cobban, 1970).

In some contemporary works, *Didymoceras* Hyatt is interpreted as a junior synonym of the generic name *Cirroceras* Conrad (C.W. Wright, 1957; J. Wiedmann, 1962; cf. also A. Błaszkiwicz, 1966). According to the latest presentations (K.W. Howarth, 1965; T. Matsumoto, 1967; Z. Lewy, 1969), the present writer treats *Cirroceras* Conrad as a nomen dubium, inapplicable for sure to any of the known genera. The holotype of the type species of the *Cirroceras* Conrad (*Ammonoceratites conradi* Morton, 1841) and R.P. Whitfield's specimen, the latter being besides the holotype the only acceptable representative of this species, are fragmentary coils, which do not include more than one whorl and do not allow one for an explicit evaluation which ontogenetic stages they represent (R.P. Whitfield, 1892, p. 269, Pl. 45, Figs. 9–11 and 14; J.B. Reeside, 1962, p. 120, Pl. 70, Figs. 1–3 and 4–6). In addition, the stratigraphic position of the two specimens is rather vague.

Didymoceras sp.

(Pl. IV, Figs. 1, 2; Pl. V, Fig. 7)

1966 *Cirroceras* sp. nov. (?) Błaszkiwicz: Błaszkiwicz A., Table.

Material: IG 1,310. II. 78–79.

Remarks. A conspicuous relationship and may be even a conspecificity seem to occur between the form under study and *Didymoceras tortum* Meek and Hayden (F.B. Meek, 1876, p. 481, Pl. 22, Fig. 4). Morphological features, differing the form described may be limited exclusively to a tight coiling of the phragmocone and to a larger number of free ribs, unattached to tubercles.

On the other hand, in the development of coil and of the tubercles themselves, as well as in its stratigraphic position, this form displays an analogy to *Bostrychoceras unituberculatum* sp. nov.

Distribution: Upper Campanian, *Bostrychoceras polyplacum* Zone, the Vistula river valley.

Didymoceras cf. *beecheri* (Hyatt, 1894)

(Pl. V, Figs. 3 and 5)

1966 *Emperoceras* aff. *beecheri* Hyatt: Błaszkiwicz A., Table.

Material: IG 1,310. II. 90.

Remarks. The specimen presented displays distinct analogies to later-formed part of the coil of one of two syntypes of "*Emperoceras*" *beecheri* Hyatt, preserved in a more complete form (A. Hyatt, 1894, Pl. 14, Figs. 15 and 16). The Polish specimen differs mostly in its lower umbilical index of whorls and a larger number of periodic ribs not connected with tubercles in the tuberculate sector. There is also no foundation for suggesting the existence of substantial differences in stratigraphic position. Nevertheless, the smaller umbilicus of whorls of the Polish specimen indicates the possibility of the occurrence of more distinct differences in early developmental stages not represented by this specimen, that is, the lack of an ellipsoidal coiling of the initial part of coil.

C.W. Wright's (1957) view that the body chamber of "*Emperoceras*" *beecheri* Hyatt may not be downturned from the rest of a coil has not been sufficiently confirmed by other North American publications. More reliable seems to be W.A. Cobban's (1970) view that, in A. Hyatt's species, a considerable angle is formed by the gerontic part of coil with the axis of normal spiral.

W.A. Cobban (1972) assumes, on the basis of analyzing also unpublished North American materials, that the specimen related by A. Hyatt (1894, Pl. 14, Figs. 13 and 14) with the type species of the *Didymoceras* Hyatt, represents a terminal part of coil of "*Emperoceras*" *beecheri* Hyatt. This specimen, maybe coming from this same locality as the syntypes of "*E.*" *beecheri* Hyatt, makes up a nontuberculate whorl of a normal spiral and a deflected, tuberculate, gerontic part of coil. At the same time, Hyatt's illustration does not allow one to assume any substantial differences in ornamentation and shape between the normal, spiral part of this specimen and the last whorl of the better preserved syntype of "*E.*" *beecheri* Hyatt.

A considerable probability of the occurrence of traces of the suture on the earlier half of the last whorl of the form described and its relationship with *Didymoceras varium* sp. nov. (see below), in which the gerontic part is downturned, are also indicative of the occurrence of a normal *Didymoceras*-like body chamber in "*E.*" *beecheri* Hyatt.

Distribution: Upper Campanian, *Bostrychoceras polyplacum* Zone, the Vistula river valley.

Didymoceras varium sp. nov.

(Pl. VI, Figs. 1–7; Pl. VII, Figs. 21, 22)

1951 *Bostrychoceras polyplacum* Roemer: Mikhailov N.P., Pl. 4 Figs. 25–27 (exclusively).

1966 *Emperoceras* sp. nov. Błaszkiwicz: Błaszkiwicz A., Table.

Holotypus. Pl. VI, Figs. 1–2 (IG 1,310. II. 4).

Stratum typicum. Upper Campanian. *Bostrychoceras polyplocum* Zone. *Locus typicus*. The Middle Vistula river valley. Dorotka, outcrop 43. *Derivatio nominis*. *Varius* (Lat.) – variable.

Diagnosis. Shell loosely coiled. Umbilicus of whorls medium-sized. The deflected part of coil makes up about a half of whorl. The plane of the deflected part forms a distinct angle with the axis of normal spiral. The tubercles of early developmental stages of normal spiral reach considerable dimensions as compared with those of ribs. Two ribs each diverge downwards and two to three each upwards from the tubercles of the lower row. The tubercles of the upper row connect ribs in pairs. Some secondary ribs are not connected with the tubercles of the upper row. In later stages, the dimensions of tubercles decrease, ribs are very frequently bifurcate in the tubercles of the lower row, secondary ribs are as a rule connected with the tubercles of the upper row and there occur simple ribs not connected with tubercles. The late section of a normal spiral displays on the whole simple ribs with tubercular swellings arranged in two rows. The deflected part of coil has more strongly developed tubercular swellings, which sometimes turn into distinct tubercles.

Material: IG 13. II. 5; IG 890. II. 144; IG 1,310. II. 4, 81–99; MZ VIII Mc 644, 687, 1,422.

Description. The holotype is a loosely, dextrally coiled spiral, comprising about 1.6 whorl. Umbilical index of initial whorl amounts to 29 and that of terminal whorl to 26. Specimen is 61 mm. high. Whorls are higher than thick, except for a very small, terminal part of spiral, which is slightly thicker than high, which, however, seems to result from a secondary deformation (the shell is visibly shattered). At the end of a sector making up one and a quarter of a whorl, the thickness amounts to 31 and the height to 38 mm. The traces of suture are visible on the whole coil, except for its small section (about $\frac{1}{14}$ of a whorl). Ornamentation composed of ribs and tubercles, the latter forming two rows.

In the initial sector of coil ($= \frac{1}{6}$ of a whorl), tubercles reach considerable dimensions as compared with the thickness of ribs. Two ribs each diverge downwards and two to three each upwards from the tubercles of the lower row. Two ribs each diverge both downwards and upwards from the tubercles of the upper row. Some secondary ribs are not connected with the tubercles of the upper row. One of the primary ribs seems not to be connected with any tubercle.

The dimensions of tubercles gradually decrease in the further sector of the coil (equalling $\frac{3}{6}$ of a whorl).

One rib diverges downwards and two (on the whole) or one upwards from each tubercle of the lower row. Bifurcate ribs either merge with one and the same tubercle of the upper row, from which one to two ribs diverge upwards, or one of them runs free between the tubercles of this row. Simple ribs always merge with the tubercles of the upper row, from which only simple elements of costulation also diverge upwards. Widely spaced primary ribs not connected with tubercles are also present.

Simple ribs, usually with tubercular swellings, occur

on the whole on the remaining sector of a coil. It is only infrequently that bifurcate ribs are visible below the tubercular swelling of the lower row or secondary elements appear at the level of this row. The secondary elements display on the whole the tubercular swellings of the upper row.

Ribs not very thick, rounded. An insignificant reduction in costulation is visible in the terminal sector of coil between rows of tubercles. On the earlier whorl, the number of ribs between rows of tubercles amounts to about 105 and on the later to about 95.

The sinistrally coiled specimen (Pl. VI, Fig. 5) makes up an incomplete whorl of a late septate part of coil. It displays a distinct similarity in the development of particular elements to the late sector of the holotype (last sector of coil, according to the description presented), from which it differs only, but decisively, in the number of its ribs (about 40 to a half of whorl) and outline of its whorl sections (compressed ventrally, 47 mm. thick and 20 mm. high at the end of the specimen).

The specimen, presented in Pl. VI, Figs. 6 and 7, makes up part of whorl of a normal spiral and a downturned sector of coil with its aperture preserved. It is sinistrally coiled. The deflected part corresponds to about a half of whorl. The whorl sections of the initial sector of coil are compressed ventrally (at the beginning of coil, it is 33 mm. thick and 20 (?) mm. high). The last sector is compressed laterally (thickness: 24 mm., height: 44 mm.). In the development of costulation, this specimen differs from the previous one in a somewhat smaller number of ribs (about 35 to a half of whorl). In the development of tuberculation, part of the specimen, representing the normal spiral, corresponds fairly distinctly to the last sector of the previous specimen, the difference consisting in a more frequent occurrence of very slightly developed tubercular swellings on ribs. The deflected part displays more strongly developed tubercular swellings of ribs, which are sometimes even replaced by normal, fine tubercles, also occurring in pairs, on particular ribs.

The specimen shown in Pl. VII, Fig. 21 is a septate, dextrally and very loosely coiled whorl. The umbilicus constitutes 31 per cent of the diameter (47 mm.). Whorl sections are compressed ventrally. In the development of ribs, this specimen displays distinct analogies to that described above. In the development of tubercles and their connection with ribs, it seems to correspond to early sectors of the holotype (its ornamentation is in places very poorly preserved). Differences may mostly consist in a larger number of ribs not connected with tubercles and in the presence of constrictions, emphasized by the occurrence of more strongly developed elements of costulation.

Remarks. Distinct differences between the holotype and some remaining specimens are observed in the outline of sections and number of ribs. The lack of stratigraphic differences and fragmentary state of preservation of most specimens do not, however, allow the present writer to erect a separate taxon.

N.P. Mikhailov's fragmentary specimen seems to be contained within the range of variability marked out by the characters of the specimens described.

The new species displays considerable relationship with *Didymoceras beecheri* Hyatt. A. Hyatt's taxon

departs from that here described in an ellipsoidal coiling of the apical part of its coil, disappearance of tuberculation, at least in late, if not middle, developmental stages, larger part of periodic ribs, not connected with tubercles, ornamentation of early stages and, finally, lack of some types of connection of tubercles and ribs observed in early developmental stages.

In middle development stages, the species described seems to display a strong analogy to a form identified by R.P. Whitfield (1902, Pls. 23–27) with "*Helicoceras*" *simplicicostatum* Whitfield (R.P. Whitfield, 1880, Pl. 14, Fig. 4), which differs, however, in its gerontic stage in the development of tubercles and a different manner of connecting tubercles with ribs. Differences are also observed here in the shape of coil in conspicuously early developmental stages.

Distribution: Upper Campanian, *Bostrychoceras polyplacum* Zone, the Vistula river valley.

Didymoceras cf. *secoenes* (Young, 1963)

(Pl. V, Figs. 4 and 6; Pl. VII, Figs. 16 and 19)

Material: IG 1,310. II. 100; MZ VIII Mc 369.

Remarks. More or less exact analogies between American specimens (K. Young, 1963, p. 42, Pl. 3, Figs. 1–5; Pl. 4, Figs. 4 and 8, Text-fig. 7s) and those found in the Middle Vistula river valley have been observed in the development of tubercles and ribs, way of coiling the shell and a general outline of whorl sections. As a matter of fact, the data published so far do not allow one for adopting any permanent, distinctive character. The conclusion on a permanent lack of bifurcation of ribs in the lower row of tubercles in the American specimens, which results from the text, becomes watered-down by an analysis of their illustration, which seems to indicate that also this type of connection between tubercles and ribs does exist (K. Young, 1963, Pl. 4, Fig. 8).

Distinct relationships seem also to occur between K. Young's species and one of the specimens identified by C. Schlüter with the species *Bostrychoceras polyplacum* (Roemer) (C. Schlüter, 1871–1876, Pl. 34, Fig. 1). In addition to analogies in the development of costulation, manner of coiling and size, it displays a close similarity in the development of tubercles themselves and in the types of connection of tubercles and ribs occurring mostly in early and late developmental stages.

Distribution: Upper Campanian, *Bostrychoceras polyplacum* and *Didymoceras donezianum* Zones, the Vistula river valley.

Didymoceras donezianum donezianum (Mikhailov, 1951)

(Pl. V, Fig. 1; Pl. VII, Figs. 9–15, 18)

1951 *Bostrychoceras polyplacum* Roemer (?) var. *doneziana* Mikhailov, Mikhailov N.P., p. 53, Pl. V, Figs. 23–24 (holotype).

1966 *Cirroceras donezianum donezianum* (Mikhailov); Błaszkiwicz A., Table.

(?) 1966 *Cirroceras donezianum renngarteni* (Mikhailov); Błaszkiwicz A., Table.

Material: IG 12. II. 92; IG 234. II. 28; IG 1,310. II. 101–103; MZ VIII Mc 333, 426–427, 1,445.

Remarks. The original separation of N.P. Mikhailov's taxon is based exclusively on its holotype (N.P.

Mikhailov, 1951, p. 53, Pl. 4, Figs. 23–24), representing mostly the earliest parts of a coil and constituting a loosely coiled, wide-umbilicus whorl, preceded by an erect sector.

This specimen is accurately contained within the range of variability, determined by the characters of the presented, best preserved ones, which represent the same development stages (Pl. VII, Figs. 10–12, 14–15).

In the present writer's concept of the taxon described, which is debatable due to the fragmentary state of preservation of particular specimens, the following characters have been assumed as diagnostic ones: dimensions of coil, which as a rule are small; straightening-up of the distinctly early part of coil; spiral and on the whole loose coiling of the remaining part of phragmocone; coarse and widely spaced costulation in the form of simple ribs, with a possibility of only infrequent bifurcation of ribs, both in the tubercles of the lower and upper row; small dimensions of tubercles as compared with the thickness of ribs and, as a rule, the lack of ribs not connected with tubercles.

Of the materials, described in literature, the most distinct relationship to the specimens here presented is displayed by that distinguished by N.P. Mikhailov as *Bostrychoceras polyplacum* var. *renngarteni* nov. var. (N.P. Mikhailov, 1951, Pl. 3, Figs. 17 and 18). It consists of about 1.5 whorl of a tightly coiled normal spiral and a downturned gerontic part of coil; lacking is perhaps only the apertural part. In the present state of knowledge, it seems that the systematic separation of this form from the taxon under study may be accepted only in the rank of subspecies. The lack of any proof for contacts with an earlier, not preserved whorl and a rarer bifurcation of ribs (in the tubercles of the lower row) are the only characters differing the specimens here presented, which represent late development stages (Pl. V, Fig. 1; Pl. VII, Figs. 13 and 18), from this form.

The material from the Middle Vistula river valley includes a specimen (Pl. VII, Fig. 17), previously identified by the present writer as *Cirroceras donezianum renngarteni* (Mikhailov) (cf. synonymy), but which is to a considerable extent transitional between the holotype of this subspecies, erected by N.P. Mikhailov, and the specimens described here. This specimen differs from the holotype of *Didymoceras donezianum renngarteni* (Mikhailov) in a decisively rarer bifurcation of ribs and size of the coil. The last-named character differs it, however, also from specimens identified with *D. donezianum donezianum* (Mikhailov). The stratigraphic position of this specimen is undoubtedly included in the range of the material related with *D. donezianum donezianum* (Mikhailov).

The separateness of the subspecific rank may be also assumed in the case of specimens described from the Donets Basin, U.S.S.R. (N.P. Mikhailov, 1951, Pl. 3, Fig. 19; Pl. 4, Figs. 20 and 22; D.P. Naydin, 1959, Pl. 4, Figs. 1, 3, 4) and identified with a species, erected by E. Favre, that is, *Nostoceras* (?) *schloenbachi* (Favre). A tight coiling of the phragmocone, with a very frequent bifurcation of ribs in the tubercles of the upper row are features characteristic of the last-named group of specimens, representing various stages, except only for very early ones. The material collected in the Middle

Vistula river valley (IG 1,310. II. 105–108), represented by specimens illustrated in Pl. VII, Figs. 1 and 5–8 and which, in addition to the characters named above differs maybe from those related with *Didymoceras donezianum* (Mikhailov) also in a slightly higher stratigraphic position, should be also included in this group.

D. densecostatum (Wiedmann) is a species which displays a distinct relationship with the taxon described.

In relation to the taxon under study, considerable similarities are also displayed by *D. stvensoni* (Whitfield) (R.P. Whitfield, 1880, Pl. 14, Figs. 5–8; 1901, Pls. 29–30). As compared with *D. donezianum* (Mikhailov), the North American species differs only in larger dimensions of its coil and a tighter coiling of the later part of phragmocone with, an occurrence of mostly simple ribs.

Distribution: Upper Campanian, *Didymoceras donezianum* Zone, the Middle Vistula river valley. Upper part of the Upper Campanian of the Donets Basin, U.S.S.R.

Didymoceras densecostatum (Wiedmann, 1962)

(Pl. VII, Figs. 2–4)

1871–1876 *Heteroceras polyplacum* ? Roemer; Schlüter C. (pars), p. 112. Pl. 35, Figs. 1–4 (holotype).

1921 *Didymoceras* sp. nov. Spath; Spath L.F., p. 249.

1962 *Cirroceras (Cirroceras) schloenbachi densecostatum* Wiedmann; Wiedmann J., p. 204.

1966 *Cirroceras donezianum densecostatum* Wiedmann; Blaszkiewicz A., table.

Material: MZ VIII Mc 371.

Remarks. J. Wiedmann's species is known only in its early developmental stages.

From *Didymoceras donezianum* (Mikhailov), displaying considerable relationship with it, it differs in the differentiation of the elements of tuberculation and different combinations of connection between ribs and these elements, as well as in a permanent lateral flattening of its whorl sections. These differing characters relate it, at the same time, with *D. postremum* sp. nov.

Distribution: Upper Campanian, *Didymoceras donezianum* Zone, the Vistula river valley. Upper Campanian of the Federal Republic of Germany.

Didymoceras postremum sp. nov.

(Pl. VIII, Fig. 1–6; Pl. IX, Figs. 1–6)

? 1951 *Bostrychoceras polyplacum* Roemer var. *schloenbachi* (Favre); Mikhailov N.P. (pars), p. 51. Pl. 3, Fig. 16.

1966 *Cirroceras* sp. nov. Blaszkiewicz; Blaszkiewicz A., table.

Holotypus. Pl. VIII, Figs. 2 and 5 (IG 1,310. II. 6).

Stratum typicum. Upper Campanian, *Didymoceras donezianum* Zone. **Locus typicus.** The Middle Vistula river valley, Ciszycza Górna, outcrop 107.

Derivatio nominis. *Postremus* (Lat.) – the last.

Diagnosis. Shell large, loosely coiled. Umbilicus of whorls of a normal spiral medium-sized, whorl sections flattened ventrally. The deflected part distinctly U-shaped, with an apertural arm flattened laterally. The elements of tuberculation of the normal spiral and of the initial sector of the deflected part are in the form of distinctly developed tubercles or tubercular swellings, the latter sometimes almost imperceptible.

The bifurcation of ribs is on the whole observed in the tubercles of the lower row.

Differentiated elements of tuberculation are also visible on the remaining sector of the deflected part. Some tubercles, both of the lower and upper row, resemble those of the "clavi" type.

In the internal area (between the rows) the tubercles of the two rows are connected with two or three ribs. Two ribs each diverge on the whole from the tubercles and run towards the lower and upper lateral part of whorl. Ribs are fairly thick, about 25 of them occurring on the lower lateral side.

Material: IG 12. II. 1–6; IG 234. II. 40; IG 890. II. 153–164, 170–172; IG 1,310. II. 6, 109–152; MZ VIII Mc 340–341, 374.

Description. The specimens under study represent various parts of coil, except for the conspicuously early sectors of phragmocone. The sector of coil, preceding the body chamber (or, at least its decidedly larger part), makes up a loosely, dextrally or sinistrally coiled spiral (Pl. VIII, Fig. 3; Pl. IX, Figs. 4 and 6). In this part of coil, the umbilicus of whorls is more or less medium-sized (26 to 32 per cent; better preserved specimens, which make up this part of coil, are secondarily flattened laterally). Changes in the size of umbilicus are also found as elements of the ontogenetic development (the umbilicus of an earlier whorl, illustrated in Pl. IX, Figs. 4 and 6, makes up 29 per cent of the diameter and that of a later whorl – 32 per cent). Whorl sections are flattened ventrally, except for some not illustrated specimens, which make up fragmentary whorls of phragmocone flattened laterally, probably as a result of secondary deformations. Body chamber distinctly U-shaped (Pl. VII, Figs. 2, 4, 5). The plane of body chamber forms, with the axis of spiral preceding it, a small angle of 20 to 30°. The sections of the initial sector of body chamber are flattened ventrally and those of the last sector – pronouncedly laterally (the initial section of body chamber is 42 to 55 mm. thick and 25 to 30 mm. high and the aperture 32 to 51 mm. thick and 46 to 64 mm. high).

On the normal spiral and initial sector of the deflected part of coil, the elements of tuberculation are represented by tubercular swellings of ribs and by tubercles (Pl. VIII, Figs. 5 and 6). As compared with the thickness of ribs, tubercles are not very large and their outlines are more distinct in the lower row only. On some ribs, the tubercular swellings are very poorly visible, or cannot be discerned for sure. In most specimens, one rib each diverges downwards and two each upwards from the tubercles of the lower row. The divergence of two ribs each downwards and three each upwards is also recorded in some specimens (Pl. VII, Fig. 4).

The rest of the deflected part also displays differentiation in the elements of tuberculation, that is, tubercular swellings of ribs and tubercles proper. However, the tubercles occur here in both the lower and upper row and reach larger dimensions as compared with the thickness of ribs. Some of them distinctly resemble those of the "clavi" type. Two (most frequently) or one rib each diverge from the lower row downwards and two or (less frequently) three each – upwards. Two or three ribs each diverge from the upper row downwards and two or (infrequently) one each – upwards.

Ribs are not very thick, those occurring between the rows of tubercles are reduced. In mid-whorl, the number of ribs in the lower lateral area fluctuates between 22 (Pl. VIII, Fig. 6) and 27 (Pl. IX, Fig. 6). The aperture is emphasized by the presence of one or two more strongly developed elements of costulation.

Remarks. The species described differs from *Didymoceras donezianum* (Mikhailov), the nearest stratigraphically of all species found in the Middle Vistula river valley, in larger dimensions, different form of whorls, more widely spaced ribs, variable development of the elements of tuberculation and occurrence of different systems of connecting tubercular elements with ribs. Larger dimensions, differences in the whorl sections, more widely spaced costulation and the occurrence of different systems of connecting tubercular elements with ribs are also recorded in comparison with *D. densecostatum* (Wiedmann), a taxon concurring with *D. donezianum* (Mikhailov) and known only in its early developmental stages.

A considerable similarity to the newly erected species is displayed by *D. sornayi* (Silva) (H.G. Silva, 1961, p. 20, Pls. 1–3), known perhaps only in its middle developmental stages. The African species differs mostly in the lack of differentiation in tubercular elements and in the occurrence of different systems of connecting tubercular elements with ribs. The shape, size, ornamentation and stratigraphic data of the specimen, described by N.P. Mikhailov from the Donets Basin, U.S.S.R. (cf. synonymy) and which presumably is part of a body chamber, allow one to relate it with the species under study.

Distribution: Upper Campanian, *Didymoceras donezianum* Zone, the Vistula river valley. Upper Campanian of the U.S.S.R. (?)

Genus *Nostoceras* Hyatt, 1894

Type species *Nostoceras stantoni* Hyatt, 1894

Diagnosis. See C.W. Wright (1957), p. L 224; M.K. Howarth (1965), p. 374 and the remarks.

Remarks. Taxons, which are transitional between *Nostoceras* Hyatt and *Didymoceras* Hyatt, include: *Nostoceras* (?) *navorroense* (Shumard) (B. Wade, 1926, p. 184, Pl. 61, Figs. 8–11, Pl. 62, Figs. 1, 2; L.W. Stephenson, 1941, Pl. 83, Figs. 9–13). For comparison of the two genera – see the remarks on *Didymoceras* Hyatt. In its loose coiling of shell, lack of a sudden deflection and a perfectly U-shaped body chamber, this species resembles forms of the genus *Didymoceras* Hyatt. With the genus *Nostoceras* Hyatt it is related, on the other hand, by its stratigraphic position and a fairly small phragmocone. Also similar to type forms of *Nostoceras* Hyatt seems to be a European species found in the Middle Vistula river valley, that is, *Nostoceras* (?) *schloenbachi* (Favre).

Anaklinoceras Stephenson (L.W. Stephenson, 1941) and *Planostoceras* Lewy (Z. Lewy, 1967) may, according to current presentations, be interpreted as subgenera of *Nostoceras* Hyatt (C.W. Wright, 1957; T. Matsumoto, 1967; Z. Lewy, 1967, 1969).

Nostoceras pozaryskii sp. nov.

(Pl. X, Figs. 1–5, 8, 9, 11–15)

1934 *Hamites vistulae* Pozaryski in sched. (IG 12. II. 7/1–16).

1966 *Nostoceras vistulae* (Pozaryski in sched.); Blaszkiewicz A., p. 1.063.

Holotypus. Pl. X, Figs. 1–5 (IG 1,310. II. 7).

Stratum typicum. Upper Campanian. *Nostoceras pozaryskii* Zone. **Locus typicus.** The Middle Vistula river valley, Piotrawin, outcrop I. **Derivatio nominis.** After Wladyslaw Pozaryski's name.

Diagnosis. U-shaped part of whorl large. Sections of the apertural arm on the whole flattened laterally. Arcuate portion with tubercular elements in the form of spines. Arms with less strongly developed tubercular elements, which, on the apertural arm, constitute tubercular swellings of ribs only. In the lower lateral area of the arcuate portion, ribs are divided and form up to four secondary, bifurcate and virgatoïdal, elements. Some of these secondary ribs are not connected with tubercles. In the upper lateral area, the number of secondary ribs is smaller. The number of secondary ribs diverging from tubercles and running toward the middle of the siphonal area of the arcuate portion fluctuates from two to three.

Material: IG 12. II. 7/1–16; IG 889. II. 120; IG 1,310. II. 7, 153–160.

Description. The specimens described represent a generic, downturned part of coil and the last whorl of a normal spiral. The whorl of normal spiral is represented only in the case of a specimen illustrated in Pl. X, Figs. 11, 13, 15, which also includes the downturned sector of coil. This whorl is secondarily deformed and preserved, only in small part, as a mold. The rest of it makes up an internal impression. The whorl is sinistrally coiled. Its umbilicus is wide and the whorl sections of the mold preserved are flattened ventrally. The traces of suture are visible on the whorl and on the transitional sector between it and the U-shaped part.

The sector transitional between the last whorl and the U-shaped part is also visible on the holotype (Pl. X, Figs. 1 and 5). The coiling of the holotype is also sinistral and the traces of suture descend to the level of aperture. In the remaining specimens, the traces of suture have never been observed below the level of aperture.

In the holotype and the specimen with the whorl preserved, the later part of the initial arm and arcuate portions are flattened ventrally. In part of the remaining specimens, these portions are flattened laterally (Pl. X, Fig. 14). The sections of the apertural arm are, in all specimens, flattened laterally (the thickness and height of aperture fluctuate within limits of 16 to 21 and 24 to 26 mm. respectively, amounting in the holotype to 19 and 25 mm. respectively; the length of the apertural arm amounts to between 3.5 and 4.5 cm.).

Tubercles on the U-shaped part of coil are large, except on the apertural arm, where they are pronouncedly smaller or turn into tubercular swellings of ribs. In the arcuate portion of the U-shaped part of coil, tubercles distinctly resemble spines. On the apertural arm, ribs are simple, except in the specimen with the whorl of normal spiral preserved, in which a distinct bi- or trifurcation of some ribs is observed between the rows of tubercular elements.

A division of primary ribs into secondary, bifurcate and virgatoïdal elements is frequently recorded in the lower lateral area of the arcuate portion. The number

of secondary ribs formed of a primary rib reaches three to four and one of this elements almost always fuses only with a tubercle of the upper row or reaches an opposite lateral area. Secondary elements, formed of a primary rib, may merge with two different tubercles of the lower row.

A total number of secondary ribs in the upper lateral area of the arcuate portion is always smaller. In some specimens, also including the holotype, considerable part of primary ribs here occurring is not subject to division. Two or three ribs each diverge from the tubercles of both the lower and upper row of the arcuate portion and run towards the middle of the siphonal area.

On the initial arm of the U-shaped part of coil, none of its lateral areas displays any distinct and frequent tendency to the division of ribs below the rows of tubercles. In the holotype and most other specimens, on the whole two ribs each diverge here from the tubercles of both the lower and upper row and run towards the middle of the siphonal area.

In both lateral areas, primary ribs are very widely spaced and sharp over the entire U-shaped part of coil. The number of primary ribs occurring over the U-shaped part, determined by the level of aperture, fluctuates within limits of 20 and 22. The secondary elements, at least their later sectors, are less distinct. A decrease in the development of ribs is also observed between the rows of tubercles, but on the apertural arm it occurs to a very small extent. The aperture is emphasized by a less prominent element of costulation.

In the sector preceding the U-shaped part of coil, the costulation becomes denser and lower. In the holotype, there occurs a bi- and trifurcation in the tubercles of the lower row and two ribs each diverge downwards and two to three ribs each diverge upwards from the tubercles of the upper row. The state of preservation of the remaining specimen representing this part of coil allows one to find only that two ribs each diverge both downwards and upwards from the tubercles of the upper row.

Remarks. Among formally erected species, a conspicuous similarity to that described above is displayed by the North American species *Nostoceras kernense* (Anderson) (F.M. Anderson, 1958, p. 196, Pl. 65, Fig. 1). The available data allow one to an equal degree to assume in this case both specific and subspecific (a geographical subspecies?) differences. F.M. Anderson's taxon differs from the specimens from the Middle Vistula river valley in a constant division of its primary ribs into secondary elements in the lower lateral area of all sectors of the U-shaped part, with which the occurrence of a larger number of ribs, not connected with the tubercles of the lower row, is related.

A considerably similarity is also displayed by *N. dracone* Stephenson (L.W. Stephenson, 1941, p. 413, Pl. 82, Figs. 5–7 and 8–9), which differs, however, in a smaller number of secondary elements on the U-shaped part of coil and a more *Didymoceras*-like character of the deflection of the U-shaped part from the normal spiral.

A specimen, illustrated in Pl. X, Figs. 8–9 and 12 and making up the U-shaped part of coil, differs from those described in the occurrence of only bifurcate elements in both lateral areas of the arcuate portion.

At the same time, one of the two ribs is always poorly visible. It also differs in a smaller number of ribs, diverging in the arcuate portion from tubercles and running towards the middle of the siphonal area. In addition, it is marked by a very distinct lateral flattening of all sectors of coil and by a more widely spaced costulation. Induced, however, by its sporadic occurrence and concordance of its stratigraphic position, the present writer interprets this form as an extreme morphological variant of the taxon described.

Distribution: Upper Campanian, *Nostoceras pozaryskii* Zone, the Vistula river valley.

Nostoceras sp.

(Pl. II, Figs. 7, 8; Pl. V, Fig. 2)

Material: IG 12. II. 8; IG 1,310. II. 5.

Remarks. As compared with *Nostoceras pozaryskii* sp. nov., these fragmentarily preserved specimens differ in a conspicuously higher stratigraphic position and rounded ribs.

On the other hand, parts of the coil preserved display outstanding morphological similarities to *N. sp.* (J.B. Reeside, 1962, Pl. 69, Figs. 10–12) described from New Jersey, U.S.A. Remarkable analogies are also displayed by a material from Barra do Dande, Angola, related with *Nostoceras hyatii* Stephenson (M.K. Howarth, 1965, Pl. 9, Pl. 10, Fig. 1).

Distribution: Lower Maastrichtian, *Belemmella lanceolata lanceolata* Zone, the Vistula river valley.

Nostoceras (?) *schloenbachi* (Favre, 1869)

(Pl. X, Figs. 6, 7, 10)

- ? 1850 *Crioceras plicatilis* Kner; Kner R., p. 9, Pl. 2, Figs. 3, 3a–b.
- 1869 *Helicoceras Schloenbachi* Favre; Favre E., p. 30, Pl. 7, Figs. 5a–c (holotype).
- ? 1913a *Heteroceras polyplocum* Roemer, var. *schloenbachi* Favre; Nowak J., p. 358, Pl. 41, Fig. 14, Pl. 44, Fig. 42.
- ? 1964 *Bostrychoceras polyplocum schloenbachi* Favre; Tsankov T.V., p. 151, Pl. 3, Figs. 2–3.
- 1966 *Nostoceras* (?) *schloenbachi* (Favre); Blaszkiewicz A., p. 1065.

Material: IG 1,310. II. 161.

Remarks. The holotype makes up an incomplete whorl. As compared with the specimen presented, it does not display any clearly defined differences in the outline of whorl sections, manner of coiling and size. In regard to ornamentation, there also seem to be only insignificant quantitative differences in the frequency of occurrence of particular manners of connecting tubercles with ribs. A distinct similarity is observed, at the same time, in the stratigraphic position.

R. Kner's and J. Nowak's specimens may be representatives of the early stages of E. Favre's species. Similar in the type of ornamentation and shape of coil seem to be also T.V. Tsankov's specimens.

Upper Campanian specimens from the Donets Basin, U.S.S.R., identified at present with E. Favre's species (N.P. Mikhailov, 1951, Pl. 3, Fig. 19, Pl. 4, Figs. 20–22; D.P. Naydin, 1959, Pl. 4, Figs. 1–4) are treated by the present writer as homeomorphic forms. They display only partial analogies to the species under study, differing from it in a less massive ornamentation and occurrence of different manner of connecting tubercles with ribs (cf. also the descriptions of these forms in remarks on *Didymoceras donezianum donezianum* (Mikhailov)).

Specimens from Madagascar, thus far identified with E. Favre's species (E. Basse, 1931, Pl. 2, Figs. 11–15) seem to be more comparable with other forms of the *Nostoceras*, that is, *Nostoceras mariateresianum* Haas and (?) *N. angolense* Haughton (O. Haas, 1943; S.H. Haughton, 1924).

Distribution: Lower Maastrichtian – *Belemnella lanceolata lanceolata* Zone, the Vistula river valley. Lower Maastrichtian of the U.S.S.R. Maastrichtian of Bulgaria (?).

Family DIPLOMOCERATIDAE Spath, 1926

Genus *Glyptoxoceras* Spath, 1925

Type species *Hamites rugatus* Forbes in Kosamat, 1895, p. 145 (49) (= *Hamites indicus* Forbes, 1846, p. 116)

Diagnosis. See Wright C.W., 1957, p. L 227; Matsumoto T., 1959–1960, p. 167.

Glyptoxoceras retrorsum (Schlüter, 1872)

(Pl. LV, Figs. 3–5)

1871–1876 *Ancyloceras retrorsum* Schlüter; Schlüter C., p. 97, Pl. 30, Figs. 5–7 (Lectotype – L.F. Spath, 1925, p. 31), Figs. 8–10.

1925 *Glyptoxoceras retrorsum* Schlüter; Spath L.F., p. 31.

non 1951 *Ancyloceras retrorsum* Schlüter; Mikhailov N.P., p. 87, Pl. 5, Fig. 32, Pl. 13, Fig. 56.

non 1959 *Neancyloceras retrorsum* Schlüter; Naidin D.P., p. 182, Pl. 3, Fig. 7.

1966 *Glyptoxoceras* (?) *retrorsum* Schlüter; Blaszkiewicz A., table.

Material: IG 1,310. II. 162.

Dimensions in mm. (Table 4)

Table 4

Specimen	L	W	H	W/H "	R	Remarks
Pl. LV, Figs. 3–5	67.4	11.6	16.7	69	5–7	The whorl displays local secondary, asymmetric deformations
	112.5	16.5	24.6	67	5–6	

Remarks. With an approximately the same maximum height of section, the specimen described departs from the lectotype in a more crioceratoid coiling of shell. In addition, its section is more oval in outline and ribs turned decidedly posteriorly in contrast to their almost rectilinear trace in the lectotype. There are also certain differences in the stratigraphic position, which in the case of the Polish specimen is undoubtedly lower. Similar differences in the manner of coiling, outline of sections and course of ribs have also been found when comparing the specimen under study with C. Schlüter's another specimen (1871–1876, Pl. 30, Figs. 9–10), marked by a decidedly smaller maximum height of whorl and identically located as the lectotype. Accurate analogies occur, on the other hand, in comparison with C. Schlüter's third specimen (1871–1876, Pl. 30, Fig. 8), whose stratigraphic position is, like that of the Polish specimen, lower than the position of the lectotype. The relations mentioned above may be a basis for adopting temporary sub-specific differentiation within the range of *Glyptoxoceras retrorsum* (Schlüter).

Distribution: Lower Campanian, *Goniotoothis quadrata* Zone, the Vistula river valley. Lower and Upper Campanian of the Federal Republic of Germany.

Genus *Neancyloceras* Spath, 1926

Type species *Ancyloceras bipunctatum* Schlüter, 1872

Diagnosis. See C.W. Wright, 1957, p. L 227.

Neancyloceras phaleratum (Griepenkerl, 1889)

(Pl. XI, Figs. 1, 2, 4–8; Pl. XII, Figs. 1–4, 6–9)

? 1885 *Ancyloceras*? *elegans* Moberg; Moberg J.C., p. 30, Pl. 3, Fig. 10a, b.

1889 *Hamites phaleratus* Griepenkerl; Griepenkerl O., p. 406, Pl. 44, Fig. 3a–i, Pl. 45, Figs. 3, 4.

non 1912 *Hamites phaleratum* Griepenkerl; Łopuski C., p. 182, Pl. 1, Figs. 1, 2.

1913a *Anisoceras* (?) *elegans* Moberg; Nowak J. p. 384, Pl. 40, Fig. 7.

1966 *Neancyloceras phaleratum phaleratum* (Griepenkerl); Blaszkiewicz A., table.

1966 *Neancyloceras phaleratum* (Griepenkerl) subsp. nov. Blaszkiewicz; Blaszkiewicz A., table.

Type. O. Griepenkerl's specimen (1889, Pl. 45, Fig. 3) has been designated by the present writer as a lectotype.

Material: IG 13. II. 6–12; IG 889. II. 10, 15, 17, 24, 45–46, 48, 54; IG 890. II. 21, 26–27; IG 1,310. II. 2, 163–207.

Dimensions in mm. (Table 5)

Table 5

Specimen	L	W	H	W/H ⁰	R
Pl. XII, Fig. 4	20.5	7.0?	8.2?	85	3?
Pl. XI, Fig. 2	52.0	–	9.6	–	3–4
Pl. XI, Fig. 5	39.0	5.0	10.7	46	3–4
Pl. XI, Figs. 1, 4	140.8	12.1	23.0	52	4–6
Pl. XII, Fig. 3	51.0	10.0	24.3	41	5
Pl. XII, Figs. 1–2	99.0	19.0	36.5	51	8
Pl. XII, Figs. 6, 7	83.5	20.1	38.4	52	8
Pl. XI, Figs. 6, 8	79.0	20.0	41.5	49	8
Pl. XI, Fig. 7	105.9	–	52.7	–	7
Pl. XII, Figs. 8–9	198.2	28.5	51.0	55	7–8

Remarks. The lectotype is here an only specimen, giving sufficient basis for interpreting the specimens presented as one species and, at the same time, for assuming that they represent coils, composed of several (at least five) rectilinear sectors, arranged parallel to each other in one plane and connected by arcuate joints. There is, however, the possibility that there occurred only small differences in the number of straight sectors between particular individuals.

The lectotype and the remaining materials, described in literature, do not include, like the specimens from the Middle Vistula river valley, the initial, earliest part of a coil. In the light of the indications resulting from the known materials, it seems, however, unlikely that the earliest part of coil might not also constitute a rectilinear sector. Nevertheless, the manner of coiling the initial sector of a complete coil is probably variable. The lectotype, beginning with an arcuate portion, whose initial section is 5 mm. high, probably represents a form in which all sectors of coil, including the arms of the earliest pair, are not tightly coiled (as indicated

by the size, shape and situation of the arcuate portion as compared with the other part of coil, loosely coiled and composed of three straight sectors connected by arcuate joints, as well as with a final, arcuate, small part). The Polish material or, at least its part, represents, unquestionably opposite relations. As follows from the description, both sectors of arms of the first pair, preserved are always tightly coiled, although in some cases this may be a result of secondary deformations.

The material known thus far is undoubtedly lacking specimens with a gerontic aperture. The whole of the available data allows one, however, to believe that all parts of a coil, with their sections more than 40 mm. high, represent a gerontic chamber, which includes two straight sectors connected by an arcuate part. In regard to the lectotype, it seems to represent only a phragmocone (a maximum height of sections amounts to 28 mm. and a trace of a single septum is most likely to occur in the terminal part of the last, straight sector).

Also noteworthy is the fact that the present writer's material proves the existence of a distinct intraspecific variability, occurring at least in later ontogenetic stages and involving the dimensions of ribs connected with tubercles (in this writer's former work, these differences were interpreted as subspecific; cf. synonymy).

The specimen, on which *Ancyloceras? elegans* Moberg (cf. synonymy) is based, may belong to the species described. The name *A. elegans* Moberg may, therefore, turn out to be a senior synonym of the name *Hamites phaleratus* Griepenkerl. J. Moberg's specimen has, however, been poorly and only fragmentarily preserved and a definite solution of this problem requires analyzing further materials coming from the same locality.

Distribution: Upper Campanian, *Neancyloceras phaleratum* Zone, the Vistula river valley and of the Mięchów trough. Upper Campanian of the Federal Republic of Germany and Sweden (?).

Neancyloceras sp.

(Pl. LV, Fig. 2)

1966 *Neancyloceras* sp. nov. Blaszkiewicz: Blaszkiewicz A., table.

Material: IG 1,310. II. 208.

Dimensions in mm. (Table 6)

Table 6

Specimen	L	W	H	W/H ¹⁰⁰	R	Remarks
Pl. LV Fig. 2	72.9	24?	34.4	69	7	A secondary, bilaterally symmetric deformation

Remarks. This fragmentary specimen displays, in its shape, a considerable similarity to the straight, late part of coil of *Neancyloceras phaleratum* (Griepenkerl). The differences consist only in a larger degree of ventral flattening in the form described. In the development of ornamentation, on the other hand, many more differing characters have been found, that is, a permanent connection of particular ribs with single tubercles, absence of differentiation in the development of ribs themselves, lack of any visible decrease in the prominence of ribs, their bifurcation on the ventral side and, finally, an anteriorly oblique course of ribs

in the form described. In addition, its stratigraphic position is somewhat higher.

In the development of its ornamentation and in its stratigraphic position, this form, more closely than *O. Griepenkerl's* species, resembles the type of the genus *Neancyloceras* Spath.

Distribution: Upper Campanian, *Bostrychoceras polyplocum* Zone, the Vistula river valley.

Neancyloceras bipunctatum (Schlüter, 1872)

(Pl. XII, Fig. 5)

1871–1876 *Ancyloceras bipunctatum* Schlüter: Schlüter C., p. 98, Pl. 29, Figs. 1–3.

1926 *Neancyloceras bipunctatum* Schlüter: Spath L.F., p. 80.

1951 *Ancyloceras bipunctatum* Schlüter: Mikhailov N.P., p. 88, Pl. 16, Figs. 66–71.

1959 *Neancyloceras bipunctatum* Schlüter: Naidin D.P., p. 182, Pl. 3, Fig. 6.

1966 *Neancyloceras bipunctatum* Schlüter: Blaszkiewicz A., table.

Type. C. Schlüter's (1871–1876) specimen, Pl. 29, Fig. 3 has been designated by the present writer as a lectotype.

Material: IG 1,310. II. 209.

Dimensions in mm. (Table 7)

Table 7

Specimen	L	W	H	W/H ¹⁰⁰	R
Pl. XII, Fig. 5	34	4.7	10.6	44	4

Remarks. In the manner of coiling and relationships between particular elements of ornamentation, the specimen from the Middle Vistula river valley is accurately or fairly well comparable to part of the coil of a specimen from the Donets Basin, U.S.S.R., corresponding to it in the size of its sections (N.P. Mikhailov, 1951, Pl. 16, Figs. 66–67). Distinct differences observed in the proportions of the thickness and height of whorl seem to result exclusively from a secondary lateral deformation of the specimen presented.

As compared to part of the coil of lectotype, similar in the size of its sections, as well as to the remaining specimen, illustrated by C. Schlüter, the specimen from the Middle Vistula river valley differs fairly distinctly in a smaller ratio of the width of intercostular spaces to the width of the ribs themselves, which in the German specimens amounts to about 2. Differences occurring, in addition, in the outline of sections are comparable to those observed in the case of the specimen from the Donets Basin.

Neancyloceras aff. *bipunctatum* (Schlüter), a form found in the Middle Vistula river valley, seems to be closely related with C. Schlüter's species.

Distribution: Upper Campanian, *Didymoceras doezianum* Zone, the Vistula river valley. Upper Campanian of the U.S.S.R. and the Federal Republic of Germany.

Neancyloceras aff. *bipunctatum* (Schlüter, 1872)

(Pl. XI, Fig. 3)

1966 *Neancyloceras* aff. *bipunctatum* Schlüter: Blaszkiewicz A., table.

Material: IG 1,310. II. 210.

Remarks. This fragmentarily and unilaterally preserved specimen, without any traces of suture, decidedly differs in its larger size from the gerontic part of coil of *Neancyloceras bipunctatum* (Schlüter) known only in its lectotype. At the same time, this specimen is marked by ribs, which are less prominent and sharp as compared with those in all specimens related with C. Schlüter's species. In addition, its stratigraphic position may be higher than that of all these specimens.

Distribution: Upper Campanian of the Vistula river valley, top part of the *Didymoceras donezianum* Zone.

Genus *Diplomoceras* Hyatt, 1900

Type species: *Baculites cylindracea* DeFrance, 1916

Diagnosis. See C.W. Wright, 1957, p. L 227.

Diplomoceras cylindraceum Ioviense Mikhailov, 1951

(Pl. LIV, Fig. 4)

- 1861 *Hamites cylindraceus* d'Orbigny: Binkhorst J.T., p. 36, Pl. 5b, Figs. 6, 7.
 1869 *Hamites cylindraceus* DeFrance; Favre E., p. 26, Pl. 7, Fig. 1.
 1913a *Hamites cylindraceus* DeFrance; Nowak J. p. 382, Pl. 41, Fig. 10, (holotype) Pl. 43, Fig. 35, Pl. 45, Fig. 47.
 1951 *Diplomoceras cylindraceum* Defr. var. *Ioviense* Mikhailov; Mikhailov N.P., p. 42, Pl. 2, Figs. 7, 8, Text-fig. 11.
 1953 *Hamites cylindraceus* DeFrance; Petkowič K., p. 33, Pl. 6, Figs. 1, 4–6.
 1964 *Diplomoceras cylindraceum* (DeFrance); Tsankov T.V., p. 152, Pl. 4, Fig. 2.
 1966 *Diplomoceras cylindraceus Ioviensis* Mikhailov; Blaszkiewicz A., table.

Material: MZ VIII Mc 1390.

Remarks. This unilaterally preserved specimen displays a set of features characteristic of N.P. Mikhailov's taxon. As compared with the nominative subspecies, N.P. Mikhailov's taxon has pronouncedly closer costulation (cf. the comparison of M.J.L. DeFrance's species with other taxons, see below).

Distribution: Upper Maastrichtian of the Vistula river valley and the Miechów trough. Maastrichtian of the Netherlands, the U.S.S.R., Bulgaria and Yugoslavia.

Diplomoceras cylindraceum cyclindraceum (DeFrance, 1916)

(Pl. LIV, Fig. 2; Pl. LV, Figs. 6, 7)

- 1840–1842 *Hamites cylindraceus* DeFrance; d'Orbigny A., p. 551, Pl. 136, Figs. 1–4.
 ? 1871–1876 *Hamites* cf. *cylindraceus* DeFrance; Schlüter C., p. 103, Pl. 31, Figs. 10–14.
 ? 1951 *Diplomoceras* cf. *cylindraceum* DeFrance; Mikhailov N.P., p. 41, Pl. 2, Figs. 9–10.
 1966 *Diplomoceras cylindraceus cyclindraceus* DeFrance; Blaszkiewicz A., table.

Type. M.J.L. DeFrance did not illustrate his species and gave its only general description (cf. C. Schlüter, 1871–1876, pp. 103–104). In conformity with contemporary elaborations (N.P. Mikhailov, 1951, p. 41; L.F. Spath, 1955, p. 17), specimens described in A. d'Orbigny's work (1840–1842, p. 551, Pl. 136, Figs. 1–4) have been adopted by the present writer as type specimens.

Material: IG 1,310. II. 9; MZ VIII Mc 530.

Dimensions in mm. (Table 8)

Table 8

Specimen	L	W	H	W/H	R	Remarks
Pl. LV, Fig. 7	113.7	20.0	46.7	41	6–7	Secondary lateral flattening of the coil
Pl. LV, Fig. 6	92.3	28.3	55.6	50	10	
Pl. LIV, Fig. 2	92.4	51.5?	60.6	84	9	

Remarks. In the development and number of their ribs, the specimens here presented fairly accurately correspond to an illustration of ornamentation in specimens from Normandy, France, published in A. d'Orbigny's work. Also the sections of a specimen without any trace of deformation (Pl. LIV, Fig. 2), resemble those shown in d'Orbigny's illustration of a section. As compared with specimens, illustrated by C. Schlüter and N.P. Mikhailov, the specimens described display a certain inconformity in the number of ribs, which is smaller.

According to N.P. Mikhailov's interpretation the distinguishing feature relates the specimens named above to *Diplomoceras cylindraceum Ioviense* Mikhailov.

Diplomoceras notabile (Whiteaves) (J.L. Usher, 1952, Pl. 29, Fig. 2 – an illustration of the holotype, Pls. 30 and 31, Figs. 26 and 27; D.L. Jones, 1961, Pl. 71; 1963, Pl. 21, Fig. 1) seems to differ from M.J.L. DeFrance's species in a less sharp costulation. *D. lambi* Spath (L.F. Spath, 1953, Pl. 2, Figs. 1–3) displays similar features of ornamentation as those of J.F. Whiteaves' species.

Distribution: Upper Maastrichtian, *Hoploscaphites constrictus crassus* Zone, the Vistula river valley, Maastrichtian of France, the U.S.S.R. and the Federal Republic of Germany (?).

Family SCAPHITIDAE Meek, 1876

Genus *Trachyscaphites* Cobban and Scott, 1964

Type species *Trachyscaphites rebirdensis* Cobban and Scott, 1964

Diagnosis. See W.A. Cobban and G.R. Scott, 1964, p. E 6.

Remarks. The taxonomic position of the species *Trachyscaphites* (?) *gibbus* (Schlüter), found in the Middle Vistula river valley, is obscure, a fact also assumed by the authors of the genus *Trachyscaphites* (W.A. Cobban and G.R. Scott, 1964, p. E 1). Occupying a very low stratigraphic position, C. Schlüter's species differs from the remaining forms of *Trachyscaphites* Cobban and Scott in a lack of tuberculation over a considerable, exposed part of normal spiral, lack of tuberculation on the siphonal area of coil, as well as distinctly variable number of the rows of tubercles.

Trachyscaphites spiniger spiniger (Schlüter, 1872)

(Pl. XIII, Figs. 1–3, 5 and 7)

- 1871–1876 *Scaphites spiniger* Schlüter; Schlüter C., p. 82, Pl. 25, Figs. 1–3, 4, 5 (?).
 ? 1885 *Scaphites spiniger* Schlüter; Moberg J.P., p. 28, Pl. 3, Figs. 6a–b.
 1966 *Scaphites spiniger spiniger* Schlüter; Blaszkiewicz A., table.

Type. C. Schlüter's (1871–1876, Pl. 25, Figs. 1–3) specimen, has been designated by the present writer as a lectotype.

A hooked part of coil, reconstructed on the basis of another specimen, is shown in the illustration (in Schlüter's work).

Material: IG 12. II. 9–10, 86; IG 889. II. 7, 14, 18; IG 1310. II. 211–212; MZ VIII Mc 363. Environs of Miechów: IG 1,310. II. 213–222.

Dimensions in mm. (Table 9)

Remarks. The specimen, presented in Pl. XIII, Figs. 1–2, displays a conspicuous similarity to the lectotype, from which it differs, however, in a character worthy of emphasizing, that is, in a less prominent costulation on its shaft. The reduction of costulation on the shaft is a general feature of the entire material here described and in some cases it is very strongly emphasized. Polish specimens display a developmental tendency which is most strongly expressed in *Trachyscaphites spiniger porchi* (Adkins) and *T. spiniger levatinensis* Lewy, separated as geographical subspecies (W. Adkins, 1929; K. Young, 1963; W.A. Cobban and G.R. Scott, 1964; Z. Lewy, 1969). The lack of costulation on most part of body chamber is a character which differs the two subspecies from the nominative one. Besides, the first of them frequently differs in a stronger development of tubercles and smaller size of coil. The second, represented by a single specimen only, differs in a wider umbilicus of its phragmocone.

In addition to the lack of reduction in costulation of the shaft, C. Schlüter's second specimen (1871–1876, Pl. 25, Fig. 4) differs from Polish specimens in the presence of a distinct curve of its dorsal margin. The remaining characters allow one to relate it, however, with the subspecies described. A fragmentary state of preservation or an indistinct illustration of the rest of the material mentioned in the synonymy are the main causes of doubts concerning its taxonomic position. A comparison with *T. spiniger posterior* subsp. nov. is included in the remarks on this taxon.

T. praespiniger Cobban and Scott (W.A. Cobban and G.R. Scott, 1964) is a closely related taxon, whose stratigraphic position is, in all likelihood, lower. This species differs in a smaller number of rows of tubercles both on the body chamber and phragmocone, the latter having on the whole one row of tubercles only. In addition, it differs in a more widely spaced costulation.

Distribution: Upper Campanian *Neancycloceras phaleratum* Zone, the Vistula river valley. Upper Campanian (lower part) of the Miechów region. Upper Campanian of the Federal Republic of Germany and Sweden (?).

Trachyscaphites spiniger posterior subsp. nov.

(Pl. XIII, Fig. 4, Pl. XIV, Figs. 1–7, Pl. XV, Figs. 2, 3, Pl. XXX, Fig. 2)

? 1840–1841 *Scaphites pulcherrimus* Roemer; Roemer F.A., Pl. 14, Fig. 4.

? 1915 *Scaphites spiniger* Schlüter; Frech F., p. 564. Text-fig. 13.
? 1951 *Acanthoscaphites spiniger* Schlüter; Mikhailov N.P., p. 100, Pl. 19, Fig. 92.

1966 *Trachyscaphites spiniger* (Schlüter) subsp. nov. Blaszkiwicz; Blaszkiwicz A., table.

Holotypus. Pl. XIV, Figs. 5–7. IG 1,310. II. 10.

Stratum typicum. Upper Campanian, *Bostrychoceras polyplacum* Zone. **Locus typicus.** The Middle Vistula river valley, Sulejów, outcrop 22. **Derivatio nominis.** *Posterior* (Lat.) – posterior.

Diagnosis. Shaft slightly exceeding phragmocone. Apertural angle about 115°. Four pairs of rows: latero-umbilical, lateral, lateroventral and ventral are formed by tubercles on the exposed sector. The largest tubercles, representing the "clavi" type, occur in ventral and lateroventral rows of shaft. The arrangement of tubercles in adjacent rows is mostly asymmetric. The number of free ribs, running between tubercles of one and the same row of the exposed part of phragmocone usually does not exceed one. No ribs of this type occur on the whole on the shaft.

Material: IG 889. II. 28, 41, 51–53, 58–61; IG 890. II. 25, 30, 31, 72, 90; IG 1,310. II. 10, 223–249, 251–260; MZ VIII Mc 420, 688, 1379, 1389.

Dimensions in mm. (Table 10)

Description. The holotype displays an insignificant loss on its ventral side and on the sides of the transitional zone between the shaft and normal spiral. The umbilicus of phragmocone is very narrow. Shaft slightly exceeding phragmocone. Dorsal margin of shaft straight. Apertural angle – 115°. Exposed sector of coil laterally convex, ventrally rounded. Sections wide (the specimen displays, however, secondary deformations). The highest section occurs in shaft, the thickest in the transitional zone between shaft and hooked sector. Four pairs of rows of tubercles, latero-umbilical, lateral, lateroventral and ventral, occur on the exposed part of coil. The largest tubercles, representing the "clavi" type, occur in ventral and lateroventral rows of shaft. The arrangement of tubercles in adjacent rows is mostly asymmetric. On normal spiral and the hooked sector, tubercles are closely spaced, the spaces growing wider towards the middle of shaft. Ribs appear at various levels of the side. Those beginning above the umbilical margin are intercalatory or furcate in character. The furcation starts as a rule in tubercles.

No more than one ribs runs between the tubercles of the same row on a normal spiral and mostly no such ribs occur on the early exposed part of this spiral. On the shaft, costulation is conspicuously reduced. No ribs running between the tubercles of the same row are as a rule observed in this place. Almost all of them either fuse with the tubercles of the nearest row, or disappear at the level of these tubercles. On most part of the ventral side of shaft, costulation is lacking also between the rows of tubercles. On the hooked sector, ribs on the whole do not occur both between the tubercles of the same row and between particular rows.

Table 9

Specimen	LS	WS	Th	H ₁	W ₁	W ₁ /H ₁ " ₀	H ₂	W ₂	W ₂ /H ₂ " ₀	H ₃	W ₃	W ₃ /H ₃ " ₀
Pl. XIII, Fig. 3	71.5	–	24.9?	26.0	22.4	86	–	23.2?	–	–	–	–
Pl. XIII, Figs. 1–2	85?	75.2	30.5?	39.7	21.0	52	47.8	25.6	53	–	–	–