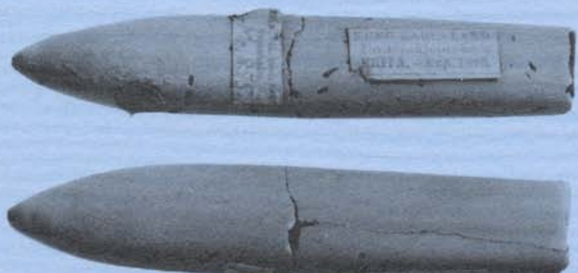
SKRIFTER NR. 189

Peter Doyle and Simon R. A. Kelly

The Jurassic and Cretaceous belemnites of Kong Karls Land, Svalbard



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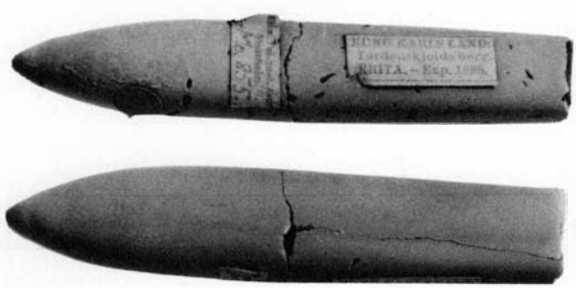

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Abstract

The Jurassic and Cretaceous belemnites collected by the 1969 Norske Fina Cambridge Svalbard Expedition from Kong Karls Land, Svalbard, are described, and the genera *Lenobelus, Paramegateuthis, Cylindroteuthis, Pachyteuthis, Acroteuthis* and *Hibolithes* are recognized. Two new species, *Paramegateuthis nalnyaevae* Doyle and *Cylindroteuthis (Arctoteuthis) bluethgeni* Doyle are described from sediments of Middle Jurassic and Lower Cretaceous age, respectively. From belemnite evidence, the oldest age of the Janusfjellet Formation in Kong Karls Land (Passet and Dunérfjellet members) is deduced as ?Toarcian/Aalenian-Bajocian, with a youngest age (Tordenskjoldberget Member) of probably late Valanginian–Hauterivian. The Kong Karls Land belemnites studied have affinities to those of the other Arctic regions (Canada, Alaska, the northern USSR, the Arctic islands), although some taxa are common to the northwest European fauna as well. This indicates that from the Middle Jurassic to Lower Cretaceous times Svalbard belonged to the Arctic belemnite province of the Boreal Realm.

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1. Introduction

1.1 The scope of the study

The purpose of this paper is to describe in detail the Jurassic and Cretaceous belemnites of the Janusfjellet Formation of Kong Karls Land, Svalbard that were collected by the Norske Fina/ Cambridge Svalbard Expedition in 1969, and to discuss their biostratigraphic and biogeographic distribution. Part of the belemnite fauna of Kong Karls Land (mainly from the Tordenskjoldberget Member) was originally described by Blüthgen (1936), using material collected by Nathorst's 1898 expedition (housed in Naturhistoriska Riksmuseet, Stockholm), and Blüthgen's results are revised below. The Kong Karls Land belemnites are of considerable importance because they have strong affinities with those occurring in the northern USSR, Canada and the other Arctic islands, although retaining some European influences. The full biogeographic implications of this fauna will be explored elsewhere. In the following discussion, italicized numbers cited thus, CSE *D.2864*, indicate specimens in the Cambridge Spitsbergen Expeditions Collection, while non-italicized numbers prefixed by CSE loc. (e.g. CSE loc. D.833) refer to localities given in Fig. 1. Type and figured specimens have been transferred to the Sedgwick Museum, University of Cambridge (e.g. SMC X.14305).

1.2 Previous work

Kong Karls Land is a small group of islands situated on the eastern edge of the Svalbard Archipelago. There are three main islands, namely Abeløya, Kongsøya and Svenskøya (Fig. 1); a summary of the topography and history of investigations into Kong Karls Land is given by Smith et al. (1976). Mesozoic sediments are known only from Kongsøya and Svenskøya, from which the first fossil to be described was a piece of wood, *Larix johnseni* (Schröter 1880, who originally assigned it a Tertiary age). Detailed palaeontological investigations commenced with the expedition led by Nathorst in 1898 which supplied the data for a series of palaeontological and biostratigraphic papers by various authors (e.g. Pompeckj 1899; Nathorst 1901, 1910; Lindström 1900; Woodward 1900; Gothan 1907, 1911; Burckhardt 1911), the most detailed being that of Blüthgen (1936) who described Jurassic and Cretaceous ammonites, bivalves and belemnites from Svenskøya and Kongsøya. The present study is based on specimens recovered by the 1969 Norske Fina/ Cambridge Svalbard Expedition. Results from this expedition have been mostly confined to the lithostratigraphy of Kong Karls Land (e.g. Smith et al. 1976), but there has been some work on the Jurassic ammonite fauna (Rawson in Smith et al. 1976; Rawson 1982), and one of us (S.R.A.K.) is presently working on the buchiid bivalve fauna. Other palaeontological studies based principally on material collected by Norwegian expeditions to Kong Karls Land include work on the microfossils (Bjærke & Manum 1977; Løfaldli 1978; Verdenius 1978; Bjærke 1980; Løfaldli & Nagy 1980) and the Triassic vertebrates (Worsley & Heintz 1977).

2. Stratigraphical distribution of Svalbard belemnites

2.1 Introduction

Belemnites are known from relatively few of the islands of the Svalbard archipelago. Rostra are unknown in the Mesozoic (predominantly Triassic) sediments of Hopen, Barentsøya, Edgeøya and Nordaustlandet, and only broken, indeterminate fragments have been recorded from Wilhelmøya (Klubov 1965). Some species have been recorded from Spitsbergen, and a brief review of these is given below. The stratigraphic distribution of the new Kong Karls Land material is then described in more detail.

2.2 Belemnites from Spitsbergen

Many early workers recorded belemnite fragments from Spitsbergen (e.g. Lindström 1865; Nordenskjöld 1866, 1867; Lundgren 1883), and many such fragments are recorded from the Festningen profile (see Hoel & Orvin 1937 for summary). Few authors have been more specific, but some did apply names, and these are briefly reviewed below and listed in Fig. 3.

Spath (1921) recorded a Triassic belemnoid from Lower Sassendal which he assigned to the aulacocerid genus *Atractites*, common in Triassic and Lower Jurassic strata of southern Europe. Belemnite phragmocones are common in the Jurassic Brentskardhaugen Bed (Fig. 3), but they

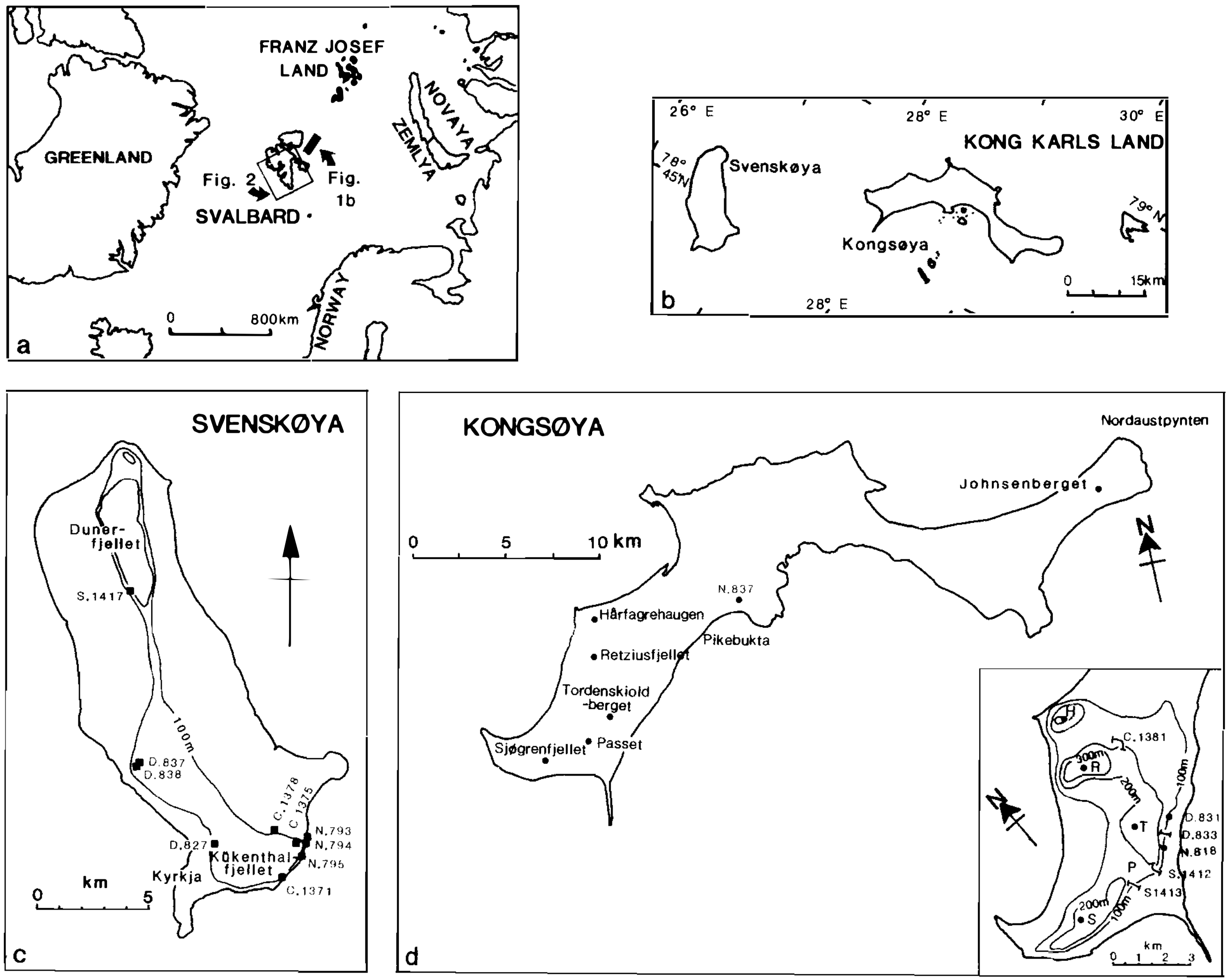

Fig. 1. Sketch maps of localities mentioned in text. 1a. Location of the Svalbard archipelago. Position of Kong Karls Land marked by black line (see Fig. 1b); Spitsbergen in box (see Fig. 2). 1b. Kong Karls Land, showing position of Svenskøya and Kongsøya. Unnamed island is Abeløya. 1c. Sketch maps of Svenskøya, and 1d. Kongsøya, with individual collecting localities (CSE locs., e.g. N.837) indicated.

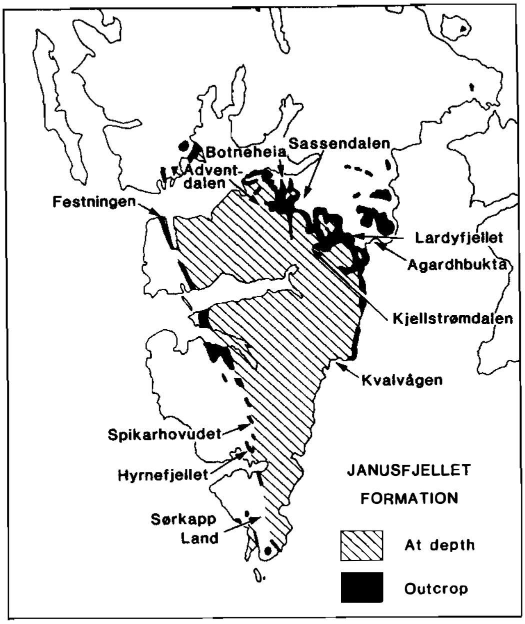

Fig. 2. Sketch map of central and southern Spitsbergen (see Fig. 1a) showing the extent of the Janusfjellet Formation (after Flood et al. 1971) and the localities mentioned in the text.

cannot be assigned with any certainty to rostra, and are of little value. However, Bäckström & Nagy (1985) did record *Hastites?* sp. (possibly a *Pseudodicoelites* sp.) from this horizon. A single rostrum of ?*Passaloteuthis* and another of ?*Acrocoelites* from the Brentskardhaugen Bed of Lardyfjellet in the CSE collection (CSE *P.2445, P.2443s*, respectively) confirm a Lower Jurassic age for this horizon and locality. In the Janusfjellet Formation, *Pachyteuthis, Lagonibelus* and *Cylindroteuthis* have been recorded from sediments of Callovian-Kimmeridgian age (Fig. 3). *Lagonibelus* has been recorded from Volgian sediments at the base of the Tirolarpasset Member of the Janusfjellet Formation (Birkenmajer & Pugaczewska 1975), and *Acroteuthis (Microbelus)* has also been recorded from strata of this age (Fig. 3). Those specimens referred to as *Acanthoteuthis* by Frebold (1930) are likely to be coleoid arm hooks only, as hook specimens in Stockholm (NRS) from Spitsbergen bear this name on their labels. Apart from some indeterminate rostra of Valanginian age, only *Hibolithes* and *Acroteuthis* s. str. are recorded with certainty from Cretaceous (Hauterivian) strata, and younger belemnites are known only as broken fragments from the Festningen profile (Hoel & Orvin 1937).

2.3 Belemnites from Kong Karls Land

The most recent review of the geology of Kong Karls Land is that of Smith et al. (1976), who were the first authors to set up a rigid stratigraphic framework for the islands. Their stratigraphic scheme is used here (Fig. 4) in conjunction with the modifications suggested by Edwards et al. (1979) and Pickton et al. (1979). The stratigraphic distribution of the belemnites in Kong Karls Land is given below and in Figs. 5–7.

Edwards et al. (1979, Table 1) include the Passet Member within the Wilhelmøya Formation, and correlated the Dunérfjellet Member with the Janusfjellet Formation. However, belemnite evidence suggests that the Passet Member may be equivalent to the lower part of the Dunérfjellet Member (see below), and because of their argillaceous nature, both members are here included within the Janusfjellet Formation (Fig. 4, see below). The precise relationship of the Brentskardhaugen Bed on Spitsbergen to the base of the Janusfjellet Formation in Kong Karls Land is still unclear, but belemnite evidence seems to suggest that it might correlate at least in part with the Passet Member (and basal Dunérfjellet Member). It was placed in the Janusfjellet Formation by Bäckström & Nagy (1985). However, it is included here in the Wilhelmøya Formation (Fig. 4) because of its predominantly arenaceous nature.

Wilhelmøya Formation (Kapp Toscana Group)

The Wilhelmøya Formation is equivalent to the Svenskøya Formation of Smith et al. (1976). No belemnites were collected from this formation which consists of predominantly sandy beds of continental origin on Svenskøya and Kongsøya, ranging in age from the Triassic to the Lower Jurassic. Bjærke (1980) has recorded dinoflagellates of Toarcian age from the top of this unit.

Janusfjellet Formation (Adventdalen Group)

The Janusfjellet Formation is equivalent to the Kongsøya Formation of Smith et al. (1976). Four

Formation	Stage	Genus / subgenus	Locality / reference
JANUSFJELLET FORMATION	HAUTER.	Hibolithes Acroteuthis (Acroteuthis)	Sørkapp Land (Pchelina 1967)
	VALANG.	indet. rostra	Festningen (Frebold 1928; Frebold & Stoll 1937) Kjellstrømdalen (Pchelina 1967)
	VOLGIAN	Acroteuthis (Microbelus) L. (Lagonibelus)	Kvalvågen (Whales Bay) - Agardhbukta (Obrutschew 1927; Girmounsky 1927) Festningen (Sokolov & Bodylevsky 1931) Spikarhovudet Birkenmajer & Pugaczewska 1975)
	KIMMERIDGIAN	L. (Lagonibelus)	Festningen (Cape Staratshin=Starostin) (Spath 1921) Kvalvågen - Agardhbukta (Obrutschew 1927; Girmounsky 1927) Festningen (Sokolov & Bodylevsky 1931)
		C. (Cylindroteuthis)	Kvalvågen - Agardhbukta (Obrutschew 1927; Girmounsky 1927) Festningen (Sokolov & Bodylevsky 1931) Agardhbukta (Birkenmajer et al. 1982)
		C. (Arctoteuthis)	Agardhbukta (Pchelina 1967; Birkenmajer et al. 1982)
		L. (Holcobeloides) P. (Simobelus) P. (Pachyteuthis)	Agardhbukta (Birkenmajer et al. 1982)
		Acanthoteuthis	Festningen (Frebold 1930)
	OXFORD	indet. rostra	Festningen (Frebold & Stoll 1937) Sørkapp Land (Pchelina 1967)
	BAT./CAL.	Pachyteuthis ?Cylindroteuthis	Sørkapp Land (Pchelina 1967)
WILHELMØYA FORMATION	TOAR./AAL.	?Hastites sp. indet. phragmocones	Adventdalen (Bäckstrom & Nagy 1985) Botneheia (Frebold 1929) Agardhbukta (Pchelina 1967) Hyrnefjellet (Birkenmajer & Pugaczewska 1975)
	TRIASSIC	Atractites	Sassendalen (Spath 1921)

Fig. 3. Stratigraphic distribution of belemnites from Spitsbergen, from published records. See Fig. 2 for details of localities.

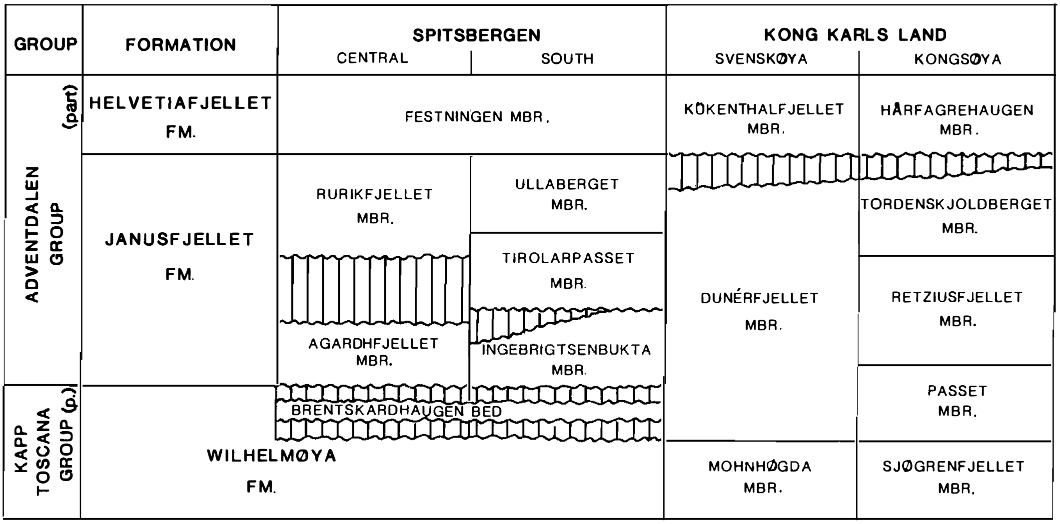

Fig. 4. Correlation of the Mesozoic strata on Spitsbergen and in Kong Karls Land.

belemnite-bearing members of this formation are recognized in Kong Karls Land (Fig. 4), namely the Dunérfjellet Member on Svenskøya and its lateral equivalents, the Passet, Retziusfjellet and Tordenskjoldberget members, on Kongsøya. All four members consist predominantly of argillaceous facies and are therefore here placed within the Janusfjellet Formation.

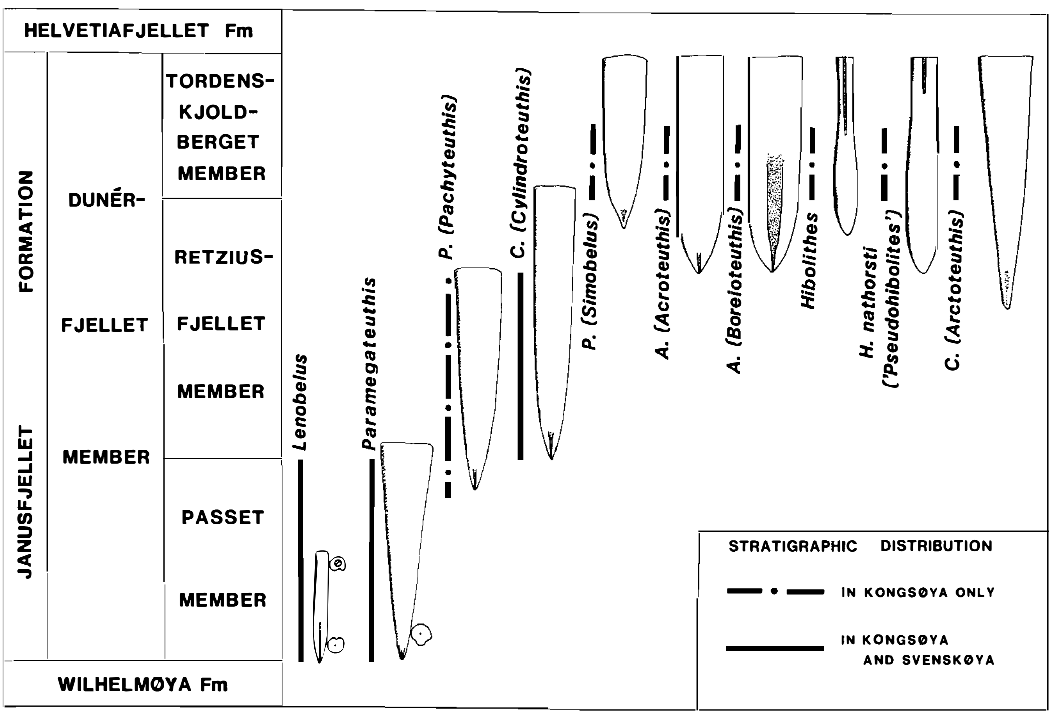

Fig. 5. Stratigraphic distribution of belemnites from Kong Karls Land.

Dunérfjellet Member. – This member is found exclusively on Svenskøya and is probably equivalent to the Passet, Retziusfjellet and Tordenskjoldberget members on Kongsøya. The type section is approximately 1 km NNW of the southern end of the Dunérfjellet Plateau (Fig. 1), where the member is in excess of 63 m thick and consists entirely of shale in two clear divisions. The lower division (42 m) contains the ammonites *Arcticoceras* and *Cadoceras* near its base, which were originally throught to indicate a late Bathonian or initial Callovian age (Rawson in Smith et al. 1976). This age was later revised by Rawson (1982) who identified *Arcticoceras* cf. *harlandi* comparable to those from Kongsøya, suggesting a Middle Bathonian age. Late Oxfordian cardioceratid ammonites have been recognized from higher in the sequence (Smith et al. 1976). One of these (CSE *C.5809*) can be identified as *Quenstedtoceras mariae* suggesting the presence of the *mariae* Zone of early Oxfordian age. Bjærke & Manum (1977) have recorded an ?Oxfordian palynological assemblage from this sequence at Kükenthalfjellet. This division contains an abundant fauna of belemnites. At various localities on Kükenthalfjellet (CSE loc. N.793–795, C.1371, C.1375) *Lenobelus* and *Paramegateuthis* of probable Aalenian-Bajocian age are recorded from its base, while *Pachyteuthis (Pachyteuthis)* and *Cylindroteuthis (Cylindroteuthis)* (which have a Bathonian-Volgian range) are known from higher levels in the type section (CSE loc. S.1417), Kükenthalfjellet (CSE loc. D.827, C.1375) and north of Kyrkja (CSE loc. D.837, D.838).

The upper shale division of the Dunérfjellet Member contains the ammonite *Amoeboceras (Amoebites)* identified as early Kimmeridgian in age by Rawson (in Smith et al. 1976), although specimens of *Buchia tenuistriata* (Lahusen) (CSE *D.2164, D.2165*) occurring in this division suggest a late Kimmeridgian age. Belemnites were recorded by members of the 1969 expedition, but unfortunately none were collected.

Passet Member. – The type section of this member is at Passet, near the southwest corner of Tordenskjoldberget on western Kongsøya. Here it consists of more than 65 m of predominantly argillaceous sediments which correspond stratigraphically to the lower part of the Dunérfjellet Member on Svenskøya. Nathorst (1901, p. 362) dated this unit (his bed 4) as early Callovian, based on a fauna of *Cadoceras* spp. and *'Belemnites subextensus-panderi'* identified by Pompeckj (1899). However, the ammonites referred to are actually from Svenskøya (Dunérfjellet Member) (Pompeckj 1899, p. 464) rather than Kongsøya. An earlier Jurassic age was provided by Løfaldli & Nagy (1980) who recognized foraminiferal assemblages of Sinemurian-Toarcian age in this member.

Smith et al. (1976) provided no additional biostratigraphic evidence beyond indicating that a fauna of small belemnites was characteristic of the Passet Member. This fauna is dominated by *Lenobelus* and *Paramegateuthis* conspecific with those from Svenskøya both at Passet (CSE loc. S.1412, S.1413) and Retziusfjellet (CSE loc. C.1381) where they occur 10–15 m below the Middle Bathonian *Arcticoceras* fauna (in the Retziusfjellet Member) described by Rawson (1982). Rare *Pachyteuthis (Pachyteuthis)* also occur with these genera, and it is possible that Pompeckj (1899) confused these specimens with the co-occurring *Paramegateuthis* rostra, assigning them both to his *'Belemnites subextensus-panderi'*. *Lenobelus* is characteristic of the Toarcian–Aalenian in the USSR and Canada, while *Paramegateuthis* is recorded from the Aalenian–Callovian of the USSR, Canada and Franz Josef Land, suggesting an Aalenian–Bajocian age (or even Toarcian, see Fig. 6) for the Passet Member, on belemnites alone.

Retziusfjellet Member. – The type section of this member on Kongsøya is between southeastern Retziusfjellet and northern Tordenskjoldberget (CSE loc. C.1381), where it comprises in excess of 75 m of shale. This member has been well dated by its ammonite fauna (Rawson in Smith et al. 1976; Rawson 1982). At the base are particularly well-preserved *Arcticoceras harlandi* Rawson and *Costacadoceras bluethgeni* Rawson, dated as early *ishmae* Zone (Middle Bathonian). This age is confirmed by specimens of the distinctive Middle Bathonian bivalve *Retroceramus (Retroceramus) retrorsus* (Keyserling) from this level in the CSE collections. Higher in the sequence the genera *Longaeviceras?* and *Quenstedtoceras* indicate the presence of the Middle or Upper Callovian, while the Lower Kimmeridgian is represented by *Amoeboceras* cf. *kitchini (cymodoce* Zone) and *Xenostephanus* sp. (*mutabilis* Zone, the highest ammonite zone recognized). *Buchia tenuistriata* (Lahusen) is recognized occurring with *Xeno-*

stephanus, and Zakharov (1981) regarded this bivalve as ranging throughout the Upper Kimmeridgian. The ammonites have a similar age range to those of the Dunérfjellet Member on Svenskøya. Belemnites from the Retziusfjellet Member include *Cylindroteuthis (Cylindroteuthis)* (at Tordenskjoldberget, CSE loc. D.833).

Tordenskjoldberget Member. – Smith et al. (1976) recognized the presence of this member only in western Kongsøya, where it thins westwards under the overstepping Helvetiafjellet Formation (Hårfagrehaugen Member). The type section is in the south face of Tordenskjoldberget, 1.5 km east of Passet (CSE loc. D.833), and consists of 30 m of sediments in two 15 m divisions. The upper division is argillaceous with a sparse fauna, while the lower division is more sandy with abundant belemnites from the so-called 'belemnite mounds' (*Belemnitenhügeln*; Pompeckj 1899).

The fauna of the lower division has been dated by Blüthgen (1936) as Lower to Middle Valanginian. He recorded *Buchia keyserlingi* (Lahusen) and *B. crassicolis* (Keyserling) from this level, both of which Zakharov (1981) has interpreted as belonging to the same species (using the former species name). *B. keyserlingi* is most typical of the Lower Valanginian *syzranicus* to *michalskii* zones, but is known to range from the earliest Valanginian *klimovskiensis* Zone to the Lower Hauterivian *bojarkensis* Zone. Verdenius (1978) also argued a Valanginian age for the Tordenskjoldberget Member, based on coccoliths. However, he noted that T. Bjærke (in a personal communication to M. B. Edwards) believed that its age was Valanginian to Barremian based on palynomorphs. Verdenius also noted that B. Thusu considered 'the immediately overlying part of the Tordenskjoldberget Member' to be Hauterivian to Barremian in age. Løfaldli (1978) briefly described two foraminiferal assemblages from the lower part (assemblage I) and from the upper part (assemblage II) of the Tordenskjoldberget Member. The age of both assemblages is given as broadly early Cretaceous. Assemblage I is dominated by nodosariids and species of *Trocholina* and *Spirillina*, typical of the neritic and upper bathyal zone, while assemblage II is dominated by arenaceous foraminifera of low diversity suggestive of a shallow marginal marine environment.

The belemnite fauna of the lower division consists of the following genera: *Acroteuthis*

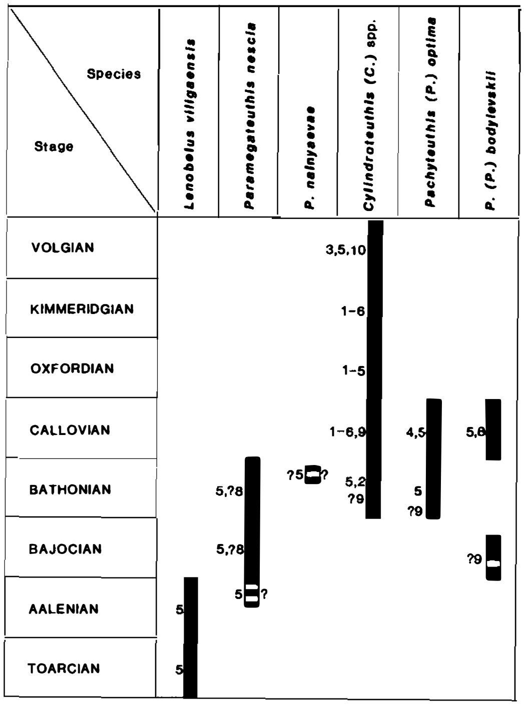

Fig. 6. Total stratigraphic range of belemnite species in the Passet, Retziusfjellet and Dunérfjellet members based on their occurrence in other successions. Compiled from various sources (see text). Key to number code (see also Table 3): 1. Europe; 2. East Greenland; 3. Russian Platform; 4. Pechora Basin; 5. Siberia; 6. Spitsbergen; 7. Novaya Zemlya; 8. Franz Josef Land; 9. Canada; 10. Alaska; 11. California.

(Acroteuthis), A. (Boreioteuthis), Pachyteuthis (Simobelus), Cylindroteuthis (Arctoteuthis) and *Hibolithes*. Some of this fauna was described by Blüthgen (1936) who assigned it a Lower to Middle Valanginian age. The fauna contains elements that range from Berriasian to Hauterivian in age, but the majority indicates that a Valanginian–Hauterivian age is likely for this division, as the species *H. jaculoides* Swinnerton, *A. (A). acmonoides* Swinnerton and *A. (A). conoides* Swinnerton occur exclusively in the Valanginian–Hauterivian interval (in Europe, the United States, Canada and Spitsbergen). Only one species from this fauna, *P. (S). curvula* Saks & Nal'nyaeva, is known to occur exclusively in the Berriasian outside Kong Karls Land (in Siberia and the Pechora Basin). The upper division is sparsely fossiliferous, and is devoid of belemnites.

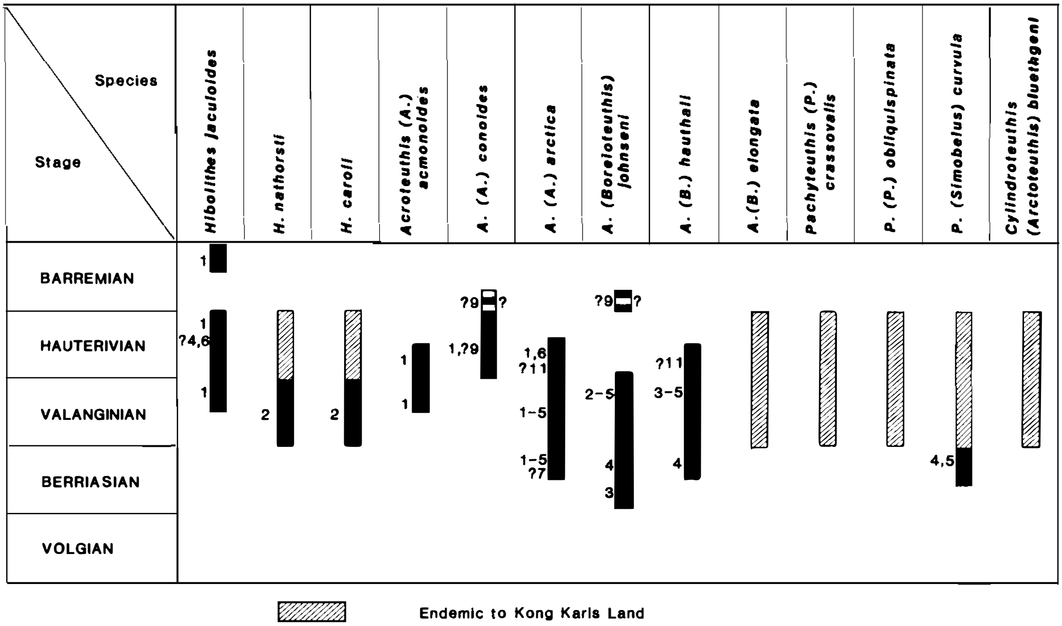

Fig. 7. Total stratigraphic ranges of the species occurring in the Tordenskjoldberget Member (lower division) based on their occurrence in other successions. Compiled from many sources (see text). Key to number code given in Fig. 6.

Helvetiafjellet Formation (Adventdalen Group)

The Helvetiafjellet Formation is equivalent to the Kong Karls Land Formation of Smith et al. (1976). No belemnites are recorded from this sequence of interbedded sandstones and lavas which cap the islands of Svenskøya and Kongsøya.

3. Belemnite rostral morphology and taxonomy

3.1 Introduction

In belemnite taxonomy, the rostrum has most significance, as phragmocone morphology varies little within lower taxonomic groupings. The features discussed here are considered to be of greatest importance in the study of belemnite rostra, and are given below in the order they appear in the diagnoses and descriptions that follow. The term 'rostrum' is used in preference to 'guard' throughout (cf. Stevens 1965), as the former has an invalid functional connotation. As discussed by Stevens (1965), the effectiveness of this structure as a protection (i.e. a 'guard') for the phragmocone would have been minimal. The characters discussed below are illustrated in Fig. 8.

3.2 Shape

This is an important specific character. There are three basic morphotypes (with intermediates), namely: hastate (double-tapering and spear-like; some authors employ the terms clavate (club-like) or lanceolate (lance-like) for this form), conical (cone-shaped) and cylindrical (parallel-sided) (see Schumann 1974). Shape is usually expressed by description of the outline (i.e. ventral or dorsal aspect), which is always symmetrical, and the profile (i.e. lateral aspect), which may be either asymmetrical or symmetrical.

3.3 Transverse section

This is an important specific character used in conjunction with shape. Sections may be described as (laterally) compressed or (dorso-

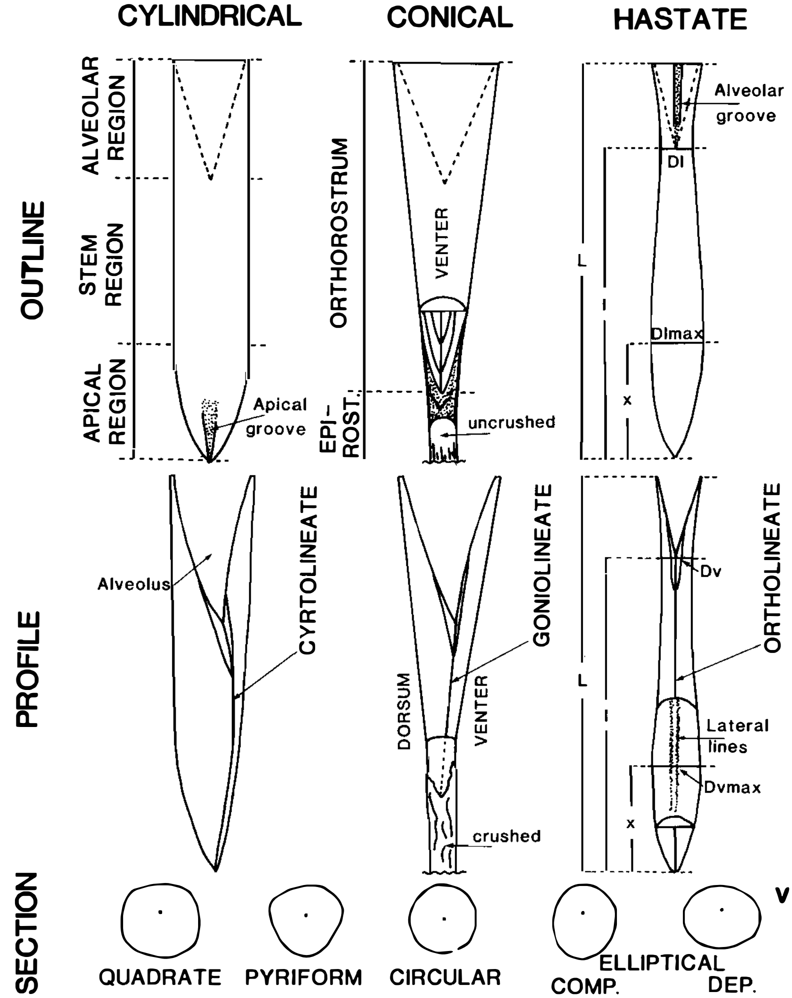

Fig. 8. Belemnite morphology illustrated by the three major rostral shapes in outline (ventral view) and profile (lateral view, venter to right), and by typical transverse sections. Dimensions explained within text. Other abbreviations: epirost., epirostrum; comp., compressed; dep., depressed; v, venter.

ventrally) depressed and are generally circular, elliptical, pyriform or subquadrate.

3.4 Grooves

Grooves are of great importance at generic and higher levels. There are two basic types: apical (confined to, or emanating from the apex) defining the Belemnitina, and alveolar (confined to, or emanating from the alveolar region) defining the Belemnopseina. Also present in all belemnites are fine lateral depressions and ridges known as 'lateral lines', useful at family and higher taxonomic levels. In the Belemnopseina, lateral lines are usually found as *Doppellinien*, closely-spaced narrow parallel lines, while in the Belemnitina (in most cases) they are less clearly defined, although commonly affecting the shape of the transverse section.

3.5 Other features

Other features such as the form of the apical line (ortholineate, goniolineate or cyrtolineate; see Schumann 1974) and the depth of penetration of the alveolus, are useful at the generic level. The alveolar angle, a feature employed by some authors, has been found to vary only slightly (in the range of approximately 25–35°) within the Belemnitida (Schwegler 1961; Stevens 1965), and is of little taxonomic value at the generic level, although it is of more value at higher taxonomic levels.

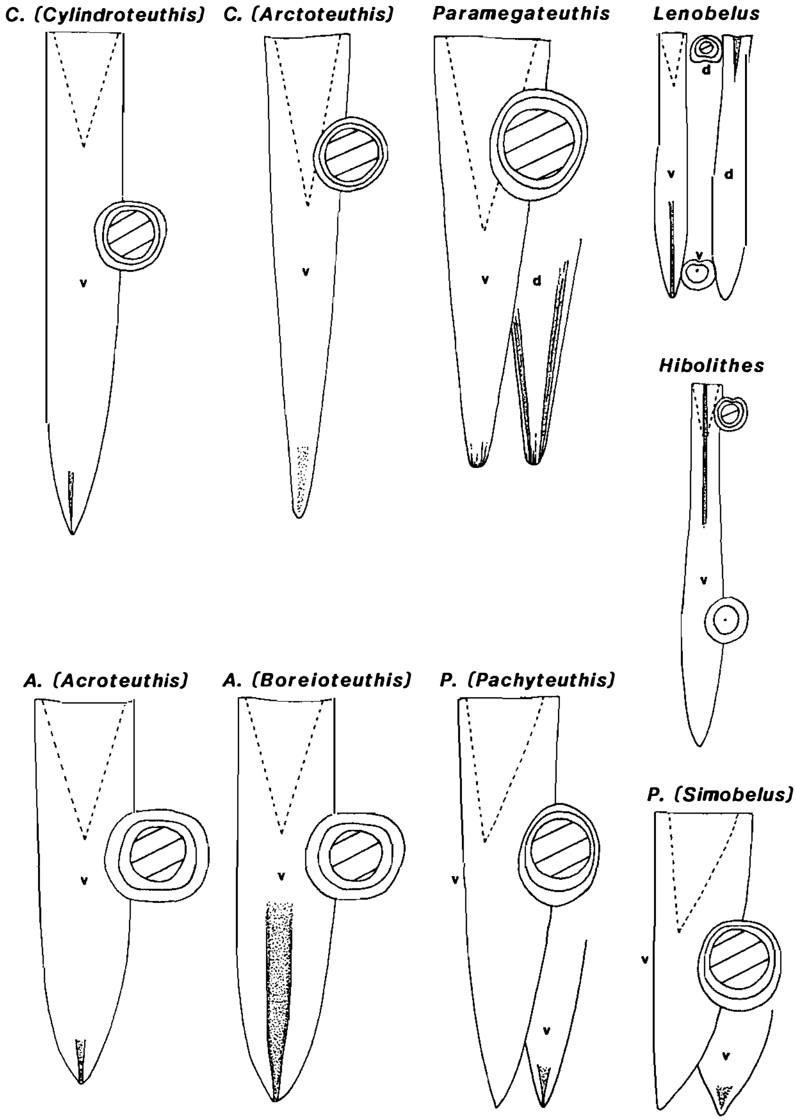

Fig. 9. Idealized reconstructions of the rostra of belemnite genera from Kong Karls Land, approximately to scale. Explanation of symbols: stipple, weak grooves; outlined stipple, grooves; v, venter; d, dorsum.

4. Systematic part

4.1 Introduction

In the descriptions given below, approximate size ranges are indicated by the terms small (<60 mm), medium (60–80 mm) and large (>80 mm). Other terms used with these sizes include: elongate, i.e. of extended length with small transverse diameter, and robust, i.e. squat with relatively large diameter. Other dimensions are given where possible, using the following abbreviations (Fig. 8): L, total preserved length; l, length from apex to tip of alveolus; x, length from apex to D_{max}; Dv, dorso-ventral diameter at the tip of the alveolus; Dv_{max}, maximum dorso-ventral diameter; Dl, lateral diameter at the tip of the alveolus; Dl_{max}, maximum lateral diameter. Dimensions of type specimens from the USSR given below are taken from the appropriate first description of the taxon. Abbreviations used in conjunction with measurement tables are: na, apex not preserved; p, approximate position; w, weathered. Abbreviations used in conjunction with synonymies follow those of Matthews (1973).

All the specimens discussed are housed in the Cambridge Spitsbergen Expeditions (CSE) Collection at the West Building of the Department of Earth Sciences, University of Cambridge, or in the Sedgwick Museum, University of Cambridge (SMC) (unless otherwise stated). Multiple numbers (e.g. *C.4844/4880*) represent the specimens comprised of several fragments. Abbreviations used are: BGS, British Geological Survey, Keyworth; BMNH, British Museum (Natural History), London; GMC, Geologisk Museum, Copenhagen; GSC, Geological Survey of Canada, Ottawa; MIGGN, Museum of the Institute of Geology and Geophysics, Siberian Branch of the Soviet Academy of Sciences, Novosibirsk; NRS, Naturhistoriska Riksmuseet, Stockholm.

In his description of the belemnites of the Tordenskjoldberget Member, Blüthgen (1936) employed a number of new names used by Pompeckj when labelling the belemnites collected by Nathorst's 1898 expedition in 1899. Pompeckj did not use these names in his paper of the same year (Pompeckj 1899), and as indicated by Blüthgen (1936) in his synonymies (e.g., p. 38 '1899 *Belemnites pilum*, Pompeckj, Etikett (label)') they are clearly manuscript names, first published by Blüthgen himself.

4.2 Systematic descriptions

Class CEPHALOPODA Cuvier, 1794

Subclass COLEOIDEA Bather, 1888

Order BELEMNITIDA Zittel, 1895

Suborder BELEMNOPSEINA Jeletzky, 1965

Family PSEUDODICOELITIDAE Saks & Nal'nyaeva, 1967
(nom. transl. ex Pseudodicoelitinae Saks & Nal'nyaeva, 1967)

Type genus. – Pseudodicoelites Saks, 1967

Diagnosis. – See Saks & Nal'nyaeva (1967, p. 20; 1975, p. 81).

Range. – Toarcian–Bajocian of the Arctic Boreal regions (northern USSR, Arctic Canada, Franz Josef Land, Svalbard).

Discussion. – Saks & Nal'nyaeva (1967) erected the subfamily Pseudodicoelitinae (within the Duvaliidae) to contain the genera *Pseudodicoelites* Saks and *Lenobelus* Gustomesov, which possess dorsal alveolar grooves, sometimes in association with a ventral apical groove. However, Jeletzky (1980) considered these genera closer to the Dicoelitidae, than the Duvaliidae. Although *Lenobelus* and *Pseudodicoelites* seem to have belemnopseid rather than duvaliid affinities on Jeletzky's evidence (1980, p. 11), his assertion that these genera should be assigned to the Dicoelitidae is not tenable. The presence of a ventral apical groove in *Lenobelus* (usually characteristic of the Belemnitina) and the absence of any ventral groove in *Pseudodicoelites*, distinguishes them clearly from the dicoelitid belemnites which possess marked ventral and dorsal alveolar grooves. Therefore Gustomesov's (1977) promotion of the Pseudodicoelitinae to full family rank is justified, although this family is retained within the Belemnopseina because of its alveolar grooves and phragmocone characteristics (see Jeletzky 1980). However, Gustomesov's (1977) subfamilial distinction of *Lenobelus* from *Pseudodicoelites* is not followed here.

Genus *LENOBELUS* Gustomesov, 1966
(=*Sibiribelus* Gustomesov, 1977)

Type species. – Lenobelus lenensis Gustomesov, 1966

Diagnosis. – Small, hastate Pseudodicoelitidae. Outline and profile are symmetrical and hastate or subhastate, with the position of maximum inflation in the apical or stem regions. The apex is acute, or obtuse and rounded. Transverse sections are generally compressed and elliptical, but may be subcircular or depressed elliptical. The apex bears a ventral groove that may either extend well into the stem of the rostrum, or be confined to the apical region. There are no dorso-lateral apical grooves. There is a short, deep dorsal alveolar groove that does not extend into the stem region of the rostrum. This groove may be underlain by a splitting surface. Lateral lines are present as two well-defined lateral depressions separated by a weak 'weal', all of which become indistinct adorally. The phragmocone penetrates approximately one quarter of the rostrum, and is ventrally displaced. The apical line is goniolineate.

Range. – Toarcian to ?Bajocian of the northern USSR, Svalbard, Franz Josef Land and Arctic Canada.

Remarks. – *Lenobelus* is distinguished from *Pseudodicoelites* Saks, which is of similar form and has been recorded with *Lenobelus* in the USSR and Canada (Gustomesov 1966; Jeletzky 1980), in possessing a ventral apical groove in addition to its dorsal alveolar groove. Jeletzky (1980, p. 19) has doubted the generic separation of these two forms, but the presence of the ventral apical groove in *Lenobelus* is considered here a valuable generic character, despite its apparent absence in some examples of *L. aberrans* Jeletzky (Jeletzky 1980). *Sibiribelus* Gustomesov (type species *Lenobelus gravis* Gustomesov) is indistinguishable from *Lenobelus* apart from a slightly more inflated rostrum.

Lenobelus cf. *viligaensis* (Saks, 1961)
Plate 1, Figs. 1–10.

cf*. 1961a *Holcobelus viligaensis* sp. n. Saks, p. 433 [brief description only].
cf. 1961b *Holcobelus viligaensis* sp. nov. Saks, pp. 77, 79 [brief description only].
cf. 1975 *Lenobelus viligaensis* (Saks); Saks & Nal'nyaeva, p. 86. Pl. XIII, Figs. 1–4.

Holotype. – MIGGN.87-166, Upper Toarcian, River Kelimiar, Siberia, USSR.

Material. – Kongsøya, Passet Member: CSE loc. C.1381, Retziusfjellet, 28 specimens, *C.4817, 4821, 4826, 4827, 4831, 4832a, c, e, 4833, 4836–38, 4849, 4856–58, 4865, 4875, 4877, 4878, 4882, 4886–88, N.2074*, SMC X.14260, X.14261; CSE loc. S.1412/1413, Passet, 16 specimens, *S.1564, 1595, 1599, 1600, 1602–04, 1622, 1629, 1641, 1713–16*, SMC X.14259, X.14262. Svenskøya, Dunérfjellet Member: CSE loc. C.1371, southern Kükenthalfjellet, 19 specimens, *C.4109, 4124, 4128, 4131, 4138, 4159, 4168, 4177, 4185, 4190–92, 4194, 4195, 4209, 4321–23, 4236*; CSE loc. C.1378, East Kükenthalfjellet, 2 specimens, *C.5881, 5887*; CSE loc. N.794, Kükenthalfjellet, 2 specimens, *N.1948, 1956.*

Diagnosis. – Small, subhastate *Lenobelus.* Outline and profile symmetrical subhastate. Transverse sections depressed elliptical. Ventral apical and dorsal alveolar grooves well-developed.

Dimensions. –

	L	x	Dv_{max}	Dl_{max}
SMC X.14262	70.6	34.2	7.3^{w}	8.9
X.14259	44.5	20.5	6.6^{w}	6.6^{w}
X.14260	47.1	24.5	7.7^{w}	8.0^{w}
X.14261	61.9	27.2	8.4	10.2

Description. – Small to medium sized, subhastate rostra with a total length of approximately eight or nine times Dv_{max}. The outline is symmetrical and weak to moderately subhastate, generally with an acute apex (18–22°). The flanks gradually diverge from the apex to Dl_{max} at the mid-point of the rostrum, and then gently converge adorally. The profile is symmetrical or almost symmetrical and subhastate, the stem region becoming dorsally inflated in some cases, Dv_{max} being at the same position as Dl_{max}. Transverse sections of the rostrum are depressed ($Dv_{max} : Dl_{max}$ 0.9) and generally subquadrate in the alveolar region, becoming rounded and elliptical in the stem and apex.

The apex bears a long ventral apical groove which extends well into the stem region, generally just over half the length of the rostrum. This groove is commonly found exfoliated and secondarily deepened. There are no dorso-lateral apical grooves. Also present is a short, deep and relatively wide dorsal alveolar groove that extends adapically to the position of the alveolar apex. This groove is commonly accompanied by a splitting surface. Lateral lines are well-developed in reasonably preserved specimens, and consist of a strong central weal bounded by two depressions, the dorsal-most depression fading out adapically. The phragmocone penetrates approximately one quarter of the rostrum, and the apical line is crytolineate.

Remarks. – Specimens of *Lenobelus* from Kong Karls Land are generally poorly preserved, although enough are well preserved for specific comparisons to be made. They most closely resemble the Siberian species *L. viligaensis* (Saks) and the Canadian species *L. plauchuti* Jeletzky, which are subhastate with depressed transverse sections. All other species of this genus possess an equidimensional or compressed section (e.g. *L. sibiricus* (Saks); *L. lenensis* Gustomesov) and many are bulbous and strongly hastate (e.g. *L. minaevae* Saks; *L. vagt* (Saks)). The Svalbard specimens are closest to the Siberian species as they are more hastate than *L. plauchuti*, which differs from them in possessing a more squat, almost cylindrical rostrum. Although the Kong Karls Land *Lenobelus* specimens approach *L. plauchuti* in size, they are tentatively assigned to the larger *L. viligaensis* as both share a similar subhastate form and grooves. Specimens of *Lenobelus* cf. *viligaensis* were collected by the Jackson-Harmsworth Expedition from Franz Josef Land. These fragments were briefly discussed by Newton & Teall (1897, as *Belemnites* spp.) and were assigned a possible Bajocian age by Pompeckj (1900).

Occurrence. – Within the basal beds of the Dunérfjellet Member (Svenskøya) and the Passet Member (Kongsøya), Janusfjellet Formation, where it occurs in association with *Paramegateuthis* Gustomesov, of probable Aalenian or Bajocian age *L. viligaensis* occurs in Toarcian–Aalenian sediments in the USSR.

Family BELEMNOPSEIDAE Naef, 1922

Type genus. – *Belemnopsis* Bayle, 1878

Genus *HIBOLITHES* Montford, 1808
(=*Pseudohibolites* Blüthgen, 1936)

Type species. – *Hibolithes hastatus* Montfort, 1808, by monotypy.

Diagnosis. – Small to large sized, hastate Belemnopsidae. The outline and profile are symmetrical and hastate. The position of maximum inflation is generally in the apical third of the rostrum. The apex may be acute, or obtuse and rounded. Transverse sections of the rostrum are usually circular, but in some species they may be weakly depressed or moderately compressed, subcircular to elliptical. The apex is devoid of grooves. There is a prominent ventral alveolar groove, which is usually deep and well-defined, underlain by a splitting surface. In the type species this groove extends down into the stem region; in other species it may be longer or shorter than this norm, and in some cases it may be much reduced. Lateral lines are present as *Doppellinien*, which occur all along the flanks of the rostrum, although fading out adapically. *Doppellinien* may merge adorally into a single, central depression. The phragmocone penetrates one fifth or one sixth of the rostrum, and the apical line is ortholineate.

Range. – This genus is long ranging, and is found from the Bajocian to the Aptian, occurring in most Tethyan and some Boreal regions. In the Lower Cretaceous, migration into some regions of the Boreal Realm was common (Mutterlose et al. 1983). In the Southern Hemisphere, a distinct Indo-Pacific *Hibolithes* fauna with mostly endemic species is present from the Upper Jurassic onwards (Stevens 1965).

Remarks. – *Hibolithes* is a distinct genus that is characterized by its regular hastate form. The related genera *Neohibolites* Stolley, *Mesohibolites* Stolley and *Parahibolites* Stolley which arose in the Aptian, are distinguished by their smaller size, their shorter grooves and in the case of the last two taxa, their respective depressed and compressed sections. Blüthgen (1936) described a new genus from Kong Karls Land that resembled *Hibolithes*, which he named *Pseudohibolites*. According to Blüthgen, this genus apparently lacked a ventral groove, and was distinguished by its large size and compressed section. Later, Stolley (1938) discussed Blüthgen's findings, and considered this new genus to be of normal *Hibolithes* form. Doyle (1987), on the basis of material collected by the Norske Fina/Cambridge Svalbard Expedition, agreed with Stolley that the name *Pseudohibolites* (which he found to be invalid according to Article 13b of the International Code of Zoological Nomenclature, as no type species was originally designated), was in fact a junior subjective synonym of *Hibolithes* Montfort. These findings are followed here. Pompeckj (1899) listed four species of the 'Hastati' group (=*Hibolithes*) from Kongsøya, namely *Belemnites jaculum* Phillips, *B. subfusiformis* d'Orbigny, *B.* cf. *pistilliformis* Blainville and *B. obtusirostris* Pavlow. This list was repeated by Stolley (1912).

Hibolithes jaculoides Swinnerton, 1937
Plate 1, Figs. 11–15; Plate 2, Figs. 8, 9.

v. 1892 *Belemnites jaculum* Phillips; Pavlow (in Pavlow & Lamplugh), p. 257, Pl. 7, Figs. 2, 3.
? 1913 *Hibolites jaculiformis* n.sp. Schwetzoff, p. 52, Pl. 2, Figs. 5, 6; Pl. 3, Figs. 4, 11, 12.
v. 1936 *Hibolites pilum* [Pompeckj MS] Blüthgen, p. 38, Pl. VII, Fig. 8.
v. 1936 *Hibolites jaculiformis* [Pompeckj MS] Blüthgen, p. 38, Pl. 7, Figs. 13–16.
v. 1936 *Hibolites jaculiformis* var. *obtusa* [Pompeckj MS] Blüthgen, p. 39, Pl. VII, Figs. 9–12.
v. 1936 *Hibolites spina* [Pompeckj MS] Blüthgen, p. 39, Pl. VII, Figs. 17, 18.
v*. 1937 *Hibolites jaculoides* sp. nov. Swinnerton, p. xxv.

v. 1938 *Belemnopsis (Hibolites) cigarroides* n.sp. Anderson, p. 230, Pl. 80, Fig. 7.
v. 1952 *Hibolites jaculoides* Swinnerton; Swinnerton, p. 54, Pl. 14, Figs. 17, 18.
v. 1978 *Hibolites jaculoides* Swinnerton; Mutterlose, p. 99, Pl. 4, Figs. 1–3, 5; Pl. 5, Fig. 4; Pl. 6, Fig. 1 [full synonymy].

Holotype. – BMNH C.42313, bed C7, Hauterivian, Speeton Clay, Speeton, Yorkshire.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 96 specimens, *D.2177, 2199, 2224, 2232–34, 2236–39, 2242, 2253, 2256, 2259–63, 2265–68, 2275, 2279, 2280, 2285–89, 2292, 2294, 2303–05, 2307, 2314–16, 2320–27, 2329–40, 2345–49, 2351–55, 2357–69, 2371–2373, 2377, 2489–91, 2493, 2494, 2496, 2499*, SMC X.14263, X.14264, X.14269; CSE loc. D.833, 1 specimen, *D.2907*; CSE loc. N.818, 5 specimens, *N.1991, 2001, 2002, 2010a, b*; CSE loc. N.837, 1 specimen, *N.2148*; 18 specimens, exact locality unknown, *H.3167, 3168, 3170, 3171, 3173, 3177, 3207, 3208, 3215, 3217–19, 3221–24, 3229, 3230*. NRS, Kongsøya, Tordenskjoldberget Member: Tordenskjoldberget, 29 specimens, MO.818, 826, 828, 2747, 2749–53, 2756–58, 2760, 2767, 2859–63, 4047, 4049–56; Johnsenberget, 98 specimens, MO.812–14, 816, 817, 819–23, 825, 827, 829, 871, 873, 2765, 2766, 2812, 2814, 2816–19, 2821–41, 2843–51, 2858, 2864, 2866–71, 2873, 2875, 2877–80, 2886–89, 4022–35, 4037–46, 4058, 4059.

Diagnosis. – Small, hastate *Hibolithes*, elongate when intact. Outline and profile symmetrical, hastate. Transverse sections equidimensional, circular. Ventral alveolar groove extends to stem region.

Dimensions. –

	L	l	x	Dv	Dl	Dv_{max}	Dl_{max}
BMNH C.42313 (Holotype)	160.1	138.9	48.1	8.8	7.7	15.2	15.6
SMC X.14264	70.8	—	36.2	—	—	12.8	12.8
CSE *D.2330*	67.0	—	36.2	—	—	12.2	11.9
D.2907	62.7	—	31.2	—	—	14.1	14.1

Description. – Elongate, hastate rostra with a total length of 20 times Dv, when complete. Usually, however, the alveolar region is lost, leaving the apical and stem regions which commonly attain a length of approximately five and a half times Dv_{max}. The outline and profile are both symmetrical and hastate, with an acute apex (27–30°), becoming more obtuse and rounded in some examples (37–44°). The flanks diverge adorally from the apex to the position of maximum inflation (Dv_{max} and Dl_{max}) in the apical third, and then converge gradually to the position of minimum inflation usually situated at the tip of the alveolus, giving an attenuated stem and alveolar region. The rostrum then expands gradually for a short distance over the phragmocone. The alveolar region is very often lost due to imperfect calcification. Transverse sections of the rostrum are equidimensional and circular, although some variants may be compressed or depressed slightly.

There is a ventral alveolar groove that extends adapically for over one half the length of the rostrum, the majority of it situated in the attenuated alveolar and posterior stem regions. As this part of the rostrum is commonly lost, it is usual to find specimens of this species which are apparently devoid of grooves; most of the Kong Karls Land examples are so preserved. Lateral lines, where preserved, are usually well-developed *Doppellinien* which lose definition adorally. The phragmocone penetrates one fifth of the rostrum, and the apical line is ortholineate.

Remarks. – Swinnerton (1937, p. xxv) proposed his new name *Hibolithes jaculoides* as a replacement for the name *Belemnites jaculum* Phillips, 1835, a junior primary homonym of *Belemnites jaculum* Biguet, 1819 (see discussion in Swinnerton 1952). However, Swinnerton's name may be a junior subjective synonym of *Hibolites jaculiformis* Schwetzoff, 1913 as implied by Mutterlose (1978) in his synonymy list. Blüthgen's species *Hibolithes jaculiformis*, in addition to being a junior primary homonym of Schwetzoff's species name, is also a junior synonym of *H. jaculoides*. Swinnerton's (1937) name is now widely used in both taxonomic and stratigraphic literature for this species (see Mutterlose 1978), and it would be advisable to continue using this name, despite the possibility of *Hibolites jaculiformis* Schwetzoff being a senior synonym. Therefore *H. jaculoides* is used throughout this paper in preference to the older name. The belemnites from Kong Karls Land referred to by

Pompeckj (1899) as *Belemnites jaculum* Phillips, *B. subfusiformis* d'Orbigny and *B.* cf. *pistilliformis* Blainville most probably represent this species.

Occurrence. – This species is found in the lower division of the Tordenskjoldberget Member on Kongsøya with species of *Acroteuthis, Pachyteuthis* and *C. (Arctoteuthis)* of probable Valanginian–Hauterivian age. Elsewhere this species has been recorded from Valanginian–?Barremian sediments in northwest Europe, European Russia, and South America (Stevens 1965).

Hibolithes nathorsti (Blüthgen, 1936)
Plate 1, Figs. 16–20; Plate 2, Figs. 1–7.

v*. 1936 *Pseudohibolites nathorsti* [Pompeckj MS] Blüthgen, p. 40, Pl. VIII, Figs. 1, 2.
v. 1936 *Pseudohibolites nathorsti* var. *rotunda* [Pompeckj MS] Blüthgen, p. 40, Pl. VIII, Figs. 3–5.
v. 1936 *Pseudohibolites nathorsti* var. *elongata* [Pompeckj MS] Blüthgen, p. 40, Pl. VIII, Figs. 6, 7.

Lectotype. – NRS MO.864 (Blüthgen 1936, Pl. VIII, Figs. 1–2), Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Paralectotypes. – NRS MO.2742 (Pl. VIII, Figs. 3–4), MO.866 (Pl. VIII, Fig. 5), MO.2738 (Pl. VIII, Figs. 6–7), same locality.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 6 specimens, *D.2174, 2192, 2218, 2228, 2255, 2295*; CSE loc. D.833, 10 specimens, *D.2714, 2737, 2807, 2823, 2888, 2910*, SMC X.14265–68; 1 specimen, exact locality unknown, *H.3204/3205*; NRS, 30 specimens, MO.853, 854, 861, 865, 867, 2723, 2727–29, 2731–37, 2741, 2743–46, 2748, 2754, 2755, 2759, 2762, 2763, 2955, 4019, 4274.

Diagnosis. – Large, hastate *Hibolithes*. Outline and profile symmetrical, hastate. Transverse sections compressed, elliptical. Ventral alveolar groove confined to alveolar region.

Description. – Large, hastate to subhastate rostra with a total length of approximately six times Dv. The outline is symmetrical and hastate, subhastate or in some cases cylindrical depending on the inflation of the apical region. The apex is bulbous and obtuse (38–45°). Dl_{max} is situated close to the apex in the apical third, and there is usually a gradual adoral convergence of the flanks from this point. The profile is symmetrical and generally similar to the outline, with Dv_{max} at the same position as Dl_{max}. In profile the apex is obtuse (41–47°) and central to the long axis of the rostrum. In one specimen (NRS MO.861) the alveolar region is lost due to imperfect calcification. Transverse sections of the rostrum are compressed (Dv : Dl 1.1) and elliptical, becoming less compressed adapically, especially in robust specimens.

There is a ventral alveolar groove that varies in incision from weak and poorly defined, to deep and accompanied by a splitting surface. The groove is short, generally not reaching the stem region, usually extending only to the tip of the alveolus. Lateral lines are in the form of normal or broadly defined *Doppellinien* (depending on the overall size of the rostrum) which are in some cases moderately incised adorally into a single depression. The alveolus generally only penetrates one sixth of the rostrum, and the apical line is ortholineate. Juveniles are hastate and compressed, with clearly defined *Doppellinien*, while older juveniles possess a more bulbous apex.

Remarks. – Blüthgen (1936) described several forms of this species under the name *Pseudohibolites nathorsti*, two of which he formally named as 'varieties' (var. *rotunda* and var. *elongata*). A similar range in variation was seen in the new material, ranging from very hastate, compressed individuals, through more robust specimens to almost cylindrical examples, and all are here included within the range of variation of *H. nathorsti*. The closest species to *H. nathorsti* are *H. caroli* (Blüthgen) and *H. obtusirostris* (Pavlow). The former differs in possessing a shorter rostrum with a less symmetrical profile,

Dimensions. –

	L	l	x	Dv	Dl	Dv_{max}	Dl_{max}
NRS MO.2738 (Lectotype)	124.9	102.0	38.8	18.4	17.2	21.5	20.4
SMC X.14268	89.9	74.3	44.2	18.2	17.7	19.6	18.8
X.14265	99.2	84.1	35.4	14.8	13.0	20.5	19.1
X.14266	77.2[na]	—	—	19.9	18.8	—	—

and the latter, although possessing a similar short groove, differs by being slender with a less compressed section and finer *Doppellinien*. It is interesting to note that Pompeckj (1899) recorded *Belemnites obtusirostris* Pavlow from Kongsøya, and it is possible that this record refers to specimens of *H. nathorsti.*

Occurrence. – The only recorded occurrence of this species is in the lower division of the Tordenskjoldberget Member on Kongsøya, Kong Karls Land with other species of *Hibolithes, Acroteuthis* and *Pachyteuthis* of probable Valanginian–Hauterivian age. However, this species also occurs with similar *Acroteuthis* species in the Valanginian sediments of East Greenland (D. T. Donovan Collection, GMC). The related species *H. obtusirostris* (Pavlow) is known from the Hauterivian–Barremian sediments of NW Europe.

Hibolithes caroli (Blüthgen, 1936)
Plate 2, Figs. 12–15.

v*. 1936 *Pseudohibolites caroli* [Pompeckj MS] Blüthgen, p. 41, Pl. VIII, Figs. 8–11.

Lectotype. – NRS MO.855, Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 1 specimen, *D.2184*; CSE loc. D.833, 2 specimens, *D.2696*, SMC X.14271; NRS, 6 specimens, MO.900, 2954, 2960, 2961, 2983.

Diagnosis. – Medium sized, hastate *Hibolithes*. Outline symmetrical, subhastate or subcylindrical. Profile symmetrical or asymmetrical, subhastate to hastate. Transverse sections compressed elliptical.

Dimensions. –

	L	l	x	Dv	Dl	Dv_{max}	Dl_{max}
NRS MO.855 (Lectotype)	73.9	65.0	30.4	13.9	12.6	15.2	13.7
SMC X.14271	72.9	67.2	26.5	13.8	11.8	15.5	12.9

Description. – Medium sized, slender hastate to subhastate rostra with a total length of approximately five times Dv. The outline is symmetrical and weakly hastate, in some cases becoming cylindrical. In hastate individuals Dl_{max} is situated just in the apical third of the rostrum, close to the stem region. The apex is acute (approximately 28°), the flanks only weakly diverging from it. The profile is usually symmetrical, although in some cases it is asymmetrical with greater inflation of the venter, and it is usually more hastate than the outline ($Dv_{max} > Dl_{max}$), with a more obtuse apex (approximately 38°). The transverse sections are compressed (Dv : Dl 1.1) for the length of the rostrum, and are elliptical.

There is a ventral alveolar groove that usually extends up to the tip of the alveolus. In some cases this groove may be poorly defined or even absent. The *Doppellinien* are well-defined and are present as fine double lateral lines in the stem and apex, developing adorally into a single undifferentiated shallow depression, similar to the lateral lines of *H. obtusirostris* (Pavlow). The alveolus penetrates approximately one fifth of the rostrum, and the apical line is ortholineate.

Remarks. – This species was one of the two species described by Blüthgen (1936) included, in his new genus *Pseudohibolites* (see above). However, although being slightly less hastate than is usual, this species is typical of the genus *Hibolithes*. *H. caroli* differs from *H. nathorsti* (Blüthgen) and *H. jaculoides* Swinnerton by its smaller size, its generally subhastate form, its almost cylindrical outline, and from the latter species by its compressed section.

Occurrence. – In Kong Karls Land this species occurs with other species of *Hibolithes, Acroteuthis, Pachyteuthis* and *C. (Arctoteuthis)* of probable Valanginian to Hauterivian age in the lower division of the Tordenskjoldberget Member on Kongsøya. This species also occurs in the Valanginian sediments of East Greenland (D. T. Donovan Collection, GMC).

Suborder BELEMNITINA Zittel, 1895

Family BELEMNITIDAE d'Orbigny, 1845

Type genus. – Doyle & Riegraf (1986, 1987) have requested that the ICZN use its plenary powers to suppress the genus *Belemnites* Lamarck, 1799, and designate *Passaloteuthis* Lissajous, 1915 type genus of the family Belemnitidae d'Orbigny, 1845.

Subfamily MEGATEUTHINAE Saks & Nal'nyaeva, 1967

Type genus. – *Megateuthis* Bayle, 1878

Genus *PARAMEGATEUTHIS* Gustomesov, 1960

Type species. – *Megateuthis (Paramegateuthis) ishmensis* Gustomesov, 1960

Diagnosis. – Large to small sized, conical to cylindriconical Megateuthinae. Outline symmetrical, conical or sometimes cylindriconical with almost parallel sides. The apex is acute, and may bear an epirostrum. The profile is symmetrical, conical to cylindriconical, becoming asymmetrical with greater inflation of the venter. Transverse sections of the rostrum are compressed, subcircular or elliptical in the alveolar region, becoming more compressed in the stem and apical regions. The apex bears two long, dorso-lateral apical grooves that extend well into the stem region of the rostrum. These grooves are generally deep at the apex and shallow adorally. There is no ventral apical groove, and both the apex and the dorso-lateral grooves are commonly striated. Lateral lines are poorly defined, but consist of two broad, parallel depressions. The phragmocone penetrates one to two thirds of the rostrum, and the apical line is goniolineate.

Range. – Aalenian to Callovian of the northern USSR, Svalbard, Arctic Canada and possibly East Greenland. It has also been described from the Aalenian of Bulgaria (although this may be a record of *Acrocoelites*, see section 5.2 below).

Remarks. – *Paramegateuthis* is distinguished from *Megateuthis* Bayle by possessing a smaller, more conical rostrum with long apical grooves. However, some juveniles of *Megateuthis* which are thorn-like in appearance may resemble adult *Paramegateuthis*, but are distinguished by their shorter apical grooves. *Paramegateuthis* was originally erected by Gustomesov (1960) as a subgenus of *Megateuthis* Bayle, but Nal'nyaeva (1974) promoted it to full generic rank due to its overall difference in form from this genus. True *Megateuthis* rostra have not been recorded from the USSR (Saks & Nal'nyaeva 1975).

Paramegateuthis nalnyaevae Doyle sp. nov.
Plate 3, Figs. 1–8.

? 1975 *Paramegateuthis ishmensis* Gustomcsov; Saks & Nal'nyaeva, p. 64, Pl. 1, Fig. 1, non Figs. 2–4 [=*Paramegateuthis ishmensis* Gustomesov].

Holotype. – SMC X.14273, CSE loc. C.1381, Passet Member, Retziusfjellet, Kongsøya.

Paratypes. – SMC X.14272, SMC X.14274, SMC X.15020, SMC X.15021, CSE loc. C.1381, Passet Member, Retziusfjellet, Kongsøya.

Other material. – Kongsøya, Passet Member: CSE loc. C.1381, Retziusfjellet, 40 specimens, *C.4839/4840, 4850, 4861/4870, 4868, 4893/4900/4923, 4894/4895, 4915/4938, 4917/4919, 4918, 4921/4927, 4924/4934, 4925/4946, 4928/4930/4934, 4940/4941, 4942, 4948/4992/4996, S.1412/1413* (whole), *C.4890, 4894, 4897, 4899, 4901, 4902/4910, 4903–08, 4912–14, 4920, 4929, 4931–33, 4936, 4939, 4945* (fragmentary); CSE loc. S.1412/1413, Passet, 1 specimen, *S.1631*. Svenskøya, Dunérfjellet Member, Kükenthalfjellet: CSE loc. N.794, 2 specimens, *N.1935, 1936*; CSE loc. N.795, 1 specimen, *N.1896*; CSE loc. C.1371, 10 specimens, *C.4211, 4226, 4280, 4314–16, 4319, 4320, 4334, 4335*.

Diagnosis. – Large, robust, conical *Paramegateuthis*. Outline symmetrical, conical. Profile slightly asymmetrical, conical. Transverse sections subcircular in alveolar region, compressed elliptical in stem and apex.

Dimensions. –

	L	x	Dv	Dl	Groove length
SMC X.14273 (Holotype)	120.1	56.8	23.7	21.2	61.2
X.14272 (Paratype)	93.1	40.3	21.1	18.8	46.4
X.14274 (Paratype)	91.6	48.5	22.0	19.7	—[w]
X.15021 (Paratype)	80.4[na]	27.9	19.3	17.4	—[w]
SMC X.14279 (*P.* aff. *nalnyaevae*)	75.9[na]	—	21.7	17.5	—
CSE *C.4299* (*P.* aff. *nalnyaevae*)	62.3[na]	—	24.8	19.9	—

Description. – Large, robust, conical rostra with a total length of approximately five times Dv. The outline is symmetrical and conical with an acute apex (18–19°) which is usually secondarily blunted at its tip. The flanks gradually diverge adorally from the apex, giving the outline a regular conical form. The profile is generally similar to the outline, but is asymmetrical due to a slight inflation and arching of the venter, with a corresponding dorsal deflection of the still acute apex (17–20°). The transverse sections are compressed (Dv:Dl 1.2) and elliptical in the alveolar region, becoming even more compressed adapically.

The apex bears two clear dorso-lateral apical grooves that extend adorally into the stem region, up to approximately one half of the length of the rostrum. These grooves are deep at the apex of the rostrum, and gradually shallow adorally. There is no ventral apical groove, and the apex is well striated. Lateral lines are indistinct on the robust flanks of this species. The phragmocone penetrates one half to two thirds of the rostrum, and the apical line is goniolineate. Juveniles are very regular and acutely conical, with long, well-defined but unstriated dorso-lateral apical grooves.

Remarks. – *P. nalnyaevae* sp. nov. is a large, conical species which resembles *P. timanensis* (Gustomesov) in form, but which differs in its greater size. *P. nescia* Nal'nyaeva and the type species *P. ishmensis* (Gustomesov) are similar, but are more compressed and cylindrical than *P. nalnyaevae*. There are other specimens from the Dunérfjellet Member that resemble *P. nalnyaevae* (e.g. SMC X.14279), but they differ in the possession of a long epirostrum (e.g. Pl. 4, Figs. 10, 11), and further collecting is required to ascertain their relationship to this species. A single, small specimen (probably an apical fragment) of *P. nalnyaevae* was collected by Nathorst's Expedition. This specimen (NRS MO.647) is accompanied by a label written in Pompeckj's hand that bears an unpublished manuscript name '*Belemnites carina* n.sp., Callovian, Schwedisch Vorland [Svenskøya]', that was not mentioned by Blüthgen (1936).

Derivation of name. – In recognition of the work of Soviet palaeontologist Dr. T. I. Nal'nyaeva.

Occurrence. – *P. nalnyaevae* sp. nov. occurs in association with *Lenobelus* cf. *viligaensis* (Saks) of probable Aalenian–Bajocian age, in the basal beds of the Passet Member on Kongsøya, and a single specimen is known from the Bathonian of the USSR. The related form *P. ishmensis* Gustomesov is recorded from the *P. parabajosicus* Zone (Bajocian–Bathonian) of Nal'nyaeva (1986).

Paramegateuthis nescia Nal'nyaeva, 1975
Plate 4, Figs. 1–7.

* 1975 *Paramegateuthis nescia* sp. nov. Nal'nyaeva (in Saks & Nal'nyaeva), p. 60, Pl. IX, Figs. 1–4.
? 1983 *Paramegateuthis* cf. *nescia* Nal'nyaeva; Yefremova et al., p. 133, Pl. IX, Fig. 3.

Holotype. – MIGGN.87-142, Upper Bathonian, Uriung-Tumus Peninsula, USSR.

Material. – Kongsøya, Passet Member, Passet: CSE loc. S.1412/1413, 9 specimens, *S.1594, 1597, 1605, 1606, 1613, 1632, 1637, 1638*, SMC X.14276. Svenskøya, Dunnérfjellet Member, Kükenthalfjellet: CSE loc. N.793, 2 specimens, *N.1892/ 1893, 1894*; CSE loc. N.794, 2 specimens, *N.1937, 1938*; CSE loc. N.795, 1 specimen, *N.1896*; CSE loc. C.1375, 5 specimens, *C.4211, 4226, 4280, 4318*, SMC X.14277; CSE loc. C.1378, 1 specimen, SMC X.14275.

Diagnosis. – Large, elongate cylindriconical *Paramegateuthis*. Outline symmetrical, cylindriconical, profile asymmetrical, cylindriconical. Transverse sections very compressed, elliptical.

Dimensions. –

	L	l	Dv	Dl
MIGGN.87-142 (Holotype)	97.0	71.0	12.5	10.0
SMC X.14275[w]	87.3	68.6	16.5	12.8
CSE *S.1637*[w]	83.7	60.9	14.5	10.1

Description. – Large, elongate cylindriconical *Paramegateuthis* with a total length of approximately six times Dv. The outline is symmetrical, conical to almost cylindrical, and the apex is acute to very acute (12–13°). The flanks diverge weakly from the apex. The profile is asymmetrical to almost symmetrical and generally cylindriconical, although approaching cylindrical. The dorsum may be slightly more inflated than the venter which is often flat, maximum inflation occurring at the mid-point of the rostrum. The apex is slightly more obtuse in profile (15–18°). Transverse sections of the rostra are markedly compressed (Dv:Dl 1.3) and elliptical. Some of the

Kong Karls Land specimens have been tectonically flattened, hindering identification.

The apex bears two dorso-lateral apical grooves that extend well into the stem region of the rostrum, but they are often difficult to observe in the Kong Karls Land material due to exfoliation and weathering, and often appear to be restricted to the apex. There is no ventral apical groove. The specimens are not sufficiently well-preserved to allow comment on the lateral lines. The alveolus penetrates approximately one quarter of the rostrum, and the apical line is goniolineate. Juveniles are elongate cylindriconical and compressed, with acute apices.

Remarks. – The specimens described here are in general poorly preserved, but closely resemble the Siberian Aalenian–Bathonian species *Paramegateuthis nescia*, to which they are assigned. Most other species of this genus (e.g. *P. ishmensis* (Gustomesov), *P. timanensis* (Gustomesov), *P. pressa* Nal'nyaeva and *P. nalnyaevae* sp. nov.) may be distinguished by their regular conical form. Many of the specimens of this species from the Passet Member were found crushed flat, although there is no firm evidence to suggest the presence of epirostra in this species.

Occurrence. – In the base of the Dunérfjellet Member, Svenskøya, and in the Passet Member, Kongsøya, Kong Karls Land, with *Paramegateuthis* and *Lenobelus* species of probable Aalenian–Bajocian age. This species also occurs in the Aalenian to Bathonian of Siberia and the ? Bathonian of Champ Island, Franz Josef Land. Nal'nyaeva (1986) recently recorded this species from her *Paramegateuthis parabajosicus* Zone (Bajocian–Bathonian) in Siberia.

?Paramegateuthis sp. nov.
Plate 4, Figs. 12–14.

Discussion. – About 80 poorly preserved belemnite fragments were collected from the lowest beds of the Passet and Dunérfjellet members of Kong Karls Land that may possibly be assigned to *Paramegateuthis*. They are slightly subhastate in profile, cylindrical in outline with a compressed elliptical section. These belemnites are unusual in that they have no clear apical grooves, possessing instead a 'withered' apex with striations. It is almost certain that these specimens possessed an epirostrum, and there are many flattened fragments of epirostra associated with these rostra in Kong Karls Land. Similar crushed fragments occur in the ?Aalenian–Bajocian sediments in Franz Josef Land. Some of the Kong Karls Land specimens (6 specimens in all) possess slightly unusual lateral lines comprising two strong 'weals' on each flank in the anterior of the rostrum, with corresponding depressions, all of which lose definition adapically. It is possible that these specimens belong to a new taxon not previously described, because, although *Paramegateuthis* possesses a short epirostrum, the shape of the rostrum and the form of the lateral lines of these specimens are unusual. However, further well-preserved material is needed for confirmation.

Family CYLINDROTEUTHIDIDAE Stolley, 1919

Type genus. – *Cylindroteuthis* Bayle, 1878

Discussion. – This family has been the subject of a number of revisions, mainly by Soviet workers (e.g. Gustomesov 1960, 1964; Saks & Nal'nyaeva 1964, 1966), and in general their interpretation is followed here. However, there has been considerable controversy surrounding the generic validity of *Pachyteuthis* Bayle, *Cylindroteuthis* Bayle and *Acroteuthis* Stolley. For example, Naef (1922), Spath (1947), Donovan (1953) and Gustomesov (1958) all considered that the names *Pachyteuthis* and *Acroteuthis* were synonyms, representing the same genus, while Spath (1936) and Hewitt (1980) suggested that in certain cases, *Cylindroteuthis* may be indistinguishable from *Pachyteuthis*. Although recognizing these problems, I have kept these genera separate following current opinion. The diagnoses of the most important genera of the Cylindroteuthididae, with the exception of *Spanioteuthis* Gustomesov and *Eocylindroteuthis* Riegraf which are not present in Svalbard, are summarized in Table 1.

Genus *CYLINDROTEUTHIS* Bayle, 1878

Type species. – *Belemnites puzosianus* d'Orbigny, 1843, by monotypy.

Diagnosis. – Large, elongate, cylindrical to cylindriconical Cylindroteuthididae. The outline and profile are usually symmetrical and cylindrical to cylindriconical in form. In outline and profile the

Table 1. Diagnostic features of the principal genera and subgenera of the Cylindroteuthididae. Abbreviations: cylind., cylindrical; asymmet., asymmetrical; symmet., symmetrical; infl., inflated.

Genus	Shape	Profile	Transverse section	Apical groove	Alveolar depth
Cylindroteuthis (Cylindroteuthis)	elongate	symmet., weak infl.	quadrate	moderate, apex, stem	0.2
Cylindroteuthis (Arctoteuthis)	elongate cylind.– cylindriconical	symmet., uninflated	subcircular	weak, apex	0.2
Pachyteuthis (Pachyteuthis)	robust conical	symmet., inflated	compressed, elliptical	weak, apex	0.5–0.3
Pachyteuthis (Simobelus)	robust conical	asymmet., inflated, flat venter	compressed, elliptical– quadrate	weak, apex	0.5–0.3
Acroteuthis (Acroteuthis)	stout cylindriconical	asymmet., inflated, flat venter	depressed, quadrate	weak– moderate, apex	0.5–0.3
Acroteuthis (Boreioteuthis)	stout cylindriconical	asymmet., inflated, flat venter	depressed, quadrate	strong, apex, stem, ?alveolar	0.5–0.3
Acroteuthis (Microbelus)	small cylindriconical	asymmet., weak infl., flat venter	depressed, quadrate	weak, apex	0.5
Lagonibelus (Lagonibelus)	elongate cylind.	symmet., weak infl., flat venter	depressed, quadrate	moderate, apex	0.2
Lagonibelus (Holcobeloides)	medium cylind.	symmet., weak infl.	depressed, elliptical– quadrate	strong, apex stem (deep), alveolar	0.3

apex is generally acute to very acute, venter and dorsum being inflated to the same degree. Transverse sections of the rostra are weak to strongly compressed, and are either subcircular or subquadrate in form. The apex may be devoid of grooves, but generally it bears a short apical grove confined to the apex, although in some species this groove extends into the stem region. There are no dorso-lateral apical grooves. The lateral lines are well-developed in some species and consist of a broad depression subdivided by one or two weak ridges or weals. The phragmocone is moderate to strongly ventrally deflected, and penetrates one fifth to one sixth of the rostrum. The apical line is cyrtolineate or goniolineate.

Range. – *Cylindroteuthis* is common throughout the Boreal Realm, where it is present from the Bathonian through to the Hauterivian. A few doubtful specimens have been recorded from the Jurassic of New Zealand (Stevens 1965).

Remarks. – *Cylindroteuthis* has been divided into a number of subgenera by Gustomesov (1964) and Saks & Nal'nyaeva (1964). The two principle subgenera *C. (Cylindroteuthis)* and *C. (Arctoteuthis)* Saks & Nal'nyaeva occur in Kong Karls Land. Both subgenera can be distinguished from *Pachyteuthis* Bayle and *Acroteuthis* Stolley in possessing a relatively uninflated cylindrical rostrum (Table 1).

Subgenus *CYLINDROTEUTHIS* Bayle, 1878

Type species. – As for genus.

Diagnosis. – Moderately elongate, cylindrical *Cylindroteuthis*. Apex acute, venter and dorsum moderately inflated. Transverse sections compressed, subquadrate. Ventral apical groove well-developed. Apical line cyrtolineate.

Range. – Widespread throughout the Boreal Realm in the Middle and Upper Jurassic, found in Arctic basin in the Lower Cretaceous.

Cylindroteuthis (Cylindroteuthis) spp. indet.
Plate 4, Figs. 15–17.

Material. – Svenskøya, Dunérfjellet Member, Kükenthalfjellet: CSE loc. D.827, 1 specimen, *D.3358-63* (many fragments of one rostrum); CSE loc. C.1375, 18 specimens, *C.5680, 5681, 5718, 5726, 5731, 5733, 5736, 5737, 5739–41, 5749, 5752, 5753, 5760, 5768, 5769, 5780*; CSE loc. S.1417, 48 specimens, *S.1819–21, 1823–68*, SMC X.14281 (all fragmentary). Kongsøya, Retziusfjellet Member, Tordenskjoldberget; CSE loc. D.833, 9 specimens, *D.2534–43*.

Description. – Several specimens of this subgenus are present in the Retziusfjellet Member. For the most part they are too poorly preserved for specific identification, being badly surface weathered. However, enough is preserved of at least one specimen (SMC X.14281) to be able to determine the subgeneric rank. These specimens possess a slender, cylindrical rostrum with a symmetrical outline and a similar profile, with only slight inflation of the dorsum. The venter bears an apical groove that is relatively incised in at least one of the specimens, but does not extend into the stem region (diagnostic of *Lagonibelus (Holcobeloides))*. The transverse sections are quadrate, although with the venter slightly broader than the dorsum. They are weakly compressed. The apical line is cyrtolineate, but as the alveolar regions of the specimens are lost there are no details of the depth of penetration of the phragmocone available.

Remarks. – Blüthgen (1963, p. 27) recorded some specimens from Tordenskjoldberget (possibly from the Retziusfjellet Member) which he referred to *Cylindroteuthis* cf. *absolutus* (Fischer). These specimens (NRS MO.656, MO.4137–4157) are generally more depressed than the above, and are probably referable to *Lagonibelus* rather than *Cylindroteuthis* (Pompeckj's original label reads *Belemnites* cf. *magnificus*, a typical *L. (Lagonibelus)* species). Blüthgen referred these specimens to a typical species of *L. (Holcobeloides)* in error, mistaking the weathered ventral surface of one of them (NRS MO.656) for a deep groove.

Occurrence. – *C. (Cylindroteuthis)* spp. occur in the Dunérfjellet Member on Svenskøya with *Pachyteuthis optima* Saks & Nal'nyaeva, of probable Bathonian to Callovian age, and in the Retziusfjellet Member on Kongsøya of possible Kimmeridgian age.

Subgenus *ARCTOTEUTHIS* Saks & Nal'nyaeva, 1964

Type species. – *Cylindroteuthis septentrionalis* Bodylevsky, 1960

Diagnosis. – Elongate to very elongate, cylindriconical to cylindrical *Cylindroteuthis.* Apex acute to very acute. Venter and dorsum only weakly inflated. Transverse sections uncompressed and subcircular, or weakly depressed and elliptical. Apical grooves weakly developed or absent. Apical line goniolineate.

Range. – Largely restricted to the Arctic Basin (the Arctic Islands, Arctic Canada, northern USSR) in the Upper Jurassic and Lower Cretaceous, although species are known from as far south as California at these times.

Remarks. – Specimens of this subgenus were originally recorded from Kong Karls Land by Blüthgen (1936) who assigned them tentatively to the genus *Oxyteuthis* Stolley (p. 37; *Oxyteuthis*(?) sp. indet.). However, this genus is easily distinguished from *C. (Arctoteuthis)* by its cylindrical or subhastate shape, and by the presence of a ventral apical groove in some of its species. Jeletzky (1964) also tentatively assigned some Canadian specimens of this genus to *Acroteuthis.* Saks & Nal'nyaeva (1972) suggested that these same specimens should be referred to *C. (Arctoteuthis)*, although indicating in the same paper that Blüthgen's *'Oxyteuthis'* were probably examples of a species of *Pachyteuthis.*

Cylindroteuthis (Arctoteuthis) bluethgeni Doyle sp. nov. Plate 5, Figs. 1–14.

v. 1936 *Oxyteuthis*(?) sp. indet. Blüthgen, p. 37, Pl. VIII, Figs. 6, 7.

Holotype. – SMC X.14282, Tordenskjoldberget Member, Tordenskjoldberget (CSE loc. D.831), Kongsøya (incomplete; most of stem section preserved, apex and alveolar region missing).

Paratypes. – SMC X.14283, X.14284, Tordenskjoldberget Member, Tordenskjoldberget (CSE loc. D.831); SMC X.15022, Tordenskjoldberget Member, Tordenskjoldberget (exact locality unknown); NRS MO.890, MO.2657, Tordenskjoldberget Member, Johnsenberget, Kongsøya.

Other material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 7 specimens, *D.2248, 2387* (stem regions), *D.2248, 2252, 2258, 2343,* SMC X.14285 (alveolar regions); CSE loc. N.818, 1 specimen, *N.2012* (alveolar region); 3 specimens, exact locality unknown, *H.3199* (alveolar region), *H.3200, 3210* (stem regions).

Diagnosis. – Large, elongate *C. (Arctoteuthis).* Outline symmetrical, acutely conical; profile similar, symmetrical or slightly asymmetrical. Transverse sections subcircular, depressed in stem and apex, slightly compressed in alveolar region.

Dimensions. –

	L	l	Dv	Dl
SMC X.14282 (Holotype)	85.4	—	20.4^p	21.0^p
X.14284 (Paratype)	71.1	—	14.5^p	15.8^p
X.14283 (Paratype)	60.9	—	18.0	17.8
X.15022 (Paratype)	59.0	—	15.1	15.3
NRS MO.890 (Paratype)	68.3	—	18.9	19.6
MO.2657 (Paratype)	79.9	—	16.9	16.8

Description. – Large (when complete) elongate and slender, acutely conical rostrum with a total estimated length of approximately nine times Dv. The Svalbard specimens are fragmentary, but enough is preserved to determine the form of the species. The outline is symmetrical and acutely conical, the flanks diverging regularly from the acute apex (11–14°). The profile is similar, uninflated and acutely conical (apical angle 10–12°), but it may be slightly asymmetrical due to a tendency for the apex to be deflected ventrally. Transverse sections are subcircular, changing in form from slightly depressed in the stem and apex, though equidimensional to slightly compressed in the alveolar region.

The tip of the apex is not preserved in these specimens, but enough is preserved to be able to report the presence of a slight ventral flattening probably corresponding to a shallow ventral groove. Lateral lines are generally undetectable in the stem and apex, but the more compressed alveolar region displays lateral lines similar to *Pachyteuthis*, with a broad dorso-lateral depression underlain by a narrower and a less obvious ventro-lateral depression. The phragmocone probably penetrates an estimated one fifth of the rostrum. The apical line is goniolineate.

Remarks. – Blüthgen (1936) described this species under the name *Oxyteuthis*(?) sp. indet. (presumably because of its regular conical form), while Saks & Nal'nyaeva (1966) referred Blüthgen's specimens to *Pachyteuthis*, probably because of the impression of a deep alveolus given by Blüthgen's (1936, Pl. VII, Fig. 7) figures. However, from the regular, elongate cylindriconical form of the rostrum, together with its subcircular section and acute apex, it is clear that this species is a typical *C. (Arctoteuthis).*

C. (Arctoteuthis) bluethgeni differs from other species of this subgenus by its more regularly tapering cylindriconical form. Most species of *C. (Arctoteuthis)* are either elongate and spicular (e.g. *C. (A.) clavicula* Anderson, *C. (A.) longissima* Saks & Nal'nyaeva), or very elongate and robust, generally similar to *C. (Cylindroteuthis)* (although distinguished by their subcircular sections and acute apices; e.g. *C. (A.) septentrionalis* Bodylevsky, *C. (A.) tehmanaensis* (Stanton)). However, *C. (A.) bluethgeni* does approach some specimens of *C. (A.) subporrecta* Bodylevsky (e.g. Saks & Nal'nyaeva 1964, pl. X, Figs. 4, 5), but the latter are distinguished by their more acute and regularly conical apices.

Derivation of name. – In recognition of the work of Dr. J. Blüthgen in first describing belemnites in detail from Kong Karls Land.

Occurrence. – This species occurs in the lower division of the Tordenskjoldberget Member with a fauna of *Acroteuthis*, *Pachyteuthis* and *Hibolithes* of probable Valanginian–Hauterivian age. It is unknown outside Svalbard.

Genus *PACHYTEUTHIS* Bayle, 1878

Type species. – *Belemnites excentralis* Young & Bird, 1822, by subsequent designation (Douville 1879, p. 91).

Diagnosis. – Medium to large sized, robust, conical or cylindriconical Cylindroteuthididae. The outline is symmetrical and conical to cylindriconical. The profile is either symmetrical and conical with a central apex, or asymmetrical and conical with a ventrally deflected or recurved (often mucronate) apex and a flat venter. Transverse sections are moderately compressed and subquadrate or elliptical. The apex bears a short ventral apical groove that may be difficult to detect in some species. The lateral lines consist of a broad dorso-lateral depression, with a narrower depression below it. The phragmocone penetrates one half to two thirds of the rostrum, and the apical line is cyrtolineate.

Range. – This genus is found throughout the Boreal Realm after its first appearance in the early Middle Jurassic (?Bajocian) and made its last appearance in the Lower Cretaceous (Hauterivian). A single dubious specimen is known from the Jurassic of Australia (Etheridge 1880).

Remarks. – As discussed above, some authors have doubted the separation of *Pachyteuthis* from *Acroteuthis* or even *Cylindroteuthis* (e.g. Naef 1922; Donovan 1953; Gustomesov 1958). However, *Pachyteuthis* is distinct from *Cylindroteuthis* in possessing a short, robust rostrum with an inflated profile, and from *Acroteuthis* in possessing a compressed section and an inflated dorsum (Table 1).

Subgenus *PACHYTEUTHIS* Bayle, 1878

Type species. – As for genus.

Diagnosis. – Conical *Pachyteuthis* with symmetrical outline and symmetrical or nearly symmetrical profile. Apex acute. Transverse sections compressed subquadrate or elliptical.

Range. – Widespread within the Boreal Realm in Middle–Upper Jurassic. Restricted to the Arctic province in the Lower Cretaceous.

Remarks. – Specimens of this subgenus have been previously recorded from Kong Karls Land as '*Belemnites subextensus-panderi*' by Pompeckj (1899, p. 464) and Nathorst (1901, pp. 350, 362), who assigned them a Callovian age. It is probable that the specimens these records refer to (possibly NRS MO.658, MO.4178–4186) are equivalent to those recorded by Newton & Teall (1897) and Pompeckj (1900) (under the same names) from Franz Josef Land.

Pachyteuthis (Pachyteuthis) bodylevskii Saks & Nal'nyaeva, 1966
Plate 5, Figs. 15–17.

* 1966 *Pachyteuthis (Pachyteuthis) bodylevskii* sp. nov. Saks & Nal'nyaeva, p. 28, Pl. III, Figs. 2, 3.

Holotype. – MIGGN.84-162, Callovian, Mount Churlianica, Hooker Island, Franz Josef Land.

Material. – Kongsøya, Passet Member, Retziusfjellet: CSE loc. C.1381, 8 specimens, *C.4863, 4867, 4869, 4873, 4876, 4885, 4894*, SMC X.14286. Svenskøya, Dunérfjellet Member, Kükenthalfjellet: CSE loc. C.1378, 9 specimens, *C.5869, 5870–72, 5874–77*, 5879; CSE loc. N.974, 1 specimen, *N.1944*.

Diagnosis. – Medium to large, cylindriconical *Pachyteuthis (Pachyteuthis)*. Outline and profile symmetrical, cylindriconical. Transverse section rounded subquadrate, with a broad venter.

Dimensions. –

	L	l	Dv	Dl
MIGGN.84-162 (Holotype)	104.0	80.0	20.3	19.3
SMC X.14286	76.7	72.3	24.1	22.1

Description. – Medium to large sized, cylindriconical rostra with a total length of approximately five times Dv. The outline is symmetrical and cylindriconical to cylindrical, with an acute apex (approximately 23°) which is often secondarily blunted. The flanks diverge regularly from the apex in the apical and stem regions, but they become more cylindrical adorally. The profile is symmetrical and uninflated, or almost symmetrical with a slightly inflated dorsum, and is cylindriconical with the venter and dorsum weakly divergent for the length of the profile (apical angle approximately 25°.) Transverse sections are compressed (Dv:Dl 1.1) and rounded subquadrate to almost pyriform with a broad venter.

The apex bears a ventral groove which usually is shallow and ill-defined, but may be accentuated by exfoliation. Lateral lines are present as a broad dorso-lateral depression underlain by a thinner ventro-lateral depression on each flank. The Kong Karls Land specimens are fragmentary, but enough is preserved to determine that the alveolus penetrates approximately one quarter of the rostrum. The apical line is cyrtolineate.

Remarks. – The Kong Karls Land specimens closely resemble the holotype figured by Saks & Nal'nyaeva (1966, Pl. III, Fig. 2) from Franz Josef Land, as both have a cylindriconical form and a similar transverse section. However, these authors included '*Belemnites subextensus-panderi*' of Pompeckj (1900) in the synonymy of their species. Pompeckj's specimens are somewhat more regular than is typical of *P. (P.) bodylevskii*, possessing a smaller rostrum with a more inflated apex and a quadrate section, and are here excluded from it. *P. (P.) bodylevskii* is distinguished from *P. (P.) optima* Saks & Nal'nyaeva by its cylindriconical form and less inflated profile.

Occurrence. – This species occurs in the Passet Member (Kongsøya) with *Lenobelus* and *Paramegateuthis* species of probable Aalenian–Bajocian age. It also occurs with a similar association of genera in the Bajocian sediments of the Canadian Arctic (Wilkie Point, GSC collections). In the USSR and Franz Josef Land *P. (P.) bodylevskii* is known from Callovian sediments.

Pachyteuthis (Pachyteuthis) optima Saks & Nal'nyaeva, 1966
Plate 6, Figs. 1–8

*. 1966 *Pachyteuthis (Pachyteuthis) optima* sp. nov. Saks & Nal'nyaeva, p. 20. Pl. I, Fig. 2; Pl. II, Figs. 1–4.

Holotype. – MIGGN.84-143, Callovian, Izhma River (Pechora Basin), USSR.

Materials. – Svenskøya, Dunérfjellet Member: CSE loc. C.1375, Kükenthalfjellet, 29 specimens, *C.5655, 5668, 5675/5669, 5712, 5713, 5715, 5716/5721, 5717, 5719, 5720, 5722, 5724, 5725, 5727–30, 5734, 5735, 5741, 5743, 5747, 5751, 5757, 5760, 5771,* SMC X.14288, X.14289; CSE loc. D.837, north of Kyrkja, 13 specimens, *D.3083–87, 3089–92, 3094, 3095, 3096/3093,* SMC X.14287; CSE loc. S.1417, Dunérfjellet, 2 specimens, *S.1826/1835, 1828.*

Diagnosis. – Large, conical *Pachyteuthis (Pachyteuthis)*. Outline symmetrical, conical. Profile symmetrical and uninflated, conical. Transverse sections weakly compressed, subquadrate.

Dimensions. –

	L	l	Dv	Dl
MIGGN.84-143 (Holotype)	112.5	83.2	25.0	23.5
SMC X.14287	98.8	67.9	23.8	22.4
X.14288	84.2	68.0	29.0	26.0

Description. – Large, regularly conical rostra with a total length of approximately four times Dv. The outline is symmetrical and conical with an acute or moderately acute apex (34–35°). The flanks gradually diverge from the apex giving the outline a regular, conical form. The profile is also symmetrical and conical, although in some individuals the dorsum may become inflated adorally (apical angle 35–38°). Some examples have a slightly recurved apex. The transverse sections are compressed (Dv : Dl 1.1) and rounded subquadrate.

The apex bears a short ventral groove which is generally indistinct. However, in some individuals the ventral groove is deeper, extending for the length of the apical region. Lateral lines are present as a broad dorso-lateral depression with a narrow and indistinct ventro-lateral depression below it on each flank. The phragmocone penetrates one third of the rostrum, and the apical line is cyrtolineate.

Remarks. – The Kong Karls Land specimens are closely comparable with Siberian examples of *P. (P.) optima*. Specimen SMC X.14287 (from CSE loc. D.837) is regularly conical and closely resembles the holotype (Saks & Nal'nyaeva 1966, Pl. I, Fig. 2), while SMC X.14288 (CSE loc. C.1375) is more robust and comparable with another specimen figured by these authors (Pl. II, Fig. 1). Specimens of this species with deepened grooves are also recorded from both Kong Karls Land (SMC X.14289, from CSE loc. C.1375) and the USSR (Saks & Nal'nyaeva 1966, Pl. II, Fig. 2).

P. (P.) optima resembles *P. (P.) tschernyschewi* (Krimholz) in form, but this species differs by being much larger with an inflated profile and rounded section. *P. (P.) panderiana* (d'Orbigny) is also similar to *P. (P.) optima*, but is distinguished by its more compressed section and very acute apex. The specimens figured by Spath (1935) as *Pachyteuthis* aff. *panderiana* (d'Orbigny) from the Lower Kimmeridgian of East Greenland (GMC MMH.8188, MMH.8197, MMH.8199) approach the Kong Karls Land specimens, but they are more elongate and robust than them, and were referred to the species *P. (P.) ingens* Krimholz by Saks & Nal'nyaeva (1966). The Kong Karls Land material is close to some Bathonian belemnites from East Greenland referred by Spath (1932) to *Cylindroteuthis subrediviva* (Lemoine). However, both the Greenland material (GMC MMH.9226, MMH.9270–71) and the type specimens of *Belemnites subrediviva* Lemoine (= *Belemnites rediviva* Blake, holotype, SMC J.5731; paratype, SMC J.5732, both from the Callovian of Yorkshire) are distinguished by their rounded elliptical sections and well-developed apical grooves. The specimens referred to as *Belemnites panderi* or *Belemnites subextensus-panderi* from Franz Josef Land by Newton & Teall (1897) and Pompeckj (1900) differ from *P. (P.) optima* in possessing a slender rostrum with a regular quadrate section.

Occurrence. – This species is recorded from Bathonian–Callovian sediments in the USSR, and Nal'nyaeva (1986) considered it typical of her *Cylindroteuthis spathi* Zone (Bathonian). In Kong Karls Land, examples are known from the Retziusfjellet Formation (Kongsøya) and the Dunérfjellet Formation (Svenskøya), of possible Bathonian–Callovian age. A single specimen, possibly referable to this species, is in the GSC collections, collected from the Bajocian sediments of the Prince Patrick Islands (Canadian Arctic).

Pachyteuthis (Pachyteuthis) crassovalis (Blüthgen, 1936)
Plate 6, Figs. 9, 10; Plate 7, Figs. 1–5.

v*. 1936 *Acroteuthis obliquespinatus* [Pompeckj MS] var. *crassovalis* n. v. Blüthgen, p. 34, Pl. VI, Figs. 8, 9.

Lectotype. – NRS MO.2967 (Blüthgen 1936, Pl. VI, Figs. 8, 9). Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE, loc. D.831, 2 specimens, *D.2291,* SMC X.14291; CSE loc. D.833, 2 specimens, *D.2729,* SMC X.14290; NRS, 3 specimens, MO.868, 2174, 2667.

Diagnosis. – Medium sized, conical *Pachyteuthis (Pachyteuthis).* Outline symmetrical, acutely conical, apex attenuated. Profile asymmetrical, acutely conical. Transverse sections strongly compressed, elliptical.

Dimensions. –

	L	l	Dv	Dl
NRS MO.2764 (Lectotype)	75.9	55.6	20.7	19.0
SMC X.14291	66.7	49.0	23.0	20.5
X.14290	79.8	50.0	22.6	21.4
CSE *D.2729*	63.3	55.3	19.3	17.8

Description. – Medium sized, conical rostra with a total length of approximately three and a half times Dv. The outline is symmetrical and acute, and the apex is usually attenuated. The flanks gradually diverge from the acute apex (27–33°) to the alveolar region, although some examples (e.g. SMC X.14290) have a slightly inflated outline at the apex. The profile is asymmetrical and conical to cylindriconical with a slightly inflated dorsum and the apex (32–33°) usually deflected ventrally. The transverse sections are compressed (Dv:Dl 1.1) and elliptical.

The apex bears a short, shallow and ill-defined ventral apical groove that is usually confined to the apical region. Lateral lines are present as a broad dorso-lateral depression with a thinner ventro-lateral depression below it on each flank. The alveolus penetrates approximately one third of the rostrum, and the apical line is cyrtolineate.

Remarks. – Blüthgen (1936) originally considered this form a 'variety' of his aberrant species *Acroteuthis obliquespinatus* (=*Pachyteuthis obliquespinata* following Saks & Nal'nyaeva 1966). However, *P. obliquespinata* has a very attenuated apex, a slender form and a more compressed section, and it is on this basis that Blüthgen's 'variety' is promoted to full specific rank. It may be possible that *P. obliquespinata* and *P. crassovalis* represent sexual dimorphs (see discussion of the former below) of a single biospecies, but further collecting is required to test the validity of this, and consequently both names are employed as morphospecies (see Doyle 1985).

Occurrence. – This species has so far only been recorded from the lower division of the Tordenskjoldberget Member on Kongsøya, with a fauna of other *Pachyteuthis. Acroteuthis* and *Hibolithes* species of probable Valanginian–Hauterivian age.

Pachyteuthis (Pachyteuthis) obliquespinata Blüthgen, 1936
Plate 7, Figs. 6–9.

v*. 1936 *Acroteuthis obliquespinatus* Pompeckj MS Blüthgen, p. 34, Pl. VI, Figs. 4–7.
1966 *Pachyteuthis (Pachyteuthis) obliquespinata* (Blüthgen); Saks & Nal'nyaeva, p. 6.

Lectotype. – NRS MO.870 (Blüthgen 1936, Pl. VI, Fig. 5) Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Paralectotypes. – NRS MO.2739, MO.2740, same locality.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.833, 1 specimen, SMC X.14292; NRS, 3 specimens, MO.869, 2739, 2740.

Diagnosis. – Elongate, conical *Pachyteuthis (Pachyteuthis)*. Outline symmetrical, cylindriconical to conical. Profile asymmetrical to nearly symmetrical, cylindriconical to conical. Apex very acute and attenuated. Transverse sections compressed, elliptical.

Dimensions. –

	L	l	Dv	Dl
NRS MO.870 (Lectotype)	83.5	60.1	15.9	14.9
SMC X.14292	102.7	61.9	19.1	18.2

Description. – Large, elongate cylindriconical rostra with a total length of approximately five times Dv. The outline is symmetrical and generally cylindriconical, although it can be conical in some cases. The apex is very acute and attenuated (15–19°), the flanks of the rostrum diverging adorally until the mid-point of the rostrum where they become more or less parallel. The profile is asymmetrical and cylindriconical, the venter being slightly inflated at the apical-most portion of the stem. From this point venter and dorsum strongly converge into an acute, attenuated apex (19–24°), which may be dorsally deflected. The transverse sections are compressed (Dv:Dl 1.1) and elliptical, although they are circular or subcircular in the attenuated apex.

Although there is some weak flattening of the apex that may approximate to a ventral groove, there are no well-developed apical grooves in this species. Lateral lines are present on the lectotype, and are defined as a broad dorso-lateral depression with a narrow underlying short ventro-lateral depression. The alveolus penetrates approximately one third of the rostrum, and appears ventrally deflected. The form of the apical line is not determined due to the lack of available specimens.

Remarks. – Although possessing an unusual attenuated apex, the reference of this species to the subgenus *P. (Pachyteuthis)* is not in doubt, because of its compressed section and general similarity to typical species such as *P. (P.) crassovalis* (Blüthgen). *P. (P.) obliquespinata* possesses a drawn-out and attenuated apex that is similar in form to the 'epirostra' of many Lower Jurassic belemnitid genera. However, the attenuated apex of this species differs from such epirostra in maintaining the concentric and radial elements of a 'normal' belemnite rostrum, rather than the confused mass to be found within a typical epirostrum. It is possible, however, that both the epirostrum in the belemnitids, and the attenuated apex of this species served the same purpose, possibly as a sexual adaptation (Doyle 1985). Therefore, it can be suggested that *P. (P.) crassovalis* (Blüthgen) would represent the other dimorph of a single biospecies, as both forms possess generally similar rostra. However, because of the paucity of specimens, and the general differences in morphology of the two forms, they are retained as separate morphospecies (see Doyle 1985).

Occurrence. – This species occurs with others of *Pachyteuthis*, *Hibolithes* and *Acroteuthis* of probable Valangingian–Hauterivian age in the Tordenskjoldberget Member on Kongsøya. It is unrecorded outside Kong Karls Land.

Subgenus *SIMOBELUS* Gustomesov, 1958

Type species. – *Belemnites breviaxis* Pavlow, 1892.

Diagnosis. – Conical *Pachyteuthis* with symmetrical outline and asymmetrical profile. Apex ventrally displaced or recurved, often mucronate. Transverse sections subquadrate.

Remarks. – Several species of this subgenus have recently been described from the Jurassic rocks of the Janusfjellet Formation of Spitsbergen (Birkenmajer et al. 1982), although they are not directly comparable with the single Lower Cretaceous species known from Kong Karls Land.

Pachyteuthis (Simobelus) cf. *curvula* Saks & Nal'nyaeva, 1966
Plate 7, Figs. 10–12; Plate 8, Figs. 1, 2.

cf*. 1966 *Pachyteuthis (Simobelus) curvula* sp. nov. Saks & Nal'nyaeva, p. 84, Pl. VII, Fig. 6; Pl. VIII, Figs. 4–7.
cf. 1984 *Pachyteuthis (Simobelus) curvula* Saks & Nal'nyaeva; Nal'nyaeva, p. 147, Pl. XXI, Fig. 3.

Holotype. – MIGGN.84-272. Berriasian, lower part of the *Tollia tolli* Zone, River Bojarka, USSR.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 2 specimens, SMC X.14293, X.14294; CSE loc. N.818, 2 specimens, *N.1995, N.2006.*

Dimensions. –

	L	l	Dv	Dl
MIGGN.84–272 (Holotype)	81.0	43.3	24.2	24.2
SMC X.14293	75.6	52.0	26.1	26.3
X.14294	73.0	56.3	25.1	—

Description. – Medium sized, robust conical rostra with a total length of approximately three times Dv. The outline is symmetrical and conical with a relatively obtuse and mucronate apex (approximately 48°). In outline the apical region is conical with the flanks reasonably divergent, although in the stem and alveolar regions the outline becomes more cylindriconical. The profile is asymmetrical and conical with a flat venter (although slightly inflated at the apex, approximately 46°), and a moderately inflated dorsum. The dorsum becomes increasingly divergent from the venter adorally. The transverse sections are slightly depressed or equidimensional and quadrate with a flat venter and curved dorsum.

The very tip of the apex is devoid of grooves, but there is a flattened area behind the apex which stretches adorally into the stem region. Lateral lines are present as a broad dorso-lateral depression with a narrower ventro-lateral depression below it on each flank. The phragmocone penetrates approximately one third to one half of the rostrum, and the apical line is cyrtolineate.

Remarks. – The Kong Karls Land specimens are tentatively assigned to the Siberian species *P. (S.) curvula* Saks & Nal'nyaeva, because they possess a similar inflated dorsum, flat venter and subquadrate section. However, they cannot be definitely assigned to this species because the holotype (Saks & Nal'nyaeva 1966, Pl. VIII, Fig. 5) is more acutely conical in profile and outline than the Kong Karls Land specimens, although some *P. (S.) curvula* later described from the Pechora Basin (Nal'nyaeva 1984, Pl. XXI, Fig. 3) are close to them. *P. (S.)* cf. *curvula* from the Tordenskjoldberget Limestone also approach some specimens of *P. (S.) subbreviaxis* Saks & Nal'nyaeva from the USSR, especially the single specimen figured by Saks & Nal'nyaeva (1966, Pl. XV, Fig. 4) which possesses a mucronate apex similar to that of SMC X.14293. However, this species is generally more robust and depressed than *P. (S.)* cf. *curvula.*

Occurrence. – This species is known from sediments of Volgian to Berriasian age in Siberia and the Pechora Basin. In Kong Karls Land, it occurs in the lower division of the Tordenskjoldberget Member with a fauna of *Acroteuthis, Hibolithes* and *C. (Arctoteuthis)* of probable Valanginian–Hauterivian age.

Genus *ACROTEUTHIS* Stolley, 1911

Type species. – *Belemnites subquadratus* Roemer, 1836, by subsequent designation. Lemoine (1915, p. 160, footnote 2) was the first to actually designate this species as a type of *Acroteuthis* (see Swinnerton 1937, p. xxxvii), following Stolley's (1911, p. 219) implication in the statement: '*Subquadratus*-Gruppe . . . =*Acroteuthis* gen. nov.'.

Diagnosis. – Large or medium sized, robust conical or cylindriconical Cylindroteuthididae. Outline symmetrical, conical or cylindriconical with an acute to moderately obtuse apex. Profile asymmetrical with flat venter and moderately inflated dorsum, although some species possess an almost symmetrical profile. Transverse sections are depressed and characteristically subquadrate, although they are more rounded in some species. The venter bears an apical groove that is either short and indistinct, or long and well-defined. The lateral lines are developed as a broad dorso-lateral depression underlain by a narrower ventro-lateral depression on each flank. The phragmocone penetrates one third to one half of the rostrum and is ventrally displaced. The apical line is cyrtolineate.

Range. – *Acroteuthis* is widespread within the Boreal Realm from its first appearance in the Volgian up to its last appearance in the ?Aptian.

Remarks. – There are three subgenera of this genus, namely *Acroteuthis* s. str., *A. (Microbelus)* Gustomesov and *A. (Boreioteuthis)* Saks & Nal'nyaeva. The intrinsic differences between these taxa are discussed below. In general, *Acroteuthis* is distinguished from *Pachyteuthis* Bayle which has an inflated dorsum, and from *Cylindroteuthis* Bayle which is very elongate and cylindrical (Table 1).

Subgenus *ACROTEUTHIS* Stolley, 1911

Type species. – As for genus.

Diagnosis. – Cylindriconical to conical *Acroteuthis* with a short, indistinct ventral apical groove. Transverse sections subquadrate.

Range. – As for genus.

Remarks. – *Acroteuthis* s. str. is characterized by its robust cylindriconical form and its short ventral apical groove. *A. (Microbelus)* is much smaller and more depressed than this genus, while *A. (Boreioteuthis)* is generally more cylindrical with a long ventral apical groove (Table 1).

Acroteuthis (Acroteuthis) acmonoides Swinnerton, 1936
Plate 8, Figs. 3–9.

v*. 1936 *Acroteuthis acmonoides* sp. nov. Swinnerton, p. 8, Pl. 4, Figs. 1–6.
v. 1936 *Acroteuthis explanatoides* (Pavlow); Blüthgen, p. 30, Pl. IV, Figs. 7, 8.
v. 1936 *Acroteuthis breviaxiformis* [Pompeckj MS] Blüthgen, p. 31, Pl. V, Figs. 1–3.
v. 1936 *Acroteuthis mobergi* [Pompeckj MS] Blüthgen (pars), p. 33, Pl. VI, Fig. 3 [has pathologically deepened groove], non Fig. 2 [= juvenile *Acroteuthis (Boreioteuthis)* sp.]
v? 1936 *Acroteuthis norvegicus* [Pompeckj MS] Blüthgen, p. 35, Pl. VI, Figs. 14, 15.
1966 *Acroteuthis (Acroteuthis) acmonoides* Swinnerton; Saks & Nal'nyaeva, p. 11.

Holotype. – BGS GSM.17662, Upper Valanginian–Lower Hauterivian, Bed D2, Speeton Clay, Speeton, Yorkshire.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.833, 16 specimens, *D.2716, 2720, 2731, 2733, 2745, 2780, 2786, 2795, 2804, 2814, 2839, 2893, 2899, 2920,* SMC X.14295, X.14296; CSE loc. N.818, 4 specimens, *N.1989, 1999–2001*; NRS, 47 specimens, MO.857, 886, 893, 896, 2670, 2671, 2680, 2787, 2788, 2790, 2793, 2796, 2798, 2800, 2803–06, 2807, 2810b, 2811, 2903, 2953, 2968, 2973, 2974, 2986, 2991, 2993, 2996–3000, 4000, 4001, 4003, 4005–10, 4012–14, 4017, 4075.

Diagnosis. – Medium sized conical *Acroteuthis (Acroteuthis)*. Outline symmetrical, conical to cylindriconical, profile weakly asymmetrical and cylindriconical. Transverse sections depressed subquadrate to pyriform.

Dimensions. –

	L	l	Dv	Dl
BGS GSM.17662 (Holotype)	81.2	45.8	16.6	19.3
SMC X.14295	72.8	42.1	17.4	18.1
X.14296	70.7	41.5	19.1	19.7

Description. – Medium sized squat, conical rostrum with a total length of approximately four times Dv. The outline is symmetrical and conical, with an acute apex (35–38°) from which the flanks gradually diverge up to the alveolar region. The profile is asymmetrical or nearly symmetrical and cylindriconical, with a flat venter and a slightly inflated dorsum, although with an acute apex (32–36°). The transverse sections are depressed (Dv:Dl 0.96) and subquadrate to pyriform.

The apex bears a short ventral apical groove restricted to the apical region that is commonly lost due to exfoliation. The lateral lines are present as a relatively broad dorso-lateral depression underlain by a thinner and impersistent ventro-lateral depression on each flank. The phragmocone penetrates approximately one half of the rostrum, and the apical line is cyrtolineate.

Remarks. – Specimens of *A. (A.) acmonoides* from Svalbard are close to the holotype of *A. (A.) acmonoides*, and correspondingly are assigned to this species. However, some of the Kong Karls Land specimens possess a slightly more inflated dorsum than is usual, although retaining the general form of this species. The specimen referred to *Acroteuthis explanatoides* (Pavlow) by Blüthgen (1936) is identical to the recently collected specimens and is within the range of variation of *A. (A.) acmonoides.* The conical species *A. (A.) explanatoides* (Pavlow) and *A. (A.) conoides* Swinnerton differ from *A. (A.) acmonoides* by being more elongate and cylindriconical. Roemer's (1836) figure of *Belemnites subquadratus* approaches some specimens of *A. (A.) acmonoides*, especially in the possession of a somewhat pyriform transverse section, but the former species is less acutely conical than the latter.

Occurrence. – *A. (Acroteuthis) acmonoides* occurs in the lower division of the Tordenskjoldberget Member on Kongsøya, with a fauna of *Pachyteuthis* and *Hibolithes* and *C. (Arctoteuthis)* of probable Valanginian–Hauterivian age. Elsewhere, this species is known only from these stages in eastern England and northern Germany (Pinckney & Rawson 1974).

Acroteuthis (Acroteuthis) arctica Blüthgen, 1936
Plate 9, Figs. 1–8.

v? 1892 *Belemnites subquadratus* Roemer; Pavlow (in Pavlow & Lamplugh), p. 234, Pl. VI, Figs. 5, ?6; Pl. VII, Fig. ?1.
? 1914 *Belemnites anabarensis* n. sp. Pavlow (pars), p. 16, Pl. 2, Figs. 2, 3 non Fig. 1. [=*A. (A). anabarensis* (Pavlow)].
v? 1936 *Acroteuthis subquadratus* Roemer; Swinnerton, p. 3, Pl. I, Figs. 13, 14; Pl. II, Figs. 1–14; Pl. III, Fig. 1.
v*. 1936 *Acroteuthis arcticus* [Pompeckj MS] Blüthgen, p. 31, Pl. 5, Figs. 4, 5.
v. 1936 *Acroteuthis* sp. indet. Blüthgen, Pl. VII, Fig. 2.
v? 1938 *Acroteuthis barrana* n. sp. Anderson, p. 228, Pl. 82, Fig. 2.
v. 1953 *Pachyteuthis subquadratus* (Roemer); Donovan, p. 99, Pl. 19, Fig. 2.
v. 1964 *Acroteuthis subquadratus* (Roemer); Jeletzky, Pl. 11, Fig. 2. [specimen GSC 17253]
. 1966 *Acroteuthis (Acroteuthis) arctica* Blüthgen; Saks & Nal'nyaeva, p. 95, Pl. XX, Figs. 5, 6; Pl. XXI, Figs. 1–4; Pl. XXII, Figs. 1–4 [full synonymy].
? 1969 *Acroteuthis arctica* Blüthgen; Gerasimov, p. 99, Pl. 37, Figs. 1–4, Pl. 58, Figs. 1–3.

Lectotype. – NRS MO.874 (Blüthgen 1936, Pl. 31, Figs. 4, 5), Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 4 specimens, *D.2175, 2342*, SMC X.14298, X.14299; CSE loc. D.833, 11 specimens, *D.2717, 2719, 2725, 2731, 2789, 2791, 2843, 2868, 2902, 2904, 2913*; CSE loc. N.818, 3 specimens, *N.1984, 1997, 2003*; 3 specimens, exact locality unknown, *H.3198, 3206, 3211/3220*; NRS, 9 specimens, MO.898, 2660, 2666, 2687, 2771, 2783, 2905, 2966, 2967.

Diagnosis. – Large, cylindrical to cylindriconical *Acroteuthis (Acroteuthis)*. Outline symmetrical, cylindrical to cylindriconical. Profile asymmetrical, cylindrical to cylindriconical, dorsum weakly inflated. Transverse sections depressed, subquadrate.

Dimensions. –

	L	l	Dv	Dl
NRS MO.874 (Lectotype)	102.8	64.5	22.5	24.8
SMC X.14299	89.4	59.0	21.4	22.7
X.14298	100.3	66.3	22.5	24.7
GSC 17253	93.2	54.2	22.2	24.2

Description. – Large, relatively robust cylindriconical rostra with a total length of approximately four and a half times Dv. The outline is symmetrical with an acute apex (35–36°), and the flanks diverge adorally until the mid-point of the rostrum where they become almost parallel. The profile is asymmetrical to nearly symmetrical and cylindriconical with an almost flat venter and a weak to moderately inflated dorsum. The apex is acute (35–37°) although it may be slightly incurved. Transverse sections of the rostrum are depressed (Dv: Dl 0.9) and subquadrate, becoming slightly more compressed in the stem and apex.

The apex bears a ventral groove that is restricted to the apical region, and it is commonly exfoliated in the Kong Karls Land specimens. The lectotype has a secondarily deepened groove that extends just past the apical region. Lateral lines take the form of a dorso-lateral depression with a weaker ventro-lateral depression below on each flank. The phragmocone penetrates approximately one third of the rostrum, and the apical line is cyrtolineate.

Remarks. – Saks & Nal'nyaeva (1966) considered Pavlow & Lamplugh's (1892) interpretation of *Belemnites subquadratus* Roemer typical of *A. (A.) arctica*. This interpretation may be correct, as Roemer's original figure of *B. subquadratus* (1836, Pl. XVI, Fig. 6) represents a small cylindriconical belemnite with a pyriform transverse section quite unlike subsequent interpretations (Pavlow & Lamplugh 1892; Swinnerton 1936) which approach more closely *A. (A.) arctica*. However, *A. (A.) arctica* is slightly more inflated than these wedge-like European belemnites, and therefore they cannot be definitely assigned to it. Swinnerton's (1936) species *A. (A.) paracmonoides* comes close to *A. (A.) arctica*, but this species is distinguished by being squat but relatively uninflated. *A. (A.) arctica* can be distinguished from *A. (A.) anabarensis* (Pavlow) which is much more inflated and robust, and from *A. (A.) acmonoides* Swinnerton and *A. (A.) conoides* Swinnerton which are more regularly conical in form.

Occurrence. – In Kong Karls Land this species occurs with *Acroteuthis*, *Pachyteuthis* and *Hibolithes* of probable Valanginian–Hauterivian age in the lower division of the Tordenskjoldberget Member on Kongsøya. Elsewhere this species is recorded from the late Berriasian–Hauterivian of northwest Europe, the Russian Platform and the Pechora Basin, the Lower Valanginian of East Greenland and the Upper Valanginian of Canada and possibly California.

Acroteuthis (Acroteuthis) conoides Swinnerton, 1937

Plate 8, Figs. 10–12.

v*. 1937 *Acroteuthis conoides* sp. nov. Swinnerton, p. 17, Pl. VI, Fig. 2.
v? 1964 *Acroteuthis* cf. *conoides* Swinnerton; Jeletzky, p. 56, Pl. XIV, Fig. 3.
v. 1964 *Acroteuthis* aff. *conoides* Swinnerton; Jeletzky, p. 58, Pl. XV, Fig. 3.
v. 1987 *Acroteuthis (Acroteuthis?) conoides* Swinnerton; Mutterlose et al., p. 639, Text-fig. 4.

Holotype. – BGS GSM.17298, Hauterivian, beds C7–8, Speeton Clay, Speeton, Yorkshire.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.833, 4 specimens, *D.2741, 2755a, 2869b, 2874*; CSE loc. N.818, 1 specimen, SMC X.14297; NRS, 1 specimen, MO.2659.

Diagnosis. – Large, conical *Acroteuthis (Acroteuthis)*. Outline symmetrical, acutely conical. Profile symmetrical, acutely conical. Transverse sections slightly depressed and rounded quadrate.

Dimensions. –

	L	l	Dv	Dl
BGS GSM.17662 (Holotype)	130.2	59.7	21.3	22.5
SMC X.14297	113.1	75.5	22.3	21.7

Description. – Large, conical to cylindriconical rostrum with a total length of approximately five times Dv. The outline is symmetrical and conical to cylindriconical, and the apex is acute to very acute (approximately 25°). The apical region and the posterior part of the stem are acutely conical, divergence from the apex reducing adorally, the flanks becoming parallel or even slightly convergent in the alveolar region. The profile is symmetrical or nearly symmetrical and acutely conical (apical angle 26°), the venter and dorsum being parallel only in the alveolar region. Transverse sections of the rostrum are depressed to almost equidimensional and quadrate in the alveolar region, becoming more depressed adapically.

The venter is weathered in the figured specimen (SMC X.14297), but the presence of a short ventral groove confined to the apical region is still apparent. Lateral lines are present as a broad dorso-lateral depression underlain by a narrow ventro-lateral depression. The phragmocone penetrates approximately one third of the rostrum, and the apical line is cyrtolineate.

Remarks. – The Svalbard specimens differ from the holotype of *A. (A.) conoides* by possessing a rather more compressed section, but otherwise they can be considered identical to this European species. *A. (A.) conoides* closely resembles *A. (A.) explanatoides* (Pavlow), but is distinguished from this species by its more robust (rather than depressed) transverse section. The specimen figured as *A.* aff. *conoides* by Jeletzky (1964, Pl. XIV, Fig. 3, GSC 17291) although possessing a penetrative alveolus (L, 152.6; l, 17.8; Dv, 25.2; Dl, 27.6), is close to the holotype and is here assigned to *A. (A.) conoides* with more certainty. *A. (A.) conoides* can be distinguished from *A. (A.) acmonoides* Swinnerton as it is elongate, robust, with a more acutely conical apex.

Occurrence. – This species occurs in the lower division of the Tordenskjoldberget Member with *Acroteuthis*, *Pachyteuthis* and *Hibolithes* of probable Valanginian–Hauterivian age. It is also present in England in the C Beds (Hauterivian) of the Speeton Clay, Yorkshire. The specimens assigned to this species by Jeletzky (1964) occur in sediments of Hauterivian age in Arctic Canada.

Subgenus *BOREIOTEUTHIS* Saks & Nal'nyaeva, 1966

Type species. – *Acroteuthis (Boreioteuthis) niiga* Saks & Nal'nyaeva, 1966.

Diagnosis. – Cylindriconical *Acroteuthis* with long, well-defined ventral apical groove. Transverse sections subquadrate to rounded subquadrate.

Range. – Common only in the Arctic Basin of the Boreal Realm, where it is known from Upper Jurassic–Lower Cretaceous sediments. This subgenus did manage to reach as far south as California in the Lower Cretaceous, and for a time populated Europe in the Hauterivian (Mutterlose et al. 1987).

Remarks. – *Acroteuthis (Boreioteuthis)* is primarily distinguished from *Acroteuthis* s. str. by its elongate ventral apical groove. The Jurassic cylindroteuthid *Lagonibelus (Holcobeloides)* Gustomesov also possesses a long ventral apical groove, but it is distinct in possessing a narrow cylindrical rostrum and a very incised apical groove.

Acroteuthis (Boreioteuthis) hauthali Blüthgen, 1936

Plate 9, Figs. 9–11; Plate 10, Figs. 1–9.

v*. 1936 *Acroteuthis hauthali* (?) [Pompeckj MS] Blüthgen, p. 30, Pl. IV, Fig. 12.
v. 1936 *Acroteuthis freboldi* sp. nov. Blüthgen, p. 35, Pl. VI, Figs. 16, 17 [juvenile].
v. 1938 *Acroteuthis aboriginalis* n. sp. Anderson, p. 225, Pl. 80, Fig. 2.
. 1966 *Acroteuthis (Boreioteuthis) freboldi* Blüthgen; Saks & Nal'nyaeva, p. 159, Pl. XXXIX, Figs. 1–4.
non 1966 *Acroteuthis (Boreioteuthis) hauthali* Blüthgen; Saks & Nal'nyaeva, p. 156, Pl. XXXVIII, Figs. 1–4 [=*A. (B.) johnseni*].

Lectotype. – NRS MO.862, Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 3 specimens, *D.2181, 2191, 2385*; CSE loc. D.833, 17 specimens, *D.2727, 2770, 2773, 2781, 2782, 2792, 2802, 2831, 2865–67, 2887, 2900, 2933*, SMC X.14300–02; CSE loc. N.818, 4 specimens, *N.1976, 1978, 1979, 1987*; CSE loc. N.837, 2 specimens, *N.2146, 2147*; 6 specimens, exact locality unknown, *H.3161, 3164, 3165, 3169, 3174, 3204*. NRS, Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: 21 specimens, MO.859, 875a, 892, 895, 2663, 2665, 2682–85, 2686, 2688, 2722, 2776, 2777, 2779, 2890, 2891, 2893, 2894, 2964; Johnsenberget, 2 specimens, MO.833, 2899.

Diagnosis. – Large, cylindriconical *Acroteuthis (Boreioteuthis)*. Outline symmetrical, cylindriconical. Profile slightly inflated, cylindriconical. Transverse sections depressed, subquadrate. Ventral groove elongate, broad, striated at apex.

Dimensions. –

	L	l	Dv	Dl
NRS MO.862 (Lectotype)	113.4	75.1	24.2	26.3
MO.887	77.6	65.2	16.8	17.6
SMC X.14300	100.3	68.6	21.0	22.0
X.14301	120.6	91.3	23.4p	23.6p

Description. – Large, cylindriconical or cylindrical rostra with a total length of approximately four and a half times Dv. The outline is symmetrical and cylindriconical although slightly more cylindrical in some individuals. The apex is usually acute (32–36°) with moderate divergence of the flanks adorally until the mid-point of the stem region where they become almost parallel. The profile is asymmetrical to almost symmetrical and cylindriconical. The dorsum is slightly inflated in some individuals although the apex itself is generally central to the long axis of the rostrum and acute (31–37°). The transverse sections are generally depressed (Dv : Dl 0.9) and subquadrate to quadrate.

The apex bears a ventral apical groove that extends well into the stem region of the rostrum, often extending further. The groove is broad and shallow except near the apex where it is more incised and often striated. Lateral lines are present as a broad dorso-lateral depression underlain by a thinner ventro-lateral one. The phragmocone penetrates one third to one quarter of the rostrum, and the apical line is cyrtolineate. Juveniles are cylindrical to slightly subhastate and are characterized by a very deep ventral apical groove and well-developed lateral lines (Pl. 10, Figs. 10, 11).

Remarks. – *A. (B.) hauthali* is distinguished from *A. (B.) johnseni* Blüthgen in possessing a more slender cylindriconical form with a more acute, less inflated apex. *A. (B.) elongata* Blüthgen is more slender with a more depressed, subquadrate section and a characteristic groove form. *A. aboriginalis* Anderson is a large cylindriconical *A. (Boreioteuthis)* which closely resembles *A. (B.) hauthali*, but as it is slightly more robust than the Kong Karls Land species, it is only tentatively assigned to *A. (B.) hauthali* here. The name *A. freboldi* Blüthgen (lectotype NRS MO.887) is here considered a synonym of *A. (B.) hauthali* as their type specimens agree in form. The type of *A. freboldi* is probably a juvenile or slightly more slender example of *A. (B.) hauthali*. Saks & Nal'nyaeva's (1966) specimens figured as *A. (B.) hauthali* are more properly assigned to *A. (B.) johnseni* as they are more robust than is typical, while conversely their specimens of *A. (B.) freboldi* are probably true representatives of *A. (B.) hauthali*. The specimen figured by Jeletzky (1964, Pl. XIX, Fig. 1) as *A.* n. sp. aff. *conoides* Swinnerton from Barremian sediments in Arctic Canada is a typical *A. (Boreioteuthis)* which agrees well in rostral shape with *A. (B.) hauthali*. However, the groove in this specimen distinguishes it from the Kong Karls Land species, as it is weak at the apex and very incised adorally. This specimen possibly belongs to a new species of *A. (Boreioteuthis)*.

Occurrence. – This species occurs with other *Acroteuthis*, *Pachyteuthis*, *Hibolithes* and *C. (Arctoteuthis)* species in the lower division of the Tordenskjoldberget Member on Kongsøya. It has also been recorded from the Upper Berriasian–Lower Valanginian sediments of the Russian Platform and the Pechora Basin, and from Lower–Upper Valanginian rocks in Siberia. The related and possibly conspecific *Acroteuthis aboriginalis* Anderson is recorded from sediments of Upper Valanginian–Hauterivian age in California (Anderson 1938; Imlay 1960).

Acroteuthis (Boreioteuthis) johnseni Blüthgen, 1936
Plate 11, Figs. 1–9; Plate 12, Figs. 1–8; Plate 13, Figs. 1–6.

v. 1936 *Acroteuthis subquadratus* Roemer; Blüthgen, p. 29, Pl. IV, Figs. 4, 6.
v. 1936 *Acroteuthis pseudorussiensis* [Pompeckj MS] Blüthgen (pars), p. 31, Pl. IV, Fig. 3, non Figs. 13–15 [= *Acroteuthis* sp. and/or *Pachyteuthis* sp.].
v*. 1936 *Acroteuthis johnseni* [Pompeckj MS] Blüthgen, p. 31, Pl. V, Figs. 6, 7.
v. 1936 *Acroteuthis johnseni* var. *obtusa* [Pompeckj MS] Blüthgen, p. 32, Pl. V, Fig. 8.
v. 1936 *Acroteuthis johnseni* var. *obliqua* [Pompeckj MS] Blüthgen, p. 32, Pl. V, Figs 11, 12.
v. 1936 *Acroteuthis johnseni* var. *acuta* [Pompeckj MS] Blüthgen, p. 32, Pl. V, Figs. 9, 10.
v. 1936 *Acroteuthis johnseni* var. *curvata* [Pompeckj MS] Blüthgen, p. 33, Pl. V, Figs. 13, 14; Pl. VI, Fig. 1.
v? 1964 *Acroteuthis pseudopanderi* (Sintzow); Jeletzky, Pl. XVI, Fig. 2; Pl. XVIII, Fig. 2 [slender form].
. 1966 *Acroteuthis (Boreioteuthis) hauthali* Blüthgen; Saks & Nal'nyaeva, p. 156, Pl. XXXVIII, Figs. 1–4.

Lectotype. – NRS MO.840 (Blüthgen 1936, Pl. V, Fig. 6), Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Paralectotype. – NRS MO.837 (Blüthgen 1936, Pl. V, Fig. 7), Tordenskjoldberget Member, Johnsenberget, Kongsøya.

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 17 specimens, *D.2172, 2176, 2210, 2243, 2245, 2247, 2251, 2254, 2272, 2290, 2310, 2350, 2487, 2488, 2492, 2501*, SMC X.14304; CSE loc. D.833, 18 specimens, *D.2700, 2704, 2706, 2759, 2779, 2784, 2809, 2836, 2840, 2843, 2849, 2855, 2872, 2880, 2881, 2889*, SMC X.14305, X.14306; CSE loc. N.818, 7 specimens, *N.1975, 1977, 1982, 1985, 1992, 1993, 1996*; CSE loc. N.837, 1 specimen, *N.2145*; 7 specimens, exact locality unknown, *H.3186/3187, 3191/3192, 3193, 3194, 3196, 3197, 3201*. NRS, Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: 53 specimens, MO.839, 841, 842, 852, 880, 882–5, 899, 2179, 2662, 2663, 2674–76, 2678, 2693, 2698, 2699, 2700–03, 2705, 2706, 2708, 2710, 2711a, b, 2713–18, 2721, 2725, 2726, 2767–70, 2775, 2781, 2782, 2785, 2799, 2808, 2862, 2892, 2963; Johnsenberget, 5 specimens, MO.832, 834, 843, 2901, 2902.

Diagnosis. – Large, robust, cylindriconical *Acroteuthis (Boreioteuthis)*. Outline symmetrical, cylindriconical to cylindrical. Profile asymmetrical becoming nearly symmetrical, cylindriconical, with inflated dorsum. Transverse sections weakly depressed, subquadrate. Ventral apical groove elongate, broad.

Dimensions. –

	L	l	Dv	Dl
NRS MO.840 (Lectotype)	119.2	89.0	26.7	—
MO.841	93.1	74.4	26.4	27.8
MO.882	100.1	70.3	28.4	29.4
SMC X.14305	111.6	61.7	30.1	30.7
X.14306	102.6	81.1	30.1	31.6

Description. – Large, robust, cylindriconical rostra with a total length of approximately three and a half times Dv. The outline is symmetrical and cylindriconical to cylindrical. In outline the rostrum has a relatively obtuse apex (44–57°), becoming more obtuse in some cases. The flanks are strongly divergent from the apex, although they become more cylindrical towards the limit of the apical region, with parallel flanks in the stem and alveolar regions. The profile is usually asymmetrical, with an inflated dorsum and a generally flattened venter (apical angle 42–52°). The transverse sections are weakly depressed to equidimensional, subquadrate to almost quadrate in form.

The apex bears a ventral apical groove that is well-defined and reasonably incised in the apical region, expanding and shallowing adorally into the stem region of the rostrum. At the tip of the apex the groove may be inverted so that a small ridge is found. Lateral lines are present in the form of a relatively broad dorso-lateral depression with a thinner ventro-lateral depression below, which becomes indistinct adapically. The phragmocone penetrates approximately one quarter to one third of the rostrum, and the apical line is cyrtolineate. Juveniles are more elongate and slightly subhastate, with a well-developed and incised ventral apical groove.

Remarks. – This species is extremely robust, and it is primarily this feature that distinguishes *A. (B.) johnseni* from *A. (B.) hauthali*, which is more slender and cylindriconical. The inflated slightly mucronate apex of *A. (B.) johnseni* is reminiscent of species of *Pachyteuthis (Simobelus)*, but *A. (B.) johnseni* may be distinguished by its depressed section and wide ventral groove (uncommon in *Pachyteuthis)*. A number of specimens of *A. (B.) johnseni* were regarded as typical *A. subquadratus* (Roemer) by Blüthgen (1936), even though this is a species without an elongate and deep groove. As these specimens are close to the lectotype of *A. (B.) johnseni*, they are here assigned to this species. A number of varieties of *A. johnseni* were described by Blüthgen (1936), but as differences between them are relatively small, they are here included within the limits of variation of *A. (B.) johnseni* s. str. The specimens figured by Saks & Nal'nyaeva (1966) as *A. (B.) hauthali* Blüthgen are rather robust and are more properly assigned to *A. (B.) johnseni*. Jeletzky (1964) figured some specimens from Barremian sediments in Arctic Canada that closely resemble *A. (B.) johnseni*. The first (Pl. XVI, Fig. 2, GSC 17296) is closest to the lectotype in possessing a robust rostrum (L, 117.8; Dv, 37.5; Dl, 38.3) and broad groove, while the second (Pl. XVIII, Fig. 2, GSC 17301) is closer to the form described as *A. johnseni* var. *obliqua* by Blüthgen (1936). However, these specimens possess only weakly defined apical grooves and are therefore only tentatively assigned to this species.

Occurrence. – This species occurs with others of *Acroteuthis, Pachyteuthis* and *Hibolithes* of probable Valanginian–Hauterivian age in the lower division of the Tordenskjoldberget Member on Kongsøya. It is also known from the Valanginian of the Russian Platform, the Berriasian of the Pechora Basin and the Lower–Upper Valanginian of Sibera. Similar specimens occur in sediments of Valanginian age in East Greenland (GMC collections) and of Barremian age in Arctic Canada (Jeletzky 1964).

Acroteuthis (Boreioteuthis) elongata Blüthgen, 1936
Plate 13, Figs. 7–13.

v*. 1936 *Acroteuthis elongatus* sp. nov. Blüthgen, p. 36, Pl. VI, Figs. 18–20.
v? 1936 *Acroteuthis regularis* sp. nov. Blüthgen, p. 34, Pl. VI, Figs, 12–13.
v? 1936 *Acroteuthis subrectangulatus* sp. nov. Blüthgen, p. 35, Pl. VI, Figs. 10, 11.
v? 1936 *Acroteuthis superelongatus* sp. nov. Blüthgen, p. 36, Pl. VII, Fig. 1.
v. 1936 *Oxyteuthis brunsviciensis* v. Strombeck; Blüthgen, p. 37, Pl. VII, Figs. 4, 5.
non 1964 *Lagonibelus (Lagonibelus) elongatus* (Blüthgen); Saks & Nal'nyaeva p. 101, Pl. XXI, Figs. 3–6. [*Lagonibelus* sp.].

Lectotype. – NRS MO.846 (Blüthgen 1936, Pl. VI, Fig. 20), Tordenskjoldberget Member, Tordenskjoldberget, Kongsøya.

Paralectotypes. – NRS MO.844, MO.2900, same locality as lectotype

Material. – Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: CSE loc. D.831, 5 specimens, *D.2328, 2381, 2388,* SMC X.14307, X.14308; CSE loc. D.833, 26 specimens, *D.2728, 2748, 2762, 2767, 2776, 2777, 2783, 2790, 2797, 2800, 2805, 2826, 2834, 2871, 2875, 2877, 2899, 2903, 2909, 2911, 2914–16, 2918, 2821, 2928;* CSE loc. N.818, 4 specimens, *N.1981, 1986, 2011, 2085;* 4 specimens, exact locality unknown, *H.3159, 3162, 3166, 3188*. NRS, Kongsøya, Tordenskjoldberget Member, Tordenskjoldberget: 19 specimens, MO.845, 847, 848, 860, 888, 2897, 2899, 2942, 2944–46, 2948–50, 2952, 2976, 2977, 2988, 2989; Johnsenberget, 1 specimen, MO.2980.

Diagnosis. – Elongate, slender cylindrical *Acroteuthis (Boreioteuthis)*. Outline symmetrical, cylindrical to cylindriconical. Profile asymmetrical, cylindrical to cylindriconical. Apex acute. Transverse sections depressed, subquadrate to quadrate. Ventral apical groove narrow and incised at the apex, broad and very shallow in the stem.

Dimensions. –

	L	l	Dv	Dl
NRS MO.846 (Lectotype)	113.4	75.1	14.2	15.7
SMC X.14308	83.7	60.7	14.5	15.6
CSE *D.2776*	81.6	64.2	14.5	15.7

Description. – Elongate, slender cylindrical to weakly cylindriconical rostra with a total length of approximately six times Dv. The outline is symmetrical and cylindrical to cylindriconical.

The apex is acute (26–36°), and the flanks are weak to moderately divergent, becoming almost parallel in the stem, finally becoming parallel in the alveolar region. The profile is asymmetrical with a slightly inflated dorsum, although still with an acute apex (26–36°), and is cylindrical or weakly cylindriconical. The transverse sections are depressed (Dv:Dl 0.9) and subquadrate. Some individuals possess a more regularly quadrate section, with flat venter, dorsum and flanks in the stem region.

The apex bears a very distinctive ventral groove. It is incised and narrow in the apical-most part of the apical region, where it may also be striated. The groove rapidly broadens adorally from this point, developing into a broad and shallow groove extending for the length of the stem region, in some cases reaching the alveolar region. The lateral lines are in the usual pattern of a broad dorso-lateral depression on each flank underlain by a much thinner ventro-lateral depression. In at least one specimen (SMC X.14308) the dorso-lateral depression is ventrally deflected in the apical region. The alveolus penetrates approximately one quarter to one third of the total length of the rostrum. The apical line is cyrtolineate. Juveniles are very slender and elongate with a weakly defined apical groove.

Remarks. – This species is distinct from other members of its subgenus because of its characteristic ventral groove and its slender elongate form. The contemporary species *A. (B.) hauthali* Blüthgen and *A. (B.) johnseni* Blüthgen are both much more robust and inflated than *A. (B.) elongata* with broad ventral grooves down to their apices. *A. (B.) elongata* most closely resembles *A. (B.) rawsoni* Pinckney which is slender with an incised ventral groove at the apex. However, this species is much less elongate than *A. (B.) elongata,* and its groove broadens adorally in a much more regular fashion.

The species *A. subrectangulatus* and *A. regularis* (lectotypes NRS MO.2943 and MO.8919, respectively) described by Blüthgen (1936) are close to *A. (B.) elongata* and are within the range of variation exhibited by this species. However, as both these forms have relatively short rostra they are only tentatively assigned to *A. (B.) elongata.* The species *A. superelongatus* Blüthgen (lectotype NRS MO.2982) may represent a juvenile *A. (B.) elongata.* Saks & Nal'nyaeva (1964) have misinterpreted *A. (B.) elongata* as a species of *Lagonibelus*. However, examination of the type series indicates that it is a true *Acroteuthis*, with a subquadrate transverse section and a relatively short rostrum compared to true species of *Lagonibelus* (e.g. *L. magnificus* (d'Orbigny), see Saks & Nal'nyaeva 1964).

Occurrence. – This species is as yet known only from the lower division of the Tordenskjoldberget Member with a fauna of *Acroteuthis, Pachyteuthis* and *Hibolithes* of probable Upper Valanginian–Hauterivian age. It is unknown outside Kong Karls Land.

5. Distribution of belemnite genera and subgenera

5.1 Lenobelus (Fig. 10)

Lenobelus is presently known only from the northern USSR (Gustomesov 1966; Saks & Nal'nyaeva 1975) and Canada (Jeletzky 1980), and is recorded from Svalbard for the first time. In Siberia *Lenobelus* is known to range from the Toarcian to the base of the Bajocian (Saks & Nal'nyaeva 1975), while in Canada it is characteristic of the Aalenian (Jeletzky 1980). The Kong Karls Land specimens appear to be more closely comparable with Siberian species (i.e. *L. viligaensis)* rather than the apparently endemic Canadian examples, and occur with large rostra of *Paramegateuthis nalnyaevae* and isolated *P. (Pachyteuthis) bodylevskii* in the basal beds of the Janusfjellet Formation. This association of genera, minus *Paramegateuthis*, is also known in Canada, but not the USSR, where the taxa occur at different intervals. In Siberia at least, *Paramegateuthis* generally succeeds *Lenobelus* in the Bajocian, becoming most common in the Callovian. The association of these genera in the Janusfjellet Formation suggests that the stratigraphic ranges of one or both genera are more extensive than was first thought, as both occur approximately 15 m below the ammonites *Arcticoceras harlandi* Rawson and *Costacadoceras bluethgeni* Rawson of *ishmae* Zone (Middle Bathonian) age at Retziusfjellet (CSE loc. C, 1381, Kongsøya), suggesting an age range of Toarcian/Aalenian to Lower Bathonian for these belemnites.

In Spitsbergen the Brentskardhaugen Bed, a reworked and condensed phosphorite conglomerate of Toarcian–?Bathonian age (Bäckström & Nagy 1985), contains few well-preserved belemnite remains, although phragmocones and a single rostrum (?*Hastites*) have been recorded. The record of ?*Hastites* could refer to the Toarcian–Bajocian Arctic genus *Pseudodicoelites* (Bäckström & Nagy 1985, Pl. 8, Fig. 4), but there is no evidence to suggest that either *Lenobelus* or *Paramegateuthis* occur in the bed. An association of *Lenobelus* and fragments of ?*Pseudodicoelites* (Toarcian–Bajocian stages of the USSR and Canada) and ?*Paramegateuthis* is also recorded here from Franz Josef Land, from amongst the specimens collected by the Jackson-Harmsworth Expedition (BMNH C.7244) from locality 5 (west of Elmwood) (Newton & Teall 1897; Pompeckj 1900). Pompeckj (1900) has suggested that the age of these fragments is Bajocian. *Pseudodicoelites* may also occur in Kong Karls Land, as two poorly preserved rostra from Kükenthalfjellet (Svenskøya, probably from the Dunérfjellet Member) collected by Nathorst (NRS MO.651a, b) resemble those fragments from Franz Josef Land.

5.2 *Paramegateuthis* (Fig. 10)

Paramegateuthis has been described from the USSR (Nal'nyaeva 1974, 1986; Saks & Nal'nyaeva 1975), Franz Josef Land (Yefremova, Ditmar & Tarakhovskii 1983; Yefremova, Meledina & Nal'nyaeva 1983) and Bulgaria (Stoyanova-Vergilova 1982a, b). It has also been recorded from Canada (Jeletzky 1964), and this record, from the Porcupine River, NW British Columbia, refers to an elongate conical specimen (GSC collection: L, 11.6; Dv, 16.4; Dl, 13.0) which probably represents a new species. *Paramegateuthis* is here described for the first time from Svalbard, the species discussed above having great affinity to those from the northern USSR and Franz Josef Land. Although the new species *Paramegateuthis nalnyaevae* is apparently endemic to Kong Karls Land, a single very similar example (of Lower Bathonian age) was illustrated by Saks & Nal'nyaeva (1975) from Siberia. *Paramegateuthis nescia* also occurs in the Janusfjellet Formation, and is known from the USSR and Franz Josef Land (Saks & Nal'nyaeva 1975; Yefremova, Ditmar & Tarakhovskii 1983; Nal'nyaeva 1986) where it occurs primarily in sediments of Bajocian–Lower Callovian age, although in Siberia it has been recorded from Aalenian strata.

The occurrence of *Paramegateuthis* with *Lenobelus* (usually of Toarcian–Aalenian age, see above) in the Janusfjellet Formation of Kong Karls Land (in both Kongsøya and Svenskøya) suggests that *Paramegateuthis* may range down into the Bajocian or even Aalenian in Svalbard.

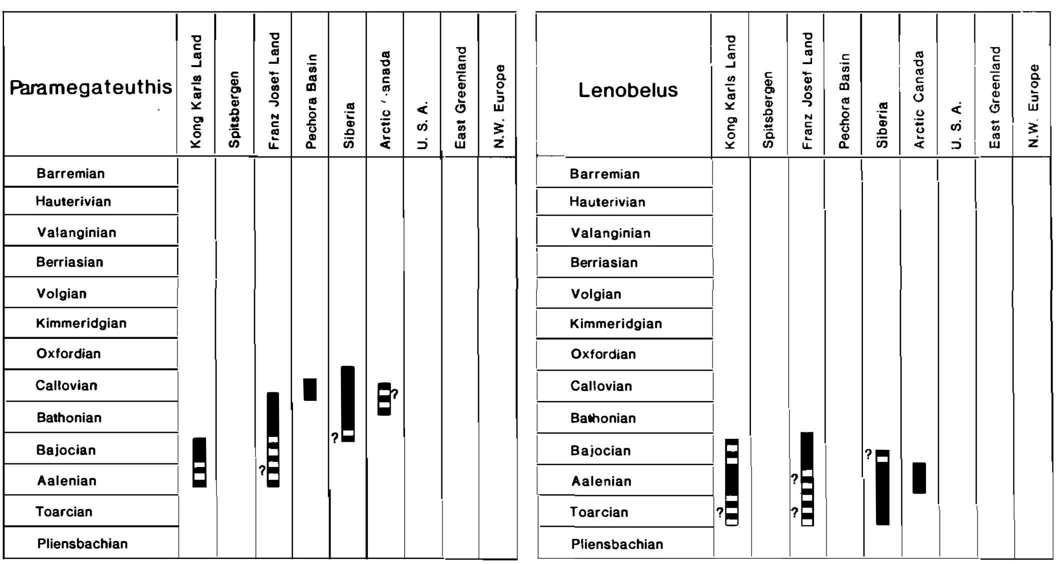

Fig. 10. Stratigraphical and geographical ranges of *Paramegateuthis* and *Lenobelus*. Compiled from numerous sources (see text). Solid line, certain record; broken line, uncertain record.

Paramegateuthis of similar age (Aalenian–Bajocian) have been recorded from Bulgaria, leading Stoyanova-Vergilova (1982a, b) to suggest, contrary to the views of Nal'nyaeva (1974), that this genus was not purely boreal in distribution. However, some of the rostra figured by this author (Stoyanova-Vergilova 1982b, e.g. Pl. II, Fig. 3) could be 'late' representatives of the genera '*Mesoteuthis*' or *Acrocoelites* rather than *Paramegateuthis. Lenobelus*, commonly occurring with *Paramegateuthis* in the Janusfjellet Formation (Kongsøya and Svenskøya), is unknown in Bulgaria (see Stoyanova-Vergilova 1982a).

5.3 Cylindroteuthis (Fig. 11)

Cylindroteuthis and its associated genera and subgenera were common in the Boreal seas of Upper Jurassic and Lower Cretaceous times. Generally, *Cylindroteuthis* is dominant, although *Lagonibelus* is also widely distributed. *Lagonibelus* has been recorded, largely from Jurassic rocks, in European Russia, Siberia, Norway, Denmark, the United States (Alaska, California), Canada and Svalbard (see Gustomesov 1964; Saks & Nal'nyaeva 1964, 1972, 1973; Stevens 1973a; Birkenmajer & Pugaczewska 1975; Birkenmajer et al. 1982; Nal'nyaeva 1983, 1984), where it has an age range of Oxfordian–Valanginian. In the present study, only *Cylindroteuthis* has been described from Kong Karls Land, although *Lagonibelus* has been described by Blüthgen (1936) (as *Cylindroteuthis* cf. *absoluta* (Fischer), see above) from Svenskøya, and by Birkenmajer & Pugaczewska (1975) from Spitsbergen.

Cylindroteuthis is widespread and has been recorded from the Jurassic sediments of most boreal regions (see above references and Phillips 1865–1870; Waterston 1952; Hewitt 1980). In the Jurassic two subgenera are dominant; *C. (Cylindroteuthis)*, most common in the European boreal area (Boreal–Atlantic province), while *C. (Arctoteuthis)* is restricted to the Arctic boreal regions (Arctic province). In Europe, *C. (Cylindroteuthis)* has a recorded range of Callovian–Kimmeridgian, while in northerly regions it has the longer range of Bathonian–Berriasian (Saks & Nal'nyaeva 1964; Nal'nyaeva 1986). In these more northerly, Arctic boreal regions (i.e. Siberia, Alaska, Arctic Canada, Svalbard) *C. (Cylindroteuthis)* is common, occurring there earlier than in Europe, although some Bathonian cylindroteuthids are known from Germany (Riegraf 1980; '*Eocylindroteuthis*').

The first *C. (Arctoteuthis)* appeared in the Volgian of the Arctic and remained largely endemic to this region until its last appearance in the Hauterivian (see Imlay 1955 (=*Cylindroteuthis* sp); Jeletzky 1964 (=*Acroteuthis* (a new

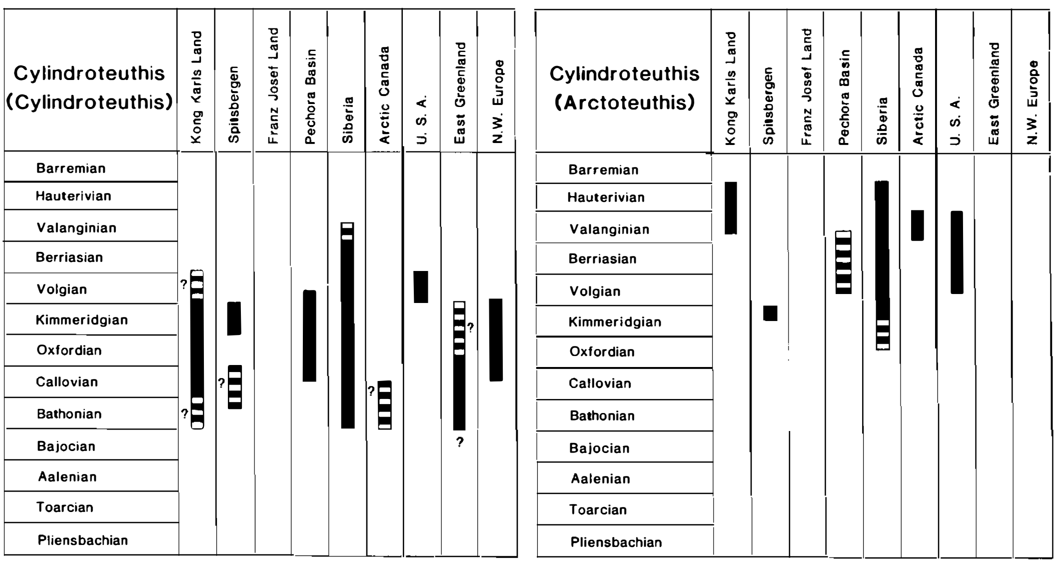

Fig. 11. Stratigraphical and geographical ranges of *Cylindroteuthis*. Compiled from numerous sources (see text). Solid line, certain record; broken line, uncertain record.

genus?) sp. A); Saks & Nal'nyaeva 1964, 1972, 1973; Stevens 1973a). However, although unable to penetrate into Europe, *C. (Arctoteuthis)* (with *C. (Cylindroteuthis)*) was able to migrate as far south as California in Upper Jurassic and Lower Cretaceous times (Stanton 1895; Anderson 1938, 1945) and possibly reached as far south as Mexico (Buitrón (1984) cited ?*Cylindroteuthis* from the northern Zacetatas). The record of *Cylindroteuthis* from New Zealand (Stevens 1965) is puzzling, but it is possible that these few, poorly preserved rostra may belong to some other genus such as *Belemnopsis*.

5.4 Pachyteuthis (Pachyteuthis) (Fig. 12)

This subgenus is well-known and has been recorded from most regions within the Boreal Realm. A single fragmentary and therefore unreliable specimen (BMNH 21573) is also known from Australia (Etheridge 1880). Within northwestern Europe species of *P. (Pachyteuthis)* are characteristic of the Oxfordian–Kimmeridgian stages (Phillips 1865–70; Stevens 1973a), while in the Pechora Basin (USSR) the subgenus has an age range of Callovian–Kimmeridgian/Lower Volgian (Gustomesov 1964; Saks & Nal'nyaeva 1964). In Siberia this subgenus is attributed with the even longer range of Bathonian–Hauterivian by Saks & Nal'nyaeva (1966, 1972, 1973), although of the 15 species described by them only two are of Lower Cretaceous age, while of the remaining 13, five have a range of Bathonian–Callovian, and either a range of Oxfordian–Volgian. J. A. Jeletzky (pers. comm. 1987) has recently recognized *Pachyteuthis* from the Bajocian sediments of the Canadian Arctic, where it occurs with *Arkelloceras*.

P. (Pachyteuthis) has been recognized from many Arctic regions, usually under the name '*Belemnites panderi*'. Although this name has been widely applied by many authors (e.g. Newton & Teall 1897, 1898; Whitfield 1906 (as *Belemnites densus*); Pompeckj 1900; Spath 1932, 1935, 1936), these occurrences are of importance as they illustrate the wide distribution of this subgenus. *P. (Pachyteuthis)* is thus recorded from Bathonian–Volgian sediments of Siberia, East Greenland, Franz Josef Land and Spitsbergen, as well as Canada and the USA (above references and Meek & Hayden 1865; Saks & Nal'nyaeva 1966; Stevens 1973b; Jeletzky 1980; Birkenmajer et al. 1982; Nal'nyaeva 1986). In Kong Karls Land the first representatives of this subgenus (*P. (P.) bodylevskii)* occur in the Passet Member with *Lenobelus* and *Paramegateuthis* of probable Bajocian age, while *P. (P.) optima* occurs higher up in the Janusfjellet Formation (Dunérfjellet and Retziusfjellet members) with a possible age of Bathonian–Callovian. A similar association of

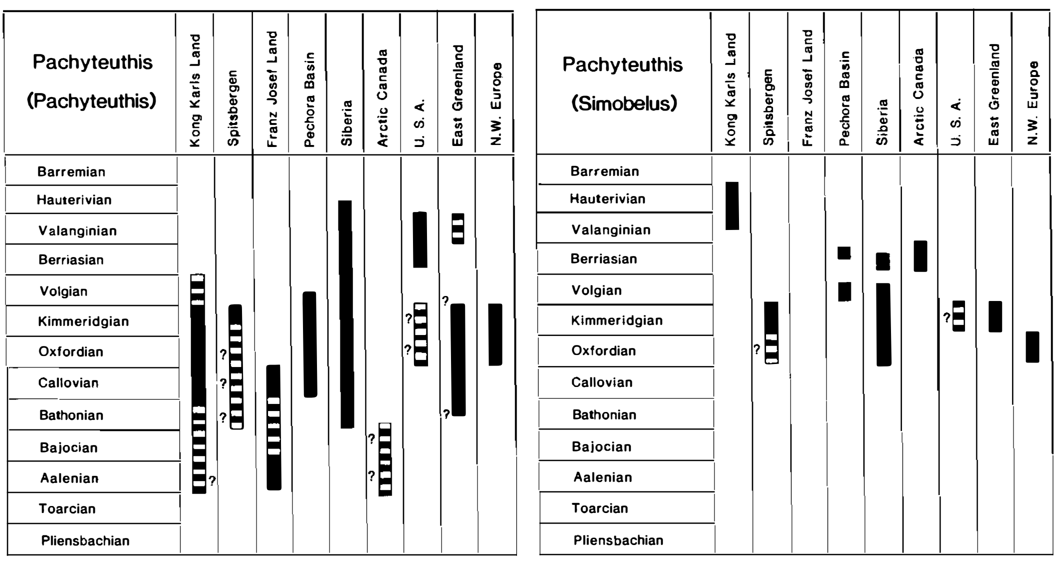

Fig. 12. Stratigraphical and geographical ranges of *Pachyteuthis*. Compiled from numerous sources (see text). Solid line, certain record; broken line, uncertain record.

taxa is present in the Bajocian of Arctic Canada (GSC collections).

There are no records of this subgenus occurring in Lower Cretaceous sediments outside Siberia and Kong Karls Land. At this time in most of Europe the dominant cylindroteuthid is *Acroteuthis*, and here neither subgenus of *Pachyteuthis* is known to occur above the Volgian stage. In Kong Karls Land, *P. (Pachyteuthis)* is represented by the species *P. (P.) crassovalis* and *P. (P.) obliquespinata* in the Tordenskjoldberget Member of probable Upper Valanginian–Hauterivian age. In addition, Saks & Nal'nyaeva (1964) have interpreted Blüthgen's (1936) new form *Acroteuthis johnseni* var. *acuta* as a *P. (Pachyteuthis)*, but these specimens are close to *A. (Boreioteuthis) johnseni* Blüthgen and are here considered cylindrical variants of this species.

5.5 *Pachyteuthis (Simobelus)* (Fig. 12)

On the whole, the distribution of this subgenus is less well-documented than that of *P. (Pachyteuthis)*, but it is clear that its distribution was almost as wide as that of the latter. Like *P. (Pachyteuthis), P. (Simobelus)* is known in northwest Europe almost exclusively from Oxfordian sediments, while in the Pechora Basin it has the wider range of Volgian–Berriasian (Saks & Nal'nyaeva 1966; Nal'nyaeva 1984). Specimens of this subgenus are present in collections from the Upper Jurassic sediments of East Greenland (GMC, personal observation), and in Siberia it is recorded from the Oxfordian–Berriasian stages (Saks & Nal'nyaeva 1966). *P. (Simobelus)* has been previously recorded from Svalbard, as Birkenmajer et al. (1982) recorded this genus from Oxfordian–Kimmeridgian sediments in Spitsbergen. In Kong Karls Land this genus occurs in the Tordenskjoldberget Member with *Hibolithes* and *Acroteuthis* species suggestive of an Upper Valanginian–Hauterivian age, which is an extension of the stratigraphic range of this subgenus.

5.6 *Acroteuthis (Acroteuthis)* (Fig. 13)

A. (Acroteuthis) is widely distributed in the Boreal Realm where it has been used as a zonal index (e.g. Jeletzky 1964; Pinckney & Rawson 1974). It is well known from Volgian–Hauterivian sediments in Europe (reviewed by Mutterlose et al. 1983), the USSR (Saks & Nal'nyaeva 1966), Arctic Canada (Jeletzky 1964), USA (Anderson 1938), Greenland (Donovan 1953), Novaya Zemlya (Salfeld & Frebold 1924) and Spitsbergen (Sokolov & Bodylevsky 1931). Coquand (1862) has also recorded it from Algeria ('*Belemnites subquadratus*'), but this record requires confirmation. Although many species are endemic (particularly in the northern USSR), there are

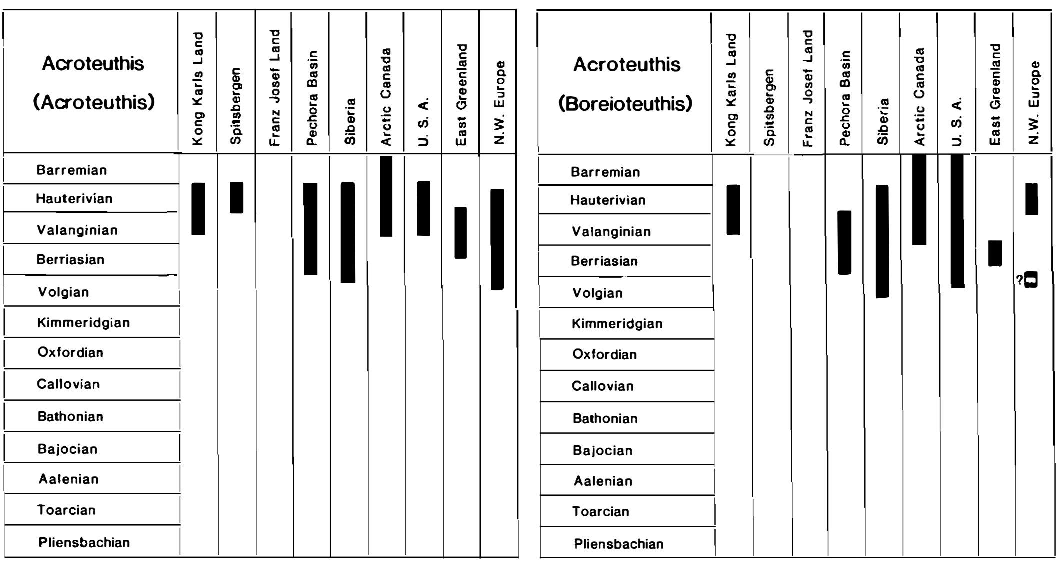

Fig. 13. Stratigraphical and geographical ranges of *Acroteuthis*. Compiled from numerous sources (see text). Solid line, certain record; broken line, uncertain record.

some that are widely distributed (e.g. *A. (A.) arctica, A. (A.) conoides*), although it has been noted that slight differences occur in their stratigraphic ranges between regions (Pinckney & Rawson 1974).

Blüthgen (1936) described a rich *Acroteuthis* fauna from the Tordenskjoldberget Member of Kongsøya, Kong Karls Land. This fauna has been re-investigated in the present study, and most of the species described by Blüthgen in fact belong to the subgenus *A. (Boreioteuthis)* (e.g. *A. (B.) hauthali, A. (B.) johnseni*). However, *A. (Acroteuthis)* does occur in some numbers, and the species *A. (A.) arctica* Blüthgen, *A. (A.) acmonoides* Swinnerton and *A. (A.) conoides* Swinnerton are dominant, suggesting an Upper Valanginian–Hauterivian age for the Tordenskjoldberget Member, belonging to assemblage zones 5 and 6 of Pinckney & Rawson (1974).

5.7 *Acroteuthis (Boreioteuthis)* (Fig. 13)

A. (Boreioteuthis) is less well-known than *A. (Acroteuthis)*, primarily because of its scarcity in northwestern Europe, and it has been generally thought that this subgenus is numerically of lesser importance than *A. (Acroteuthis)*, because more species of the latter are recorded (see Saks & Nal'nyaeva 1972). However, in the Upper Valanginian–Hauterivian sediments of California this situation is reversed, and in Kong Karls Land, the numbers are about equal. *A. (Boreioteuthis)* is recorded from the USSR (Saks & Nal'nyaeva 1966, 1972, 1973), Arctic Canada (Jeletzky 1964), California (Anderson 1938) and East Greenland (personal observation, GMC). It occurs in large numbers in the Tordenskjoldberget Member, Kongsøya, Kong Karls Land. This subgenus also reached Europe in the Hauterivian, two species occurring in England and Germany (assemblage zone 7 of Pinckney & Rawson 1974, see also Mutterlose et al. 1983, 1987). In Siberia *A. (Boreioteuthis)* has primarily a range of Volgian–Hauterivian, as the species (e.g. *A. (B.) absolutus* (Fischer)) that have been recorded from the early Upper Jurassic (Saks & Nal'nyaeva 1966) are probably referable to *Lagonibelus (Holcobeloides)*, while in Canada it is known predominantly from Barremian sediments (Jeletzky 1964).

5.8 *Hibolithes* (Fig. 14)

This genus has a very wide geographic and stratigraphic distribution after its first appearance in the Bajocian of the Tethyan region. It is common in the Jurassic sediments of the Tethyan regions, such as southern Europe (e.g. Riegraf 1980) and the Southern Hemisphere (e.g. Stevens 1965, 1973a), rarely penetrating farther north (Stevens 1973a; Gustomesov 1976; Callomon & Birkelund 1980) to mingle with the boreal cylindroteuthid or endemic hastitid/pseudodicoelitid genera. Anderson's (1945) Californian Upper Jurassic *Hibolithes* records were interpreted by Stevens (1965) as juvenile cylindroteuthids, but Saks & Nal'nyaeva (1972) have questioned this reinterpretation.

In the Lower Cretaceous *Hibolithes* was able to migrate widely into both the Northern and the Southern Hemisphere (Stevens 1965; Mutterlose et al. 1983), and mingle with boreal elements such as *Acroteuthis* for the first time. Thus, *H. jaculoides* Swinnerton occurs commonly in northwestern Europe in sediments of Upper Valanginian–Hauterivian age (Mutterlose 1978), and similarly it occurs in Kong Karls Land in large numbers with the Arctic boreal subgenus *A. (Boreioteuthis)*. *Hibolithes* did not manage to penetrate into Siberia, but it did reach the Pechora Basin (Saks & Nal'nyaeva 1966; Nal'nyaeva 1984), California (Anderson 1938), Spitsbergen (Pchelina 1967) and East Greenland (personal observation, GMC). However, there are no

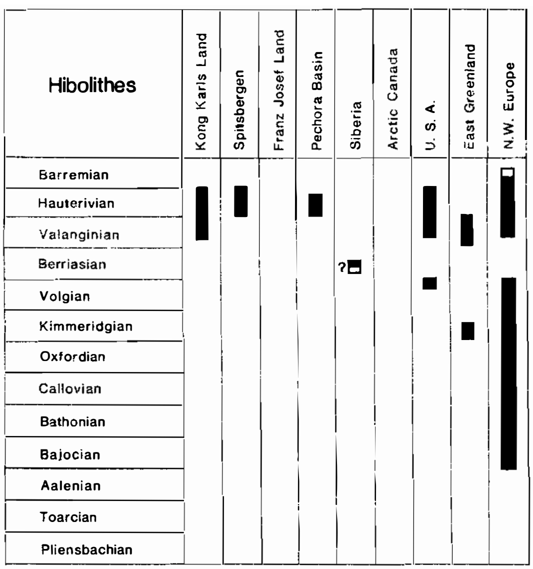

Fig. 14. Stratigraphical and geographical ranges of *Hibolithes* in the Boreal Realm. Compiled from numerous sources (see text). Solid line, certain record; broken line, uncertain record.

records of this genus reaching Arctic Canada (Jeletzky pers. comm. 1986). All these records are of belemnites close to *H. jaculoides*, although occurring in the Tordenskjoldberget Member of Kongsøya, Kong Karls Land are two distinctive species (*H. nathorsti* and *H. caroli*) which were originally separated by Blüthgen (1936) into a new genus (*Pseudohibolites*). These species are *Hibolithes* species close to *H. obtusirostris* Pavlow, but appear to be endemic to Kong Karls Land.

6. Conclusions

On belemnite evidence alone, the age of the Passet and basal Dunérfjellet members is deduced to be Aalenian (possibly Toarcian) to Bathonian, and the age of the Retziusfjellet Member is probably Bathonian–Volgian. The Tordenskjoldberget Member contains a rich belemnite fauna of predominantly late Valanginian–Hauterivian age.

Nine belemnite genera and subgenera are found to occur in Kong Karls Land, Svalbard, ranging in age from ?Toarcian/Aalenian to Hauterivian. With the exception of the Tethyan migrant *Hibolithes*, these genera are of boreal aspect, most belonging to the Arctic province which was initiated in the Toarcian. The majority of the species (including the two new species *Paramegateuthis nalnyaevae* and *Cylindroteuthis (Arctoteuthis) bluethgeni)* have very close affinities to those species occurring in the northern USSR, the Arctic islands, and to a lesser extent, in North America.

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Plates 1–13

All figures are natural size (×1), and specimens have been coated with ammonium chloride. All transverse sections are oriented with the venter uppermost. Right profile, venter to the left; left profile, venter to the right. Specimen numbers prefixed by the letter X refer to specimens formerly in the Cambridge Spitsbergen Expeditions (CSE) collection, now housed in the Sedgwick Museum, Cambridge (SMC), while those prefixed by MO are in Naturhistoriska Riksmuseet, Stockholm (NRS).

Plate 1

Figs. 1–10. Lenobelus cf. *viligaensis* (Saks). Passet Member, Kongsøya. 1, 2: ventral and dorsal outlines, X.14259 (CSE loc. S.1412/1413). 3, 4: ventral outline, transverse section, X.14260 (CSE loc. C.1381). 5–7: ventral outline, right profile and transverse section, X.14261 (CSE loc. C.1381). 8–10: ventral outline, left profile, dorsal outline, X.14262 (CSE loc. S.1412/1413).

Figs. 11–15. Hibolithes jaculoides Swinnerton. Tordenskjoldberget Member, Kongsøya. 11–13: ventral outline, left profile, transverse section, X.14263 (CSE loc. D.831). 14, 15: ventral outline, right profile, X.14264 (CSE loc. D.831).

Figs. 16–20. Hibolithes nathorsti (Blüthgen). Tordenskjoldberget Member, Kongsøya. 16–18: alveolar section, ventral outline, left profile, X.14265 (CSE loc. D.833). 19, 20: paralectotype, ventral outline, right profile, MO.2738 (Tordenskjoldberget).

PLATE 1

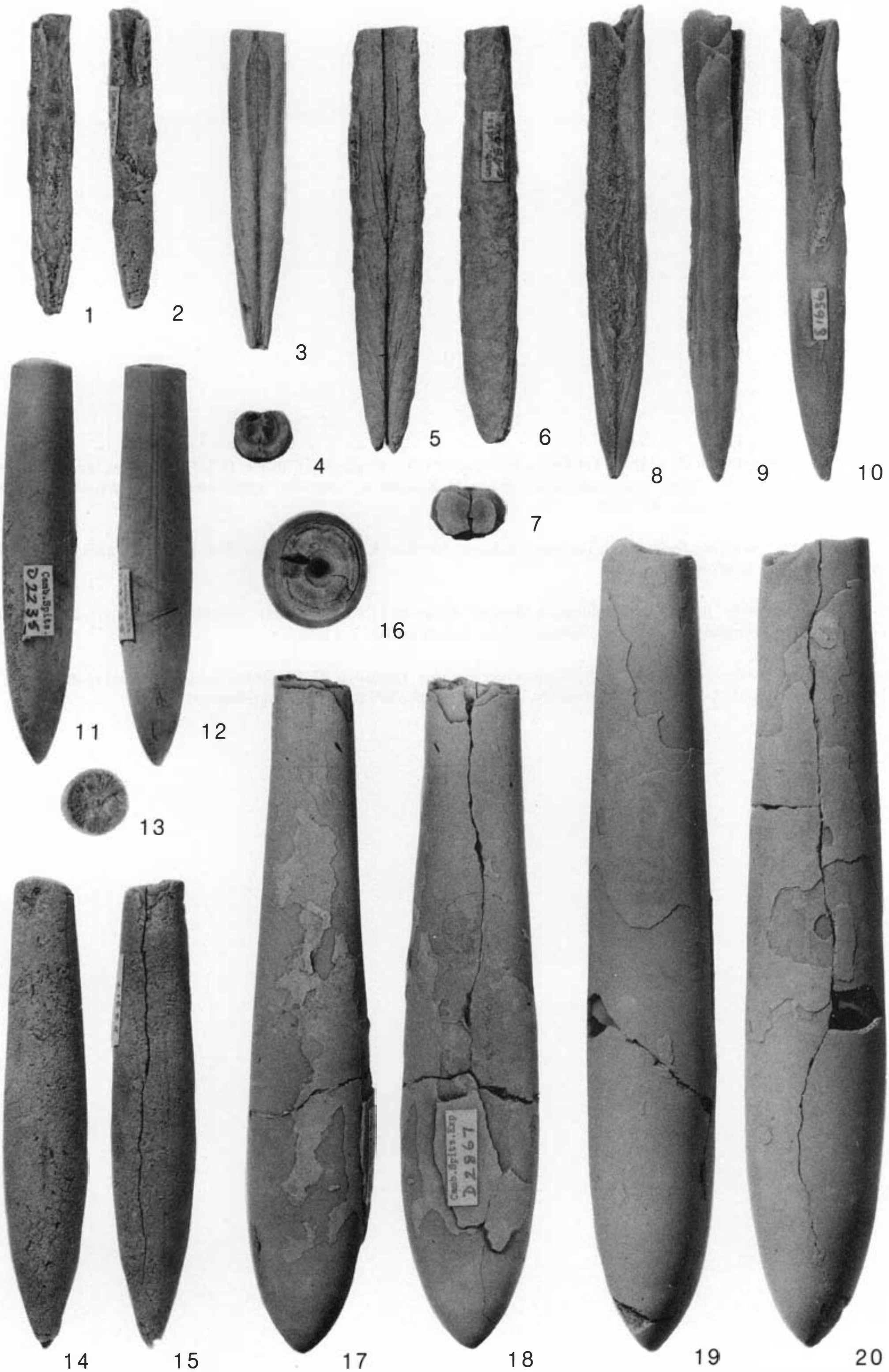

Plate 2

Figs. 1–7. Hibolithes nathorsti (Blüthgen). Tordenskjoldberget Member, Kongsøya (CSE loc. D.833). 1–3: large individual, stem and alveolar region, ventral outline, right profile, alveolar section, X.14266. 4, 5: juvenile, ventral outline and left profile, X.14267. 6, 7: ventral outline, right profile, X.14268.

Figs. 8, 9. Hibolithes jaculoides Swinnerton. Tordenskjoldberget Member, Kongsøya (CSE loc. D.831). Inflated individual, ventral outline, right profile, X.14269.

Figs. 10, 11. Hibolithes sp. juv. Tordenskjoldberget Member, Kongsøya (CSE loc. D.831). Juvenile of either *H. nathorsti* or *H. caroli* (indicated by its compressed section), ventral outline and left profile, X.14270.

Figs. 12–15. Hibolithes caroli Blüthgen. Tordenskjoldberget Member, Kongsøya. 12, 13: ventral outline and right profile, X.14271 (CSE loc. D.831). 14, 15: Lectotype, ventral outline and right profile, MO.855 (Tordenskjoldberget).

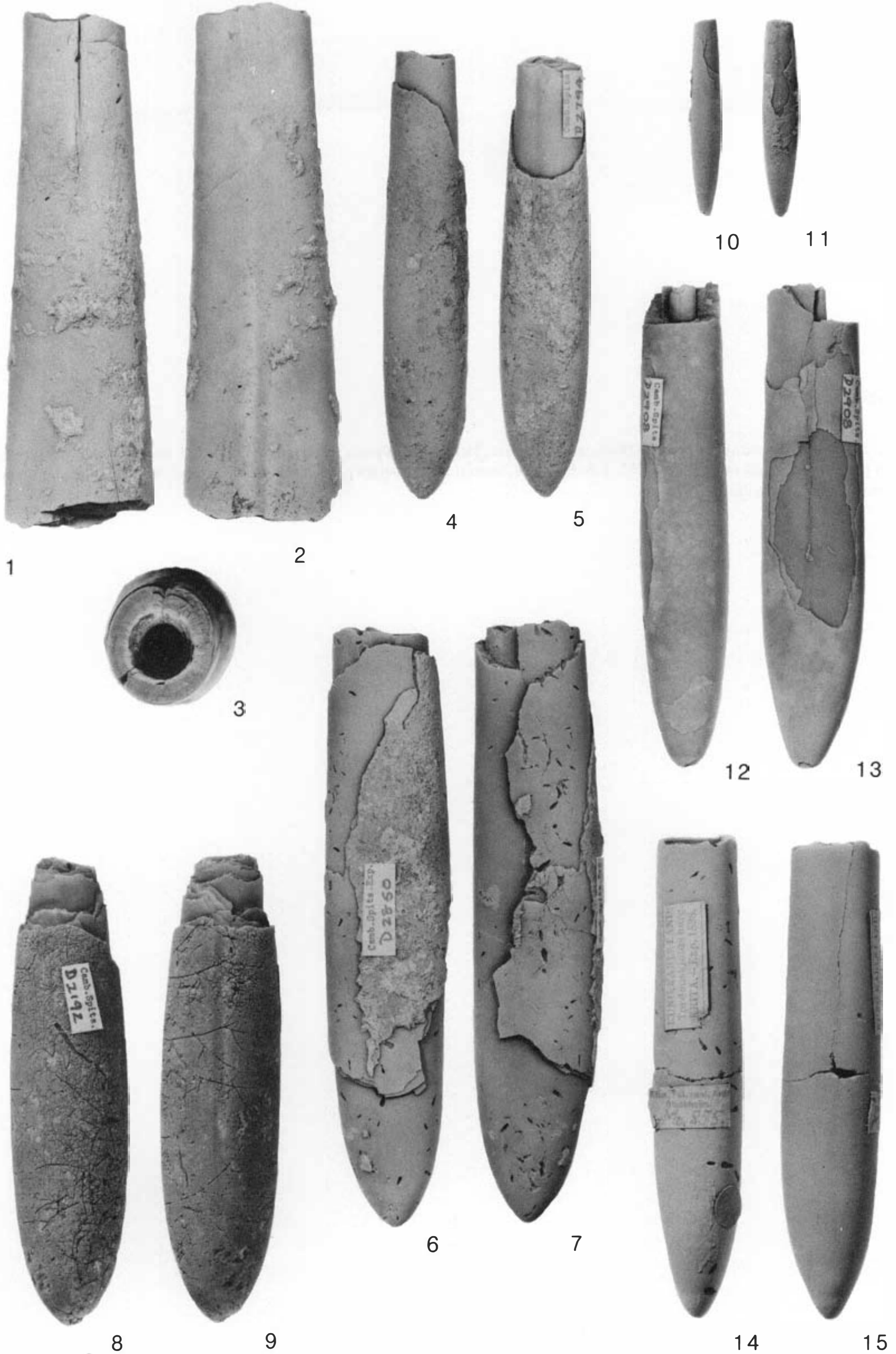

Plate 3

Figs. 1–8. Paramegateuthis nalnyaevae Doyle sp. nov. Passet Member, Kongsøya (CSE loc. C.1381). 1–3; paratype, ventral outline, right profile and dorsal outline, X.14272. 4–6: holotype, ventral outline, right profile and dorsal outline, X.14273. 7, 8: paratype, ventral outline, right profile, X.14274.

PLATE 3

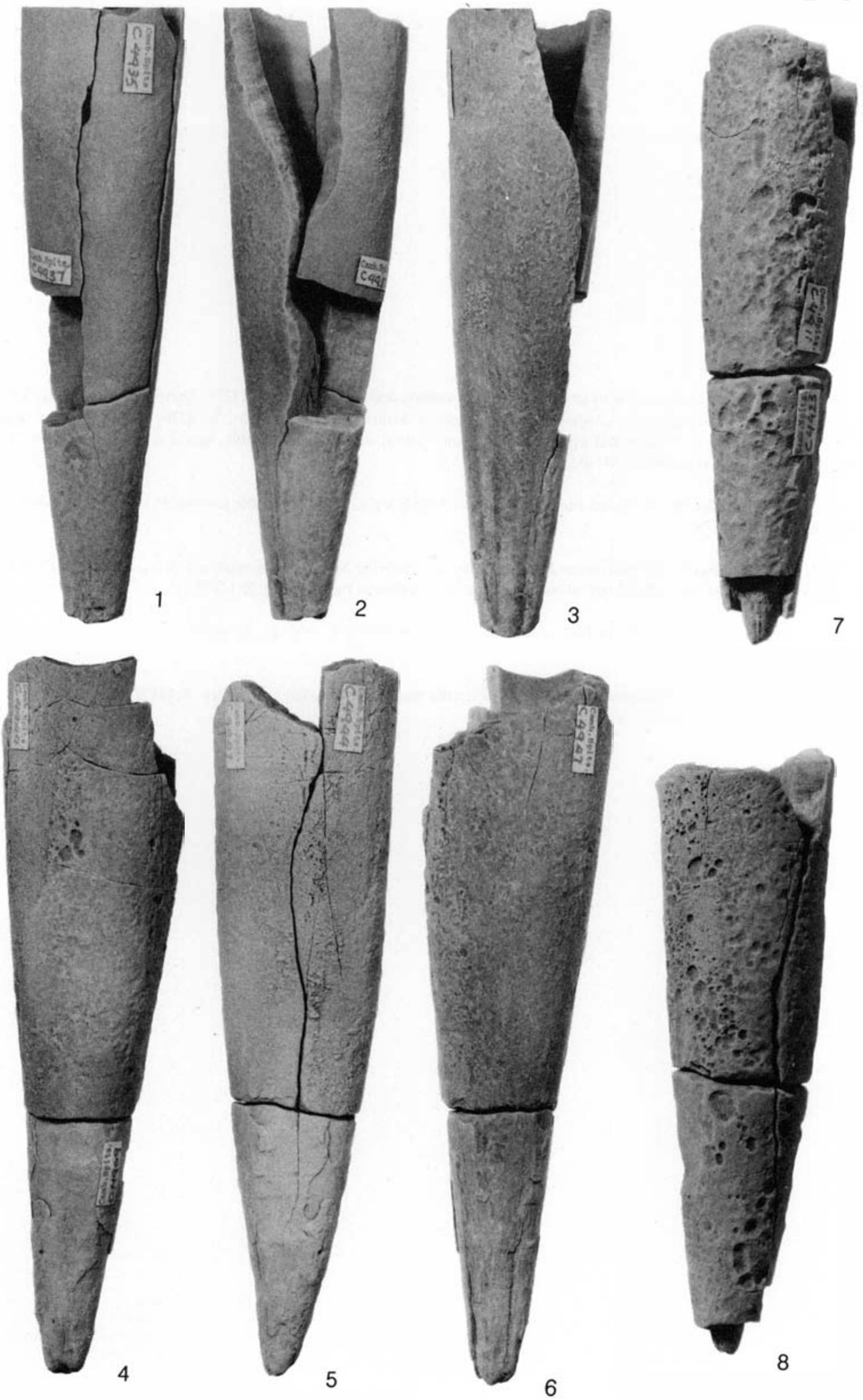

Plate 4

Figs. 1–7. Paramegateuthis nescia Nal'nyaeva. 1, 2: ventral outline and right profile, X.14275, Dunérfjellet Member, Svenskøya (CSE loc. C.1378). 3, 4: completely crushed individual, ventral outline and right profile, X.14276, Passet Member, Kongsøya (CSE loc. S.1412/1413). 5–7: stem and upper apical region, ventral outline, right profile, apical transverse section, X.14277, Dunérfjellet Member, Svenskøya (CSE loc. C.1371).

Figs. 8, 9. Paramegateuthis sp. juv. Passet Member, Kongsøya (CSE loc. C.1381). Probable juvenile *P. nalnyaevae*, ventral outline and right profile, X.14278.

Figs. 10, 11. Paramegateuthis aff. *nalnyaevae* Doyle sp. nov. Dunérfjellet Member, Svenskøya (CSE loc. C.1371). Orthorostrum with epirostrum crushed and 'nipped-off' at its apex, ventral outline and right profile, X.14279.

Figs. 12–14. ?Paramegateuthis sp. Dunérfjellet Member, Svenskøya (CSE loc. C.1371). Alveolar section, ventral outline and right profile, X.14280.

Figs. 15–17. Cylindroteuthis (Cylindroteuthis) sp. Dunérfjellet Member, Svenskøya (CSE loc. S.1417). Stem and apex, ventral outline, left profile and transverse section, X.14181.

PLATE 4

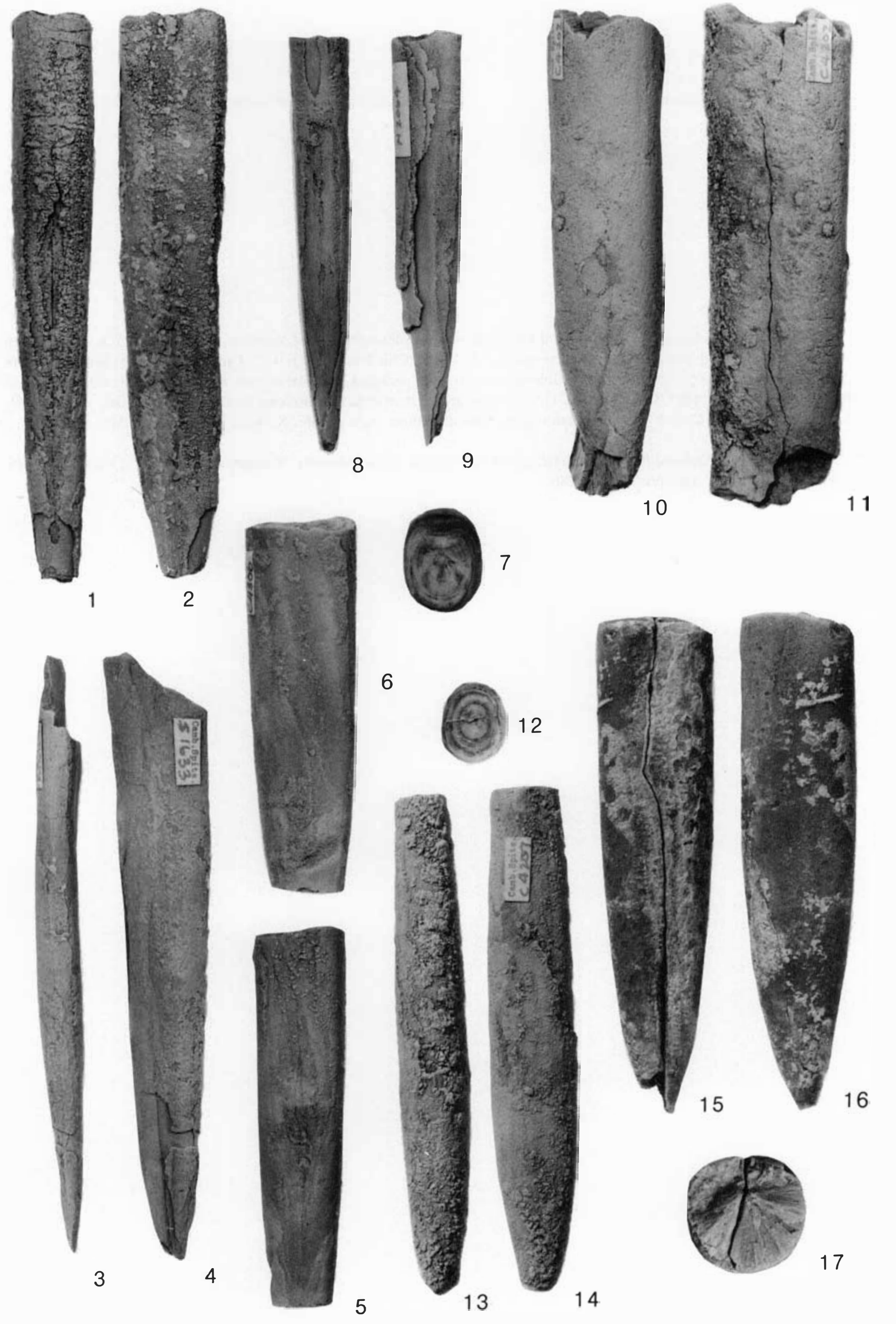

Plate 5

Figs. 1–14. Cylindroteuthis (Arctoteuthis) bluethgeni Doyle sp. nov. Tordenskjoldberget Member, Kongsøya. 1–3: holotype, stem region; ventral outline, right profile and transverse section, X.14282 (CSE loc. D.831). 4, 5: Paratype (figured, Blüthgen 1936, Pl. VII, Fig. 6, as *Oxyteuthis* (?) sp.), MO.2657 (Johnsenberget). 6–9: paratype, alveolar region; alveolar section, ventral outline, left profile, long section, X.14283 (CSE loc. D.831). 10–12: paratype, stem region; transverse section, dorsal outline, right profile, X.14284 (CSE loc. D.831). 13, 14: juvenile, stem region; ventral outline, right profile, X.14285 (CSE loc. D.831).

Figs. 15–17. Pachyteuthis (Pachyteuthis) bodylevskii Saks & Nal'nyaeva. Passet Member, Kongsøya (CSE loc. C.1381). Transverse section, ventral outline and right profile, X.14286.

PLATE 5

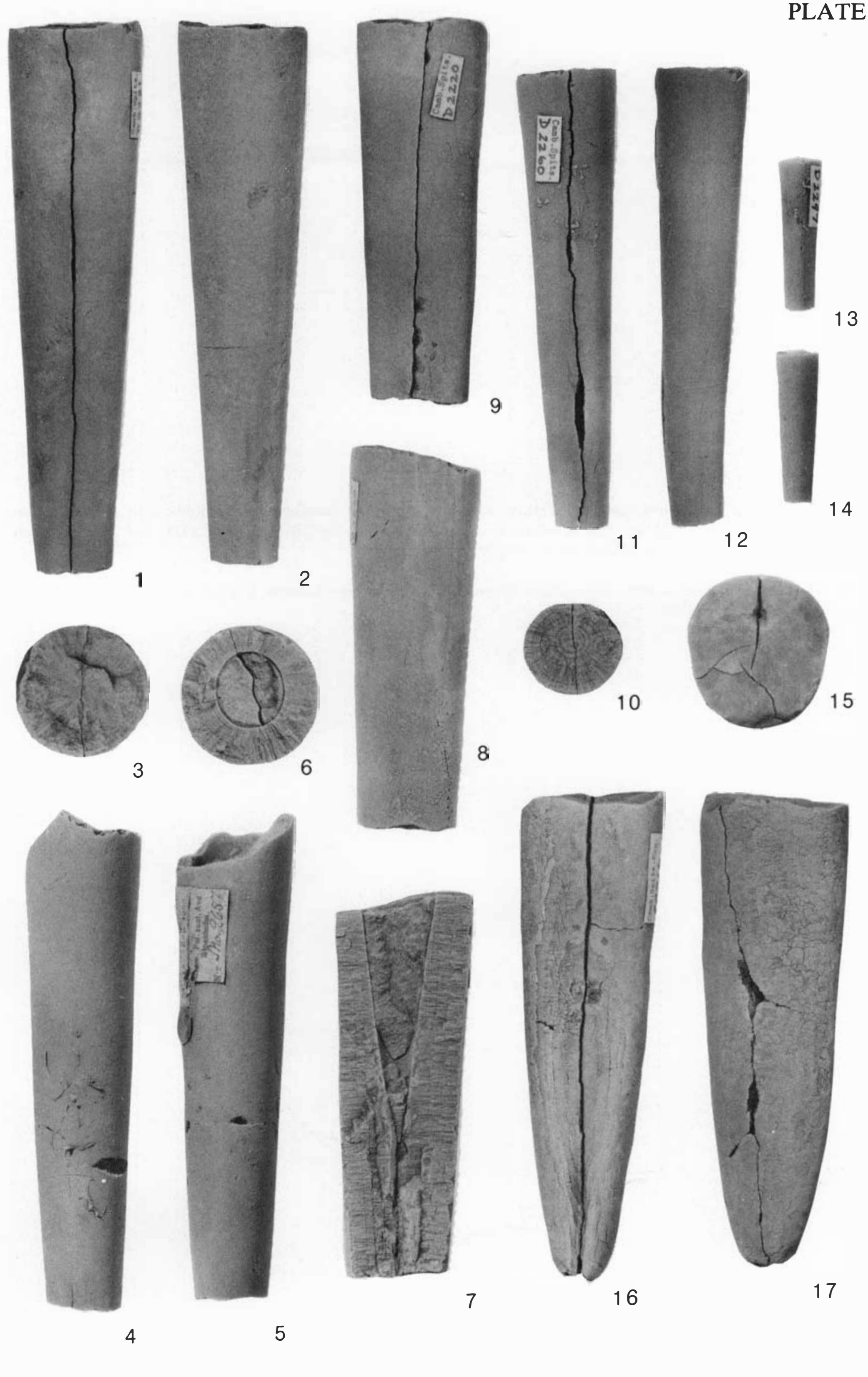

Plate 6

Figs. 1–8. Pachyteuthis (Pachyteuthis) optima Nal'nyaeva. Dunérfjellet Member, Svenskøya. 1, 2: ventral outline and right profile, X.14287 (CSE loc. D.837). 3–5: ventral outline, left profile and alveolar section, X.14288 (CSE loc. C.1375). 6–8: alveolar section, ventral outline and right profile, X.14289 (CSE loc. C.1375).

Figs. 9, 10. Pachyteuthis (Pachyteuthis) crassovalis (Blüthgen). Tordenskjoldberget Member, Kongsøya (CSE loc. D.833). Ventral outline and left profile, X.14290.

PLATE 6

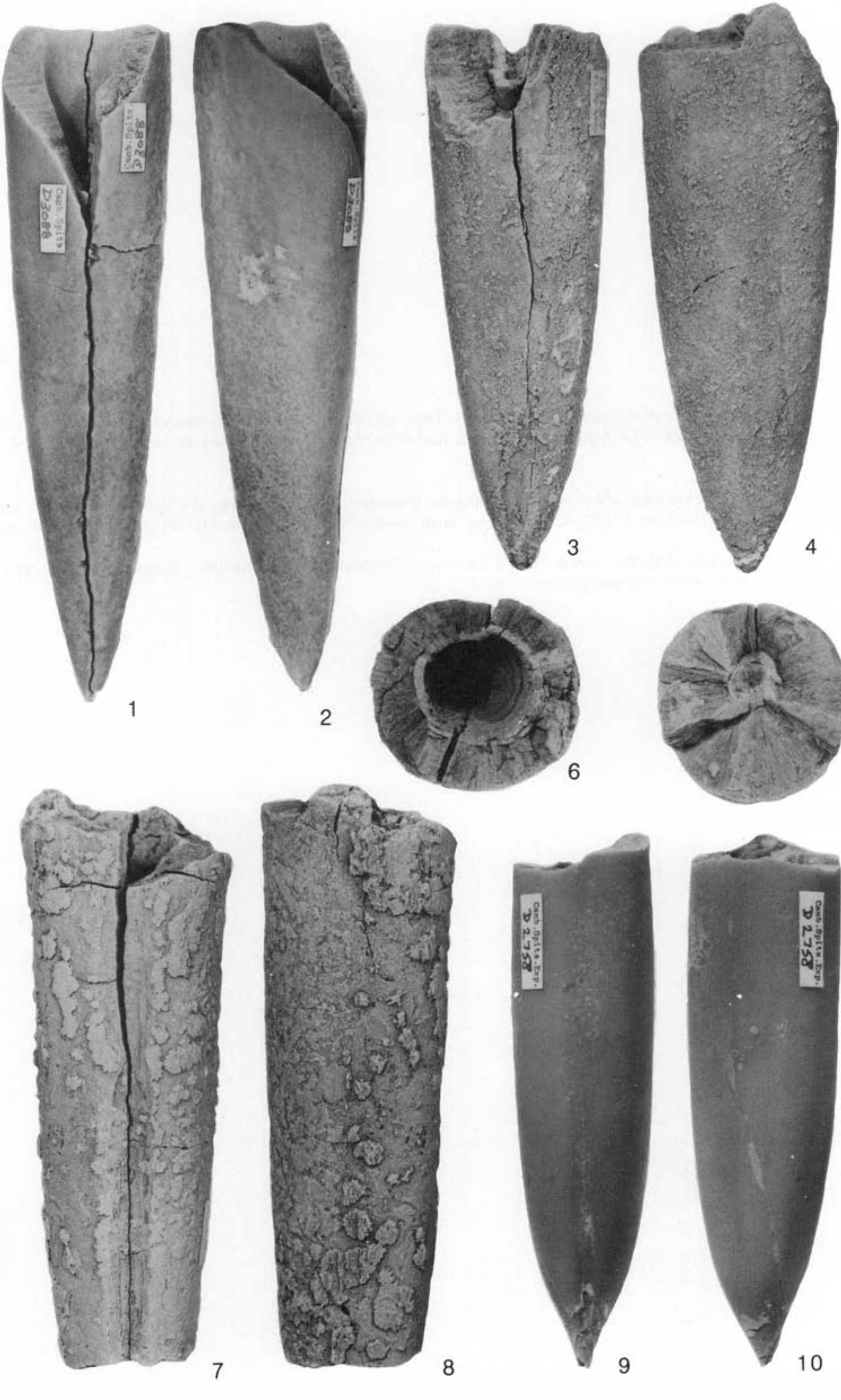

Plate 7

Figs. 1–5. Pachyteuthis (Pachyteuthis) crassovalis (Blüthgen). Tordenskjoldberget Member, Kongsøya, 1, 2: lectotype, ventral outline and right profile, MO.2967 (Tordenskjoldberget). 3–5: ventral outline, left profile and alveolar section, X.14291 (CSE loc. D.831).

Figs. 6–9. Pachyteuthis (Pachyteuthis) obliquespinata (Blüthgen). Tordenskjoldberget Member, Kongsøya. 6, 7: ventral outline and right profile, X.14292 (CSE loc. D.833). 8, 9: lectotype, ventral outline and right profile, MO.870 (Tordenskjoldberget).

Figs. 10–12. Pachyteuthis (Simobelus) cf. *curvula* Saks & Nal'nyaeva. Tordenskjoldberget Member, Kongsøya (CSE loc. D.831). Alveolar section, ventral outline and right profile, X.14293.

PLATE 7

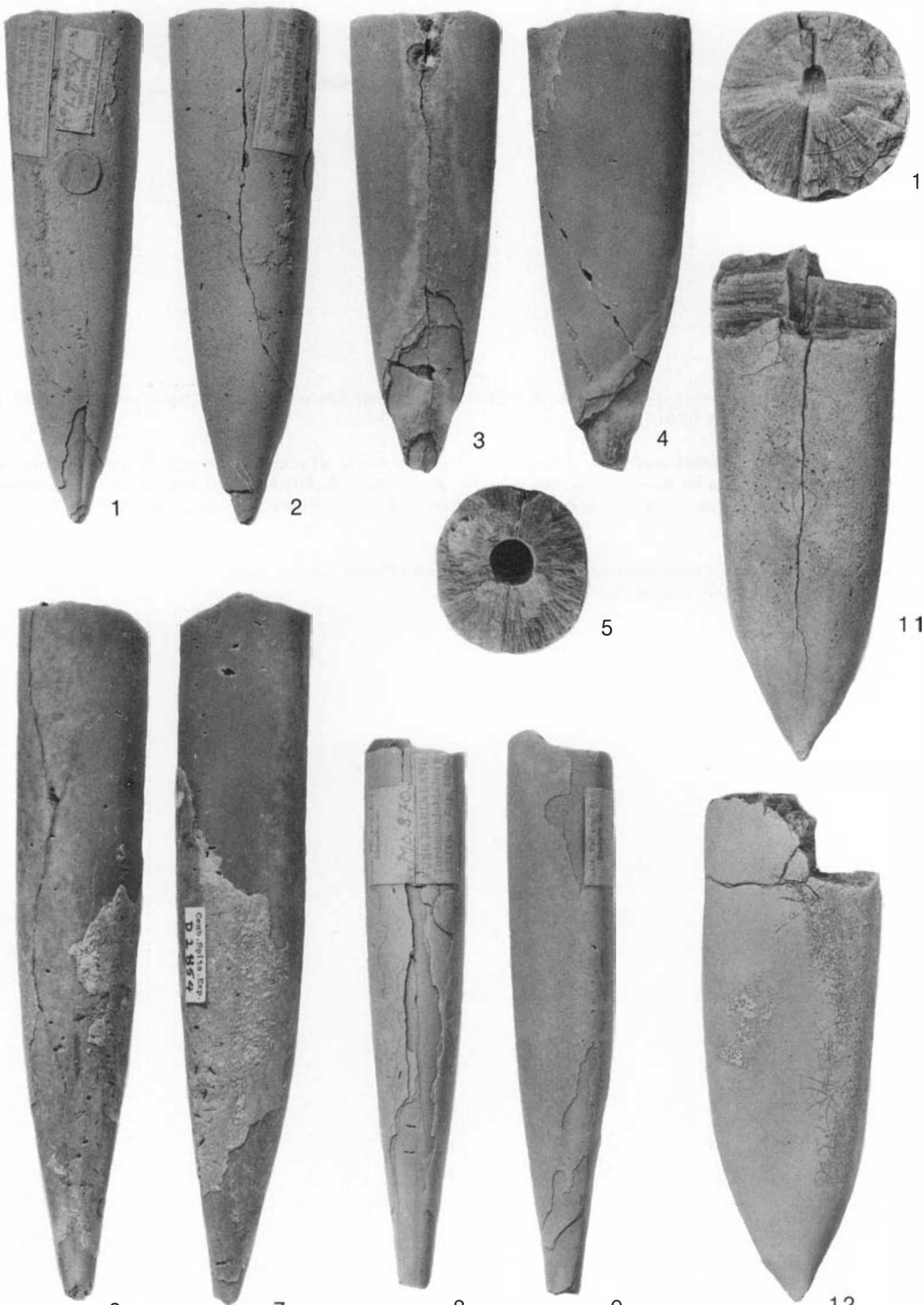

Plate 8

Figs. 1, 2. Pachyteuthis (Simobelus) cf. *curvula* Saks & Nal'nyaeva. Tordenskjoldberget Member, Kongsøya (CSE loc. D.831). Left profile and long section, X.14294.

Figs. 3–9. Acroteuthis (Acroteuthis) acmonoides Swinnerton. Tordenskjoldberget Member, Kongsøya, 3, 4: ventral outline and right profile (lectotype, *Acroteuthis breviaxiformis* Blüthgen, 1936, Pl. V, Figs. 1, 2), MO.857 (Tordenskjoldberget). 5–7: ventral outline, right profile and alveolar section, X.14295 (CSE loc. D.833). 8, 9: ventral outline and right profile, X.14296 (CSE loc. D.833).

Figs. 10–12. Acroteuthis (Acroteuthis) conoides Swinnerton. Tordenskjoldberget Member, Kongsøya (CSE loc. N.818). Ventral outline, right profile and alveolar section, X.14297.

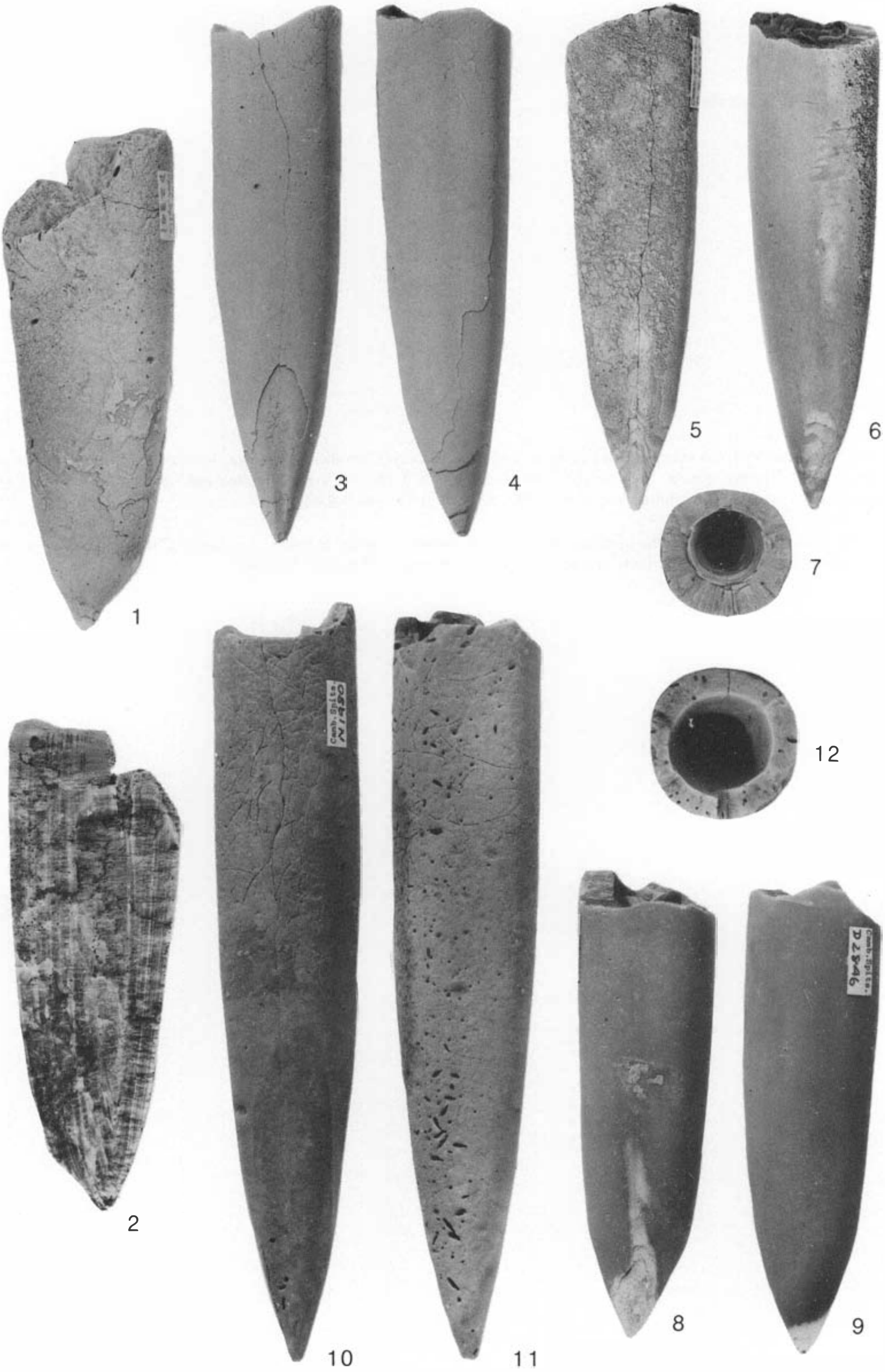
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Plate 9

Figs. 1–8. Acroteuthis (Acroteuthis) arctica Blüthgen. Tordenskjoldberget Member, Kongsøya. 1–4: ventral outline, right profile, long section and alveolar section, X.14298 (CSE loc. D.831). 5, 6: lectotype, ventral outline and right profile, MO.874 (Tordenskjoldberget). 7, 8: ventral outline and right profile, X.14299 (CSE loc. D.831).

Figs. 9–11. Acroteuthis (Boreioteuthis) hauthali Blüthgen. Tordenskjoldberget Member, Kongsøya (CSE loc. D.833). Alveolar section, ventral outline (groove partially obscured by exfoliation) and right profile, X.14300.

PLATE 9

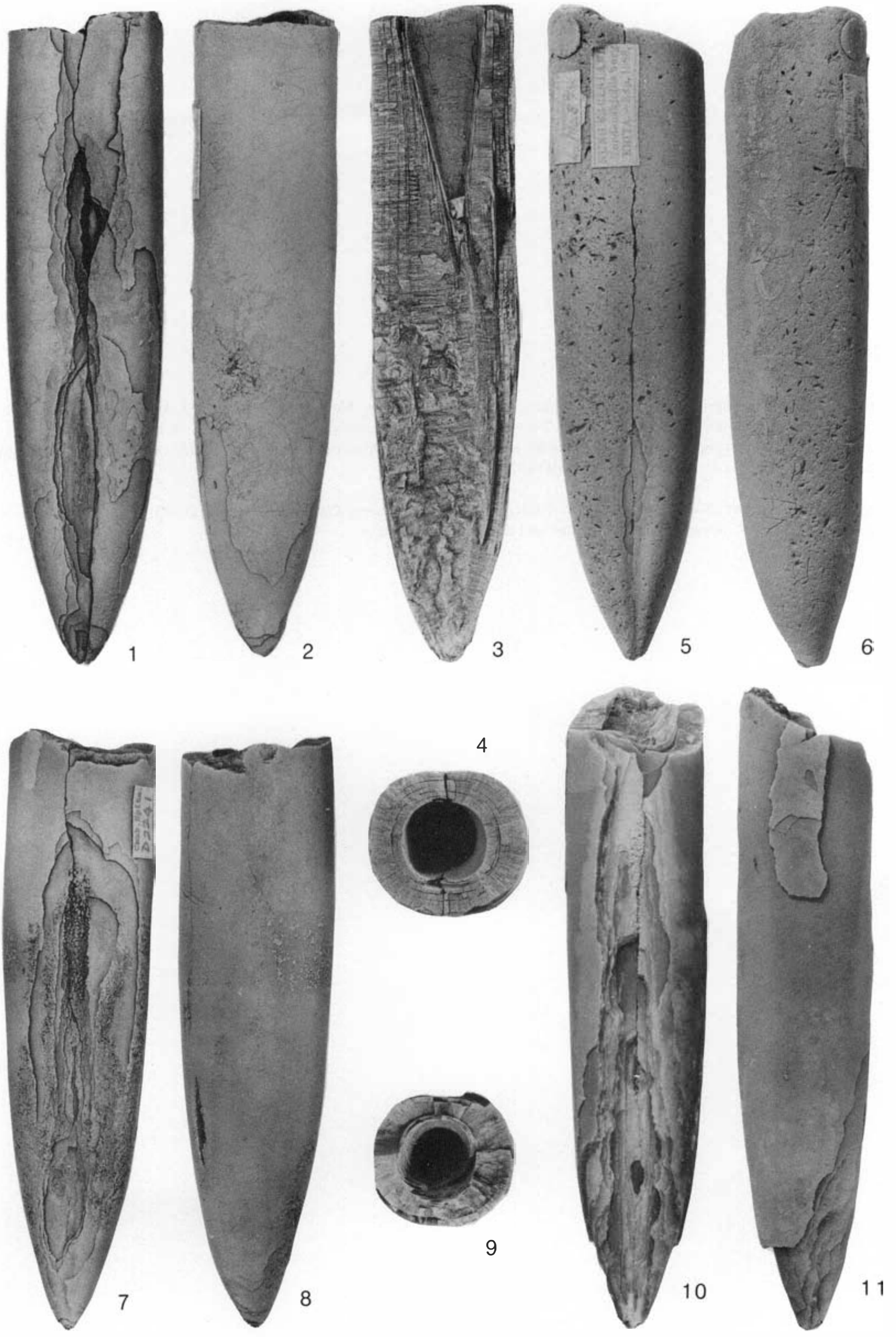


Plate 10

Figs. 1–9. Acroteuthis (Boreioteuthis) hauthali Blüthgen. Tordenskjoldberget Member, Kongsøya. 1, 2: lectotype, ventral outline and right profile, MO.862 (Tordenskjoldberget). 3–5: ventral outline, left profile and alveolar section, X.14301 (CSE loc. D.833). 6, 7: ventral outline and right profile, X.14302 (CSE loc. D.833). 8, 9: ventral outline and right profile (lectotype of *Acroteuthis freboldi* Blüthgen, 1936, Pl. VI, Figs. 16, 17). MO.887 (Johnsenberget).

Figs. 10, 11. Acroteuthis (Boreioteuthis) sp. juv. Tordenskjoldberget Member, Kongsøya (CSE loc. D.833). Probable juvenile *A. (B.) hauthali* or *A. (B.) johnseni,* ventral outline and left profile, X.14303.

PLATE 10

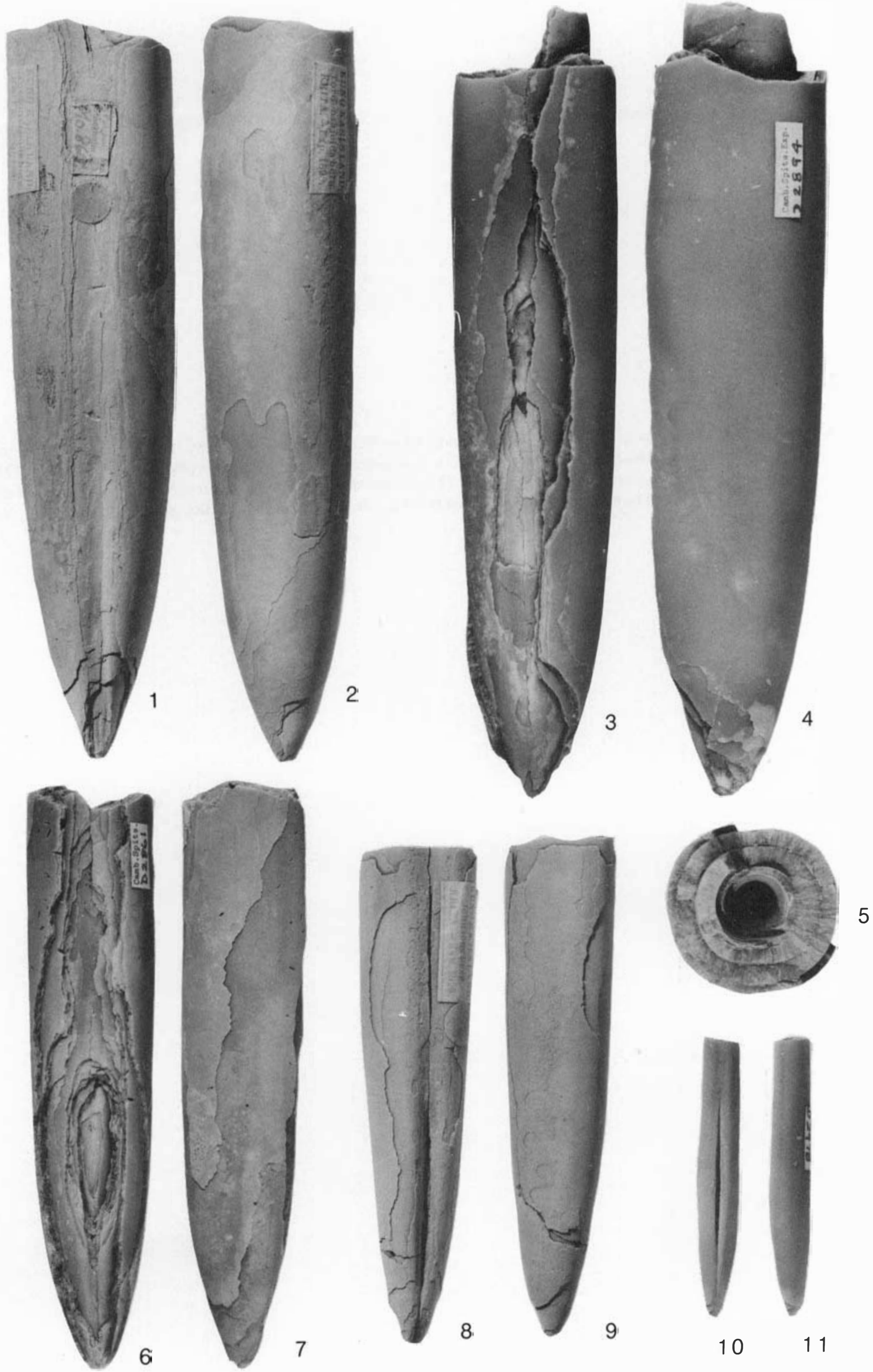


Plate 11

Figs. 1–9. Acroteuthis (Boreioteuthis) johnseni Blüthgen. Tordenskjoldberget Member, Kongsøya. 1–3: lectotype, ventral outline, right profile and long section, MO.840 (Tordenskjoldberget). 4, 5: ventral outline and right profile (figured, Blüthgen 1936, Pl. IV, Fig. 6 as *Acroteuthis subquadratus* Roemer), MO.882 (Tordenskjoldberget). 6–8: apical region with well-preserved groove, ventral outline, right profile and transverse section, X.14304 (CSE loc. D.831). 9: alveolar section (see Pl. 12, Figs. 1, 2), X.14305 (CSE loc. D.833).

PLATE 11

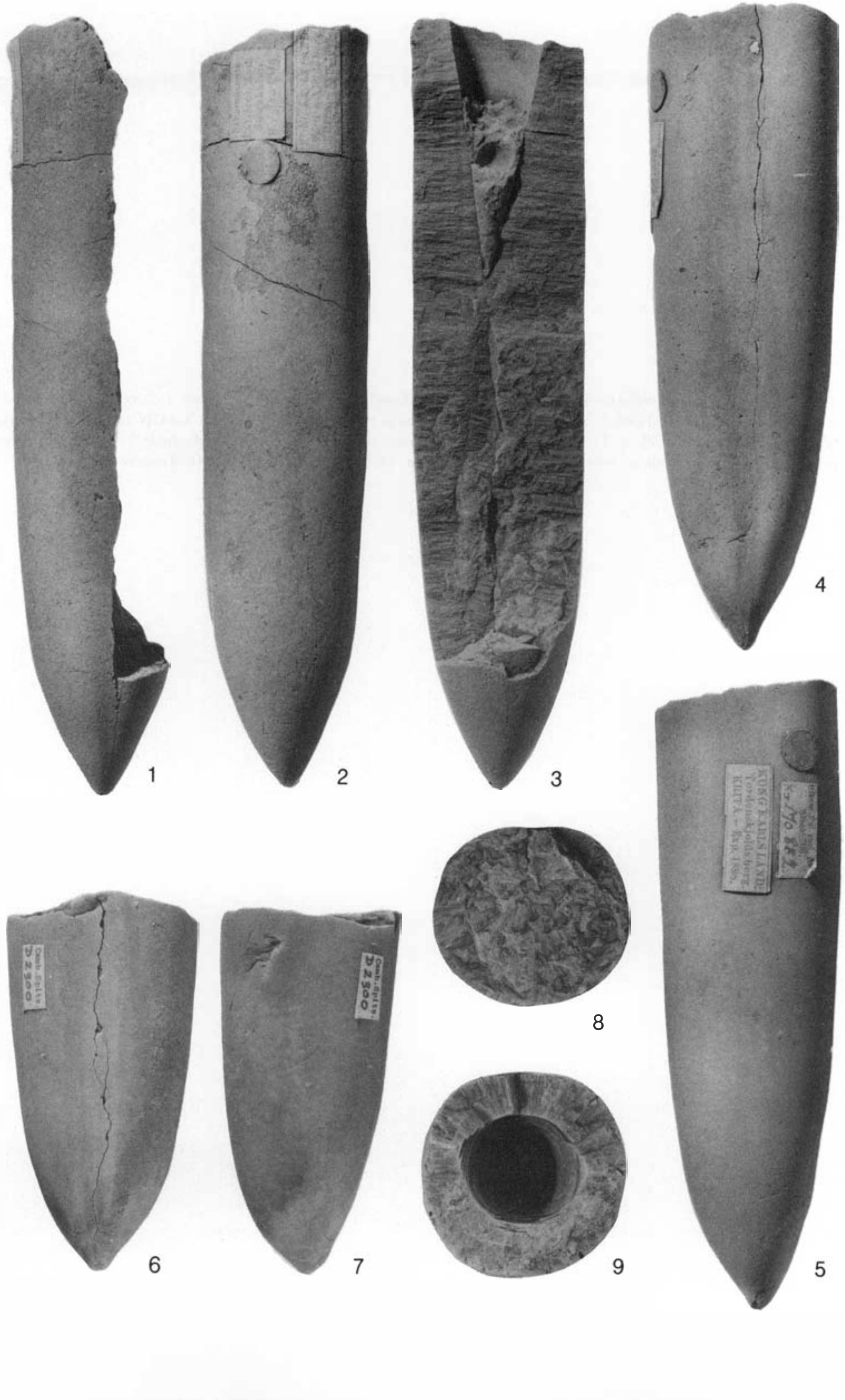


Plate 12

Figs. 1–8. Acroteuthis (Boreioteuthis) johnseni Blüthgen. Tordenskjoldberget Member, Kongsøya. 1, 2: ventral outline and right profile (see Pl. 11, Fig. 9), X.14305 (CSE loc. D.833). 3, 4: ventral outline and right profile, X.14306 (CSE loc. D.833). 5, 6: paralectotype (Blüthgen 1936, Pl. V, Fig. 7), ventral outline and right profile, MO.837 (Johnsenberget). 7, 8: ventral outline and right profile (lectotype, *Acroteuthis johnseni* var. *obtusa* Blüthgen, 1936, Pl. V, Fig. 8), MO.841 (Tordenskjoldberget).

PLATE 12

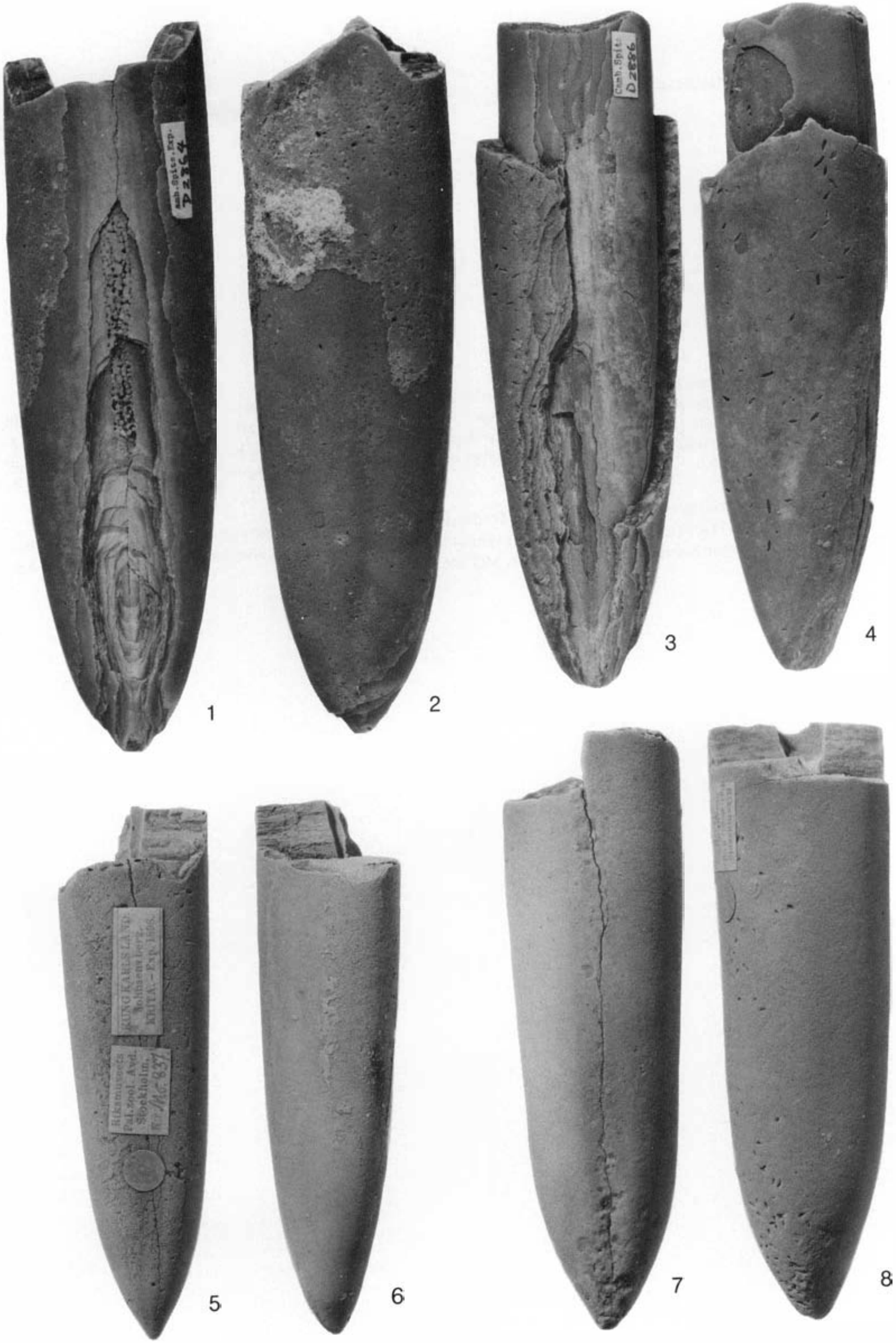
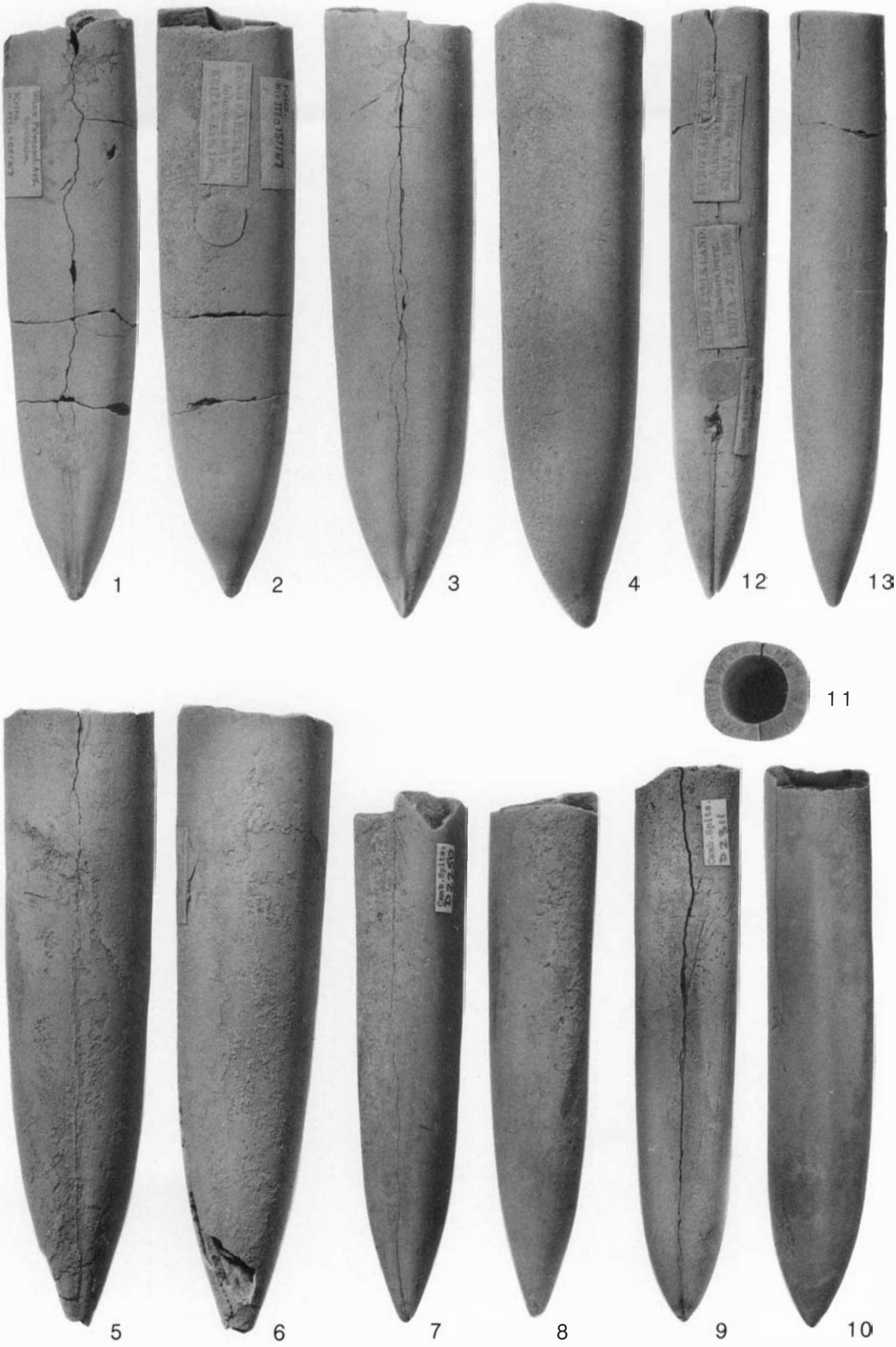


Plate 13

Figs. 1–6. Acroteuthis (Boreioteuthis) johnseni Blüthgen. Tordenskjoldberget Member, Kongsøya. 1, 2: ventral outline and right profile (lectotype of *Acroteuthis johnseni* var *obliqua* Blüthgen, 1936, Pl. V, Figs. 11, 12), MO.151167 (Johnsenberget). 3, 4: ventral outline and right profile (lectotype of *Acroteuthis johnseni* var. *curvata* Blüthgen, 1936, Pl. V, Figs. 13, 14), MO.830 (Johnsenberget). 5, 6: ventral outline and right profile (lectotype of *Acroteuthis johnseni* var *acuta* Blüthgen, 1936, Pl. V, Figs. 9, 10), MO.832 (Johnsenberget).

Figs. 7–13. Acroteuthis (Boreioteuthis) elongata Blüthgen. Tordenskjoldberget Member, Kongsøya. 7, 8: stem and apex, ventral outline and right profile, X.14307 (CSE loc. D.831). 9–11: ventral outline, right profile and alveolar section, X.14308 (CSE loc. D.831). 12, 13: lectotype, ventral outline and right profile, MO.846 (Johnsenberget).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