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BELEMNOIDS FROM THE JURASSIC OF POLAND

Abstract. — 29 belemnoid species (including 1 new), belonging to 12 genera and 4 subfamilies within the Belemnitidae, are described from the Middle and Upper Jurassic beds of Poland. Individual variation, ontogeny and structure of the rostra are investigated. General remarks on the Jurassic stratigraphy in the Kraków-Częstochowa Highlands and in the north-eastern margin of the Holy Cross Mountains (Góry Świętokrzyskie) are given. Methods of investigation, terminology, ontogenetic changes of rostrum, stratigraphic and geographic distribution of the species are described and examples of the rostral deformation and destruction discussed.

INTRODUCTION

The belemnoids described in the present paper come from the Middle and Upper Jurassic of the Kraków-Częstochowa Highlands and from the north-eastern margin of the Holy Cross Mountains. They have been collected by the writer between 1954 and 1958. She also had at her disposal a part of the material collected and handed to her by the late Dr E. Panow.

The studied specimens go into many tens of thousands, but their specific differentiation is rather poor. It has not been possible to identify more than 29 species representing 12 genera. Among these species, two, belonging to the genus *Rhopaloteuthis*, have been described previously (Pugaczewska, 1957), so that only very abreviated descriptions of these forms are now given.

The richest collections have been obtained from the Middle and Upper Calloway and the Lower Oxfordian beds of the Kraków-Częstochowa region. The north-eastern margin of the Holy Cross Mountains has yielded barely some tens of specimens representing 6 species, of which one is new.

So far the knowledge on belemnites from the Jurassic of Poland has been very limited. The first descriptions are to be found in a paper by

Alth (1875) who mentions 8 species known in his time: *Belemnites canaliculatus* Schlotheim, *B. beyrichi* Oppel, *B. waageni* Neumayr, *B. subhastatus* Zieten, *B. calloviensis* Oppel, *B. hastatus* Blainville, *B. bzoviensis* Zeuschner, *B. disputabilis* Neumayr, and one new species: *B. majeri* Alth. Among other authors who have mentioned belemnites from the Jurassic of Poland are: Pusch (1830, 1837), Bronn (1851/52), and Zeuschner (1859, 1864). In 1869 the last mentioned author described a new species from Bzów near Kromołów — *Belemnites bzoviensis* Zeuschner. Three new species: *B. disputabilis*, *B. waageni* and *B. beneckei* have been described by Neumayr (1871, 1873); Makowski (1952) mentions two species, of which one — *Belemnoteuthis polonica* Makowski — is new. 17 species from the Jurassic of Poland are mentioned by Różycki (1953). The materials collected by that author have been destroyed during the war. The present writer has identified 29 species within the material she collected from sites lying in close proximity to those which have supplied Różycki's specimens. The specific composition of these collections, however, is different: 4 of Różycki's species are not identified in this material which, on the other hand, contains 16 species not mentioned by Różycki.

The writer's laboratory studies have been conducted at the Institute of Palaeozoology of the Warsaw University under the guidance of Professor R. Kozłowski, and the warmest thanks are conveyed to him for the valuable criticism and suggestions offered throughout the preparation of the present work. The financial support for the field work was received from the Polish Academy of Sciences.

The writer is also indebted to the following persons for cooperation: to Miss M. Czarnocka for the photographs, to Miss M. Witkowska, Mr W. Skarżyński, Mr W. Siciński and Mr A. Kryszewski for the cleaning of specimens and the preparation of thin slides, as well as for assistance in the field work, to Mrs K. Budzyńska for drawing the text-figures. Mrs J. Humnicka did the English translation of the Polish text.

The described material is part of the collections of the Palaeozoological Laboratory of the Warsaw University and is referred to as Z. Pal. UW No. Bj. 1 — Bj. 855.

GENERAL PART

DESCRIPTION OF THE JURASSIC DEPOSITS OF THE KRAKÓW-CZĘSTOCHOWA HIGHLANDS AND OF THE NORTH-EASTERN MARGIN OF THE HOLY CROSS MOUNTAINS

The facial development of marine sediments within the Jurassic Kraków-Częstochowa Highlands is strongly differentiated. On the base of facial differences Różycki (1953) has recognized there two main re-

gions: the northern and the southern. The northern region, extending between Częstochowa and Zawiercie, displays fair uniformity of relief in the substratum of Jurassic deposits that lie conformably to marine sediments of continental Lias rocks. In the southern region, extending between Olkusz and Kraków, on the other hand, the Jurassic sediments rest on a substratum made up of various rocks (Rhaetic-Liassic, Keuper, Muschelkalk, Permian, Carboniferous or Devonian, also extrusive Older Palaeozoic) showing extremely variable relief forms. In the northern region the lithofacies are fairly constant in the different horizons, while no such dependence is observable in the southern region. The quarry at Wrzosowa gives a typical section of the northern region. Here, as elsewhere in the Jurassic of the Kraków-Częstochowa Highlands, the Astartian and the Upper Jurassic horizons are missing. The Bathonian is mostly represented by dark-grey clays with sphaerosiderites, and brown arenaceous clays with oolites, the Callovian by brown limestones and glauconitic marls of a grey-greenish colour. In the Upper Callovian a characteristic "concretionary horizon" is encountered, consisting of phosphorite-limestone concretions yielding a rich and differentiated fauna. These deposits are overlain by a layer of stromatolites. The Devisian, occurring in the eastern part of that area, is represented by marls and marly limestones with a rich fauna of cephalopods, brachiopods and sponge assemblages of a bioherm type. The Devisian is absent at Wrzosowa where a stratigraphic hiatus is noted. The Nevisian does not fundamentally differ from the Devisian, its upper horizon being represented by marly fragmented limestones, the terminal one by laminated limestones which prevail also in the Argovian. The last named horizon is missing at Wrzosowa.

In the southern region the facial development is much more differentiated. Traces of washout, stratigraphic breaks, the absence of the concretionary and stromatolitic beds, in some sections even that of oolites, so characteristic of the northern region, are readily observable. Iron ore-bearing clays are, on the other hand, encountered here, as well as detritic sediments occurring in various horizons. The latter are represented by gravels, sands and conglomerates. Pink and grey-olive marls occur in the Upper Devisian, overlaid by stromatolites (in Ogrodzieniec) whose presence in this region and within this horizon is exceptional. The Nevisian is characterized by shaly marls alternating with sponge beds. Laminated limestones in this region, too, are referable to the Argovian (fig. 1, 2).

In the north-eastern margin of the Holy Cross Mountains the Jurassic sediments include rocks ranging in age from the Bajocian to the Kimeridgian. The character of these sediments differs from that of rocks in the Kraków-Częstochowa Highlands. Marine transgression

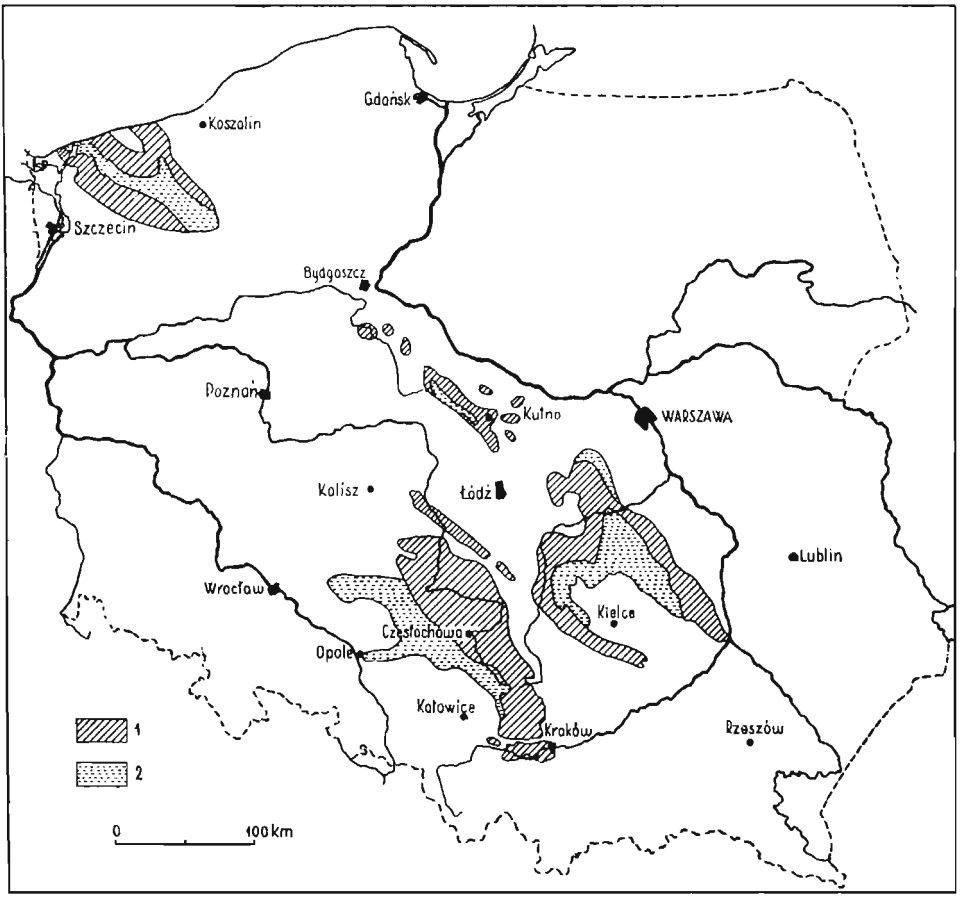

Fig. 1. — Diagrammatic map of Poland showing the distribution of the Jurassic formations: *1* Middle and Upper Jurassic, *2* Lower Jurassic.

here is associated with the formation of argillaceous-shaly, black, pyritic sediments suggesting a rather shallow and poorly aerated sea (Pożaryski, 1953). During the Callovian the sediments change from terrigenic into zoogenic and chemical. The fauna consists mainly of cephalopods, brachiopods, pelecypods and echinoderms. Other sediments occur here, such as white and yellow ferruginous sands, often with spongiolite inclusions, also arenaceous and crinoidal limestones. These sediments indicate an open sea. Higher Jurassic horizons are characterized by a chert facies with sponges, towards the top passing into an oolitic one. In the Oxfordian, reef rocks built up mainly by sponges make their appearance along with the Cordatum Zone, developed as marly limestones. In the Rauracian, shallow-sea sediments are encountered. A reef facies with corals and stromatoporoids is predominant, while limestones intergrown with cherts are frequent. The Astartian is

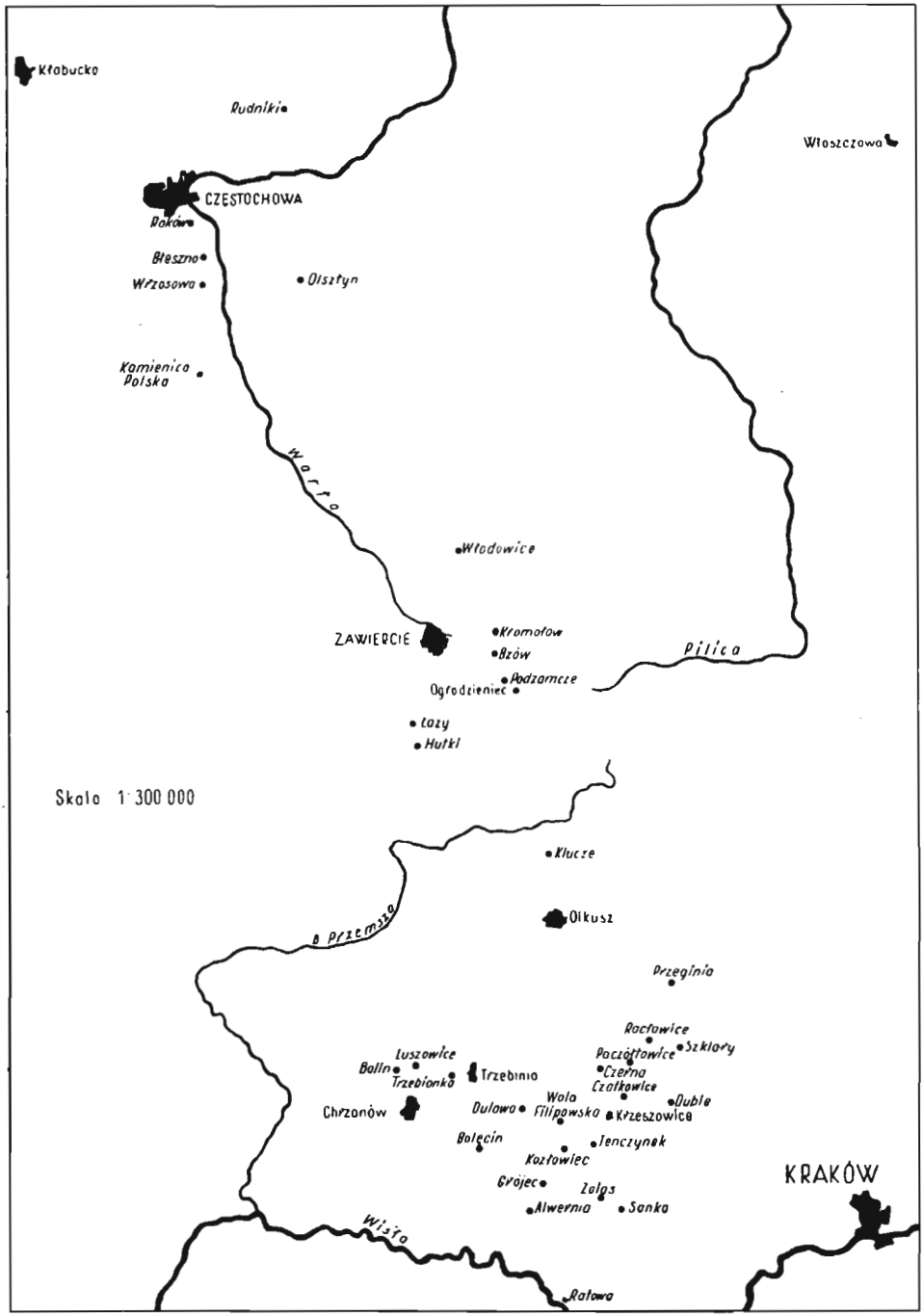

Fig. 2. — The distribution of the localities with Jurassic belemnites in Kraków--Częstochowa Higlands.

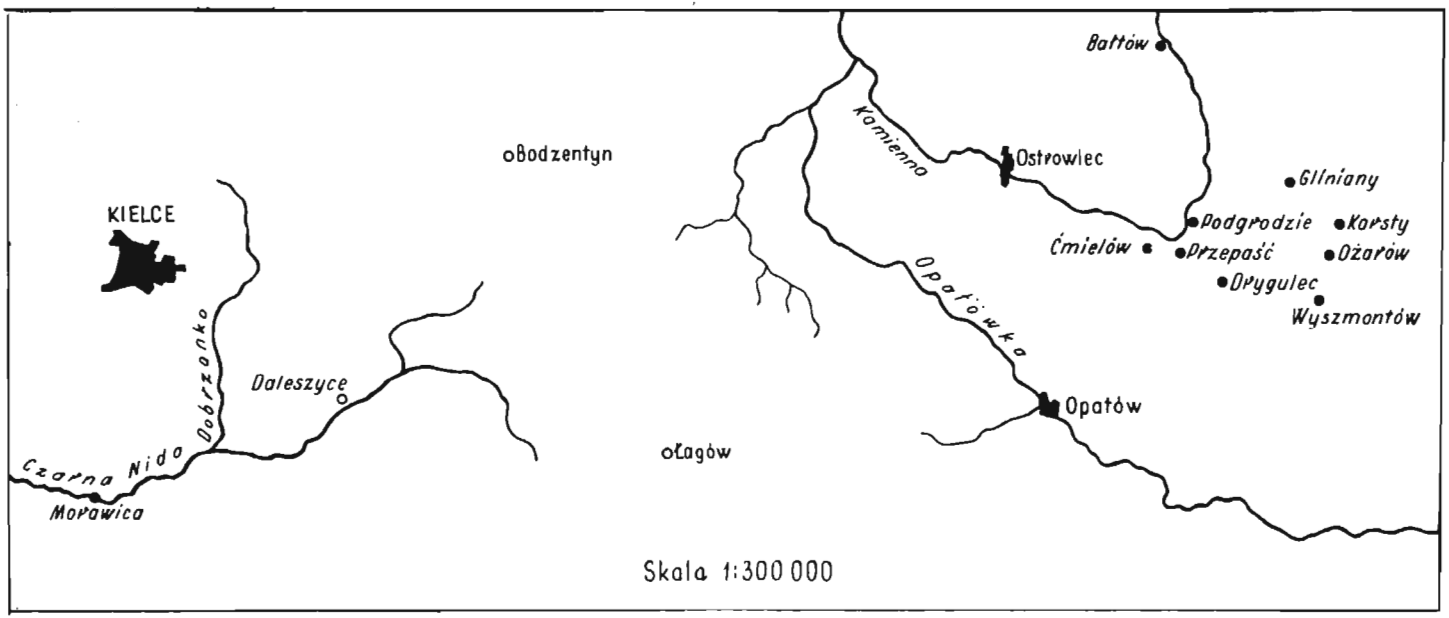

Fig. 3. — The distribution of the localities with Jurassic belemnites in the north-eastern margin of the Holy Cross Mountains.

represented by oolitic, very light, fine-grained limestones. The same facies as in the Astartian continues during the Kimeridgian, accompanied by stronger dolomitization of sediments, disappearance of oolites in the higher Kimeridgian horizons, while argillaceous marls with oysters and terebratules are frequent. The highest horizons of the Jurassic and the Lower Cretaceous are missing (fig. 3).

MATERIAL

The belemnites were collected from successive beds of the various horizons of the Middle and Upper Jurassic. The lowermost Jurassic horizons are developed as dark-grey Bathonian clays, commonly iron ore-bearing. These sediments are known from the vicinity of Kamienica Polska (district Częstochowa), Rudnik (distr. Zawiercie), Łęczyca near Kutno, and Trzebionka in the Kraków district. The Bathonian clays carry a rich belemnite fauna, with a different species predominant in each of the just mentioned localities. Over 500 specimens of *Megateuthis giganteus* have been collected by the writer from the vicinity of Kamienica Polska, while at Rudniki this species is rare. Approximately 200, more or less complete rostra of *Hibolites beyrichi* have been found at Łęczyca, over 50 rostra of *H. württembergicus* at the Trzebionka quarry, as well as the species: *Belemnopsis fusiformis, B. subhastatus, B. latesulcatus, B. prallelus parallelus, Rhopaloteuthis gillieroni, Gastrobelus ventroplanus, Brachybelus breviformis, Rhabdobelus exilis* and *Rh. parvus*, in numbers ranging from a few to some tens of specimens. The belemnites always occur in association with ammonites, brachiopods, gastropods, pelecypods and with less numerous echinoids and crinoids.

The greatest number of specimens, i. e. more than ten thousands, has been collected from the Callovian. The predominant species here are such as *Hibolites hastatus, Belemnopsis latesulcatus, B. subhastatus, B. canaliculatus*, as well as the less common *Belemnopsis parallelus germanicus* (approx. 30 specimens) and *Hastites privatensis* (10 specimens), collected from Upper Callovian deposits of Balin in the district of Chrzanów. The presence of *Hibolites girardoti* and *Belemnopsis semiarcuatus* n. sp. is restricted to Upper Callovian strata; the former passes into the lower horizons of the Oxfordian. The facial development of Callovian sediments is greatly varied, hence the state of preservation of material obtained from these rocks differs, too. The Ornatenton (Lower Oxfordian) of Regulice (distr. Krzeszowice) and the Upper Callovian glauconitic beds in the Wiek quarry near Ogrodzieniec (distr. Zawiercie) have supplied the most satisfactorily preserved fossils.

The quarry at Wrzosowa (distr. Częstochowa), though crowded with remains of belemnites and of other animal groups, does not constitute

the best collecting site owing to the bad state of preservation of rostra. The predominant facies here is arenaceous-calcareous, often ferruginous and argillaceous. These sediments were repeatedly subject to washout and re-deposition, in result whereof the belemnite rostra, though occurring in great number, are broken up, crushed, corroded by iron oxides and weathered (fig. 4). The stromatolite horizon, completely unfossilliferous, is here strongly developed. This horizon overlies Callovian sediments. Owing to its brown-brick colouration it is readily distinguishable from the light-coloured marly Lower Oxfordian rocks and consti-

Fig. 4. — Accumulation of rostra in the Callovian of Wrzosowa; nat. size.

tutes an additional index horizon of the Upper Callovian. A large collection of over 4 thousand belemnite specimens, has been obtained from rocks at the Wrzosowa quarry. It furnishes such ubiquitous Jurassic species as *Belemnopsis canaliculatus*, *B. latesulcatus*, *Hibolites hastatus*, as well as the less common *Belemnopsis parallelus germanicus* and *Hibolites girardoti*. A small part only of the Wrzosowa material could be worked out in detail. All the rest, on account of a very bad state of preservation, was useful merely for identifying species from particular horizons, and for correlating deposits from the profile of Wrzosowa with corresponding profiles of other quarries.

The best preserved fossils are collected from the argillaceous sediments of the Callovian. Approx. 100 specimens of *Rhopaloteuthis bzoviensis* and *Rh. majeri* have been collected from the ornatum clays of Regulice, the glauconitic horizon in the Wiek quarry near Ogrodzieniec, and the argillaceous deposits of Balin (distr. Chrzanów). Moreover approx. 30 rostra of *Duvalia disputabilis* have been found at Regulice and in the Wiek quarry.

Some very interesting forms have been obtained from the quarry at Wyszmontów (distr. Opatów) where the writer has discovered approx. 15 rostra of *Dicoelites meyrati* and two of *Rhopaloteuthis sauvanausus*. The first of the just named species has not been ascertained from any other

place outside that quarry, while the other one has also been recorded from Regulice (distr. Krzeszowice). The other belemnite forms occurring in the quarry at Wyszmontów are referable to the genera *Belemnopsis* and *Hibolites*, very common in all the Jurassic strata of Poland. The belemnites here occur in association with a fauna consisting mostly of gastropods, brachiopods, few ammonites, also of teeth belonging to shark-like fishes, occasionally those of reptiles.

Within the Upper Callovian clay sediments at Balin (distr. Chrzanów) the writer has discovered two rostra of *Rhopaloteuthis spissus*, a species not reported from the other outcrops, also several specimens of *Rh. bzoviensis* and *Rh. majeri* as well as other common Jurassic species belonging to the genera *Belemnopsis* and *Hibolites*.

The compact, crystalline limestones, occurring at Wola Morawicka (province of Kielce), characteristic by their unusual hardness, contain rare belemnites. The writer succeeded to extract from the rock there 3 rostra of *Rhopaloteuthis argovianus*, not recorded from the other quarries, and several other rostra belonging to the genera *Belemnopsis* and *Hibolites*.

In the higher Oxfordian horizons, belemnites are less abundant. The predominant genera are *Belemnopsis* and *Hibolites*. Ammonites, echinoderms and brachiopods occur in far greater numbers.

METHODS OF INVESTIGATION AND TERMINOLOGY

In describing the species and discussing the ontogeny of rostra the writer has given consideration to the following characters: the shape, length, width and thickness of rostrum, the development of apical part, alveolar furrows on the ventral and dorsal sides, their length, the character of their edges, depth and extent of apical compression, apical furrows; the transverse section, lateral lines; angle and depth of alveoles, apical line, growth index and compression index. The last two terms — index of growth and index of compression — are introduced by the writer. The remaining terms have been taken from Krimholz (1960, p. 15-30).

The measurements were taken by means of a caliper and are stated in millimeters with an accuracy of 0.1 mm. The rostra were measured for their minimum and maximum width and depth (d-s and d-v diameter respectively).

Where the alveolar part was not preserved, the values of the minimum diameters were disregarded on account of the lack of a constant orientation point, i. e. of the alveolar apex.

Changes in rostral ontogeny were investigated by studying specimens of various size and analysing the thin sections. Transverse sections

were cut at regularly spaced intervals, longitudinal sections — on the dorso-ventral plain. The method of celluloid peels has been used in addition to that of thin sections. This permits to study the structure on the polished surface without damaging the specimen. The polished surfaces of rostra were lightly etched with hydrochloric acid, in order to examine the growth layers. After a thorough rinsing and drying of the surfaces, celluloid peels, wetted with acetone, were pressed on them. The membrane is softened by the acetone and hence, under pressure, enters into the slightest depression of the etched surface, giving a clear picture of all its structural details. The resulting peels are then mounted, i. e. placed between two glass slides and a strip of plaster fixed around the edges to protect the specimen from slipping out or being contaminated. Photographs of membranes taken in transmitted light are very distinct, not being obscured by the natural colouration of the specimen which is unavoidable in slides.

Complete rostra were coated with ammonium chloride before being photographed.

The mode of examining the above enumerated characters and the terminology used in the description of species are as follows.

1. The *shape of the rostrum* may be conical, cylindrical, mace-like, fusiform. These terms have been used by the writer together with others such as: shape obliquely club-like, subcylindrical, etc. The shape of rostrum is one of the important specific features.

2. The *length* of the here studied rostra does not, in most cases, represent their absolute length, since the rostra are, as a rule, broken off, in the proximal or distal portion. In descriptions of external morphology the relative length of the smallest and largest specimen of a species are stated only to give a rough idea of that dimension. The usually accepted definitions here are: rostrum small, of moderate size, large.

3. The *width and the diameter of rostrum* (fig. 5, 6) are the best growth indices, and are considered as the important characters in the investigation of growth changes.

4. The *apical part* (fig. 5*b*) is the term used by the writer with respect to the distal portion of the rostrum starting at the point of its maximum lateral diameter (d-s), since there the rostrum gradually tapers out. The shape of the apical part in some species may be strongly variable. As a rule, with age, this portion of the rostrum becomes either more rounded and expanded, or compressed. It may be slender, swollen, pointed or rounded.

5. The *dorsal and ventral alveolar furrows* are an important index character even in the identification of subfamilies. The two furrows may occur together, or one only may be present. Their length, width, the borders of the furrows called the edges, as well as the position and

the extent of apical compression are all characters subject to specific variations, while the general habitus of the furrow is constant within each subfamily.

6. *Apical furrows.* In the material available to the writer their presence has only been ascertained in the genus *Megateuthis.* They are, indeed, an important index feature for the whole subfamily of Passaloteuthinae, while their number is a generic character. In *Megateuthis* it has been possible to distinguish double lateral furrows: longer dorso-lateral furrows and shorter ventro-lateral ones, as well as the faintly marked single furrows on the dorsal and ventral sides. With individual growth these furrows become narrow, deeply incised into the rostral surface.

7. *Lateral lines* (fig. 6*b*) may be either single or double. They are a somewhat unreliable generic character, since it is not always possible to ascertain their presence. Occasionally they disappear in the adult stage. Their course is closely correlated with the shape of the rostrum. In forms with an asymmetrical rostrum they are mostly curved. Their extent varies specifically, sometimes they are detectable over the complete length of rostrum, while in other cases they reach the point of maximum width only.

8. The *alveolar angle* (fig. 7*a*) is most readily measured on longitudinal sections. The beginning of the alveolus is the starting point. Changes of the alveolar angle during ontogeny are extremely rare, e. g. in *Megateuthis giganteus.* If they do occur, the angle increases during the younger stages, but decreases with age. This angle may vary in congeneric species but the range of its size variations is very limited and does not exceed the generic variablility.

9. *Depth and position of alveolus* (fig. 7*b*). The depth measurements were made on complete rostra and on longitudinal sections. The terms used are: deep or shallow in relation to the complete length of rostrum, e. g. in *Rhopaloteuthis majeri* the alveolar depth increases with individual growth from 1/2 to 2/3 of rostral length. The alveolus may be placed centrally, sometimes excentrically. E. g. in young specimens of *Megateuthis giganteus* it is central, but with growth gradually becomes excentric, approaching the ventral wall.

10. The *fissural area* (fig. 8, 9) varies generally in shape and extension in different genera, and constitutes an important diagnostic character. The fissural area is connected either with the ventral or dorsal furrow. Near the border of the dorso-ventral surface of a split-up rostrum, a smooth area can be seen, often displaying very delicate longitudinal striae. The extension of that smooth area varies specifically, most commonly, however, its length is slightly smaller than that of the furrow. In the presence of a ventral furrow, e. g. in the genus *Belemno-*

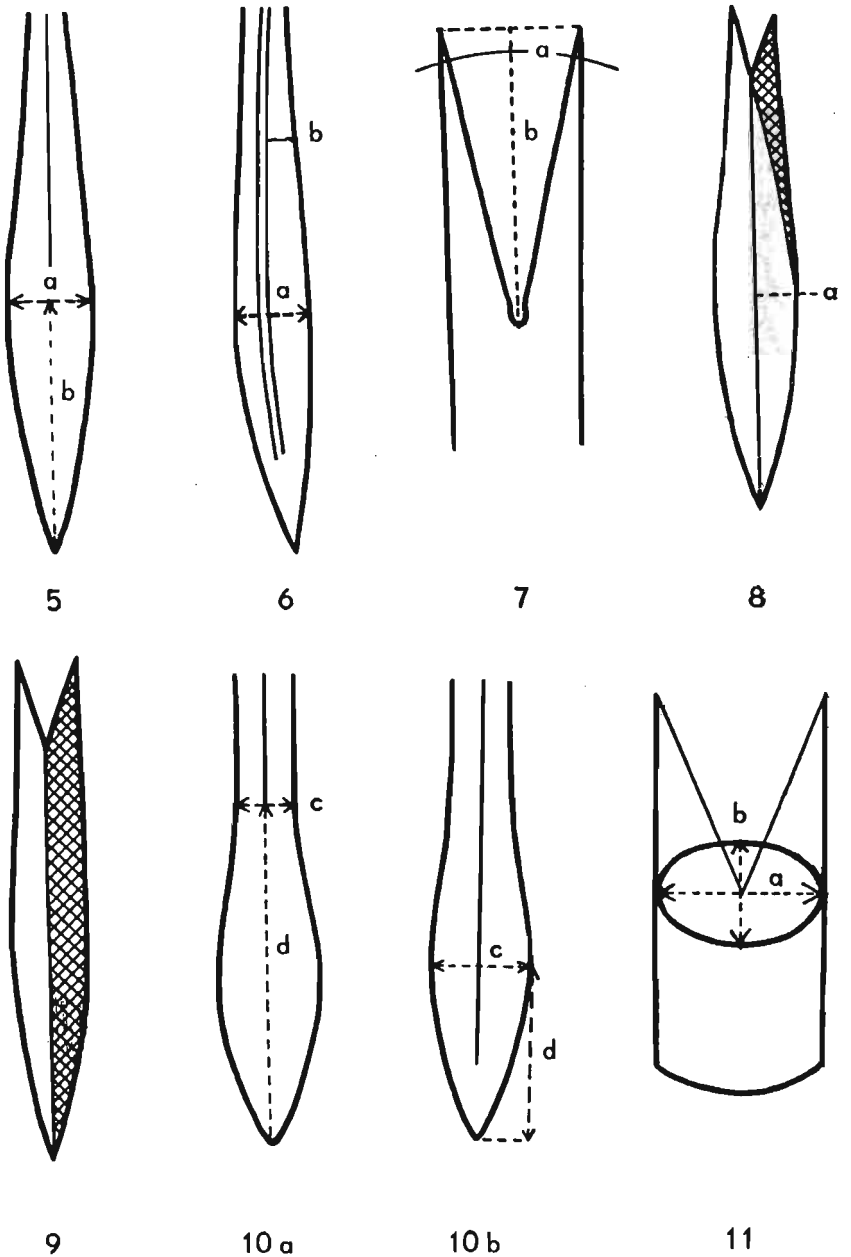

Fig. 5-11. — Diagrammatic drawings of rostra, indicating the method of measurements and terminology used.

5 Ventral side: *a* maximum width (d-s diameter), *b* apical part. **6** Lateral side: *a* maximum thickness (d-v diameter), *b* lateral lines. **7** Section of the alveolus in plane of symmetry: *a* alveolar angle, b alveolar depth. **8** Section of the rostrum of genus *Hibolites* in plane of symmetry, showing the fissural area; *a* apical line. **9** Section of the rostrum of genus *Belemnopsis* in plane of symmetry, showing the fissural area. **10** Diagrams of two rostra: *a* dorsal view, and *b* ventral view, showing the method of determination of the growth index; *c* d-s diameter *d* distance between the end of furrow and that of rostrum, *d* : *c* growth index. **11** Section through the alveolus in plane of symmetry: *a* d-s diameter, *b* d-v diameter, *a* : *b* depression index.

psis, the fissural area occupies the cleavage plane between the apical line and the ventral wall, stretching nearly to the end of the rostrum. In the genus *Hibolites*, which has a shorter ventral furrow, the fissural area occupies a smaller portion of the cleavage plane. Slightly above the end of the furrow, it wedges out near the ventral edge. This area is not equivalent to the alveolar fissure common in Cretaceous belemnites. In the presence of both, the ventral and the dorsal furrows, e. g. in the genus *Dicoelites*, the fissural areas occur on either side of the rostrum.

11. The *apical line* (fig. 8a) is formed in result of the fusion of the successive ends of the rostrum in its growth stages. By Naef (1922, p. 204, 206) this line is regarded as a material rostral element, and not as a mere line. Its peculiar character is believed by that author to be suggested by the possibility of the formation in this line of a longitudinal canal, due to the secondary process of the resorption of the apical parts of the rostrum during the successive growth stages. In most cases the apical line lies in the rostral axis, sometimes however it is considerably deviated from it and has an excentric course being situated closer to the ventral side. Its direction and course often constitute a specific character, and it cannot alone be taken into account, but must be considered together with the other characters.

12. The *transverse section* is a very reliable character in specific identification and closely connected with the shape of the rostrum. The section may be rounded, dorso-ventrally depressed or laterally compressed, reniform, quadrate or intermediate between the just named shapes. It changes with individual growth, in young forms it is commonly circular or subcircular, in the adults quadrate, laterally compressed or dorso-ventrally depressed. Quite frequently the transverse section of the proximal, medial and distal parts of the same individual may differ, too.

13. *Growth index* (fig. 10). This term is introduced here to determine the length ratio of the apical part of rostrum to its maximum lateral diameter. When the rostrum is irregularly shaped or laterally compressed throughout its length, it seems more convenient not to measure the length of the apical part, but the distance from the end of the furrow to that of the rostrum, and to establish the ratio of that distance to the transverse diameter at the end of the furrow. The latter measurement method has, e. g. been used in species of the genus *Rhopaloteuthis*. The growth index has proved most useful in studying growth processes and certain interdependence of the above mentioned characters. This index often decreases with the growth of rostrum occasionally it may remain unchanged, and once only, in *Belemnopsis fusiformis*, it increases. It is a feature of considerable specific value.

14. The *compression and depression indexs* (fig. 11) are the other termes, introduced in this paper to define the mutual relation of the two diameters. They have been used in studies on *Megateuthis giganteus* and on *Hibolites girardoti* where the lack of complete adult rostra impeded the use of the growth index. The compression index has been measured at the beginning of the alveolus on *M. giganteus* and at the end of the furrow on *H. girardoti*. In adult forms it differed from that in the young forms and constituted a fairly reliable individual growth criterion for that species.

ONTOGENETIC CHANGES

In the ontogenetic development of *Dictyoconites groenlandicus* Fischer (family Aulacoceratidae) from the Permian of Greenland, Fischer (1947) has recognized three growth stages: the nepionic, the neanic, and the ephebic-gerontic. The characters on which this differentiation was based are: the shape of the rostrum — needle-like in nepionic specimens, fusiform — in the older growth stages; transverse section — circular in the youngest specimens, but ovate in the neanic and older stages; the character of costae and striae on the surface of the rostrum, and the internal structure which makes its appearance during the neanic stage and becomes more differentiated in the final growth stage. The nepionic specimens are structureless, without external ornamentation.

These stages may be comparable with the young, adult, and senile or gerontic stages of Kongiel (1960 MS), distinguished in his study on the ontogeny of the genus *Belemnitella* and *Belemnella* from the Cretaceous of Poland. Imprints of blood vessels give in this case a basis for the recognition of stages. They are faint in young individuals, conspicuous in adults, while in gerontic specimens they may partly disappear below the covering of the so-called cortex layer which is formed towards the end of ontogeny.

When working on the Jurassic belemnites of Poland the writer has conducted observations concerning the ontogeny of rostra of the greater part of the here considered species. A comparison of their ontogenetic development indicates that it is not possible to determine some general characters of the successive growth stages which would be common for all the studied species. In Jurassic belemnites the rostral surface is smooth, the internal structure does not modify during the growth process and imprints of blood vessels and the cortex layer are not preserved. The three essential growth stages could, however, be distinguished in these forms, too. Occasionally they display certain analogies, but in the majority of cases these stages differ in the parti-

cular species. In studying the ontogeny of the rostrum the successive growth stages have been characterized on changes of such features as shape of rostrum, its transverse section in the alveolar part, and sometimes the alveolar angle, the depth of alveolus, the furrows on the surface of rostrum, the growth indices and, occasionally, compression indices. The terminology introduced by Fischer (1947) has been followed in the definition of growth stages since it is commonly used in analogous descriptions of other animal groups.

Shape of rostrum

In *Megateuthis giganteus* (Schlotheim) the nepionic rostrum is shaped like a short cone with an obtuse angle. In the neanic stage the growth in length increases considerably as compared with the slight growth in width and diameter. The ephebic-gerontic forms are conical, too, but more elongate, slender, with acute angle.

In *Belemnopsis canaliculatus* (Schlotheim) the nepionic rostrum is fusiform, with the alveolar part distinctly tapering and median portion expanded. In the next stage the shape of rostrum gradually passes into a cylindric one. The growth in width and diameter increases, particularly so in the alveolar part. The ephebic-gerontic stage is characterized by the distinctly cylindric shape of rostrum and by nearly parallel sides.

In *Dicoelites meyrati* (Ooster) the rostrum is conical-shaped throughout all the evolutionary stages and it is only the position of the alveolus that changes with age. In the nepionic stage the alveolus lies in the rostral axis, in the older stages it deviates from it and lies obliquely, nearer to the ventral side. Rostral asymmetry here, due to the deviation of the alveolus, increases during the ephebic-gerontic stage, the end of the rostrum being bent dorsally and somewhat laterally.

In several cases the shape of the rostrum does not change much throughout all the evolutionary stages, with the exception of a rapid increase in diameter as compared to that of length. The younger forms are more slender. In the final stages the apical part is shortened owing to the more backward shifting of the maximum diameter. The apical part becomes less pointed, even rounded. The following species, referable to various genera, display evolutionary changes such as those just mentioned: *Belemnopsis subhastatus* (Zieten), *B. latesulcatus* (d'Orbigny), *B. semiarcuatus* n. sp. *B. parallelus germanicus* (Roemer), *B. fusiformis* (Parkinson), *Hibolites beyrichi* (Oppel), *H. württembergicus* (Oppel), *H. hastatus* (Blainville), *H. girardoti* (Loriol), *Duvalia disputabilis* (Neumayr), *H. semihastatus* (Blainville), *Hastites privatensis* (Mayer) and *Gastrobelus ventroplanus* (Voltz).

In representatives of the genus *Rhopaloteuthis: Rh. gillieroni* (Mayer), *Rh. bzoviensis* (Zeuschner) and *Rh. majeri* (Alth), nepionic rostra are

in the shape of an elongated cone. In the neanic stage the rostrum diameter increases rapidly, particularly so at 1/3 length from the apical part. A certain asymmetry is observable here, i. e. a slight dorsal deviation of the apical part. In the ephebic-gerontic stage the rostrum grows to be obliquely club-like, while the apical part becomes swollen and rounded, with a mucro occasionally present.

In *Hibolites hastatus* (Blainville) and *H. girardoti* (Loriol) it has been possible to distinguish the embryonic stage, too. It occurs as a short spine stretching to the distal wall of the embryonic chamber, it is darker coloured, and its growth lines are not distinguishable.

Transverse section

In the nepionic stage the transverse section is circular or subcircular. During the neanic stage this contour becomes elliptic, as a rule dorso-ventrally depressed. In *Dicoelites meyrati* (Ooster) and *Duvalia disputabilis* (Neumayr) a lateral compression is observable. It is in the final stage only that the dimensions show an increase, solely in *D. disputabilis* (Neumayr) the transverse section may retain its elliptic or pyriform shape with a wider ventral wall. The transverse section in *Megateuthis giganteus* (Schlotheim) varies during the successive growth stages. In the nepionic stage it is pyriform, with greater width of the ventral wall, in the neanic stage it is elliptic with equal breadth of the ventral and dorsal walls, while during the ephebic-gerontic stage the transverse section goes back again to the pyriform contour, but with a wider dorsal wall (fig. 12).

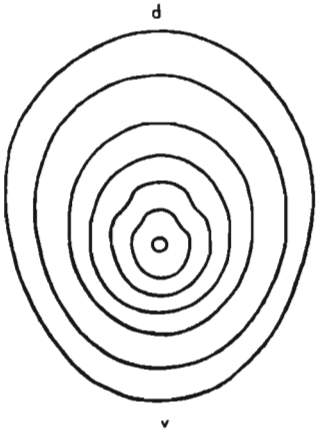

Fig. 12 — *Megateuthis giganteus* (Schlotheim, transverse section of adult rostrum showing the growth variability: v-ventral side, d-dorsal side..

In representatives of the genus *Rhopaloteuthis* the transverse section vary in shape. During the initial evolutionary stages the section may be circular or slightly quadrate. In the neanic stage it passes into being distinctly quadrate as in *Rh. majeri*, or elliptic, dorso-ventrally depressed as in *Rh. gillieroni*, or irregular, with a longer dorso-ventral diameter as in *Rh. bzoviensis*.

Angle and depth of alveolus

In most species the angle and depth of alveolus are not subject to ontogenetic changes, they are only affected by the normal increase of dimensions in proportion to the growth in length of the rostrum. The only species gradually modified in this respect, during the neanic and later stages, is *Megateuthis giganteus* in which the nepionic alveolus

occupies approx. 1/3 of rostral length, and its final depth does not exceed 1/5 of rostral length. The alveolar angle, initially wider, decreases considerably with individual age.

Furrows

The width and depth of the ventral and dorsal furrows as a rule increases with individual growth. In *Megateuthis giganteus* the width of the apical furrows decreases with age and they are at the same time gradually pushed deeper into the rostral wall. In young forms these furrows disappear at 1/2 length of rostrum, in adults at 1/3 length from the apical part.

Growth, compression and depression indices

These indices behave differently according to the age of specimens. In *Belemnopsis fusiformis* (Parkinson) the growth index increases with age from 3.7 to 4.5. Occasionally it was observed not to differ much from that in the youngest and oldest specimens, but frequently it decreases, sometimes even considerably. In *Belemnopsis parallelus germanicus* (Roemer) it decreases from 3.0 to 2.4; in *B. semiarcuatus* n. sp. from 3.0 to 1.6; in *B. subhastatus* (Zieten) from 4.2 to 3.2; in *Hibolites württembergicus* (Oppel) from 3 to 2; in *Dicoelites meyrati* (Ooster) from 4.6 to 2.4; in *Hibolites beyrichi* (Oppel) from 9.1 to 6.3; in *Rhopaloteuthis gillieroni* (Mayer) from 4.0 to 2.3; in *Rh. bzoviensis* (Zeuschner) from 7.7 to 1.8; in *Rh. majeri* (Alth) from 3.5 to 1.1; in *Gastrobelus ventroplanus* from 2.7 to 2.0. The depression or the compression index measured in two cases scarcely changes during its ontogeny, e. g. as in *Hibolites girardoti* (Loriol) where the respective figure is 1, or else changes very slightly, as in *Megateuthis giganteus* where in nepionic form it is 1, changing to 1.3 in ephebic-gerontic forms.

The above considerations show that growth changes are variously expressed. Greatest differences are observable in the nepionic stage whose development often differs from that of the later stages. Specifically characteristic changes occur during the neanic stage, while during the oldest stage the particular features are definitely established.

LIFE - TIME DEFORMATIONS OF ROSTRA

(pl. I, fig. 1-14)

The here investigated material illustrates numerous examples of deformed rostra. The majority represent anormal swelling of the apical part or knob-like excrescences in the anterior, occasionally the median part of rostrum (pl. I, fig. 3-6, 10).

Besides knob-like deformations, some rostra with the ventral groove show a varying degree of axial twisting (fig. 4, 5, 13*a*). Arcuate inflexions of the whole rostrum or of its posterior part only, sigmoidal curves and minute corrugations in the apical end, are also frequent (fig. 2, 8, 9, 13).

Other types of deformity are observable in rostra with a slightly bifurcating apical part. The two apexes may display symmetric lateral deviations from the axis, as is shown in fig. 11, or one tip may be longer, spine-like, while the other is short and blunt (fig. 13). In some rostra with bifurcated apexes the two tips are differently disposed to each other. The knee-like backward inflexion of one apex is separated by a narrowing from the other, the latter being probably the true end of rostrum (fig. 1).

The sigmoidal end of rostrum, polished in the dorso-ventral plane, very accurately represents the course of the growth lines which curve identically throughout all the growth stages. Initially this curve is rather small, but with age it becomes more conspicuous. The growth layers are added continuously without traces of any injuries (fig. 14). Similarly curved rostra have been figured by Abel (1935, p. 555, fig. 463), but his longitudinal section shows two fractures produced during the early growth stages. Hence two similar deformations cannot always be analogously interpreted on external similarities only. The thin section of another rostrum (fig. 12) shows the alveolar part domed in a knob-like fashion. In this case the rostrum was probably injured in an early growth stage. The growth layers encircling the injured part are initially strongly outcurved, but subsequently take a normal course. The injury of the rostrum must have occurred in the animal's life time, for the growth layers continuously encircle the injured part.

Compressions of the various parts of the rostrum, of varying extent, are frequent, too. This type of deformation is shown in fig. 7. It is possible that they have occurred after the animal's death, either in result of the dissolving by solutions circulating in the deposit, or owing to the mechanical pressure of the overlying layers. The injuries and deformations, however, which have been mentioned before, indicate mechanical injuries probably inflicted during the animal's life time. They may have occurred owing to the impact of the rostrum with submarine rocks or in result of the attacks of some marine animals of prey.

In a discussion on analogous deformations and injuries of the rostral surface, Kabanov (1959, p. 30-40) is inclined to admit that during the life time the belemnite rostrum was elastic, having a cartilageous consistency and properties, and not rigid or hard as was generally admitted. In analysing various types of pits, depressions or pricks, that author observed that they have smooth borders. In his opinion, these observa-

tions suggest elasticity during the animal's life time, since, otherwise, if the rostrum had been hard and brittle, the margins of the pits or depressions would be unevenly rough. Had the consistency of the rostrum been firm, damage suffered during its early growth stages in the form of breaking or crushing, would result in injuries of the mantle secreting the new growth layers. On the other hand, if after Kabanov we admit the elasticity of the rostrum, the regenerating function of the mantle might have been accelerated. This would certainly be an important factor warranting the security of the animal and protecting his normal functions connected with growth and self-defence.

Moreover, Kabanov also discusses the question of the floating ability of belemnites. A heavy unelastic rostrum would not, indeed, have been of any help in this function, but, on the contrary, its weight and rigidity would hinder it considerably.

Kabanov's argumentation does not seem convincing to the present writer. Fissures, pricks or pits with smooth and rounded borders are not sufficient evidence that the injuries were inflicted during the animal's life time. To prove this, it would be necessary to cut a section of the rostrum through the investigated injuries in order to determine if the growth layers near the fissure bend during the earlier growth stages, or whether they are merely broken. Kabanov, however, has not analysed this problem. Fissures or punctures may have occurred in the sediment, after the animal's death, owing to the activities of numerous animals searching for food among the organic remains on the sea floor. In the next chapter of the present paper reasonable evidence is given in support of the last supposition. Similar fissures and punctures observed by the writer have smooth borders, circular or subcircular in section, and they have undoubtedly been produced in the deposit after the animal's death. Hence, it seems that, in agreement with the common opinion, belemnite rostra were hard and rigid during the animal's life. Otherwise it would be hardly possible to account for their utility to the animal, since it is the rostrum that protected the very delicate phragmocone.

DAMAGED ROSTRA

(pl. II, fig. 1-8)

Rostra bearing traces of the destructive activity of other organisms are frequently encountered among the here studied material. Fig. 1 in pl. II shows a rostrum covered by pits of various size. These pits have smooth margins, and rostra with destroyed internal structure are pierced by them. In the transverse section of rostrum, several canalicules are seen as continuation of pits, extending vertically to the outer wall. Analogous pits are discernible at the bottom of canalicules, penetrating the

rostrum parallel to the outer wall. The pits are approx. 2 mm in diameter. That type of small openings has been noted on very few rostra only.

In other cases minute longitudinal slits (pl. II, fig. 4), oriented vertically, obliquely or parallely to one another, are scattered all over the surface of the rostrum. They have the semblance of puncture traces. Their length does not exceed 1.3 mm, with breadth of approx. 0.2 mm.

Slightly larger slits, longitudinal and narrow, too, are shown in fig. 3 of pl. II. In the apical part of rostrum the surface layers have been destroyed revealing the presence of canalicules penetrating the rostrum. The fragment shown in fig. 2 of pl. II represents a deep subcircular canalicule with several round pits in close vicinity.

After comparing the traces of injuries detectable on the here figured specimens with those described in available literature, the writer believes that they are all referable to the action of polychaete annelids. Abel (1935, p. 457-458, fig. 382-383) and Roman (1921, p. 162-163, pl. 8, fig. 4-9) quote numerous examples of injuries suffered by various shells, also of rocks bored by organisms searching for food within the deposit, mainly referable to Annelida Polychaeta.

Various types of traces (rounded pits, longitudinal slits, canalicules) may suggest their different derivation, but this supposition does not seem very probable inasmuch that they are present on the same rostrum next to one another (fig. 2) and that the pits pass e. g. into canalicules.

Sessile organisms, most frequently serpulids and foraminifers, may be attached on the rostra. Serpulid tubes (pl. II, fig. 7) are of varying length, initially narrow but gradually increasing in width towards the aperture. The transverse section of tubes is round interiorly, but triangular exteriorly. Similar serpulid tubes have been figured already by Quenstedt (1846-49, pl. 28, fig. 2, and 1858, pl. 21, fig. 16 and pl. 65, fig. 2) and are called by him *Serpula limax*.

Among the foraminifers attached on rostra the writer has encountered representatives of the subfamily Ramulininae, probably *Bullopora rostrata* Quenstedt, 1858 (pl. II, fig. 5, 6), (Cushman, 1948, p. 230, pl. 22, fig. 24). These foraminifers are of the colonial type, they resemble elongated beads strung onto a thread, with tapering ends of the particular individuals. Analogous organisms were by Quenstedt (1858, p. 580, pl. 73, fig. 28) regarded as bryozoans.

Some rostra are marked by concentric discs, corresponding to the secondary concentration of chalcedony which substitutes calcite on the surface (pl. II fig. 8). This phenomenon has already been noted by Alth (1875, p. 213) and by later authors.

Legend to Table 1: *L* Lias, *B* Bathonian, *K* Calloway, *O* Oxfordian, + present, — absent.

Geographic and stratigraphic distribution of the described species — Table 1

Species	Poland			Germany				France				Switzerland				England				USSR				Asiatic countries			
	B	K	O	L	B	K	O	L	B	K	O	L	B	K	O	L	B	K	O	L	B	K	O	L	B	K	O
Hastites privatensis (Mayer)	—	+	—	—	—	—	+	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhabdobelus exilis (d'Orbigny)	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—	+	—	—	—	+	—	—	—
Rh. parvus (Hartmann)	+	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gastrobelus ventroplanus (Voltz)	+	+	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dactyloteuthis irregularis (Schlotheim)	—	+	—	+	+	—	—	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—
Megateuthis giganteus (Schloteim)	+	—	—	+	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—
Brachybelus breviformis (Voltz)	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	+	—	—	+	+	—	—	—	+	—	—
Belemnopsis canaliculatus (Schlotheim)	+	+	+	—	+	+	+	—	+	+	+	—	—	+	+	—	—	+	+	—	—	+	+	—	—	+	+
B. fusiformis (Parkinson)	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	+	+	—	—	—	—	—	—	—	—	—
B. parallelus parallelus (Phillips)	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
B. parallelus germanicus (Roemer)	+	+	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B. subhastatus (Zieten)	+	+	—	—	+	+	—	—	+	+	—	—	—	—	—	—	+	+	—	—	—	+	—	—	+	+	—
B. latesulcatus (d'Orbigny)	+	+	—	—	+	+	—	—	—	+	—	—	+	+	—	—	+	—	—	—	+	—	—	—	—	—	—
B. semiarcuatus n. sp.	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hibolites hastatus (Blainville)	+	+	+	—	—	+	+	—	—	+	+	—	—	+	+	—	—	+	+	—	—	+	+	—	—	+	+
H. semihastatus (Blainville)	+	+	+	—	+	+	—	—	+	+	+	—	+	+	—	—	—	—	—	—	+	+	—	—	—	—	—
H. beyrichi (Oppel)	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	+	—	—	—	+	—	—	—	—	—	—
H. girardoti (Loriol)	—	+	+	—	—	—	—	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
H. württembergicus (Oppel)	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dicoelites meyrati (Ooster)	—	+	—	—	—	—	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	+	—
D. waageni (Neumayr)	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Duvalia disputabilis (Neumayr)	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pseudobelus coquandus (d'Orbigny)	—	+	+	—	—	—	+	—	—	+	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Rhopaloteuthis sauvanausus (d'Orbigny)	—	+	—	—	—	—	+	—	—	—	+	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	—
Rh. bzoviensis (Zeuschner)	—	+	+	—	—	—	—	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Rh. majeri (Alth)	—	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rh. spissus (Gillieron)	—	+	+	—	—	—	—	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Rh. argovianus (Mayer)	—	+	+	—	—	—	+	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Rh. gillieroni (Mayer)	+	+	—	—	+	+	—	—	+	+	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—

GEOGRAPHIC DISTRIBUTION OF BELEMNITES FROM THE MIDDLE AND UPPER JURASSIC

(table 1)

Some species of the here described Jurassic belemnites have a very wide geographic range. *Hibolites hastatus* and *Belemnopsis canaliculatus* are recorded from throughout Europe, the Caucasus, Sicily, Algiers, Arabia, India and Madagascar. Other species are restricted to certain countries only. E. g. *Hibolites girardoti* has thus far been reported only from France, Switzerland and Poland. Several species occur only in Poland. They are: *Rhopaloteuthis majeri, Duvalia disputabilis, Dicoelites waageni* and the new species *Belemnopsis semiarcuatus*. For the most part, however, the same species are encountered in the same horizons throughout central Europe, including Poland, Germany, France and Switzerland. These areas have been invaded by the sea encroaching from the west during the great Middle Jurassic transgression, and the belemnite fauna could freely circulate and migrate all over the seas of central Europe. Marine transgression of the southern and eastern parts of Europe was followed by the opening up of new routes accessible to the local fauna. Hence, some species characteristic of alpine or boreal faunas may have penetrated into areas previously separated by continental barriers. *Dicoelites meyrati*, reported in Poland from one quarry only in the Holy Cross Mountains, represents an Alpine species. Zoogeographic and facial provinces were differentiated during the Jurassic, and they were the chief factors in the separation of the warm and boreal faunas.

SYSTEMATIC PART

Subfamily **Hastitinae** Naef, 1922

Genus *Hastites* Mayer, 1883

Hastites privatensis (Mayer, 1866)

(pl. III)

1866. *Belemnites privatensis* Mayer; Ch. Mayer, Diagnoses ..., p. 366.
1871. *Belemnites privasensis* Mayer; E. Dumortier, Sur quelques gisements ..., p. 20, pl. 3, fig. 1-8.
1920. *Hibolites* (?) *Privatensis* Mayer; E. v. Bülow-Trummer, Fossilium Catalogus, p. 150.
1921. *Hastites privatensis* Mayer; F. Roman, La Montagne ..., p. 159.
1922. *Hastites Privatensis* Mayer; A. Naef, Die fossilen Tintenfische, p. 227.
1924. *Hastites privatensis* Mayer; A. Riche & F. Roman, Études ..., p. 40.
1925. *Hastites privatensis* Mayer; M. Lissajous, Répertoire ..., p. 32, 124.
1953. *Pseudobelus privasensis* Mayer; S. Z. Różycki, Górny dogger ..., p. 326.

Material. — 10 rostra of various individual age, more or less crushed or proximally broken off, several smaller fragments; alveolus and phra-

gmocones not preserved; surface of rostra smooth; state of preservation satisfactory.

Description (pl. III, fig. 1-3). — *External morphology*. Rostra fusiform in shape, with conspicuously tapering and elongated anterior part, gradually expanding and swollen posteriorly. The maximum breadth occurs somewhere at 1/3 length from the apical part. Apical part relatively short, more or less sharply pointed, occasionally somewhat rounded or mucronate. Distinct, double lateral lines run on the side walls, for the most part they stretch to the end of rostrum, sometimes they are shorter extending only to the maximum diameter of rostrum. Side walls connected with the dorsal and ventral wall by rounded edges, in the central part of rostrum they sometimes meet at a right angle, while distally they are mostly rounded. The dorsal and the ventral furrows are missing. Measurements of 9 rostra are given in table 2.

Table 2

Dimensions of rostra of *Hastites privatensis* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
729	7.0	7.0	17.5	2.5
730	7.7	9.4	20.0	2.6
731	8.0	9.0	18.0	2.2
732	9.1	9.6	20.0	2.2
733	9.4	10.0	21.0	2.2
734	10.0	10.0	22.0	2.2
735	11.0	11.0	26.0	2.3
736	11.0	11.0	26.0	2.3
737	11.4	12.4	30.0	2.6

The growth index ranges between 2.2 and 2.6, its most common value being 2.2. The growth index variability is small and it is probably reasonable to suppose that it increased uniformly in diameter, width and length.

Internal morphology (pl. III, fig. 4-5). Delicate growth lines are visible in thin sections, more conspicuous at certain intervals. The apical line is centrally placed and somewhat thicker than the growth lines. The older growth stages do not differ in shape from the younger, since the growth lines are parallel throughout all the growth stages. In thin transverse sections the growth lines are concentric. Those more centrally placed are circular in outline, those nearer to the outside — subcircular or quadrate. Distally the section is ovate, with greater dorso-ventral diameter. Depressions of the growth lines corresponding to the lateral lines

are faintly indicated, being more stressed in the external parts of the section.

Ontogeny (pl. III, fig. 4-5). — With growth of the rostrum the dimensions increase. In shape the nepionic stage does not differ from the next growth stages, the transverse section only being modified. In the nepionic stage it is circular or subcircular, in the neanic stage it becomes quadrate, and thereafter retains this outline. The lateral lines are double in all the growth stages, their length varies. The particular growth stages have not been differentiated owing to the scarcity of specimens and the lack of any important ontogenetic variations.

Variability. — The individual variability of specimens of the same age is not strong, consisting merely in certain dimension changes of the two diameters. Sometimes the dorso-ventral diameter is slightly greater than the lateral, for the most part, however, they are equal. In most cases the rostra are sharply terminated, sometimes the end may be more or less rounded, in one specimen it is slightly mucronate.

Remarks. — The Polish specimens are identical with those figured and described by Dumortier (1871) and agree with the description of Mayer (1866) who is the author of that species. *Hastites privatensis* somewhat approaches *Belemnites zitteli* (Sinzova, 1877) in the fusiform shaped rostrum, as well as in the presence of long lateral lines. It differs in the lack of a ventral furrow (in *B. zitteli* it is 1/3 of the complete rostral length), also in the shape of the transverse section which in *B. zitteli* is ovate, with a longer lateral diameter.

The majority of authors assign this species to the genus *Hastites*. This is justified by the peculiar shape of the rostrum, the club-like terminal expansion, the long and narrow proximal part and the variability of the transverse section. Różycki's assignment of this species to the genus *Pseudobelus* does not seem correct, since *Pseudobelus* belongs to the subfamily Duvaliinae, and is characterized by different shape, certain asymmetry, ovate or pyriform transverse section, and a varying extent of side compression.

Occurrence. — The Callovian and Oxfordian of France and Germany; Upper Callovian of Balin in Poland (distr. Chrzanów).

Genus *Rhabdobelus* Naef, 1922

Rhabdobelus parvus (Hartmann *in* Quenstedt, 1858)

(pl. IV, fig. 9-11)

1958. *Belemnites parvus* Hartmann; F. A. Quenstedt, Der Jura, p. 286.
1920. *Rhopalobelus parvus* Hartmann; E. v. Bülow-Trummer, Fossilium Catalogus, p. 93.
1922. *Rhabdobelus parvus* Hartmann; A. Naef, Die fossilen Tintenfische, p. 228.
1925. *Pseudobelus parvus* Hartmann; M. Lissajous, Répertoire ..., p. 117.

Material. — 3 rostra without alveolus and phragmocones.

Description. — *External morphology.* Rostra of small dimensions, irregularly shaped, slightly distally expanded. The apical part short, asymmetric, bending somewhat away from the rostral axis towards the dorsal side. The side walls slightly wider than the dorsal and ventral walls, meeting them at a right angle. Transverse section of rostrum quadrate over the greater part, rounded near the apical part only. Deep, sometimes double lateral lines run along the side walls, terminating behind the maximum expansion of rostrum, or just in front of it. A slight swelling, similar to the mucronic wart, occurs at the apical part. Dimensions of the measured rostra are given in table 3.

Table 3

Dimensions of rostra of *Rhabdobelus parvus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
741	3.2	3.5	6.7	2.1
742	4.3	4.4	7.2	1.6
743	5.5	5.8	9.0	1.6

Remarks. — The Polish specimens are identical with those figured by Quenstedt (1858) from Germany. The age of the German specimens is established by the mentioned author as the Uppermost Lias, while the Polish specimens are Lower Dogger in age. To the present writer, Naef's (1922) assignment of this species to the genus *Rhabdobelus* and the subfamily Hastitinae, seems fully justifiable. As evidence in support of this systematic position may be regarded such characters as distinct lateral lines, quadrate transverse section, a nearly club-like shape of the rostrum and stratigraphic occurrence.

Occurrence. — The Upper Lias of Germany. In Poland — the Bathonian of Trzebionka (distr. Chrzanów).

Rhabdobelus exilis (d'Orbigny, 1842)

(pl. IV, fig. 8)

1842. *Belemnites exilis* d'Orbigny; A. d'Orbigny, Paléontologie ..., p. 101, pl. 11, fig. 6-12.

1846—49. *Belemnites exilis* d'Orbigny; F. A. Quenstedt, Petrefactenkunde ..., p. 415, pl. 25, fig. 16-17.

1857. *Belemnites exilis* d'Orbigny; W. A. Ooster, Catalogue ..., p. 8.

1858. *Belemnites exilis* d'Orbigny; F. A. Quenstedt, Der Jura, p. 286, pl. 41, fig. 15.

1920. *Rhopalobelus exilis* d'Orbigny; E. v. Bülow-Trummer, Fossilium Catalogus, p. 93.

1922. *Rhabdobelus exilis* d'Orbigny; A. Naef, Die fossilen Tintenfische, p. 228.

1923. *Belemnites exilis* d'Orbigny; J. Siemiradzki, Fauna ..., p. 5, pl. 6, fig. 17, 17a; pl. 8, fig. 6.

1925. *Pseudobelus exilis* d'Orbigny; M. Lissajous, Répertoire ..., p. 32—33, p. 85—86.

Material. — 1 rostrum, with the proximal part broken off, but satisfactorily preserved, with smooth, undamaged surface.

Description. — *External morphology.* Rostrum strongly elongated, sharply pointed. Side walls smooth. Deeply incised lateral lines stretch along the dorso-lateral sides, proximally they are single and narrower, distally broader, bifurcating, separated by a low crest. These lines terminate near the dorsal border in a broad depression at some distance from the apical part. Owing to the close proximity of the lateral lines to the dorsal edge, the dorsal wall is extremely narrow, while the ventral one is broad. An exceedingly delicate, double bifurcated groove runs along the ventral wall, terminating just before the dorso-lateral lines. A very faint dorsal groove is hardly detectable along the dorsal wall. The apical part is without grooves. Across the proximal part of rostrum the transverse section is pyriform, with a broader ventral edge.

Dimensions of rostrum (Z. Pal. UW, No. Bj. 740) in mm:

Diameter near the proximal part:	
d-s	3.0
d-v	3.5
Diameter on the thinning out lateral lines:	
d-s	3.0
d-v	3.2

Remarks. — The Polish specimen comes nearest to the German specimens figured by Quenstedt (1846-49, pl. 25, fig. 16), both in strongly elongate shape, deep lateral lines and a pointed end, whereas it differs from them in a quadrate transverse section near the proximal border. This difference may possibly be a result of the breaking off of the proximal part in the Polish specimen. Naef (1922) clearly stresses the peculiar character of the lateral lines on the rostrum of specimens belonging to the genus *Rhabdobelus*, most particularly so their close proximity to the dorsal border. The last named feature is, indeed, influenced by the irregularly quadrate outline of the transverse section, in agreement with the here described specimen.

On comparing the opinions of various authors concerning the generic assignment of the here described species, the writer thinks that it is referable to the genus *Rhabdobelus* Naef, 1922, and together with it to the subfamily Hastitinae.

Occurrence. — The Upper Lias and the Bathonian of Germany, France, Switzerland, the U.S.S.R. and the Asiatic countries. In Poland — the Podhale Lias (Siemiradzki, 1922) and the Bathonian of Trzebionka (distr. Chrzanów).

Subfamily **Passaloteuthinae** Naef, 1922
Genus *Gastrobelus* Naef, 1922
Gastrobelus ventroplanus (Voltz, 1830)
(pl. V)

1830. *Belemnites ventroplanus* Voltz; M. Voltz, Observations ..., p. 40, pl. 1, fig. 10.
1836. *Belemnites subdepressus* Voltz; F. A. Roemer, Die Versteinerungen ..., p. 166.
1846—49. *Belemnites ventroplanus* Voltz; F. A. Quenstedt, Petrefactenkunde ..., p. 400, pl. 23, fig. 20 a-d; p. 405, pl. 24, fig. 17 a-c.
1920. *Rhopalobelus ventroplanus* Voltz; E. v. Bülow-Trummer, Fossilium Catalogus, p. 94.
1922. *Gastrobelus ventroplanus* Voltz; A. Naef, Die fossilen Tintenfische, p. 197, p. 235, text-fig. 69/16.
1925. *Hastites ventroplanus* Voltz; M. Lissajous, Répertoire ..., p. 151.

Material. — Over 200 specimens, all with the alveolar part broken off; alveolus and phragmocones not preserved.

Description. — *External morphology* (pl. V, fig. 3-6). Rostra small, with narrowing proximal part, but expanding distally to about 1/3 of length from the apical part; a slight dorso-ventral swelling results in a club-like shape of the rostrum. The ventral wall is compressed and somewhat broader than the dorsal. Ventro-lateral side lines run along the side walls, in the proximal part of rostrum they stretch just beyond the protruding ventral wall, causing its widening. Centrally and distally these lines are gradually shifted nearer to the centre of the wall. Their length varies and in most specimens they stretch behind the maximum width of the rostrum. The apical part is short, swollen, pointed or somewhat rounded. The transverse section passes from quadrate, strongly depressed in the proximal part, to ovate in the central part, and rounded in the apical part. The dimensions of 15 measured rostra are given in table 4.

The growth index changes in a reverse proportion as compared with the age of the individual, decreasing from 2.7 to 2. The greatest number of specimens is grouped near the 2.5 index.

Internal morphology (pl. V, fig. 1-2). Extremely delicate growth lines and a somewhat thicker apical line, placed centrally, are discernible in longitudinal thin sections. Throughout all the growth stages, the growth lines are of identical outline, with a characteristic longer and narrower proximal part and an apical distal swelling. In transverse sections concentric lines, very faintly indicated, alternate with thicker ones, those more interior being of circular outline, while the more exterior are ovate, laterally elongated. Across the proximal part the transverse section is strongly depressed, displaying a depression of the ventral wall too. In the central part the two walls, ventral and dorsal, are slightly convex,

Table 4

Dimensions of rostra of *Gastrobelus ventroplanus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
704	3.0	2.6	8.0	2.7
705	3.4	3.2	8.4	2.5
706	3.4	3.1	8.4	2.5
707	4.0	3.5	10.0	2.5
708	4.0	3.5	10.0	2.5
709	4.0	3.3	10.0	2.5
710	4.0	3.5	10.0	2.5
711	4.1	3.5	10.4	2.5
712	4.2	3.5	10.0	2.4
713	4.8	4.5	10.6	2.2
714	5.0	4.3	10.0	2.0
715	5.0	4.4	10.0	2.0
716	5.8	5.0	11.6	2.0
717	6.2	5.7	13.0	2.1
718	8.5	7.4	17.0	2.0

in the apical part somewhat rounded. A depression of the growth lines is visible where the lateral lines run. It is more conspicuous and nearer to the ventral wall in the proximal part of rostrum, but shifted nearer to the centre of the lateral walls in the distal part.

Ontogeny (pl. V. fig. 1-2). — The ontogenetic changes affect both the general shape of the rostrum, its transverse section and the length of the apical part. Three growth stages may be distinguished on the base of ontogenetic observations: nepionic, neanic and ephebic-gerontic. The characteristics of these stages are given in table 5.

Variability. — The individual variability of mature specimens small, consisting in certain modifications of the apical part which may be either elongated, slender, sharply pointed and slightly swollen, or reduced, club-like and circular.

Remarks. — The Polish specimens come closest to Quenstedt's (1846-49) material from Germany, both in shape of the rostrum which is ventrally depressed, and the slight asymmetry of the apex, hardly discernible in young individuals. Moreover, youthful specimens are more slender and less depressed than the adults; from German specimens they differ in stronger tapering of the proximal part. Though in the writer's material this species is represented by very numerous specimens, not a single phragmocone or alveolar part has been preserved. Naef (1922) states that in *Gastrobelus ventroplanus* the angle of the phragmocone is blunt (26°), the alveolus circular in transverse section.

Table 5

Characteristics of the ontogeny of *Gastrobelus ventroplanus*

Growth stages	Maximum diameter d-s mm	Maximum diameter d-v mm	Growth index mm	Characters of rostrum
Nepionic	3.0-4.0	2.6-3.5	2.7-2.5	Elongated, slightly swollen at about 1/4 of length from apex; transverse section circular; apical part sharply elongated.
Neanic	4.1-5.0	3.6-4.5	2.4-2.1	Expanded to a club-like shape, strongly depressed, ventral wall flat; apical lines deep; apical part shorter, ovate in transverse section.
Ephebic-gerontic	5.1-8.5	4.6-7.5	2.0	Strongly expanded, less swollen, apex rounded; lateral lines less distinct; transverse section ovate, less depressed.

The assignment of *G. ventroplanus* to the genus *Gastrobelus* seems reasonably correct to the writer, in that the ventral side of rostrum is more or less strongly depressed. The inclusion of this genus into the subfamily Passaloteuthinae is suggested by the conical shape of rostrum in the youngest growth stages, the blunt alveolar angle, and absence of furrows on the alveolar edge.

Occurrence. — The Upper Lias through the Lower Callovian of Germany and France. In Poland — the Bathonian and Lower Callovian of Trzebionka (distr. Chrzanów), Błeszno, Wrzosowa (distr. Częstochowa), Ogrodzieniec, Włodowice (distr. Zawiercie).

Genus *Dactyloteuthis* Bayle, 1878

Dactyloteuthis irregularis (Schlotheim, 1820)

(pl. VI, fig. 4)

1820. *Belemnites irregularis* Schlotheim; E. F. v. Schlotheim, Die Petrefactenkunde ..., p. 48.
1830. *Belemnites irregularis* Schlotheim; C. H. v. Zieten, Die Versteinerungen ..., p. 30, pl. 23, fig. 6.
1830. *Belemnites digitalis* Faure-Biguet; C. H. v. Zieten, *Ibid.*, p. 31, pl. 23, fig. 9.
1836. *Belemnites digitalis* Faure-Biguet; F. A. Roemer, Die Versteinerungen ..., p. 167.
1846—49. *Belemnites digitalis* Blainville: F. A. Quenstedt, Petrefactenkunde ..., p. 416-418, pl. 26, fig. 1-10.
1842. *Belemnites irregularis* Schlotheim; A. d'Orbigny, Paléontologie ..., p. 74-76, pl. 4, fig. 2-5.
1857. *Belemnites irregularis* Schlotheim; W. A. Ooster, Catalogue ..., p. 9.

1920. *Dactyloteuthis irregularis* Schlotheim; E. v. Bülow-Trummer, Fossilium Catalogus, p. 97.
1922. *Dactyloteuthis irregularis* Schlotheim; A. Naef, Die fossilen Tintenfische, p. 236, text-fig. 85 i, k.
1925. *Dactyloteuthis irregularis* Schlotheim; M. Lissajous, Répertoire ..., p. 100-101; p. 26-27, text-fig. 14.

Material. — 1 rostrum, almost complete, well preserved, with smooth surface.

Description. — *External morphology* (pl. VI, fig. 4). Rostrum in the shape of an irregular cone, gradually tapering towards the distal end, apex blunt, slightly mucronate, curving away from the axis to the ventral side. Ventral wall narrower, convex; dorsal wall broader and proximally somewhat flattened. Lateral walls narrow, flat; proximal breadth 4 mm, distal 2 mm. Nearer to the back of the rostrum these walls draw slightly nearer to one another at the ventral side. Alveolus deep, probably occupying 2/3 of the rostral length.

Dimensions of rostrum (Z. Pal. UW, No. Bj. 703) in mm:

Length	33.0
Maximum diameter:	
d-s	10.5
d-v	9.5

The rostrum is slightly depressed, the furrows not preserved.

Remarks. — *Dactyloteuthis irregularis* comes closest to *Belemnites digitalis* Faure-Biguet (Zieten, 1830, p. 31, pl. 23, fig. 9). Both these species lack the apical furrow. On this character Zieten (1830) distinguished *B. digitalis* from *B. irregularis*, for the latter has a short apical furrow on the ventral side. Bülow-Trummer (1920) and Lissajous (1925) unite these two species under the common name of *B. irregularis* Schlotheim, on similarities of rostral shape and the same occurrence in the Upper Liassic horizons. In Poland this species is encountered in higher horizons, i. e. in the Lowermost Callovian. Some representatives, however, of the genus *Dactyloteuthis*, e. g. *D. similis* (Bülow-Trummer, 1920, p. 100) have been reported from the Dogger, too, therefore the vertical range of *D. irregularis* may also be greater.

Occurrence. — The Lias and Lower Dogger of Germany (Württemberg), France, England, the U.S.S.R.; the Lias of Switzerland and of Poland (Tatra Mountains), also the Lower Callovian of Ogrodzieniec (distr. Zawiercie).

Genus *Megateuthis* Bayle, 1878

Megateuthis giganteus (Schlotheim, 1820)

(fig. 12; pl. VII-VIII)

1820. *Belemnites giganteus* Schlotheim; E. F. v. Schlotheim, Die Petrefactenkunde ..., p. 45.

1846-49. *Belemnites giganteus* Schlotheim; F. A. Quenstedt, Petrefactenkunde ..., p. 428, pl .28.
1842. *Belemnites giganteus* Schlotheim; A. d'Orbigny, Paléontologie ..., p. 112, pl. 14-15.
1858. *Belemnites giganteus* Schlotheim; F. A. Quenstedt, Der Jura, p. 408-410, pl. 56, fig. 1-5.
1904. *Belemnites giganteus* Schlotheim; M. Clerc, Étude monographique ..., p. 5-6.
1911. *Megateuthis giganteus* Schlotheim; W. Wetzel, Faunistische ..., p. 219, pl. 19, fig. 7-8, 52; p. 221.
1916. *Mucroteuthis giganteus* Abel; O. Abel, Paläobiologie ..., p. 126, 140, text--fig. 49.
1925. *Megateuthis giganteus* Schlotheim; M. Lissajous, Répertoire ..., p. 23-24, 90, text-fig. 12.
1933. *Megateuthis giganteus* Schlotheim; E. Dacqué, Leitfossilien, pl. 17, fig. 5.
1953. *Belemnites (Megateuthis) giganteus* Schlotheim; S. Z. Różycki, Górny dogger ..., p. 326.

Material. — Over 500 specimens, 37 of which belong to young individuals; 10 nearly perfect rostra, numerous fragmentary rostra of adults, and 60 phragmocones. State of preservation varies, frequently the surfaces of rostra are smooth and lustrous, in many other cases rough and dull. The phragmocones occur as moulds or they are re--crystallized, impregnated by iron oxides.

Description. — *External morphology* (pl. VII, fig. 2). Rostra in the shape of a cone with obtuse angle in young specimens, but acute in adults, length of rostrum considerable, up to 2 m and more (Wetzel, 1911). In nepionic specimens the length increases in proportion to the increase of thickness and diameter; in more mature specimens these correlations are not observable since with individual age the growth in length progressively increases and exceeds that in diameter and width. Nepionic forms are in the shape of a short cone, with an obtuse apical angle, while the ephebic-gerontic forms are markedly elongated, slender, with an acute apical angle.

Dimensions of 10 measured rostra are given in table 6.

In the most youthful specimens the alveolus is deep and occupies about 1/3 of the entire length of the rostrum, in adults not less than 1/5 of that length.

In adult specimens, minute, longitudinal wrinkles are observable, in addition to distinct apical furrows. Furrows stretching from the alveolar edge are missing; out of the apical furrows, the lateral paired ones are well marked, namely the longer dorso-lateral and the shorter ventro-lateral. In young individuals the ventro-lateral furrows are occasionally poorly developed, while in adults the two paired furrows are distinct and nearly equal in length, the dorso-lateral being slightly longer. The ventral and dorsal furrows occasionally occur on the apical part,

Table 6

Dimensions of rostra of *Megateuthis giganteus* (in mm)

Z. Pal. UW. No. Bj.	Length	Diameter d-s		Diameter d-v	
		proximal part	distal part	proximal part	distal part
1	20.0	8.0	3.5	9.0	4.0
2	31.0	9.0	2.0	14.0	2.0
3	28.0	11.5	4.0	12.5	5.0
4	37.0	10.0	2.5	12.0	4.0
5	38.5	13.0	4.5	14.5	5.5
6	40.0	13.5	5.5	16.0	6.4
7	56.0	14.6	6.5	16.0	7.0
8	55.5	18.0	7.6	22.0	10.0
9	72.0	15.0	7.0	20.0	8.0
10	82.0	19.0	5.0	25.0	7.0
38*	145.0	39.0	38.0	51.0	48.0
39*	110.0	40.0	38.0	49.0	47.0

* Fragmentary rostra of adult individuals.

the former of them is more frequent. As a rule, only the lateral paired furrows occur. In nepionic individuals they are broad and shallow, and become obsolete at about midlength of rostrum, while in ephebic--gerontic individuals the lateral furrows are more impressed into the surface of the rostrum, so that they form extremely narrow grooves, up to 3 mm in depth. These furrows are shorter than in the nepionic stage, as they disappear at a distance of about 1/3 of length from the apex.

In the proximal part the rostrum is somewhat compressed distally, owing to the deeply incised apical furrows, the compression is occasionally very strong, so much so that even angular side surfaces may be indicated, particularly in the oldest specimens. The compression varies in the different parts of rostrum and also according to the individual age. The lateral surfaces are more or less parallel; they pass into the dorsal and ventral surfaces with margins rounded, except for the apical part which is angular in oldest individuals.

A great number of measurements have been taken of the ratio of diameter to that of width in the alveolar and apical parts, separately for individuals of nepionic, neanic and ephebic-gerontic stage, also for phragmocones. They have permitted the establishment of the so-called compression index. That index changes as follows: in nepionic specimens, over the entire length of rostrum, the compression is slight, being 1.1 — 1.2 in the alveolar part, and 1.3 in the apical part. The neanic specimens are a little more compressed, the respective compression values being

1.3, and 2—3. The phragmocones are circular or subcircular in transverse section, throughout their length, the compression index ranging from 1.0 to 1.1. Their apical angle is obtuse (pl. VII, fig. 6) and they stick in the rostrum with the axis somewhat ventrally inclined (pl. VIII, fig. 8).

During the ephebic-gerontic stage, specimens will be encountered somewhat deviating from the most common shape of an elongated cone. Their lateral surfaces are domed; occasionally one only may be convex. In these cases the growth in diameter on the ventral side of rostrum differed from that on the dorsal side. It is also possible that we are here dealing with differences of sex, as is believed by some authors, e. g. Wetzel (1911, p. 222).

Internal morphology (pl. VII, fig. 1-3, 5, 7-8, pl. VIII). Longitudinal and transverse thin sections disclose growth lines which are more distinct at certain intervals. The apical line is somewhat excentric, nearer to the ventral side of rostrum. The growth layers are more closely spaced on the lateral sides of rostrum than along the median line. A fissure of varying width is often observable in the apical line, most likely caused by the crumbling up of the central layers.

A corrugated mass, showing lamellar structure, is discernible on the longitudinal thin section in the central part of rostrum (pl. VII, fig. 1). This structure is probably due to a very rapid growth in length of the rostrum. During the intense elongation of rostrum, the calcite carbonate in the central part was unable to assume its normal crystalline pattern, but developed as a fibrous corrugated structureless mass. Similar structures are known as epirostra. On some specimens it is possible to trace the formation of an epirostrum. A rather small rostrum, normally built, is seen at the end of the alveolus. The growth layers superposed onto the apical part of that rostrum begin to corrugate in the median part only, while in the lateral parts their structure is normal. In the lower parts of rostrum the corrugation progressively involves the sides, too. In transverse thin sections and in celluloid peels we may observe the corrugation of the central layers, and the gradual extension of the corrugated area. The modifications taking place from the proximal part of the rostrum towards the distal are readily traced here, as well as differences between the young and adult specimens. Apical furrows, so characteristic of *Megateuthis giganteus*, are formed owing to the corrugation of the central part of rostrum. Observations of numerous specimens partly confirm the opinions of authors who postulate the presence in this species of an epirostrum. The epirostrum, which displays a typical development in Liassic belemnites (Müller-Stoll, 1936), is here represented by a similar structure, but very imperfectly developed.

A deformation of the interior structure of the rostrum, of a different type than that described above, developing from the apex to the

alveolus, has been observed on several specimens, sectioned in the dorso-ventral symmetry plane. This modification was probably a result of processes, by Müller-Stoll (1936) referred to as resorption. The central layers are the first to be attacked, since they are the least resistant being less cohesive than the external layers. This resorption process may have occurred in the animal's life time, owing to the dissolving properties of the epithelium or that of the fibrous tissue of the mantle closely coating the apical part of rostrum (Müller-Stoll, *l.c.*). It is illustrated in fig. 7 of pl. VII.

Several rostra of older individuals are preserved together with an initial phragmocone, in most cases, however, the alveoli are filled with sediment. Moulds of phragmocones display imprints of septa, sometimes that of the siphon, too. The initial part of the phragmocone, provided with a dozen or so air chambers, could be traced in the longitudinal thin section. The protoconch is a transversely elongated vesicle (pl. VII, fig. 8).

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW. No. Bj. 54):

Number of successive air chambers	Length of each air chamber (in mm)	
	longer Ø	shorter Ø
protoconch	0.75	0.50
1— 5	0.10	—
6— 9	0.12	—
10—12	0.16	—
13—17	0.20	—

The septa between chambers are readily discernible under strong magnification, 7 layers being distinguishable, according to the observations of Christensen (1925) and of Müller-Stoll (1936). They are: 1° the main layer (Hauptschicht), centrally placed, splitting up into two laminae near the external phragmocone walls; these laminae overlap the two adjacent septa; 2° two side layers (Nebenschicht); 3° two intermediate layers (Zwischenschicht); 4° two covering layers (Deckschicht), one on either side of the main layer. The lateral layers do not participate in the construction of the external wall of chamber, but they expand considerably towards the siphonal tube, resulting in a conspicuous swelling of the septum.

The septa are in the shape of a distally convex watch glass, the first septum being much more domed than the remaining ones. The siphonal tube lies near the ventral side of the phragmocone. The siphon is developed as elongated and depressed, somewhat obliquely oriented vesicles. In ventral view it appears as a number of connected segments, anteriorly constricted, but gradually expanding posteriorly. From the

alveolus to the apex the particular segments are so arranged that the distal part of each segment is overlapped by the next segment. In lateral view the compression of segments and their oblique arrangement is readily discernible.

On phragmocones, polished ventrally, one can see that the septal necks run out of the septum as strongly outcurved rings which, after describing a semicircle, come somewhat nearer to one another, without, however, contacting or reaching to the next septum (pl. VII, fig. 3). The resulting picture resembles that observable in Nautiloidea of the cyrtochoanites type.

The alveolar angle measured in young and mature individuals ranges from 23° to 28° in the dorso-ventral direction, and from 18° to 24° in the lateral direction. According to Wetzel (1911), this angle measures 19-24°, and according to d'Orbigny (1842) — 20-23°.

On younger septa of the phragmocone, the particular semicircular layers are seen, well discernible in thin sections (pl. VII, fig. 4). These layers are alternatively light and dark, and of varying thickness. The distribution of layers is irregular, but usually they occur at the concave side of the septum, near the siphonal tube. They are connected with the septa, since the covering layer of septum overlaps them, by encircling them exteriorly. The thickness of these structures depends on the thickness of the covering layer of septum: the thicker is the covering layer, the more poorly developed are the superposed layers, and vice versa. Christensen (1925, p. 152) describes similar structures and regards them as some anomalies. They are indeed an isolated phenomenon, without analogies among other cephalopods. With the exception of the family Polyteuthidae (partly Passaloteuthinae Naef, 1922), that writer has not encountered similar structures among the belemnites. Christensen (*l.c.*) suggests two concepts to account for the formation of these semicircular structures: 1° either they result from a hypertrophy of the marginal layers of septum, or 2° they are connected with the presence of liquid in the phragmocone itself. That author does not admit the possibility of the infiltration of the entire shell by liquid from the outside, since, were this so, the phenomenon would be of common occurrence. The origin of the semicircular structures is thus still an open question, and conclusions are risky owing to the lack of additional evidence.

Ontogeny. — During the rostral growth, important changes take place which are well illustrated in the longitudinal and transverse sections (fig. 12; pl. VIII). Three growth stages may be distinguished, i. e. the nepionic, neanic and ephebic-gerontic. The characteristics of these stages are given in table 7.

The apical furrows are indicated in the inner layers of rostrum. The

Table 7

Characteristics of the ontogeny of *Megateuthis giganteus*

Growth stages	Apical dorso-lateral furrows	Apical ventro-lateral furrows	Compression index mm	Characters of rostrum
Nepionic	Shallow, broad, stretching to the midlength of rostrum.	Shallow, tapering, barely stretching to the midlength of rostrum.	1.1-1.2	Short, conical, with obtuse angle; alveolus oblique, beginning near the ventral side; apex pointed; growth in diameter and width proportional to that of length; more rapid at the dorsal side of rostrum; transverse section rounded or slightly compressed; ventral wall broader.
Neanic	Broad, deeper, terminating at a distance of 1/3 of length from the apex.	Narrow, deep terminating at a distance of 1/4 of length from the apex.	1.3	Elongated, conical, with more acute apical angle; alveolus less oblique; apex long, less pointed; growth in length exceeds that in diameter and width; transverse section elliptical with longer d-v diameter; ventral and dorsal walls of equal length.
Ephebic-gerontic	Narrow, strongly incised into the rostrum, shorter in relation to the considerable length of rostrum, up to 3 mm deep.	Narrow, strongly incised into the rostrum as narrow grooves, shorter than in the neanic stage.	1.4	Strongly elongated, alveolus centrally placed; growth in length increasing progressively, that in diameter and width slight; transverse section elliptical, compressed, dorsal wall broader (fig. 12).

particular stages of the formation of lateral, dorsal and ventral furrows during the growth of rostrum, discernible on the surface, are illustrated in photographs of thin transverse sections (pl. VIII, fig. 1-7).

Variability. — In *M. giganteus* the variability is not great and affects but slightly the length of the dorso-ventral diameters and of the lateral ones in relation to the length of rostrum. It is also expressed in small changes of the length of paired apical furrows and in the degree of rostrum compression. More important variations may be observed in the structure of the corrugated interior of rostrum, affecting the successive formation of the apical furrows. In some cases, characteristic lateral inflections, subsequently growing deeper (pl. VIII, fig. 6, 7),

may occur even in the earliest evolutionary stage. Elsewhere the corrugation of the central layers is irregular, asymmetric, and additional lateral folds appear which become gradually extinct (pl. VIII, fig. 1-5). Sections figured in pl. VIII, fig. 1-7 are exemplary of the most typical ontogenetic development of furrows. The fold, initially affecting the central layers only, gradually extends outwards to embrace in its terminal part the marginal layers, too.

Remarks. — Schlotheim (1820, p. 45) was the first to describe this species. The swelling of the central part of rostrum, mentioned by Schlotheim, is not a constant character; most of the rostra in the collection of the present writer are in the shape of an elongated, uniformly tapering cone.

D'Orbigny (1842, p. 117), when discussing the specimens related with *Megateuthis giganteus*, postulates that their assignment to separate species by a number of authors is not reasonably correct and that they all represent *M. giganteus*, differing in age and sex only. *Belemnopsis ellipticus*, *B. gladius*, *B. grandis* and *B. acuminatus* are by that author considered as male individuals, and *B. quinquesulcatus*, *B. aalensis*, *B. longus* and *B. gigas* — as female specimens. A confirmation of these suggestions calls for adequate evidence, but no attempt has thus far been made to clear up this point.

The question of sexual differences in *M. giganteus* has also been discussed by Wetzel (1911, p. 222). According to him, these differences are expressed by a distinct ratio of diameter increase to the length growth, also in different development of the apical part and of the apical furrow.

Fundamentally different views are advanced by some authors with regard to the presence in *M. giganteus* of a structureless element, called the „epirostrum", as well as to causes of its origin. Abel (1916, p. 140) mentions the occurrence in the rostrum of *M. giganteus* of central plicated layers and gives to the strongly elongated distal segment the name of a „spear" (Spiess). Müller-Stoll (1936, p. 176-177, fig. 4-11; pl. 1, fig. 8; pl. 2, fig. 1-8; pl. 3, fig. 3, 4-7) in his investigations of the Liassic species of Aulacoceratidae, described in detail and figured similar structureless rostra, introducing for them the term "epirostrum". From that author's studies it results that the epirostrum is distinguishable even externally, since the two diameters of rostrum change obviously within the area of the formation of epirostrum. In longitudinal section this part is particularly well marked. The end of a normally constructed rostrum penetrates into the tube-like element corresponding to the epirostrum. This element is filled up by a substance of unknown origin and composition, by Müller-Stoll called the "corpus pulposum". The majority of authors: Buch (1839), d'Orbigny (1842), Wetzel (1911), Naef

(1922), Lissajous (1925), Roger (1952), do not make any mention about the presence of an epirostrum in *M. giganteus*. Quenstedt (1846-49), in his description of *B. giganteus ventricosus*, mentions a folded structure in the rostrum of that species, interpreting its formation by excessive elongation of the rostrum. Fischer (1952, p. 387, 389, text-fig. 43) describes an epirostrum as it occurs in *M. giganteus*, illustrating it by a diagram.

Occurrence. — The Bathonian of Germany, France, England, Switzerland and the U.S.S.R. In Poland — the same formation at Kamienica Polska (distr. Częstochowa), Rudniki, Blanowice (distr. Zawiercie), Łęczyca (distr. Kutno) and at many other localities.

Genus *Brachybelus* Naef, 1922

Brachybelus breviformis (Voltz, 1830)

(pl. IV, fig. 12)

1830. *Brachybelus breviformis* Voltz sp.; M. Voltz, Observations ..., p. 42, pl. 2, fig. 2-4.
1846-49. *Belemnites breviformis* Voltz; F. A. Quenstedt, Petrefactenkunde ..., p. 428, pl. 27, 28 a, b (non fig. 21-26).
1922. *Brachybelus breviformis* (Voltz); A. Naef, Die fossilen Tintenfische, p. 241.
1925. *Pachyteuthis breviformis* Voltz; M. Lissajous, Répertoire ..., p. 26, 61-63.

Material. — 1 complete specimen, with the surface smooth and slightly lustrous.

Description. — *External morphology.* Rostrum in the shape of a broadly open cone, rapidly tapering posteriorly, with subquadrate section in the proximal part, with rounded edges. Lateral walls broad, the dorsal and ventral narrow, all flat. Distally the somewhat more domed dorsal wall is constricted towards the apex, which thus appears to be mucronate. The apical part short, pointed, deviating slightly from the axis to the dorsal side. Furrows wanting. Alveolus probably deep.

Dimensions of rostrum (Z. Pal. UW, No. Bj. 702) in mm:

Length	18.0
Maximum diameter:	
d-s	6.5
d-v	7.0

Remarks. — The only collected specimen comes closest to *Belemnites breviformis* Voltz (Quenstedt, 1846-49), both in general shape and small dimensions. It resembles very strikingly Quenstedt's specimen in pl. 27, fig. 28 a-b. Lissajous (1925) refers Voltz's species to the genus *Pachyteuthis*. But the species of that genus have greater dimensions and are distinguished by strong elongation of rostrum; moreover they occur from the Upper Dogger (Naef, 1922, p. 242-246). The present writer thinks that it would be more correct to assign *B. breviformis* to the genus

Brachybelus Naef (Naef, l.c.) occurring from the Middle Lias to the Lower Dogger, and on the characteristic shape of cone, also to include it in the subfamily Passaloteuthinae Naef.

Occurrence. — The lower horizons of the Dogger and the Uppermost Lias of Germany, France, England, the U.S.S.R. and the Asiatic countries. In Poland — the Bathonian deposits at Trzebionka (distr. Chrzanów).

Subfamily **Belemnopsinae** Naef, 1922

Genus *Belemnopsis* Bayle, 1878

Belemnopsis canaliculatus (Schlotheim, 1820)

(fig. 13; pl. IX)

1820. *Belemnites canaliculatus* Schlotheim; E. F. v. Schlotheim, Die Petrefactenkunde ..., p. 49.
1830. *Belemnites canaliculatus* Schlotheim; C. H. Zieten, Die Versteinerungen ..., p. 27, pl. 21, fig. 3 a-e.
1842. *Belemnites canaliculatus* Schlotheim; A. d'Orbigny, Paléontologie ..., p. 108-110, pl. 13, fig. 1-5.
1857. *Belemnites canaliculatus* Schlotheim; W. A. Ooster, Catalogue ..., p. 9.
1875. *Belemnites canaliculatus* Schlotheim; A. Alth, Rzecz o belemnitach ..., p. 217, 221, pl. 3, fig. 1 a-b, 2-5.
1920. *Belemnopsis canaliculatus* Schlotheim; E. v. Bülow-Trummer, Fossilium Catalogus, p. 127.
1922. *Belemnopsis canaliculatus* Schlotheim; A. Naef, Die fossilen Tintenfische, p. 249.
1925. *Belemnopsis canaliculatus* Schlotheim; M. Lissajous, Répertoire ..., p. 33-35, 67.
1953. *Belemnites canaliculatus* Schlotheim; S. Z. Różycki, Górny dogger ..., p. 325.

Material. — 15 almost complete rostra, also many fragments. State of preservation varies depending on the type of deposit: in Bathonian clays and Oxfordian marls the rostra are satisfactorily preserved and display smooth uninjured surfaces, while those yielded by ferruginous deposits have coarse, cracked surfaces, coated with iron oxides. Phragmocones not preserved.

Description. — *External morphology* (pl. IX, fig. 1-5). Rostra cylindrical, with length ranging from 34 mm in nepionic specimens to 52 mm in ephebic-gerontic. Maximum lateral (d-s) diameters are 4.4 to 9.8 mm respectively, while the thickness, i. e. the dorso-ventral (d-v) diameter at that point ranges from 3.7 to 7.6 mm. The minimum lateral and dorso-ventral diameters, measured at the base of alveolus, are usually smaller than that. The differences between the maximum and minimum diameter, as a rule, range from 0.7 to 1.0 mm. The thickness of rostrum does not change to any important extent along the whole length, the differences between the maximum and the minimum thickness not exceeding 0.1 to 0.5 mm. Rostra are strongly depressed, somewhat less so proximally than distally. The lateral walls are nearly parallel, slightly

nearer to each other in the alveolar area. The dorsal wall is flat and gently domed. A broad, angular, well depressed furrow runs along the ventral wall. Towards the apex it grows shallower and broader and its edges are rounded. The apical part is elongated and pointed in nepionic specimens, but with age becomes less slender, occasionally mucronate. Its length is for the most part equal to half that of the complete length of rostrum. Transverse section is reniform in outline, with a longer lateral diameter. The side walls are rounded, sometimes displaying extremely fine lateral lines, varying in length, but most commonly exceeding one half of the total length of the rostrum. Dimensions of 15 specimens are given in table 8.

Table 8

Dimensions of rostra of *Belemnopsis canaliculatus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
86	4.4	3.4	16.0	3.6
87	4.7	3.7	17.0	3.6
88	5.0	3.7	18.5	3.7
89	5.5	4.4	20.0	3.6
90	6.0	4.6	20.0	3.3
91	5.7	4.1	21.0	3.6
92	6.0	5.0	20.0	3.3
93	6.0	4.7	20.0	3.3
94	7.0	5.2	25·0	3.5
95	7.0	5.4	24.0	3.4
96	6.7	6.3	26.6	3.8
97	7.4	6.0	25.0	3.3
98	7.7	5.7	27.0	3.5
99	8.0	7.2	28.0	3.5
100	9.8	7.6	30.0	3.1

With the growth in length, the width and thickness increase gradually, and the apical part is proportionally elongated. The growth index does not vary to any important extent, hence it may be stated that it is the same in rostra of different age.

Internal morphology (pl. IX, fig. 6, 7). In the thin longitudinal and transverse sections, numerous growth lines are visible, more conspicuous in some stages. The apical line approaches markedly the ventral side of rostrum.

In longitudinal sections it is possible to analyse changes affecting the shape of the rostrum during the successive growth stages. Nepionic rostra in shape come nearer to the representatives of genus *Hibolites*, in that they are similarly constricted in the proximal and distal parts,

and expanded centrally. Each successive growth stage is progressively more cylindrical.

Transverse sections across different parts of the rostrum, from the alveolus to the apex, allowed to trace changes affecting the outline of section along the complete length of rostrum during the various growth stages (pl. IX, fig. 6). Across the proximal part the section is ovate, with longer lateral (d-s) diameter; across the distal and central parts it is reniform, strongly depressed. Proximally the growth lines are rather deeply incised along the furrow, but distally they become progressively less deep. The apex of rostrum is without a furrow, with section again passing to the ovate, with longer lateral diameter. Slight folds are observable on either side of rostrum along the course of the lateral lines. During the early growth stages they have a symmetric arrangement to be later somewhat shifted to the ventral side (pl. IX, fig. 6 *b*, *c*).

The fissural area occupies the entire space between the apical line and the ventral wall of rostrum, stretching nearly to the apex.

The alveolar depth is rather small, occupying about 1/5 of the rostral length. The alveolar angle ranges from 26 to 28°. The phragmocone is not preserved.

Ontotgeny (fig 13). — The earliest growth stages differ considerably in shape and outline of the transverse section from the later stages. Three stages may be distinguished in rostral ontogeny: nepionic, neanic and ephebic-gerontic. Characteristics of these stages are given in table 9.

Ventral furrow does not change during ontogeny. Throughout all its stages it is broad, proximally angular, distally more shallow, with edges progressively rounded.

Variability.—The majority of the collected specimens belong to the intermediate stage of ontogeny, hence it is in this stage that a certain extent of variability may be observed. It concerns the shape of specimens, which may be more or less cylindrical, also the diameter/width ratio. Some rastra with the same diameter, equal to 3,7 mm, vary in width from 4.7 to 5 mm. The ventral furrow is also subject to certain width and length variations. The apical part may be pointed or gently rounded, occasionally mucronate, sometimes longer and more slender, or shorter and thicker. All these variations are, however, rather insignificant.

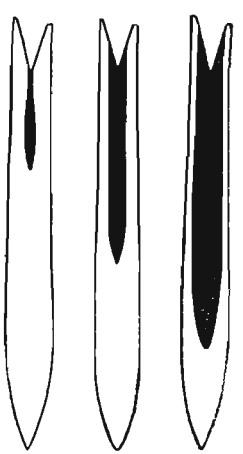

Fig. 13 — *Belemnopsis canaliculatus* (Schlotheim), adult rostrum cut in the plane of symmetry, showing three growth stages.

Table 9

Characteristics of the ontogeny of *Belemnopsis canaliculatus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	4.4-5.5	3.4-5.0	Elongated, fusiform, apex pointed; transverse section slightly depressed; lateral lines single, hardly detectable.
Neanic	5.6-7.5	5.1-6.5	Elongated, less fusiform, apex not so pointed; transverse section reniform, more depressed; lateral lines barely visible or missing; apex occasionally mucronate.
Ephebic-gerontic	7.6-9.8	6.6-7.6	Distinctly cylindrical, lateral walls subparallel; transverse section reniform, much depressed; apex occasionally mucronate.

Remarks. — *Belemnopsis canaliculatus* (Schlotheim) occurs from the lowermost horizons of the Middle Jurassic to the lower horizons of the Upper Jurassic, and displays very wide geographic distribution. The writer's observations on the whole agree with the descriptions of other authors. Schlotheim (1820, p. 49) gives a very brief specific description of species only stressing the presence of a long and broad furrow. At the same time, however, he suggests that this furrow may have developed owing to the pressure, exercised by the overlying sediment during the process of fossilization. No figures are given by that author. In addition to a short description, Zieten (1830, p. 27, pl. 21, fig. 3) also publishes some illustrations of this species. His specimens come from the same locality as those mentioned by Schlotheim, hence other authors make references to Zieten's paper regarding the figured specimen as typical.

The assignment of *B. canaliculatus* to the genus *Belemnopsis* seems fully justified by the characteristically fusiform shape of the nepionic specimens, passing to cylindrical in adults, also by the presence of a long ventral furrow and the strong dorso-ventral depression.

Occurrence. — The various horizons of the Middle and Upper Jurassic throughout Europe, Asia, the Caucasus, India and Australia. In Poland — all the Jurassic horizons of the Kraków-Częstochowa Highlands, namely at Kłobuck, Błeszno, Wrzosowa (distr. Częstochowa), Rudniki, Kromołów, Ogrodzieniec (distr. Zawiercie), Trzebionka, Luszowice, Balin, Bolęcin (distr. Chrzanów), Czatkowice, Regulice, Tenczynek (distr. Krzeszowice) and at Wyszmontów in the north-eastern margin of the Holy Cross Mountains.

Belemnopsis fusiformis (Parkinson, 1811)

(pl. X)

1811. *Belemnites fusiform* Parkinson; J. Parkinson, Organic remains ..., p. 128, pl. 8, fig. 13.
1842. *Belemnites Fleuriausus* d'Orbigny; A. d'Orbigny, Paléontologie ..., p. 111, pl. 13, fig. 14-18.
1857. *Belemnites Fleuriausus* d'Orbigny; W. A. Ooster, Catalogue ..., p. 14.
1865-70 (1869). *Belemnites aripistillum* Phillips; J. Phillips, A monograph ..., p. 107, pl. 26, fig. 64.
1904. *Belemnites fusiformis* Parkinson; M. Clerc, Étude ..., p. 5, pl. 2, fig. 5.
1920. *Hibolites fusiformis* Parkinson; E. v. Bülow-Trummer, Fossilium Catalogus p. 140.
1922. *Belemnopsis fusiformis* Parkinson; A. Naef, Die fossilen Tintenfische, p. 149.
1923. *Belemnopsis fusiformis* Parkinson; M. Lissajous, Étude ..., p. 43-44.
1925. *Belemnopsis fusiformis* Parkinson; M. Lissajous, Répertoire ..., p. 88.

Material. — 19 rostra, more or less broken off in the alveolar or distal parts; numerous fragments. Preservation satisfactory, surfaces smooth.

Description. — *External morphology* (pl. X, fig. 1-6). Rostra subfusiform, proximally tapering, distally expanding as far as 1/3 of the distance from the apex. Length of rostra ranges from 22 to 96 mm, with the corresponding maximum lateral diameters from 2.7 to 10 mm, and the dorso-ventral ones from 2.4 to 7.5 mm. Transverse section is rounded across the proximal part, but distally passes to elliptic with a longer lateral (d-s) diameter. Along the ventral wall stretches, nearly to the apex, a long furrow, varying in width, with anguear edges. Proximally this furrow is narrow, but distally widens out to 2 mm and grows shallow, occasionally to expand again. Lateral lines, gently curved, are readily observable on the lateral sides of rostrum, particularly so in young individuals. In adults poorly developed keels may be formed along the lateral lines. For the most part, however, the lateral walls are connected with adjacent ones by rounded surfaces. The apical part occupies about one half of the total length of the rostrum; from the maximum width of rostrum it gradually tapers backwards to form a long, sharply terminated apex.

Dimensions of specimens are given in table 10.

With individual length growth, the width and diameter increase correspondingly, and the apical part grows longer. The lateral diameters (d-s) are longer than the dorso-ventral during all the growth stages. The growth index increases from 2.8 to 6, thus being proportional with individual age.

Internal morphology (pl. X, fig. 7 *a-d*). As compared with the slow increase of the rostrum diameter, growth lines, visible on thin longitudinal sections, are strongly elongated even in the early growth

Table 10

Dimensions of rostra of *Belemnopsis fusiformis* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
264	2.7	2.4	9.0	3.4
265	3.0	2.5	12.8	4.2
266	3.0	2.9	10.0	3.3
267	3.2	3.0	9.0	2.8
268	3.9	3.1	13.0	3.3
269	4.4	3.8	17.5	3.9
270	4.2	3.5	19.0	4.5
271	5.0	4.0	19.5	3.9
272	5.5	4.1	22.0	4.0
273	5.6	4.7	21.0	3.7
274	6.0	5.0	22.5	3.7
275	7.0	6.5	21.0	3.0
276	6.0	4.5	25.0	4.1
277	7.0	6.0	27.0	3.8
278	7.5	5.9	28.5	3.8
279	7.0	5.5	29.0	4.1
280	8.0	6.5	40.0	5.0
281	9.0	7.0	55.0	6.0
282	10.0	7.5	45.0	4.5

stages, hence they are more crowded on the lateral sides, but rather far-spaced along the apical line. This deviates slightly from the axis to the ventral side. Near the course of the ventral furrow the growth lines are more deeply incised and slightly curved on the lateral sides of rostrum near the course of the lateral lines. The ventral depression of the growth line, relatively wide and deep in the proximal part, becomes shallow and narrow in the distal part, to disappear in the apical part. In the alveolar area the transverse section is nearly quadrangular in outline, with rounded edges and a slightly longer lateral diameter. Distally the sections gradually become more elliptic, to be nearly circular in the apical part (pl. X, fig. 7*d*). The alveolus is circular in transverse section, with depth not exceeding 1/5 of the total length of rostrum and with an angle of 18—20°. The protoconch is a globose vesicle, about 0.5 mm in diameter. The air chambers of the phragmocone not preserved. The extent of the fissural area is nearly equal to the length of the ventral furrow, towards the apex this area grows thinner and disappears near the ventral side of the rostrum.

Ontogeny. — Beginning with the earliest growth stages, the shape of the rostrum does not change fundamentally during ontogeny. Changes

Table 11

Characteristics of the ontogeny of *Belemnopsis fusiformis*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	2.7- 4.4	2.4-3.8	Fusiform, tapering in the alveolar part, expanding at midlength; transverse section rounded; lateral lines single, occasionally double; apical part relatively short.
Neanic	4.5- 7.0	3.9-5.0	Shape of rostrum as in preceding stage; transverse section laterally elongated; lateral lines faint or not marked; apical part slender, sharply pointed.
Ephebic-gerontic	7.1-10.0	5.1-7.5	Strongly elongated, shape not changed; depression stronger than during the neanic stage, slightly less so in the alveolar region; lateral lines faint or obsolete.

affect the transverse section which is circular in nepionic specimens, but becomes depressed in adults. The lateral lines, conspicuous in early ontogeny, become slightly obscured during the later growth stages. The ventral furrow grows deeper and expands with age, but its length is not essentially modified, and it stretches nearly to the apex of rostrum throughout all the growth stages. Three growth stages may be distinguished in the ontogeny: nepionic, neanic and ephebic-gerontic. Characteristics of these stages are given in table 11.

Variability. — The individual variability is not great; it is expressed by certain width differences of the ventral furrow; other characters fairly constant.

Remarks. — The Polish specimens agree with those described by Parkinson (1811) and by Phillips (1869), or d'Orbigny (1842). They display the same characters and have been found in the same horizons. The assignment of *B. fusiformis* to the genus *Belemnopsis* seems reasonably correct in view of the just given description and on the peculiar character of the fissural area, justifying the inclusion of the genus *Belemnopsis* into the subfamily Belemnopsinae.

In its subfusiform shape *B. fusiformis* somewhat resembles *Belemnopsis latesulcatus* d'Orbigny (d'Orbigny, 1845), but differs from it in smaller depression, smaller dimensions and in the apical part, which is constantly long, slender and pointed, while in *B. latesulcatus* it may be apically rounded or even mucronate.

Occurrence. — The Bathonian of Germany, France, England and Switzerland. In Poland — the Bathonian quarry at Trzebionka (distr. Chrzanów).

Belemnopsis latesulcatus (d'Orbigny, 1845)
(fig. 14; pl. XI, XII, fig. 1)

1845. *Belemnites latesulcatus* d'Orbigny; A. d'Orbigny, Paléontologie ..., p. 301, pl. 50, fig. 3-8.
1846-49. *Belemnites semihastatus depressus* Quenstedt; F. A. Quenstedt, Petrefactenkunde ..., p. 440, pl. 29, fig. 12-19.
1910. *Belemnites latesulcatus* Voltz; E. W. Benecke, Über Belemnites ..., p. 129-132, text-fig. 1, 2.
1920. *Hibolites latesulcatus* Voltz; E. v. Bülow-Trummer, Fossilium Catalogus, p. 145.
1922. *Hibolites latesulcatus* Voltz; A. Naef, Die fossilen Tintenfische, p. 249.
1925. *Belemnopsis latesulcatus* d'Orbigny; M. Lissajous, Répertoire ..., p. 105.

Material. — 20 nearly complete rostra and a great number of fragments. The majority of rostra satisfactorily preserved, with smooth surface, occasionally only cracked or crushed in the alveolar part.

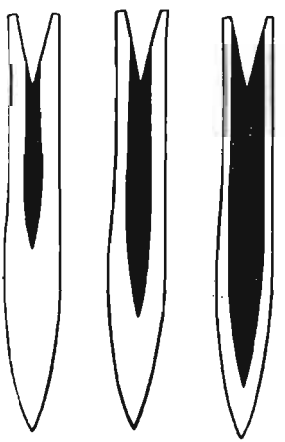

Fig. 14. — *Belemnopsis latesulcatus* (d'Orbigny), adult rostrum cut in the plane of symmetry, showing three growth stages.

Description. — *External morphology* (pl. XI, fig. 9-12). Rostra cylindrical, slightly tapering in the alveolar part, expanded at 1/3 of the distance from the apex, and thereafter tapering again towards the apex. The length of rostra ranges from 22 to 120 mm. The greatest lateral diameters (d-s) are from 4 to 15.5 mm, while the greatest dorso-ventral diameters are from 3.4 to 10.6 mm respectively. Rostra are strongly depressed along the entire length. In the proximal part the lateral walls approach each other. The lateral lines are faint, of varying length, sometimes stretching to the apex. The ventral furrow long, extending nearly to the apex, about 4 mm in width. In the apical part this furrow grows shallow and expands, and the edges, angular proximally, are rounded distally. The dorsal and ventral walls nearly parallel and connected with the adjacent walls by rounded edges. Some rostra, particularly so in older specimens, are centrally strongly depressed, so that distinct keels are formed on the lateral wals (pl. XI, fig. 12*b*). In transverse section the rostrum is more or less elliptic, with a longer lateral diameter. The apical part is relatively short, pointed, occasionally rounded, sometimes mucronate.

Dimensions of specimens are given in table 12.

Table 12
Dimensions of rostra of *Belemnopsis latesulcatus* (in mm)

Z. Pal. UW No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
105	4.4	3.4	13.3	3.0
106	4.0	3.2	12.0	3.0
107	4.0	3.3	14.0	3.5
108	5.0	4.0	15.0	3.0
109	6.0	4.5	18.0	3.0
110	6.0	4.8	18.0	3.0
111	6.0	5.0	18.0	3.0
112	8.2	6.2	22.0	2.7
113	9.5	7.0	28.6	3.0
114	10.0	8.0	30.0	3.0
115	10.0	8.0	30.0	3.0
116	10.5	7.6	35.0	3.3
117	10.3	8.4	31.0	3.0
118	11.3	9.0	36.0	3.1
119	11.0	8.4	38.0	3.4
120	10.3	9.0	31.0	3.0
121	12.5	10.0	37.5	3.0
122	14.5	10.4	48.0	3.3
123	15.5	11.0	60.0	4.0
124	16.5	12.0	48.0	3.0

Growth index nearly equal in rostra of different age, the average being 3. Hence the increase in length is proportional with that of width. The lateral diameters are longer than the dorso-ventral, throughout all the growth stages.

Internal morphology (pl. XII, fig. 1; XIII, fig. 8-9). Growth lines, more conspicuously indicated at certain growth stages, are distinct in longitudinal and transverse thin sections. The apical line is somewhat excentric and situated nearer to the ventral wall of rostrum. In transverse thin sections the growth lines are deeply incised along the ventral furrow. Distally this depression grows shallow and narrows. The earlier stages display a more circular course of growth lines, the older ones — an elliptical course, with a longer lateral diameter.

During the ephebic-gerontic stage the course of the growth line is frequently disturbed, i. e. behind the alveolus these lines are curved on the lateral sides of rostrum; this inflection increases progressively from the inner towards the outer growth lines, so that the last lines, marginally situated, produce a semblance of edges. In external morphology this structure is expressed in lateral compression of rostrum and formation of keel-like thickenings (pl. XII, fig 1b,c). The alveolus is circular in transverse section, its depth takes up approx. 1/4 of the total length of rostrum. The average alveolar angle is 22—24°. The protoconch has the appearance of a globose vesicle and is considerably larger than the primary air chambers.

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. U. W. No. Bj. 129):

Number of successive air chambers	Length of each air chamber (in mm)
protoconch	0.5
1—5	0.2
6—8	0.5
9—11	0.7

The protoconch is separated from the first air chamber by a septum that is strongly convex backwards. The next septa are distinctly less convex. The siphonal tube is placed on the ventral side of the phragmocone, without being in close contact with it. In the first air chambers it is extremely thin, thicker in the following ones. It has the semblance of a string, consisting of several elongated slanting segments, which narrow slightly when passing through the septa and expand in the chambers. The fissural area occupies the whole space between the apical line and the ventral wall of rostrum, stretching to the very apex.

Ontogeny (fig. 14). — The nepionic, i. e. the youngest growth stages, are distinguished by a fairly considerable increase in length as compared to the slow increase of diameter. Nepionic specimens are slightly fusiform, since they narrow proximally and expand a little more centrally. The ventral furrow is broad even in the earliest stages, with age this character is all the more so conspicuous. Three stages are distinguishable in rostral ontogeny: nepionic, neanic and ephebic-gerontic. Their characteristics are given in table 13. Neanic specimens predominate in the writer's collection.

Variability. — Rostra of approximately the same age are subject to strong individual variability, in the first place affecting the apical part. Specimens may be differentiated, passing from a short apex with acute angle to an elongated one with obtuse angle (pl. XI, fig. 4-6). Other specimens have a mucronate apex, with the mucro displaying a varying mode of development (pl. XI, fig. 1-3). In some specimens the ventral furrow is broad, in others narrower, angular over the complete length, or in a certain part of the rostrum only (pl. XI, fig. 7-8).

Remarks. — *B. latesulcatus*, described by d'Orbigny in 1845, had not been figured by him, and this lack of illustrations probably led later authors to incorrect interpretations of the species. Specimens from Poland are identical with those figured by Benecke (1910, p. 130, fig. 1, 2), from Germany. He figures two rostra, that shown in his fig. 1 is supposed to represent *B. latesulcatus*, that in fig. 2 — *B. calloviensis*. Size excepted, these rostra do not differ in any other features and Benecke himself drew the conclusion that they must be regarded as conspecific. The present writer is likewise of the opinion that the

Table 13
Characteristics of the ontogeny of *Belemnopsis latesulcatus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	4.0- 6.5	3.2- 5.0	Slightly fusiform, with maximum expansion at midlength; depression not strong.
Neanic	6.6-12.0	5.1-10.0	Analogous to the nepionic stage; depression stronger, particularly so in the central and distal parts; apical part long, with apex pointed or rounded, often mucronate.
Ephebic-gerontic	12.1-16.0	10.1-12.0	Shape unchanged, rostrum more elongated and thickened; considerable depression, with keel-like thickening on the lateral sides; apical part with an obtuse angle, often mucronate at apex.

two rostra figured by Benecke are conspecific, but she has doubts with regard to the interpretation of *B. calloviensis*, synonymous with *B. semihastatus*, but not with *B. latesulcatus*. *B. calloviensis (B. semihastatus)* differs from *B. latesulcatus* in such characters as: differently fusiform shape, transverse section compressed across the proximal part, but rounded or slightly depressed across the distal part; ventral furrow tapering proximally, expanding distally, and shorter than that in *B. latesulcatus;* dimensions of rostra much smaller than in *B. calloviensis*. Benecke likewise makes references to *B. semihastatus* Blainville (1827) and analyses the differences noted by him between that species and *B. latesulcatus;* concluding however that it is identical with *B. latesulcatus*, certain differences being referable to the inaccuracy of Blainville's figures. The present writer does not agree with Benecke; in her opinion *B. semihastatus* is a distinct species and it should not be mistaken for, or united with *B. latesulcatus*.

Belemnopsis latesulcatus (d'Orbigny) somewhat resembles *B. canaliculatus* (Schlotheim), but differs from it in less cylindrical shape and much larger dimensions. The early growth stages in these two species are almost identical, the fusiform rostrum being their common, very characteristic, feature.

Occurrence. — The Middle Jurassic of Germany, France, Switzerland, England, the U.S.S.R., Portugal, Algiers. In Poland within the same horizons in numerous Jurassic quarries of the Kraków-Częstochowa High lands and the north-eastern margin of the Holy Cross Mountains; most satisfactorily preserved specimens have been collected from Regulice (distr. Krzeszowice), Trzebionka (distr. Chrzanów) and Ogrodzieniec (distr. Zawiercie).

Belemnopsis subhastatus (Zieten, 1827)
(fig. 15; pl. XII, fig. 2, XIII, fig. 1-7)

1830. *Belemnites subhastatus* Zieten; C. H. v. Zieten, Die Versteinerungen ..., p. 27, pl. 21, fig. 2 a-e.
1856/58. *Belemnites subhastatus* Zieten; A. Oppel, Die Juraformation ..., p. 546.
1875. *Belemnites subhastatus* Zieten; A. Alth, Rzecz o belemnitach ..., p. 225-227, pl. 3, fig. 7 a-c.
1920. *Hibolites subhastatus* Zieten; E. v. Bülow-Trummer, Fossilium Catalogus, p. 154-155.
1925. *Belemnopsis subhastatus* Zieten; M. Lissajous, Répertoire ..., p. 141.
1934. *Hibolites subhastatus* Zieten; E. Stoll, Die Brachiopoden ..., p. 36, pl. 3, fig. 11.
1952. *Hibolites subhastatus* (Zieten); H. Makowski, La faune ..., p. 41.
1953. *Belemnites (Hibolites) subhastatus* Zieten: S. Z. Różycki. Górny dogger ..., p. 326.

Material. — 50 more or less complete rostra, numerous fragments, state of preservation satisfactory; some specimens are with preserved alveolar parts.

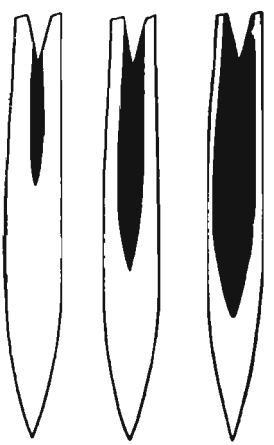

Fig. 15. — *Belemnopsis subhastatus* (Zieten), adult rostrum cut in the plane of symmetry, showing three growth stages.

Description. — *External morphology* (pl. XIII, fig. 1-6). Rostra cylindrical, strongly elongated, depression less conspicuous proximally, stronger distally. The smallest of the collected rostra is 9 mm in length, the largest 68 mm long. The corresponding maximum lateral diameters are 1 and 11 mm, the dorso-ventral ones 0.9 and 9 mm. Rostra are slightly swollen at midlength, the swelling being discernible in lateral and in ventral view. From midlength the rostra narrow very gradually to form a long, pointed apical part. The lateral walls pass into the ventral and dorsal wall by rounded edges. Lateral lines of varying length run along the lateral walls, usually exceeding 1/2 of the length of rostrum; in the proximal part they are somewhat nearer to the ventral side, but in the median and distal parts they have a central position. A long and proximally broad furrow runs along the ventral wall, it grows shallow and narrows backwards. At a certain distance from the apex this furrow disappears, its edges are angular proximally, but rounded distally. The transverse section is slightly compressed across the proximal part, but usually with the lateral diameter longer; across the central part it is reniform and rounded distally.

Dimensions of 18 specimens are given in table 14.

The growth index decreases with individual age, ranging from 4.2

Table 14
Dimensions of rostra of *Belemnopsis subhastatus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
169	1.0	0.9	4.0	4.0
171	2.0	1.9	7.0	3.5
174	2.9	2.2	9.9	3.4
176	3.0	2.8	11.0	3.6
182	3.5	3.4	12.5	3.5
183	4.0	3.5	17.0	4.2
185	4.0	3.5	15.0	3.7
188	4.0	3.2	15.0	3.7
196	5.5	4.5	20.0	3.6
199	6.1	5.5	25.0	4.1
205	8.0	7.0	28.0	3.5
212	9.0	7.8	32.0	3.5
213	8.5	7.1	33.0	3.8
214	9.0	8.0	29.0	3.2
215	9.5	8.1	34.0	3.5
216	10.5	9.0	34.0	3.2
217	10.5	9.0	34.0	3.2
218	11.0	9.0	35.0	3.2

in the youngest specimens to 3.2 in the oldest, the most common index being 3.5 and 3.2.

Internal morphology (pl. XII, fig. 2; XIII, fig. 7). Numerous fine growth lines are visible in the longitudinal thin section, also a somewhat lighter apical line, slightly nearer to the ventral side of rostrum. The neanic stage is better differentiated than the other growth stages. It is less slender than the earlier stages, with a shorter, less pointed apex. In the next growth stages, the growth lines display a reduction of the apical part, while the maximum diameter is shifted backwards. The more centrally situated growth lines are circular in transverse thin sections, the outer ones are elliptical with greater lateral diameter. Along the course of the ventral furrow, the growth lines are more incised across the outer parts of section. Along the course of the lateral lines, a slight depression only of the growth line is detectable. The alveolus is relatively shallow and occupies 1/7 of the whole length of rostrum. Its angle is acute, ranging from 22° to 23°. The fissural area, characteristic for the genus *Belemnopsis*, stretches nearly to the apex.

Ontogeny (fig. 15). — The nepionic stage is characterized by an elongated rostrum, slightly swollen in the central part, and by rather small diameter. The ephebic-gerontic stages display a greater increase of diameter as compared with the length increase and a reduction of the apical part owing to the more backward shifting of the maximum width of rostrum. The ventral furrow is very conspicuous thraghout all the growth stages, being angular in the proximal part, slightly expanded and deeper with growth, usually narrower distally than proximally. Three

Table 15
Characteristics of the ontogeny of *Belemnopsis subhastatus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	1.0-5.0	0.9-4.0	Strongly elongated, slender, pointed; somewhat fusiform, slightly swollen at midlength; ventral furrow narrow, long; transverse section elliptical or rounded.
Neanic	5.1-8.0	4.1-7.0	Less slender, apical part shorter, central swelling somewhat more conspicuous; ventral furrow with angular edges, sometimes it stretches nearly to the apex and grows wider; transverse section reniform.
Ephebic-gerontic	8.1-11.0	7.1-9.0	Continues to be strongly elongated, less slender, pointed, maximum swelling shifted behind midlength; ventral furrow long, wider than during the neanic stage.

fundamental growth stages may be distinguished in rostral ontogeny: nepionic, neanic and ephebic-gerontic. Their characteristics are given in table 15.

Variability .— Rostra of about the same age, show some differences in respect to the length of lateral and dorso-ventral diameters, as compared with the elongation of the apical part and the more or less backward shifting of the maximum width and diameter of rostrum. Variability also affects the length and width of the ventral furrow and the apical sharpness.

Remarks. — Specimens from Poland agree with those described by Zieten (1830). Young individuals in shape resemble *B. hastatus*, but differ in greater depression. They also approach nepionic specimens of *B. canaliculatus*, differing from them, however, in smaller depression, which is not uniform in the proximal and distal parts, while *B. canaliculatus* is equally depressed throughout the entire length of rostrum. Moreover, *B. subhastatus* is characterized by a certain swelling across the central part that is lacking in other species. Oppel (1856/58) in his description states that in view of its shape *B. subhastatus* occupies an intermediate position between *B. canaliculatus* and *H. calloviensis* (= *H. semihastatus*). This remark seems to be correct and stresses the characteristic shape of rostrum of *B. subhastatus*.

In agreement with the opinion of Lissajous (1925, p. 141) the writer believes that on features mentioned in the description and on the character of the fissural area, this species is referable to the genus

Belemnopsis, and not to *Hibolites*, as has been suggested i. a. by Bülow-Trummer (1920, p. 154) and Stoll (1934, p. 36).

Occurrence. — The Bathonian and Callovian of Germany, France, England, Serbia and India. In Poland — the same horizons of numerous Jurassic quarries in the Kraków-Częstochowa Highlands and the north-eastern margin of the Holy Cross Mountains; numerous well preserved rostra have been collected at Rudniki, Ogrodzieniec (distr. Zawiercie), Tenczynek (distr. Krzeszowice) and Wyszmontów (distr. Opatów).

Belemnopsis parallelus parallelus (Phillips, 1869)
(fig. 16; pl. V, fig. 7)

1869. *Belemnites parallelus* Phillips; J. Phillips, A monograph..., p. 108, pl. 27, fig. 65-66.
1920. *Hibolites parallelus* Phillips; E. v. Bülow-Trummer, Fossilium Catalogus, p. 147.
1925. *Belemnopsis parallelus* Phillips; M. Lissajous, Répertoire..., p. 117.

Material. — Three rostra with proximal part more or less damaged. State of preservation satisfactory, surfaces smooth, without cracks.

Description. — *External morphology* (pl. V, fig. 7). Rostra elongated, cylindrical, proximally tapering, expanding distally to about midlength. Ventral furrow shallow, proximally narrow and angular, tapering and growing more shallow distally, terminating near the apex. Lateral lines single, sometimes double, faintly marked, stretching to behind midlength of the rostrum. Section circular across the proximal part, depressed distally. Apical part long, pointed. The dimensions of rostra are given in table 16.

Remarks. — The Polish specimens resemble those described by Phillips (1869) from the Bathonian of England, both in shape, strong depression, character of the ventral furrow and in sharply pointed apex. The alveolus is not preserved in the Polish specimens.

Occurrence. — The Bathonian of England and Germany. In Poland — the Middle Bathonian of Trzebionka (distr. Chrzanów).

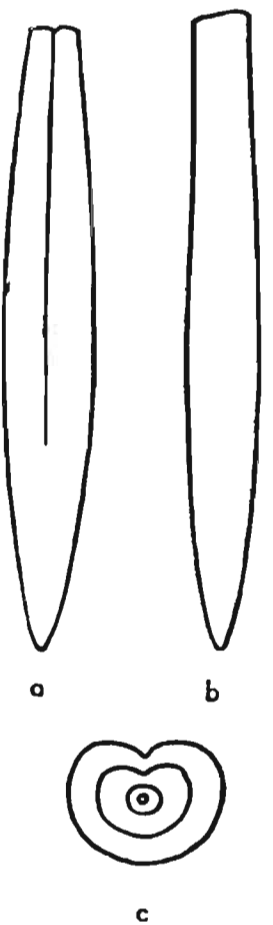

Fig. 16. — *Belemnopsis parallelus parallelus* (Phillips), diagram of adult rostrum: *a* ventral view, *b* side view, *c* in transverse section.

Table 16

Dimensions of rostra of *Belemnopsis parallelus parallelus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
699	7.3	6.0	24.5	3.3
670	7.6	6.3	25.4	3.3
671	7.3	6.0	26.0	3.5

Belemnopsis parallelus germanicus (Roemer, 1911)

(fig. 17; pl. XIV)

1911. *Belemnites parallelus* var. *germanica* Roemer; J. Roemer, Die Fauna..., p. 49, pl. 9, fig. 13 a-c, 14.

1920. *Hibolites parallelus* var. *germanica* Roemer; E. v. Bülow-Trumer, Fossilium Catalogus, p. 147.

Material. — Thirty more or less complete rostra of varying individual age, with smooth, well preserved surfaces.

Description. — *External morphology* (pl. XIV, fig. 1-5). Rostra cylindrical in shape, with strong depression along the entire length, the alveolar part excepted, where the depression is smaller. Proximally the rostra slightly taper, expanding distally as far as 1/4 of distance from the apex. Length of rostrum ranges from 23 to 53 mm. The corresponding maximum lateral diameters are from 4 to 10 mm, the dorso-ventral diameters — from 3.0 to 7.5 mm. Ventral and dorsal sides parallel, both flat and broad. Sides narrower, most frequently connected with the adjacent ones by rounded edges and only proximally meeting at a right angle. A distinct, relatively narrow furrow runs along the ventral wall, usually terminating at a certain distance in front of the apex. Sometimes its width is increased to 1 mm and the length shortened to half that of rostrum. Along the sides stretch medially single lateral lines, slightly incised into the surface, extending mostly to the maximum width of rostrum. The apical part is short, broad, rounded. In most cases the apex is blunt, sometimes a little more pointed, occasionally mucronate. Rostrum quadrate in transverse section, with the lateral diameter longer proximally, while centrally and distally it becomes more elliptical. The younger specimens are distinguished by being more slender and pointed, while the adults are with a shorter apical part which is thickened and blunt. The dimensions of 30 measured rostra are given in table 17.

The growth index does not change much with individual age, slightly decreasing from 3.0 in the youngest rostra to 2.2 in the oldest, i. e. reversely to the growth proportion.

Table 17

Dimensions of rostra of *Belemnopsis parallelus germanicus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
228	4.0	3.0	12.0	3.0
229	4.2	3.8	12.0	2.9
230	4.3	3.4	12.5	2.9
231	4.4	3.5	11.0	2.5
232	4.8	4.0	11.5	2.4
233	5.0	3.5	12.0	2.4
234	5.5	4.2	14.0	2.5
235	5.5	4.5	14.0	2.5
236	5.9	4.6	16.0	2.7
237	6.0	5.0	16.0	2.6
238	6.2	5.5	15.0	2.4
239	6.2	5.2	16.0	2.5
240	6.0	4.5	15.5	2.5
241	6.2	4.5	16.0	2.6
242	6.5	5.0	17.0	2.6
243	6.5	5.5	17.0	2.6
244	6.5	5.2	17.0	2.6
245	6.5	5.0	16.0	2.5
246	6.6	4.8	15.0	2.2
247	7.0	5.0	18.0	2.5
248	7.0	5.0	17.0	2.4
249	7.0	5.0	17.0	2.4
250	7.5	6.2	19.0	2.5
251	7.4	5.3	18.0	2.4
252	7.5	5.8	18.0	2.4
253	7.6	6.0	18.7	2.4
254	8.2	6.0	21.0	2.5
255	8.8	6.0	24.0	2.7
256	9.5	7.0	26.0	2.7
257	10.0	7.5	27.0	2.7

Internal morphology (pl. XIV, fig. 6-8). Numerous growth lines are observable in thin sections, more distinct in some stages. In transverse section these lines are more crowded on the ventral side. The apical line is somewhat excentrically placed, being nearer to the ventral side. Depressed growth lines are visible near the ventral furrow and the lateral lines; they grow shallower from the proximal towards the distal part of rostrum and thin out quite near the apex. In longitudinal section the growth lines do not vary in outline throughout all the growth stages. Even the earliest stages are strongly elongated in relation to the small increase of rostrum in diameter and width.

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW. No. Bj. 260):

Number of succesive air chambers	Length of each air chamber (in mm)
protoconch	0.40
1- 8	0.13
9-14	0.17
15-28	0.25
29-31	0.33
32-33	0.40
34-35	0.60

The alveolus is relatively shallow and occupies from 1/6 to 1/8 of the whole rostral length. It is somewhat obliquely oriented with the tip directed to the ventral side. In transverse section it is circular, with the angle slightly over 22°. The fissural area takes up the whole space between the apical line and the ventral side of rostrum.

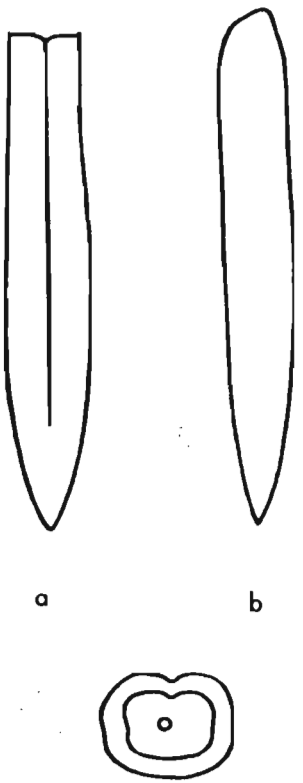

Fig. 17. — *Belemnopsis parallelus germanicus* (Roemer), diagram of adult rostrum: *a* ventral view, *b* side view, *c* in transverse section.

Ontogeny. — Changes occurring in the rostrum during growth are, in the first place, those, affecting the shape, the outline in transverse section, character of the apical part and of the ventral furrow. Rostral ontogeny may be expressed by three growth stages: nepionic, meanic and ephebic-gerontic. The characteristics of rostrum are given in table 18.

Ventral furrow very narrow, stretching to midlength of rostrum; with individual age it grows a little longer and widens out to 1 mm. The alveolus does not change in shape or position in relation to the axis, increasing in depth only in the normal course of ontogeny.

Variability. — The individual variability of rostra similar in age is expressed only by some deviations of the width and length of the ventral furrow, and the degree of roundness or sharpness of the apical part.

Remarks. — The Polish specimens fully agree with those described and figured by Roemer (1911) from the Lower Bathonian of Germany. They also approach *B. parallelus parallelus* (Phillips, 1869) in the strong depression, long and narrow ventral furrow, and in that they occur at the same time. *B. parallelus germanicus* differs from Phillips'

Table 18

Characteristics of the ontogeny of *Belemnopsis parallelus germanicus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	4.0- 5.9	3.0-4.9	Elongated, with depression, proximally less distinct; maximum diameters at 1/3 distance in front of the apex; lateral lines single, stretching to maximum width of rostrum; transverse section circular; apical part sharply pointed, sometimes rounded, mucronate.
Neanic	6.0- 7.9	5.0-6.9	More depressed; lateral lines slightly shorter than before; transverse section rectangular; apical part somewhat shorter, less slender, sometimes mucronate.
Ephebic-gerontic	8.0-10.0	7.0-7.5	With subparallel sides, strongly depressed; lateral lines hardly discernible; transverse section elliptical; apical part broad, flat, occasionally mucronate.

subspecies in that its proximal part does not taper to such an extent, the apical part is shorter, often rounded, mucronate, and the rostrum is more strongly depressed on its whole length (fig. 16, 17). The writer agrees with Roemer's standpoint postulating the separation from Phillips' species of a subspecies — *B. parallelus germanicus*. Lissajous (1925, p. 90) doubts the independence of the German subspecies and regards it as synonymous with *B. semihastatus* Blainville. The writer thinks that they are two separate species, fundamentally different and not congeneric. They have no characters in common and differ both in external and internal morphology.

Occurrence. — The Bathonian of Germany and France. In Poland — from the Upper Bathonian to the Lower Callovian at Trzebionka (distr. Chrzanów), Ogrodzieniec (distr. Zawiercie) and Wrzosowa (distr. Częstochowa).

Belemnopsis semiarcuatus n. sp.

(fig. 18, 19; pl. XV)

Holotypus: rostrum, pl. XV, fig. 4a, b. No. Z. Pal. Bj. 310.

Stratum typicum: Upper Callovian, ornatum beds with *Cosmoceras ornatum*.

Locus typicus: Regulice (distr. Krzeszowice).

Derivatio nominis: Lat. *semiarcuatus* — rostrum semiarcuately curved.

Diagnosis. — Rostra of small dimensions, fusiform, proximally long and narrow, apically short and club-like, arcuate on the ventral side; ventral furrow long and deep, strongly expanding towards the back, terminating in a broad depression near to the apex; lateral lines long, curved, sometimes double; rostra slightly depressed along the whole length.

Material. — Over 500 specimens, out of which 26 well preserved. State of preservation varies with the nature of sediment. The Regulice

Fig. 18. — *Belemnopsis semiarcuatus* n. sp., diagram of adult rostrum, lateral view: *v* ventral side, *d* dorsal side.

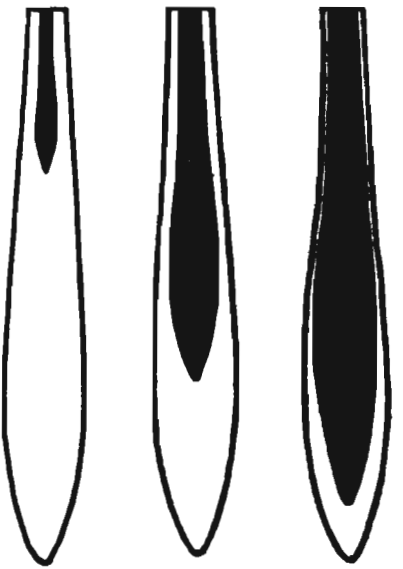

Fig. 19. — *Belemnopsis semiarcuatus* n. sp. adult rostrum cut in the plane of symmetry, showing three growth stages.

specimens are with smooth lustrous surfaces, while those from Ogrodzieniec are more damaged, with coarse surfaces displaying traces of injuries, probably inflicted by animals searching for food. All the specimens are proximally more or less broken off; phragmocones are not preserved. The collected material contains all the growth stages.

Description. — *External morphology* (pl. XV, fig. 1-6). The length of our specimens ranges between 16 and 39 mm; with the maximum lateral diameters — from 2.4 to 7.6 mm and the dorso-ventral ones — from 2.0 to 5.7 mm respectively. The maximum expansion of rostrum occurs at a distance of approx. 1/5 from the apex. The ventral furrow

Table 19

Dimensions of rostra of *Belemnopsis semiarcuatus* n. sp. (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
292	2.4	2.0	6.6	3.0
293	3.0	2.8	7.2	2.6
294	3.2	2.6	7.4	2.3
295	3.2	2.8	7.0	2.2
296	3.2	2.8	6.6	2.1
297	3.0	2.5	5.5	1.9
298	3.4	3.0	6.2	1.8
299	3.4	3.0	6.2	1.8
300	3.6	3.0	7.0	1.9
301	3.6	3.4	6.8	1.8
302	4.0	3.6	7.0	1.7
303	4.0	3.8	7.0	1.7
304	4.6	4.0	8.5	1.8
305	4.8	3.8	8.8	1.8
306	4.8	3.7	9.2	1.9
307	4.8	4.0	9.0	1.9
308	5.0	3.8	9.0	1.8
309	5.0	4.0	9.0	1.8
310	5.4	4.0	10.0	1.8
311	5.0	4.0	8.0	1.6
312	5.0	4.0	8.0	1.6
313	5.5	4.2	10.2	1.8
314	6.0	5.0	10.5	1.7
315	5.5	4.2	9.4	1.8
316	6.0	5.0	11.0	1.8
317	7.6	5.7	12.0	1.6

stretches nearly to the apex, it is narrow proximally, widens out to 2.5 mm distally and terminates in a broad depression or a more shallow strip. Long, often double, gently curving lateral lines run along the lateral walls, proximally nearer the ventral side. The rostra are ventrally slightly domed and semiarcuate (fig. 18). At about midlength of rostrum the dorsal wall is more strongly curved out. Along the whole length the rostra are somewhat depressed in transverse section. The apical part varies in length, on the whole it is short, in young specimens more slender and sharply pointed, with age it becomes thicker, often rounded and mucronate. The dimensions of rostra are given in table 19.

The growth index is reversely proportional to individual age and decreases from 3.0 to 1.6. The majority of rostra are grouped around the 1.8 index.

Internal morphology (pl. XV, fig. 7-9). The apical line, lying on the

Table 20
Characteristics of the ontogeny of *Belemnopsis semiarcuatus* n. sp.

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	2.4-3.0	2.0-2.8	Elongated, fusiform, with the maximum diameter and width shifted backwards; ventral furrow long, stretching beyond 1/2 of rostrum, proximally narrow and angular, distally expanding; lateral lines long, ending behind the midlength of rostrum; transverse section circular or rounded.
Neanic	3.1-5.0	2.9-4.0	Less slender, with the proximal part long and expanding beyond the midlength of rostrum; the ventral furrow wider and deeper, very wide near the apex, often reaching the apex as a slightly depressed strip; lateral lines unchanged, transverse section subcircular; depression stronger distally; rostrum deviating from the axis, with the ventral side convex; apical part shorter, less pointed.
Ephebic-gerontic	5.1-7.6	4.1-5.7	Strongly thickened, differences of diameters smaller proximally and distally; ventral furrow unchanged; lateral lines less distinctly indicated; depression without changes; apical part shorter, often rounded, mucronate.

rostral axis, is rather thick. The growth lines are extremely delicate, more densely spaced in the proximal and the apical part than in the central. In transverse sections the growth lines appear depressed near the course of the ventral furrow, nearly along the whole length of rostrum, the apex excepted. The fissural area occupies the whole space between the apical line and the ventral wall of rostrum, stretching to the very apex (pl. XV, fig. 1).

Ontogeny (fig. 19). — Nepionic rostra are similar to the older ones, differing only in greater slenderness and more pointed apex. On comparing rostra of different individual age, three main ontogenetic stages can be distinguished: nepionic and ephebic- gerontic. Theih characteristics tre given in table 20.

Variability. — Most specimens belong to the neanic stage, in which certain variations are more readily traced. They affect the slenderness of rostra, some being strongly elongated, only slightly expanding towards the apex, while others are thickened, with a club-like apical swelling.

The apical part may be more or less short, broad and blunt, or slightly elongated, narrower and pointed. Other characters subject to small variations are the dimensions of the two rostral diameters, the width and length of the ventral furrow and the length of the lateral lines.

Remarks. — *Belemnopsis semiarcuatus* n. sp. differs from other congeneric belemnites, studied by the writer from Jurassic beds, foremost in its subfusiform shape, strong elongation of the proximal part and its arcuate inflection. It somewhat resembles the younger stages of *B. canaliculatus* and *B. latesulcatus* which taper very much proximally, also *Hibolites württembergicus*. From all the just mentioned species it differs in being semiarcuately curved; from the two latter forms — in a less distinct depression, and stronger distal expansion; from *H. württembergicus* moreover in its long wide ventral furrow. On the basis of characters (described in table 20) and on the presence of a long and broad fissural area, this new species is assigned to the genus *Belemnopsis*.

Occurrence. — The Upper Callovian of numerous localities in the Kraków-Częstochowa Jurassic zone. Among others *B. semiarcuatus* n. sp. has been found at Ogrodzieniec (distr. Zawiercie), Regulice (distr. Krzeszowice), Kłobuck and Błeszno (distr. Częstochowa). The best preserved specimens have been yielded by the Ornatenton of Regulice.

Genus *Hibolites* Mayer, 1883

Hibolites hastatus (Blainville, 1827)

(pl. XVI-XVIII)

1827. *Belemnites hastatus* Blainville; D. de Blainville, Mémoire..., p. 71, pl. 2, fig. 4-4a, 5 c-i; pl. 5, fig. 3, 3a.
1830. *Belemnites semihastatus* Zieten; C. H. v. Zieten, Die Versteinerungen..., p. 29, pl. 22, fig. 4.
1842. *Belemnites hastatus* Blainville; A. d'Orbigny, Paléontologie..., p. 121-126, pl. 18-19.
1846-49. *Belemnites semihastatus rotundus* Quenstedt; F. A. Quenstedt, Petrefactenkunde..., p. 440, pl. 29, fig. 8-11.
1846-49. *Belemnites hastatus* Blainville; F. A. Quenstedt, *Ibid.*, p. 442, pl. 29, fig. 35a, non fig. 31-34.
1858. *Belemnites semihastatus rotundus* Quenstedt; F. A. Quenstedt, Der Jura, p. 548, pl. 72, fig. 13, 15; pl. 74. fig. 11, p. 597.
1865-70. *Belemnites hastatus* Blainville; J. Phillips, A monograph..., part 5, p. 111, pl. 28, fig. 67-70.
1875. *Belemnites hastatus* Blainville; A. Alth, Rzecz o belemnitach..., p. 229, pl. 4, fig. 1-3.
1902. *Hibolites hastatus* Blainville; P. de Loriol, Etude..., p. 5, pl. 1, fig. 1, 1a.
1922. *Hibolites hastatus* Blainville; A. Naef, Die fossilen Tintenfische, p. 249, p. 204, fig. 71, k, p., p. 246, fig. 89f.
1925. *Hibolites hastatus* Blainville; M. Lissajous, Répertoire..., p. 35, fig. 20, p. 94.
1953. *Belemnites (Hibolites) hastatus* Blainville; S. Z. Różycki, Górny dogger..., p. 326.

Material. — 28 nearly complete rostra of various individual age, more than one thousand fragments. State of preservation varies with sediment. Rostra from loamy or marly sediments are well preserved, with smooth lustrous surfaces, while those from iron deposits usually show cracked, coarse surfaces.

Description. — *External morphology* (pl. XVI, XVII). Rostra fusiform in shape, slender, strongly elongated, narrow at the beginning of the alveole and expanding in its proximal part. Maximum expansion occurs at a distance of approx. 1/4 from the end. The length from 18 to 21 mm. The maximum lateral diameters are from 2.1 to 20 mm, the dorso-ventral ones — from 2.0 to 18.5 mm respectively. In the alveolar part the rostra are compressed to a varying degree, while centrally and distally they are depressed. The lateral walls are rounded, except near the alveolus where they are flat, sometimes uniting with the ventral wall by rounded edges. The ventral wall is somewhat broader than the dorsal, these differences are, however, observable only in the proximal part of rostrum. The ventral furrow runs along the ventral wall, in most cases terminating beyond the midlength of rostrum. Proximally this furrow is narrower, incised to a depth of 2 mm, with angular edges, in the distal direction the furrow edges become more rounded, the furrow itself more shallow with width increasing to 3.5 mm. Sometimes this furrow stretches to the apex as a broad shallow strip. Lateral lines run along the side walls, sometimes very distinct, single, occasionally double. In the alveolar part these lines move a little nearer to the ventral side of rostrum, centrally and distally to the dorsal. Young rostra are more slender, showing smaller width differences in the proximal and central parts of the rostrum. The apical part tapers to form a long and pointed apex. The dimensions of rostra are given in table 21.

At their maximum width young rostra (comp. table 21) are less depressed than the rostra of adults, since initially the differences between the d-s and d-v diameters are small — from 0.1 to 0.9 mm — with individual age increasing to 3.5 mm. The growth index varies, decreasing generally with age from 3.8 to 2.0.

Internal morphology (pl. XVIII). In transverse and longitudinal thin sections the growth lines are faintly marked, somewhat thicker and darker coloured in certain intervals. The apical line comes a little nearer the ventral side and much closer to it behind the end of the ventral furrow, where the rostrum is strongly flattened. In the alveolar part, below the ventral furrow, the growth lines are deeply incised and display sharply outlined edges, while posterioly the odges are progressively rounded and the ventral depression expands and grows shallower. No depression is discernible across the apical part. Near the course of the lateral lines, growth lines curve only very slightly. Trans-

Table 21
Dimensions of rostra of *Hibolites hastatus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
361	2.1	2.0	7.0	3.3
362	2.5	2.1	6.5	2.7
363	2.6	2.5	6.5	2.7
364	3.8	3.5	9.8	2.5
365	4.5	4.3	13.0	2.8
366	5.5	5.0	14.0	2.5
367	6.5	5.8	25.0	3.8
368	7.0	6.0	26.0	3.7
369	9.0	8.6	23.0	2.5
370	10.2	8.8	35.0	3.4
371	10.0	8.2	36.0	3.6
372	11.5	10.0	38.0	3.3
373	12.0	10.0	37.0	3.1
374	12.5	10.5	36.0	2.7
375	13.0	12.0	35.0	2.7
376	15.0	12.0	43.0	2.8
377	14.0	12.0	40.0	2.8
378	15.0	13.5	44.0	2.8
379	17.5	14.0	45.0	2.6
380	15.0	14.0	45.0	3.0
381	16.5	14.0	50.0	3.0
382	17.5	15.5	45.0	2.6
383	17.5	15.5	63.0	3.5
384	18.0	16.0	52.0	2.9
385	18.0	14.5	56.0	3.1
386	20.0	16.5	42.0	2.1
387	19.5	18.0	62.0	3.1
388	20.0	18.5	41.0	2.0

verse sections across the alveolar part are rounded or laterally slightly compressed, towards the back, however the section becomes ovate, with a longer lateral diameter; in the apical part it is quite round.

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW, No. Bj. 401):

Number of successive air chambers	Length of each air chamber (in mm)
protoconch	0.50
1- 5	0.20
6- 9	0.25
10-15	0.33
16-17	0.50
18-19	0.75
20-21	1.00

Thus the length of the air chambers increases 0.5 mm along the space occupied by the 21 measured septa (pl. XVIII, fig. 3-4).

In the alveolar part the fissural area takes up the whole space between the alveolus and the ventral furrow. Behind the alveolus the fissural area tapers progressively, moving away from the apical line to wedge out at the ventral edge after attaining a greater length than the ventral furrow.

Table 22

Characteristics of the ontogeny of *Hibolites hastatus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	2.1-3.0	2.0-2.5	Strongly elongated, tapering in the alveolar part, expanding at about 1/3 distance from the apex; ventral furrow narrow, with angular edges, stretching to midlength of rostrum; lateral lines straight; transverse section circular or slightly compressed, medially slightly depressed; apical part long, sharply pointed.
Neanic	3.1-10.0	2.6-9.0	Elongated , but less slender, more expanded at approx. 1/3 distance from the apex; ventral furrow somewhat broader, proximally with angular edges, medially and distally broad with rounded edges; transverse section as in the earlier stage; apical part relatively shorter and somewhat thicker, sharply pointed.
Ephebic-gerontic	10.1-20.0	9.1-18.0	Shape varying, either more slender and elongated, or strongly thickened beyond midlength; ventral furrow attaining a width of 3.5 mm at the apex, proximally sharp-edged and deep, often stretching to the apex as a broad, shallow depression; lateral lines frequently curving, in the alveolar part drawing nearer to the ventral wall, and medially to the dorsal; transverse section elliptical across the alveolar part slightly compressed, across the central part depressed, and rounded in the distal; the apical part relatively shorter, often pointed, sometimes rounded and thicker, slightly deviating to the ventral side.

The alveolus is rather small, with depth equal to approx. 1/5-1/7 of the whole length of rostrum. The alveolar angle is acute, ranging from 15 to 18°.

Ontogeny. — Four main growth stages may be distinguished in *H. hastatus*, i. e. an embryonic stage in addition to the three main stages normally observable in other species (nepionic, neanic, ephebic-gerontic). The embryonic rostrum is like a short, sharply pointed spine, fiting tightly to the phragmocone. The pigmentation of the embryonic rostrum is darker than in the later stages, no growth lines are detectable in it. The next stages differ considerably, their shape changes to club-like with a long proximal part expanding posteriorly. With growth the rostra lose some of their slenderness, the apical part is shortened, while the median becomes expanded and thicker. During ontogeny the transverse section, rounded in the youngest stages, becomes depressed. The dimensions of rostra are given in table 22.

Variability. — Rostra of the same individual age are subject to slight variations affecting their thickness and width, the width and length of the ventral furrow, the slenderness of the apical part; all these characters display greatest variability in the oldest stages. During that stage the apical part may be long and slender, or thick and short. Sometimes it is placed in the axial line of the rostrum, at others it leans towards the ventral side.

Remarks. — The Polish specimens resemble those figured by Blainville (1827) from France, also those from Germany and England. From the specimen described by Blainville (*l. c.*, p. 71) they differ, however, in a very characteristic shape of the apical part. Since that author did not have a complete specimen, he merely supposed the apex to be strongly swollen and blunt, while actually it is elongated and pointed, and only some very few rostra are less fusiform, with the apical part conspicuously thicker and shorter. Long, slender, pointed rostra are encountered in the deposit side by side with short, distinctly thicker rostra, displaying a short, often rounded apical part (pl. XVI, fig, 9). These features may possibly express sexual differences in that species. Analogous supposed sexual differentiation is mentioned by d'Orbigny (1842, p. 67) and Lissajous (1925, p. 43-44).

The embryonic rostrum which occurs as a short spine-like structure, protruding from the distal wall of the protoconch, has been described by Quenstedt (1849), d'Orbigny (1842, pl. 19, fig. 6), Stolley (1919) and Naef (1922, p. 203, fig. 71). These authors gave it different names, such as the „primordialrostrum", the „embryo" or simply the „small belemnite". The shape of that „embryo", suggested to Abel (1916) the repartition of all the belemnites into the two families: „Clavirostridae"

and „Conirostridae". According to Naef (1922, p. 208), this type of „primary rostra" occur in all the younger belemnites, the Liassic forms excepted. Among her material, the writer has observed the embryonic rostrum in *H. hastatus* and *H. girardoti*.

The assignment of *H. hastatus* to the genus *Hibolites* is unanimously accepted by all the later authors: Bülow-Trummer (1920, p. 125, 135), Naef (1922, p. 225, 247), Lissajous (1925, p. 36) and Roger (1952, p. 714). The present writer believes this species to be a typical representative of the genus Hibolites, moreover, she agrees with Naef in his assignment of the genus *Hibolites* to the subfamily Belemnopsinae.

Occurrence. — The Middle and Upper Jurassic of Germany, France, England, Switzerland, Austria, Portugal, Spain, Algeria, the Caucasus, Russia, Arabia, India and Madagascar. In Poland — the same horizons throughout the Jurassic strata of the Kraków-Częstochowa Highlands and the north-eastern margin of the Holy Cross Mountains; well preserved specimens have been collected at Ogrodzieniec (distr. Zawiercie), Regulice, Tenczynek (distr. Krzeszowice), and Trzebionka (distr. Chrzanów).

Hibolites semihastatus (Blainville, 1827)

(fig. 20; pl. XIX)

1827. *Belemnites semihastatus* Blainville; D. de Blainville, Mémoire..., p. 72, pl. 2, fig. 5, 5a-b, non fig. 5 c-i.
1856-58. *Belemnites calloviensis* Oppel; A. Oppel, Die Juraformation..., p. 546.
1871. *Belemnites semihastatus* Blainville; E. Dumortier, Sur quelques gisements ..., p. 22.
1870. *Belemnites semihastatus* Blainville; F. A. Roemer, Geologie ..., p. 256.
1875. *Belemnites calloviensis* Oppel; A. Alth, Rzecz o belemnitach..., p. 227, pl. 3, fig. 8.
1922. *Hibolites semihastatus* Blainville; A. Naef, Die fossilen Tintenfische, p. 249.
1925. *Belemnopsis semihastatus* Blainville; M. Lissajous, Répertoire..., p. 132.
1953. *Belemnites (Hibolites) calloviensis* Oppel; S. Z. Różycki, Górny dogger..., p. 325.
1953. *Belemnites semihastatus* Blainville; S. Z. Różycki, *Ibid.*, p. 326.

Material. — 46 more or less complete rostra, numerous fragments, representing all the stages of ontogeny. State of preservation on the whole satisfactory, the rostral surfaces smooth, not cracked.

Description. — *External morphology* (pl. XIX, fig. 1-5). Rostra fusiform, with rather small dimensions ranging from 21 to 76 mm. The maximum lateral diameters are respectively from 3 to 12 mm, the dorso-ventral — from 3 to 10 mm. The sides pass to the dorsal and ventral wall by rounded surfaces, near the alveolus they draw closer

to one another at the dorsal wall, so that the latter is slightly narrower than the ventral one. The ventral furrow is relatively broad, of varying length, extending nearly to the apex. Proximally this furrow is usually narrow and sharp-edged, distally it expands and becomes more shallow. Distinct lateral lines, mostly single, occasionally double, stretch to the apex. The maximum expansion of rostrum occurs at approx. 1/3 distance from it, thereafter the rostrum tapers rapidly, resulting in a short apical part with obtuse angle. The apical thickening of rostrum is very characteristic of *H. semihastatus* and is observable throughout its ontogeny. The younger specimens are slightly more slender than the adults. The transverse section is somewhat compressed across the proximal part, changing to subcircular or ovate across the median and distal parts, with a longer lateral diameter. The dimensions of rostra are given in table 23.

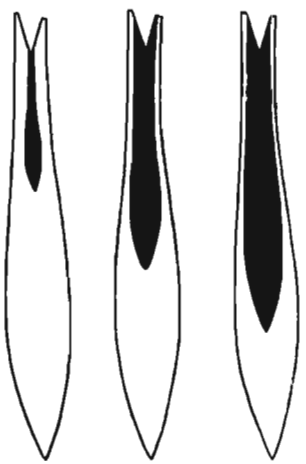

Fig. 20. — *Hibolites semihastatus* (Blainville), adult rostrum cut in the plane of symmetry, showing three growth stages.

Measurements show that the width of rostra exceeds their thickness and that with growth it increases from 0.5 to 3.5 mm, while the corresponding increase of thickness is from 0.5 to 2.0 mm. The growth index does not change much with age and it is possible to ascertain that in *H. semihastatus* the length increase is proportional to that in width.

Internal morphology (pl. XIX, fig. 6-8). The apical line is nearly centrally placed, drawing only just a little nearer to the ventral side. The transverse section passes from a slightly compressed one across the proximal part to subcircular across the central part, and circular across the distal part, respectively. The growth lines are incised along the course of the ventral furrow and the lateral lines. The ventral incision is narrower and deeper proximally, growing more shallow and expanding distally. At about 1/3 distance from the apex, the growth lines become rounded and the ventral depression is obliterated. The longitudinal sections of the rostrum allow to trace its outline during the various stages of ontogeny. On the whole the growth lines in the later stages of ontogeny are very similar to those of the younger stages; only the nepionic stage differs in a somewhat narrower proximal part and in greater apical expansion.

Table 23

Dimensions of rostra of *Hibolites semihastatus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
403	3.0	3.0	8.0	2.7
404	3.5	3.1	8.0	2.3
405	3.5	3.0	10.0	2.9
408	4.0	3.5	12.0	3.0
411	4.3	4.2	9.0	2.1
412	5.0	4.5	11.0	2.2
413	5.0	4.5	12.0	2.4
414	5.0	5.0	12.0	2.4
416	5.2	5.0	10.5	2.0
417	5.2	5.0	14.0	2.7
418	5.4	5.0	14.0	2.6
420	6.0	6.0	13.0	2.2
423	6.2	6.0	15.0	2.4
425	6.5	6.0	18.0	2.8
428	7.0	6.0	15.0	2.1
431	7.0	6.2	16.0	2.3
432	7.0	6.5	18.0	2.6
434	7.5	7.0	15.0	2.0
436	8.0	7.0	21.0	2.6
437	8.0	7.0	17.0	2.1
439	9.0	6.5	19.0	2.4
440	8.5	7.5	21.0	2.5
441	8.5	7.5	22.0	2.6
443	8.5	7.0	21.0	2.5
442	8.5	7.5	20.0	2.4
444	9.0	7.5	21.0	2.3
445	9.0	8.0	20.0	2.2
446	9.8	8.5	25.0	2.5
447	10.0	8.0	28.0	2.6
448	12.0	10.0	27.0	2.3

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW, No. Bj. 450):

Number of successive air chambers	Length of each air chamber (in mm)
protoconch	0.50
1- 6	0.17
7-10	0.25
11-14	0.35
15-16	0.45

The fissural area near the alveolus occupies the space between the apical line and the ventral wall, behind the alveolus it diminishes on

Table 24
Characteristics of the ontogeny of *Hibolites semihastatus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	3.0-5.0	3.0-4.5	Fusiform, with strongly elongated proximal part; circular or sub-circular in transverse section; lateral lines faintly indicated, single, stretching to 1/3 distance in front of the apex.
Neanic	5.1-8.0	4.6-7.0	Retains its previous shape; transverse section rounded or slightly compressed across the proximal part, and rounded or depressed across the central part.
Ephebic-gerontic	8.1-12.0	7.1-10.0	Less slender, apical part shorter; maximum width shifted a little nearer the apex; other characters without changes.

the side of the apical line and thins out near the ventral wall at a small distance from the apex. The contour of the fissural area is typical for representatives of the genus *Hibolites* (pl. XIX, fig. 7).

The alveolus is relatively shallow, occupying about 1/8 of the whole length of rostrum, with the angle ranging from 18 to 20°.

Ontogeny (fig. 20). — Even in the earliest growth stages, the rostra are of a characteristic fusiform shape, proximally long, distally short and expanded. In the older growth stages the length increases proportionally to that of width and thickness, while the younger stages are characterized by a more rapid growth in length. The various growth stages do not fundamentally differ in transverse sections, the nepionic stages only are more circular than the older stages. The depth and angle of alveolus are not subject to ontogenetic changes. Three growth stages: nepionic, neanic and ephebic-gerontic, can be distinguished in the ontogeny of *H. semihastatus*, based on its maximum diameter and some slight changes of outline in transverse section. Their characteristics are given in table 24.

Variability. — Rostra of approximately the same age are not subject to fundamental variations, except the small differences of width and diameter, length of the apical part and the more or less pointed apex.

Remarks. — Polish specimens fully agree with those from France (Blainville, 1827, p. 72, pl. 27, fig. 5, 5 a-b). Blainville's interpretation of the earliest stages of ontogeny is not correct in that he believed them

to lack the alveolar depression and compared them to oat grains, owing to both ends being similarly pointed. On evidence of thin longitudinal sections it is clear, however, that a very small alveolar depression is present even in the earliest stages of ontogeny.

A review of literature accessible to the writer has led to the conclusion that *B. semihastatus* Blainville (Blainville, 1827, p. 72) and *B. calloviensis* Oppel (Oppel, 1856-58, p. 546) are conspecific.

On the characteristically fusiform shape of rostrum, circular transverse section and the shape of the fissural area, *B. semihastatus* seems reasonably referable to the genus *Hibolites*.

Occurrence. — From the Upper Bathonian to the Lower Oxfordian of Germany, France, Russia and England. In Poland — at many places within Middle Jurassic horizons and lower Upper Jurassic horizons of the Kraków-Częstochowa Highlands; well preserved specimens have been collected at Ogrodzieniec, Ryczówka (distr. Zawiercie), Balin (distr. Chrzanów), Czatkowice and Regulice (distr. Krzeszowice).

Hibolites beyrichi (Oppel, 1856-58)
(fig. 21-22; pl. XX; XXI, fig. 1-4)

1856-58. *Belemnites Beyrichi* Oppel; A. Oppel, Die Juraformation ..., p. 472.
1858. *Belemnites canaliculatus gracilis* Quenstedt; F. A. Quenstedt, Der Jura, p. 484, pl. 65, fig. 2-4.
1870. *Belemnites Beyrichi* Oppel; F. A. Roemer, Geologie..., p. 210, 228, pl. 17, fig. 32.
1871. *Belemnites Beyrichi* Oppel; M. Neumayr, Die Cephalopoden..., p. 25.
1875. *Belemnites Beyrichi* Oppel; A. Alth, Rzecz o belemnitach..., p. 223, pl. 3, fig. 6.
1888. *Hibolites Beyrichi* Oppel; O. Schlippe, Die Fauna..., p. 193.
1920. *Hibolites Beyrichi* Oppel; E. v. Bülow-Trummer, Fossilium Catalogus, p. 136.
1922. *Hibolites Beyrichi* Oppel; A. Naef, Die fossilen Tintenfische, p. 249.
1925. *Belemnopsis Beyrichi* Oppel; M. Lissajous, Répertoire..., p. 58.
1927. *Belemnopsis Beyrichi* Oppel; F. Roman, Etude..., p. 13, pl. 2, fig. 1, 2.
1953. *Belemnites (Belemnopsis) beyrichi* Oppel; S. Z. Różycki, Górny dogger..., p. 325.

Material. — 10 almost complete rostra of various individual age, and about 200 smaller fragments. State of preservation on the whole satisfactory, some rostra are finely coated with iron oxides, on others the surface is smooth and lustrous. In some cases a characteristic mode of weathering is observed, i. e. the outer layers exfoliate first and then the inner ones, so that the central part protrudes to the outside as a short rod.

Description. — *External morphology* (pl. XX, fig. 1-4). Rostra strongly elongated, fusiform, with the length of transverse diameters varying considerably in the different parts of rostrum. Rostral length —

from 16 to 140 mm. Maximum lateral diameters occur at midlength of rostrum, ranging from 6.5 to 9.0 mm, while the dorso-ventral are from 7.0 to 9.5 mm. Proximally the rostrum is somewhat compressed, across the remaining area it is circular or subcircular in transverse section. The ventral furrow narrow, angularly edged, stretches to just beyond the midlength of rostrum. Long lateral lines extend to nearly the apex, being mostly single, but sometimes double. The apical part long, slender, sharply pointed. The dimensions of rostra are given in table 25.

Table 25

Dimensions of rostra of *Hibolites beyrichi* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
517	8.0	8.0	79.0	9.1
518	7.0	7.0	63.0	9.0
519	6.5	7.5	63.0	8.4
520	8.0	8.0	63.0	7.8
521	9.0	9.0	70.0	7.8
522	8.0	8.0	56.0	7.0
523	9.0	9.5	60.0	6.3

The growth index is reversely proportional to the individual growth index and decreases from 9.1 to 6.3 mm. This interrelation indicates that the apical part is longer in younger specimens, and is shorter, less slender in older ones.

Internal morphology (pl. XX, fig. 5; pl. XXI, fig. 1-4). Longitudinal sections show the central position of the apical line and the strong elongation of numerous growth lines discernible even in the earliest growth stages. The course of these lines does not change in the successive stages. In transverse sections the growth lines are incised beneath the ventral furrow, and slightly depressed beneath the lateral lines. This depression of the growth lines is distinct proximally, but grows shallower distally, and is obliterated below the midlength of rostrum. In several transverse sections, cut through the proximal, median and distal parts of the rostrum, the outline passes from elliptic, with longer lateral diameter across the proximal part, to subcircular and circular across the median and distal parts. In transverse section the alveolus is likewise dorso-ventrally elongated. Air chambers and the protoconch are observable in longitudinal sections of the phragmocone. In the first section through the phragmocone it was possible to measure the length of the preserved chambers. On the young septa there occur the semicircular layers, comparable with those observed in *Megateuthis giganteus*

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW, No. Bj. 524, 529):

Number of successive air chambers		Length of each air chamber (in mm)
I.	protoconch	0.60
	1	0.20
	2	0.25
	3–7	0.35
II.	protoconch	0.80
	1	0.25
	2	0.40
	3–7	0.66
	8–12	0.88
	13	1.16
	14	1.26

Thus the length of chambers is not constant and may be subject to strong intraspecific variations. The alveolus occupies about 1/9 of rostral length, its angle is acute of about 20°.

Ontogeny (fig. 21-22). — The successive growth stages, traced on the course of the growth lines, differ merely in progressive increase

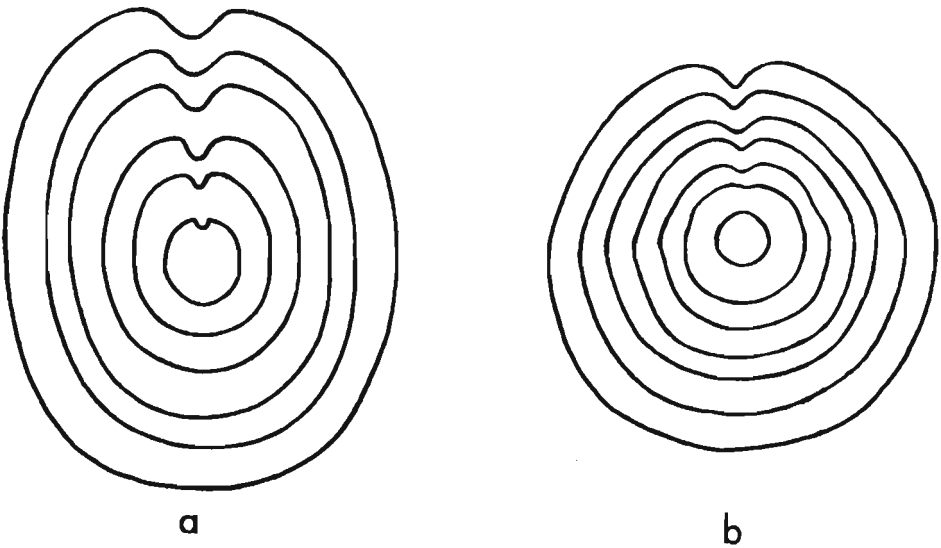

Fig. 21. — *Hibolites beyrichi* (Oppel); diagrammatic transverse sections of adult rostrum, showing the growth lines: *a* behind the alveolus, *b* at midlength.

of length as compared with the slower increase in width and diameter. Even the earliest stage is strongly elongated, with a narrow alveolar part, it expands only a little at midlength thereafter very gradually to taper towards the apex. The apical part is slender, long and pointed. The next growth stages differ in size, with age small changes take

place, expressed by a shortening of the apical part and a small increase in the width and diameter of rostrum. Owing to the scarcity of complete rostra of various age, it was impossible reliably to distinguish the three growth stages differentiated in the majority of the studied species.

Variability. — Specimens of the same individual age are not subject to great variations, only differences of width and diameter, and the extent of elongation of the apical part are observed.

Remarks. — The Polish specimens are indentical with those described and figured from Germany (Quenstedt, 1858, pl. 65, fig. 2-4) under the name of *Belemnites canaliculatus gracilis*, also with French specimens known as *Belemnopsis beyrichi* Oppel (Lissajous, 1925; Roman, 1927). The writer supports the opinion of Schlippe (1888), Bülow-Trummer (1920) and Naef (1922) that this species should be referred to the genus *Hibolites*.

According to Roman (1927) the ventral furrow extends on 3/4 of the rostral length, but according to the observations of the present writer, it barely attains the midlength of rostrum, only occasionally being slightly longer.

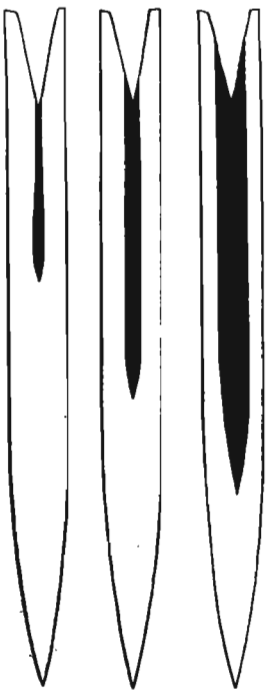

Fig. 22. — *Hibolites beyrichi* (Oppel), adult rostrum cut in the plane of symmetry, showing three growth stages.

Occurrence. — The Bathonian of Germany, France and England. In Poland — the same horizons in the vicinity of Łęczyca (distr. Kutno), Kamienica Polska (distr. Częstochowa), Kierszula, Łazy (distr. Zawiercie), Tenczynek, Balin, Grójec, Czatkowice (distr. Chrzanów and Krzeszowice).

Hibolites württembergicus (Oppel, 1856-58)

(fig. 23; pl. XXI, fig. 5; XXII)

1846-49. *Belemnites fusiformis* Quenstedt; F. A. Quenstedt, Petrefactenkunde..., p. 442, pl. 29, fig. 20-24.

1830. *Actinocamax* Miller; C. H. v. Zieten, Die Versteinerungen..., p. 33, pl. 25, fig. 3 a-b.

1830. *Actinocamax fusiformis* Hartmann; C. H. v. Zieten, *Ibid.*, p. 33, pl. 25, fig. 3 c-f.

1856-58. *Belemnites württembergicus* Oppel; A. Oppel, Die Juraformation..., p. 365.

1858. *Belemnites fusiformis* Quenstedt; F. A. Quenstedt, Der Jura, p. 411, pl. 56, fig. 8-12; non fig. 7.

1880/81. *Belemnites württembergicus* Oppel; W. Branco, Beiträge..., p. 41, pl. 8, fig. 5.
1911. *Belemnopsis württembergicus* Oppel; W. Wetzel, Faunistische..., p. 223.
1920. *Hibolites württembergicus* Oppel; E. v. Bülow-Trummer, Fossilium Catalogus, p. 155.
1922. *Hibolites württembergicus* Oppel; A. Naef, Die fossilen Tintenfische, p. 249.
1923. *Belemnites württembergicus* Oppel; J. Siemiradzki, Fauna..., p. 5, pl. 4, fig. 16.
1925. *Belemnopsis württembergicus* Oppel; M. Lissajous, Répertoire..., p. 37, 153.

Material. — 40 rostra of various individual age; all specimens without alveolus and phragmocones. Preservation satisfactory, rostral surfaces smooth and lustrous. Some specimens display a characteristic pattern of weathering, the external layers of the proximal part of rostrum being exfoliated so that the central part protrudes as a short rod (pl. XXII, fig. 7).

Description. — *External morphology* (pl. XXII, fig. 1-5, 7-8). Rostra fusiform, of moderate length from a few to 60 mm. Maximum lateral diameters slightly longer than the corresponding dorso-ventral diameters; they range from 3.8 to 7.3 mm and from 3.4 to 6.3 mm, respectively. The maximum thickness and width of rostrum occurs at approx. 1/4 distance from the apex. An extremely narrow ventral furrow stretches to just behind the midlength of rostrum. Deep and broad proximally, it grows narrower and more shallow distally and then terminates rapidly. On some specimens this furrow is somewhat sharter, terminating before it reaches the maximum rostral width. Weak lateral lines run on the side walls, stretching mostly to the maximum rostral width, often, however, they may be absent. The lateral walls unite with the dorsal and ventral walls by rounded surfaces. The transverse section is ovate across the proximal part, with a longer lateral diameter, and more or less rounded distally. The young specimens have a more circular transverse section than the adults. The depression in adult individuals is very slight since differences between the two diameters do not exceed 1 mm. The dimensions of rostra are given in table 26.

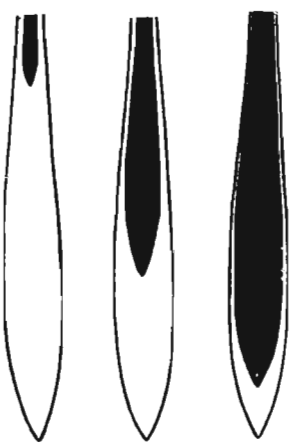

Fig. 23. — *Hibolites württembergicus* (Oppel), adult rostrum cut in the plane of symmetry, showing three growth stages.

The growth index ranges from 3.6 to 2.0 and its proportion is just the reverse of the individual age index.

Internal morphology (pl. XXI, fig. 5; pl. XXII, fig. 6). A thick, distinct apical line is visible in the longitudinal section; it lies along

Table 26
Dimensions of rostra of *Hibolites württembergicus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
495	3.8	3.4	11.5	3.0
496	3.8	3.6	12.0	3.1
497	4.1	4.0	11.0	2.7
498	4.0	3.7	10.0	2.5
499	4.0	3.8	11.0	2.7
500	4.3	4.0	12.4	2.9
501	4.4	4.0	16.0	3.6
502	4.6	4.3	13.5	2.9
503	4.8	4.5	14.0	2.9
504	4.6	4.5	12.0	2.6
505	5.0	4.5	14.8	2.9
506	5.0	4.7	13.5	2.7
507	6.0	5.4	17.0	2.8
508	5.8	5.4	15.4	2.6
509	7.3	6.3	15.0	2.0

the rostral axis, being somewhat excentric in the apical part only, where it deviates to the ventral or dorsal side. The growth lines are very dense and do not change in outline throughout all stages. The transverse sections change across the various parts of rostrum: being subcircular proximally, broadly rectangular medially, and again subcircular or circular distally. Along the course of the ventral furrow the growth lines are marked by a stronger incision than along the lateral lines. The fissural area stretches just a little behind the middle of rostrum and thins out at its ventral side.

Ontogeny (fig. 23). — The shape of rostrum does not change with growth to any great extent. The younger specimens are more slender, the older somewhat thicker, while the maximum diameters are shifted gradually towards the apex. The increase in thickness and width is rather small from the earliest growth stages; individuals of all stages are conspicuously elongated, particularly so in the proximal part. The ventral furrow, poorly marked in the youngest specimens, becomes more distinct, broader and deeper with age, though in comparison with other Jurassic species it is always very narrow. Three growth stages: nepionic, neanic and ephebic-gerontic may be differentiated. Their characteristics are given in table 27.

Variability. — Rostra of the same individual age are subject to small variations only. They concern the shape which may be more or less fusiform, the degree of depression, the differences in width and thickness, also the length and the tapering of the terminal part. The width and

Table 27
Characteristics of the ontogeny of *Hibolites württembergicus*

Growth stages	Maximum diameter d-s mm	Maximum diameter d-v mm	Characters of rostrum
Nepionic	3.8-4.8	3.4-4.5	Strongly elongated, displaying small increase in thickness and width; ventral furrow very narrow, attaining the midlengt of the rostrum, often shorter or missing; lateral lines very faintly incised or missing; apical part long, pointed; transverse section subcircular, largest across 1/3 of the distance from the apex.
Neanic	4.9-6.0	4.6-5.5	Elongated, pointed, increase in thickness and width small; ventral furrow a little broader, attaining the midlength of the rostrum; lateral lines unchanged; apical part somewhat shorter; transverse section slightly depressed, the largest at approx. 1/4 of the distance from the apex.
Ephebic-gerontic	6.1-7.3	5.6-6.3	Less slender, with somewhat greater increase in thickness and width; ventral furrow unchanged; lateral lines faint, occasionally as slight depressions or low edges; transverse section slightly more depressed.

length of the ventral furrow vary, too; sometimes it exceeds the midlength of the rostrum, or may terminate before it. The oldest growth stage is subject to a certain variability in that the maximum rostral width may be more or less shifted towards the back. When the maximum width occurs near or at the apex, the rostrum changes from fusiform into club-like.

Remarks. — Oppel's (1856-58) description of *Belemnites württembergicus* was not accompanied by illustrations. Other authors refer to *B. fusiformis*, figured by Quenstedt (1846-49, pl. 29, fig. 20-24) as to the type specimen. *B. fusiformis* was established by Parkinson (1811) whose idea of that form did not on any point agree with Quenstedt's species; *B. fusiformis* Quenstedt, 1846-49, on the other hand, is conspecific with *Hibolites württembergicus* (Oppel), (Oppel, 1856-58).

In shape and in proportions the Polish specimens come near Quenstedt's *B. fusiformis* from Germany; they also agree with Oppel's description of *H. württembergicus*.

On such characters as a more or less fusiform shape of rostrum, varying length of the ventral furrow, and in the degree of shifting of the maximum width towards the back, Wetzel (1911, p. 223) differentiated several varieties of *H. württembergicus*. The writer thinks, however, that these differences fit into the range of individual variations.

The phragmocone of *B. württembergicus* is not known; on the basis of a figure in Branco's paper (1880/81, pl. 8, fig. 5), however, it may reasonably be supposed that the protoconch was a globose vesicle 0.5 mm in diameter, while the first air chamber was 0.23 mm long. These are the dimensions most commonly encountered among Jurassic species.

The German specimens are referred by Zieten (1830, p. 33, pl. 25, fig. 3 a-b) to the genus *Actinocamax*, since the alveolus is likewise absent in this genus. That author, however, strongly doubts the correctness of his own assignment, while the German specimens have a short furrow, a circular transverse section nearly along the whole length of rostrum, and have a different time-range than the genus *Actinocamax*. More slender specimens (Zieten, l. c., pl. 25, fig. 3 c-f) are by Zieten referred to *Actinocamax lanceolatus* Hartmann. In the writer's opinion, Zieten's doubts are justifiable and the here considered specimens ought to be considered as belonging to *Hibolites württembergicus*. The absence of the alveolus is not a diagnostic character, that part may have been destroyed. The German specimens agree in their specific characters with *H. württembergicus*, while their short fissural area, as in the Polish specimens, allows to assign them all to the genus *Hibolites*.

Occurrence. — The Lower Dogger of Germany, France, England. In Poland — the Bathonian clays of Trzebionka (distr. Chrzanów) and the Tatra Mountains (Siemiradzki, 1923).

Hibolites girardoti (Loriol, 1902)
(pl. XXIII)

1902. *Belemnites (Hibolites) Girardoti* Loriol; P. de Loriol, Étude..., p. 6, pl. 1, fig. 2-7.
1920. *Hibolites Girardoti* de Loriol; E. v. Bülow-Trummer, Fossilium Catalogus, p. 141.
1922. *Hibolites Girardoti* Loriol; A. Naef, Die fossilen Tintenfische, p. 249.
1925. *Hibolites Girardoti* Loriol; M. Lissajous, Répertoire..., p. 93.

Material. — 20 rostra, proximally and distally more or less broken off; also more than 100 smaller fragments. Rostral surfaces generally smooth, sometimes only showing cracks.

Description. — *External morphology* (pl. XXIII, fig. 1-5). Rostra elongated, slender, fusiform, of moderate size. Proximally somewhat tape-

ring, in transverse section circular across the central part, but slightly depressed across the distal part. Maximum width occurs approximately at midlength of rostrum. The ventral furrow relatively short, in most specimens not exceeding 1/2 of the length of rostrum, narrow, slightly wider proximally, distally tapering and gradually more shallow. Single lateral lines run along the side walls, commonly reaching the apex. The apical part is long and pointed. The measurement table includes both maximum rostral diameters and their mutual ratios which show the so-called depression index. The dimensions are given in table 28.

Table 28
Dimensions of rostra of *Hibolites girardoti* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Compression index a : b
	d-s	d-v	
	a	b	
464	3.0	2.9	1.0
465	3.1	3.0	1.0
466	4.5	4.0	1.1
467	5.5	5.0	1.1
468	6.0	5.0	1.2
469	6.5	5.5	1.2
470	7.0	6.0	1.2
471	7.0	6.0	1.2
472	7.0	6.0	1.2
473	7.0	6.0	1.2
474	7.0	6.0	1.2
475	7.5	6.5	1.1
476	8.0	7.0	1.1
477	8.0	7.0	1.1
478	8.5	7.5	1.1
479	8.5	7.5	1.1
480	9.0	8.0	1.1
481	10.0	8.5	1.2
482	11.7	9.5	1.2
483	12.1	10.5	1.1

The depression index scarcely differs in specimens of various individual age, ranging from 1 to 1.2.

Internal morphology (pl. XXIII, fig. 6-7). In thin longitudinal sections the apical line is seen slightly nearer the ventral wall of rostrum. The growth lines in older stages are analogous in outline with the earlier. The youngest rostral element, probably the embryonic stage, is developed similarly as that in *H. hastatus*, in the form of a short spine, issuing from the distal wall of the protoconch. In thin transverse section it is possible to observe changes in the outline of rostrum from the proximal part towards the distal. In the proximal part the section is circular, in the distal it becomes slightly depressed. The maximum depression is

at midlength of the rostrum, hence the growth lines there are crowded near the ventral and dorsal walls, but more widely spaced near the lateral walls. Along the ventral furrow, especially in the proximal part, the growth lines are more incised, while along the lateral lines they are considerably less incised.

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW, No. 487):

Number of successive air chambers	Length of each air chamber (in mm)
protoconch	0.40
1— 6	0.16
7—10	0.22
11—13	0.40
14—19	0.50
20—22	1.00

The alveolus is shallow, occupying approx. 1/7 of the rostral length, the alveolar angle ranges from 20 to 24°, the most common one being 22°. The extent of the fissural area slightly exceeds the length of the ventral furrow, but later on it thins out rapidly near the ventral wall of the rostrum.

Table 29

Characteristics of the ontogeny of *Hibolites girardoti*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	3.0-4.5	2.9-4.0	Intermediate between cylindrical and fusiform, slightly expanded at midlength; ventral furrow extremely narrow, sometimes in the form of a line, attaining to 1/2 of rostrum; lateral lines faintly indicated; transverse section subcircular; apical part long, pointed.
Neanic	4.5-9.0	4.1-8.0	Distinctly fusiform; ventral furrow slightly broader, occasionally reaching behind 1/2 of the rostrum; lateral lines distinct; transverse section somewhat elliptical behind the alveolus, with longer side diameter; apical part a little thicker, pointed.
Ephebic-gerontic	9.1-12.0	8.1-10.5	Fusiform, less elongated; ventral furrow and lateral lines unchanged; depression the same or smaller than previously; apical part somewhat shorter and relatively thicker.

Ontogeny. — In the ontogeny of *H. girardoti* one may differentiate an embryonic stage, characterized by the shape completely different from the next growth stages. The ontogenetic changes affecting the rostrum may be expressed in three main growth stages: nepionic, neanic and ephebic-gerontic. The embryonic stage has the short spine form, issuing from the distal wall of the protoconch. The characteristics are given in table 29.

Variability. — Rostra of approximately the same individual age are not subject to any considerable variations, except certain oscillations in the length of the ventral furrow.

Remarks. — The Polish specimens are identical with those from Switzerland, described by Loriol (1902). Both in shape and in the shortness of the ventral furrow *H. girardoti* resembles *B. semisulcatus* Münster (Münster, 1830), differing from it in transverse section; this is circular or subcircular across the proximal part, and slightly depressed across the central and apical parts, while in *B. semisulcatus* it is circular in transverse section along the whole length of rostrum. All the diagnostic features, the shape and the range of the fissural area are characteristic of the genus *Hibolites.*

Occurrence. — The Lower Oxfordian of Switzerland. In Poland — the Upper Callovian through the Lower Oxfordian of Wrzosowa, Błeszno (distr. Częstochowa), Ogrodzieniec (distr. Zawiercie), Regulice (distr. Krzeszowice), Szklary and Radwanowice (distr. Radwanowice), and other numerous localities and quarries in the Kraków-Częstochowa Highlands.

Genus *Dicoelites* Böhm, 1906
Dicoelites meyrati (Ooster, 1857)
(fig. 24; pl. XXIV).

1857. *Belemnites Meyrati* Ooster; A. Ooster, Catalogue..., p. 18-19, pl. 3, fig. 1-17
1908. *Belemnites (Duvalia) Meyrati* Ooster; F. Roman, Révision..., p. 10-14, pl. 1, fig. 1-5.
1915. *Dicoelites Meyrati* Ooster; M. Lissajous, Quelques remarques..., p. 26-27, pl. 1, fig. 2.
1920. *Dicoelites Meyrati* Ooster sp.; E. v. Bülow-Trummer, Fossilium Catalogus, p. 134.
1922. *Dicoelites Meyrati* Ooster; A. Naef, Die fossilen Tintenfische, p. 254, 297.
1925. *Dicoelites Meyrati* Ooster; M. Lissajous, Répertoire..., p. 40, fig. 22, p. 109.

Material. — 15 nearly complete rostra and 4 smaller fragments. Preservation not very satisfactory, numerous rostra cracked and with coarse surfaces.

Description. — *External morphology* (pl. XXIV, fig. 1-2). Rostra conical, broader in the proximal part, gradually tapering towards the apex. Length varies from 19 to 64 mm. The maximum lateral diameters

are correspondingly from 4 to 11 mm, the dorso-ventral — from 4 to 13 mm. Two furrows run from the alveolar edge: the ventral extending nearly to the apex, the dorsal most commonly to just a little over the midlength of rostrum. In the vicinity of the alveolus the two furrows are connected to it by narrow fissures (pl. XXIV, fig. 3*a*, *b*). In trans-

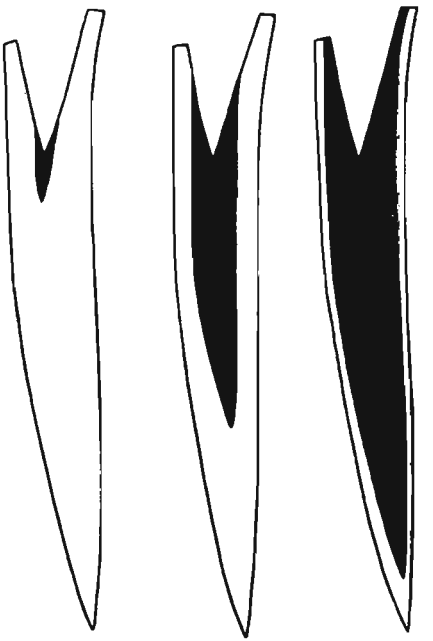

Fig. 24. — *Dicoelites meyrati* (Ooster), adult rostrum cut in the plane of symmetry, showing three growth stages.

verse section the alveolus is somewhat compressed, at first it approaches the ventral side, later its position is median. In transverse section the rostrum is somewhat compressed across the proximal part and rounded medially and distally. The apical part, measured from the end of the dorsal furrow, tapers rapidly towards the pointed apex, deviating from the axis to the dorsal side and turning slightly to the side, thus producing rostral asymmetry of varying degree. The dimensions of rostra are given in table 30.

Measurements indicate that the individual increase in length is not correlated with that in thickness and width, and the length of the apical part varies. The growth index, however, indicating the relation of that part to the lateral diameter distinctly decreases with individual age from 4.6 to 2.4. With individual growth the length of the apical part decreases in relation to that of width, so that rostra become less slender, while the growth in thickness and width increases. 53 per cent of specimens represent an intermediate stage. Both alveolar furrows

Table 30

Dimensions of rostra of *Dicoelites meyrati* (in mm)

Z. Pal. UW. No. Bj.	Diameter at end of dorsal furrow		Length of apical part	Growth index c : a
	d-s	d-v		
	a	b	c	
808	3.5	4.0	16.0	4.6
810	5.5	6.0	25.0	4.5
811	7.0	7.0	25.0	3.6
812	8.0	9.0	28.0	3.5
813	8.0	8.0	27.0	3.4
814	9.5	8.5	30.0	3.2
815	9.0	9.0	28.0	3.1
816	7.0	7.2	22.0	3.1
818	9.0	9.0	27.0	3.0
819	7.0	7.0	19.0	2.9
820	7.0	7.5	19.0	2.7
821	8.0	8.0	19.0	2.4

— the ventral and the dorsal — are very narrow, with sharp edges. The lateral lines are missing.

Internal morphology (pl. XXIV, fig. 3-4). In thin longitudinal sections the apical line is situated near the ventral side. Beneath the furrows the growth lines are rather strongly curved, somewhat more so on the ventral side. The incision of the growth lines grows shallower distally, to thin out at a small distance from the apex near the ventral side, and somewhat earlier near the dorsal side. At the alveolus the narrow slits are observable on either side of the rostrum, due to a discontinuity of the growth lines (pl. XXIV, fig. 3*a*). The ventral slit tapers considerably behind the alveolus and is discernible as a line over the whole length of rostrum, while the dorsal slit disappears behind the alveolus.

The alveoli are usually empty or filled with the sediment. In one specimen only has a part of the phragmocone with the protoconch and 16 air chambers been preserved (pl. XXIV, fig. 4). The protoconch is a globose vesicle.

Dimensions of the air chambers measured on the longitudinal section of the phragmocone (Z. Pal. UW, No. Bj. 820):

Number of successive air chambers	Length of each air chamber (in mm)
protoconch	0.50
1— 8	0.13
9—14	0.17
15—16	0.25

As compared with other species, the protoconch in *D. meyrati* seems to lean more away from the phragmocone axis to the ventral side of rostrum, while the length of the first air chambers is slightly smaller here. The alveolus is deep, attaining even in nepionic specimens 1/3 of the rostral length, and in ephebic-gerontic individuals — exactly 1/2 of it. The alveolar angle is acute, from 19 to 24° laterally and from 21 to 26° dorso-ventrally.

Ontogeny (fig. 24). — All the growth stages are characterized by similar conical shape of the rostrum. With age the orientation of rostrum to the alveolus changes. In the nepionic stage rostra occur in a prolongation of the phragmocone; beginning with the neanic stage their position gradually grows more excentric, deviating from the axis to the dorsal side. This is associated with the uneven length increase of the ventral and dorsal sides, that on the ventral being slightly more

Table 31

Characteristics of the ontogeny of *Dicoelites meyrati*

Growth stages	Maximum diameter		Growth index	Characters of rostrum
	d-s	d-v		
	mm	mm		
Nepionic	4.0- 6.0	4.0- 7.0	4.6-3.6	Conical in shape, increase in length proportional to that in thickness; ventral furrow narrow, faintly indicated, reaching nearly the apex; dorsal furrow also narrow, reaching the midlength of the rostrum; transverse section compressed; alveolus occupies 1/3 of the rostral length.
Neanic	6.1-10.0	7.1-11.0	3.5-3.0	Conical, elongated; increase in length somewhat greater ventrally; both furrows wider, with angular edges, the ventral stretching nearly to the apex, more incised, the dorsal slightly longer than before; transverse section less compressed; apex slightly curved.
Ephebic-gerontic	10.1-11.0	11.1-13.0	2.9-2.4	Shape unchanged, increase in thickness and width uniform; ventral furrow as previously, dorsal furrow slightly longer, just exceeding half of the rostral length; transverse section unchanged; apex leaning more away from the axis to the dorsal side.

rapid. In the ontogeny of rostrum three main growth stages can be distinguished; nepionic, neanic and ephebic-gerontic. Their characteristics are given in table 31.

Variability. — In specimens of about the same individual age the variability is expressed in certain differences of the thickness and width ratio to the length, and in the extent of deviation from the axis of the apical part.

Remarks. — The Polish specimens agree perfectly with the description and figures of specimens from Switzerland. They also somewhat resemble other representatives of the genus *Dicoelites* in shape and the presence of two alveolar furrows. They differ from the Swiss specimens, however, in the width and length of furrows, also in the deviation from the axis of the apical part. In the species *D. keuwensis*, *D.* cf. *keuwensis* and *Dicoelites* sp. (Boehm, 1912, p. 136-139, pl. 32) the furrows are of nearly equal length, sometimes up to 2 mm in width and more deeply incised into the rostral wall. *D. mihanus*, another of Boehm's species (1912), differs from the Polish specimens in tubular shape and greater length, resembling them in the presence of two furrows of uneven length.

The genus *Dicoelites* was by Naef (1922, p. 225, 254) referred to the subfamily Belemnopsinae. This assignment is correct, since it is confirmed by the just mentioned characters and that of the fissural area.

Occurrence. — The Callovian of the Swiss Alps, also of France, the Crimea, the Caucasus, India and Indonesia. In Poland — the Callovian of Wyszmontów, in the north-eastern margin of the Holy Cross Mountains.

Dicoelites waageni (Neumayr, 1871)
(pl. VI, fig. 5-6)

1871. *Belemnites Waageni* Neumayr; M. Neumayr, Die Cephalopodenfauna..., p. 26, pl. 9, fig. 1.
1920. *Dicoelites Waageni* Neumayr; E. v. Bülow-Trummer, Fossilium Catalogus, p. 134.

Material. — Two rostra, one with preserved proximal part, the other with the apical. Rostral surfaces cracked and coarse.

Description. — *External morphology* (pl. VI, fig. 5, 6). Rostra conical, very gradually tapering distally. A long furrow with angular edges stretches on the ventral side, most likely reaching the apex. A slightly narrower furrow runs dorsally, its length exceeding 1/2 of rostrum. Rostra are slightly depressed over the whole length. The apex is elongated, weakly pointed. The dimensions of rostra are given in table 32.

Table 32

Dimensions of rostra of *Dicoelites waageni* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Minimum diameter	
	d-s	d-v	d-s	d-v
806	11.2	12.4	8.5	8.5
807	8.0	8.7	5.0	5.3

Remarks. — *D. waageni* resembles *D. meyrati* in conical shape and the presence of two alveolar furrows, but differs in symmetry of rostrum, less pointed apical part and lack of deviation of the apex from the axis. This species could not be more thoroughly studied owing to lack of adequate material.

Occurrence. — The Lower Callovian of the vicinity of Balin in Poland (distr. Chrzanów).

Subfamily **Duvaliinae** Pavlov, 1914

Genus *Duvalia* Bayle, 1878

Duvalia disputabilis (Neumayr, 1871)

(fig. 25; pl. XXV)

1871. *Belemnites disputabilis* Neumayr; M. Neumayr, Die Cephalopodenfauna..., p. 26, pl. 9, fig. 2 a-d.
1920. *Hibolites disputabilis* Neumayr sp.; E. v. Bülow-Trummer, Fossilium Catalogus, p. 139.
1925. *Duvalia disputabilis* Neumayr; M. Lissajous, Répertoire..., p. 30, 81.
1953. *Belemnites disputabilis* Neumayr; S. Z. Różycki, Górny dogger..., p. 326.

Material. — 28 rostra, with the proximal part more or less broken off, all lacking the alveolar part and phragmocone. State of preservation satisfactory. Some rostra display characteristic weathering, owing to which the oldest central part protrudes to the outside more than the peripherical.

Description. — *External morphology* (pl. XXV, fig. 1-5). Rostra more or less cylindrical. Apex usually blunt, rounded, occasionally swollen or mucronate, sometimes weakly pointed, especially so in younger specimens. Length of rostra rather small, ranging from 14 to 38 mm, at the maximum width of rostrum the lateral diameters are from 2 to 7.5 mm, the dorso-ventral — from 2.2 to 9.0 mm. The proximal and

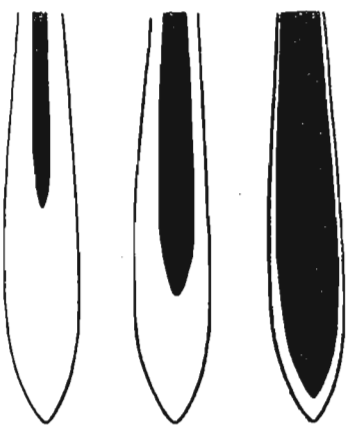

Fig. 25. — *Duvalia disputabilis* (Neumayr), adult rostrum cut through the plane of symmetry, showing three growth stages.

distal thickness and width do not differ much. There are no visible furrows starting at the alveolar edge, owing perhaps to the breaking off of the alveolar part. The rostra are more or less compressed along their whole length. The lateral walls are usually broader than the dorsal and ventral. Distinct, frequently double lateral lines run along the side walls, being medially placed, except in asymmetric specimens, where they deviate in the same direction as the apex. These lines are occasionally united to form a broad depression. The dimensions of rostra are given in table 33.

The growth index has not been calculated owing to lack of criterion for the delimitation of the apical part. Other measurements indicate, however, that we are not dealing here with close correlation of the increase in thickness and that in width, usually the thickness being greater.

Internal morphology (pl. XXV, fig. 6-7). In transverse section the growth lines run symmetrically to the apical line and parallel to each other. In the oldest stages the growth lines are of identical shape with those of the earlier stages. Beginning with the first stages, the growth in length is rapid as compared with the small increase in thickness. On the lateral sides the growth lines are more dense, while on the ventral and dorsal sides — rather widely spaced. The transverse section across the central part of rostrum is usually circular, dorso-ventrally elongating towards the outside. Specimens in the oldest growth stage are often pyriform in transverse section, with one wall broader than the other. On an analogy with other representatives of the subfamily

Table 33

Dimensions of rostra of *Duvalia disputabilis* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Z. Pal. UW. No. Bj.	Maximum diameter	
	d-s	d-v		d-s	d-v
	mm	mm		mm	mm
766	2.0	2.2	780	4.0	4.0
767	2.1	3.1	781	4.0	4.9
768	2.1	3.5	782	4.0	4.5
769	2.4	3.0	783	4.2	4.8
770	3.0	3.1	784	4.0	5.0
771	2.5	3.0	785	5.0	5.0
772	3.0	3.5	786	4.1	5.0
773	3.0	3.1	787	4.7	5.1
774	3.0	3.1	788	4.1	4.2
775	3.4	4.1	789	5.1	6.1
776	3.0	3.3	790	5.1	5.6
777	3.0	3.8	791	5.2	6.0
778	3.1	4.0	792	6.0	7.0
779	3.9	4.2	793	7.5	9.0

Duvaliinae it may be supposed that in this case, too, the narrower side is the dorsal, the broader one — the ventral (pl. XXV, fig. 6). Some thin transverse sections display a certain disturbance of the uniformity of the growth process, expressed by the presence in the central part of several light coloured crystals. In outline this structure is rosette-like, with indented edges. Extremely delicate, but strongly corrugated growth lines stretch concentrically from near the centre towards the outside. The last four are much more distinct, light-coloured, but also corrugated. The corrugation decreases in the direction of the outer lines. The next lines are densely spaced to form a fairly thick light-coloured ring. Thereafter the growth lines display a normal course, ovate in outline, and more widely spaced between the successive ventral and dorsal lines (pl. XXV, fig. 7).

Ontogeny (fig. 25). — Ontogenetic changes affecting the rostral structure are expressed both in shape, outline of transverse section and the development of the apical part. On these characters, the nepionic, neanic and ephebic-gerontic stages can be distinguished. Their characteristics are given in table 34.

Lateral lines distinct and strongly incised throughout all the stages, occasionally deviating to the ventral side. Phragmocone unknown.

Table 34

Characteristics of the ontogeny of *Duvalia disputabilis*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	2.0-4.0	2.2-4.2	Strongly elongated, increase in thickness and width small; transverse section subcircular or ovate, with longer dorso-ventral diameter; apex weakly pointed, occasionally rounded, mucronate.
Neanic	4.1-6.0	4.3-6.2	Less elongated, though the increase in length still exceeds that in thickness and width; transverse section ovate, with longer dorso-ventral diameter, sometimes pyriform with broader ventral wall; apex swollen, occasionally asymmetric, mucronate.
Ephebic-gerontic	6.1-7.5	6.3-9.0	Strongly swollen; transverse section subcircular, sometimes subquadrate; apex more strongly swollen than before, occasionally weakly pointed, commonly mucronate.

Variability. — *D. disputabilis* is subject to strong variations expressed foremost in considerable oscillations in the degree of depression. and changes in transverse section. Young specimens are those most affected by variations. Some of them are subcircular in transverse section, other ovate, or strongly compressed. The distal part and the apex are likewise subject to strong variations. This part may be either more or less slender or swollen, the apex weakly pointed, rounded or swollen. The mucro occurs throughout the ontogeny, but it may be either like a spine or like a wart. These variations, however, are not associated with any particular individual age.

Remarks. — This species has been described by Neumayr (1871) from Paczołtowice (distr. Krzeszowice) from the so-called Balin oolithic horizon. Specimens described in that paper, collected from Regulice and from the vicinity of Ogrodzieniec, agree perfectly with those described by Neumayr. Outside Poland, this species has not been reported.

Occurrence. — The Bathonian and Lower Callovian in the vicinity of Ogrodzieniec (distr. Zawiercie), Paczołtowice, Regulice (distr. Krzeszowice) and Balin (distr. Chrzanów) in Poland.

Genus *Rhopaloteuthis* Lissajous, 1915

Rhopaloteuthis majeri (Alth, 1875)

1875. *Belemnites Majeri* Alth; A. Alth, Rzecz o belemnitach..., p. 236, pl. 4, fig. 6.
1925. *Rhopaloteuthis Majeri* Alth; M. Lissajous, Répertoire..., p. 108.
1953. *Belemnites (Rhopaloteuthis) majeri* Alth; S. Z. Różycki, Górny dogger..., p. 326.
1957. *Rhopaloteuthis* majeri Zeuschner; H. Pugaczewska, O dwóch gatunkach... p. 387-389, pl. 1-3, 5, text-fig. 2.

Description. — Rostra obliquely club-like, of rather small dimensions. Dorsal furrow broad, occasionally slit-like, attaining 3/4 of the rostral length. Lateral lines distinct, somewhat curved, similarly as the rostrum. Transverse section quadrate across the alveolus, distally passes to rounded. Apical part elongated in younger specimens, with age growing rounded and thicker. A more or less distinct mucro occurs throughout the ontogeny. The alveolus is deep even in the youngest specimens, attaining half the length of rostrum; grows deeper with age and in the oldest specimens it is 2/3 of the length of rostrum. The alveolar angle ranges from 26 to 32°. Behind the dorsal furrow the rostrum becomes swollen, both laterally and dorso-ventrally. The maximum lateral diameter occurs at 1/4 of distance from the apex. The youngest growth stages differ conspicuously from the following. The nepionic rostra are short, pointed. With growth the rostrum becomes strongly elongated and thickened, the apex is rounded, the dorsal furrow expands and elongates, the growth index decreases.

Occurrence. — Recorded only in Poland from the Lower Oxfordian in the vicinity of Ogrodzieniec (distr. Zawiercie), Balin (distr. Chrzanów), Racławice, Paczołtowice, Regulice (distr. Krzeszowice).

Rhopaloteuthis bzoviensis (Zeuschner, 1869)

1869. *Belemnites bzoviensis* Zeuschner; L. Zeuschner, Über Belemnites..., p. 565, pl. 13, fig. 1 a-e, 3 a-e, 4 a-b.
1875. *Belemnites bzoviensis* Zeuschner; A. Alth, Rzecz o belemnitach..., p. 235, pl. 4, fig. 4,5.
1895. *Belemnites bzoviensis* Zeuschner; E. Gallinek, Der obere Jura..., p. 412-414.
1908. *Belemnites bzoviensis* Zeuschner; J. Lewiński, Les dépôts..., p. 414, pl. 22, fig. 5, 6.
1925. *Rhopaloteuthis bzoviensis* Zeuschner; M. Lissajous, Répertoire..., p. 65.
1927. *Rhopaloteuthis bzoviensis* Zeuschner; M. Lissajous, Description..., p. 36, pl. 4 a-b, fig. 5-7.
1953. *Belemnites (Rhopaloteuthis) bzoviensis* Zeuschner; S. Z. Różycki, Górny dogger..., p. 326.
1957. *Rhopaloteuthis bzoviensis* Zeuschner; H. Pugaczewska, O dwóch gatunkach..., p. 391-397, pl. 4, 5, fig. 2; text-fig. 3-5.

Description. — Rostra obliquely club-like, small. Dorsal furrow short and narrow, sometimes slit-like and longer, stretching to midlength of the rostrum. Lateral lines single, occasionally double, curved similarly as the rostrum. Transverse section ovate or quadrate, broader ventrally. The youngest stages are characterized by the circular section, greater increase in length, as compared to small increase in width, also by smaller compression. The asymmetry of the apical part and its swelling increase with growth, the transverse section becomes ovate with longer dorso-ventral diameter, later to pass to a pyriform shape with expanded ventral wall. Mucro present throughout all the stages. The alveolus relatively shallow, occupying approx. 1/6 of the length of rostrum, with an average angle of 30°. The growth index decreases with individual age.

Occurrence. — The Lower Oxfordian of France. In Poland — the same horizon, at Bzów, Ogrodzieniec, Rodaki (distr. Zawiercie), Balin, Czatkowice, Racławice, Regulice, Grójec, Zalesie and Parcze Górne (distr. Chrzanów and Krzeszowice).

Rhopaloteuthis argovianus (Mayer, 1863)

(pl. VI, fig. 1-3)

1846-49. *Belemnites hastatus impressae* Quenstedt; F. A. Quenstedt, Petrefactenkunde..., p. 447, pl. 29, fig. 36-37; non fig. 38, 39.
1877. *Belemnites argovianus* Mayer; E. Favre, La zone..., p. 11, pl. 1, fig. 7-8.
1902. *Belemnites (Hibolites) argovianus* Mayer; P. de Loriol, Étude..., p. 10, pl. 1, fig. 16-17.

1920. *Hibolites argovianus* Mayer; E. v. Bülow-Trummer, Fossilium Catalogus, p. 135.

1925. *Rhopaloteuthis argovianus* Mayer; M. Lissajous, Répertoire..., p. 55-56.

Material. — Three nearly complete rostra of various individual age, well preserved, with smooth surfaces.

Description. — *External morphology.* Rostra of small dimensions, obliquely club-like, slightly compressed, proximally somewhat tapering and very gradually widening out as far as 1/5 of distance from the apex, thereafter rapidly tapering again. The apical part short, pointed, slightly mucronate, more or less asymmetrical, deviated to the dorsal side. Side walls broader, with median lateral lines. These are single, deeply incised, but sometimes hardly discernible, stretching to 1/2 or 2/3 of the rostral length. Dorsal furrow narrow, with angular edges, exceeding one half of the rostral length. The dimensions of rostra are given in table 35.

Table 35

Dimensions of rostra of *Rhopaloteuthis argovianus* (in mm)

Z. Pal. UW. No. Bj.	Length of rostrum	Maximum diameter		Minimum diameter	
		d-s	d-v	d-s	d-v
543	27.6	4.0	4.4	3.1	3.5
544	28.3	4.1	4.5	3.2	3.3
545	33.0	5.7	6.0	5.4	5.7

Since the rostra are proximally crushed, it was not possible to measure the angle and depth of the alveolus.

Remarks. — The Polish specimens come closest to those from Germany (Quenstedt, 1846-49, pl. 29, fig. 36-37) in shape, size and character of the dorsal furrow. They also resemble the Swiss specimens (Loriol, 1902, pl. 1, fig. 16-17), though they differ in a more distinctly mucronate apex. The majority of authors believe the furrow to be ventral; only Lissajous (1925) postulates that it is dorsal. The writer thinks the latter view to be the correct one, since both the slightly asymmetric, obliquely club-like shape of rostrum and the mucronate apex reasonably refer the here considered species to the genus *Rhopaloteuthis* whose representatives are, among others, characterized by the dorsal position of the furrow.

Occurrence. — The Lower Oxfordian of Germany, France, Switzerland and Poland (Wola Morawicka near Kielce).

Rhopaloteuthis sauvanausus (d'Orbigny, 1842)

(pl. VI, fig. 7-9)

1842. *Belemnites sauvanausus* d'Orbigny; A. d'Orbigny, Paléontologie..., p. 128-130, pl. 21, fig. 1-10.

1857. *Belemnites Sauvanausus* d'Orbigny; W. A. Ooster, Catalogue..., p. 17.

1871. *Belemnites Sauvanausus* d'Orbigny; E. Dumortier, Sur quelques gisements..., p. 22.
1900. *Hibolites Sauvanaui* d'Orbigny; P. de Loriol, Étude..., p. 6, pl. 2, fig. 2.
1902. *Hibolites Sauvanaui* d'Orbigny; P. de Loriol, *Ibid.*, p. 9, pl. 1, fig. 12.
1920. *Hibolites Sauvanausus* d'Orbigny; E. v. Bülow-Trummer, Fossilium Catalogus, p. 151.
1922. *Hibolites Sauvanaui* d'Orbigny; A. Naef, Die fossilen Tintenfische, p. 259.
1925. *Rhopaloteuthis sauvanausus* d'Orbigny; M. Lissajous, Répertoire..., p. 41-43, p. 131, text-fig. 23.
1953. *Belemnites (Rhopaloteuthis) sauvanausus* d'Orbigny; S. Z. Różycki, Górny dogger..., p. 326.

Material. — Three nearly complete rostra with the alveolus, one specimen with the phragmocone. Preservation fairly good, surfaces bearing signs of weathering.

Description. — *External morphology.* Rostra of fairly small dimensions, obliquely club-like, proximally tapering, distally widening out to 1/3 of distance from the apex. Apical part relatively short, slightly leaning away from the axis to the dorsal side, somewhat rounded or pointed, occasionally mucronate. Dorsal furrow rather deeply incised, slit-like, stretching to approx. 1/3-1/4 of distance from the apex. Lateral lines more or less distinct, mostly stretching to maximum width of rostrum. Transverse section circular or subcircular. The alveolus occupies about 1/3 of the rostral length, the alveolar angle being about 20°. The dimensions of rostra are given in table 36.

Table 36
Dimensions of rostra of *Rhopaloteuthis sauvanausus* (in mm)

Z. Pal. UW. No. Bj.	Length of rostrum	Maximum diameter		Length of apical part	Growth index c : a
		d-s	d-v		
		a	b	c	
573	35.5	7.0	6.4	14.3	2.0
574	43.5	7.3	7.0	18.0	2.4
575	50.0	9.4	7.0	19.0	2.0

Remarks. — The Polish specimens are identical with those from France, described and figured by d'Orbigny (1842).

Occurrence. — The Lower Oxfordian of Germany, France, Switzerland, Portugal, Algiers, India, Madagascar. In Poland — the Upper Callovian of Wyszmontów (distr. Opatów), Regulice (distr. Krzeszowice) and Lower Oxfordian of Parcze Górne, Parcze Dolne, Sikorka, Jaroszowice (distr. Olkusz).

Rhopaloteuthis spissus (Gillieron, 1873)
(pl. IV, fig. 6-7)

1902. *Belemnites (Hibolites) spissus* Gillieron; P. de Loriol, Étude..., p. 11, pl. 1, fig. 14-15.

1920. *Hibolites (?) spissus* Gillieron; E. v. Bülow-Trummer, Fossilium Catalogus, p. 153.
1925. *Rhopaloteuthis spissus* Gillieron; M. Lissajous. Répertoire..., p. 41-42, 138.

Material. — Two rostra with the alveolar part broken off. Preservation satisfactory, the surface not damaged, slightly weathered, with traces of sessile organisms.

Description. — *External morphology.* Rostra club-like, showing slight asymmetry of the apical part and slight compression which somewhat increases proximally. Near the alveolus the rostrum tapers, then widens out distally to 1/3 of distance from the apex. Lateral walls broader, the dorsal and ventral walls narrower. Lateral lines broad, stretching to maximum width of rostrum or to the apex. Dorsal furrow narrow, in one specimen relatively short, in the other one stretching to 1/2 of the rostrum. Apex rounded, slightly deviated from the axis to the dorsal side, occasionally mucronate. The alveolus occupies approx. 1/4 length of the rostrum, the alveolar angle is about 20°. The dimensions of rostra are given in table 37.

Table 37
Dimensions of rostra of *Rhopaloteuthis spissus* (in mm)

Z. Pal. UW. No. Bj.	Length of rostrum	Maximum diameter		Minimum diameter	
		d-s	d-v	d-s	d-v
541	50.0	12.5	14.0	8.5	10.0
542	30.0	8.0	10.0	5.5	6.5

Remarks. — This species somewhat resembles *Rh. bzoviensis*, also *Rh. sauvanausus*, but differs from them in greater dimensions, rounded apex, narrower and longer dorsal furrow.

Occurrence. — The Lower Oxfordian of Switzerland. In Poland — the same horizon of Balin (distr. Chrzanów).

Rhopaloteuthis gillieroni (Mayer, 1866)
(fig. 26; pl. XXVI)

1866. *Belemnites Gillieroni* Mayer; M. Ch. Mayer, Diagnoses..., p. 365.
1888. *Belemnites (Hibolites) peregrinus* Schlippe; O. Schlippe, Die Fauna..., p. 194, pl. 5, fig. 4 a-c.
1921. *Rhopaloteuthis Gillieroni* Mayer; A. Riche & F. Roman, La Montagne..., p. 168.
1923. *Rhopaloteuthis Gillieroni* Mayer; M. Lissajous, Étude..., p. 47, pl. 1, fig. 9, 9a. fig. 9, 9a.
1924. *Rhopaloteuthis Gillieroni* Mayer; F. Roman, Études..., p. 41.
1925. *Rhopaloteuthis Gillieroni* Mayer; M. Lissajous, Répertoire..., p. 92.
1927. *Rhopaloteuthis Gillieroni* Mayer; M. Lissajous, Description..., p. 38, pl. 4, fig. 8-11.
1953. *Belemnites gillieroni* Mayer; S. Z. Różycki, Górny dogger..., p. 326.

Material. — 30 rostra with the alveolar part broken off, also numerous fragments. Preservation not very good, the surface of rostra coarse and cracked.

Description. — *External morphology* (pl. XXVI, fig. 1-5). Rostra of moderate size, irregularly, slantingly club-like in shape. Rostral length ranging from 19.5 to 35 mm, the lateral diameters measured at the end

Fig. 26. — *Rhopaloteuthis gillieroni* (Mayer), adult rostrum cut through the plane of symmetry, showing three growth stages.

of the dorsal furrow are 3.5 to 10 mm long. Proximally the rostra taper slightly, distally they gradually widen out to 1/3-1/4 of distance from the apex. The dorsal furrow short, proximally deep, shallowing towards the apex. Its length does not exceed 1/4 that of the rostrum. Lateral lines of varying length run along the side walls, stretching to the maximum width of the rostrum. Transverse section is quadrate across the proximal part, medially ovate, with longer lateral diameter, across the distal part ovate or circular. Ventral wall often depressed, the dorsal rounded. The apical part tapers rapidly to form a pointed apex which is often asymmetric, deviated to the dorsal side, sometimes rounded, with a mucro. Young rostra are slender, elongate, the older ones thicker and asymmetric. The table of measurements covers the rostra with a dorsal furrow which is indispensable in calculating the growth index. The dimensions of rostra are given in table 38.

The distance between the end of the furrow and the apex, as well as the dimensions of both diameters increase with individual age. The growth index decreases with age from 4 to 2.3.

Internal morphology (pl. XXVI, fig. 6-7). Minute growth lines, more distinct at certain spaces, are seen in thin longitudinal and transverse

Table 38

Dimensions of rostra of *Rhopaloteuthis gillieroni* (in mm)

Z. Pal. UW. No. Bj.	Diameter at end of furrow		Distance from end of furrow to the apex	Growth index c : a
	d-s	d-v		
	a	b	c	
546	4.8	5.0	19.0	4.0
547	5.0	5.5	20.2	4.0
548	5.6	5.0	17.0	3.0
549	6.2	7.0	17.5	2.1
550	6.8	6.8	24.2	3.0
551	7.0	7.0	15.2	2.1
552	7.0	7.0	21.0	3.0
553	7.8	7.5	17.0	2.1
554	8.0	8.0	18.5	2.3
555	8.2	8.0	28.0	3.4
556	8.2	8.2	21.0	2.5
557	8.5	8.8	26.2	3.1
558	8.6	8.0	25.0	2.9
559	8.8	8.2	22.0	2.5
560	9.8	8.6	23.0	2.3

Table 39

Characteristics of the ontogeny of *Rhopaloteuthis gillieroni*

Growth stages	Diameter of rostrum at end of furrow		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	3.5-6.5	4.5-6.8	Strongly elongated, conical, pointed; dorsal furrow narrow, short, deep; lateral lines as broad depressions; transverse section circular.
Neanic	6.6-7.5	6.9-7.5	Less elongated, somewhat thicker; dorsal furrow as in previous stage; lateral lines narrower, deeper; transverse section laterally expanded, with ventral wall somewhat depressed; apical part short with asymmetric apex, deviated to the dorsal side.
Ephebic-gerontic	7.6-10.0	7.6-9.0	Strongly thickened; increase in thickness and width greater than that in length; transverse section, lateral lines and dorsal furrow unchanged; apical part short, thick, rounded, often mucronate.

sections. Proximally the apical line is medially placed, distally it deviates towards the dorsal side. Changes in the shape of the various parts of rostrum may be observed in the transverse sections. Across the proximal part the section is quadrate in outline, with rounded corners, distally it becomes laterally elongated, the dorsal wall being gently convex, the ventral depressed. The distal part is ovate or subcircular in the transverse section. Beneath the dorsal furrow the growth lines are distinctly incised. Distally this incision disappears. Beneath the lateral lines the growth lines are slightly corrugated.

Ontogeny (fig. 26). — The youngest growth stages differ from the older in different shape, increase of thickness and width in comparison with length, and character of the apical part. Three growth stages — nepionic, neanic and ephebic-gerontic — may be distinguished. Their characteristics are given in table 39.

Variability. — Rostra of this species, of approximately the same individual age, are subject to distinct variations, expressed in certain oscillations of dimensions of the lateral and dorso-ventral diameters in relation to length, by a different outline of the transverse section, and by the apex being either pointed or rounded. Some rostra do not show any depression of the ventral wall; the apex may be perfectly circular or slightly pointed.

Remarks. — The Polish specimens agree with those described by Mayer (1886). The specimens at Mayer's disposal were from the Callovian of Switzerland. Roman (Riche & Roman, 1921, p. 168; 1924, p. 41) characterizes this species as being subject to strong variations; in his opinion, the more elongate and slender specimens are more strongly depressed and, vice versa, the shorter, thicker ones, do not display strong depression. Mayer (1866) regarded the furrow to be ventral, the present writer agrees, however, with Roman *(l. c.)* that the furrow is placed dorsally.

Occurrence. — The Bathonian and Callovian of Germany, France, Switzerland. In Poland — the Bathonian of Trzebionka (distr. Chrzanów) and the Lower Callovian of Ogrodzieniec (distr. Zawiercie).

Genus *Pseudobelus* Blainville, 1827

Pseudobelus coquandus (d'Orbigny, 1842)

(pl. IV, fig. 1-5)

1842. *Belemnites Coquandus* d'Orbigny; A. d'Orbigny, Paléontologie..., p. 130, pl. 21, fig. 11-18.

1871. *Belemnites Coquandus* d'Orbigny; E. Dumortier, Sur quelques gisements..., p. 23, pl. 2, fig. 25, 26, non fig. 21-24.

1920. *Hibolites coquandus* d'Orbigny; E. v. Bülow-Trummer, Fossilium Catalogus, p. 138.

1922. *Pseudobelus Coquandus* d'Orbigny; A. Naef, Die fossilen Tintenfische, p. 258.
1925. *Pseudobelus Coquandus* d'Orbigny; M. Lissajous, Répertoire..., p. 75.
1953. *Pseudobelus coquandi* d'Orbigny; S. Z. Różycki, Górny dogger..., p. 325.

Material. — 16 rostra with considerable proximal parts broken off; also several smaller fragments; phragmocones unknown.

Description. — *External morphology* (pl. IV, fig 1-3). Rostra of rather small size, club-like or obliquely club-like in shape. Some of them more or less expanded at 1/5 distance from the apex, proximally tapering, most frequently rather strongly compressed. Rostrum walls smooth, rounded or with rounded edges. Dorsal wall narrower, the ventral expanded. Distinct double lateral lines run along the side walls, stretching nearly to the apex, or disappearing at maximum rostral width. These lines are somewhat nearer to the dorsal side, distally they curve in the dorsal direction following the outline of the rostrum. Transverse section ovate, with longer dorso-ventral diameter, subquadrate or pyriform with broader ventral wall. Apical part more or less short, asymmetric, deviating from the rostral axis towards the dorsal side. The apex provided with a mucro, sometimes as an elongated spine, or as a wart. No dorsal or ventral furrows. The dimensions of rostra are given in table 40.

Table 40
Dimensions of rostra of *Pseudobelus coquandus* (in mm)

Z. Pal. UW. No. Bj.	Maximum diameter		Compression index b : a
	d-s	d-v	
	a	b	
747	2.6	2.8	1.1
748	2.0	2.2	1.1
749	2.0	2.2	1.1
750	3.0	4.0	1.3
751	3.0	4.2	1.4
752	3.6	4.6	1.3
753	4.0	4.5	1.1
754	3.7	4.5	1.2
755	3.5	4.8	1.2
756	3.5	4.5	1.3
757	4.0	5.0	1.2
758	3.8	5.0	1.3
759	3.5	5.0	1.3
760	4.1	5.4	1.3
761	4.2	5.8	1.3
762	6.5	7.5	1.2

The compression index, illustrating the greater dorsal diameter ratio to the smaller ventral diameter ratio, increases with age, hence the older

specimens are more depressed than the younger. Certain deviations in the correlation of compression with individual age are due to individual variations.

Internal morphology (pl. IV, fig. 4-5). Numerous minute growth lines, more distinct in certain spaces, are observable in thin longitudinal and transverse sections. The apical line is thick, conspicuous, situated in the rostral axis. Medially the growth lines are parallel and symmetrical in relation to the apical line. The more outer growth lines have an asymmetric course, the ventral differing from the dorsal. This asymmetry which is most distinct in the distal part of rostrum, has most likely been caused by the differences in rate of growth between the ventral and dorsal parts. On the ventral side the growth layers are more strongly curved exteriorly, resulting in a slight deviation of the apex into an opposite direction. The curves of the growth layers, observable in transverse sections beneath the course of the lateral lines, are stronger in the outer parts of the rostrum. On the lateral sides these layers are densely arranged, while ventrally and dorsally they are widely spaced.

Table 41

Characteristics of the ontogeny of *Pseudobelus coquandus*

Growth stages	Maximum diameter		Characters of rostrum
	d-s	d-v	
	mm	mm	
Nepionic	2.0-3.5	2.2-4.5	Elongated, slender, maximum width at midlength or just behind it; lateral lines median in the proximal part, but behind the maximum width curving in the dorsal direction similary as the rostrum; transverse section circular or ovate, with longer dorso-ventral diameter; apical part more or less elongated, provided with an elongated mucro.
Neanic	3.6-4.5	4.6-5.5	Less slender, thicker; lateral lines more strongly incised; transverse section ovate or pyriform, with broader ventral wall, along the course of the lateral lines strongly constricted; apical part relatively shorter, thicker, apex often bearing a mucronate wart.
Ephebic-gerontic	4.6-6.5	5.6-7.5	Short, thick, with stronger asymmetry of the apex; lateral lines somewhat less incised; transverse section subquadrate with faintly indicated incisions at the lateral lines; the apical part short, bearing a small mucronate wart.

The outline of the transverse section is not uniform over the whole of the rostral length; across the proximal part it may be ovate, pyriform or circular, medially subquadrate, distally most commonly either ovate or circular.

Ontogeny. — Rostral shape, transverse section and the apical part change in the ontogeny. On these changes three main growth stages may be distinguished: nepionic, neanic and ephebic-gerontic. Their characteristics are given in table 41.

Variability. — In specimens of *Pseudobelus coquandus* (d'Orbigny) of approximately the same individual age, certain variations affect the apical part which may either be elongated and more slender or shorter and thicker, provided with a mucro in the form of a spine or of a wart.

Remarks. — The Polish specimens agree with the description and figures of forms from France (d'Orbigny, 1842, p. 130, pl. 21, fig. 11-18). All the younger authors agree in the assignment of this species to the genus *Pseudobelus*. The present writer thinks that it may reasonably be referred to the subfamily Duvaliinae on such specific characters as rostral asymmetry, the varying shape of transverse section (ovate or irregularly pyriform and quadrate), the presence of mucro, and the deviation of the apex from the axis.

Occurrence. — The Callovian and Oxfordian of Germany, France, Switzerland, Algeria. In Poland — the Callovian and Lower Oxfordian of the vicinity of Ogrodzieniec (distr. Zawiercie), Regulice, Racławice (distr. Krzeszowice) and Balin (distr. Chrzanów).

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HALINA PUGACZEWSKA

BELEMNITY Z JURY POLSKI

Streszczenie

WSTĘP

W pracy niniejszej zostały przeprowadzone badania nad belemnitami ze środkowej i górnej jury pasma krakowsko-częstochowskiego oraz płn.-wschodniego obrzeżenia Gór Świętokrzyskich. Materiał do badań został zebrany przez autorkę w latach 1954-58, a także wykorzystano zbiory Dra E. Panowa.

Zgromadzony materiał obejmuje dziesiątki tysięcy okazów, lecz jest mało zróżnicowany pod względem gatunkowym. Najbogatsze zbiory pochodzą ze środkowego i górnego keloweju i z niższych poziomów oksfordu jury krakowsko-częstochowskiej.

Dotychczasowe dane o belemnitach z jury Polski są bardzo ograniczone. Pierwsze opisy znajdują się w pracy Altha (1875), Puscha (1830-37), Bronna (1851-52), Zeuschnera (1859, 1864, 1869), Neumayra (1871, 1873). Różycki (1953) daje listę 18 gatunków z jury krakowsko-częstochowskiej.

Autorka opisała 29 gatunków, należących do 12 rodzajów i 4 podrodzin, w tym 1 gatunek nowy — *Belemnopsis semiarcuatus* n. sp.

CHARAKTERYSTYKA UTWORÓW JURAJSKICH PASMA KRAKOWSKO-CZĘSTOCHOWSKIEGO I PŁN.-WSCHODNIEGO OBRZEŻENIA GÓR ŚWIĘTOKRZYSKICH

W jurze krakowsko-częstochowskiej można wyróżnić, według Różyckiego (1953), dwa regiony: 1) północny, o wyrównanym urzeźbieniu podłoża i pewnej stałości typu petrograficznego osadów, oraz 2) południowy, o bardziej urozmaiconym urzeźbieniu, nie wykazującym stałości typu petrograficznego.

W regionie północnym baton jest reprezentowany przez ciemnoszare iły ze sferosyderytami, oraz brunatne, piaszczyste gliny z oolitami. *Kelowej* reprezentują wapienie brunatne, margle glaukonitowe; w górnych poziomach keloweju występuje warstwa bulasta, a nad nią — stromatolitowa. *Dywez* charakteryzują margle i wapienie margliste; niekiedy dywezu brak i występuje luka stratygraficzna. Górny poziom *newizu* stanowią wapienie margliste okruchowe, przykryte wapieniami płytowymi, które dominują w *argowie*.

W regionie południowym częste są ślady rozmycia, luki stratygraficzne, brak warstwy bulastej i stromatolitowej, a nawet oolitu. Częste są tu natomiast iły rudonośne, a także w różnych poziomach osady detrytyczne. Margle różowe i szaro-oliwkowe pojawiają się w *górnym dywezie*, a nad nimi znana z Ogrodzieńca

(pow. zawierciański) warstwa stromatolitowa, wyjątkowo tu reprezentowana. *Newiz* charakteryzują osady marglisto-łupkowe, leżące na przemian ze scyfiowymi. Wapienie płytowe i w tym regionie należą do *argowu* (fig. 1, 2).

Na *płn.-wschodnim* obrzeżeniu Gór Świętokrzyskich osady jurajskie są odmienne od osadów w pasmie krakowsko-częstochowskim. W *bajosie* tworzą się osady ilasto-łupkowe, czarne, pirytowe, świadczące o niegłębokim i źle przewietrzanym morzu (Pożaryski, 1953). W keloweju następuje zmiana osadu z terrygenicznego na zoogeniczny i chemiczny. Fauna składa się głównie z głowonogów, ramienionogów, małżów i szkarłupni. Częste są osady piasków białych, żółtych, żelazistych, niekiedy z wkładkami spongiolitów, a także wapienie piaszczyste i krynoidowe. Osady te odpowiadają morzu otwartemu. Wyższe poziomy jurajskie charakteryzuje facja scyfiowo-krzemienista, wyżej zaś — oolitowa. W *oksfordzie*, obok poziomu kordatowego, wykształconego w postaci wapieni marglistych, pojawiają się utwory rafowe składające się głównie z gąbek. W *rauraku* panuje facja rafowa z koralami i stromatoporami. Częste są wapienie poprzerastane krzemieniami. *Astart* reprezentują wapienie drobnopylaste i facja oolitowa. W *kimerydzie* wzrasta dolomityzacja osadów, w górnych poziomach zanikają oolity, częste są margle ilaste z ławicami ostryg i terebratul. Najwyższych poziomów jury brak (fig. 3).

MATERIAŁ

Z batońskich iłów rudonośnych zebrano ponad 500 okazów *Megateuthis giganteus* (Schlotheim) w Kamienicy Polskiej, ponad 200 okazów *Hibolites beyrichi* (Oppel) w Łęczycy, 50 okazów *Hibolites württembergicus* (Oppel) w Trzebionce, oraz po kilka do kilkudziesięciu okazów *Belemnopsis fusiformis* (Parkinson), *B. subhastatus* (Zieten), *B. latesulcatus* (d'Orbigny), *B. parallelus parallelus* (Phillips), *Rhopaloteuthis gillieroni* (Mayer), *Gastrobelus ventroplanus* (Voltz), *Brachybelus breviformis* (Voltz), *Rhabdobelus exilis* (d'Orbigny) i *Rh. parvus* (Hartmann). Belemnitom towarzyszą wszędzie amonity, brachiopody, ślimaki, małże oraz w małych ilościach jeżowce i człony liliowców.

Najwięcej materiału zebrano z keloweju, gdyż około 10 tysięcy okazów. Przeważają takie gatunki, jak *Hibolites hastatus* (Blainville), *Belemnopsis latesulcatus, B. subhastatus, B. canaliculatus* (Schlotheim) oraz rzadziej spotykane, jak *B. parallelus germanicus* (Roemer), (ok. 30 okazów), czy *Hastites privatensis* (Mayer), (10 okazów). W górnym keloweju występują *Hibolites girardoti* (Loriol) i *Belemnopsis semiarcuatus* n. sp. Najlepiej zachowane rostra pochodzą z iłów ornatowych Regulic i z warstw glaukonitowych okolic Ogrodzieńca. Kamieniołom we Wrzosowej, przepełniony fauną głowonogów (fig. 4), dostarczył około 4 tysięcy okazów, należących do gatunków znanych z innych miejsc. Niewielka jednak ilość materiału nadawała się do szczegółowych badań, gdyż większość była przeżarta tlenkami żelaza, pokruszona i zniszczona. W osadach ilastych keloweju zostały zebrane okazy *Rhopaloteuthis bzoviensis* (Zeuschner) i *Rh. majeri* (Alth), (ok. 100 okazów w Regulicach, Ogrodzieńcu i Balinie), oraz około 30

rostrów *Duvalia disputabilis* (Neumayr) i 2 rostra *Rh. spissus* (Gillieron) w Balinie. Około 15 rostrów *Dicoelites meyrati* (Ooster) i 2 rostra *Rh. sauvanausus* (d'Orbigny) znaleziono w Wyszmontowie (pow. opatowski). Zbite krystaliczne wapienie z Woli Morawickiej (pow. kielecki) są bardzo ubogie w belemnity. Zebrano stamtąd 3 rostra *Rh. argovianus* (Mayer) oraz kilka innych, znanych z jury krakowsko-częstochowskiej. Wyższe poziomy oksfordu są ubogie w belemnity; spotyka się czasem znane już gatunki.

METODY BADAŃ I TERMINOLOGIA

Przy opisie gatunków i badaniach nad ontogenezą brano pod uwagę następujące cechy: kształt rostrum, jego długość, szerokość i grubość; wykształcenie odcinka końcowego; bruzdy alweolarne (wentralną i dorsalną), z uwzględnieniem ich długości, charakteru brzegów, głębokości i stopnia spłaszczenia końcowego; bruzdy apikalne; linie boczne; kąt alweoli i jej głębokość; linię apikalną; przekrój poprzeczny; wskaźniki wzrostu i wskaźniki spłaszczenia. Ostatnie dwa terminy — wskaźniki wzrostu i spłaszczenia — zostały wprowadzone przez autorkę w badaniach nad belemnitami po raz pierwszy, pozostałe zaczerpnięto z Krimholza (1960).

Pomiary wykonywano suwmiarką i podawano ich wartość w milimetrach z dokładnością do 0,1 mm. Mierzono najmniejszą i największą szerokość rostrów (♂ d-s) oraz najmniejszą i największą grubość (♂ d-v). Przy badaniach ontogenetycznych opierano się na zewnętrznych obserwacjach okazów różnej wielkości oraz na analizie szlifów cienkich. Prócz nich, zastosowano w pewnych przypadkach metodę odcisków powierzchni rostrów na błonkach filmowych. Powierzchnię naszlifowanego uprzednio rostrum traktowano z lekka kwasem solnym w celu nadtrawienia powierzchni i uwydatnienia warstewek przyrostowych. Błonkę filmową polewano acetonem i przykładano do opłukanej wodą powierzchni (nadtrawionej) przekroju, silnie przy tym uciskając. Rozpulchniona błonka wnika w zagłębienia powierzchni rostrum, oddając jego strukturę ze wszelkimi szczegółami. Błonki umieszczano pomiędzy szkiełkami, oklejano dookoła plastrem i fotografowano jak zwykłe szlify. Przy fotografowaniu całych okazów pokrywano ich powierzchnię chlorkiem amonu. Sposób badania wymienionych cech i terminologia, jaką się posłużono w opisach gatunków, wyjaśniają podane schematy (fig. 5-11).

ZMIANY ONTOGENETYCZNE

W badaniach ontogenetycznych nad belemnitami jurajskimi wyróżniono 3 stadia wzrostowe: nepioniczne, neaniczne i efebiczno-gerontyczne, opierając się na zmianie takich cech, jak kształt rostrum, jego przekrój poprzeczny i podłużny, bruzdy na powierzchni rostrum, w niektórych przypadkach głębokość alweoli i jej kąt, wskaźniki wzrostu i niekiedy wskaźniki spłaszczenia. Należy zaznaczyć, że nie można dać wspólnej charakterystyki tych stadiów dla wszystkich gatunków, niekiedy bowiem stadia wzrostu mają podobny przebieg; w większości przypadków należy je rozpatrywać indywidualnie.

PRZEŻYCIOWE ZNIEKSZTAŁCENIA ROSTRÓW

Najczęściej spotyka się anormalne zgrubienia rostrów w różnych ich częściach, guzowate narośla, wygięcia kolankowe, skręcenia osi, rozdwojenie końca, mniej lub bardziej silne zgniecenia. Kabanow (1959) wysuwa przypuszczenie, że za życia zwierzęcia rostra belemnitów były elastyczne i przypominały składem chrząstkę. Autorka pracy nie zgadza się z Kabanowem, wysuwając odpowiednie przeciwargumenty.

ZNISZCZENIA ROSTRÓW

Częste są przypadki zniszczeń rostrów przez organizmy żerujące na dnie. Powierzchnie rostrów pokryte są licznymi drobnymi, całobrzegimi otworkami, które mogą mieć zarys okrągły lub wydłużony, a także kanalikami drążącymi w głąb rostrum. Zniszczenia te spowodowane zostały prawdopodobnie przez Annelida z grupy Polychaeta. Często spotyka się organizmy osiadłe na rostrach, są to serpule, a także otwornice (*Serpula limax*, *Bullopora rostrata*).

ROZPRZESTRZENIENIE GEOGRAFICZNE BELEMMITÓW

Niektóre gatunki opisane z Polski mają bardzo szerokie rozprzestrzenienie geograficzne, inne mają ograniczony zasięg występowania; np. *Hibolites girardoti* (Loriol) znany jest jedynie z Francji, Szwajcarii i Polski. W Polsce występuje kilka gatunków endemicznych, np. *Rhopaloteuthis majeri* (Alth), *Duvalia disputabilis* (Neumayr), *Dicoelites waageni* (Neumayr) i nowy gatunek *Belemnopsis semiarcuatus*. Podczas wielkiej transgresji środkowo-jurajskiej morze zalało tereny środkowej i zachodniej Europy, wskutek czego fauna belemnitowa tych regionów swobodnie przemieszczała się i mieszała. Po wkroczeniu morza na wschodnie i południowe tereny nastąpiła swobodna cyrkulacja i przewędrowywanie fauny na nowo zdobyte przez morze obszary. Niektóre gatunki właściwe faunie alpejskiej czy borealnej mogły przeniknąć wówczas na tereny poprzednio oddzielone barierami lądowymi. Do gatunków alpejskich znanych w Polsce należy *Dicoelites meyrati* (Ooster), (por. tabela 1).

KLUCZ ANALITYCZNY OPISANYCH BELEMNITIDAE

I. Rostrum stożkowate, bruzd alweolarnych brak, często występują bruzdy apikalne mniej lub bardziej wyraźne, czasem występują pojedyncze linie boczne ..... podrodzina **Passaloteuthinae**

A. Rostrum krótkie, o tępym końcu

1. Brak bruzd apikalnych i alweolarnych, linie boczne występują, ścianka wentralna spłaszczona . . . . . rodzaj *Gastrobelus*

a) Linie boczne zbliżone do wentralnej ścianki rostrum w jego części proksymalnej, poniżej biegną po środku ścianek . . . . . *G. ventroplanus* (Voltz); pl. V, fig. 1-6.

2. Czasem występuje apikalna bruzda po stronie wentralnej, linii bocznych brak, ścianka wentralna nie spłaszczona, rodzaj *Dactyloteuthis*

a) Ścianki boczne wąskie, często z szerokim wgłębieniem po środku . . . . . D. *irregularis* (Schlotheim); pl. VI, fig. 4.

B. Rostrum krótkie, o ostrym końcu, bez bruzd apikalnych

1. Alweola głęboka, przekrój poprzeczny czworokątny, rodzaj *Brachybelus*

a) Ścianki boczne szerokie, koniec asymetryczny . . . . . *B. breviformis* (Voltz); pl. IV, fig. 12.

C. Rostrum mniej lub bardziej wydłużone, z bruzdami apikalnymi

1. Alweola głęboka, przekrój poprzeczny owalny, rodzaj *Megateuthis*

a) 2 pary bruzd apikalnych: dorso- i wentrolateralne, oraz pojedyncza bruzda wentralna, rzadziej dorsalna

M. giganteus (Schloteim); fig. 12; pl. VII-VIII.

II. Rostrum maczugowate, bruzd apikalnych brak, niekiedy występuje słaba bruzda wentralna, istnieją podwójne linie boczne, przekrój poprzeczny czworokątny, rostrum symetryczne, nie spłaszczone bocznie, podrodzina **Hastitinae**

1. Rostrum średnich rozmiarów, linie boczne słabo zagłębione, rodzaj *Hastites*

a) Przekrój poprzeczny w części proksymalnej czworokątny, w środkowej i końcowej okrągły . . . . . *H. privatensis* (Mayer); pl. III.

2. Rostrum krótkie, linie boczne silnie zagłębione, przekrój poprzeczny czworokątny . . . . . rodzaj *Rhabdobelus*

a) Rostrum zgrubiałe, linie boczne leżą po środku ścianek . . . . *R. parvus* (Hartmann); pl. IV, fig. 9-11.

b) Rostrum wąskie, wydłużone, linie boczne leżą bliżej ścianki dorsalnej . . . . . *R. exilis* (d' Orbigny); pl. IV, fig. 8.

III. Rostrum skośnie maczugowate, asymetryczne, spłaszczone bocznie, średnich rozmiarów, wyraźna bruzda dorsalna przy brzegu alweolarnym, linie boczne podwójne, koniec tępy lub zaostrzony, często mukronowaty . . . . . podrodzina **Duvaliinae**

1. Koniec tępy, spłaszczenie boczne mniej lub bardziej silne, przekrój poprzeczny owalny lub nieregularny . . . . . rodzaj *Duvalia*

a) Ścianki boczne równoległe, przekrój poprzeczny owalny, o dłuższej średnicy dorso-wentralnej . . *D. disputabilis* (Neumayr); fig. 25, pl. XXV.

2. Koniec mniej lub bardziej zaostrzony, spłaszczenie boczne słabe, przekrój poprzeczny okrągły, owalny lub nieregularny . . rodzaj *Rhopaloteuthis*

A. Rostrum zgrubiałe, alweola głęboka, koniec mniej lub bardziej zaokrąglony.

a) Bruzda długa, szeroka, ścianka wentralna zaokrąglona, *R. majeri* (Alth).

b) Bruzda niezbyt długa, wąska, ścianka wentralna zaokrąglona . . . . . *R. spissus* (Gillieron); pl. IV, fig. 6-7.

c) Bruzda krótka, szeroka, ścianka wentralna spłaszczona . . . . . *R. gillieroni* (Mayer); fig. 26, pl. XXVI.

B. Rostrum nie zgrubiałe, alweola nie głęboka, koniec mniej lub bardziej ostry.

a) Bruzda niezbyt wąska, nie sięga do połowy długości rostrum, alweola płytka . . . . . *R. bzoviensis* (Zeuchner).

b) Bruzda wąska, sięga do połowy długości rostrum, alweola płytka . . . . . *R. argovianus* (Mayer); pl. VI, fig. 1-3.

c) Bruzda niezbyt wąska, sięga do połowy długości rostrum, alweola niezbyt płytka . . . . *R. sauvanausus* (d'Orbigny); pl. VI, fig. 7-9.

3. Rostrum silnie zgrubiałe w części dystalnej, znacznie spłaszczone bocznie . . . . . rodzaj *Pseudobelus*

a) Koniec mukronowaty, asymetryczny
P. coquandus (d'Orbigny); pl. VI, fig. 1-5.

IV. Rostrum cylindryczne, wrzecionowate lub stożkowe, bez bruzd apikalnych, z bruzdami alweolarnymi, linie boczne słabo rozwinięte lub brak . . . . . podrodzina **Belemnopsinae**

1. Rostrum cylindryczne, spłaszczone dorso-wentralnie, bruzda wentralna długa, sięga prawie do końca, linie boczne słabo zaznaczone, rodzaj *Belemnopsis*
   A. Rostrum średnich rozmiarów, silnie spłaszczone dorso-wentralnie, ścianki równoległe.
      a) Bruzda wentralna szeroka, *B. canaliculatus* (Schlotheim); fig. 13, pl. IX.
      b) Bruzda wentralna wąska
      B. parallelus germanicus (Romer); fig. 17, pl. XIV.
   B. Rostrum wydłużone, ścianki boczne w części proksymalnej zbliżone do siebie.
      a) Bruzda wentralna szeroka i długa, przekrój poprzeczny silnie spłaszczoly dorso-wentralnie
      B. latesulcatus (d'Orbigny); fig. 14; pl. XI; XII; fig. 1; XIII, fig. 8-9.
      b) Bruzda wentralna wąska i długa, przekrój poprzeczny spłaszczony dorso-wentralnie, *B. parallelus parallelus* (Phillips); fig. 16, pl. V, fig. 7.
      c) Bruzda długa, średniej szerokości, spłaszczenie dorso-wentralne niezbyt duże . . . . . *B. fusiformis* (Parkinson); pl. X.
      d) Bruzda długa, średniej szerokości, w ozęści proksymalnej rostrum słabo spłaszczone bocznie, w części tylnej słabo spłaszczone dorso-wentralnie
      B. subhastatus (Zieten); fig. 15; pl. XII, fig. 2; pl. XIII, fig. 1-7.
   C. Rostrum niewielkich rozmiarów, ścianka wentralna łukowato wygięta . . . . . *B. semiarcuatus* n. sp.; fig. 18-19, pl. XV.

2. Rostrum wrzecionowate, bruzda wentralna krótka, linie boczne wyraźne, przekrój poprzeczny okrągły lub owalny . . . . . rodzaj *Hibolites*
   A. Rostrum z bruzdą wentralną, rozszerzającą się przy końcu przebiegu; przekrój poprzeczny w części proksymalnej spłaszczony bocznie, w ozęści tylnej — dorso-wentralnie.
      a) Rostrum dużych rozmiarów, rozszerzone mniej lub bardziej w odległości ok. 1/4 od końca, bruzda wentralna szeroka ,sięga poniżej połowy rostrum . . . . . *H. hastatus* (Blainville); pl. XVI-XVIII.
      b) Rostrum dużych rozmiarów, smukłe, silnie wydłużone, słabo rozszerzone w połowie długości, bruzda wąska
      H. beyrichi (Oppel); fig. 21-22; pl. XX; XXI, fig. 1-4.
      c) Rostrum średnich rozmiarów, silnie rozszerzone w pobliżu końca, bruzda długa i szeroka, *H. semihastatus* (Blainville); fig. 20, pl. XIX.
   B. Rostrum z bruzdą wentralną zwężającą się przy końcu przebiegu, przekrój poprzeczny w części proksymalnej mniej lub bardziej okrągły.
      a) Rostrum dużych rozmiarów, słabo rozszerzone w połowie długości . . . . . .*H. girardoti* (Loriol); pl. XXIII.
      b) Rostrum niewielkich rozmiarów, rozszerzone w pobliżu końca . . . . . .*H. württembergicus* (Oppel); fig. 23; pl. XXI, fig. 5; XXII.

3. Rostrum stożkowate, wydłużone, spłaszczone bocznie, dwie bruzdy alweolarne . . . . . rodzaj *Dicoelites*
   a) Koniec ostry odchylony od osi, *D. meyrati* (Ooster); fig. 24, pl. XXIV
   b) Koniec słabo zaostrzony, nie odchyla się od osi
   D. waageni (Neumayr); pl. VI, fig. 5-6.

CHARAKTERYSTYKA GATUNKÓW

Hastites privatensis (Mayer, 1866)
(pl. III)

Rostra kształtu wrzecionowatego o największym rozszerzeniu w odległości ok. 1/3 od końca. Odcinek końcowy krótki, mniej lub bardziej ostro zakończony, czasem z lekka zaokrąglony, z mukronem. Linie boczne podwójne, sięgające do końca rostrum. Przekrój poprzeczny zaokrąglony lub czworokątny. Bruzd alweolarnych czy apikalnych brak. Największe średnice d-s wahają się w granicach 7,0-11,4 mm, największe średnice d-s — 7,0-12,4 mm.

Gatunek ten znany jest z keloweju i oksfordu Niemiec i Francji. W Polsce został znaleziony w górnym keloweju Balina (pow. chrzanowski).

Rhabdobelus parvus (Hartmann, in Quenstedt, 1858)
(pl. IV, fig. 9-11)

Rostra niewielkich rozmiarów, kształtu nieregularnego, nieco rozszerzone w końcowej części. Odcinek końcowy krótki, asymetryczny, odchylony od osi ku stronie dorsalnej. Ścianki boczne nieco szersze, niż wentralna i dorsalna, i łączą się z nimi pod kątem prostym. Przekrój poprzeczny czworokątny. Linie boczne głębokie, czasem podwójne. Na końcu widoczna mała brodawka mukronowata.

Gatunek ten znany jest z liasu górnego Niemiec. W Polsce był znaleziony w batonie Trzebionki (pow. chrzanowski).

Rhabdobelus exilis (d'Orbigny, 1842)
(pl. IV, fig. 8)

Rostrum niewielkich rozmiarów, silnie wydłużone, o ostrym końcu. Przekrój poprzeczny gruszkowaty, o szerszej ściance wentralnej. Linie boczne leżą wzdłuż płaszczyzn dorso-lateralnych; są one głęboko wcięte, pojedyncze w części proksymalnej, podwójne, szerokie w części dystalnej. Linie te silnie zbliżają się do siebie przy brzegu dorsalnym rostrum, wskutek czego ścianka dorsalna jest bardzo wąska, wentralna zaś szeroka. Po stronie wentralnej i dorsalnej widoczne są bardzo delikatne bruzdki.

Gatunek ten występuje w górnym liasie i batonie Niemiec, Francji, Szwajcarii, Związku Radzieckiego i krajów azjatyckich. W Polsce znany jest z liasu podhalańskiego (Siemiradzki, 1923) oraz z batonu Trzebionki (pow. chrzanowski).

Gastrobelus ventroplanus (Voltz, 1830)
(pl. V, fig. 1-6)

Rostra niewielkich rozmiarów, o wąskiej części proksymalnej, rozszerzające się ku tyłowi najbardziej w odległości ok. 1/3 od końca, lekko maczugowate. Ścianka ventralna płaska, szersza niż dorsalna. Linie boczne zbliżone ku stronie

wentralnej, w części proksymalnej zaś leżą tuż za rozszerzonym występem krawędzi wentralnej. W części środkowej rostrum linie te leżą centralnie. Odcinek końcowy krótki, nabrzmiały, ostry lub słabo zaokrąglony. Przekrój poprzeczny silnie spłaszczony, o zarysie czworokątnym w części proksymalnej, zmienia się na owalny w części środkowej i na okrągły — w końcowej. Bruzd apikalnych czy alweolarnych brak. Największa średnica d-s waha się od 3,0 do 8,5 mm, zaś d-v — od 2,6 do 7,4 mm.

Gatunek ten znany jest z górnego liasu i dolnego keloweju Niemiec i Francji. W Polsce znaleziony był w batonie i dolnym keloweju Trzebionki (pow. chrzanowski), Błeszna, Wrzosowej (pow. częstochowski), Ogrodzieńca i Włodowic (pow. zawierciański).

Dactyloteuthis irregularis (Schlotheim, 1820)
(pl. VI, fig. 4)

Rostra kształtu nieregularnego stożka. Koniec tępy, ze słabym mukronem, odchylony od osi ku stronie wentralnej. Ścianka wentralna węższa, wypukła, dorsalna szersza i spłaszczona w części proksymalnej. Ścianki boczne wąskie, płaskie, szerokości 4 mm w części proksymalnej. Ścianki te w kierunku tylnym zbliżają się nieco ku sobie przy brzegu wentralnym. Alweola zajmuje ok. 2/3 długości rostrum. Rostrum jest nieco spłaszczone dorso-wentralnie na całej długości. Bruzd brak.

Gatunek ten znany jest z liasu i dolnego doggeru Niemiec, Francji, Anglii i Związku Radzieckiego, oraz z liasu Szwajcarii. W Polsce został znaleziony w liasie Tatr (Siemiradzki, 1923) i w dolnym keloweju Ogrodzieńca (pow. zawierciański).

Megateuthis giganteus (Schlotheim, 1820)
(fig. 12; pl. VII-VIII)

Rostra krótkostożkowate u okazów nepionicznych, natomiast silnie wydłużone (do 20 mm), wysmukłe, o wąskim kącie otwarcia u okazów starszych. Bruzd alweolarnych brak, bruzdy apikalne dobrze widoczne — 2 pary: dłuższe dorso-lateralne, krótsze wentro-lateralne, czasem występuje jeszcze bruzda apikalna po wentralnej i dorsalnej stronie. Przekrój poprzeczny owalny lub gruszkowaty, o dłuższej średnicy dorso-wentralnej. W stadium nepionicznym przekrój ma zarys gruszkowaty, o szerszej ściance wentralnej; w stadium neanicznym obie ścianki są jednakowo szerokie, przekrój ma zarys owalny; w stadium efebiczno-gerontycznym przekrój jest znów gruszkowaty, o szerszej ściance dorsalnej. Na szlifie podłużnym widoczna jest bezstrukturalna, pofałdowana masa, leżąca w linii apikalnej rostrum. Utwór ten przypomina tzw. epirostrum, znane u belemnitów liasowych. Alweola głęboka, u najmłodszych okazów zajmuje 1/3 długości rostrum, u dorosłych głębokość jej wzrasta do ok. 1/5. Kąt alweolarny w kierunku dorso-wentralnym wynosi 23-28°, w kierunku bocznym 18-24°.

Gatunek ten występuje w batonie Niemiec, Francji, Anglii, Szwajcarii i Związku Radzieckiego. W Polsce został znaleziony również w batonie Kamienicy Polskiej (pow. częstochowski), Rudnikach, Blanowicach (pow. zawierciański), w Łęczycy (pow. kutnowski) i in.

Brachybelus breviformis (Voltz, 1830)
(pl. IV, fig. 12)

Rostrum stożkowate, krótkie, ostro zakończone. Przekrój poprzeczny zbliżony do kwadratowego. Ścianki boczne szersze, płaskie, dorsalna i wentralna węższe, również płaskie. Bruzd na rostrum brak.

Gatunek ten występuje w dolnych poziomach jury brunatnej i najwyższym liasie Niemiec, Francji, Anglii, Związku Radzieckiego i krajów azjatyckich. W Polsce został znaleziony w batonie Trzebionki (pow. chrzanowski).

Belemnopsis canaliculatus (Schlotheim, 1820)
(fig. 13; pl. IX)

Rostra kształtu cylindrycznego, średnich rozmiarów, silnie spłaszczone dorso-wentralnie. Bruzda wentralna szeroka, długa, ostrokanciasta. Linie boczne słabo widoczne. Okazy młode mają kształt wrzecionowaty. Alweola zajmuje ok. 1/5 długości rostrum, jej kąt wynosi 26-28°.

Gatunek ten znany jest z całej jury środkowej i górnej Europy, Azji, Kaukazu, Indii i Australii. W Polsce został znaleziony w licznych miejscowościach jury krakowsko-częstochowskiej i płn.-wschodniego obrzeżenia Gór Świętokrzyskich.

Belemnopsis fusiformis (Parkinson, 1811)
(pl. X)

Rostra kształtu prawie wrzecionowatego, długość ich dochodzi do 96 mm, największa szerokość do 10 mm, grubość do 7,5 mm. Przekrój poprzeczny w części przedniej zaokrąglony, zmienia się ku tyłowi na eliptyczny. Bruzda wentralna długa, o ostrych kantach. Linie boczne słabo zaznaczone u okazów nepionicznych; z wiekiem, w miejscu linii tworzą się niekiedy słabe kile. Odcinek końcowy stanowi 1/2 długości rostrum, jest długi i ostro zakończony.

Gatunek ten występuje w batonie Niemiec, Francji, Anglii i Szwajcarii. W Polsce został znaleziony w batonie Trzebionki (pow. chrzanowski).

Belemnopsis latesulcatus (d'Orbigny, 1845)
(fig. 14; pl. XI; XII, fig. 1; XIII, fig. 8-9)

Rostra kształtu cylindrycznego, nieco zwężone w części proksymalnej i silnie rozszerzone w 1/3 odległości od końca. Długość ich dochodzi do 120 mm, największa szerokość — do 15,5 mm, grubość — do 10,6 mm. Bruzda wentralna długa, dochodzi prawie do końca, szerokość do 4 mm. Rostra silnie spłaszczone dorso-

-wentralnie. Odcinek końcowy stosunkowo krótki, szeroki, niekiedy zaokrąglony, z mukronem.

Gatunek ten znany jest z jury środkowej Niemiec, Francji, Szwajcarii, Anglii, Związku Radzieckiego, Portugalii i Algeru. W Polsce występuje w całej jurze środkowej.

Belemnopsis subhastatus (Zieten, 1830)
(fig. 15; pl. XII, fig. 2; XIII, fig. 1-7)

Rostra kształtu cylindrycznego, silnie wydłużone, długość dochodzi do 68 mm, największa średnica boczna wynosi 11 mm, dorso-wentralna — 9 mm. Spłaszczenie dorso-wentralne, niewielkie w części proksymalnej, zwiększa się w kierunku ku tyłowi. W połowie długości rostra są lekko nabrzmiałe zarówno z boku, jak i od strony wentralnej. Odcinek końcowy długi, ostro zakończony. Bruzda wentralna długa i szeroka, o ostrych kantach. Linie boczne sięgają do połowy długości rostrum. Przekrój poprzeczny w części proksymalnej lekko spłaszczony bocznie, w środkowej nerkowaty, w dystalnej zaokrąglony. Alweola nie przekracza 1/7 długości rostrum. kąt je wynosi 22-23°.

Gatunek ten znany jest z batonu i keloweju Niemiec, Francji, Anglii, Serbii i Indii. W Polsce występuje w tych samych poziomach licznych kamieniołomów całej jury.

Belemnopsis parallelus parallelus (Phillips, 1869)
(fig. 16; pl. V, fig. 7)

Rostra kształtu cylindrycznego, smukłe, wydłużone, zwężone w części proksymalnej, rozszerzające się ku tyłowi do połowy długości. Bruzda wentralna wąska, płytka, ostrokanciasta, kończy się w niewielkim oddaleniu od końca. Linie boczne słabo zaznaczone, pojedyncze, czasem podwójne. Przekrój poprzeczny zaokrąglony w części proksymalnej, silnie spłaszczony dorso-wentralnie w części środkowej i dystalnej. Odcinek końcowy długi, ostro zakończony.

Gatunek ten występuje w batonie Anglii i Niemiec. W Polsce znaleziony został w batonie Trzebionki (pow. chrzanowski).

Belemnopsis parallelus germanicus (Roemer, 1911)
(fig. 17; pl. XIV)

Rostra kształtu cylindrycznego, silnie spłaszczone dorso-wentralnie, krótkie; największe z nich ma 53 mm długości. Średnica boczna w najszerszym miejscu wynosi 10 mm, dorso-wentralna — 7,5 mm. Obie ścianki, wentralna i dorsalna, spłaszczone, szerokie; boczne, wąskie tworzą z sąsiednimi kąt prawie prosty w części proksymalnej. Bruzda wentralna wąska, nie sięga do końca. Linie boczne, nieco zagłębione, dochodzą do najszerszego miejsca rostrum. Odcinek końcowy krótki, szeroki, zaokrąglony, czasem kończy się mukronem. Alweola zajmuje ok. 1/7 długości rostrum, kąt jej wynosi ok. 22°.

Gatunek ten znany jest z batonu Niemiec i Francji. W Polsce występuje od batonu do keloweju; znaleziony został w Trzebionce (pow. chrzanowski), koło Ogrodzieńca (pow. zawierciański). i we Wrzosowej (pow. częstochowski).

Belemnopsis semiarcuatus n. sp.
(fig. 18-19; pl. XV)

Rostra kształtu wrzecionowatego, do 39 mm długości, o wąskiej i długiej części proksymalnej, a krótkim, buławkowatym odcinku końcowym, łukowato wygięte od strony wentralnej. Bruzda wentralna długa, silnie rozszerzająca się ku tyłowi, do 2,5 mm, kończąca się szerokim wgłębieniem w pobliżu końca. Linie boczne długie, wygięte, czasem podwójne. Przekrój poprzeczny splaszczony dorso-wentralnie. Odcinek końcowy krótki, z wiekiem grubieje, zaokrągla się, czasem występuje mukron.

Gatunek ten znany jest z gurnego keloweju w licznych miejscowościach jury krakowsko-częstochowskiej.

Hibolites hastatus (Blainville, 1827)
(pl. XVI-XVIII)

Rostra wybitnie wrzecionowatego kształtu, do 210 mm długości, spłaszczone bocznie w części proksymalnej, zaokrąglone lub słabo splaszczone dorso-wentralnie w części środkowej i dystalnej. Największa szerokość rostrum przypada w odległości ok. 1/4 od końca i wynosi 20 mm, grubość w tym miejscu — 18,5 mm. Bruzda wentralna głęboka, w części proksymalnej do 2 mm i węższa, spłyca się i poszerza do 3,5 mm w części końcowej, tj. poniżej połowy długości rostrum. Linie pojedyncze, czasem podwójne. Rostra młodych osobników smuklejsze, o dłuższej części końcowej. Alweola zajmuje ok. 1/6 długości rostrum, jej kąt wynosi 15-18°.

Gatunek ten występuje w środkowej i górnej jurze Europy środkowej, Portugalii, Anglii, Hiszpanii, Algieru, Kaukazu, Rosji, Arabii, Indii i Madagaskaru. W Polsce — w tych samych poziomach całej jury.

Hibolites semihastatus (Blainville, 1827)
(fig. 20; pl. XIX)

Rostra kształtu wrzecionowatego, do 76 mm długości, szerokość największa 12 mm, grubość 10 mm. Bruzda wentralna wąska i ostrokanciasta w części proksymalnej, poszerza się i spłyca w kierunku dystalnym, kończy się w niewielkim oddaleniu od końca. Linie boczne długie do końca, pojedyncze, czasem podwójne. Największa szerokość przypada w odległości 1/3 od końca. Przekrój poprzeczny w części proksymalnej spłaszczony bocznie, staje się owalny lub zaokrąglony w części dystalnej. Odcinek końcowy krótki i szeroki. Alweola zajmuje ok. 1/3 długości rostrum, kąt jej wynosi 18-20°.

Gatunek ten występuje od górnego batonu do dolnego oksfordu Niemiec, Francji, Rosji i Anglii. W Polsce znany jest z całej jury krakowsko-częstochowskiej, z tych samych poziomów.

Hibolites beyrichi (Oppel, 1856-58)
(fig. 21-22; pl. XX, XXI, fig. 1-4)

Rostra bardzo smukłe, silnie wydłużone, kształtu wrzecionowatego, długości do 140 mm, największa szerokość do 9 mm, grubość 9,5 mm. W połowie długości rostrum jest nieznacznie rozszerzone. W części proksymalnej spłaszczone bocznie, na pozostałej długości okrągłe lub zaokrąglone. Bruzda wentralna, sięgająca do połowy lub nieco poniżej, jest wąska, o ostrych kantach. Linie boczne długie prawie do końca, pojedyncze, niekiedy podwójne. Odcinek końcowy długi, wysmukły, ostro zakończony.

Gatunek ten występuje w batonie Niemiec, Francji i Anglii. W Polsce znany jest z batonu (wezul) Łęczycy (pow. kutnowski), Kamienicy Polskiej (pow. częstochowski), Kierszuli, Łaz (pow. zawierciański) i in.

Hibolites württembergicus (Oppel, 1856-58)
(fig. 23; pl. XXI, fig. 5; XXII)

Rostra kształtu wrzecionowatego, do 60 mm długości. Najszersze miejsce rostrum przypada w odległości 1/4 od końca i wynosi 7,3 mm, największa grubość w tym miejscu 6,3 mm. Bruzda wentralna jest wąska, sięga poniżej połowy rostrum, w kierunku ku tyłowi bruzda zwęża się i spłyca jeszcze bardziej. Niekiedy występują linie boczne. Przekrój poprzeczny owalny, o dłuższej średnicy bocznej, zmienia się na zaokrąglony w kierunku ku tyłowi. Przesunięcie największej szerokości i grubości bardziej do tyłu zmienia kształt rostrum na buławkowaty. Okazy młode mają ledwo widoczną bruzdę wentralną w postaci linii.

Gatunek ten znany jest z dolnego doggeru Niemiec, Francji i Anglii. W Polsce występuje w iłach batońskich Trzebionki (pow. chrzanowski).

Hibolites girardoti (Loriol, 1902)
(pl. XXIII)

Rostra wydłużone, średnich rozmiarów, kształtu wrzecionowego. W części proksymalnej lekko zwężone, o przekroju poprzecznym okrągłym; w części dystalnej i środkowej przekrój jest słabo spłaszczony dorso-wentralnie. Największa szerokość rostrum, przypadająca w połowie długości, wynosi do 12,1 mm, największa grubość w tym miejscu 10,5 mm. Bruzda wentralna sięga do połowy rostrum i jest wąska już w części proksymalnej, przy czym zwęża się jeszcze w kierunku końcowym. Linie boczne pojedyncze sięgają często do końca rostrum. Odcinek końcowy długi, ostro zakończony.

Gatunek ten znany jest z dolnego oksfordu Szwajcarii. W Polsce występuje od górnego keloweju do dolnego oksfordu we Wrzosowej, Błesznie (pow. częstochowski), Ogrodzieńcu (pow zawierciański) i. in.

Dicoelites meyrati (Ooster, 1857)
(fig. 24; pl. XXIV)

Rostra kształtu stożkowatego, do 64 mm długości. Największa szerokość wynosi 11 mm, grubość — 13 mm. Bruzda wentralna sięga prawie do końca, dorsalna przekracza połowę długości rostrum. W okolicy alweoli bruzdy te łączą się z nią wąskimi szczelinkami. Przekrój poprzeczny nieco bocznie spłaszczony w części proksymalnej, a w środkowej i dystalnej zaokrąglony. Odcinek końcowy ostro zakończony i odchylony od osi ku stronie dorsalnej. Alweola zajmuje 1/3 długości rostrum, a nawet jego połowę u form dorosłych. Kąt alweolarny wynosi 19-24°.

Gatunek ten znany jest z keloweju Szwajcarii, Francji, Krymu, Kaukazu, Indii oraz Indonezji. W Polsce został znaleziony w keloweju Wyszmontowa (pow. opatowski) w Górach Świętokrzyskich.

Dicoelites waageni (Neumayr, 1871)
(pl. VI, fig. 5-6)

Rostra kształtu stożkowatego, spłaszczone bocznie na całej długości, koniec symetryczny, słabo zaostrzony .Dwie bruzdy: wentralna, sięgająca do końca, dorsalna — poza połowę rostrum.

Gatunek ten występuje w Polsce w dolnym keloweju Balina (pow. chrzanowski).

Duvalia disputabilis (Neumayr, 1871)
(fig. 25; pl. XXV)

Rostra niewielkich rozmiarów, do 38 mm długości, kształtu mniej lub bardziej cylindrycznego. Największe rozszerzenie dochodzi do 7,5 mm, największa grubość — do 9 mm. Wzdłuż ścianek bocznych biegną wyraźne, często podwójne linie boczne, w końcowym przebiegu odchylone nieco od osi w tę stronę, co i odcinek końcowy. Bruzd brak. Przekrój poprzeczny owalny lub gruszkowaty, o szerszej ściance wentralnej.

Gatunek ten znany jest z batonu i dolnego keloweju Polski z okolic Ogrodzieńca (pow. zawierciański), z Paczołtowic i Regulic (pow. krzeszowicki).

Rhopaloteuthis majeri (Alth, 1875)

Rostra kształtu skośnie maczugowatego, do 40 mm długości; największa średnica w odległości 1/4 od końca wynosi w kierunku bocznym do 14 mm, w dorso-wentralnym — 14 mm. Przekrój rostrum prawie czworokątny w okolicy

alweoli, zmienia się ku tyłowi na zaokrąglony. Alweola głęboka, stanowi 2/3 długości rostrum, kąt jej wynosi 26-32°. Bruzda dorsalna szeroka, niekiedy szczelinowata, osiąga 3/4 długości rostrum. Linie boczne wyraźne, nieco wygięte, podobnie jak i rostrum. Koniec zaokrąglony, zgrubiały, z mukronem.

Gatunek ten znany jest z dolnego oksfordu okolic Ogrodzieńca (pow. zawierciański), Regulic (pow. krzeszowicki), Balina (pow. chrzanowski) oraz Racławic i Paczołtowic (pow. krzeszowicki).

Rhopaloteuthis bzoviensis (Zeuschner, 1869)

Rostra kształtu skośnie maczugowatego, do 40 mm długości, największa szerokość — 10,3 mm, grubość — 11 mm. Przekrój poprzeczny owalny lub nieregularnie czworokątny, o szerszej ściance wentralnej. Bruzda dorsalna krótka, wąska, czasem szczelinowata. Linie boczne pojedyncze lub podwójne, wygięte tak jak rostrum. W odległości 1/4 od końca, rostrum jest dość silnie nabrzmiałe. Odcinek końcowy stosunkowo krótki, zaostrzony, często z mukronem. Alweola zajmuje ok. 1/6 długości rostrum, jej kąt wynosi ok. 30°.

Gatunek ten znany jest z dolnego oksfordu Francji i Polski. W Polsce znaleziono go w Bzowie, Ogrodzieńcu, Rodakach (pow. zawierciański), w Balinie, Czatkowicach, Racławicach, Regulicach, Grójcu i in. (pow. chrzanowski i krzeszowicki).

Rhopaloteuthis argovianus (Mayer, 1863)
(pl. VI, fig. 1-3)

Rostra do 33 mm długości, spłaszczone bocznie, kształtu skośnie maczugowatego. Największa szerokość przypada w odległości 1/5 od końca. Bruzda dorsalna wąska, ostrokanciasta, dochodzi do 1/2 długości rostrum. Linie boczne pojedyncze, silnie zagłębione, najczęściej sięgające do połowy rostrum. Odcinek końcowy krótki, o ostrym końcu. Ścianki boczne szersze. Koniec często asymetryczny, odchylony ku stronie dorsalnej, z mukronem.

Gatunek ten występuje w oksfordzie Niemiec, Francji i Szwajcarii. W Polsce został znaleziony w Woli Morawickiej (pow. kielecki).

Rhopaloteuthis sauvanausus (d'Orbigny, 1842)
(pl. VI, fig. 7-9)

Rostra niewielkich rozmiarów, do 50 mm długości. Wąskie w części proksymalnej, rozszerzone najbardziej w odległości 1/4 od końca. Bruzda dorsalna dość głęboka, szczelinowata. Przekrój poprzeczny okrągły lub zaokrąglony. Linie boczne wyraźne, sięgające do największej szerokości rostrum. Alweola zajmuje ok. 1/3 długości rostrum, kąt jej wynosi 20°.

Gatunek ten znany jest z dolnego oksfordu Niemiec, Francji, Szwajcarii, Portugalii, Algieru, Indii i Madagaskaru. W Polsce występuje w górnym keloweju Wyszmontowa (pow. opatowski).

Rhopaloteuthis spissus (Gillieron, 1873)
(pl. IV, fig. 6-7)

Rostra kształtu maczugowatego, z lekką asymetrią odcinka końcowego, lekko spłaszczone bocznie, zwężone nieco w okolicy alweoli. Największe rozszerzenie przypada w 1/3 odległości od końca. Ścianki boczne szersze. Linie boczne szeroki, sięgają niekiedy do końca. Bruzda dorsalna wąska, krótka, lub sięgająca do połowy długości rostrum. Koniec zaokrąglony, odchylony ku stronie dorsalnej, czasem mukronowaty. Alweola zajmuje ok. 1/4 długości rostrum, jej kąt wynosi ok. 20°.

Gatunek ten znany jest z dolnego oksfordu Szwajcarii. W Polsce został znaleziony w Balinie (pow. chrzanowski).

Rhopaloteuthis gillieroni (Mayer, 1866)
(fig. 26; pl. XXVI)

Rostra nieduże, do 35 mm długości, kształtu nieregularnego, skośnie maczugowatego. Największe średnice wynoszą ok. 10 mm. Rostra są nieco zwężone w części proksymalnej, poszerzają się w odległości 1/4 od końca. Bruzda dorsalna krótka, głęboka. Linie boczne głębokie, sięgają do miejsca największej szerokości rostrum. Przekrój poprzeczny w części proksymalnej czworokątny, w środkowej owalny, o dłuższej średnicy bocznej, w dystalnej zaokrąglony. Ścianka wentralna spłaszczona, dorsalna wypukła. Koniec ostry, asymetryczny, odchylony ku stronie dorsalnej, czasem zaokrąglony, mukronowaty.

Gatunek ten występuje w batonie i keloweju Niemiec, Francji i Szwajcarii. W Polsce został znaleziony w batonie Trzebionki (pow. chrzanowski) oraz w dolnym keloweju Ogrodzieńca (pow. zawierciański).

Pseudobelus coquandus (d'Orbigny, 1842)
(pl. IV, fig. 1-5)

Rostra nieduże, kształtu maczugowatego, największe rozszerzenie przypada w odległości ok. 1/5 od końca. W części proksymalnej silnie zwężone, dość znacznie spłaszczone bocznie. Ścianka dorsalna węższa, wentralna szersza. Linie boczne podwójne, wygięte, jak i koniec rostrum, w kierunku dorsalnym. Przekrój poprzeczny owalny, o dłuższej średnicy dorso-wentralnej, zbliżony do kwadratowego lub gruszkowaty, o szerszej krawędzi wentralnej. Odcinek końcowy krótki, asymetryczny, na końcu widoczny mukron, niekiedy kolcowaty, kiedy indziej brodawkowaty. Bruzd brak.

Gatunek ten występuje w keloweju i oksfordzie Niemiec, Francji, Szwajcarii i Algieru. W Polsce został znaleziony w keloweju i dolnym oksfordzie okolic Ogrodzieńca (pow. zawierciański), Regulic, Racławic (pow. krzeszowicki) oraz Balina (pow. chrzanowski).

OBJAŚNIENIA DO ILUSTRACJI

Fig. 1 (p. 108)

Schematyczna mapka rozprzestrzenienia utworów jurajskich; *1* jura środkowa i górna, *2* jura dolna.

(Fig. 2 (p. 109)

Rozmieszczenie odkrywek z belemnitami jurajskimi w pasmie jury krakowsko-częstochowskiej.

Fig. 3 (p. 110)

Rozmieszczenie odkrywek z belemnitami jurajskimi na płn.-wschodnim obrzeżeniu Gór Świętokrzyskich.

Fig. 4 (p. 111)

Nagromadzenie rostrów z keloweju Wrzosowej; wielk. nat.

Fig. 5–11 (p. 116)

Schematyczne rysunki rostrów, objaśniające stosowane pomiary i używane terminy.

Fig. 5. Strona wentralna: *a* największa szerokość (⌀ d-s), *b* odcinek końcowy.

Fig. 6. Strona boczna: *a* największa grubość (⌀ d-v), *b* linie boczne.

Fig. 7. Przekrój alweoli w płaszczyźnie symetrii: *a* kąt alweolarny, *b* głębokość alweoli.

Fig. 8. Przekrój rostrum rodzaju *Hibolites* w płaszczyźnie symetrii z zaznaczonym polem szczelinowym, *a* linia apikalna.

Fig. 9. Przekrój rostrum rodzaju *Belemnopsis* w płaszczyźnie symetrii z zaznaczonym polem szczelinowym.

Fig. 10. Schematy dwóch rostrów: *a* od strony dorsalnej, *b* od strony wentralnej, wyjaśniające sposób wyznaczania wskaźnika wzrostu; *c* ⌀ d-s przy końcu bruzdy, *d* odległość między końcem bruzdy a końcem rostrum, *d* : *c* wskaźnik wzrostu.

Fig. 11. Przekrój przez alweolę w płaszczyźnie symetrii: *a* ⌀ d-s, *b* ⌀ d-v; *a* : *b* wskaźnik spłaszczenia.

Fig. 12 (p. 120)

Megateuthis giganteus (Schlotheim), przekrój poprzeczny rostrum osobnika dorosłego, przedstawiający zmiany wzrostowe: *v* strona wentralna, *d* strona dorsalna.

Fig. 13 (p. 145)

Belemnopsis canaliculatus (Schlotheim), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 14 (p. 150)

Belemnopsis latesulcatus (d'Orbigny), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 15 (p. 154)

Belemnopsis subhastatus (Zieten), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 16 (p. 157)

Belemnopsis parallelus parallelus (Phillips), schemat rostrum osobnika dorosłego: *a* od strony wentralnej, *b* z boku, *c* w przekroju poprzecznym.

Fig. 17 (p. 160)

Belemnopsis parallelus germanicus (Roemer), schemat rostrum osobnika dorosłego: *a* od strony wentralnej, *b* z boku, *c* w przekroju poprzecznym.

Fig. 18 (p. 162)

Belemnopsis semiarcuatus n. sp., schemat rostrum osobnika dorosłego, z boku: *v* strona wentralna, *d* strona dorsalna.

Fig. 19 (p. 162)

Belemnopsis semiarcuatus n. sp. rostrum osobnika, dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 20 (p. 171)

Hibolites semihastatus (Blainville), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 21 (p. 176)

Hibolites beyrichi (Oppel); schematyczne przekroje poprzeczne rostrum osobnika dorosłego, z zaznaczonymi liniami przyrostu: *a* za alweolą, *b* w połowie rostrum.

Fig. 22 (p. 177)

Hibolites beyrichi (Oppel), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 23 (p. 178)

Hibolites württembergicus (Oppel), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 24 (p. 185)

Dicoelites meyrati (Ooster), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 25 (p. 189)

Duvalia disputabilis (Neumayr), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Fig. 26 (p. 197)

Rhopaloteuthis gillieroni (Mayer), rostrum osobnika dorosłego, przecięte w płaszczyźnie symetrii, z zaznaczonymi trzema stadiami wzrostu.

Pl. I

Przykłady zniekształceń rostrów

Fig. 1. Rostrum o rozdwojonym końcu; wielk. nat. (Bj. 843).

Fig. 2. Esowato wygięty koniec rostrum; × 2 (Bj. 839).

Fig. 3. Guzowate narośla w proksymalnej części rostrum; nieco powiększ. (Bj. 832).

Fig. 4. Guzowate narośla w środkowej części rostrum oraz skręcenie bruzdy; (Bj. 833).

Fig. 5. Skręcenie bruzdy i rozszerzenie części końcowej rostrum; nieco powiększ. (Bj. 835).

Fig. 6, 10. Rostra anormalnie zgrubiałe w części końcowej; wielk. nat. (Bj. 830, 834).

Fig. 7. Rostrum o anormalnie zwężonej części końcowej; nieco powiększ. (Bj. 844).

Fig. 8. Łukowato wygięta część końcowa rostrum z licznymi zmarszczkami podłużnymi; × 2 (Bj. 841).

Fig. 9. Rostrum o łukowato wygiętym końcu; wielk. nat. (Bj. 858).

Fig. 11. Rostrum o symetrycznie rozdwojonym końcu; wielk. nat. (Bj. 842).

Fig. 12. Cienki przekrój podłużny rostrum, uszkodzonego we wczesnych

stadiach wzrostowych i anormalnie przebiegających liniach przyrostu; × 3 (Bj. 846).

Fig. 13. Rostrum łukowato wygięte, o rozdwojonym końcu, ze skręceniem bruzdy: *a* od strony wentralnej, *b* z boku; ca ×1,5 (Bj. 845).

Fig. 14. Cienki przekrój przez esowato wygięte rostrum; × 4 (Bj. 413).

Pl. II

Fig. 1. Rostrum pokryte okrągłymi otworkami; wielk. nat. (Bj. 847).

Fig. 2. Półksiężycowaty, głęboki kanalik i okrągłe otworki obok; × 2 (Bj. 850).

Fig. 3. Rostrum z podłużnymi, wąskimi otworkami i przenikającym w głąb kanalikiem w części końcowej; × 2 (Bj. 849).

Fig. 4. Liczne drobne otworki podłużne; × 1,5 (Bj. 848).

Fig. 5, 6. Otwornica *Bullopora rostrata* osiadła na powierzchni rostrum; × 8 (Bj. 852-3).

Fig. 7. Rurka *Serpula limax* osiadłej na powierzchni rostrum; × 1,5 (Bj. 851).

Fig. 8. Koncentryczne skupienia chalcedonu; × 2 (Bj. 854).

Pl. III

Hastites privatensis (Mayer)

Fig. 1-3. Trzy rostra różnego wieku osobniczego: *a* z boku, *b* od strony wentralnej; × 1,5 (Bj. 732-3, 755).

Fig. 4. Przekrój podłużny rostrum osobnika dorosłego, z liniami przyrostu zaznaczającymi kolejne stadia wzrostowe; × 2 (Bj. 738).

Fig. 5 (*a-d*). Cztery przekroje poprzeczne rostrum osobnika dorosłego: *a-b* zarys czworokątny w części proksymalnej, *c-d* zarys zaokrąglony w części dystalnej; × 6 (Bj. 739).

Pl. IV

Pseudobelus coquandus (d'Orbigny)

Fig. 1-3. Trzy rostra różnego wieku osobniczego: *a* z boku, *b* od strony wentralnej; × 1,5 (Bj. 754, 760, 763).

Fig. 4 (*a-d*). Cztery przekroje poprzeczne osobnika dorosłego: *a* za alweolą, *b-c* w części środkowej, *d* w części końcowej; × 3 (Bj. 765).

Fig. 5. Przekrój podłużny rostrum osobnika dorosłego w płaszczyźnie symetrii; × 4 (Bj. 764).

Rhopaloteuthis spissus (Gillieron)

Fig. 6, 7. Dwa rostra osobników dorosłych: *a* od strony dorsalnej, *b* z boku; × 1,5 (Bj. 541-2).

Rhabdobelus exilis (d'Orbigny)

Fig. 8. Rostrum osobnika dorosłego: *a* z boku, *b* od strony wentralnej; × 1,5 (Bj. 740).

Rhabdobelus parvus (Hartmann)

Fig. 9-11. Trzy rostra różnego wieku osobniczego, z boku; × 1,5 (Bj. 744-746).

Brachybelus breviformis (Voltz)

Fig. 12. Rostrum osobnika dorosłego: *a* od strony wentralnej, *b* z boku; × 1,4 (Bj. 702).

Pl. V

Gastrobelus ventroplanus (Voltz)

Fig. 1. Przekrój podłużny rostrum osobnika dorosłego w płaszczyźnie symetrii; × 3 (Bj. 803).

Fig. 2 (*a-e*). Pięć przekrojów poprzecznych rostrum osobnika dorosłego, idących w kierunku od części proksymalnej do dystalnej; × 9 (Bj. 804).

Fig. 3-6. Cztery rostra różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; × 1,6 (Bj. 712, 714, 717, 718).

Belemnopsis parallelus parallelus (Phillips)

Fig. 7. Rostrum osobnika dorosłego: *a* od strony wentralnej, *b* z boku; × 1,5 (Bj. 701).

Pl. VI

Fig. 1-3. *Rhopaloteuthis argovianus* (Mayer). Trzy rostra różnego wieku osobniczego: *a* od strony dorsalnej, *b* z boku; × 1,5 (Bj. 543-545).

Fig. 4. *Dactyloteuthis irregularis* (Schlotheim). Rostrum osobnika dorosłego: *a* od strony wentralnej, *b* z boku; × 1,5 (Bj. 703).

Fig. 5, 6. *Dicoelites waageni* (Neumayr). Dwa rostra osobników dorosłych: *a* z boku, *b* od strony wentralnej; × 1,5 (Bj. 806-7).

Fig. 7-9. *Rhopaloteuthis sauvanausus* (d'Orbigny). Trzy rostra różnego wieku osobniczego: *a* od strony dorsalnej, *b* z boku; × 1,5 (Bj. 573-575).

Pl. VII

Megateuthis giganteus (Schlotheim)

Fig. 1. Przekrój podłużny rostrum o lamelarnej budowie w części osiowej; × 5 (Bj. 53).

Fig. 2. Rostrum osobnika młodego z szerokimi bruzdami apikalnymi: *v* strona wentralna, *d* dorsalna; wielk. nat. (Bj. 10).

Fig. 3. Fragmokon naszlifowany od strony wentralnej, ilustrujący stosunek szyjek przegrodowych do przegród; × 2 (Bj. 57).

Fig. 4. Przekrój podłużny fragmokonu z „utworami półkolistymi"; × 10 (Bj. 58).

Fig. 5. Fragmokon z przegrodami i rurką syfonalną; × 3 (Bj. 56).

Fig. 6. Fragmokon widziany z boku; wielk. nat. (Bj. 46).

Fig. 7. Przekrój podłużny końcowej części rostrum, ilustrujący resorpcję postępującą od końca; × 1,5 (Bj. 52).

Fig. 8. Fragmokon z protokonchą i wielowarstwowymi przegrodami oraz widoczną częściowo rurką syfonalną; × 15 (Bj. 54).

Pl. VIII

Megateuthis giganteus (Schlotheim)

Fig. 1-5. Pięć przekrojów poprzecznych rostrum osobnika dorosłego, z zaznaczonymi głównymi liniami przyrostu, ilustrującymi nieregularne początkowo bruzdy apikalne; × 4 — × 6 (Bj. 41-a, c, e, i, l).

Fig. 6, 7. Dwa przekroje poprzeczne osobnika dorosłego, z zaznaczonymi głównymi liniami przyrostu, ilustrującymi regularne powstawanie bruzd apikalnych; × 7, × (Bj. 60 a, b).

Fig. 8. Przekrój podłużny części alweolarnej osobnika dorosłego, z zaznaczonymi głównymi liniami przyrostu; × 2,5 (Bj. 43).

Pl. IX

Belemnopsis canaliculatus (Schlotheim)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 86, 91, 95, 97, 100).

Fig. 6 (*a-c*). Trzy przekroje poprzeczne rostrum osobnika dorosłego, od części alweolarnej do środkowej; × 6 (Bj. 104).

Fig. 7. Przekrój podłużny rostrum osobnika dorosłego w płaszczyźnie symetrii; × 2 (Bj. 102).

Pl. X

Belemnopsis fusiformis (Parkinson)

Fig. 1-6. Sześć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 265, 269, 279, 281, 271, 272).

Fig. 7 (*a-c*). Trzy przekroje poprzeczne w różnych częściach rostrum, od alweoli ku końcowi; × 7 (Bj. 287).

Pl. XI

Belemnopsis latesulcatus (d'Orbigny)

Fig. 1-3. Końcowe części trzech rostrów, ilustrujące przejście od wydłużonego i ostrego końca do mukronowatego; wielk. nat. (Bj. 131, 135, 138).

Fig. 4-6. Końcowe części trzech rostrów, ilustrujące przejście od końca zaostrzonego do zaokrąglonego; wielk. nat. (Bj. 139-141).

Fig. 7, 8. Końcowe części dwóch rostrów ilustrujące zmianę szerokości bruzdy wentralnej; wielk. nat. (Bj. 132-3).

Fig. 9-12. Cztery rostra różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 111, 116, 120, 123).

Pl. XII

Fig. 1 (*a-d*). *Belemnopsis latesulcatus* (d'Orbigny). Cztery przekroje poprzeczne w różnych częściach rostrum, od alweoli ku końcowi; ×3 (Bj. 125, 130).

Fig. 2 (*a-c*). *Belemnopsis subhastatus* (Zieten). Trzy przekroje poprzeczne w różnych częściach rostrum, od alweoli ku końcowi; × 10 (Bj. 221).

Pl. XIII

Belemnopsis subhastatus (Zieten)

Fig. 1-6. Sześć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 169. 190. 195, 203, 208, 215).

Fig. 7. Przekrój podłużny w płaszczyźnie symetrii; × 2,2 (Bj. 225).

Belemnopsis latesulcatus (d'Orbigny)

Fig. 8*a*, 9. Przekroje podłużne dwóch rostrów w płaszczyźnie symetrii; ca × 2 (Bj. 127, 129). 8*b*. Przekrój podłużny przez fragmokon okazu 8*a*; × 3 (Bj. 129).

Pl. XIV

Belemnopsis parallelus germanicus (Roemer)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; 1,5 (Bj. 232, 242, 248, 252, 254).

Fig. 6. Fragmokon z protokonchą i komorami powietrznymi; × 18 (Bj. 258).

Fig. 7. Przekrój podłużny przez fragmokon z protokonchą; × 7 (Bj. 260).

Fig. 8 (*a, b*). Dwa przekroje poprzeczne: *a* za alweolą, *b* w połowie długości rostrum; × 9 (Bj. 261).

Pl. XV

Belemnopsis semiarcuatus n. sp.

Fig. 1-6. Sześć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; × 2 (Bj. 297, 302, 316, 318-holotyp, 322-3).

Fig. 7. Rostrum rozłupane w płaszczyźnie symetrii, z widocznym polem szczelinowym od strony lewej; wielk. nat. (Bj. 319a).

Fig. 8. Przekrój podłużny w płaszczyźnie symetrii; × 2 (Bj. 326).

Fig. 9 (*a-d*). Cztery przekroje poprzeczne w różnych częściach rostrum, od alweoli ku końcowi; × 10 (Bj. 324).

Pl. XVI

Hibolites hastatus (Blainville)

Fig. 1-8. Osiem rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 361-2, 365-367, 369, 371-2).

Fig. 9. Dwa rostra osobników dorosłych: *a* osobnik typowy kształtu wrzecionowatego, *b* osobnik o grubej części końcowej; wielk. nat. (Bj. 375-6).

Pl. XVII

Hibolites hastatus (Blainville)

Fig. 1-3. Trzy rostra osobników dorosłych: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 379, 382, 384).

Pl. XVIII

Hibolites hastatus (Blainville)

Fig. 1. Przekrój podłużny rostrum dorosłego osobnika w płaszczyźnie symetrii; × 1,2 (Bj. 399).

Fig. 2 (*a-d*). Cztery przekroje poprzeczne rostrum osobnika dorosłego przez różne części, od alweoli do odcinka końcowego; × 3,5 (Bj. 400).

Fig. 3, 4. Dwa przekroje podłużne przez frakmokon, z protokonchą i komorami powietrznymi; × 4, × 2,5 (Bj. 401-2).

Pl. XIX

Hibolites semihastatus (Blainville)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 414, 434, 439, 442, 447).

Fig. 6 (*a-e*). Pięć przekrojów poprzecznych w różnych częściach rostrum, od alweoli ku końcowi; × 5 (Bj. 454).

Fig. 7. Rostrum rozłupane w płaszczyźnie symetrii, wykazujące pole szczelinowe; nieco powiększ. (Bj. 449).

Fig. 8. Przekrój podłużny przez fragmokon z protokonchą i licznymi komorami powietrznymi; × 4 (Bj. 450).

Pl. XX

Hibolites beyrichi (Oppel)

Fig. 1-4. Cztery rostra różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; wielk. nat. (Bj. 517-519, 521).

Fig. 5. Przekrój podłużny rostrum osobnika dorosłego w płaszczyźnie symetrii; × 2 (Bj. 529).

Pl. XXI

Hibolites beyrichi (Oppel)

Fig. 1, 2. Dwa przekroje poprzeczne: *a* przez początek alweoli, *b* w połowie długości rostrum; × 6 (Bj. 530).

Fig. 3. Fragmokon osobnika dorosłego z protokonchą i licznymi komorami powietrznymi; × 3 (Bj. 524).

Fig. 4. Przekrój podłużny fragmokonu w płaszczyźnie symetrii z protokonchą i komorami powietrznymi; × 4 (Bj. 529).

Hibolites württembergicus (Oppel)

Fig. 5 (*a-e*). Pięć przekrojów poprzecznych w różnych częściach rostrum, od alweoli ku końcowi; × 8 (Bj. 512).

Pl. XXII

Hibolites württembergicus (Oppel)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; × 2 (Bj. 495, 498, 504, 507, 509).

Fig. 6. Przekrój podłużny rostrum osobnika dorosłego w płaszczyźnie symetrii; × 2,5 (Bj. 511).

Fig. 7. Fragment rostrum ilustrujący charakterystyczny sposób wietrzenia części proksymalnej; × 2,5 (Bj. 510).

Fig. 8. Rostrum typowego osobnika dorosłego z rurką *Serpuli* przytwierdzoną na bruździe wentralnej; × 2,5 (Bj. 506).

Pl. XXIII

Hibolites girardoti (Loriol)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony wentralnej, *b* z boku; × 1,5 (Bj. 464, 466, 474, 479-80).

Fig. 6. Przekrój podłużny fragmokonu z protokonchą i komorami powietrznymi; × 4 (Bj. 487).

Fig. 7 (*a-e*). Pięć przekrojów poprzecznych w różnych częściach rostrum osobnika dorosłego, od alweoli ku końcowi; × 6 (Bj. 488).

Pl. XXIV

Dicoelites meyrati (Ooster)

Fig. 1, 2. Dwa rostra osobników dorosłych: *a* od strony wentralnej, *b* dorsalnej, *c* z boku; × 1,5 (Bj. 811, 817).

Fig. 3 (*a-c*). Trzy przekroje poprzeczne w różnych częściach rostrum, od alweoli ku końcowi; × 4 (Bj. 823), × 12 (Bj. 823d).

Fig. 4. Fragmokon z protokonchą i komorami powietrznymi; × 15 (Bj. 820).

Pl. XXV

Duvalia disputabilis (Neumayr)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* z boku, *b* od strony wentralnej; × 2,4 (Bj. 766-770).

Fig. 6. Przekrój poprzeczny rostrum za alweolą: *v* strona wentralna, *d* dorsalna; × 11 (Bj. 800).

Fig. 7. Przekrój poprzeczny rostrum osobnika dorosłego o pofałdowanych środkowych liniach przyrostu; × 70 (Bj. 800).

Pl. XXVI

Rhopaloteuthis gillieroni (Mayer)

Fig. 1-5. Pięć rostrów różnego wieku osobniczego: *a* od strony dorsalnej, *b* z boku; × 1,6 (Bj. 692-696).

Fig. 6 (*a-d*). Cztery przekroje poprzeczne rostrum osobnika dorosłego w różnych częściach, od alweoli ku końcowi; × 4,5 (Bj. 562).

Fig. 7. Przekrój podłużny rostrum osobnika gerontycznego w płaszczyźnie symetrii: *v* strona wentralna, *d* dorsalna; × 2 (Bj. 698).

ГАЛИНА ПУГАЧЕВСКА

БЕЛЕМНИТЫ ИЗ ЮРЫ ПОЛЬШИ

Резюме

В работе изложены результаты исследований над средне- и верхнеюрскими белемнитами из краковско-ченстоховской полосы скал и северо-восточного обрамления Свентокржиских Гор. Материал для исследований собран автором в годах 1954—1958. Состоит он из десятков тысячей образцов, но в отношении количества видов мало дифференцированный, содержа только 29 идентифицированных видов принадлежащих 12 родам из 4 подсемейств. Среди них находится описанный тут один новый вид — *Belemnopsis semiarcuatus* n. sp.

ХАРАКТЕРИСТИКА ЮРСКИХ ОТЛОЖЕНИЙ КРАКОВСКО-ЧЕНСТОХОВСКОГО ПОЯСА СКАЛ И СЕВЕРО-ВОСТОЧНОГО ОБРАМЛЕНИЯ СВЕНТОКРЖИСКИХ ГОР

В пределах краковско-ченстоховской юры Ружыцки (1953) выделяет два районы: 1) северный — с выровненным рельефом геологического основания и с некоторым постоянством петрографического типа отложений, 2) южный — с более разнообразным рельефом, не обнаруживающий постоянства петрографического типа. В северным районе в бате выступают илы со сферосидеритами, илы песчанистые и с оолитами, в келловее — комообразный и строматолитовый слой, в дивезе часто встречаются мергели и мергелистые известняки, иногда дивезу соответствует стратиграфический пробел; в невизе и аргове преобладают мергелистые и плитообразные известняки. В южным районе часты следы размывания, стратиграфические пробелы, отсутствует комообразный и строматолитовый слой. В самых нижних горизонтах преобладают рудоносные глины и детритовые отложения. Горизонты лежащие выше представлены попеременно мергелистыми и сцифиевыми осадками. Плитообразные известняки выступают тоже и тут в аргове.

В северо-восточном обрамлении Свентокржиских Гор отложения несколько иные. Сначала глинистые, пиритовые, чёрные, затем выше зоогенные и химические, а также железистые и песчанистые, иногда криноидные известняки. В оксфорде появляются рифовые образования с губками, кораллами и строматопорами. Часты известняки проросшие кремнями. Самые высшие горизонты представлены тонкопылистыми известняками и оолитовой фацией. Одновременно возрастает доломитизация осадков, постепенно исчезают оолиты. Часты мергели с банками усриц и теребратуль. Самые высшие горизонты в этом районе отсутствуют.

МАТЕРИАЛ

В батских рудоносных глинах собрано свыше 500 образцов *Megateuthis giganteus*, свыше 200 образцов *Hibolites beyrichi*, 50 образцов *H. württembergicus* и небольшое количество других видов, обычных в средне- и верхнеюрских отложениях. Самый обильный материал получен из келловея. Из более редко встречаемых видов собрано тут примерно 30 ростров *B. parallelus germanicus* и больше 10 образцов *Hastites privatensis*. *B. semiarcuatus* n. sp. и *H. girardoti* найдено в верхнем келловее, также как и свыше 100 образцов представителей рода *Rhopaloteuthis*. В северо-восточном обрамлении Свентокржиских Гор собрано 15 ростров *Dicoelites meyrati* и несколько образцов *Rh. sauvanausus*. Плотные известняки в Воле Моравицкой (келецкая область) бедны белемнитами. Собрано тут рядом с другими известными видами только 3 ростры *Rh. argovianus*.

МЕТОДЫ ИССЛЕДОВАНИЙ И ТЕРМИНОЛОГИЯ

При описывании видов и изучении онтогенеза учитывано следующие признаки: форму ростра, его длину, ширину и толщину, концевой участок, вентральную, дорсальную и апикальную борозду, боковые линии, угол и глубину альвеолы, апикальную линию, поперечный разрез и индекс роста и сплюснутости. Последние два названия — индекс роста и сплюснутости — введены автором, остальные же почерпнуты у Кримгольца (1960). Измерения проведено пользуясь линейным нониюсом с точностью до 0,1 мм. При изучении онтогенеза автор основывался на анализе тонких шлифов. В некоторых случаях применено метод отпечатков на фотографических плёнках.

ОНТОГЕНЕТИЧЕСКИЕ ИЗМЕНЕНИЯ

При изучении онтогенеза выделено три возрастные стадии: непионическую, неаническую и ефебическо-геронтическую, на основании изменений таких признаков как: форма ростра, его поперечный разрез, борозды на поверхности ростра, индексы ростра и сплюснутости. Следует подчеркнуть, что невозможно дать характеристику этих стадий общую для всех видов. В некоторых случаях стадии роста обнаруживают сходный ход, в большинстве-же случаев следует их рассматривать индивидуально.

ПРИЖИЗНЕННЫЕ ДЕФОРМАЦИИ РОСТРОВ

Наиболее часто встречаемыми деформациями являются ненормальные утолщения ростров в разных их частях, массивные наросли, коленевидные изгибы, скручивание оси, раздвоение конца, боле или менее сильное сдавление. Кабанов (1959) выдвигает предположение, что во время жизни животного ростры белемнитов были эластичны на подобие хряща. Автор настоящей работы не согласен с мнением Кабанова и выдвигает соответствующие контраргументы.

ПОВРЕЖДЕНИЕ РОСТРОВ

Часты случаи повреждения ростров организмами откармливающимися на дне водоема. Поверхности ростров покрыты мелкими, продолговатыми или-же

круглыми отверстиями, а также канальцами проникающими вглубь. Они являются вероятно следствием деятельности кольчецов из группы Polychaeta. Часто встречаются организмы поселившиеся на рострах, а именно серпули и фораминиферы (*Serpula limax*, *Bullopora rostrata*).

ГЕОГРАФИЧЕСКОЕ РАСПРОСТРАНЕНИЕ БЕЛЕМНИТОВ

Географическое распространение белемнитов известных из Польши показано на таблице 1.

СИСТЕМАТИЧЕСКАЯ ЧАСТЬ

Подсемейство **Hastitinae** Naef. 1922

Род *Hastites* Mayer, 1883

Hastites privatensis (Mayer, 1866)

(пл. III)

Ростры веретенообразные, наибольший боковой поперечник на расстоянии около 1/3 длины от конца и равный 11,4 мм, дорсо-вентральный — 12,4 мм. Конец слабо заостренный, иногда округленный, с мукроном. Поперечный разрез округленный или четырехугольный. Боковые линии отчетливые, двойные, достигающие конца. Борозды отсутствуют.

Род *Rhabdobelus* Naef, 1922

Rhabdobelus parvus (Hartmann, in Quenstedt, 1858)

(пл. IV, фиг. 9—11)

Ростры небольшие, нерегулярные, расширенные возле конца. Конец асимметрический, отклоняется от оси к дорсальной стороне. Боковые стенки несколько более широкие, чем вентральная и дорсальная, соединяются с ними под прямым углом. Разрез четырехугольный. Боковые линии глубокие. Имеется мукрон.

Rhabdobelus exilis (d'Orbigny, 1842)

(пл. IV, фиг. 8)

Ростры небольшие, сильно удлиненные, с острым концом. Поперечный разрез грушевидный с более широкой вентральной стороной. Боковые линии дорсо-лятеральные, двойные возле конца. Дорсальная стенка очень узкая. На дорсальной и вентральной стороне видны очень деликатные бороздки в виде линий.

Подсемейство **Passaloteuthinae** Naef, 1922

Род *Gastrobelus* Naef, 1922

Gastrobelus ventroplanus (Voltz, 1830)

(пл. V, фиг. 1—6)

Ростры небольшие, с узкой проксимальной частью, наибольшее расширение в расстоянии около 1/3 от конца, несколько палицеобразны. Вентральная стенка

сплюснута и более широкая, чем дорсальная. Боковые линии отчетливые, приближаются к вентрально стороне. Максимальная ширина равна 8,5 мм, толщина — 7,4 мм. Поперечный разрез четырехугольный.

Род *Dactyloteuthis* Bayle, 1878
Dactyloteuthis irregularis (Schlotheim, 1820)
(пл. VI, фиг. 4)

Ростры небольшие, формы неправильного конуса, конец тупой, со слабым мукроном, отклоненный от оси к вентральной стороне. Вентральная сторона более узкая, выпуклая, дорсальная шире, сплющенная. Боковые стенки узкие, плоские. Ростр несколько сплюснут дорсо-вентрально. Альвеола занимает примерно 2/3 длины роста. Борозды отсутствуют.

Род *Megateuthis* Bayle, 1878
Megateuthis giganteus (Schlotheim, 1820)
(фиг. 12; пл. VII, VIII)

Ростры конусообразные, величины до 2 м, сильно удлиненные, 2 пары апикальныах борозд, более длинные дорсо-лятеральные, вентро-лятеральные покороче. Поперечный разрез овальный, с более длинным дорсо-вентральным диаметром. В непионической стадии более широкая стенка вентральная, в ефебическо-геронтической более широкая стенка дорсальная. В апикальной линии видна бесструктурная волокнистая масса — эквивалент эпиростра. Альвеола глубокая; у самых младших образцов занимает 1/3 длины роста, у взрослых ее глубина уменьшается до 1/5. Альвеолярный угол равный 24—28° в боковом направлении и 18—24° в дорсо-вентральном.

Род *Brachybelus* Naef, 1922
Brachybelus breviformis (Voltz, 1830)
(пл. IV, фиг. 12)

Ростр конусообразный, короткий, остро законченный. Поперечный разрез приближается к квадратному. Более широкие боковые стенки плоские, дорсальная и вентральная более узкие и тоже плоские. Борозды отсутствуют.

Подсемейство **Belemnopsinae** Naef, 1922
Род *Belemnopsis* Bayle, 1878
Belemnopis canaliculatus (Schlotheim, 1820)
(фиг. 13; пл. IX)

Ростры средней величины, цилиндрической формы, сильно сплющенные в дорсо-вентральном направлении. Вентральная борозда широкая, длинная, с острыми краями. Молодые образцы веретенообразные. Альвеола занимает 1/5 длины ростра, ее угол равный 26—28°. Поперечный разрез почкообразный.

Belemnopsis fusiformis (Parkinson, 1811)
(пл. X)

Ростры почти веретенообразной формы, длина до 96 мм, максимальная ширина — 10 мм, толщина 7,5 мм. Поперечный разрез округленный в части проксимальной, а в части дистальной сплющенный в дорсо-вентральном направлении. Вентральная борозда не достигает конца, острогранная, широкая. Боковые линии слабые, у взрослых образцов образуют иногда кили. Концевой участок длинный, остро оконченный.

Belemnopsis latesulcatus (d'Orbigny, 1845)
(фиг. 14; пл. XI; XII, фиг. 1; XIII, фиг. 8—9)

Ростры веретенообразные, сильно сплющенные в дорсо-вентральном направлении; длина до 120 мм, ширина до 15,5 мм; толщина до 10,6 мм. Вентральная борозда длинная, доходит почти до конца, с шириной до 4 мм. Концевой участок короткий, широкий, округленный, иногда с мукроном.

Belemnopsis subhastatus (Zieten, 1830)
(фиг. 15; пл. XII, фиг. 2; XIII, фиг. 1—7)

Ростры цилиндрические, сильно удлиненные. Длина до 68 мм, ширина до 11 мм, толщина до 9 мм. Сплющенность дорсо-вентральная в части проксимальной небольшая, увеличивается в части дистальной. В половине длины ростры легко вздутые. Концевой участок длинный, остро оконченный. Вентральная борозда длинная, острогранная. Поперечный разрез сплющенный в боковом направлении в части проксимальной, почкообразный в средней части и округленный в дистальной. Альвеола занимает 1/7 длины ростра, ее угол равняется 23°.

Belemnopsis parallelus parallelus (Phillips, 1869)
(фиг. 16; пл. V, фиг. 7)

Ростры цилиндрические, стройные, удлиненные, несколько суженные в проксимальной части. Вентральная борозда узкая, неглубокая, острогранная, доходит почти до конца. Боковые линии слабые, единичные, иногда двойные. Поперечный разрез округленный в части проксимальной, сильно сплющенный дорсо-вентрально в части средней и дистальной. Концевой участок длинный, остро оконченный.

Belemnopsis parallelus germanicus (Roemer, 1911)
(фиг. 17; пл. XIV)

Ростры цилиндрические, сильно сплющенные в дорсо-вентральном направлении. Длина до 53 мм, ширина до 10 мм, толщина до 7,5 мм. Вентральная и дорсальная стенки сплющенные и более широкие, боковые стенки более узкие, вместе с соседними образуют простый угол. Вентральная борозда узкая, неглубокая, не доходит до конца. Боковые линии несколько углубленные, доходят до

места наибольшей ширины ростра. Альвеола занимает около 1/7 длины ростра. Ее угол равняется около 22°.

Belemnopsis semiarcuatus n. sp.
(фиг. 18--19; пл. XV)

Ростры веретенообразные, уплощенные дорсо-вентрально, с длинной и узкой проксимальной частью и коротким, булавообразным концевым отрезком, дугообразно изогнутые с вентральной стороны. Длина до 39 мм. Вентральная борозда сильно расширяется у конца до 2,5 мм, окончена широким углублением в поблизости конца. Поперечный разрез сплющенный дорсо-вентрально. Боковые линии длинные, изогнутые подобным образом как и ростр. Концевой участок короткий, утолщающийся с возрастом особи, округленный, иногда с мукроном.

Род *Hibolites* Mayer, 1883
Hibolites hastatus (Blainville, 1827)
(пл. XVI—XVIII)

Ростры веретенообразные, длины до 210 мм, ширины до 20 мм, толщины до 18,5 мм. В проксимальной части сплющенные в боковом направлении, в средней и дистальной — дорсо-вентрально. Вентральная стенка возле конца вентральной борозды сплющенная. Вентральная борозда глубокая, острогранная в проксимальной части, становится менее глубокой и расширяется в половине длины ростра, где кончается широким углублением. Альвеола занимает около 1/6 длины ростра, ее угол равный 15—18°.

Hibolites semihastatus (Blainville, 1827)
(фиг. 20; пл. XIX)

Ростры веретенообразной формы, длины до 76 мм, ширины до 12 мм, толщины до 10 мм. Вентральная борозда узкая и острогранная в проксимальной части, расширяется и становится менее глубокой по направлению к заднему концу, кончается в небольшом расстоянии от заднего конца. Боковые линии длинные, единичные, иногда двойные. Поперечный разрез в проксимальной части сплющенный в боковом направлении, овальный с более длинным боковым диаметром в средней части и округленный в дистальной. Альвеола занимает около 1/8 длины ростра, ее угол равный 18—20°. Концевой участок, короткий и широкий, составляет 1/3 длины ростра.

Hibolites beyrichi (Oppel, 1856—58)
(фиг. 21—22; пл. XX; XXI, фиг. 1—4)

Ростры веретенообразные, тонкие, сильно удлиненые, длины до 140 мм, ширины до 9 мм, толщины до 9,5 мм. Незначительно расширенные на уровне половины длины ростра. Поперечный разрез сплющенный в боковом направлении в проксимальной части, становится округленным в части средней и дистальной.

Вентральная борозда узкая, с острыми гранями, достигает половину длины ростра или заходит еще дальше. Боковые линии длинные, проходят почти до конца, единичные, иногда двойные. Концевой участок длинный, тонкий, остро оконченный.

Hibolites wiirttembergicus (Oppel, 1856—58)
(фиг. 23; пл. XXI, фиг. 5; XXII)

Ростры веретенообразные, длины до 60 мм, ширины до 7,3 мм, толщины до 6.3 мм. Вентральная борозда узкая, доходит дальше чем до половины ростра. По направлению назад борозда суживается и становится менее глубокой. Иногда присутствуют боковые линии. Поперечный разрез, легко сплющенный дорсо-вентрально в части проксимальной, становится в большей или меньшей степени округленным в части дистальной. Концевой участок короткий, составляет 1/4 длины ростра. Иногда участок этот еще короче и округленный, а ростры принимают булавообразную форму.

Hibolites girardoti (Loriol, 1902)
(пл. XXIII)

Ростры удлиненные, средней величины, веретенообразные. В проксимальной части несколько суженные, с круглым поперечным разрезом, в средней и дистальной части легко сплющенные дорсо-вентрально. Максимальная ширина находится в половине длины ростра и равна 12 мм, ширина достигает 10,5 мм. Вентральная борозда доходит до половины ростра, узкая и остроганная в проксимальной части, становясь менее глубокой и еще больше суживаясь в концевом участке. Боковые линии единичные, длинные, почти достигают конца. Концевой участок длинный, остро оконченный.

Род *Dicoelites* Böhm, 1906
Dicoelites meyrati (Ooster, 1857)
(фиг. 24; пл. XXIV)

Ростры конусообразной формы, длины до 64 мм, ширины до 11 мм, толщины до 13 мм. Вентральная борозда доходит почти до конца ростра, дорсальная заходит дальше чем до половины ростра. В области альвеолы борозды соединяются с альвеолой узкими щелями. Поперечный разрез немного сплющенный в боковом направлении в проксимальной части, округленный в средней и дистальной. Концевой участок острый, отогнутый от оси к дорсальной стороне. Альвеола занимает 1/3 длины ростра или больше, ее угол равный 19—24°.

Dicoelites waageni (Neumayr, 1871)
(пл. VI, фиг. 5—6)

Ростры конусообразные, сплющенные в боковом направлении, конец симметричный, слабо заостренный. Вентральная борозда доходит до конца, дорсальная ближе чем до половины ростра.

Подсемейство **Duvaliinae** Pavlov, 1914

Род *Duvalia* Bayle, 1878

Duvalia disputabilis (Neumayr, 1871)

(фиг. 25; пл. XXV)

Ростры более или менее цилиндрические, длины до 3 мм, ширины до 7,5 мм, толщины до 9 мм. Боковые линии отчетливые, часто двойные. Борозд нет. Поперечный разрез овальный или грушеобразный, с более широкой вентральной стенкой.

Род *Rhopaloteuthis* Lissajous, 1915

Rhopaloteuthis majeri (Alth, 1875)

Ростры косо палицеобразные, длины до 40 мм, ширины до 14 мм, толщины до 14 мм. Дорсальная борозда широкая, иногда щелеобразная, длины равной 3/4 полной длины ростра. Боковые линии отчетливые, несколько изогнутые, так как и ростр. Поперечный разрез почти четырехугольный в проксимальной части, в дистальной округленный. Альвеола составляет 2/3 длины ростра, ее угол равный 26—32°. Концевой участок округленный, утолщенный, с мукроном.

Rhopaloteuthis bzoviensis (Zeuschner, 1869)

Ростры косо палицеобразные, длины до 40 мм, ширины до 10,3 мм, толщины до 11 мм. Дорсальная борозда короткая, узкая, иногда щелеобразная. Боковые линии единичные, иногда двойные, изогнутые, также как и ростр. Поперечный разрез овальный или нерегулярно четырехугольный, с более широкой вентральной стенкой. Альвеола занимает около 1/6 длины ростра, ее угол равный около 30°. Концевой участок относительно короткий, заостренный, часто с мукроном.

Rhopaloteuthis argovianus (Mayer, 1863)

(пл. VI, фиг. 1—3)

Ростры косо палицеобразные, сплющенные в боковом направлении, длины до 33 мм, максимальная ширина находится в расстоянии 1/5 от конца. Дорсальная борозда узкая, острогранная, доходит до половины длины ростра. Боковые линии единичные, сильно углубленные, доходят до половины ростра. Боковые стенки более широкие. Конец асимметричный, отклоненный к дорсальной стороне, часто с мукроном.

Rhopaloteuthis sauvanausu (d'Orbigny, 1842)

(пл. VI, фиг. 7—9)

Ростры косо палицеобразные, длины до 50 мм. Суженные в проксимальной части, расширенные в расстоянии 1/4 от конца. Дорсальная борозда довольно глубокая, щелеобразная. Поперечный разрез круглый или округленный. Боковые линии отчетливые, доходят до 1/4 расстояния от конца. Альвеола занимает около 1/3 длины ростра, ее угол равный 20°.

Rhopaloteuthis spissus (Gillieron, 1873)
(пл. IV, фиг. 6—7)

Ростры палицеобразные, сплющенные в боковом направлении, с небольшой концевой асимметрией, несколько суженные в проксимальной части. Дорсальная борозда доходит до половины ростра. Боковые линии широкие, длинные, доходят до конца ростра. Конец короткий, округленный, отклоненный к дорсальной стороне, иногда мукронообразный. Альвеола занимает около 1/4 длины ростра, ее угол равный около 20°.

Rhopaloteuthis gillieroni (Mayer, 1866)
(фиг. 26; пл. XXVI)

Ростры нерегулярно косо палицеобразные, длины до 35 мм, ширины 9,8 мм, толщины 8,6 мм, несколько суженные в проксимальной части. Дорсальная борозда короткая, глубокая. Боковые линии глубокие, доходят до 1/4 расстояния от конца. Поперечный разрез четырехугольный в проксимальной части, в средней сплющенный немного дорсо-вентрально, в дистальной округленный. Вентральная стенка сплющенная, дорсальная выпуклая. Конец острый, асимметричный, отклоненный к дорсальной стороне, иногда округленный, мукронообразный.

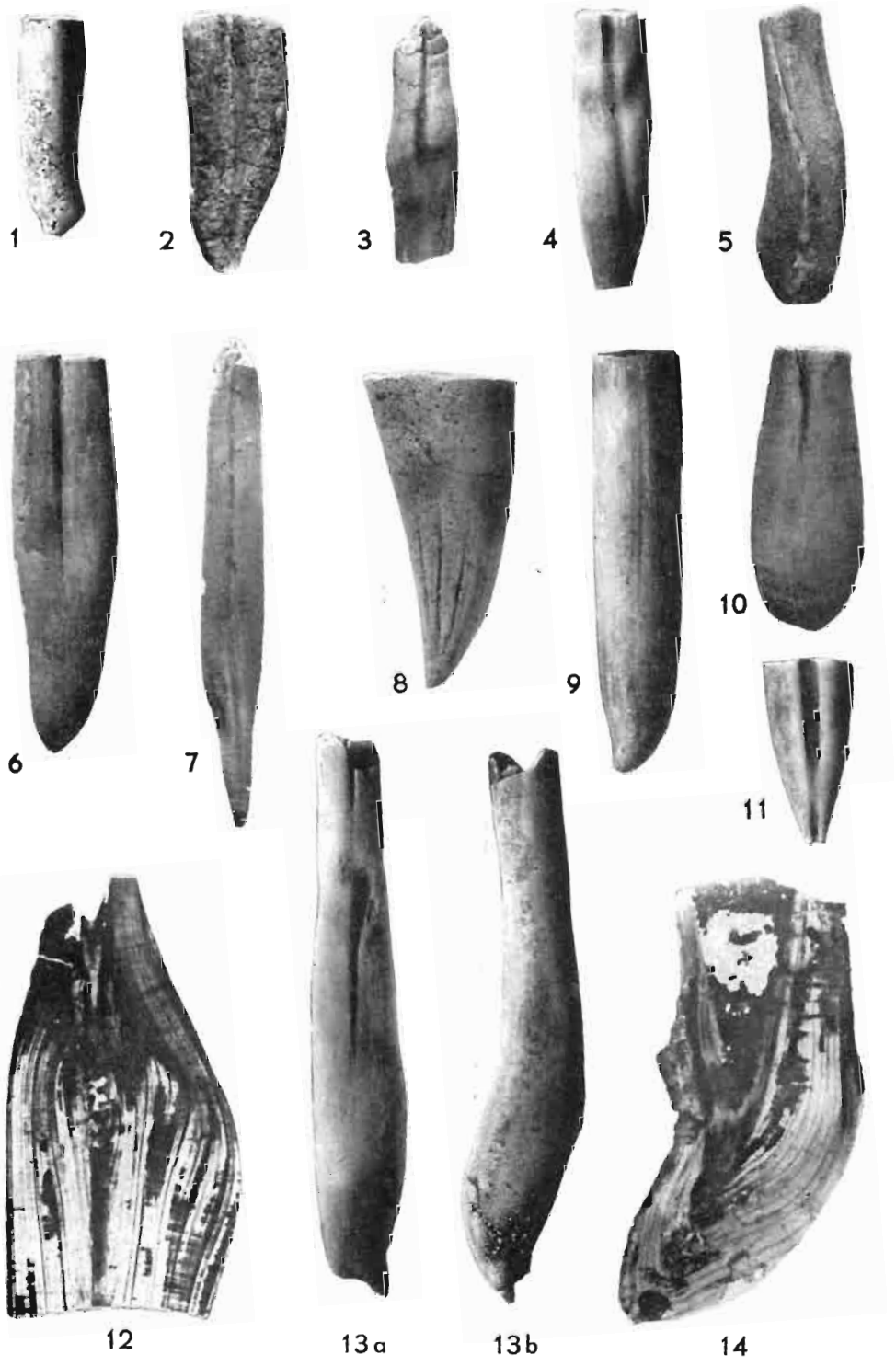
Род *Pseudobelus* Blainville, 1827
Pseudobelus coquandus (d'Orbigny, 1842)
(пл. IV, фиг. 1—5)

Ростры палицеобразные, небольшой величины, суженные сильно в проксимальной части и сильно сплющенные в боковом направлении. Дорсальная стенка более узкая, вентральная пошире. Боковые линии двойные, изогнуты также как и ростр к дорсальной стороне. Поперечный разрез овальный, с более длинным дорсо-вентральным диаметром, приближается к квадратному, или грушеобразный, с более широкой вентральной стенкой. Концевой участок короткий, асимметричный, снабжен шипообразным или бородавчатым мукроном. Борозды отсутствуют.

PLATES

Pl. I

Fig. 1. Rostrum with bifurcated apex; nat. size (Bj. 843).
Fig. 2. The apex sigmodally curved; × 2 (Bj. 839).
Fig. 3. Intumescences in the proximal part of rostrum; slightly magnified (Bj. 832).
Fig. 4. Intumescences in the medial part of rostrum and the bending of furrow; nat. size (Bj. 833).
Fig. 5. The bent of furrow and widening of the apical part of rostrum: slightly magnified (Bj. 835).
Fig. 6, 10. Two rostra with anormal apical thickening; nat. size (Bj. 830, 834).
Fig. 7. Rostrum with anormal apical constriction; slightly magnified (Bj. 844).
Fig. 8. Apical part of rostrum arcuately bent, with numerous longitudinal corrugations; × 2 (Bj. 841).
Fig. 9. Rostrum with arcuately bent apex; nat. size (Bj. 858).
Fig. 11. Rostrum with symmetrical bifurcation of the apex; nat. size (Bj. 842).
Fig. 12. Thin longitudinal section of rostrum, damaged during the early growth stages, with anormal course of growth lines; × 3 (Bj. 846).
Fig. 13. Arcuately bent rostrum with bifurcated apex and curved furrow: *a* ventral view, *b* side view; approx. × 1.5 (Bj. 845).
Fig. 14. Thin section through a sigmoidal rostrum; × 4 (Bj. 413).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13b
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Pl. II

Fig. 1. Rostrum covered with round pits; nat. size (Bj. 847).
Fig. 2. Semicrescent, deep canalicule with adjacent pits; × 2 (Bj. 850).
Fig. 3. Rostrum with long, narrow pits and a canalicule penetrating the apical part; × 2 (Bj. 849).
Fig. 4. Numerous, minute, longitudinal pits; × 1.5 (Bj. 848).
Fig. 5, 6. A foraminifer *Bullopora rostrata* settled on the surface of rostrum; × 8 (Bj. 852-3).
Fig. 7. A tube of *Serpula limax* settled on the surface of rostrum; × 1.5 (Bj. 851).
Fig. 8. Concentric aggregates of chalcedony; × 2 (Bj. 854).

Pl. III

Hastites privatensis (Mayer)

Fig. 1-3. Three rostra of different individual age: *a* side view, *b* ventral view; × 1.5 (Bj. 732-3, 755).

Fig. 4. Longitudinal section of the adult rostrum with growth lines, indicating the successive growth stages; × 2 (Bj. 738).

Fig. 5. *(a-d)*. Four transverse sections of adult rostrum: *a-b* quadrangular outline in proximal part, *c-d* subcircular outline in distal part; × 6 (Bj. 739).


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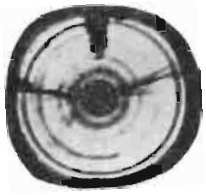
1b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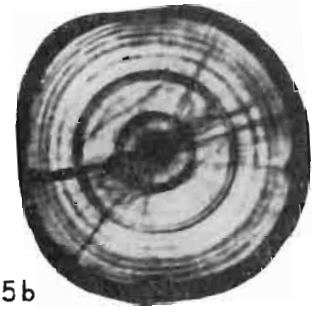
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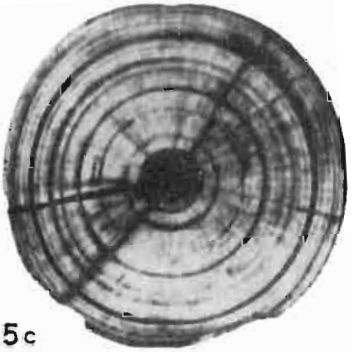
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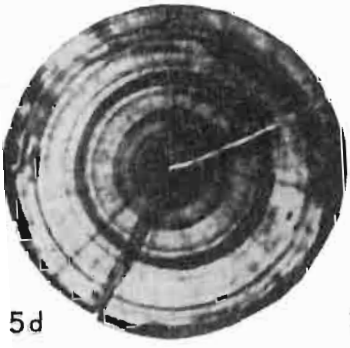
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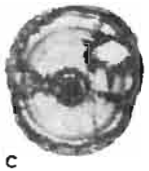
3a
3b

4a


4b


4c


4d


1a 1b

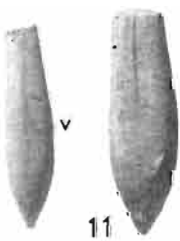
5


8a 8b


2a 2b

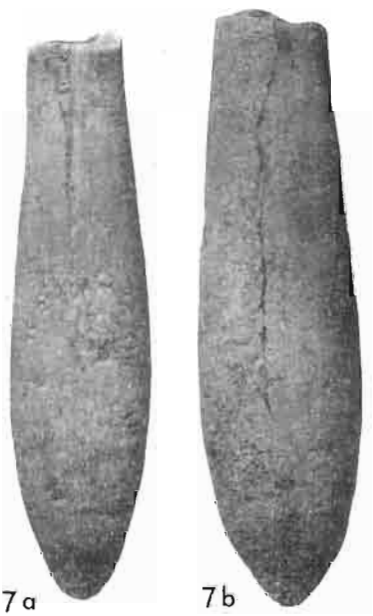

9

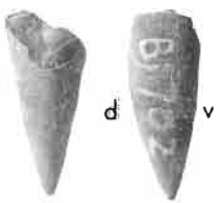

3a 3b



10 11


6a 6b


7a 7b



12a 12b

Pl. IV

Pseudobelus coquandus (d'Orbigny)

Fig. 1-3. Three rostra of different individual age: *a* side view, *b* ventral view; × 1.5 (Bj. 754, 760, 763).

Fig. 4 (*a-d*). Four transverse sections of adult rostrum: *a* behind the alveolus, *b-c* medially, *d* apically; × 3 (Bj. 765).

Fig. 5. Longitudinal section of adult rostrum in the plane of symmetry; × 4 (Bj. 764).

Rhopaloteuthis spissus (Gillieron)

Fig. 6, 7. Two rostra of adult individuals: *a* dorsal view, *b* side view; × 1.5 (Bj. 541-2).

Rhabdobelus exilis (d'Orbigny)

Fig. 8. Rostrum of an adult individual: *a* side view, *b* ventral view; × 1.5 (Bj. 740).

Rhabdobelus parvus (Hartmann)

Fig. 9-11. Three rostra of different individual age, side view; × 1.5 (Bj. 744-746).

Brachybelus breviformis (Voltz)

Fig. 12. Rostrum of an adult individual: *a* ventral view, *b* side view; × 1.4 (Bj. 702).

Pl. V

Gastrobelus ventroplanus (Voltz)

Fig. 1. Longitudinal section of an adult rostrum in the plane of symmetry; × 3 (Bj. 803).

Fig. 2 (*a-e*). Five transverse sections of an adult rostrum from proximal to distal part; × 9 (Bj. 804).

Fig. 3-6. Four rostra of different individual age: *a* ventral view, *b* side view; × 1.6 (Bj. 712, 714, 717-18).

Fig. 7. An adult rostrum: *a* ventral view, b side view; × 1.5 (Bj. 701).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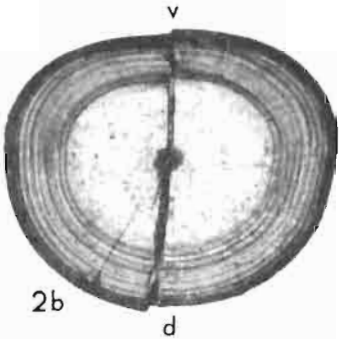
2a



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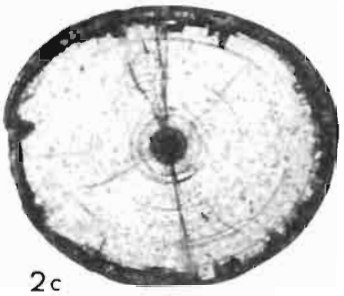
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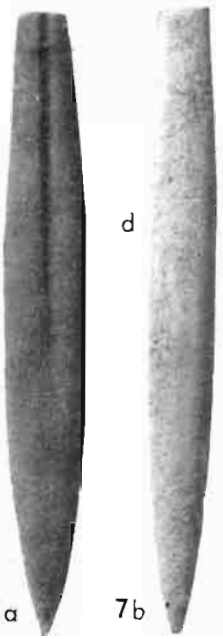
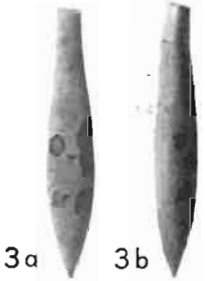
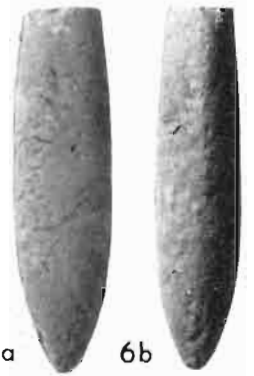


7a 7b

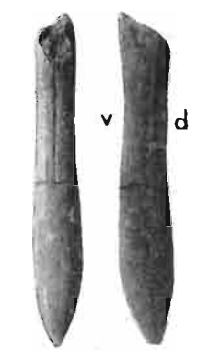

3a 3b

4a 4b


5a 5b

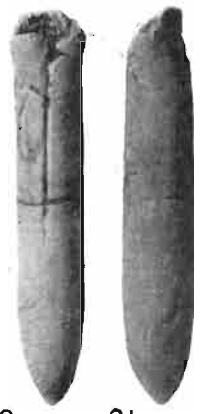

6a 6b

1a 1b



v d

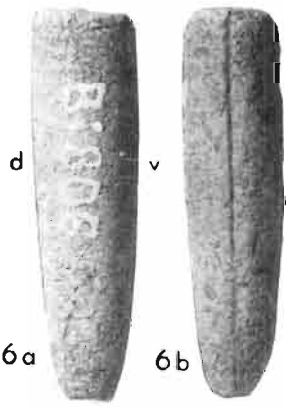
2a 2b



3a 3b

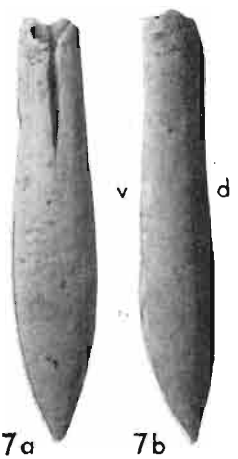
4a 4b

5a 5b



d v

6a 6b



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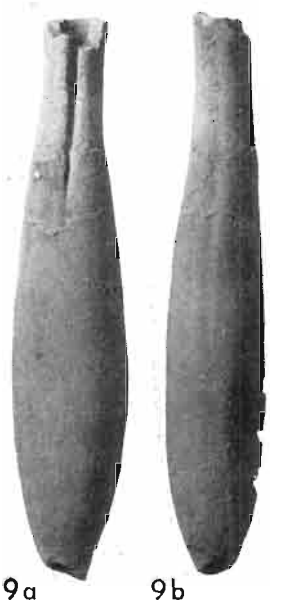

9a 9b

Pl. VI

Fig. 1-3. *Rhopaloteuthis argovianus* (Mayer). Three rostra of different individual age: *a* dorsal view, *b* side view; × 1.5 (Bj. 543-545).

Fig. 4. *Dactyloteuthis irregularis* (Schlotheim). An adult rostrum: *a* ventral view, *b* side view; × 1.5 (Bj. 703).

Fig. 5, 6. *Dicoelites waageni* (Neumayr). Two adult rostra: *a* side view, *b* ventral view; × 1.5 (Bj. 806-7).

Fig. 7-9. *Rhopaloteuthis sauvanausus* (d'Orbigny). Three rostra of different individual age: *a* dorsal view, *b* side view; × 1.5 (Bj. 573-575).

Pl. VII

Megateuthis giganteus (Schlotheim)

Fig. 1. Longitudinal section of rostrum, showing lamellar structure of the axial part: × 5 (Bj. 53).

Fig. 2. Young rostrum with broad apical furrows: *v* ventral side, *d* dorsal side; nat. size (Bj. 10).

Fig. 3. Phragmocone polished ventrally, showing the ratio of septal necks to that of septa; × 2 (Bj. 57).

Fig. 4. Longitudinal section of phragmocone with „subcircular structures"; × 10 (Bj. 58).

Fig. 5. Phragmocone with septa and siphonal tube; × 3 (Bj. 56).

Fig. 6. Side view of phragmocone; nat. size (Bj. 46).

Fig. 7. Longitudinal section of the apical part of rostrum, showing the resorption progressing from the apex; × 1.5 (Bj. 52).

Fig. 8. Phragmocone with protoconch and multilamellar septa, showing a part of siphonal tube; × 15 (Bj. 54).

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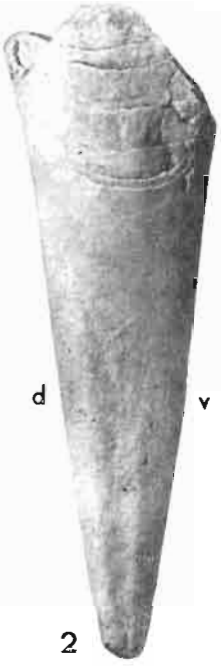

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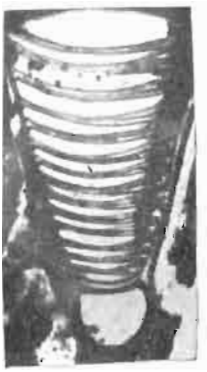

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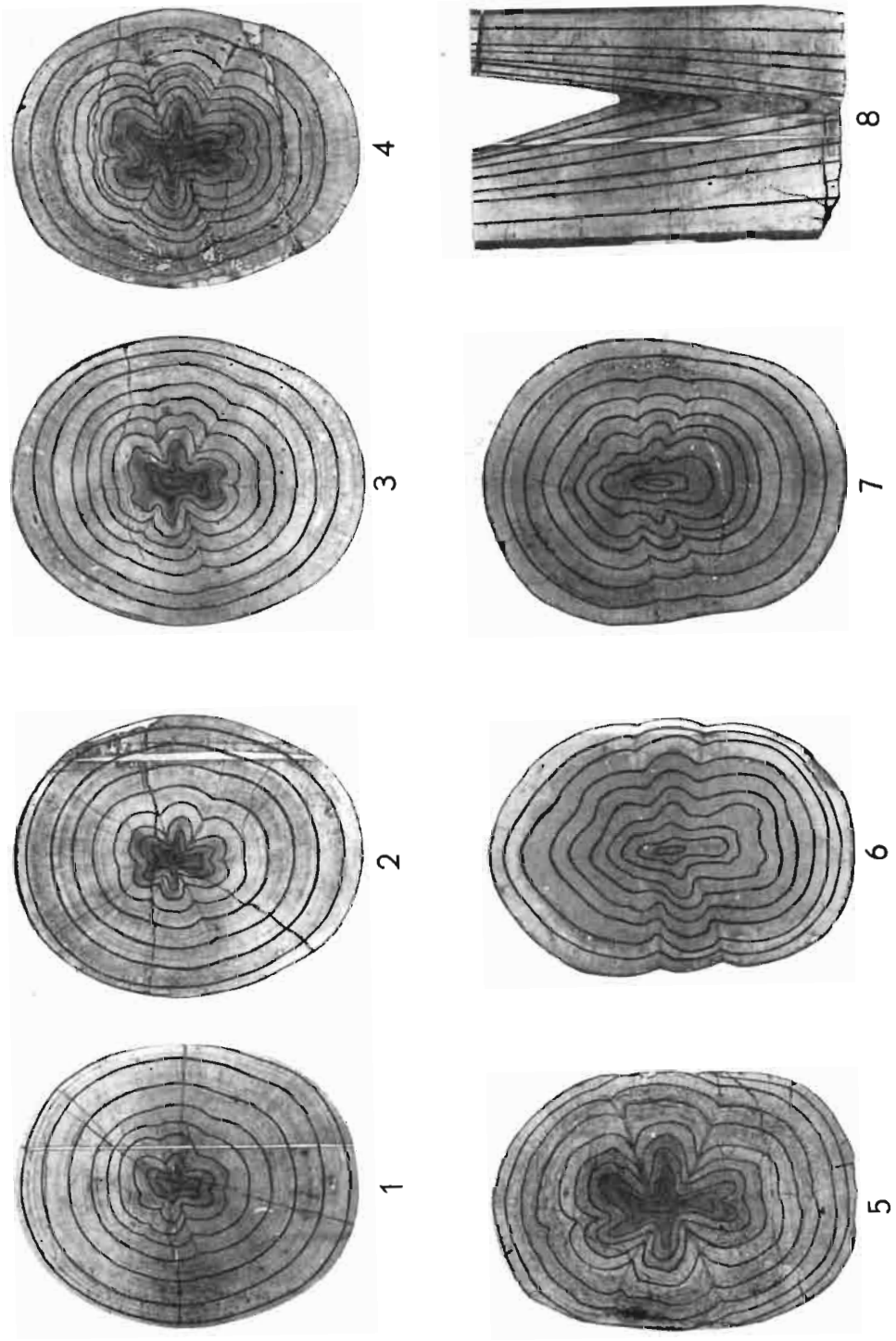
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Pl. VIII

Megateuthis giganteus (Schlotheim)

Fig. 1-5. Five transverse sections of adult rostrum with main growth lines marked, showing the initially irregular apical furrows; × 4-×6 (Bj. 41-a, c, e, i, l).

Fig. 6, 7. Two transverse sections of adult rostrum with main growth lines marked, showing the regular apical furrows; × 7, × 8 (Bj. 60-a, b).

Fig. 8. Longitudinal section of the alveolar part of adult rostrum with main growth lines marked; × 2.5 (Bj. 43).

Pl. IX

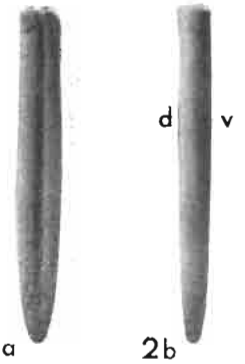
Belemnopsis canaliculatus (Schlotheim)

Fig. 1-5. Five rostra of different individual age: *a* ventral view, *b* side view; nat. size (Bj. 86, 91, 95, 97, 100).

Fig. 6 (*a-c*). Three transverse sections of adult rostrum, from the alveolar to medial part; × 6 (Bj. 104).

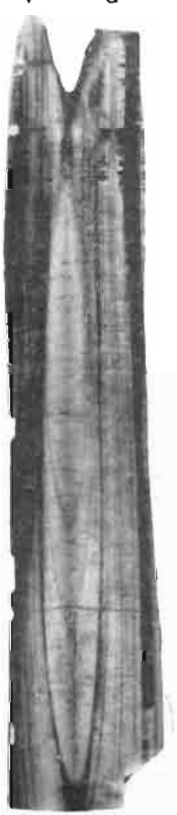
Fig. 7. Longitudinal section of adult rostrum in the plane of symmetry; × 2 (Bj. 102).

1a 1b



2a 2b

3a 3b



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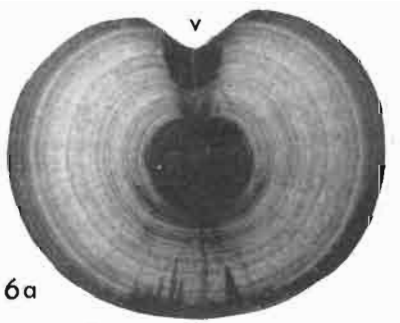
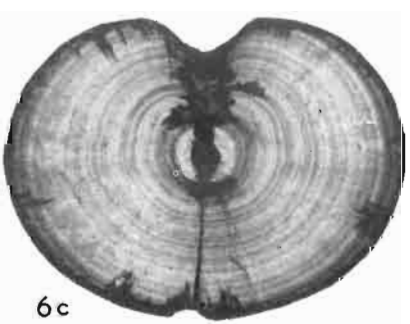


6a

6b



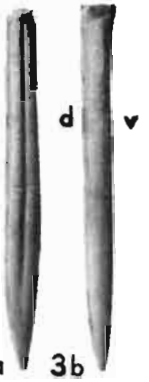
6c

4a 4b

5a 5b

1a 1b

2a 2b

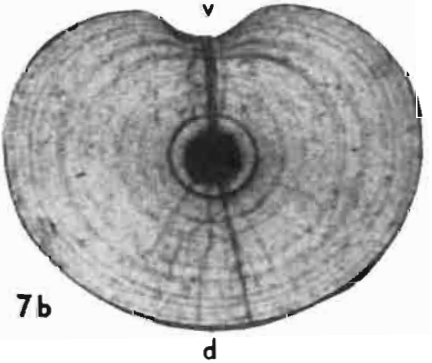


3a 3b

4a 4b

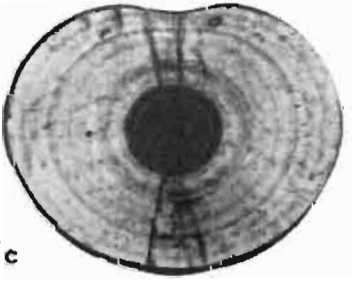
7a

6a 6b



7b

5a 5b



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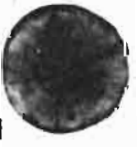


7d

Pl. X

Belemnopsis fusiformis (Parkinson)

Fig. 1-6. Six rostra of different individual age: *a* ventral view, b side view; nat. size (Bj. 265, 269, 271-2, 279, 281).

Fig. 7 (*a-c*). Three transverse sections in various parts of rostrum, from the alveolus to the apex; × 7 (Bj. 287).

Pl. XI

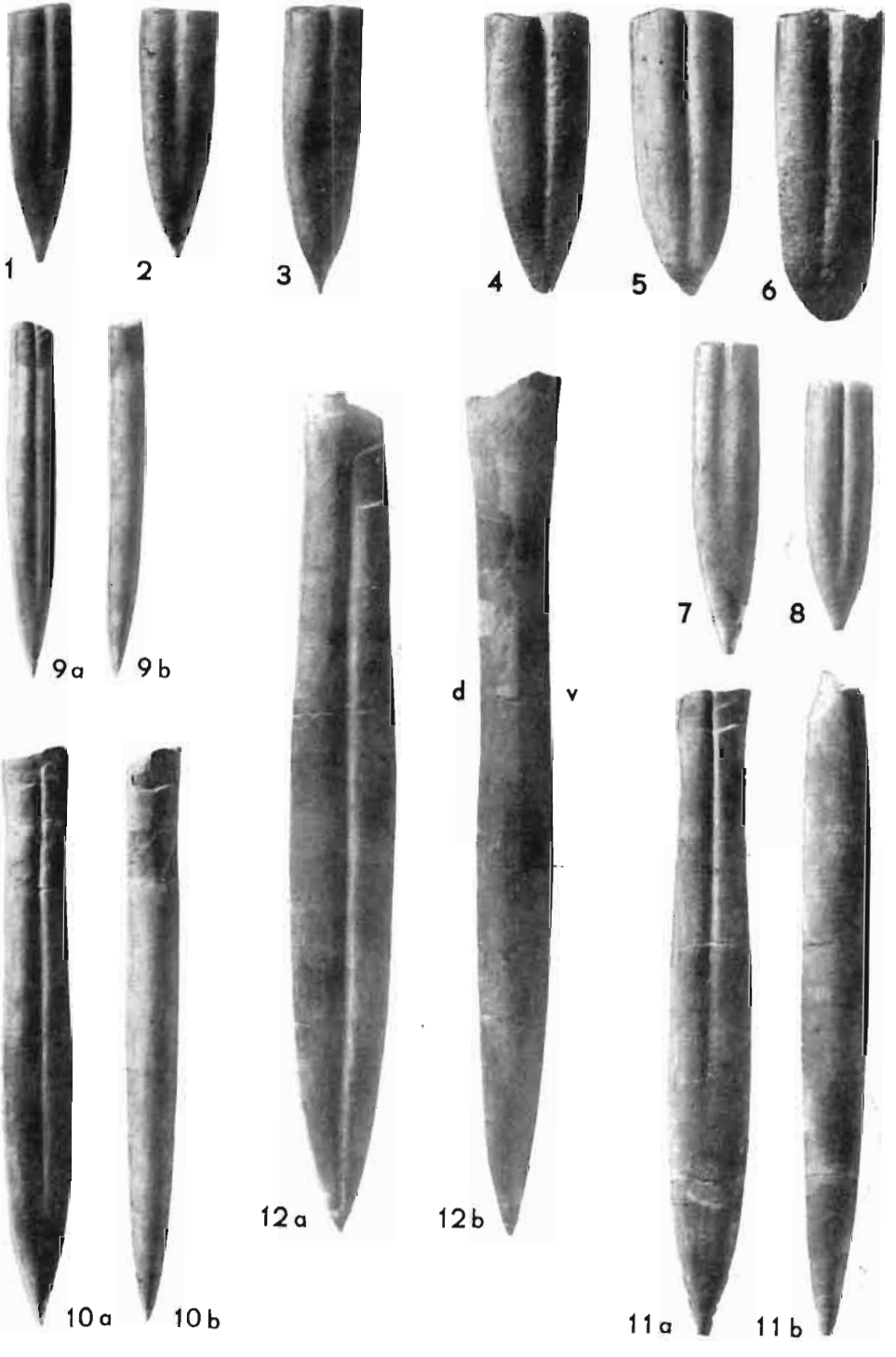
Belemnopsis latesulcatus (d'Orbigny)

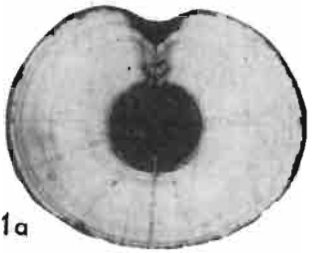
Fig. 1-3. Apical parts of three rostra, showing the passage from an elongated and pointed apex to a mucronate one; size (Bj. 131, 135, 138).

Fig. 4-6. Apical parts of three rostra, showing the passage from a pointed apex to a rounded one; nat. size (Bj. 139-141).

Fig. 7, 8. Apical parts of two rostra, showing width variations of the ventral furrow; nat. size (Bj. 132-3).

Fig. 9-12. Four rostra of different individual age: *a* ventral view, *b* side view; nat. size (Bj. 111, 116, 120, 123).


1
2
3
4
5
6
9a
9b
12a
d
v
12b
7
8
10a
10b
11a
11b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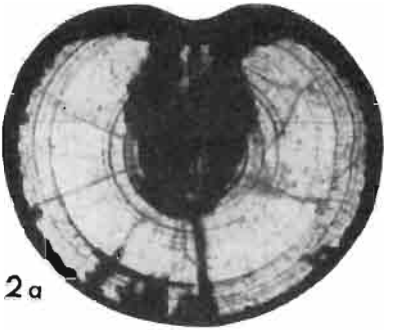
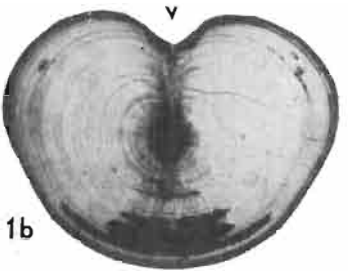

2a



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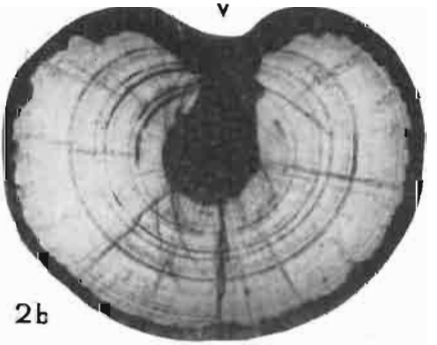

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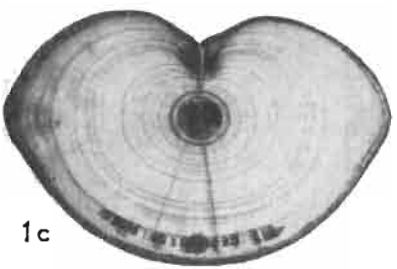
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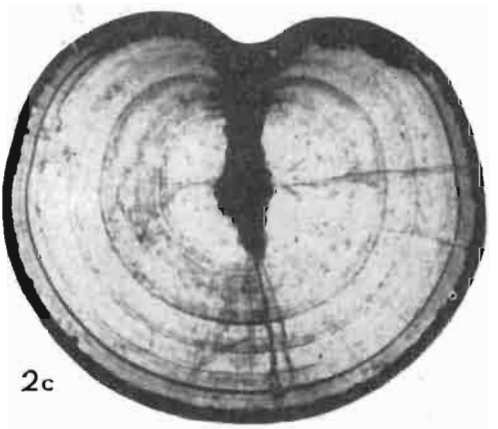

2c


1d

Pl. XII

Fig. 1 (*a-d*). *Belemnopsis latesulcatus* (d'Orbigny). Four transverse sections in various parts of rostrum, from the alveolus to the apex; × 3 (Bj. 125, 130).

Fig. 2 (*a-c*). *Belemnopsis subhastatus* (Zieten). Three transverse sections in various parts of rostrum, from the alveolus to the apex, × 10 (Bj. 221).

1a 1b

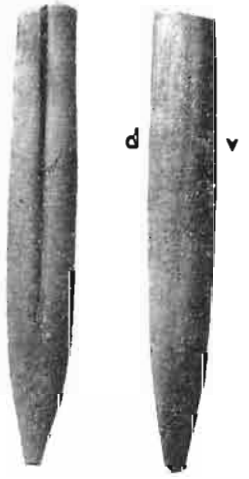
2a 2b

3a 3b

4a 4b

5a 5b

7



d v

6a 6b

8a

d v

8b

v d

9

Pl. XIII

Belemnopsis subhastatus (Zieten)

Fig. 1-6. Six rostra of different individual age: *a* ventral view, *b* side view; nat. size (Bj. 169, 190, 195, 203, 208, 215).

Fig. 7. Longitudinal section in the plane of symmetry; × 2.2 (Bj. 225).

Belemnopsis latesulcatus (d'Orbigny)

Fig. 8a, 9. Longitudinal sections of two rostra in the plane of symmetry; × 2 (Bj. 127, 129); 8b longitudinal section of the phragmocone of specimen 8*a*; × 3 (Bj. 129).

Pl. XIV

Belemnopsis parallelus germanicus (Roemer)

Fig. 1-5 Five rostra of different individual age: *a* ventral view, *b* side view; × 1.5 (Bj. 232, 242, 248, 252, 254).

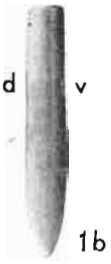
Fig. 6. Phragmocone with protoconch and air chambers; × 18 (Bj. 258).

Fig. 7. Longitudinal section of phragmocone with protoconch; × 7 (Bj. 260).

Fig. 8. (*a*-*b*). Two longitudinal sections: *a* behind the alveolus, *b* at midlength of rostrum; × 9 (Bj. 261).


1a


6



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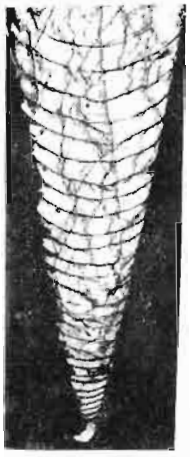
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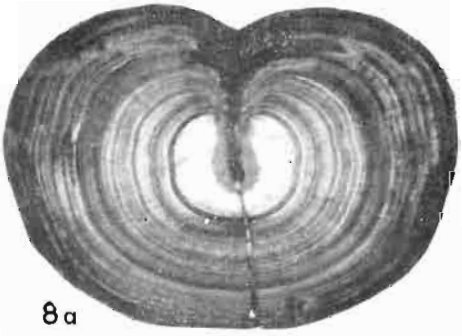
2a


2b


3a


3b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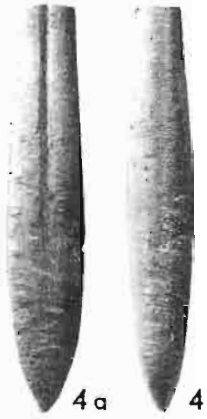
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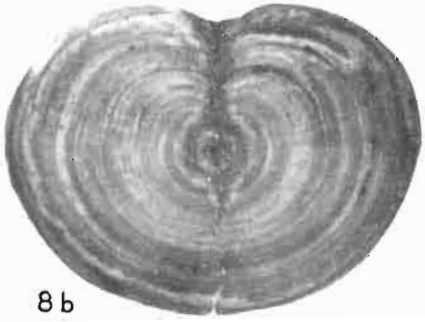
4b


8b


5a


5b

Pl. XV

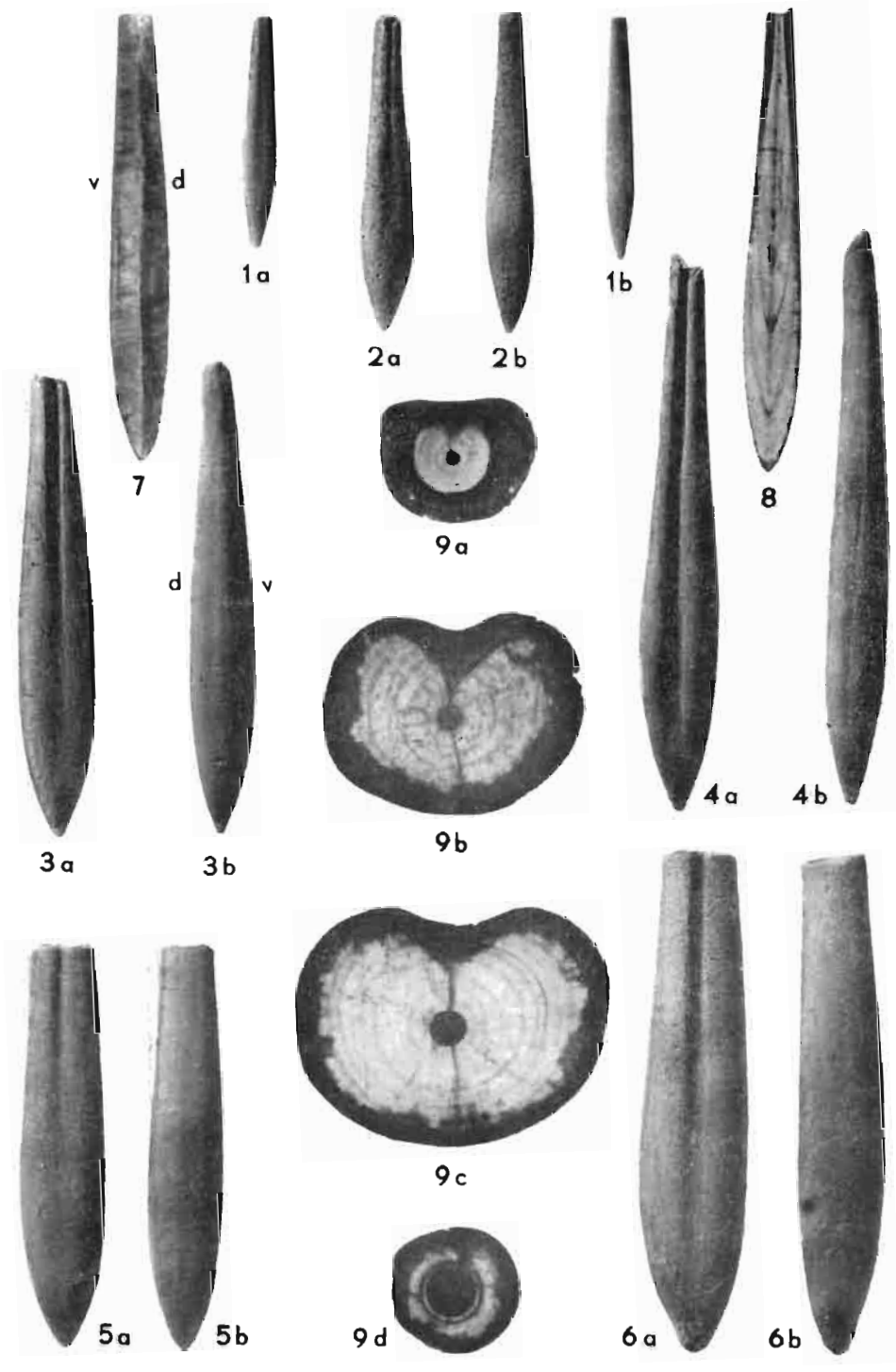
Belemnopsis semiarcuatus n. sp.

Fig. 1-6. Six rostra of different individual age: *a* ventral view, *b* side view; × 2 (Bj. 297, 302, 316, 318-holotype, 322-3).

Fig. 7. Rostrum cleaved in the plane of symmetry, showing the fissural area in left view; nat. size (Bj. 319a).

Fig. 8. Longitudinal section in the plane of symmetry; × 2 (Bj. 326).

Fig. 9 (*a-d*). Four transverse sections in various parts of rostrum, from the alveolus to the apex; × 10 (Bj. 324).

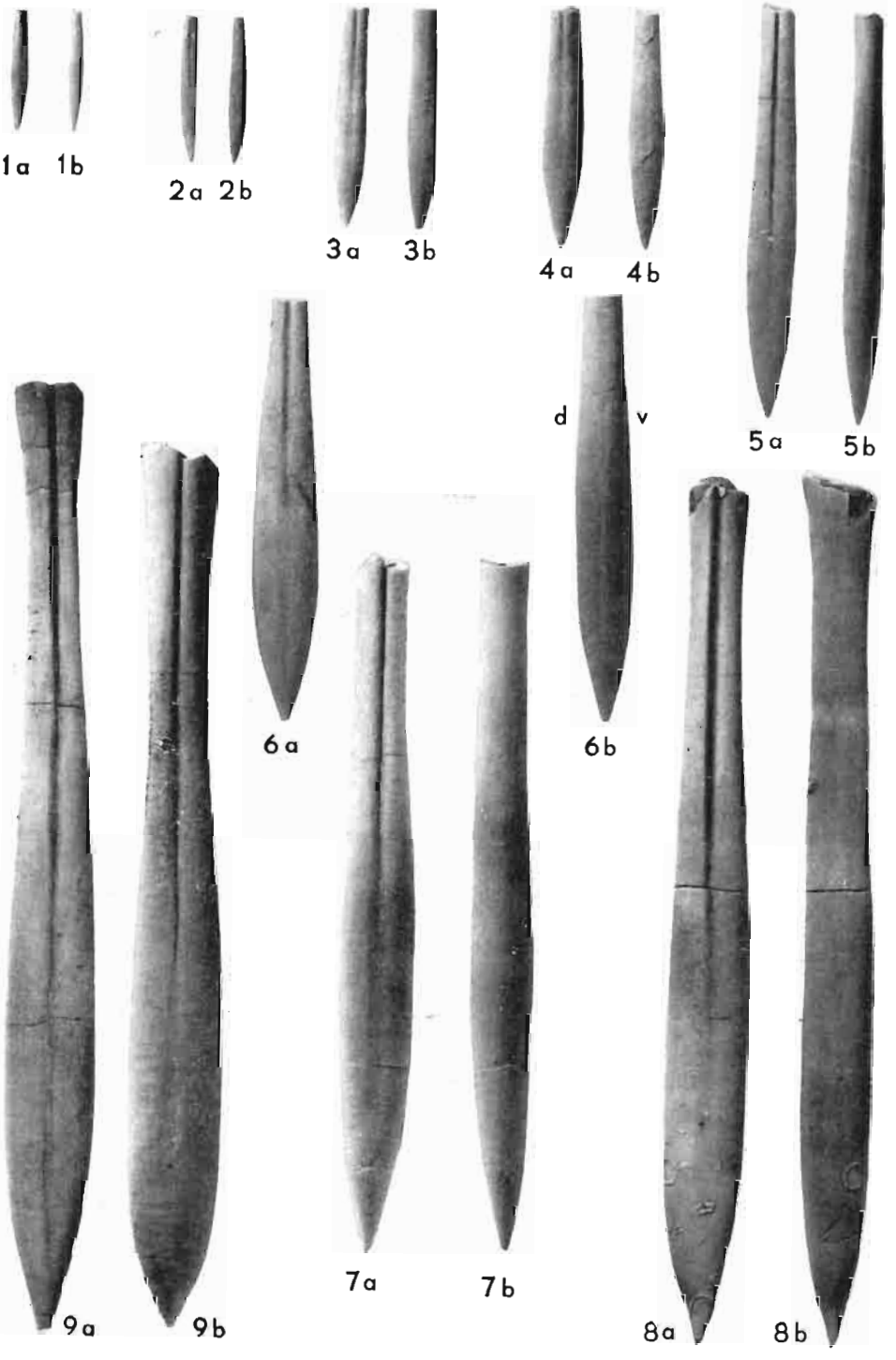

v
d
1a
2a
2b
1b
7
8
9a
d
v
3a
3b
4a
4b
9b
9c
5a
5b
9d
6a
6b

Pl. XVI

Hibolites hastatus (Blainville)

Fig. 1-8. Eight rostra of different individual age: *a* ventral view, *b* side view; nat. size (Bj. 361-2, 365-7, 369, 371-2).

Fig. 9. Two adult rostra: *a* typical individual of fusiform shape, *b* individual with thick apical part; nat. size (Bj. 375-6).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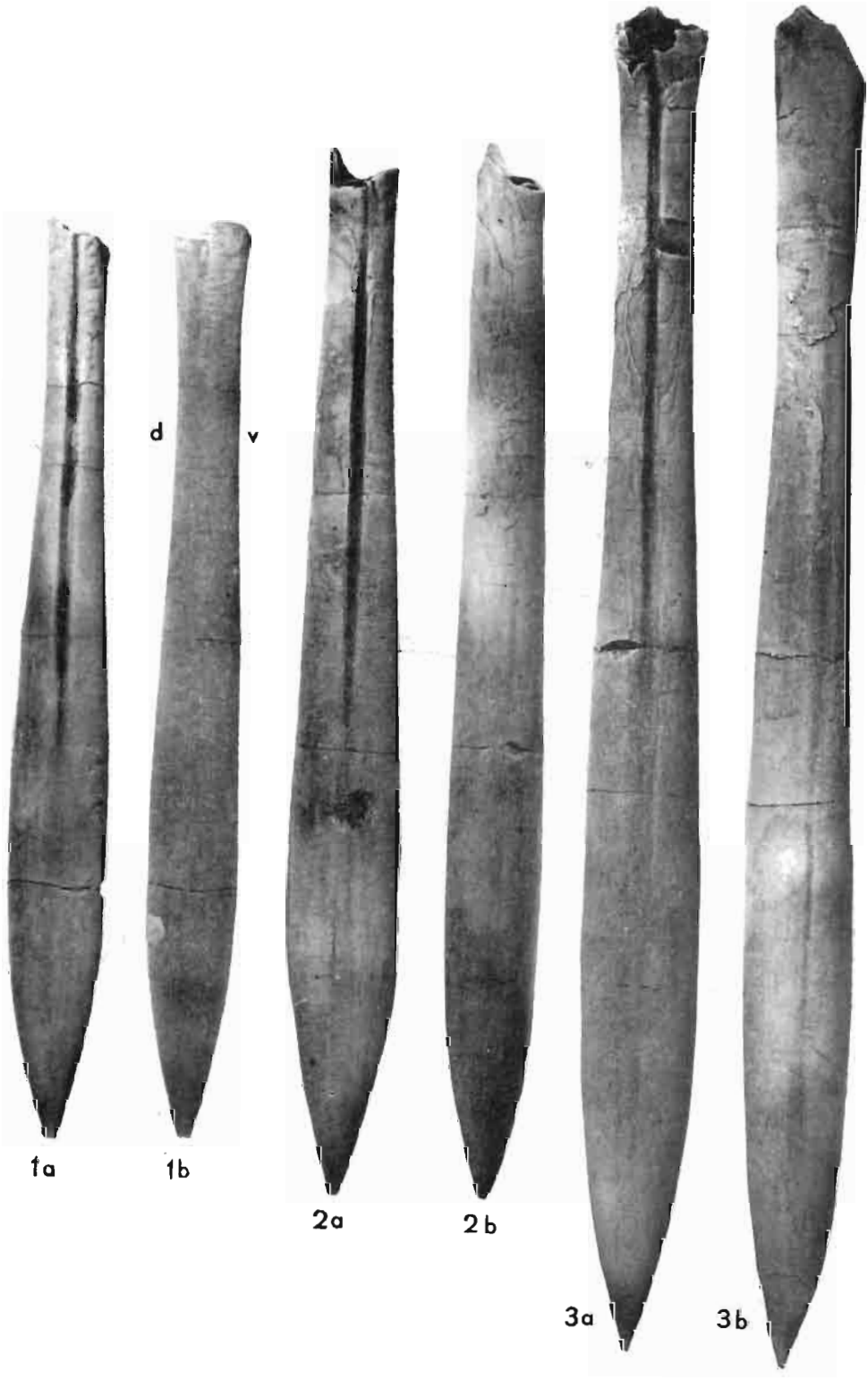
2a 2b
3a 3b
4a 4b
5a 5b
d v
6a
6b
7a 7b
8a 8b
9a 9b


d
v
1a
1b
2a
2b
3a
3b

Pl. XVIII

Hibolites hastatus (Blainville)

Fig. 1. Longitudinal section of adult rostrum in the plane of symmetry; × 1.2 (Bj. 399).

Fig. 2 (*a*-d). Four transverse sections of adult rostrum in various parts, from the alveolus to the apex; × 3.5 (Bj. 400).

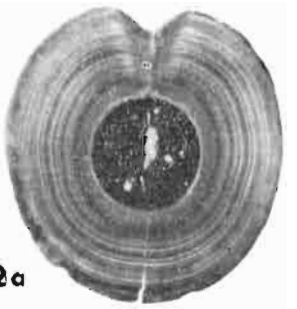
Fig. 3, 4. Two longitudinal sections of the phragmocone, with protoconch and air chambers; × 4, × 2.5 (Bj. 401-2).

Pl. XVII

Hibolites hastatus (Blainville)

Fig. 1-3. Three adult rostra: *a* ventral view, *b* side view; nat. size (Bj. 379, 382, 384).

1



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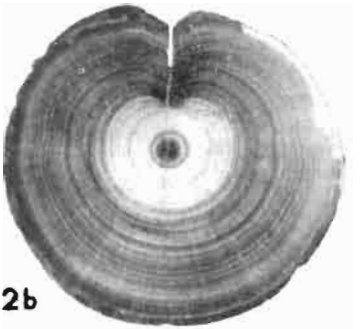

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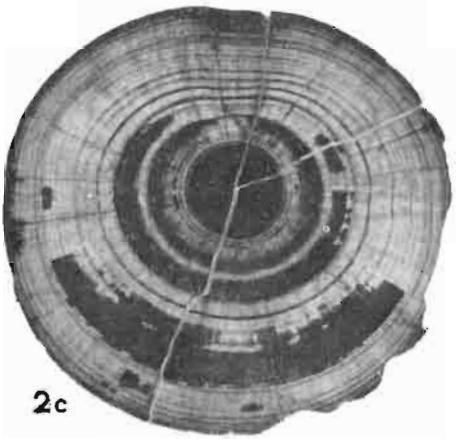

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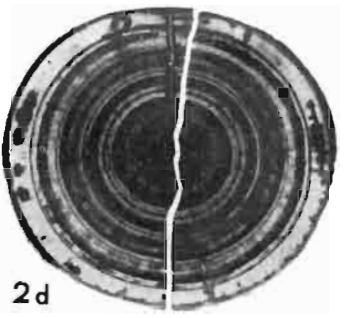
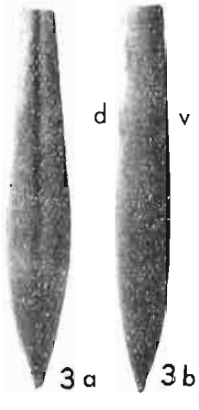


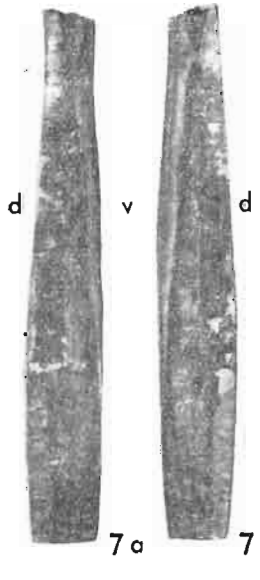
2d

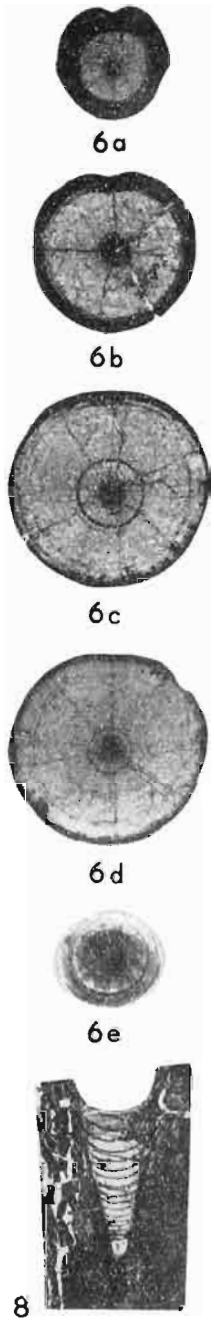
3

4


1a
1b


d
v
3a
3b


d
v
d
7a
7b


6a
6b
6c
6d
6e
8


2a
2b


4a
4b


5a
5b

Pl. XIX

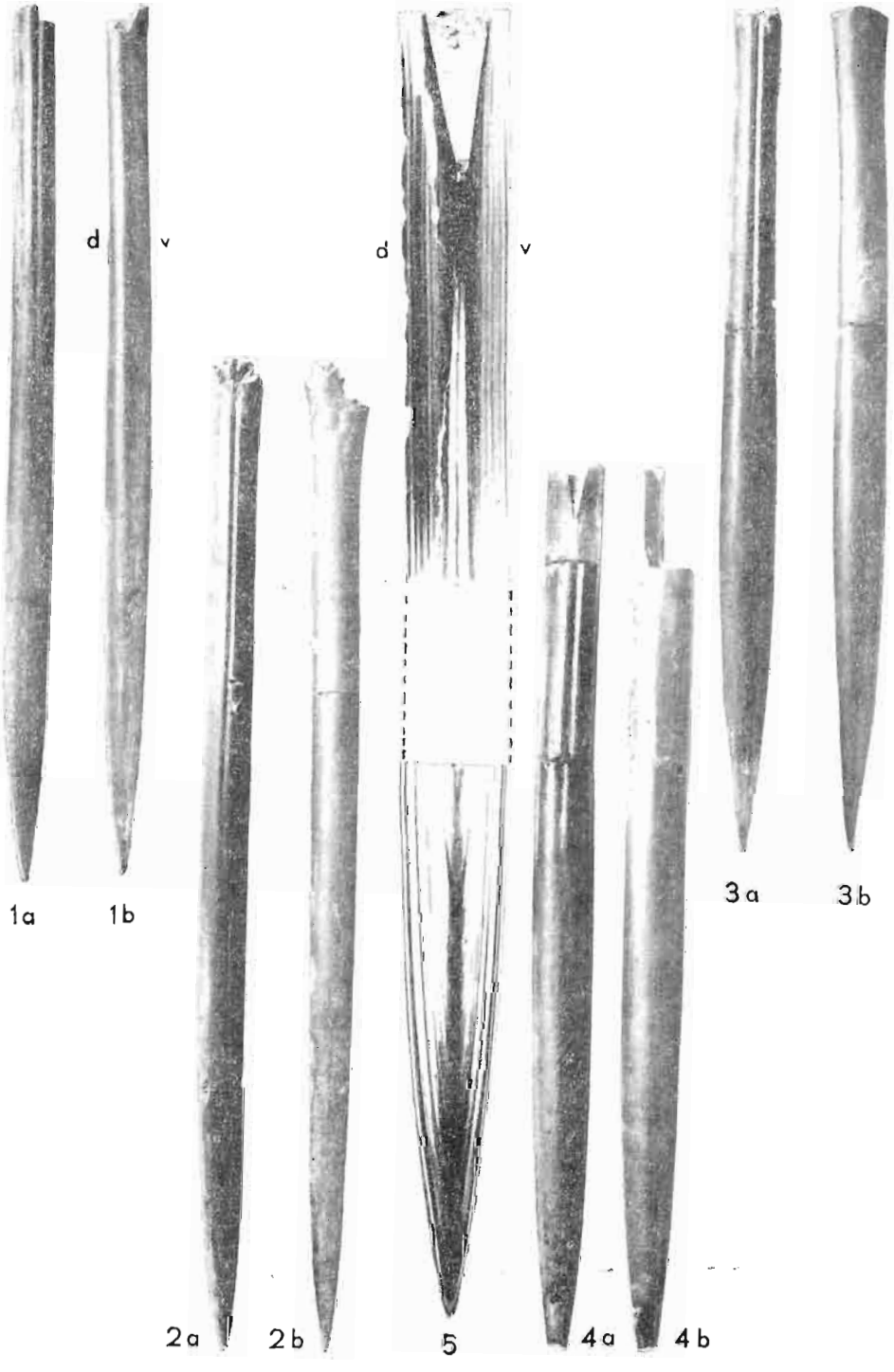
Hibolites semihastatus (Blainville)

Fig. 1-5. Five rostra of different individual age: *a* ventral view, b side view; nat. size (Bj. 414, 434, 439, 442, 447).

Fig. 6 (*a-e*). Five transverse sections in various parts of rostrum, from the alveolus to the apex; × 5 (Bj. 454).

Fig. 7. Rostrum cleaved in the plane of symmetry, showing the fissural area; slightly magnified (Bj. 449).

Fig. 8. Longitudinal section of the phragmocone, with protoconch and numerous air chambers; × 4 (Bj. 450).


d
v
d
v
1a
1b
2a
2b
5
4a
4b
3a
3b

Pl. XX

Hibolites beyrichi (Oppel)

Fig. 1-4. Four rostra of different individual age: *a* ventral view, *b* side view; nat. size (Bj. 517-19, 521).

Fig. 5. Longitudinal section of adult rostrum in the plane of symmetry; × 2 (Bj. 529).

Pl. XXI

Hibolites beyrichi (Oppel)

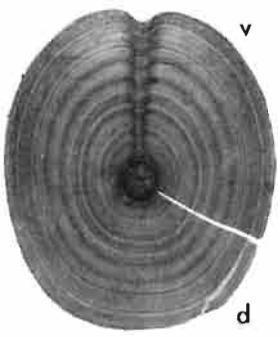
Fig. 1, 2. Two transverse sections: *a* in the initial part of alveolus, *b* in midlength of rostrum; × 6 (Bj. 530).

Fig. 3. Phragmocone of adult individual, with protoconch and numerous air chambers; × 3 (Bj. 524).

Fig. 4. Longitudinal section of phragmocone in the plane of symmetry, with protoconch and air chambers; × 4 (Bj. 529).

Hibolites württembergicus (Oppel)

Fig. 5 (*a-e*). Five transverse sections in various parts of rostrum; from the alveolus to the apex; × 8 (Bj. 512).



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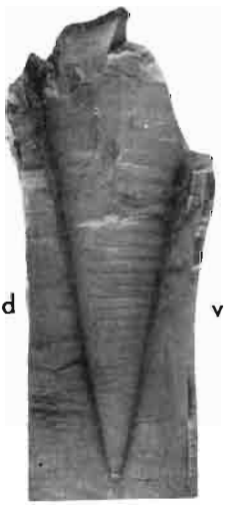
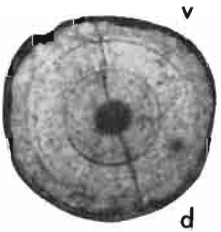


3

5a

5b

4



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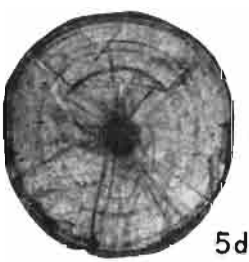

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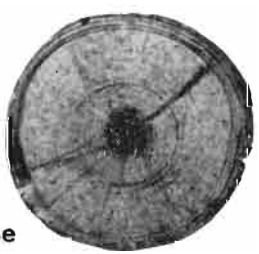
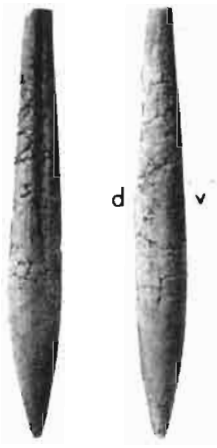


5e

1a 1b



2a 2b

3a 3b

6

4a 4b

7

5a 5b

8

Pl. XXII

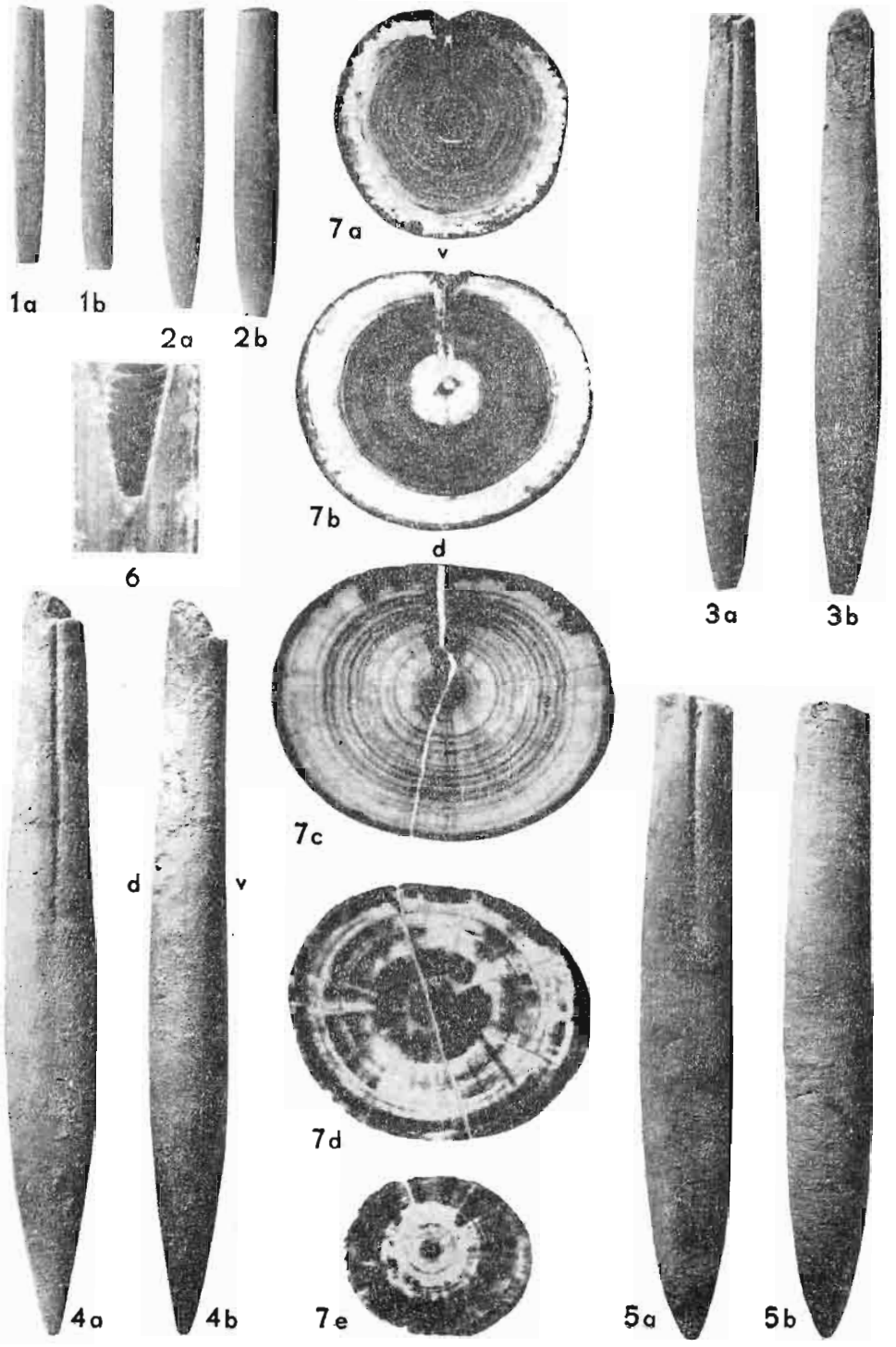
Hibolites württembergicus (Oppel)

Fig. 1-5. Five rostra of different individual age: *a* ventral view, *b* side view; × 2 (Bj. 495, 498, 504, 507, 509).

Fig. 6. Longitudinal section of adult rostrum in the plane of symmetry; × 2.5 (Bj. 511).

Fig. 7. Fragmentary rostrum showing the characteristic weathering of the proximal part; × 2.5 (Bj. 510).

Fig. 8. Typical adult rostrum with a serpuloid tube attached to the ventral furrow; × 2.5 (Bj. 506).


1a
1b
2a
2b
7a
v
7b
d
6
3a
3b
7c
4a
d
v
4b
7d
7e
5a
5b

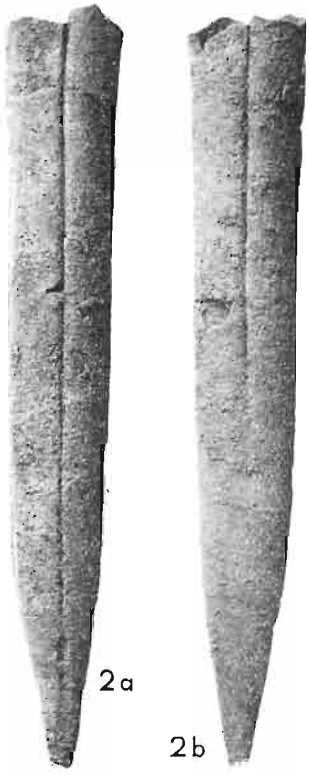

1a


1b

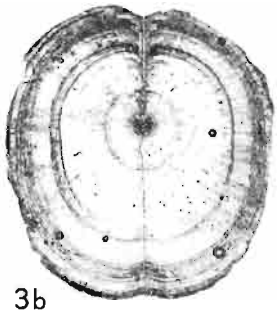

4


1c

3a


2a

2b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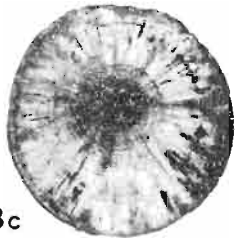

3c

2c

Pl. XXIII

Hibolites girardoti (Loriol)

Fig. 1-5. Five rostra of different individual age: *a* ventral view, *b* side view; × 1.5 (Bj. 464, 466, 474, 479-80).

Fig. 6. Longitudinal section of phragmocone, with protoconch and air chambers; × 4 (Bj. 487).

Fig. 7 (*a-e*). Five transverse sections in various parts of adult rostrum, from the alveolus to the apex; × 6 (Bj. 488).

Pl. XXIV

Dicoelites meyrati (Ooster)

Fig. 1, 2. Two adult rostra: *a* ventral view, *b* dorsal view, *c* side view; × 1.5 (Bj. 811, 817).

Fig. 3 (*a*-*c*). Three transverse sections in various parts of rostrum, from the alveolus to the apex: × 4 (Bj. 823); × 12 (Bj. 823d).

Fig. 4. Phragmocone with protoconch and air chambers; × 15 (Bj. 820).

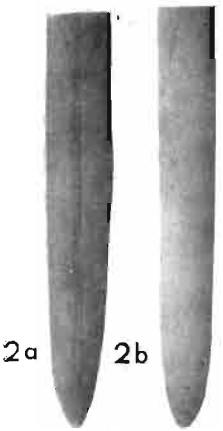
Pl. XXV

Duvalia disputabilis (Neumayr)

Fig. 1-5. Five rostra of the various individual age: *a* side view,*b* ventral view; × 2.4 (Bj. 766-770).

Fig. 6. Transverse section of the rostrum behind the alveolus: *a* ventral side, *d* dorsal side; × 11 (Bj. 800).

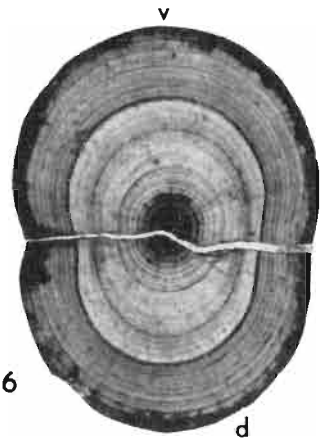
Fig. 7. Transverse section of the adult rostrum with folded medial growth lines; × 70 (Bj. 800).


2a 2b


1a 1b


4a 4b

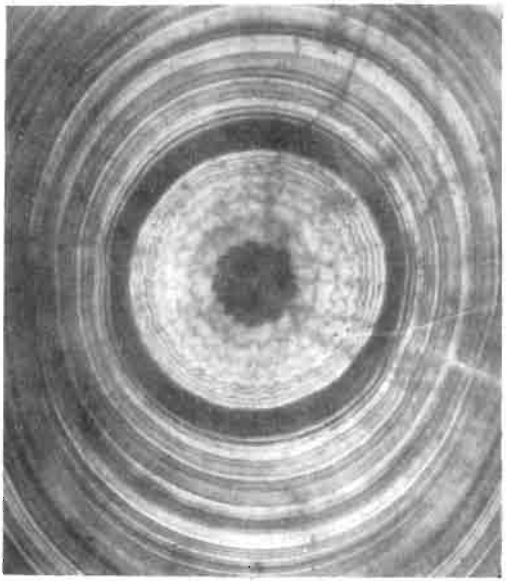

3a



6


3b


5a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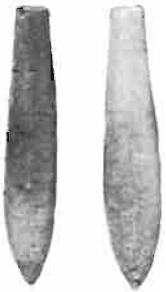
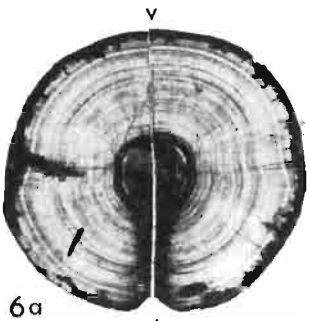
5b

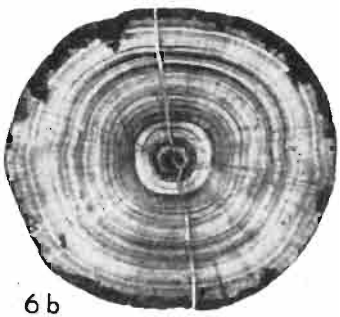


1a 1b

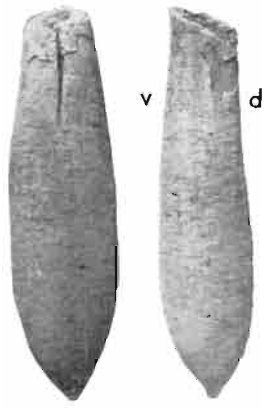


6a

7

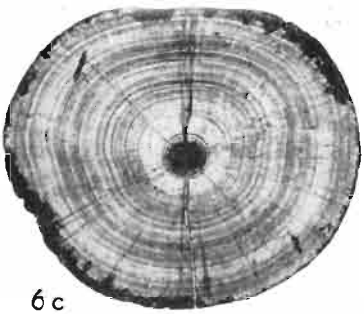


6b

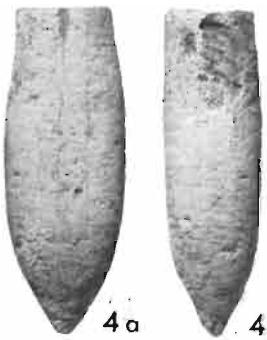


3a 3b

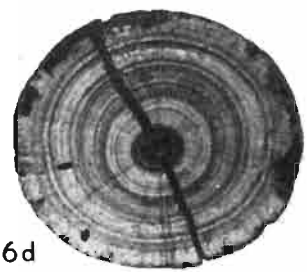
2a 2b



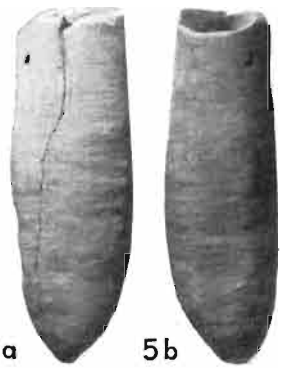
6c



4a 4b



6d



5a 5b

Pl. XXVI

Rhopaloteuthis gillieroni (Mayer)

Fig. 1-5. Five rostra of the various individual age: *a* dorsal view, *b* side view; × 1.6 (Bj. 692–696).

Fig. 6 (*a-d*). Four transverse sections of an adult rostrum in various parts, from the alveolus to the apex; × 4.5 (Bj. 562).

Fig. 7. Longitudinal section of a gerontic rostrum in the plane of symmetry: *v* ventral side, *d* dorsal side; × 2 (Bj. 698).