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DICOELITID BELEMNITES FROM THE TOARCIAN - MIDDLE BAJOCIAN OF WESTERN AND ARCTIC CANADA

J.A. Jeletzky

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Preface

The usefulness of belemnites for subdivision and correlation of Mesozoic rocks is well established in various parts of the World. In this report the first definitive results of a comprehensive study undertaken to evaluate the potential of belemnitid cephalopods for biostratigraphic use in Canada are given.

This study, based on examination of extensive collections from Lower and Middle Jurassic rocks of western British Columbia, Yukon, and Northwest Territories, indicates that belemnites in Jurassic rocks of these regions are biostratigraphically valuable if studied thoroughly. Descriptions and illustrations of four genera and twelve species (four of them new) of belemnites previously unknown in North America are provided. Genetic relationships, origin and the patterns of stratigraphic and paleogeographic distribution of these belemnites in Canada and abroad are also discussed.

The information and interpretations given in this publication will assist in a better understanding of the geology of western and Arctic Canada, an understanding essential to a reliable evaluation of the abundance and distribution of fuel and mineral resources in those parts of the country. This evaluation, a major objective of the Geological Survey, requires a continuing input of stratigraphic and paleontological data.

D.J. McLaren,
Director General,
Geological Survey of Canada

Ottawa
January 1980

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Abstract

The following dicoelitid (Family Dicoelitidae Saks and Nalniaeva, 1967 emend.) belemnites from Toarcian-Bajocian rocks of northwestern British Columbia, the northern and southern Yukon and the Canadian Arctic Archipelago are described and figured: *?Dicoelites* sp. nov. indet. A, *?Dicoelites* sp. nov. indet. B, *Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm 1906), *Conodicoelites* sp. aff. *C. meyrati* (Ooster 1857), *Lenobelus plauchuti* sp. nov., *Lenobelus aberrans* sp. nov., *Pseudodicoelites* aff. *Ps. bidgievi* (Saks), *Pseudodicoelites canadensis* sp. nov., *Pseudodicoelites epigonos* sp. nov., *Pseudodicoelites* cf. *hibolitoides* (Saks), *?Pseudodicoelites* sp. nov. indet. A. Also described is a very peculiar belemnitid tentatively assigned to ?Belemnopseidae gen. and sp. nov. indet. from Toarcian or Bajocian rocks of northwestern British Columbia. All these belemnites are recorded for the first time in North America.

On the basis of a comparison of the sculpture of the guard and the structure of the phragmocone of *Dicoelites, Conodicoelites, Lenobelus,* and *Pseudodicoelites* with those of several genera of Duvaliidae and Belemnopseidae, it is concluded that:

1. *Dicoelites, Conodicoelites, Lenobelus* and *Pseudodicoelites* have a Belemnopseidae-like structure of the phragmocone. They are closely similar to each other and to *Belemnopsis* in the sculpture of the guard, including the presence of mediodorsal and medioventral alveolar grooves.

2. Because of the close morphologic similarity of *Lenobelus* and *Pseudodicoelites* to *Dicoelites* and *Conodicoelites* and to the Belemnopseidae, the subfamily Pseudodicoelitinae Saks and Nalniaeva, 1967 is superfluous. It is proposed therefore to synonymize this subfamily with the family Dicoelitidae Saks and Nalniaeva, 1967 and to treat *Lenobelus* and *Pseudodicoelites* as a Boreal stock of this family. The proposal of Saks and Nalniaeva (1967a,b, 1975) that *Lenobelus* and *Pseudodicoelites* are closely related to the Duvaliidae Pavlow, 1914 is erroneous.

It is inferred that the dicoelitid belemnites described from Toarcian rocks of northwestern British Columbia are descendants of European hastitids which migrated there via the Caribbean region, Mexico, and the Pacific slope of the United States in the latest Pliensbachian or earliest Toarcian. Farther northwestward migration and concurrent evolution of this hastitid stock along the Pacific slope of North America produced the Toarcian *Lenobelus* and *Pseudodicoelites* of northern Siberia which then migrated into the Canadian Arctic Archipelago, the northern and southern Yukon and possibly into northwestern British Columbia in the early Bajocian (=Aalenian).

The Bajocian to Kimmeridgian *Dicoelites* and *Conodicoelites* of the Mediterranean region of Europe, the Himalayan region of India, Indonesia, New Zealand, and South America are interpreted as descendants of the Toarcian *Dicoelites* and *Conodicoelites* of northwestern British Columbia.

Résumé

On décrit ici et on présente par des illustrations les Dicoelitidés suivants (famille Dicoelitidae Saks et Nalniaeva, 1967 emend.), bélemnites provenant de roches d'âge Toarcien et Bajocien du nord-ouest de la Colombie-Britannique, du nord et du sud du Yukon et de l'archipel Arctique canadien: *?Dicoelites* sp. nov. indet. A, ?Dicoelites sp. nov. indet. B, *Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm 1906), *Conodicoelites* sp. aff. *C. meyrati* (Ooster 1857), *Lenobelus plauchuti* sp. nov., *Lenobelus aberrans* sp. nov., *Pseudodicoelites* aff. *Ps. bidgievi* (Saks), *Pseudodicoelites canadensis* sp. nov., *Pseudodicoelites epigonos* sp. nov., *Pseudodicoelites* cf. *hibolitoides* (Saks), *?Pseudoicoelites* sp. nov. indet. A. On a aussi décrit un bélemnitidé très curieux, que l'on a provisoirement placé dans ?les Belemnopseidae gen. et sp. nov. indet. trouvés dans des roches d'âge Toarcien ou Bajocien du nord-ouest de la Colombie-Britannique. C'est la première fois que l'on note l'existence de ces bélemnites en Amérique du Nord.

Après avoir comparé la sculpture du rostre et la structure du phragmocone de *Dicoelites, Conodicoelites, Lenobelus* et *Pseudodicoelites* avec celles de plusieurs genres de Duvaliidae et Belemnopseidae, on a conclu que:

1. *Dicoelites, Conodicoelites, Lenobelus* et *Pseudodicoelites* ont le même type de phragmocone que les Belemnopseidae, et présentent une grande ressemblance les uns avec les autres et avec Belemnopsis, du point de vue de la sculpture du rostre, pourvu de sillons alvéolaires médiodorsaux et médioventraux.

2. En raison de l'étroite similarité morphologique de *Lenobelus* et de *Pseudodicoelites* avec *Dicoelites* et *Conodicoelites* et les Belemnopseidae, la sous-famille Pseudodicoelitinae Saks et Nalniaeva 1967 est superflue. On propose donc de faire de cette sous-famille un synonyme de la famille Dicoelitidae Saks et Nalniaeva 1967, et de considérer *Lenobelus* et *Pseudodicoelites* comme une branche boréale de cette famille. La suggestion de Saks et Nalniaeva (1967a, b, 1975), à savoir que *Lenobelus* et *Pseudodicoelites* sont étroitement apparentés aux Duvaliidae Pavlow 1914, est erronée.

On a déduit que les Dicoelitidés bélemnites décrits dans les roches d'âge Toarcien du nord-ouest de la Colombie-Britannique sont des descendants de Hastitidés européens, qui ont migré jusque-là, en passant par la région antillaise, Mexico et le talus continental pacifique des États-Unis, à la fin du Pliensbachien ou au début du Toarcien. La poursuite de la migration vers le nord-ouest, et l'évolution concomitante de cette branche des Hastitidés le long du talus continental pacifique de l'Amérique du Nord ont produit au Toarcien les espèces *Lenobelus* et *Pseudodicoelites* originaires du nord de la Sibérie, qui ont ensuite migré dans l'archipel Arctique canadien, le nord et le sud du Yukon et peut-être même jusque dans le nord-ouest de la Colombie-Britannique au Bajocien inférieur (=Aalénien).

On considère les espèces *Dicoelites* et *Conodicoelites*, d'âge Bajocien à Kimmeridgien, de la région méditerranéenne d'Europe, de la région himalayenne de l'Inde, d'Indonésie, de Nouvelle-Zélande et d'Amérique du Sud comme des descendants des espèces *Dicoelites* et *Conodicoelites* d'âge Toarcien, originaires du nord-ouest de la Colombie-Britannique.

DICOELITID BELEMNITES FROM THE TOARCIAN-MIDDLE BAJOCIAN OF WESTERN AND ARCTIC CANADA

INTRODUCTION AND ACKNOWLEDGMENTS

During the last twenty years or so a number of true belemnites (order Belemnitida Zittel, 1895 emend. Jeletzky, 1966) have been collected in Toarcian and Bajocian rocks of northwestern British Columbia, the Yukon, and the northwestern part of the Canadian Arctic Archipelago by officers of the Geological Survey of Canada and field geologists of several oil and mining companies. These belemnites have been found, for the most part, in beds reliably dated by ammonites identified by Hans Frebold, consultant to the Geological Survey of Canada.

When submitted to the writer for identification, some of the above belemnitid collections were found to include most unusual morphologic types. In terms of the taxonomy recently proposed by Saks (in Saks and Nalniaeva, 1967a, b), these morphologic types form part of the families Dicoelitidae Saks and Nalniaeva, 1967 and Duvaliidae Pavlow sensu Saks and Nalniaeva, 1967 (i.e. of its subfamily Pseudodicoelitidae Saks and Nalniaeva, 1967). They include, in particular, forms belonging to or closely related to the genera *Conodicoelites* Stevens, 1965, *Dicoelites* Boehm 1906 sensu stricto, *Lenobelus* Gustomessov, 1966, and *Pseudodicoelites* Saks, 1967. Except for a brief mention by Jeletzky (1966, p. 162, Addendum), none of these belemnites has been recorded previously in North America. However, representatives of Dicoelitidae are widespread in Bajocian, Callovian (?and/or Bathonian) to Kimmeridgian rocks of the Indo-Pacific (e.g. India, Indonesia, New Caledonia, New Zealand), Antarctica, and southeast African regions of the Tethyan Realm (see Stoliczka, 1866; Stolley, 1929; Stevens, 1965b, 1973, p. 262-264, Figs. 2, 3). They are also known from ?Bajocian to Callovian rocks of the northern fringe of the Tethyan Realm in Europe (e.g. Swiss Alps, southern Poland, southeastern France; see Pugaczewska, 1961; Stevens, 1973, p. 262-264, Figs. 2, 3) and the USSR (e.g. Crimea; see Krimholz, 1931, p. 37-39).

Representatives of the subfamily Pseudodicoelitinae Saks and Nalniaeva, 1967 were previously known only from upper lower to upper Toarcian, Bajocian and Bathonian rocks of the northern Siberian region of the Boreal Realm (see Saks, 1961; Gustomessov, 1966; Saks and Nalniaeva, 1967a, b, 1975).

The dicoelitid and pseudodicoelitid belemnites of Western and Arctic Canada are of exceptional stratigraphic, paleozoogeographic, and taxonomic-phylogenetic interest. They were collected in geographically remote, rather inaccessible parts of the country. Therefore it was decided to publish the fragmentary material now available even though it is mostly scarce and poorly preserved (especially in the Bowser Basin).

This study revealed unexpectedly close affinities of the dicoelitid belemnites of northwestern British Columbia with the pseudodicoelitid belemnites of the northern Yukon and the Canadian Arctic Archipelago. This necessitated a fairly detailed study of microscopic structures of the phragmocone and the ontogeny of the guard of some European representatives of the Dicoelitidae and Duvaliidae (i.e. Duvaliinae of Saks and Nalniaeva, 1967). The results of this study are included in this paper to substantiate the rather drastic revision of the taxonomy of dicoelitid and pseudodicoelitid belemnites proposed.

The bulk of the dicoelitid belemnites from northwestern British Columbia (i.e. from Bowser Basin) described in this report were collected by H.W. Tipper, T. Richards, and T.P. Poulton. Scarce but important specimens of dicoelitid belemnites were found in old fossil collections from the same region made by various other officers of the Geological Survey. The only pseudodicoelitid belemnites known from the southern Yukon were collected by D.D. Cairnes (1906).

Scarce but important specimens of pseudodicoelitid belemnites from the northern Yukon were collected by D.K. Norris and R. Young, of the Geological Survey of Canada, geologists of the Shell Oil Company of Canada, Ltd. and the writer.

The bulk of the pseudodicoelitid belemnites from the Canadian Arctic Archipelago was collected by geologists of the Elf Oil Company of Canada Ltd. (formerly Petropar of Canada Ltd.) and of the the Triad Oil Company of Canada Ltd. These belemnites were made available by B.P. Plauchut of the Elf Oil Company Ltd. and by R.E.B. de Caen of the Triad Oil Company Ltd., respectively. Some other specimens were collected by geologists of Sproule and Associates Stratigraphic Services Ltd. and made available by the late J.C. Sproule. Further specimens were collected by R. Thorsteinsson and E.T. Tozer of the Geological Survey of Canada.

All localities of Dicoelitidae are shown in Figure 1.

The writer expresses his sincere thanks to all the above colleagues for making the belemnite material available for study and publication and for providing him with valuable locality and stratigraphic data.

Special thanks are due to the following colleagues who provided the important comparative belemnitid material used in this report and permitted the study of fossil collections in their care:

1. J.P. Thieuloy, Institut Dolomieu, Institut Dolomieu, Université Scientifique et Médicale de Grénoble, France.

2. E. Lanterno, Département de Géologie et de Paléontologie, Museum de 'Histoire Naturelle de Genève, Switzerland.

3. Bernard Kummel, Museum of Comparative Zoology, Harvard University, Cambridge, Massachussetts, U.S.A.

4. J. Wiedmann, Geologisches und Paläontologisches Institut und Museum der Universität Tübingen, West Germany.

5. H. Zapfe and F. Steininger, Paläontologisches Institut der Universität Wien, Austria.

6. F. Bachmayer, Geologisch-Paläontologische Abteilung, Naturhistorisches Museum in Wien, Austria, and

7. E. Gasche and R. Panchaud, Geologische Abteilung, Naturhistorisches Museum, Basel, Switzerland.

The writer's assistant, M.F. McLaughlin, supervised photography of the belemnite specimens, prepared the plaster and latex casts, and helped in many other ways. K. Vincent, who took over McLaughlin's duties in 1978, drafted the figures, arranged some of the fossil plates and helped to organize the final manuscript. Jeanne White and J.W. Kempt of the G.S.C. Photographic Unit in Ottawa prepared respectively the photographs and photomicrographs reproduced in the paper.

HISTORICAL REMARKS

Coleoid specialists around the world (e.g. Stevens, 1965a, p. 618; 1965b, p. 168, footnote; Jeletzky, 1966, p. 142) were startled by the discovery of mediorally grooved, *Hibolites-*, *Belemnopsis-* and *Dicoelites-*like belemnopseid belemnites in Toarcian and Lower Bajocian (=Aalenian) rocks of northern Siberia deep inside the Boreal Realm (Saks, 1961). These belemnites were originally placed in the genus *Dicoelites* Boehm, 1906) and interpreted as ancestors of *Dicoelites* (sensu lato) forms of the Tethyan Realm (Saks, 1961, p. 78, 79). Additional closely related belemnopseid belemnites from the Toarcian and lower Bajocian (=Aalenian) rocks of northern Siberia have been described by Gustomessov (1966) who erected two new genera (*Sachsibelus* and *Lenobelus*) which were placed in the subfamily Hastitinae Naef, 1922. However, *Lenobelus* was interpreted by Gustomessov as an ancestor of *Dicoelites* (sensu lato) (see Gustomessov, 1966, p. 69, Fig. 1).

The *Dicoelites-* like belemnites described and figured by Saks (1961) and Gustomessov (1966) were restudied by Saks and Nalniaeva (1967a, p. 440; 1967b, p. 17; 1975, p. 82-110, Pls. XII-XIX) and assigned to the family Duvaliidae Pavlow, 1914 because of the mediodorsal position of the principal alveolar groove (previously believed to be medioventral by Saks, 1961). A new genus *Pseudodicoelites* Saks, 1967 was erected for the forms of *Lenobelus* Gustomessov, 1966 centred on *Dicoelites bidgievi* Saks, 1961. These forms are characterized by a long, strongly developed mediodorsal alveolar groove, a feebly developed to absent medioventral alveolar groove, and an absence of grooves on the adapical part of the guard. The genus *Lenobelus* Gustomessov, 1966 was likewise placed in the Duvaliidae and restricted to forms characterized by a short mediodorsal alveolar groove and a medioventral groove beginning at the guard apex but not reaching its alveolar part. A new subfamily Pseudodicoelitidae was erected for *Pseudodicoelites* and *Lenobelus*. Most of these ideas have been endorsed by Kabanov (1969). However, the ideas of Saks and Nalniaeva (loc. cit.) were opposed by Gustomessov (1972) who insisted on the hastitid affinities of *Lenobelus* and *Pseudodicoelites* previously proposed (Gustomessov, 1966).

As mentioned by Jeletzky (1966, p. 162), *Sachsibelus*, *Lenobelus* and *Hibolithes* have also been found in Toarcian and lower Bajocian (=Aalenian) rocks of the Canadian Arctic Archipelago. After the appearance of the papers by Saks and Nalniaeva (1967a, b), the writer realized that belemnites he had identified as species of *Hibolithes* actually belonged to new species of the genera *Pseudodicoelites* Saks, 1967 and *Lenobelus* Gustomessov, 1966 and, furthermore, that all representatives of *Lenobelus* and *Pseudodicoelites* appear to be restricted to Bajocian (including Aalenian) rocks in Canada. Later, in 1970, additional representatives of *Pseudodicoelites*, *Lenobelus* and *?Dicoelites* were identified from lower Bajocian (=Aalenian) and ?middle Bajocian rocks of the northern Yukon, from middle Bajocian rocks (*Arkelloceras* beds) of the Canadian Arctic Archipelago, and from undifferentiated Bajocian beds of the southern Yukon (Lake Labarge area; GSC loc. 83477).

GENERAL TAXONOMIC COMMENTS

Quantitative versus qualitative taxonomic approach

Recent students of Belemnitida are deeply divided on whether to classify belemnites according to quantitative or qualitative criteria. One group (e.g. Kongiel, 1962; Saks and Nalniaeva, 1964, p. 24, 1966, 1972; Schumann, 1974, p. 6), strongly influenced by the generally quantitative approach of contemporary science, tries to classify the order down to the species level with an essentially unweighted use of ratios of all measurable features of the guard. Others (e.g. Tripp, 1936, 1937; Zoch, 1940; Schwegler, 1961; Jeletzky, 1965, p. 135-136, 1966, p. 8-10) favour an essentially qualitative approach based on careful grading of all morphologic features of the belemnitid shell, measurable and non-measurable. This approach eliminates taxonomically useless features and assigns taxonomic rank to individual taxonomically valuable morphologic features. The statistical use of ratios of measurable features is considered to be useful for support and illustration only.

The writer is opposed to the so-called statistical taxonomy of Belemnitida based on unweighted use of ratios of all measurable morphologic features of their shell for the following reasons:

First, it cannot be denied that morphologic features of the Belemnitida shell (and for that matter those of any other fossil group) are of very unequal taxonomic value (see Jeletzky, 1965, p. 135-136; 1966, p. 8-10).

Second, contrary to the opinion of its adherents, the so-called statistical taxonomic approach is highly subjective, instead of an objective procedure. It favours unavoidably those particular morphologic features of the belemnitid shell which happen to be easily measurable while neglecting or ignoring other morphologic features which are either difficult to measure or are not measurable at all.

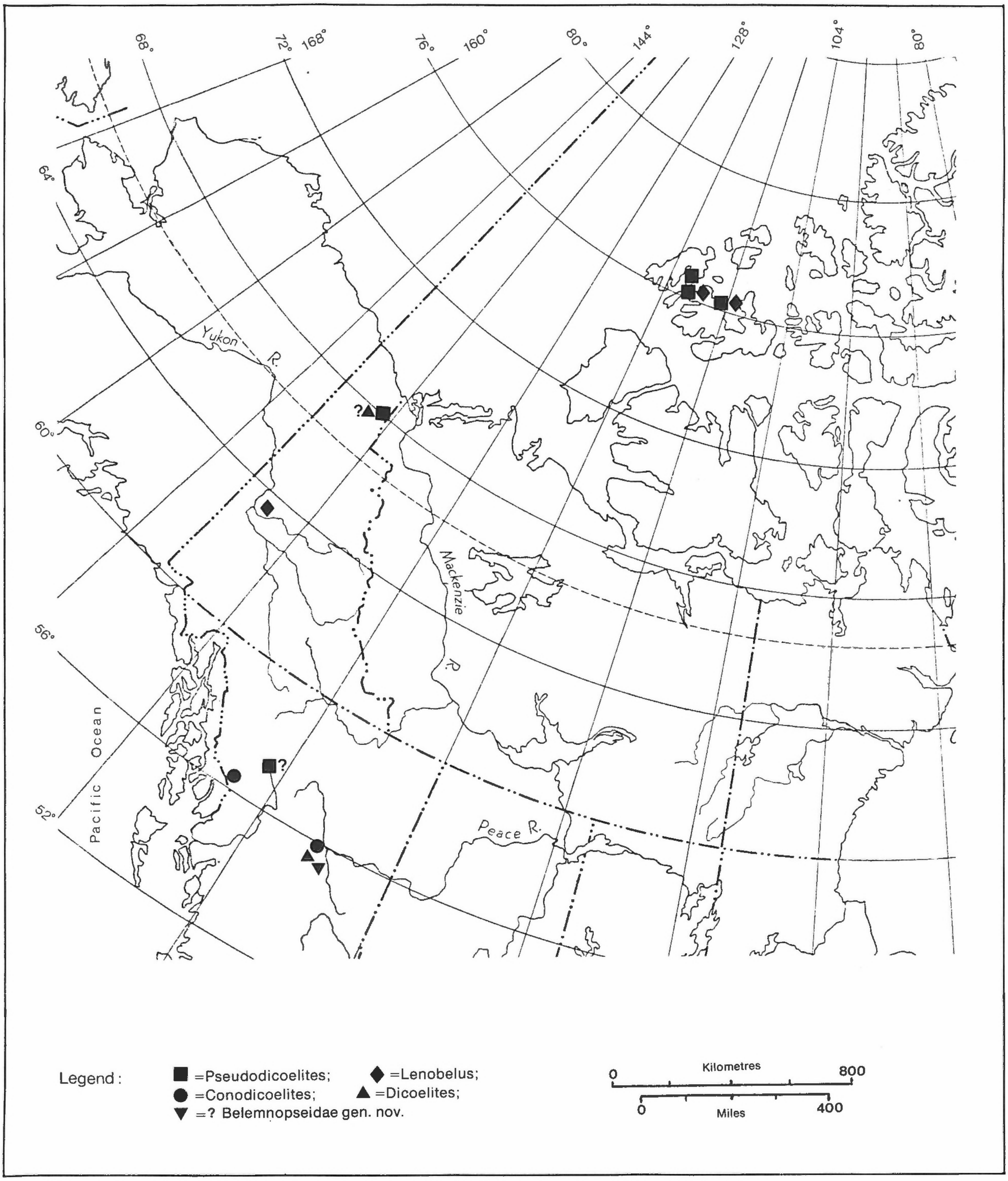

Fig. 1. Map of northwestern Canada showing approximate locations of the Dicoelitidae localities referred to in the text.

Third, and last, the so-called statistical approach relies largely on a numerical evaluation of measurements of various aspects of the outer shape of the belemnitid guard (e.g. Swinnerton, 1935, p. IV; Saks and Nalniaeva, 1964, p. 24; Schumann, 1974, p. 6) which is taxonomically speaking the least reliable, lowest ranking morphologic element of the shell (Jeletzky, 1966, p. 10-11). Not only is the shape of the belemnitid guard much more variable in time and space than any other morphologic element of its shell but the same, or nearly the same, shapes of the guard recur homoeomorphically in most presently known belemnitid families, subfamilies, and even genera (Tripp, 1936, 1937; Zoch, 1940; Schwegler, 1961, p. 98 and elsewhere; Jeletzky, 1949, p. 258-262; 1966, p. 10-11). The writer feels that the shape of the belemnitid guard and the ratios of its various elements should only be used under a constant control of other morphological features, such as alveolar canals, apical grooves, patterns of longitudinal lateral furrows (including double lateral lines), character of ontogenetic development of the guard, various morphologic features of phragmocone etc., which are more stable in time and space and less subject to iterative evolution. Most of these taxonomically higher ranking features happen to be either difficultly measurable or non-measurable. In this respect the writer agrees with the conclusions of Schwegler (1961, p. 98 and elsewhere) regarding the taxonomic unreliability of ratios of measurable morphologic features of the belemnitid guard.

Because of the above the writer strongly favours a basically qualitative approach to the taxonomy of the Belemnitida. The following general sections of the paper will be devoted to such a qualitative grading of the available morphologic features of the belemnitid taxa including those of their phragmocones. The empirically recognized relative degree of stability of features concerned in time and space will then be used as the principal criterion of their taxonomic rank (Jeletzky, 1966, p. 8).

Morphology and taxonomic status of Pseudodicoelitinae Saks and Nalniaeva 1967 and Dicoelitidae Saks and Nalniaeva 1967

The introduction of a separate subfamily Pseudodicoelitinae and its subordination to the family Duvaliidae Pavlow 1914 by Saks and Nalniaeva (1967a, p. 440; 1967b, p. 15, 21; 1975, p. 81, 82) is based almost exclusively on the presence of a well-developed mediodorsal alveolar canal (i.e. alveolar groove underlain by a splitting surface) in *Lenobelus* and *Pseudodicoelites*. In their studies, however, Saks and Nalniaeva (1967a, 1967b) overlooked several other most important morphologic features, as well as several palaeozoogeographic and biochronologic considerations which are incompatible with their proposal. These will be discussed below.

The taxonomic significance of the mediodorsal alveolar groove and splitting surface

Other belemnites besides those of the family Duvaliidae possess a mediodorsal alveolar groove and the underlying splitting surface. Such alveolar groove with an underlying splitting surface has been long known to exist in *Dicoelites* and *Conodicoelites* (e.g. Stolley, 1919, p. 44; Stevens, 1965a, p. 607-609; 1965b, p. 53, 58). The only difference in the mediodorsal groove (and splitting surface) of these two genera from that of *Lenobelus* and *Pseudodicoelites* consists in its normally less prominent development compared with that of the ventral groove (and splitting surface) (see Pl. XI, figs. 4A, 4D, 5a, 5c, Pl. IX, fig. 1A, 1D). These relationships are, as a rule, reversed in *Lenobelus* and *Pseudodicoelites*. However, the prominence and length of the mediodorsal alveolar groove is an extremely variable feature in *Dicoelites* Boehm 1906 sensu Stevens 1965a. This groove may occasionally (e.g. as in *D. stefanini* Spath) extend the length of the guard, making the dorsal and ventral surfaces almost identical. The prominence and length of the mediodorsal alveolar groove varies even more strongly in the genus *Lenobelus* (see Gustomessov, 1966, pl. VI, figs. 2b, 5b, 6b, 7b, 8a, 9) as this genus includes *L. minaevae* with a prominent mediodorsal alveolar groove extending over the whole of the anterior half of the guard as well as *L. gravis* where this groove is completely absent. There appears to be a complete intergradation of *Dicoelites* and *Lenobelus* where the development of the mediodorsal alveolar groove is concerned and one has to use the appearance of the ventral face of the guard (e.g. the presence of the medioventral apical groove or the completely smooth appearance of the ventral face) for differentiation of some *Lenobelus* species from otherwise closely similar *Dicoelites* species. Therefore, and because *Pseudodicoelites* is very similar morphologically to some *Lenobelus* species (e.g. to *Lenobelus aberrans* sp. nov.; see below), it is more logical to consider these two genera as close relatives of *Dicoelites* and *Conodicoelites* than to relate them to *Duvalia* and other representatives of the Duvaliidae Pavlow 1914 on the basis of the mediodorsal alveolar groove.

It must be pointed out in this connection that, as noted by Stolley (1919, 1927), Spath (1927-33, p. 663), Stevens (1965a, p. 608-609) and most recently Jeletzky (1966, p. 139): "the dorsal alveolar canals and splitting surfaces of *Dicoelites* are not fundamentally different from the ventral alveolar canals and splitting surfaces of *Belemnopsis*, as typical forms of both genera are connected by transitions." This morphologic intergradation of *Dicoelites* with *Belemnopsis* is illustrated by the guard of *Belemnopsis* ex aff. *canaliculatus* (Schlotheim) reproduced in Pl. XV, figs. 3A, 3D. This intergradation, and the above morphologic intergradation of *Dicoelites* with *Lenobelus* and *Pseudodicoelites*, suggest a genetic relationship of the latter two genera either with the early Belemnopseidae (e.g. Toarcian to Bajocian *Belemnopsis*) or with the early Hastitidae instead of the Duvaliidae. This morphologic intergradation alone makes Gustomessov's (1966, p. 69-70, Text-fig. opp. p. 68) hypothesis of a hastitid origin of *Lenobelus* s. lato (i.e. inclusive of *Pseudodicoelites*) much more plausible than the duvaliid affinities proposed by Saks and Nalniaeva (1967a, 1967b).

Ontogeny of belemnopseid, duvaliid, and dicoelitid guards

As already pointed out by Jeletzky (1972, p. 170, 171): "The ontogenetic development of *S. somaliensis* guard differs from that in the Duvaliidae in the insertion of a fairly prolonged and well developed growth stage characterized by a clavirostrid (i.e. fusiform) shape of juvenile guards (Pl. 32, fig. 1) between that of the primordial guard on the one hand and the short and sturdy, only slightly to feebly subfusiform adult guard on the other. The Duvaliidae are characterized by the persistence of the needle-like guards from the primordial well into the early juvenile growth stage and by the absence or a feeble development of the clavirostrid growth stages."

Judging by the sections of belemnopseid and duvaliid guards in this study, the above distinctions of the ontogeny of the guard of *Somalibelus somaliensis* are just as valid for *Hibolithes hastatus* (Pl. VII, fig. 1A) and *Mesohibolites ewaldi* (Pl. VIII, fig. 1B). Furthermore, the older data of Hanai (1953, Pl. VI, figs. 4, 5; Pl. VII, figs. 2-4) on the guard's ontogeny in *Neohibolites miyakoensis*, and the newer data of Spaeth (1971, Pl. 2, fig. 2; Pl. III, fig. 3, 4; Text-fig. 4a, 4b) on that in *N. minimus* indicate that the guard of *Neohibolites* is characterized by a similar type of ontogeny.

The duvaliid guards sectioned (Pl. I, figs. 1E, 1F, 1H; Pl. IV, fig. 1; Pl. V, figs. 1A, 1B, 2A) confirm the earlier ideas of the writer that guard ontogeny in all Duvaliidae genera progresses from an obtuse and short (i.e. *Coeloteuthis*-like) conirostrid earliest visible guard, through first an elongate and then a very elongate conirostrid (i.e. *Acrocoelites*- like) intermediate growth stage to an irregularly subcylindrical *(Duvalia graziana)*, sturdily subfusiform *(Rhopaloteuthis* and *Conobelus)*, or irregularly oval *(Duvalia emerici)* adult growth stage. The *Acrocoelites*-like conirostrid growth stage does not correspond to that of the primordial guard, as it does in the belemnopseid genera studied, but continues well beyond it with the intermediate and late *Acrocoelites*-like shaped guards enveloping the protoconch and extending for some distance around the early part of the phragmocone (e.g. Pl. I, fig. 1E; Pl. IV, fig. 1; Pl. V, figs. 1A, 1B, 2A). It is estimated that the length of the final juvenile guards of the *Acrocoelites*-like ontogenetic stage reaches from one-fourth to two-fifths of that of the adult guards in the duvaliid genera studied.

The above, contrasting ontogenies of belemnopseid and duvaliid guards suggest that these two families are not as closely related as was suggested by Jeletzky (1966, p. 143, 144, Fig. 15) and evolved from two different groups of Hastitidae. The earliest, presumably *Rhopaloteuthis*-like Duvaliidae probably did not evolve out of the typical representatives of Hastitidae characterized by a very early, rapid to momentary (no *Acrocoelites*- like ontogenetic stage is discernible) transformation of the earliest, short-conirostrid growth stage into a *Hastites*-like fusiform to club-shaped juvenile guard. Judging by the ontogeny of their guard, they probably are descendants of some other, primitive Hastitidae (e.g. *Pleurobelus* or *Rhabdobelus*) characterized by a more Belemnitidae-like ontogeny. Only Belemnopseidae can be derived directly from the above typical representatives of the Hastitidae (e.g. *Hastites clavatus lanceolatus* Hartmann; see Jeletzky, 1966, p. 143, 144). This problem is now under study and its results will be reported elsewhere.

The guard ontogeny of Dicoelitidae has so far only been studied in one fairly well-preserved guard of *Conodicoelites meyrati* (Pl. IX, fig. 1F, 1G). Although many details of the primordial ontogeny of this guard are obliterated by re-crystallization, the short- and long-conical juvenile guards are confined to this growth stage (Pl. IX, fig. 1G). Already the latest primordial guards are distinctly subfusiform in this specimen. This admittedly scant, evidence suggests that at least *Conodicoelites* Stevens 1965 is characterized by a typical belemnopseid ontogeny of the guard. The same appears to be true of Pseudodicoelitidae, judging by the ontogenetic development of the only guard of *Lenobelus aberrans* sp. nov. sectioned (see p. 23, 24; Pl. XIII, fig. 1D for further details). Because of the essential similarity of the phragmocone structure of all belemnopseid, dicoelitid, and pseudodicoelitid genera studied (see below), the writer presumes that *Dicoelites* s. str. and *Pseudodicoelites* are characterized by an ontogeny of the guard that resembles closely that of *Conodicoelites meyrati* (Ooster) and *Lenobelus aberrans* sp. nov.

Morphology of duvaliid, dicoelitid, pseudodicoelitid and belemnopseid phragmocones

General Remarks.

The hypothesis of duvaliid affinities of *Lenobelus* and *Pseudodicoelites* does not find any support in the morphology of their phragmocone, contrary to the conclusions of Saks (in Saks and Nalniaeva, 1967b, p. 21) and Kabanov (1969). Because this subject has been confused by the contradictory conclusions of several recent workers it is necessary to outline briefly its history and to summarize the results of the writer's most recent study of thin-sections of duvaliid, pseudodicoelitid, dicoelitid and belemnopseid phragmocones.

Gustomessov (1972, p. 123) has pointed out that Kabanov's (1963a, 1963b, 1967, 1969) conclusions about a central position of the siphuncle in the first camera of Duvaliidae is erroneous. He concluded, furthermore, that the same applies to the simultaneous presence of adorally and adventrally directed prongs (actually collars if viewed in three dimensions) in the early septal necks of this family claimed by Kabanov (1963a, 1963b, 1967, 1969). These conclusions of Gustomessov (1972) seemed to provide a welcome confirmation of the previously expressed doubts of the writer (Jeletzky, 1966, p. 129) concerning the validity of Kabanov's (1963a, 1963b, 1967, 1969) conclusions. However, a more recent study of eight phragmocones (partly well-preserved) of

Duvalia graziana (Duval-Jouve 1841)(Pl. I, figs. 1A-1H; Pl. II, figs. 1A-1D; Pl. III, figs. 1A-1D; Pl. IV, figs. 2A-2C), *Duvalia emerici* (Raspail, 1829)(Pl. IV, fig. 1; Pl. V, figs. 1A, 1B), *Conobelus (Conobelus) conophorus* (Oppel 1856-58)(Pl. VI, figs. 1A-1E), *Conobelus (?Conobelus) orbignyanus* (Duval-Jouve 1841) (Pl. V, figs. 2A-2D) indicates that Jeletzky's (1966) and Gustomessov's (1972) criticisms of Kabanov's (1963a, 1963b, 1967, 1969) conclusions are justified in part only. The results of this study are summarized in following sections.

A comprehensive reappraisal of the microscopic structure and interpretation of the comparative anatomy of the phragmocone and conotheca of the order Belemnitida was recently undertaken by Jeletzky (1966, p. 110-129). This was followed by an attempt to reappraise these features of the belemnopseid phragmocone and conotheca on the basis of a detailed study of *Somalibelus somaliensis* (Jeletzky, 1972). In spite of the partly preliminary character of this research, most of Jeletzky's (1966, 1972) morphologic terms and conclusions have been found to be valid and applicable to the phragmocones (including conothecae) of the duvaliid, pseudoduvaliid, dicoelitid, and belemnopseid forms described below.

These terms and conclusions are, therefore, used unchanged in this paper and readers are referred to the above publications for further details. The following description of the morphology of the phragmocone is restricted according to the elements which are either peculiar to the duvaliid, pseudodicoelitid dicoelitid and belemnopseid forms discussed here or otherwise add to our understanding of the morphology and comparative anatomy of the belemnitid phragmocone.

Comparison of duvaliid and belemnopseid phragmocones.

Orientation of the siphuncle. The new thin-sections prepared by the writer confirm Jeletzky's (1966, p. 129) and Gustomessov's (1972, p. 123) conclusion that the apical end of the siphuncle of all Duvaliidae genera studied is situated subventrally (i.e. on the side of the alveolus opposite to that where the medioalveolar groove is situated). As in all other representatives of the Belemnitida studied by Jeletzky (1966, p. 129), the distance separating the ventral wall of all duvaliid siphuncles observed from the ventral wall of the conotheca is approximately one-fifth to one-sixth of that separating it from the opposite dorsal wall (Pl. I, fig. 1H; Pl. II, fig. 1D, Pl. V, fig. 2C). However, unlike the siphuncles of all other belemnites studied (see Jeletzky, 1966, 1972) the duvaliid siphuncle shifts abruptly ventralward within the earliest camera. Consequently, the distance between the ventral wall of the siphuncle and that of the ventral wall of the conotheca decreases to between one-twelfth and one-fifteenth of that separating the ventral wall from the opposite dorsal wall of the conotheca in the second camera. Thereafter the now almost adventrally situated ventral wall of siphuncle migrates ventralward only very gradually until it reaches a hard adventral position with the central part of the segment actually impressed into the conotheca in the 13th to 15th camerae (Pl. I, fig. 1F; Pl. II, figs. 1A-1B; Pl. III, fig. 1D; Pl. V, fig. 2B; Pl. VI, fig. 1A). The unusually rapid adventral migration of the duvaliid siphuncle differentiates it sharply from the belemnopseid siphuncle. As already pointed out by Jeletzky (1966, p. 128, 129, Pl. 9, figs. 1A, 1B; Pl. 10, figs. 1A, 1C; 1972, p. 180, Pl. 33, figs. 1a, 1b, 1d, 1e; Pl. 36, figs. 1a, 1d; Pl. 37, fig. 1a; Pl. 38, figs. 1a-1e), the adventral migration of the belemnopseid siphuncle is a prolonged and gradual process. The brim parts of ventral septa do not begin to touch the conotheca until the 15th camera at the earliest. However, even then they do not become directly superimposed on the conotheca throughout their length and partly impressed into it as the equivalent ventral septa of Duvaliidae do (see below for further details). Instead, these belemnopseid ventral septa become S-like bent with the residual ventral camerae persisting beneath their middle free parts throughout the most advanced parts of the phragmocone known (i.e. at least to the 40th septum).

Free septum and septal neck of the dorsal side. The lack of suitably preserved duvaliid phragmocones prevented Jeletzky (1966, p. 115, 116) from making any definitive comments about the results of Kabanov's (1963a, p. 144-145, 1963b, p. 123, figs. 2a, 2b) study of duvaliid septa and septal necks. However, more recent observations made on thin-sections of fairly well to well-preserved phragmocones of *Duvalia graziana* (Pl. I, figs. 1E-1H; Pl. II, figs. 1A-1D; Pl. III, figs. 1A-1D; Pl. IV, figs. 2A-2C), *Conobelus (?Conobelus) orbignyanus* (Pl. V, figs. 2B-2D), and *Conobelus (Conobelus) conophorus* (Pl. VI, figs. 1A, 1B, 1D) have now confirmed Kabanov's (l. cit. and 1967, p. 42, Figs. 27, 28, 29, Pl. X, figs. 1a, 1b) conclusion that short and stubby, loxochoanitic dorsal necks of the earliest six to seven septa of duvaliid belemnites become transformed into double-pronged dorsal necks in later septa.

In the duvaliid forms sectioned by the writer, the generally loxochoanitic early dorsal necks, which may or may not exhibit incipient adoral protuberances, change gradually into distinctly double pronged (see Fig. 2) advanced dorsal necks resembling those of some Aulacocerida (compare Jeletzky, 1966, p. 18, 19, Fig. 1A) in the 10th to 15th dorsal septa. However, this morphologic change occurs slightly earlier in some of the duvaliid forms studied by Kabanov (1967, Fig. 29g). Thereafter the double-pronged dorsal necks persist to the oralmost (i.e. 20th to 40th) septa available for study to the writer (i.e. Pl. I, fig. 1G; Pl. III, figs. 1B, 1C; Pl. VI, figs. 1A, 1B, 1D) and Kabanov (1967, p. 42, 44, Figs. 29A, B). The same double-pronged dorsal necks occur also in advanced septa of other duvaliid forms sectioned by Combemorel (1972, Pl. A, figs. 5, 15; Pl. B, fig. 1). It is presumed accordingly that the double-pronged dorsal necks characteriz the intermediate and adult growth stages of all duvaliid phragmocones.

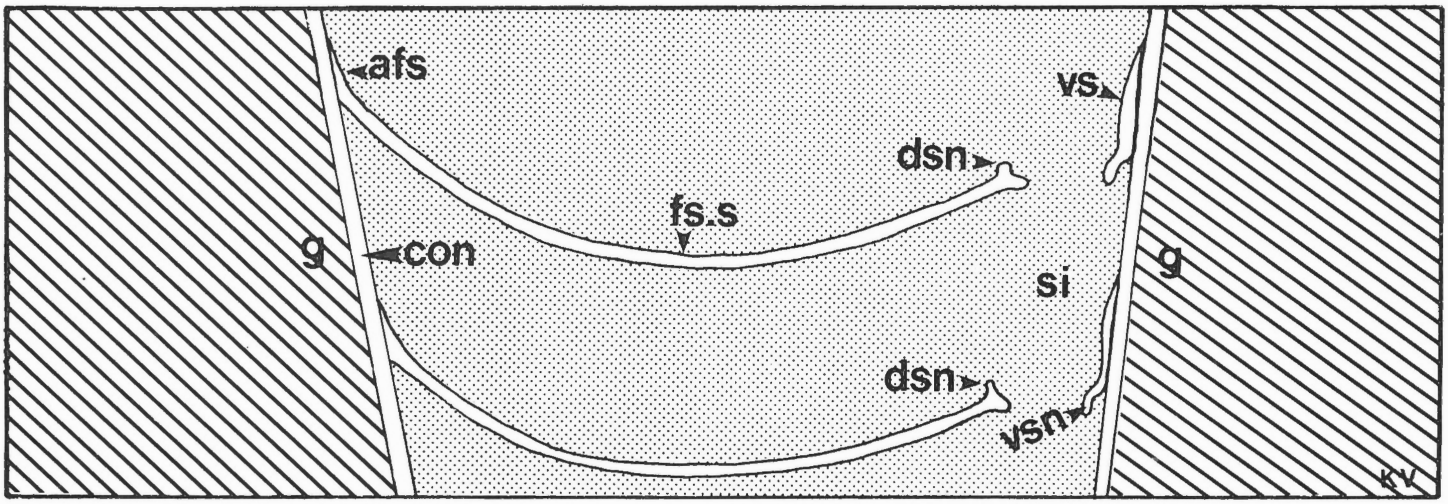

Fig. 2. *Duvalia graziana* (Duval-Jouve 1841). The two oralmost septa of the phragmocone shown in Pl. I, fig. 1G, x 13. Compare with the septa of *Mesohibolites ewaldi* (Strombeck) reproduced in Fig. 3. Explanation: inward and adapically bent, ventral part of septal neck (vsn), double-pronged dorsal part of septal neck (dsn). Ventral septum (vs) including dorsal flange; adoral flange of mural part of dorsal septum (afs), free segment of dorsal part of septum (fs.s). Siphonal tube (si), conotheca (con), guard (g).

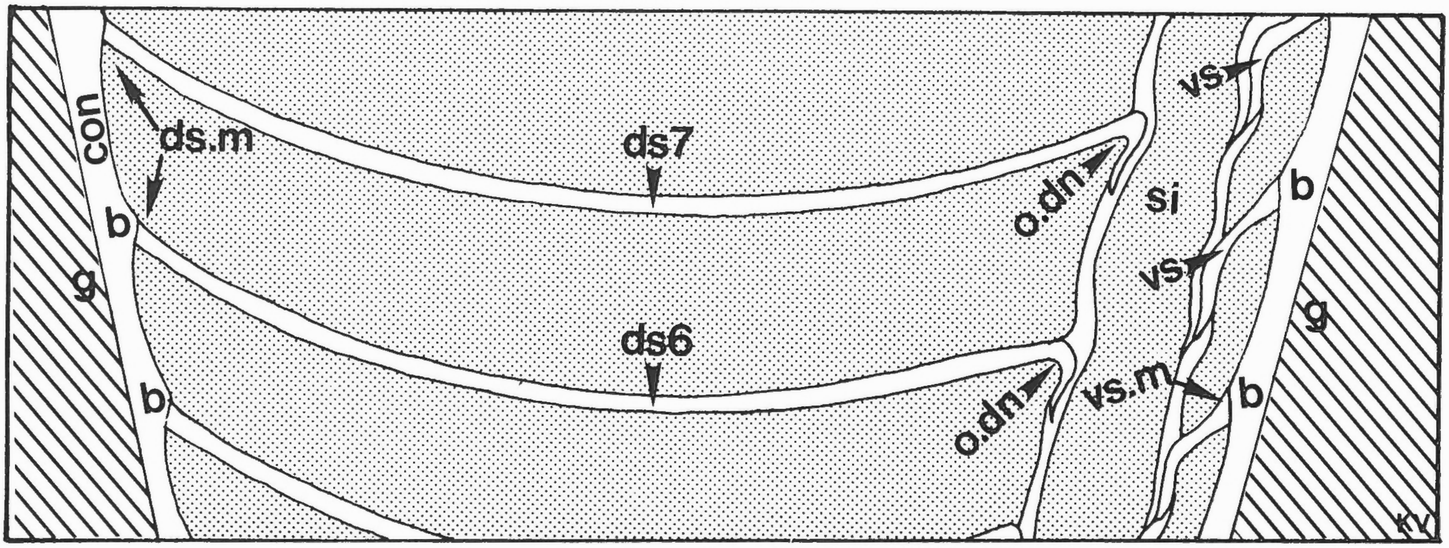

Fig. 3. *Mesohibolites ewaldi* (Strombeck 1861). Drawing of the 5th to the 7th septa of the phragmocone shown in Pl. VIII, Fig. 1B, x 83. Compare with the septa of *Duvalia graziana* (Duval-Jouve) reproduced in Fig. 2. Explanation of symbols as in Fig. 2, except for: flangeless mural ends of dorsal (ds.m) and ventral (vs.m) septa; bulges (b) of conotheca at adnation surfaces of mural ends of ventral and dorsal septa; orthochoanitic dorsal parts of septal necks (o.dn). Free segments of dorsal parts of both septa designated as ds.6 and ds.7.

In some duvaliid forms, such as *Duvalia graziana* (e.g. Pl. I, fig. 1G), the double-pronged, advanced necks are markedly inclined in relation to the long axis of the alveolus with their ventral faces sloping adventrally. The taxonomic value of this feature is uncertain as some other *Duvalia* species, such as *D. dilatata* var. *majoriana* (Pl. V, fig. 1B), exhibit only slightly inclined advanced dorsal necks. Other duvaliids, such as *Conobelus (Conobelus) conophorus* (Pl. VI, figs. 1A, 1B, 1D), *Conobelus (?Conobelus) orbignyanus* (Combemorel, 1972, Pl. A, fig. 15) and *Conobelus (Berriasibelus) extinctorius* (Combemorel, 1972, Pl. B, fig. 1), do not exhibit this adventral sloping at all, all their preserved dorsal necks being oriented along the long axis of the alveolus. Yet other duvaliids, such as the specimen of *Conobelus (?Conobelus) orbignyanus* sectioned by the writer (Pl. V, fig. 2B) and the *Duvalia conica* figured by Combemorel (1972, Pl. A, fig. 5), exhibit the same marked adventral sloping of the double-pronged dorsal necks as *D. graziana*.

The rather bizarre shapes of advanced dorsal septal necks figured (mostly drawings only!) by Kabanov (1967, Figs. 27, 28A, 28B, 28V; 29B, 29V, 29G; Pl. X, figs. 1a, 1b) were not observed by the writer. These shapes are not apparent in the thin-sections of Combemorel (1972, Pl. A, figs. 5, 15; Pl. B, fig. 1) either. The writer is inclined accordingly to ascribe the details (but not the general shapes themselves) of these bizarre septal necks studied by Kabanov (1967) to postmortal weathering and etching.

Like the short and stubby, loxochoanitic dorsal necks of the earliest growth stages originally described by Gustomessov (1972, p. 123) and more extensively documented in this paper, the double-pronged, advanced and ?adult dorsal necks appear to be one of the most diagnostic features of the duvaliid phragmocone. No similar dorsal necks are known to exist in any other taxon of the order Belemnitida.

The dorsal parts of septal necks of all Belemnopseidae genera studied differ sharply from those of the Duvaliidae as they remain orthochoanitic in all growth stages studied (Fig. 3). This is true of *Somalibelus somaliensis* (see Jeletzky, 1972, p. 175, Pl. 35, fig. 2d; Pl. 38, figs. 1a, 1b) where the orthochoanitic necks persist at least to the 30th septum without exhibiting the slightest tendency to become either loxochoanitic or double-pronged. This is true also of the thin-sections of *Hibolithes hastatus* (Pl. VII, figs. 1A-1C) and *Mesohibolites ewaldi* (Pl. VIII, figs. 1C, 1D) published in this paper. Finally, the same is true of *Neohibolites miyakoensis* figured by Hanai (1953, Pl. VI, figs. 4, 5), *Neohibolites* cf. *semihastatus*, *N.* cf. *elegans*, *Hibolites* sp., and *Hibolithes hastatus* figured by Kabanov (1967, Figs. 25, 26, 28G; Pl. X, fig. 2), and *Belemnopsis canaliculatus* figured by Christensen (1925, Pl. V, fig. 15). The persistence of orthochoanitic septal necks at least to the 25th or 30th septum in all above belemnopseid forms suffice to infer that orthochoanitic septal necks are diagnostic of the family as a whole.

Free septum and septal neck of the ventral side. In the specimen of *Duvalia graziana* sectioned by the writer (Pl. I, figs. 1E, 1F; Pl. II, figs. 1A, 1B; Pl. III, fig. 1D), the residual ventral parts of the camerae disappear after the 8th septum. The 9th ventral septum adheres to the conotheca throughout its length, except for the inward bent apical part discussed below. Such directly superimposed and partly impressed ventral parts of the septa are then retained to the oralmost preserved part of this phragmocone (Pl. I, fig. 1G; Pl. III, figs. 1B, 1C; Pl. IV, figs. 2B, 2C) which ends with the 27th septum. The oralmost parts of the ventral septa become more and more impressed into the conotheca in the 20th to 27th septa (Pl. IV, figs. 2B, 2C). Finally, the mural part of the 27th septum comes to rest almost directly on the innermost layer of the guard (Pl. IV, fig. 2B). This extreme attenuation of the conotheca beneath the oralmost preserved ventral septum of *Duvalia graziana* was not observed in any other duvaliid phragmocone studied. This feature may be either pathological or it may reflect a postmortal squeezing out of the less completely calcified conotheca by the better calcified mural part of the septum.

The inward bent, hooklike apicalmost part of the ventral septum of *Duvalia graziana* is evidently homologous to the ventral part of the septal neck of other belemnitids. This uniquely shaped and directed ventral part of the septal neck persists unchanged from the 1st septum to the oralmost preserved septum in the only phragmocone studied (compare Pl. III, fig. 1D with Pl. IV, fig. 2B).

The ventral parts of the septa of the sectioned phragmocone of *Conobelus (?Conobelus) orbignyanus* (Pl. V, figs. 2A-2D) resemble more closely the equivalent ventral parts of belemnopseid septa in retaining the tiny slit-like residual ventral camerae to at least the 18th septum. Their appearance is elucidated by the best preserved 12th and 13th camerae (Pl. V, fig. 2B). The 18th ventral septum being the oralmost sufficiently well-preserved to see (but not to photograph!) the residual ventral camera, it is not known whether or not the still more advanced ventral septa of *C. (?C.) orbignyanus* begin to adhere to the conotheca as do the ventral septa of *D. graziana*. However, the apparent absence of residual ventral camerae in the more advanced parts of the phragmocone of *Conobelus (Conobelus) conophorus* (see below) suggest that they do.

In spite of its belemnopseid-like residual ventral camerae, the advanced ventral septa of *C. (?C.) orbignyanus* are characteristically duvaliid because of the inward bent shape of the free apicalmost part corresponding to the ventral part of the ventral neck of other belemnitids. This characteristically duvaliid ventral part of the septal neck only differs from that of *D. graziana* in the presence of two prongs (Pl. V, fig. 2B) instead of only one.

The much less satisfactorily preserved, advanced (estimated to be 34th to 37th) ventral septa of *Conobelus (Conobelus) conophorus* (Pl. VI, fig. 1B, 1D) appear to adhere to the conotheca just as do those of *Duvalia graziana*. They also possess the inward bent, free ventral part of the neck (Pl. VI, fig. 1D). However, the preservation of this duvaliid septal neck is too poor to decide whether it is double or single-pronged.

It is difficult to compare most of the ventral septa of duvaliid genera described and figured by Kabanov (1963b, 1967) with those of the genera sectioned by the writer as Kabanov rarely numbered them. However, the phragmocone of *Pseudobelus bipartitus* (Blainville), sectioned by Kabanov (1963b, 1967, Fig. 27), is characterized by an even more retarded appearance of advanced ventral septa adhering to the ventral wall of the conotheca throughout their length than does the *Conobelus (?Conobelus) orbignyanus* sectioned by the writer. Namely, the 15th to 17th ventral septa of this phragmocone are still completely detached from the conotheca. Furthermore, the still substantial ventral camerae do not underlie the middle parts of the septa only as do the equivalent residual ventral camerae of *R. (?R.) orbignyanus* (Pl. V, fig. 2B). Instead, the ventral septa and camerae of *Pseudobelus bipartitus* resemble closely the corresponding septa and camerae of the Hastitidae (*compare* Jeletzky, 1966, Pl. 25, fig. 3) in the above respects. However, the apicalmost parts of them corresponding to the orthochoanitic or suborthochoanitic ventral necks of other belemnitids (including Hastitidae) are already markedly bent inward in the duvaliid fashion and noticeably thickened.

The 8th and 9th (Kabanov, 1967, Fig. 29G), 14th (Kabanov, 1967, Fig. 29V) and 23rd ventral septa of *Duvalia lata* figured by Kabanov (ibid.) exhibit what appears to be the same relatively retarded ontogenetic development as that displayed by the above phragmocone of *Pseudobelus bipartitus* (Blainville). The most interesting, rather aberrant feature of this ontogeny is the apparent restriction of the characteristically duvaliid ventral septa with their inward bent apicalmost parts (i.e. ventral necks; *see* Kabanov, 1967, Fig. 29G) to the earlier septa. Only the 8th and 9th ventral septa of the phragmocone are so shaped. Its 14th and 23rd ventral septa acquire (?revert to) irregularly shaped and thickened but unmistakably suborthochoanitic necks (Kabanov, 1967, Figs. 29B, 29V).

In the writer's opinion, the above morphologic peculiarities of the early and intermediate ventral septa of *Conobelus (?Conobelus) orbignyanus* (Duval-Jouve), *Pseudobelus bipartitus* (Blainville) and *Duvalia lata* (Blainville) are primitive features reflecting their greater age (Valanginian) in comparison with those of the Aptian *Duvalia graziana*. These primitive features of the Valanginian duvaliids apparently reflect their closer affinity to the hastitid rootstock of Duvaliidae (Jeletzky, 1966, p. 143, 144, Fig. 15), representatives of which are known to possess normally developed ventral septa (Jeletzky, 1966, Pl. 25, fig. 3). These primitive features of the ventral septa of the above Valanginian duvaliids do not suggest their exclusion from Duvaliidae, all the more so as their corresponding dorsal septa are already characteristically double-pronged and do not differ materially from the equivalent dorsal septa of *Duvalia graziana*.

Because of the strong variability of the duvaliid ventral septa proper, the apparently invariably present, uniquely shaped apicalmost parts of these septa corresponding to the orthochoanitic to suborthochoanitic necks of other belemnitids represent their most diagnostic feature. The strong morphological distinctions characterizing the equivalent ventral septa of forms belonging to different duvaliid genera suggest strongly that they are taxonomically useful on the generic level. However, this problem is beyond the scope of this paper.

Mural ends of septa. As already pointed out by Jeletzky (1972, p. 179): "it seems possible that the complete absence of adoral flanges of mural parts of septa is diagnostic of all Belemnopseidae". This suggestion is confirmed by study of the mural ends of septa of additional, better preserved representatives of *Hibolithes hastatus* (Blainv.) (Pl. VII, figs. 1B, 1C), and *Mesohibolites ewaldi* (Strombeck) (Pl. VIII, figs. 1B, 1E; Fig. 3). All better preserved mural ends of dorsal and ventral parts of the septa of these specimens are entirely similar to those of *Somalibelus somaliensis* (Jeletzky, 1972, p. 178, Pl. 34, figs. 1d-1g; Pl. 35, figs. 2b, 2c) in being wedge-shaped (in cross-section) and in abutting the apical surfaces of pronounced bulges of the conotheca. These observations invalidate the earlier ideas of Jeletzky (1966, p. 123, Pl. 9, fig. 1A, 1B; Pl. 10, fig. 1A, 1C) about the possible presence of Belemnitidae-like adoral flanges in the mural parts of septa of *Hibolithes hastatus* and *Mesohibolites miyakoensis*.

The mural parts of dorsal and ventral parts of the septa of all Duvaliidae genera studied by the writer differ sharply from those of Belemnopseidae in the presence of long and slender, triangular-shaped oral flanges which attenuate to a point adorally. These flanges were observed in *Duvalia graziana* (Pl. I, fig. 1G; Pl. II, figs. 1A-1D; Pl. III, figs. 1B, 1C; Pl. IV, figs. 2A-2C), *Conobelus (?Conobelus) orbignyanus* (Pl. V, fig. 2B) and *Conobelus (Conobelus) conophorus* (Pl. VI, figs. 1B-1E). In all of the above genera the oral flanges are present in the dorsal as well as in the ventral mural ends of the septa. So far as it is possible to tell, they are present in the early and intermediate septa alike.

The general validity of the writer's results is confirmed by Kabanov's (1967) studies. This worker established the presence of similar oral flanges in the mural parts of dorsal and ventral septa on the following duvaliid forms, none of which has been studied by the writer:

1. *Pseudobelus bipartitus* (Blainville)(Kabanov, 1967, Fig. 27, 28V);

2. *Duvalia lata* (Blainville)(Kabanov, 1967, Fig. 28A, 29A-29G; Pl. X, figs. 1A, 1B, 5); and

3. *Berriasibelus extinctorius* (Raspail)(Kabanov, 1967, Fig. 28B, Pl. XI, figs. 1, 2).

So far as is known, the oral flanges of the septa of all duvaliid forms studied are remarkably uniformly shaped and proportioned from one form to another and between the ventral and dorsal septa of one and the same form. This indubitably phylogenetically primitive, diagnostic feature of Duvaliidae sensu Pavlow 1914 confirms their direct derivation from the Hastitidae postulated by Jeletzky (1966, p. 143, 144, Fig. 15). At the same time the constant presence of the oral flanges of septa in Duvaliidae and their apparently constant absence in Belemnopseidae suggest that these two families are independent offshoots of the Hastitidae.

Other morphologic features of the phragmocone.

None of the other morphologic features of the phragmocones of duvaliid and belemnopseid forms studied by the writer and other workers (e.g. Kabanov, 1967) provide any distinguishing features. The proseptum and foot of the siphuncle, the closing membrane, the protoconch, the conothecal layers and the septal layers appear to be similarly built in these two families. The morphology of these features is, therefore, only commented upon in the description of the individual fossil plates.

The morphology of the phragmocone of Dicoelites and Pseudodicoelites.

Only one well-preserved phragmocone of *Conodicoelites meyrati* (Pl. IX, figs. 1F-1H; Pl. X, fig. 1A-1D) and one poorly preserved phragmocone of *Pseudodicoelites* aff. *P. bidgievi* (Pl. XIV, figs. 1G-1L) were available for study. These two phragmocones are of the belemnopseid rather than of the duvaliid type in all their taxonomically significant morphologic features. Namely, their siphuncles (Pl. IX, figs. 1G, 1H; Pl. X, figs. 1A, 1B; Pl. XIV, fig. 1G) shift only gradually into a marginal ventral position. The dorsal parts of septal necks remain orthochoanitic throughout the investigated growth stages and do not exhibit the slightest tendency to form adoral protuberances. The ventral parts of septal necks are at first long-orthochoanitic and then become suborthochoanitic. They do not exhibit the slightest tendency to develop the inward-bent ventral parts of septal necks diagnostic of Duvaliidae. On the contrary, it is the neck parts of their ventral septa that approach the conothecal wall most closely and then begin to touch it. At the same time the free parts of ventral septa of the two phragmocones studied become more and more inward bent like those of all belemnopseids studied. This results in the preservation of residual ventral parts of the camerae beneath the middle parts of the ventral septa. There is not the slightest tendency for the ventral parts of early septa to become superimposed on the conotheca throughout their length (i.e. except for the inward bent, free septal neck) as happens with the equivalent septa of Duvaliidae. Finally, the mural ends of all better preserved septa on the dorsal and ventral sides of the two phragmocones lack adoral flanges and abut onto the adapical surfaces of conothecal bulges. This condition matches exactly that observed in equivalent parts of all belemnopseid phragmocones studied.

No *Lenobelus* phragmocones were available for study. However, one phragmocone of *L. minaevae* (Saks) was studied by Gustomessov (1972, p. 123) with the following results (writer's translation from Russian): "The genus *Lenobelus*, which V.N. Saks and T.I. Nalniaeva (6), and following them G.K. Kabanov (paper read at the session of Moscow Soc. of Naturalists, 1968), referred to the family Duvaliidae, is characterized by a quite different structure of the septal necks. The dorsal parts of the necks of *Lenobelus minaevae* Saks[1]) differ in: 1. A greater length (up to one-third and even more of the length of corresponding camerae); 2. A clearly expressed orthochoanitic structure; and 3. A relative thinness." Although scant, these observations made on the 8th to 11th septal necks inclusive leave no doubt about the belemnopseid nature of this *Lenobelus* phragmocone. As described by Gustomessov (loc. cit.), the growth stage concerned does not resemble the corresponding ontogenetic stage of the Duvaliidae phragmocone characterized by the presence of short and stubby, loxochoanitic dorsal necks combined with the inward-bent, free ventral necks. At the same time the orthochoanitic septal necks described by Gustomessov (1972, p. 123) appear to match exactly the equivalent septal necks of the phragmocone of *Pseudodicoelites* aff. *bidgievi* (Saks) described and figured in this paper (p. 25-26, Pl. XIV, figs. 1G-1L).

Although the studied material of dicoelitid and pseudodicoelitid phragmocones is scant, it suffices to recognize the complete correspondence of all its taxonomically significant morphologic features with those of the equivalent growth stages of the phragmocone of all Belemnopseidae genera studied (e.g. Jeletzky, 1966, p. 127, Pl. 7, figs. 1B-1E; Figs. 6A, 6B; 1972, Pl. 33, figs. 1a-1e; Pl. 34, figs. 1a-1g; Pl. 35, figs. 2a-2d and this paper Pls. VII, VIII; Fig. 3). At the same time the dicoelitid and pseudodicoelitid phragmocones studied differ fundamentally from the corresponding growth stages of all duvaliid phragmocones studied in every taxonomically significant detail (compare this paper Pls. I-VI; Fig. 2 and Kabanov, 1967). Finally, and most significantly, the phragmocones of *Lenobelus* and *Pseudodicoelites* do not appear to differ materially from that of *Conodicoelites meyrati* figured and described herein (Pls. IX, X and descriptions of these plates).

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[1] Specimen from the basin of Lena River, thin-section No. 5 is preserved in the museum of the Moscow Geological Museum - Prospecting Institute named in honour of A.P. and M.V. Pavlows.

General Conclusions

The above analysis of the morphology of duvaliid, dicoelitid and pseudodicoelitid phragmocones combined with studies of mediodorsal alveolar grooves and the ontogenetic development of their guards clearly indicates their close affinities with representatives of Belemnopseidae. The presence of a mediodorsal alveolar groove and splitting surface in all the dicoelitid and pseudodicoelitid genera known does not contradict this conclusion as homologous grooves have long been known to exist in some belemnopseid genera (see p. 4 for further details). Such grooves accompanied by incipient splitting surfaces are, furthermore, known in some hastitid genera (Jeletzky, 1966, p. 143) which appear to be direct ancestors of belemnopseids, dicoelitids, pseudodicoelitids and duvaliids alike. Finally, and contrary to the ideas of Saks and Nalniaeva (1975, p. 119), the character of longitudinal lateral furrows (including the double lateral lines) of pseudodicoelitids does not differ materially from that of some hastitid and belemnopseid belemnites, including *Parahastites* Nalniaeva 1967 (see p. 35 for further details).

The above information necessitates a somewhat drastic revision of the taxonomy of Belemnopseina (= Duvaliacea sensu Saks and Nalniaeva) introduced by Saks and Nalniaeva (1967a, p. 440; 1967b, p. 15; 1975, p. 119). Namely, the family Dicoelitidae Saks and Nalniaeva, 1967 should be expanded to include the genera *Lenobelus* Gustomessov 1966 and *Pseudodicoelites* Saks 1967. The allegedly duvaliid subfamily Pseudodicoelitinae Saks and Nalniaeva 1967 should be suppressed as a synonym of the family Dicoelitidae. The family Duvaliidae introduced by Pavlow (1914) should be used in its customary (since Stolley 1919) interpretation (i.e. excluding *Lenobelus* and *Pseudodicoelites*) followed by all subsequent workers prior to the appearance of Saks and Nalniaeva's (1967a, 1967b) papers.

Techniques

Like New Zealand belemnite specimens studied by Stevens (1965b, p. 13), most of the dicoelitid specimens occurring in strongly indurated argillaceous or arenaceous rocks of northwestern British Columbia are natural external moulds resulting from a complete or partial leaching of the calcareous substance of the guard. These moulds can only be studied using their casts. Following Stevens' (1965b, p. 13) example, casts of these moulds were obtained by filling holes representing parts or all of the guard by the "compounded moulding latex". As some remnants of guards and, sometimes, considerable accumulation of loose sediment were found in most of the holes, great care had to be taken to rinse the holes left by belemnite guards thoroughly with water and/or to extract the debris using a long preparation needle hooked at the tip.

As again with the New Zealand belemnite specimens (Stevens, 1965b, p. 13), attempts to chisel bodily preserved belemnite guards out of an indurated matrix were mostly unsuccessful. The softer, crystalline guards tend to shatter into small fragments during preparation. Furthermore, their outermost layers tended to stick to the surrounding rock. Future collectors of belemnites from the strongly indurated and commonly silicified Jurassic and Lower Cretaceous rocks of western British Columbia are, therefore, advised to collect well-preserved belemnite moulds rather than to attempt to chisel bodily preserved guards out of the solid rock. The effort to collect bodily preserved guards is apt to be rewarding only in strongly weathered surface layers.

Collecting of complete guards still embedded in surrounding, indurated matrix may be worthwhile as Stevens (1965b, p. 13) has been successfully leaching such guards with diluted hydrochloric acid and prepared latex casts of the resulting moulds. However, the writer did not have the opportunity to try this method because of the scarcity of suitably preserved material.

SYSTEMATIC PALEONTOLOGY

Coleoidea Bather 1888
Belemnitida Zittel 1895
emend. Jeletzky 1966
Belemnopseina Jeletzky 1965
Dicoelitidae Saks and Nalniaeva 1967
emend. (inclusive of subfamily
Pseudodicoelitinae Saks and
Nalniaeva 1967)

General Remarks

For reasons presented in the preceding section, the original concept of the family Dicoelitidae introduced by Saks and Nalniaeva (1967a, p. 440; 1967b, p. 15; 1975, p. 119) is drastically revised in this paper. This revision completely supresses the subfamily Pseudodicoelitinae Saks and Nalniaeva 1967, which is synonymyzed here with the family Dicoelitidae Saks and Nalniaeva 1967. Furthermore, the writer returns to the accustomed interpretation of the family Duvaliidae Pavlow 1914 introduced by Stolley (1919, p. 49, 50) and followed by all subsequent workers prior to Saks and Nalniaeva (1967a, 1967b). The following diagnosis is compiled in accordance with the above conclusions.

Diagnosis

Guards mostly characterized by the simultaneous presence of medioventral and mediodorsal alveolar grooves beginning at the alveolar rim and extending for a variable distance adapically. Either one, or both, of these medioalveolar grooves may (or may not) be accompanied by a poorly or well-developed splitting surface. Hence, any of them may be either a simple groove or a true alveolar canal.

The medioventral alveolar groove may be strongly reduced or even completely absent. It may also be replaced by a medioventral apical furrow devoid of a splitting surface. When present this furrow may either be restricted to the apicalmost part of the ventral face or extend for a variable distance adorally from the apex. It is not known to reach the alveolar region of the guard. Lateral longitudinal grooves are developed essentially as in primitive Hastitidae (e.g. *Parahastites*, *Gastrobelus*, and *Pleurobelus*; see p. 35 for further details) so that only the anterior double lateral lines are present. Structure of phragmocone essentially as in Hastitidae and Belemnopseidae with orthochoanitic septal necks on the dorsal and orthochoanitic (early) to suborthochoanitic (intermediate to late) necks on the ventral side of the siphuncle. Cameral deposits unknown and apparently absent.

Time Range

Toarcian to Kimmeridgian inclusive.

Geographic Range

Northern fringe of the Tethyan Realm in Europe and near East (southern France, Switzerland, southern Poland, Bulgaria, Crimea, Caucasus), Boreal Realm, (northern Siberia, Canadian Arctic Archipelago, northern Yukon, southern Yukon), northern fringe of Tethyan Realm in northwestern British Columbia, the Indo-Pacific Province of the Tethyan Realm (Indonesia, India, New Zealand), western South America (Peru, Argentina) and Antarctica.

Genus *Dicoelites* Boehm, 1906 non Stolley, 1927

(= *Prodicoelites* Stolley, 1927)

Type species. *Belemnites dicoelus* Rothpletz 1892.

Remarks. The writer follows Stevens' (1965a, pp. 608-609) interpretation of the genus *Dicoelites* Boehm 1906. The genus is restricted accordingly to slender and elongate, hastate guards with a narrow and deep medioventral groove extending to the posterior extremity of the apical region and a more narrow and shallow mediodorsal groove which does not extend very far back from the alveolar region. *Belemnites dicoelus* Rothpletz, 1892 is the type species of *Dicoelites* by monotypy (see Boehm, 1906).

?*Dicoelites* sp. nov. indet. A

Pl. XI, figs. 1, 2

Material. One external mould of the ventral side of a complete guard and one external mould of an undeformed alveolar part of the guard in the rock collected at GSC loc. 91125.

Description and generic assignment. The slender and thin (preserved length 58 mm; estimated total length 75 to 80 mm; estimated coefficient of elongation ≈18 to 19[1]) impression of a complete guard GSC Cat. No. 59003 (Pl. XI, fig. 1) resembles closely the dorsal aspect of a half-grown representative of *Lenobelus minaevae* (Saks, 1961 nomen nudum) Gustomessov (1966, Pl. VI, fig. 6B) or *Pseudodicoelites hibolitiformis* Saks (in Saks and Nalniaeva 1967b, Pl. II, fig. 4b) in shape, proportions and relative elongation. The same is true of the general appearance of the median alveolar groove starting at the alveolar rim and extending over the anterior half of the guard's length, although it is relatively longer than the mediodorsal alveolar groove of any known species of *Lenobelus* of *Pseudodicoelites*. This impression would have been interpreted tentatively as that of a half-grown *Lenobelus* or *Pseudodicoelites*, except for the presence in collection GSC loc. 91125 of another undeformed external mould of alveolar fragment GSC Cat. No. 59004 (Pl. XI, fig. 2A-2E), which appears to be identical with the corresponding part of the former impression in its size, shape and proportions.

The external mould of fragment 59004 is ornamented by two median alveolar grooves. Of these grooves, one (Pl. XI, fig. 2A) is a little wider and deeper than the other. This groove extends the whole length of the fragment without any sign of shallowing. It is interpreted accordingly as the equivalent of the adoral part of the long median groove of impression 59003 (Pl. XI, fig. 1). The other more shallow and narrow groove (Pl. XI, fig. 2B) shallows noticeably but gradually at the apical end of the fragment and probably disappears a short distance farther towards the apex. This groove does not seem to be represented in impression 59003.

Because of the presence of two median alveolar grooves, of which one (presumably the apparently shorter groove shown in Pl. XI, fig. 2B) must be dorsal while the other (presumably the apparently longer groove shown in Pl. XI, fig. 2A) must be ventral, fragment 59004 cannot be assigned either to *Lenobelus* Gustomessov, 1966 emend. Saks, 1967a, 1967b or to *Pseudodicoelites* Saks 1967a, 1967b. Neither of these two genera possesses the two well-developed median alveolar grooves so well displayed in our fragment. *Lenobelus* (see Gustomessov, 1966, p. 84, 85) as redefined by Saks (in Saks and Nalniaeva, 1967b, p. 17, 20-21) is characterized by the presence of a medioventral groove beginning at the apex but not reaching the alveolar part of the guard. *Pseudodicoelites* (see Saks in Saks and Nalniaeva, 1967b, p. 17, 21, 22) is characterized by either the complete absence of a medioventral alveolar groove or by the presence of a shallow and wide, short medioventral alveolar groove which is dissimilar to that of fragment 59004 reproduced in Pl. XI, fig. 2A.

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[1] Footnote. Coefficient of elongation is the ratio of the estimated complete length of the guard (including the graphically reconstructed extent of the broken off part of the alveolar region) and the maximum dorso-ventral diameter of the guard.

So far as the writer knows (compare Stevens 1965a, 1965b), only the genus *Dicoelites* Boehm 1906 s. str. (= *Prodicoelites* Stolley 1927) combines the presence of a longer medioventral alveolar groove and a shorter but well-developed and deep mediodorsal alveolar groove with a slender, elongate and hastate shape of the guard. Fragment 59004 appears, therefore, to be assignable to this genus.

The above impression of the complete guard (Pl. XI, fig. 1) appears to be congeneric and conspecific with the more diagnostic external cast of the alveolar fragment 59004 because of the close morphologic similarity of their equivalent parts. It is interpreted, therefore, to be the ventral face of a complete guard of *?Dicoelites* sp. nov. indet. A. Both impressions available are only tentatively assigned to the genus *Dicoelites* s. str. in spite of the excellent agreement in all the morphologic features observed. The reason is that these impressions could also possibly belong to an as yet undescribed, more primitive dicoelitid genus ancestral to *Dicoelites* Boehm 1906 non Stolley 1927. Many external (e.g. the character of longitudinal lateral grooves and double lateral lines) and internal (e.g. the presence or absence of splitting surfaces beneath the median alveolar grooves, depth of the alveolus, position and shape of the apical line, character of the ontogenetic development) morphological features of the guard and phragmocone (e.g. presence or absence of cameral deposits) are unknown. Any or all of them may differ significantly from the corresponding features of *Dicoelites* s. str. Furthermore, the material occurs in beds much older (see below) than those from which all previously known representatives of *Dicoelites* s. str. have been described.

Comparison. As interpreted from the two specimens above, the *?Dicoelites* sp. nov. indet. A is considerably smaller but relatively more slender than any *Dicoelites* (=*Prodicoelites*) species described and figured by Stolley (1929, pp. 185-196, Pl. CCLIII, figs. 1-46). However, comparison of the Canadian form with all the Indonesian forms described by Stolley (ibid.) is made difficult by their almost invariably fragmentary state. The same is true of *Dicoelites mihanus* Boehm as refigured by Stevens (1965a, Pl. 94, figs. 5, 6, 11, 12). The fragmentary and poorly preserved type species of *Dicoelites-D.dicoelus* Rothpletz 1892 - differs even more strongly from the Canadian form in possessing a medium-sized, sturdy, subcylindrical guard. This species is obviously transitional to such more slender, subcylindrical forms of *Conodicoelites* Stevens 1965a as *C. waageni* (Neumayr).

The above morphologic distinctions of the Canadian *?Dicoelites* sp. nov. indet. A, in combination with its much older (mid-Toarcian) age indicate it to be a new species. However, neither of the two specimens known is well enough preserved to be a holotype of a new species. It was therefore decided to leave the species unnamed pending discovery of better preserved material.

Stratigraphy and age. The two fragmentary specimens of *?Dicoelites* sp. nov. indet. A were collected by T.P. Poulton in 1973 from the Hazelton Group, northwestern British Columbia, southern Bait Range, north of the head of Frypan Creek, Lat. 55°33'N; Long. 126°23.7'W (Field No. PU-10-73-3F).

Other fossils collected at locality GSC No. 91125 include poorly preserved ammonites which belong to the family Phymatoceratidae Hyatt? and indicate a middle Toarcian age according to Hans Frebold (unpublished intradepartmental Report J-11-1974-HF).

?Dicoelites sp. nov. indet. B

Pl. XV, figs. 5A-5F

Material. One fragment of the anterior half of the guard which does not include any part of the alveolus, from GSC loc. 86555 in the northern Yukon.

Description. The thin fragment GSC Cat. No. 59030 resembles *?Dicoelites* sp. nov. indet. A in its slender proportions and presence of almost equally strongly developed mediodorsal and medioventral alveolar grooves. However, the pronouncedly adorally contracting shape of the specimen (Pl. XV, figs. 5A-5D) contrasts with the feebly adorally contracting shape of the corresponding parts of both fragments of *?Dicoelites* nov. sp. indet. A. The northern Yukon specimen closely resembles *Pseudodicoelites clavatoides* Saks (see Saks and Nalniaeva, 1975, Pl. XVIII, figs. 1-3) in this respect. Another distinction of the northern Yukon form is the greater width of the ventroalveolar and dorsoalveolar grooves which have a rounded-rectangular and flat-bottomed rather than a V-shaped cross-section. These grooves are, finally, equally strongly developed and extend all over the length of the present fragment. Therefore, it is only possible to say which is the medioventral and which the mediodorsal groove by using the position of the apical line within the guard's cross-section. On this basis the wider groove visible in Pl. XV, fig. 5A is the medioventral alveolar groove. Neither of the grooves exhibits any traces of splitting surfaces, even in their oralmost preserved parts.

Because of the presence of two equally strongly developed median alveolar grooves (see Pl. XV, figs. 5A, 5B for their orientation using the adventral position of the apical line), fragment 59030 is a representative of the family Dicoelitidae as defined above. Within this family it cannot be assigned either to *Lenobelus* Gustomessov 1966 emend. Saks 1967a; 1967b or to *Pseudodicoelites* Saks 1967a, 1967b. As already mentioned under the discussion of *?Dicoelites* sp. nov. indet. A (see p. 12), neither of these two genera possesses two medioalveolar grooves so well developed as those in the fragment.

The apparent equal development of the two grooves seems to count against reference of *?Dicoelites* sp. indet. B to the genus *Dicoelites* Boehm 1906 s. str. (=*Prodicoelites* Stolley 1927) as the latter genus is characterized by the presence of a long medioventral alveolar groove and a shorter but well-developed and deep mediodorsal alveolar groove. However, the only available fragment of the adoral part of the guard is too short to display this feature and it can be presumed that the groove reproduced in Pl. XV, fig. 5B weakens and disappears earlier than the other within the missing posterior part of the guard just as it does in *?Dicoelites* sp. nov. indet. A (see there). Finally, fragment 59030 cannot be placed in the genus *Conodicoelites* Stevens 1965 because of the very slender, pronouncedly subfusiform shape of its guard. Under these circumstances fragment 59030 can only be assigned to the genus *Dicoelites* Boehm 1906 s. str.

It cannot be overstressed that fragment 59030 is only tentatively assigned to the genus *Dicoelites* because of its incompleteness and generally poor preservation. Any or all of the unavailable morphological features may be significantly different from the corresponding features of *Dicoelites* s. str. Furthermore, like the closely similar *?Dicoelites* sp. indet. A, *?Dicoelites* sp. indet. B occurs in beds much older (see below) than those from which all previously known representatives of *Dicoelites* s. str. have been described.

Stratigraphy and age. The only representative of *?Dicoelites* sp. nov. indet. B was collected by geologists of Shell Oil Canada Ltd. in Kingak shale restr., northern Yukon, Sleepy Mountain, in headwaters of Driftwood River; Lat. 68°03'N; Long. 137°54'W. Other fossils collected at GSC loc. 86555 consist only of poorly preserved, generically indeterminate ammonites. However, the adjacent GSC loc. 86556 situated at about the 15 m (50-foot) level in the same section has yielded small ammonites probably referable to a *Leioceras* form of an early Bajocian age according to Hans Frebold (unpublished intradepartmental report J-14-71-HF). This suggests an early Bajocian (=Aalenian) age for *?Dicoelites* sp. nov. indet. B.

Genus *Conodicoelites* Stevens 1965
(=*Dicoelites* Stolley 1927 non Boehm 1906)

Type species. *Dicoelites keeuwensis* Boehm 1912.

Remarks. The validity of Stevens' (1965a, p. 613, 614) interpretation of the genus *Conodicoelites* is questionable, in the writer's opinion. Stevens placed in this genus indiscriminately such typical, sturdy and conically shaped forms as *Dicoelites keeuwensis* Boehm and *Belemnites sulcacutus* Stoliczka and such moderately slender, subcylindrically shaped forms as *Belemnites meyrati* Ooster. Furthermore, the palaeogeographic range of typical *Conodicoelites* ex gr. *keeuwensis* does not entirely coincide with that of *Belemnites* ex gr. *meyrati*. However, the writer follows the interpretation of *Conodicoelites* proposed by Stevens (1965a, p. 613, 614) for the time being because of very poor knowledge of the morphology, time-ranges, and palaeogeographic distribution of all species assigned to it.

So far as is known *Conodicoelites* is confined to the Tethyan and the Antiboreal Realms. In the Tethyan Realm it occurs in the southern (Indonesia, New Zealand, South America) as well as in the northern (Switzerland, southern Poland, Crimea, Carpathians) belt of the Realm (see Stevens, 1965a, 1965b for further details). The North American (northwestern British Columbia) representatives of the genus described below also occur in the northernmost part of the Tethyan Realm (equivalent in palaeogeographic position to that of southern Poland).

Conodicoelites sp. nov. aff. *keeuwensis*
(Boehm, 1912)

Pl. XI, figs. 4A-4E, 6A-6C; Pl. XV, 6A-6C

Material. One undeformed external mould from GSC loc. 91078 including alveolar, stem, and apical regions of a well-preserved guard; two apparently undeformed external moulds (lacking the apical region) from GSC loc. 93268.

Description. Presuming the external mould of the most nearly complete specimen, GSC Cat. No. 59006, to include most of the alveolar region (which is reasonable because of the considerable length of preserved mediodorsal alveolar groove; see Pl. XI, fig. 4D), this fairly small guard is moderately short and markedly conically shaped in dorso-ventral (Pl. XI, figs. 4A, 4D) and lateral (Pl. XI, figs. 4B, 4C) aspects. Estimating the complete length of this guard at about 60 mm (of which about 55 mm are actually preserved) and its maximum dorso-ventral diameter at about 16 mm (by projecting the maximum preserved diameter of 7.4 mm at the apical end of the mediodorsal groove to the oral rim of the guard; see Pl. XI, figs. 4B, 4C) one arrives at a coefficient of elongation of around 4.

The generally conical shape of guard 59006 is modified by a slight, gradual increase in adapical tapering of the flanks throughout its preserved length producing a feebly convex shape in lateral (Pl. XI, figs. 4B, 4C) and dorso-ventral (Pl. XI, figs. 4A, 4D) aspects. The rate of adapical tapering increases appreciably and fairly abruptly at a level 18 to 20 mm above the apex and then becomes stabilized at the new rate of increase to the apex. The increase which is noticeable in lateral and dorso-ventral aspects delimits the stem and apical regions. The apical angle (in dorso-ventral and lateral aspects; see Pl. XI, figs. 4A-4D) within the apical region is about 27 degrees. The apical region ends in a sharp, pointed apex. The outline of the guard appears to be perfectly symmetrical in dorso-ventral aspect and almost so in lateral aspect. The symmetry of the lateral aspect is slightly distorted by the faintly concave shape of the apicalmost 8 to 10 mm of the dorsal side (Pl. XI, fig. 4B) which differs from the feebly convex shape of the corresponding segment on the ventral side. This asymmetry produces a slight addorsal displacement of the apex.

The cross-section is about equidimensional throughout the completely preserved, ?post-alveolar part of the guard. The dorso-ventral diameter at the apical end of the mediodorsal groove is 7.3 to 7.4 mm (the measurement is approximate because its ventral surface is partly weathered) and the lateral diameter at the same level is 7.4 mm. These respective diameters are about 5.0 mm each at the boundary of the stem and apical regions (i.e. 18 mm above apex). However, the cross-section is rounded-quadrangular rather than regularly rounded throughout the guard's length with strongly flattened flanks, ventral face, and dorsal face. In the imperfectly preserved (destruction of ventral face) oralmost 18 mm the addorsal part of the cross-section appears to be more narrow than the adventral part, the maximum lateral diameter being situated near to the ventral face. This asymmetry disappears completely farther adapically (Pl. XI, fig. 4E).

The medioventral groove extends adapically to the level 4 to 5 mm above the apex (Pl. XI, fig. 4A) and may possibly continue to the very tip. However, the character of the ventral face within the apicalmost 4 to 5 mm has been obscured by strong weathering. Complete destruction of the ventral face of the guard has removed the medioventral groove in the oralmost 18 mm of its preserved length. However, because of the relationships observed in specimen 59031 (see below), the groove is presumed to extend adorally to the alveolar rim just as it does in *Conodicoelites keeuwensis* (see Stevens, 1965a, Pl. 94, figs. 1, 7) and *C. sulcacutus* (see Stoliczka, 1866, Pl. VIII, figs. 2, 3). The medioventral groove is shallow, broad (1.5 to 2.0 mm wide) and has regularly rounded edges throughout its preserved length (see Pl. XI, fig. 4A). The apparent gradual adapical narrowing of the groove may be the result of stronger weathering of its adoral part. Judging by the appearance of the medioventral groove, its preserved part was not underlain by a splitting surface. If present, and the relationships observed in specimen 59031 indicate that it was present, the medioventral splitting surface was probably restricted to the oralmost 18 mm of the guard where the ventral face has been destroyed by weathering.

The mediodorsal alveolar groove is restricted to the adoral 21 to 22 mm of the preserved part of the guard (Pl. XI, fig. 4D). This well-preserved, apparently unweathered groove is narrow, deep, and slit-like throughout its preserved extent. The narrow V-shaped cross-section is, however, combined with well-rounded edges. The groove is about 1.2 mm wide at the adoral end and narrows down evenly and gradually to its apical end. Adapically from the groove proper (i.e. from its slit-like shaped part) a narrow median zone of the ventral face remains feebly depressed for another 4 mm adapically (see Pl. XI, fig. 4D). This faint furrow disappears completely at the end of this short interval.

Judging by the slit-like character of the mediodorsal alveolar groove proper it was underlain by a well-developed mediodorsal splitting surface throughout (except for the faint furrow adapically from it). No other grooves were observed on the ventral and dorsal faces of the guard.

The flanks of guard 59006 appear to lack any longitudinal grooves, lines or striae, except in the apical segment where a shallow and poorly delimited dorso-lateral apical groove occurs on each flank. These paired grooves begin at the apex and extend for about 17 mm adorally before merging into the regularly curved flanks (Pl. XI, figs. 4B, 4C).

So far as it is possible to tell, the shape and proportions of incomplete external cast 59008 (Pl. XI, figs. 6A-6C) match closely those of the above specimen 59006, except that the former appears to be more slender and to taper more slowly adapically. However, the specimen has a ventral surface that is well-preserved to its oral rim (Pl. XI, fig. 6A). The oralmost preserved part of this surface, presumably representing the alveolar part of the guard, exhibits a narrow and deep medioalveolar groove which has a narrow V-shaped cross-section. Judging by its appearance, this groove is underlain by a splitting surface and represents the medioventral alveolar canal of *Conodicoelites*. At a point about 12 mm below the preserved oral rim this slit-like groove merges abruptly into a much wider and shallow, roundbottomed groove, which extends all the way to the apical end of the specimen. This part of the medioventral groove matches closely the preserved part of the medioventral groove of specimen 59006 (compare Pl. XI, fig. 6A with Pl. XI, fig. 4A).

Incomplete specimen 59031 (Pl. XV, figs. 6A-6C) is a much more slender and longer conical form than the other two representatives. Furthermore, it is distinguished from them in its essentially straight shape in lateral and dorso-ventral aspect and in its degree of apicalward tapering (in lateral aspect; Pl. XV, fig. 6B) of 10 to 11 degrees. In these features specimen 59031 resembles closely *Conodicoelites sulcacutus* (Stoliczka) (1866, Pl. VIII, figs. 2, 3). It differs markedly from specimens 59008 and 59006 which resemble more closely *C. keeuwensis* Boehm 1906 in the same features.

Specimen 59031 is rather more incomplete at its oral end than the other two specimens because only the apicalmost 6 to 7 mm of the mediodorsal alveolar groove (Pl. XV, fig. 6C) and the apical tip of the slit-like part of the medioventral alveolar groove (Pl. XV, fig. 6A) are preserved there. The preserved part of these two grooves, including the shallow, roundbottomed posterior part of the medioventral groove (Pl. XV, fig. 6A), do not differ materially from their equivalents in specimens 59006 and 59008.

In spite of the morphologic differences from the other two representatives of the form discussed here the writer allocates all three specimens to the same species. This was done largely because specimens 59031 and 59008 were found at the same locality. Because of this, and because of the extreme scarcity and poor preservation of the material available (fragmentary external casts only!), it is preferable to interpret specimen 59031 as an extreme morphologic variant of the species, for the time being at least. The flanks of specimen 59031 are ornamented by what appears to be fine mediolateral longitudoval furrows (Pl. XV, fig. 6B). It is impossible to say whether or not these faint furrows harbour double lateral lines.

Because they are preserved as external casts, the internal morphology of guards 59006, 59031 and 59008 is unknown.

Remarks. The three guards are characterized by the coexistence of a longer, presumably medioventral, alveolar groove, apparently representing an alveolar canal in part, with a shorter, presumably mediodorsal, alveolar groove apparently representing an alveolar canal for the most part. In combination with the short, markedly conical shape of the guard and the absence of a medioventral apical groove, these features are diagnostic of the genus *Conodicoelites* Stevens 1965 (see p. 613, 614). They are accordingly referred to that dicoelitid genus in spite of their much older, mid-Toarcian age (see below) in comparison with that of all previously described *Conodicoelites* species. Because of the reasons presented below the specimens are designated *Conodicoelites* sp. nov. aff. *C. keeuwensis* (Boehm).

Within the genus *Conodicoelites, C.* sp. nov. aff. *keeuwensis* is particularly closely related to *C. keeuwensis* (Boehm, 1912) and *C. sulcacutus* (Stoliczka, 1866). Together with these species it comprises a well-defined species group of typical, truly conical *Conodicoelites* forms.

The Canadian specimens differ from the morphologically most closely similar species *C. keeuwensis* (Boehm, 1912) in the following features:

1. A feebly convex (rather than virtually straight) shape of the guard in lateral aspect;

2. An essentially symmetrical (rather than distinctly asymmetrical) lateral outline of the guard and an almost central (instead of markedly addorsally displaced) position of the apex;

3. A considerably shorter mediodorsal alveolar groove, which does not exceed two-fifths of the estimated length of the guard in *C.* sp. nov. aff. *keeuwensis* compared with about two-thirds of its length in *C. keeuwensis* (see Stevens, 1965a, p. 614, Pl. 94, figs. 2, 8);

4. A distinctly rounded-quadrangular cross-section of the guard with strongly flattened flanks, ventral face, and dorsal face;

5. The presence of well-defined paired, dorsolateral, apical grooves.

Conodicoelites sulcacutus (Stoliczka 1866), another closely similar but poorly known conical form, differs from *C.* sp. nov. aff. *keeuwensis* in possessing:

1. A considerably more acute apical angle. The lateral apical angle of *C. sulcacutus* (see Stoliczka, 1866, Pl. VIII, figs. 2, 3) is about 14 degrees as compared with the corresponding angle of 27 to 28 degrees in specimen 59006 of *C.* n. sp. aff. *keeuwensis* (Pl. XI, figs. 4B, 4C); however, the fragmentary, longer conical specimen 59031, which lacks the apical region, could conceivably have a *C. sulcacutus*-like apical angle.

2. The almost perfect conical shape of the guard in dorso-ventral aspect as compared with the slightly convex shape of *C.* sp. nov. aff. *keeuwensis*. However, here again, fragmentary specimen 59031 does not seem to differ from *C. sulcacutus* in this respect;

3. A regularly rounded, adorally depressed and adapically compressed cross-section of the guard (see Stoliczka, 1866, Pl. VIII, figs. 2, 2a, 3, 3a).

All other described *Conodicoelites* species, such as *C. meyrati* (Ooster), *C. waageni* (Neumayr), *C. flemingi* Stevens, *C. orakaensis* Stevens and *Conodicoelites* sp. nov. of Stevens (1965b, p. 69, Pl. I, figs. 10-12) can be readily distinguished from *Conodicoelites keeuwensis, C. sulcacutus* and *C.* sp. nov. aff. *C. keeuwensis.* All these former species differ markedly from the three truly conical forms in that the flanks of their alveolar and stem regions are subcylindrical (sometimes slightly contracting adapically) to faintly hastate in lateral and dorso-ventral aspects. Only the flanks of their apical region contract distinctly to markedly adapically in lateral and dorso-ventral aspects. This results in the distinct delimitation of their stem and apical regions. In the writer's opinion (see under the generic discussion of *Conodicoelites*), the more elongate, subcylindrical to slightly subhastate representatives of this species group (e.g. *C. waageni*) are morphologically similar to *Dicoelites dicoelus* rather than to *Conodicoelites* ex gr. *keeuwensis-sulcacutus-C.* sp. nov. aff. *C. keeuwensis,* and for this reason may have to be transferred into the genus *Dicoelites* s. str.

Considering the mid-Toarcian age (see below) of all known guards of *Conodicoelites* sp. nov. aff. *C. keeuwensis* (Boehm), there is little doubt that it belongs to a well-defined, new species of *Conodicoelites* possibly ancestral to *C. keeuwensis* (Boehm). However, because all of the guards presently available are preserved only as external casts, open nomenclature is adapted pending the discovery of additional, better-preserved material.

Stratigraphy and age. The best-preserved representative of *Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm), 59006, was collected by T.P. Poulton from the Haselton Group on a nameless ridge at a point 4.8 km (3 miles) NNW of Sithka Pass and due east of Iktlake Peak; Lat. 55°56.6'N; Long. 126°3.1'W. This guard is associated with Middle Toarcian ammonites including *Haugia* sp. identified and dated by

Hans Frebold. Less well-preserved specimens 59031 and 59008 were collected by H.W. Tipper in 1975 from rocks of the Haselton Group in Section 11TD measured on the ridge bearing toward 178° from Mt. Carruthers. This section is situated at Lat. 56°12.5'W; Long. 126°21'N; in the McConnell map-area, British Columbia. The fossils were collected from talus but probably came from the same bed. According to Hans Frebold (unpublished fossil report J-8-1976-HF) this fossil collection also contains: "*Haugia?* sp. indet. (very poorly preserved)" and is of "Toarcian Middle?" age.

Conodicoelites sp. aff. *C. meyrati*
(Ooster, 1857)

Pl. XI, figs. 5A-5D, 7A-7D, 8A-8D, 9A-D

Material. One slightly deformed fragmentary guard from GSC loc. 86273 (Pl. XI, fig. 5). The guard is almost complete in its alveolar part but lacks an estimated two-fifths to one-half of the posterior segment, including the apex.

Three comparably dimensioned fragments, which possibly form parts of the same specimen, but do not fit together, come from GSC loc. 90963 (Pl. XI, figs. 7-9). Ten apical fragments (unfigured) probably belong to this form but are not positively assignable to it.

Description. Guard moderately large, the restored length of an approximately complete large specimen reconstructed from fragments reproduced in Pl. XI, figs. 7-9 being estimated at about 100 mm. The guard appears to be moderately elongated with an estimated coefficient of elongation in the order of 7 to 8.

In dorso-ventral aspect the guard is subcylindrical with approximately parallel flanks in the anterior one-half to three-fifths of its length, including all of the alveolar and stem regions (i.e. GSC Cat. No. 59007; Pl. XI, figs. 5A, 5C, 7A, 7C). It is slightly subconical in shape with faintly and evenly adapically contracting flanks in lateral aspect (Pl. XI, figs. 5B, 7B) throughout the same interval. The posterior two-fifths to one-half of the guard's length comprising the apical region appears to be of a regular and elongate conical shape in lateral and dorso-ventral aspects. The shape of the best-known fragments of this region (Pl. XI, fig. 8, 9) suggests that it tapers evenly all the way to the apex. The guard probably had a long, slender, regularly conical apical region with an acutely pointed apex similar to that of *Conodicoelites meyrati* (see Pugaczewska, 1961, Pl. XXIV, figs. 2a-2c). However, additional better-preserved material, including the apex proper and the segment connecting the stem and the apical region, is needed to confirm this suggestion. The lateral profile of the apical region seems to be slightly asymmetric, its ventral face tapering somewhat more than the dorsal face.

The cross-section of the guard is markedly compressed in its alveolar part, with strongly flattened flanks in this interval (Pl. XI, fig. 7D). The diameters of the oral end of undeformed alveolar fragment GSC 59009 (Pl. XI; fig. 7D) are: 1) dorso-ventral diameter - 17.2 mm); and 2) lateral diameter 15.8 mm. This results in a coefficient of compression of 0.92. The somewhat deformed guard 59007 (Pl. XI, fig. 5E) is believed to have originally had a compressed alveolar cross-section. The compression decreases gradually adapically until the diameters become subequal in the middle of the stem region. In the two specimens available, the guard cross-section has a distinct egg shape from this middle region (Pl. XI; figs. 5D, 8D) to the apex with the maximim lateral diameters becoming markedly displaced adventrally. This egg shape of the cross-section of the posterior half of the guard is enhanced by the absence of a mediodorsal alveolar groove and the presence of a medioventral alveolar groove throughout this interval.

The apical line is distinctly displaced adventrally throughout the stem and apical regions. At the apical break of guard 59007 (Pl. XI, figs. 5D) the ventral radius is 5.3 mm as compared with a dorsal radius of 6.4 mm with a resulting adventral displacement of 1.2 mm. The oral break of apical fragment 59011 (Pl. XI, fig. 9D) has a ventral radius of 5 mm and a dorsal radius of 6 mm with a resulting adventral displacement of 1.2 mm.

The ventral surface bears a 1.5 to 2.5 mm wide medioventral alveolar groove which begins at the alveolar rim (Pl. XI, figs. 5A, 7A, 8A, 9A) and extends to within a few mm of the apex (presumably to its very tip) in all the apical fragments available (Pl. XI, fig. 9A). This groove is about 1.5 mm wide and at least 1.5 mm deep and combines a narrow V-shaped cross-section with rounded rims in the adoral 29 to 30 mm of the ventral face of guard 59007 (Pl. XI, fig. 5A). The medioventral groove has the same shape in the approximately 22 mm long alveolar fragment 59009 (Pl. XI, fig. 7A) and the same is true of the oralmost 18.5 mm of the medioventral groove in stem region fragment 59010 (Pl. XI, fig. 8A). Farther adapically the medioventral groove widens to 2.0 to 2.5 mm and becomes appreciably more shallow and roundbottomed (Pl. XI, figs. 8A, 9A). So far as it is possible to tell, this change in appearance of the groove coincides with the approximate position of the apical limit of the medioventral splitting surface. The rims of the groove are more broadly rounded in the posterior part in comparison with the V-shaped anterior part (Pl. XI, fig. 5A).

Like the medioventral groove, the mediodorsal groove is deep (at least 1.5 mm) and V-shaped in the oralmost 25 to 30 mm of the guard 59007. However, it is narrower (about 1.0 mm wide) than the medioventral groove within this interval and has subangular rims (Pl. XI, fig. 5C). This is equally true of the above guard and of the better preserved alveolar fragment 59010 (Pl. XI, fig. 7C). Farther adapically the mediodorsal groove rapidly becomes shallow, round-bottomed and wider. However, it remains much more narrow (about two-fifths of the width) than the corresponding part of the medioventral groove. In guard 59007 (Pl. XI, fig. 5C), which exhibits the entire length of the mediodorsal groove, the latter extends for only another 20 mm adapically before disappearing at a level about 2 mm above the apical break. The mediodorsal groove gradually becomes shallower and shallower adapically but remains at the same width until the point of its disappearance in guard 59007 (Pl. XI, fig. 5C). The same is true in stem fragment 59009 (Pl. XI, fig. 8C) which clearly exhibits the tip of the mediodorsal groove.

The oral cross-section of guard 59007 (Pl. XI, fig. 5E) and both cross-sections of alveolar fragment 59009 (Pl. XI, fig. 7D) reveal the presence of well-developed, quite smooth adventral and addorsal splitting surfaces underlying the corresponding grooves and cutting respectively right through the ventral and dorsal wall of the guard. Neither the adapical extent nor the shape of the bottom of either of the splitting surfaces was actually seen. However, they are believed to be restricted to the oralmost 25 to 30 mm of the preserved parts of the guards studied, for previously explained reasons.

The apical break of alveolar fragment 59009 (Pl. XI, fig. 7D) is situated only 5 to 6 mm above the protoconch. This indicates that the length of the alveolus did not exceed one-seventh to one-eighth of the estimated complete length of the guard. No data are available about any other internal features of *Conodicoelites* sp. aff. *C. meyrati* as no specimens could be spared for sectioning or splitting.

Remarks. At present the writer is unable to suggest any taxonomically significant morphologic distinctions of *Conodicoelites* sp. aff. *C. meyrati* from material of this lower Callovian European species described and figured by Pugaczewska (1961, pp. 184-8, pl. 24, figs. 1-4), Stevens (1965a, p. 615) and in this paper (Pl. IX, figs. 1A-1E). However, he doubts that the two forms are actually conspecific because of the much older age of the beds which yielded the Canadian form. This feeling is reflected in the open nomenclature applied to the latter. A definitive naming of the Canadian form must await better-preserved and more complete material.

Stratigraphy and age. The three presumably complementary fragments 59009, 59010, and 59011 found at GSC loc. 90963 were collected by T.A. Richards in rocks of the Haselton Group, Haselton map-area, NTS - E½, northwestern British Columbia, on Driftwood River; Lat. 55°58.2'N; Long. 126°53.0'W. These fragments of *Conodicoelites* sp. aff. *C. meyrati* are associated with ammonites tentatively identified as *Uptonia* sp. or *Dayiceras* sp. (poorly preserved) and a pelecypod, *Weyla* sp. The ammonites were determined by Hans Frebold and assigned a general early Pliensbachian age. However, these ammonites apparently were mixed up with the belemnites either in the field or in the laboratory as the rocks which yielded collection 90963 appear to be of a general Toarcian age on the basis of lithology and stratigraphic position (H.W. Tipper, pers. comm. 15/XII, 1975).

Guard 59007 was collected by E.W. Grove, in the Iskut-Bowser area, northwestern British Columbia, approx. Lat. 56°44'00"N; Long. 130°35'30"W, from undifferentiated Jurassic rocks. According to Hans Frebold (unpublished intradepartmental report) this specimen of *Conodicoelites* sp. aff. *C. meyrati* is associated with: "Imprints and flattened specimens of Hildoceratаceae in shale. Some specimens somewhat similar to *Haugia* and related genera but no safe identification of genus can be made. Better material requested. Age is probably Toarcian".

Genus *Lenobelus* Gustomessov 1966 emend. Saks 1967

Synonymy

1961 *Dicoelites* (in part) Saks, p. 77
1966 *Lenobelus* (in part) Gustomessov, p. 84
1967a *Lenobelus* Saks in Saks and Nalniaeva, p. 440
1967b *Lenobelus* Saks in Saks and Nalniaeva, p. 20
1975 *Lenobelus* Saks in Saks and Nalniaeva, p. 83, p. 117

Type species. *Lenobelus lenensis* Gustomessov, 1966.

Diagnosis. Strongly elongated, fusiform to mace-like guards which are mostly compressed but may be equidimensional or even depressed in cross-section. A deep mediodorsal alveolar groove occurs on the oral part of the guard. This groove is mostly underlain by a splitting surface and so is a true alveolar canal. A medioventral groove beginning in the adapical part of the guard may either be restricted there or extend over the whole length of the guard. This groove, which is not underlain by a splitting surface, may be almost absent or only sporadically present in some extreme representatives. The flanks are ornamented by paired furrows which diverge somewhat toward the posterior part of the guard and disappear in the apical region.

The apex of the alveolus and the apical line are nearer to the ventral side of the guard. The earliest visible juvenile guards are relatively short, with either an elongate cone or subcylinder shape.

Remarks. As shown in the above diagnosis, the writer essentially follows Saks (in Saks and Nalniaeva, 1975, p. 83) in his interpretation of the morphology and delimitation of *Lenobelus*. However, the morphology of some Canadian representatives of the genus indicates that the genera *Lenobelus* s. str. and *Pseudodicoelites* Saks are connected by transitional forms and are very closely related. In particular, such a cardinal morphologic character of *Lenobelus* s. str. as the medioventral apical groove appears to be an extremely variable feature. This is well illustrated by *Lenobelus aberrans* sp. nov.

from lower Bajocian (=Aalenian) rocks of the Canadian Arctic Archipelago (see p. 21-25). In this species the medioventral apical groove is rather irregularly shaped, morphologically variable and, generally speaking, very short. Furthermore, this *Lenobelus*-like groove is absent in some 50 per cent of the specimens studied and is only faintly suggested in some of the specimens where it is present. The shape and proportions of the guard of *L. aberrans* sp. nov. do not support its placement in *Lenobelus* s. str. in preference to *Pseudodicoelites* Saks 1967. The writer finally assigned this morphologically transitional species to *Lenobelus* s. str. because of the absence of a well-developed throughgoing splitting surface underneath its mediodorsal alveolar groove.

The above evidence puts in doubt the validity of the separation of *Pseudodicoelites* and *Lenobelus* s. str. as full genera proposed by Saks (1967a, p. 440). However, the infraspecific variability of the oldest known representatives of these two genera (i.e. *Lenobelus lenensis* Gustomessov and *Pseudodicoelites primoris* Saks) must be determined from large collections before any definitive decision about their status can be made.

Lenobelus plauchuti sp. nov.

Pl. XII, Figs. 1-3

Holotype. GSC Cat. No. 59013 (Pl. XII, figs. 1A-1D).

Derivation of name. Named for B.P. Plauchut, former chief geologist of Elf Oil Canada Ltd. in recognition of his contribution to the geology of the Canadian Arctic. All available material of *Lenobelus plauchuti* sp. nov. was collected by geologists of Elf Oil Canada Ltd.

Material. Two fragmentary guards (including the holotype) and two readily identifiable fragments of the apical region from GSC loc. 72654.

Diagnosis. Moderately slender *Lenobelus* with markedly depressed cross-section of the postalveolar part of the guard. Medioventral groove begins at the apex and is restricted to the postalveolar part of the guard; it is strongly widened in the middle part.

Description. Guard medium-sized (the preserved length of the holotype, which is largest specimen known, is about 65.5 mm) and moderately slender (coefficient of elongation of the preserved postalveolar part of the holotype is about 6.5 but it probably would approach 8 in guards with the alveolar part preserved). The stem region is subcylindrical to faintly subfusiform in lateral and dorso-ventral aspects in all available growth-stages (compare Pl. XII, figs. 1A-1C with Pl. XII, figs. 2A-2C). The apical region comprises about one-third of the preserved postalveolar part of the guard (it is about 24 mm long in the holotype) and tapers gradually and approximately evenly to a point, producing straight to feebly convex outlines of this region. The apical region is moderately long, straight and attenuated in the holotype (Pl. XII, figs. 1A-1C). However, it is moderately short and tapers increasingly towards the apex in the only juvenile specimen available (Pl. XII; figs. 2A-2C). This results in feebly convex lateral and dorso-ventral outlines of the apical region and a distinctly shortened, somewhat obtuse apex in this specimen (59014). The apical region of the third figured, apparently halfgrown specimen (59015; see Pl. XII; figs. 3A-3C) is morphologically transitional between the other two. The above variation of the shape of the apical region apparently reflects its ontogenetic changes. However, this suggestion needs confirmation through study of a larger population sample.

The cross-section of the guard is markedly depressed throughout the preserved postalveolar parts of all four guards studied. In the holotype the diameters at the alveolar end are: 1) Dorso-ventral diameter 10.3 mm; and 2) Lateral diameter 11.7 mm. This produces a coefficient of depression of 0.88. The diameters at the beginning of the apical region (i.e. 24 mm above apex) are: 1) Dorso-ventral diameter - 9.5 mm; and 2) Lateral diameter 10.6 mm. The resulting coefficient of depression is 0.90. The diameters at the alveolar end of the juvenile guard 59014 are: 1) Dorso-ventral diameter - 4.7 mm; and 2) Lateral diameter - 5.7 mm. The resulting coefficient of depression is 0.82. The diameters at the beginning of the apical region of the same specimen (i.e. about 8 mm above apex) are: 1) Dorso-ventral diameter - 4.5 mm; and 2) Lateral diameter - 5.0 mm with a resulting coefficient of depression of 0.90. Finally, the diameters at the alveolar end of the presumably halfgrown specimen 59015 are: 1) Dorso-ventral diameter - 7.7 mm; and 2) Lateral diameter - 9.7 mm with a resulting coefficient of depression of 0.79.

The surface of all specimens studied is too poorly preserved to show the pattern of lateral longitudinal depressions and double lateral lines. Two or three very faint apical longitudinal striae not exceeding 3 mm in length occur on the flanks of the apex of the holotype.

The medioventral apical groove begins at the apex in all specimens. It is narrow and deep in apicalmost 5 to 12 mm and then begins to widen gradually adorally to a level in the middle of the preserved postalveolar part of the guard. The cross-section of the groove thus changes from that of a deep fissure near the apex to that of a broad V in the middle of the postalveolar part of the guard. Farther adorally the medioventral groove narrows gradually until it changes again into a deep fissure and then ends closely before the broken oral end of the preserved postalveolar part of the guard. The complete length of the medioventral groove is preserved in the holotype only (see Pl. XII, fig. 1A). The sloping walls of the widened middle part of the medioventral groove expose the edges of the concentric growth layers. This suggests that its widening is a postmortal phenomenon caused by poor calcification of those parts of the guards adjacent to the middle part of the groove. So far as it is possible to see, this groove is not accompanied either by marked inward bends of the growth layers of the guard or by a splitting surface. It is therefore an apical groove rather than a canal in terms of the terminology used in this report.

The mediodorsal alveolar canal is a deep, V-shaped (in cross-section) groove which begins at the broken off alveolar end in all three guards figured (Pl. XII, figs. 1C, 2C, 3C). This groove appears to be restricted to the anterior half of the complete guards as it occurs only in the oralmost few mm of their preserved postalveolar parts. It shallows rapidly and then disappears in the apicalmost few mm of its preserved length. This groove is a true mediodorsal alveolar canal as the growth layers are markedly bent inward underneath it and it is accompanied by a well-developed splitting surface except in the apicalmost few mm.

The cross-section of the preserved postalveolar part of the guard has a rounded-trapezoidal shape with its maximum lateral diameter situated close to the strongly flattened ventral surface. The dorsal surface is likewise strongly flattened throughout while the flanks are fairly regularly rounded.

The dorso-ventral (Pl. XII, figs. 1A, 1C, 2A, 2C, 3A, 3C) and lateral (Pl. XII, figs. 1B, 2B, 3B) outlines of the stem region are roughly symmetrical. However, the apical region is slightly (in the holotype; Pl. XII, fig. 1B) to distinctly (in the other two figured specimens; Pl. XII, figs. 2B, 3B) asymmetrical in lateral aspect as its ventral side is slightly to distinctly more convex than the dorsal side and its apex is correspondingly displaced addorsally.

The apical line is distinctly (in the holotype) to pronouncedly (in the other two figured specimens) displaced adventrally. In the holotype the ventral radius is 4.1 mm while the dorsal radius is 6.2 mm. In the juvenile specimen 59014, the ventral radius is 1.5 mm while the dorsal radius is 3.2 mm. Finally, in the halfgrown specimen, 59015, the ventral radius is 2.1 mm while the dorsal radius is 5.6 mm. The displacement of the apical line fluctuates therefore from 27.3 to 39.9 per cent. As the farther adapically situated cross-sections of the guards 59014 and 59015 are characterized by a greater adventral displacement of the apical line than the more adorally situated cross-section of the guard 59013, this displacement probably increases markedly adapically.

Nothing is known about the morphology of the alveolar part of the guard of *Lenobelus plauchuti* sp. nov. It was not possible to observe its ontogeny in a thin-section because not enough material was available.

Stratigraphy and age. All four guards of *Lenobelus plauchuti* sp. nov. were collected (apparently lying loose on the surface, judging by their preservation) at GSC loc. 72654 in the Lower Bajocian (=Aalenian) beds of the Wilkie Point Formation in Section #65-PK-IV of Elf Oil Canada Ltd. The section is situated at the top of Wilkie Point, Prince Patrick Island, District of Franklin, N.W.T. The only other belemnite found at this locality is *Pachyteuthis* sp. nov.

The Lower Bajocian (=Aalenian) age of the beds concerned is indicated by the association of *Lenobelus plauchuti* sp. nov. with *Leioceras opalinum* (Reinecke) and *Oxytoma jacksoni Pompeckj* identified and dated by Hans Frebold (unpublished external report J4-1966-HF).

Comparison. In spite of the small number of specimens available and their invariable fragmentary preservation, *Lenobelus plauchuti* sp. nov. can be confidently recognized as a new species, which can be easily distinguished from any other hitherto described *Lenobelus* species.

Lenobelus sibiricus (Saks, 1961; see p. 85-87, Pl. 1, figs. 9-14) differs strongly in the distinctly subfusiform shape of its guard in lateral and dorso-ventral aspects, its feebly compressed cross-section and its possession of double dorso-lateral and double ventro-lateral grooves at the apex.

Lenobelus minaevae (Saks, 1961 nomen nudum) Gustomessov (1966, p. 65, Pl. VI, fig. 6; Pl. VII, fig. 13) differs in possessing a much more slender, distinctly subfusiform shape of the guard and restriction of the medioventral groove to the adapical part of the guard.

Lenobelus lenensis Gustomessov (1966, p. 66-67, Pl. VI, figs. 2-3; Pl. VII, fig. 12) has an extremely slender, pronouncedly fusiform guard which is compressed in its expanded, posterior part.

Lenobelus gravis Gustomessov (1966, p. 67-68, Pl. VI, figs. 4-5; Pl. VII, fig. 11) differs in having a markedly subfusiform shape of the guard, a compressed to equidimensional cross-section of the guard, a somewhat flattened appearance of the flanks, and lacking a mediodorsal alveolar canal. This species was recently transferred to *Holocobelus* by Saks (in Saks and Nalniaeva, 1975, p. 74, 75, Pl. XVIII, figs. 5, 6) and is of doubtful generic affinity, in the writer's opinion.

Lenobelus reconditus Gustomessov (1966, p. 68, Pl. VI, fig. 7; Pl. VII, fig. 15), which closely resembles *L. plauchuti* in the general shape of the adult guard, differs in having an approximately equidimensional cross-section at all growth stages and a pronouncedly subfusiform shape of its juvenile guard.

Lenobelus vagt Saks, 1961 (p. 86) was originally nomen nudum as Saks (ibid) neither designated a holotype nor provided any reference to a figured specimen. However, the subsequent description and figures provided by Saks (in Saks and Nalniaeva, 1975, p. 91-93, Pl. XV, fig. 4-7) demonstrate that *L. vagt* is an even more pronouncedly subfusiform species than *L. minaevae* (Saks). It is neither conspecific with nor closely allied to *L. plauchuti* sp. nov.

Lenobelus viligaensis (Saks, 1961) resembles *L. plauchuti* sp. nov. in the shape of its guard and the appearance of its medioventral groove. However, it is a much more slender form with a much more strongly depressed cross-section (see Saks in Saks and Nalniaeva, 1975, Pl. XIII, figs. 1-4) and thus specifically distinct from the Canadian species.

Lenobelus aberrans sp. nov.

Pl. XIII, figs. 1-4, ?Pl. XV, figs. 7, 8

Synonymy

1966 *Hibolithes*, Jeletzky, p. 162, Addendum (in part).

Holotype. GSC Cat. No. 59025 (Pl. XIII, figs. 4A-4I).

Derivation of name. To point out the aberrant morphology of this species which combines features characteristic of *Lenobelus* with those hitherto believed to be characteristic of *Pseudodicoelites*.

Diagnosis. Guard feebly to markedly subfusiform, moderately elongate (coefficient of elongation 7 to 8) and consequently moderately slender. Calcification is imperfect in the alveolar and apical regions which results in common partial exfoliation, irregular postmortem deformation and even partial destruction of these regions. The strongly developed mediodorsal alveolar groove is restricted to the anterior half of the guard and comprises rather less than one-half of its length. The groove widens and shallows markedly on the oralmost parts of small to medium-sized, presumably half-grown guards but is narrow and deep throughout in large, presumably adult guards. The medioventral alveolar groove is distinguishable in some specimens only where it is restricted to the alveolar part of the guard and may be only suggested by preferential exfoliation of the outermost layers in the median zone. A short medioventral apical furrow is also present in some specimens only where it is deep and restricted to the apicalmost few mm of the ventral face. A variable number of finer, shorter furrows may occur on the lateral and dorsal faces of the apex. The ontogenetic development progresses from a markedly subfusiform, distinctly compressed early growth stages with long and acute apical regions to feebly subfusiform, but slightly compressed to circular, forms with short, moderately obtuse apical regions.

Material. Four well-preserved partial to almost complete guards, from GSC loc. 70053. Two fragments consisting of the alveolar one-half to ?three-fifths of the guard, from GSC loc. 91272.

Description. The guard is medium-sized (i.e. almost complete guards are 50-70 mm long) to moderately large (the largest specimen known has an estimated length of 105 mm of which 95 mm are preserved; Pl. XIII, figs. 4A-4D). The guard is slightly (Pl. XIII, figs. 1A-1D, 4A-4D) to distinctly (Pl. XIII, figs. 2A-2D, 3A-3D) subfusiform in lateral and dorso-ventral aspects. This subfusiform shape is, as a rule, more strongly expressed in lateral than in dorso-ventral aspect because of a characteristic compressed cross-section in most specimens. The guard is moderately elongate with an estimated coefficient of elongation ranging from 7 (e.g. in specimen 59025) to 8 (e.g. in specimen 59024).

The guard contracts faintly adapically from the alveolar rim to a level close to the apex of the alveolus in the most slender representatives (Pl. XIII, figs. 2A-2D, 3A-3D). Then it begins to expand adapically. The resulting "waist" coincides approximately with the boundary between the alveolar and stem regions. More sturdily-built representatives (Pl. XIII, figs. 1A-1D, 4A-4D), including the holotype, lack this alveolar contraction and "waist". Below the "waist", the slender guards expand slightly to markedly and approximately evenly to the level of maximum dorso-ventral and lateral diameters at or near the boundary between the middle and apical thirds of the guard's length. The sturdy guards expand slightly and evenly all the way from the oral rim to the level of maximum diameters. Adapically from the level of maximum diameters the apical region is characterized by either a fairly even (Pl. XIII, figs. 3A-3D) or a gradually but distinctly increasing (Pl. XIII, figs. 4A-4D) adapical contraction which continues all the way to an imperfectly preserved, moderately acute to moderately obtuse apex. Depending whether the contraction is even or gradually increasing, the flanks of the apical region are either fairly straight or feebly convex. As in the alveolar and stem regions, the adapical contraction of the apical region is more strongly expressed in lateral than in dorso-ventral aspect (e.g. Pl. XIII, figs. 2A-2D). The lateral apical angle varies from about 27 to 35 degrees in the material studied. The dorso-ventral apical angle varies from about 22 to 33 degrees. Small to medium-sized guards (e.g. Pl. XIII, figs. 2, 3) are characterized by a more elongate, moderately acute shape of the apex whereas the large guards are characterized by a shorter, moderately obtuse shape (e.g. Pl. XIII, figs. 1, 4). These morphologic changes are probably ontogenetic in character. This conclusion is supported by the fact that the early growth stages of the guard seen in a polished longitudinal section of an adult guard (Pl. XIII, fig. 1D) are characterized by an even longer and more acute shape of the apex (see section on internal morphology). The outline of the guard is symmetrical in lateral and dorso-ventral aspects and the apex is approximately central. Because of imperfect calcification of the apex, a 1 to 2 mm diameter hole occurs here in all specimens studied (Pl. XIII, fig. 3F).

The undeformed cross-section of the alveolar part of the guard has a distinctly rounded-square shape and is slightly compressed to equidimensional in all small to medium-sized guards (Pl. XIII, figs. 2E, 3F). In contrast, the alveolar cross-section of all large, presumably adult guards is almost regularly rounded and slightly compressed to equidimensional (Pl. XIII, figs. 1E, 4E). Because of the presence of a wide and shallow mediodorsal alveolar groove the cross-section has a hoof-like shape. The shape of the alveolar cross-section is commonly distorted (especially in the oralmost part) because of defective calcification of this part of the guard (e.g. Pl. XIII, fig. 3E). The cross-section of the postalveolar part of the guard varies from a markedly compressed, rounded-rectangular shape in specimen 59023 (see Pl. XIII, fig. 2F) to regularly rounded and equidimensional shape in specimen 59025 (see Pl. XIII, fig. 4I). Some other specimens (e.g. 59024; see Pl. XIII, fig. 3F) combine a rounded-rectangular shape and equidimensional proportions of the postalveolar cross-section. Generally speaking, the largest guards tend to have a more nearly rounded and equidimensional postalveolar cross-section.

The dorsal face of all specimens bears a strong mediodorsal alveolar groove which begins at the alveolar rim and extends adapically almost to the middle of the guard. This groove does not extend onto the posterior half of the dorsal face in the material studied. The mediodorsal alveolar groove is more shallow and wide in all small to medium-sized guards studied. In these guards it becomes gradually more and more shallow and at the same time wider and wider adorally (e.g. the specimens 59023 and 59024). In guard 59024, for example, the groove is about 2 mm wide, about 1 mm deep, and broadly V-shaped at its apical end but becomes 3 to 3.5 mm wide but less than 1 mm deep at the oral end just below a broad triangular embayment of the oral rim caused by imperfect calcification and subsequent destruction of the middle zone of the adoral part of the ventral face of the guard (Pl. XIII, fig. 3A). The small, presumably halfgrown guard 59023 (see Pl. XIII, fig. 2A) exhibits a similar development of its mediodorsal alveolar groove. All large, presumably adult guards are characterized by a deep and narrow, mostly slit-like mediodorsal alveolar groove throughout their length (see Pl. XIII, figs. 1A, 4A). However, both adult and halfgrown guards lack the oralmost 15 to 20 mm (estimated) of the alveolar part, as exemplified by the specimen 59024. The groove may therefore become more shallow and wider in this missing interval. A more detailed interpretation of these presumably ontogenetic morphologic changes in the mediodorsal alveolar groove is attempted below in the description of the internal morphology of the guard.

The ventral face of the guard is mostly ornamented by a short medioventral alveolar groove. Whenever present, this narrow, slightly impressed and ill-defined groove begins at the alveolar rim (none of the specimens bearing it is complete or nearly complete in its alveolar part). It only extends adapically a few mm beyond the apex of the alveolus before merging imperceptibly into the regularly rounded ventral face of the guard (Pl. XIII, figs. 1C, 4D). Truncated edges of the one to three outermost layers of the guard may be exposed in the flanks of the most strongly developed examples of this medioventral alveolar groove (Pl. XIII, fig. 1C). This suggests a pre-existing weakness (probably an incomplete calcification) of these layers around the groove. The medioventral alveolar groove is completely absent in some well-preserved, almost complete guards (e.g. 59023; see Pl. XIII, fig. 2D). In other equally well-preserved guards (e.g. 59024; see Pl. XIII, fig. 3D) it is barely indicated by an exfoliation of the outermost growth layers in the median zone of the ventral face of the guard.

The adapical part of the ventral face of holotype 59025 (Pl. XIII, fig. 4D) and two topotypes (#59022 and 59023; see Pl. XIII, figs. 1C, 2D) is ornamented by a short, medioventral apical furrow. This furrow, 16 to 18 mm long, begins at the apex. In the holotype and topotype 59022 it is narrow (1 to 1.5 mm wide), deep and well delimited in its apicalmost 6 to 10 mm. Farther adorally this incised, U-shaped furrow rapidly becomes poorly delimited and slightly impressed into the guard's surface. In guard 59023 the furrow is slightly impressed and ill delimited throughout its length. No trace of this furrow was observed in guard 59024 despite good preservation of the adapical part of its ventral face. The adapical part of the ventral face of the holotype (see Pl. XIII, fig. 4D) bears an additional, apparently pathological, furrow close to the right of the slightly impressed, adoral part of the medioventral apical furrow. This distinctly asymmetrically situated longitudinal furrow resembles the adapical, incised part of the medioventral apical furrow in its width, depth and delimitation. No similar furrows were observed in the other guards.

The lateral and dorsal faces of the apical region of the holotype exhibit several short and fine to very fine longitudinal apical furrows up to 13 mm long and less than 0.2 mm wide. These somewhat irregularly shaped furrows are mostly concentrated on the dorsal and ventral faces of the guard (Pl. XIII, fig. 4A, 4D). They are interpreted to be a coarsened version of the adapical longitudinal striae commonly surrounding the apex of various Hastitidae forms. However, because of their somewhat irregular appearance and distribution, these furrows may be either a result of the imperfect calcification of the apical region of the guard characteristic of *L. aberrans* or represent a pathological feature. Of the other guards whose apex is preserved, only 59023 (see Pl. XIII, fig. 2A) exhibits somewhat similar apical furrows on the dorsal face of the apical region. However, these 3 to 5 mm long supplementary furrows do not reach the apex but end blindly at both ends.

The flanks of all better preserved guards are ornamented by what appear to be triple lateral longitudinal grooves of the type described by Gustomessov (1962, p. 33 etc., Figs. 1, 2; Tables 1-2) in the Cylindroteuthididae, Oxyteuthididae and Belemnitidae (=Passaloteuthidae of Gustomessov, 1962). Most of the specimens studied exhibit clearly only two (the adventral and addorsal) of these lateral longitudinal grooves of which one occurs in a ventro-lateral and the other in a dorso-lateral position (see Pl. XIII, figs. 2C, 3C). However, this pattern, already observed by Gustomessov (1966, p. 84) in other *Lenobelus* forms, appears to be simulated only by a feeble development of the median lateral groove which is commonly destroyed by weathering. The better preserved flanks of guard #59023 (Pl. XIII, figs. 2B, 2C) clearly exhibit all three longitudinal lateral grooves, at least on their postalveolar parts. In this guard the adventral groove definitely consists of double lateral lines, which appear to persist adapically all the way from the alveolar region to near the apex. These relationships are best seen on the right flank of the guard where the component double lateral lines of the adventral groove are particularly clearly visible in the interval 8 to 18 mm from the apex (Pl. XIII, fig. 2B). Although less well-preserved, the double lateral lines are still faintly visible in the same interval of the left flank (Pl. XIII, fig. 2C). The presence of these double lateral lines on the sides of the flanks farthest from the face bearing the median alveolar groove confirms the interpretation that this is the mediodorsal alveolar groove (see above). All three lateral grooves appear to extend throughout the length of the flanks in guard #59023, even though they are only faintly indicated within the alveolar region which is more strongly weathered. The grooves are only slightly impressed in the guard's surface. Their width fluctuates between 1 and 2 mm. The adventral groove appears to be rather wider than the other two. It is 1.5 to 2.0 mm wide on the right flank (Pl. XIII, fig. 2B). The adventral groove forms a slight adventrally convex curve in the stem and apical regions, conforming closely to the ventral outline of the guard. The median and addorsal grooves appear to maintain a fairly straight course throughout their extent. So far as it is possible to judge, the same is true of the adventral and addorsal lateral grooves on the flanks of the other guards studied. No longitudinal striation, granulation or other sculpture, other than the above elements, was observed on any of the guards.

The undeformed alveolus has a regularly rounded, approximately equidimensional cross-section at all exposed levels (Pl. XIII, figs. 2E, 4E, 4G, 4F). The exceptions have been distorted posthumously because of imperfect calcification of alveolar walls (Pl. XIII, fig. 3E).

The alveolus is rather shallow. The only sectioned guard 59022 (Pl. XIII, fig. 1D), presents an estimated one third of a complete alveolus. According to this estimate, the complete alveolus comprised one-sixth to one-seventh of the length of the complete guard. The alveolus is distinctly asymmetric, its ventral wall being much more steeply inclined than the dorsal wall. It is markedly displaced adventrally, the ventral radius at the apex being 3.9 mm compared with the corresponding dorsal radius of 6.6 mm. This results in the coefficient of its adventral displacement of 1.7. The apical angle is 20 to 21 degrees (measured dorso-ventrally; see Pl. XIII, fig. 1D). The apical line is markedly adventrally displaced through most of its length and its outline is feebly adventrally convex (Pl. XIII, figs. 1D, 4I). Generally speaking, the course of the apical line parallels that of the ventral surface of the postalveolar part of the guard and the ratio of adventral displacement is similar to that occurring at the apex of the alveolus. However, the line moves addorsally within the apicalmost few mm of its length and becomes subcentral at the apex.

The phragmocone is not preserved in the specimen sectioned. The shape of the protoconch was not observed because of an accidental over-grinding of the polished plate prepared from this specimen. The alveolus is well calcified throughout and no trace of a pseudoalveolus was seen.

The earliest growth stages of the guard up to a length of 28 mm are indistinct but seem to conform closely to the subsequent late juvenile growth stages (described below) in shape and proportions. These earliest growth stages are badly obscured by extensive post-mortal recrystallization of the innermost parts of the guard, which produced the typical, fusiform-shaped "Spitzenkegel" of Christensen (1925, p. 127-130, Pl. VI, fig. 1; Figs. 6-7) The earliest clearly visible juvenile guard differs from adult guard 59022 in a more slender and elongate, distinctly more subfusiform dorso-ventral outline, a considerably longer, more acute apical region, and a subcentral (only slightly adventrally displaced) position of the apical line (Pl. XIII, fig. 1D). The dorso-ventral apical angle of this guard is only 17 to 18 degrees. A well-defined, late juvenile guard about 43 mm long has a maximum dorso-ventral diameter of 4.7 mm with a coefficient of elongation of about 9. The alveolus (complete) of this juvenile guard is about 5.5 mm deep and comprises slightly more than one-eighth of its complete length. This *Hibolithes*-like shape of the juvenile guard is retained essentially unchanged until the guard reaches an estimated length of 75 to 80 mm. The position of the apical line within the guard changes rapidly within the same interval. This was probably because the guard grew more slowly on the ventral side compared with the dorsal side. The apical line becomes progressively more and more adventrally displaced until it reaches its adult position at the guard's length of 75 to 80 mm.

When the halfgrown adult guard reaches the estimated length of 75 to 80 mm it matches the adult guard closely in all respects, except for a somewhat more subfusiform dorso-ventral outline and a much longer and more acute (with a dorso-ventral apical angle of 20 to 22 degrees) apical region. Thereafter the apical region becomes rapidly shorter and correspondingly less acute until it is moderately short and moderately obtuse (i.e. like that of adult guards #59022 and #59025) at the estimated complete length of 90 to 95 mm. This ontogeny agrees well with the proportions and shape of the halfgrown guard #59023 which at its preserved (almost complete) length of 74.5 mm matches closely the corresponding growth stage of sectioned guard #59022.

The ontogenetic development of the mediodorsal alveolar groove was observed in transverse cross-sections of the alveolar parts of the guard (e.g. Pl. XIII, figs. 4G, 4F) of all better preserved representatives of *Lenobelus aberrans* sp. nov. The innermost growth layers of the alveolar wall comprising one-quarter to one-fifth of its thickness are not bent inward underneath the mediodorsal alveolar groove. The adjacent outer layers comprising the next one-quarter to one-fifth of the alveolar wall are only slightly and very broadly bent inward. Only the younger layers comprising the remaining one-half to three-fifths of the thickness of the alveolar wall next to the outer surface of the guard are deeply and narrowly bent inward. The depth of these U-shaped bends increases progressively towards the outside of the guard. These ontogenetic changes are responsible for the previously discussed (see under external morphology) progressive increase in depth and decrease in width of the mediodorsal alveolar groove during the growth of the guard until it becomes narrow and deep, V-shaped to slit-like in cross-section in the largest-known, presumably adult representatives of the species (Pl. XIII, fig. 4G). Another result of these ontogenetic changes is the absence of a well-developed splitting surface in *Lenobelus aberrans* sp. nov. Only the deeply and narrowly inward bent outer layers may be associated with an ill-defined (or incipient), rough splitting surface extending adapically beyond the apex of the alveolus and widening inward in this direction. However, this incipient splitting surface does not "cut through" the shallow and broadly bent inner layers of the alveolar wall but ends blindly against them (Pl. XIII, fig. 4G). When the guard is split, an entirely irregularly shaped breaking surface, which contrasts with the splitting surface, forms within the interval of the alveolar wall corresponding to these inner growth layers. This interval separates the above described incipient splitting surface from the alveolar wall.

The above incipient dorsal splitting surface of *L. aberrans* sp. nov. appears to be very similar to the less well-known dorsal splitting surface of *L. plauchuti* sp. nov. (see there).

The previously described (see under external morphology), broad and shallow, adorally broadened and flattened mediodorsal alveolar groove of small- to medium-sized (presumably one-half to three-quarters grown) representatives of *L. aberrans* and its contrast with the narrow and deep, V-shaped to slit-like (*Pseudodicoelites*-like) appearance of this groove in all the largest (presumably adult) representatives of the species is evidently caused by the above ontogenetic changes of the inward bends of the guard layers beneath the groove.

Stratigraphy and age. The four guards of *Lenobelus aberrans* sp. nov. found at GSC loc. 70053 were collected by geologists of Triad Oil Co. Ltd., in the Wilkie Point Formation on Melville Island, N.W.T., approx. Lat. 76°6 1/2'N; Long. 112°56 1/2'W. These guards were found in association with *Leioceras opalinum* (Reinecke), identified by Hans Frebold, and, on this basis, are regarded as being of early Bajocian (=Aalenian) age. Two more fragmentary guards were collected by D. Campbell of J.C. Sproule and Associates Ltd., Calgary, Alberta, in the Wilkie Point Formation, at an unspecified point on Prince Patrick Island, GSC loc. 91272. They are associated with small ammonites referable to *Leioceras opalinum* Reinecke of the early Bajocian (=Aalenian) age according to Hans Frebold (see unpublished intradepartmental fossil report J-15-1974-HF).

A couple of fragments of *Lenobelus* apparently belonging to *L. aberrans* sp. nov. (GSC Nos. 59032 and 59033) were found by Cairnes (1906) in the southern Yukon (Lake Labarge area) on the Toric Mountains 11.2 km (7 miles) west of Robinson. These fragments found at GSC loc. 83477 in the same piece of rock, presumably belong to the same specimen (Pl. XV, figs. 7, 8). No information is available about their stratigraphic source and age. However, their association with *Myophorella* ex gr. *dawsoni* (Whiteaves) identified by T.P. Poulton (personal communication in 1974) indicate a general Bajocian age and derivation from some part of the Labarge Group. The palaeogeographic significance of these fragments is discussed below (see p. 37).

Remarks. As indicated by its specific name, *Lenobelus aberrans* sp. nov. is a peculiar form, which is not easy to fit into the presently used concept of *Lenobelus* (Saks, in Saks and Nalniaeva, 1967b, p. 17, 20, 21). The species combines such typical *Lenobelus* features as the presence of a medioventral apical furrow, with other features which were hitherto believed to be restricted to *Pseudodicoelites*. The latter features include the presence of a long and deep, mediodorsal alveolar groove accompanied by an imperfectly developed (incipient) dorsal splitting surface, which extends inward only part of the way to the alveolar wall. To complicate matters further, the medioventral apical furrow is not a constant morphologic feature in *L. aberrans* sp. nov. It is completely absent in some of the guards which are otherwise typical of the species. However, the species was assigned to *Lenobelus* because of the presence of the medioventral apical furrow and the imperfect development of the dorsal splitting surface (see under the generic description of *Lenobelus* for further details).

Lenobelus aberrans sp. nov. differs from its closest relative and possible ancestor *L. minaevae* (Saks 1961, nomen nudum) Gustomessov 1966 in possessing a much less elongate, sturdier and less subfusiform guard (see Gustomessov, 1966, Pl. VI, fig. 6). Judging by the comments of Saks (in Saks and Nalniaeva, 1967b, p. 20, and 1975, p. 94, 95) and from the morphologic appearance of the figured specimens (Gustomessov, 1966, Pl. VI, fig. 6a; Saks in Saks and Nalniaeva, 1975, Pl. XV, figs. 1, 2), the medioventral apical furrow of *L. minaevae* is longer than that of *L. aberrans*, begins a few mm above the apex (instead of at the apex) and is a constant morphologic feature of the species.

Although specifically distinct, *L. minaevae* and *L. aberrans* are so closely similar to each other in the strongly elongate, subfusiform shape of the guard, length of the mediodorsal alveolar groove, obtuse appearance of the apex, etc., that it seems reasonable to interpret the Lower Bajocian (=Aalenian) *L. aberrans* sp. nov. as an immediate descendant of the Toarcian *L. minaevae*. If so, the evolution of this lineage of *Lenobelus* with its slender and subfusiform shape proceeded convergently toward forms resembling *Pseudodicoelites* ex gr. *bidgievi-hibolitoides*.

Lenobelus lenensis Gustomessov (1966, p. 66-67, Pl. VI, figs. 2, 3, Pl. VII, fig. 12), *L. gravis* Gustomessov (1966, p. 67, 68, Pl. VI, figs. 4, 5, Pl. VII, fig. 11), *L. reconditus* Gustomessov (1966, p. 68, Pl. VI, fig. 7, Pl. VII, fig. 15), *Lenobelus viligaensis* (Saks, in Saks and Nalniaeva, 1975, Pl. XIII, figs. 1a, 2a, 3a) and *L. plauchuti* sp. nov. differ strongly from *L. aberrans* in the presence of a long, medioventral apical furrow, which extends over most or all of the postalveolar part of the guard. *Lenobelus viligaensis* (Saks) (Saks in Saks and Nalniaeva, 1975, Pl. XIII, figs. 4a, 4b) and *L. plauchuti* sp. nov. differ also in the markedly depressed cross-section of the guard. *L. lenensis, L. reconditus* and *L. gravis* are reported to lack a dorsal splitting surface. All five above species appear either to lack a mediodorsal alveolar groove (*L. gravis* was transferred to *Holcobelus* by Saks (in Saks and Nalniaeva, 1975, p. 74, Pl. XVIII, figs. 5, 6) for that reason) or to have a mediodorsal alveolar groove which is shorter (not longer than one-third of the guard's length) than that of *L. aberrans*. However, only post-alveolar parts of the guard are known for all five species concerned and this distinction may be more apparent than real.

Pseudodicoelites Saks 1967
(in Saks and Nalniaeva, 1967a, p. 440)

1961 *Dicoelites* (in part) Saks, p. 84
1966 *Lenobelus* (in part) Gustomessov, p. 84
1967a *Pseudodicoelites* Saks (in Saks and Nalniaeva, p. 440)
1967b *Pseudodicoelites* Saks (in Saks and Nalniaeva, p. 20)
1975 *Pseudodicoelites* Saks (in Saks and Nalniaeva, p. 96, 117)

Genotype. *Dicoelites bidgievi* Saks 1961.

Diagnosis. *Dicoelites*-like belemnites characterized by the mediodorsal alveolar groove being much deeper and longer than its medioventral counterpart; only the mediodorsal alveolar groove is underlain by the splitting surface; the relatively weaker medioventral alveolar groove is commonly replaced by a slight depression of the adveolar part of the ventral surface of the guard or is absent completely; adapical furrows are absent, as a rule; however, some apical striae may be present and in some species the medioventral part of the apical region may develop a furrow-like appearance when weathered.

Discussion. The more pronounced development of the mediodorsal alveolar groove over its medioventral counterpart or its solitary presence differentiates *Pseudodicoelites* Saks 1967 from *Dicoelites* Boehm 1906 sensu Stevens 1965 and *Conodicoelites* Stevens 1965 nom. nov. (pro *Dicoelites* Stolley 1919 non Boehm 1906). An additional distinction is provided by the restriction of the splitting surface to the mediodorsal alveolar groove.

From *Lenobelus Gustomessov* 1966 emend. Saks 1967. *Pseudodicoelites* differs first of all in the absence of a medioventral groove which either extends the whole length of the guard or is restricted to its apical part only. The much stronger development of the splitting surface beneath the mediodorsal alveolar groove of *Pseudodicoelites* provides a second distinctive feature. However, there are *Lenobelus* forms (e.g. *L. aberrans* sp. nov.) which resemble *Pseudodicoelites* closely in this respect. Saks' (1975, p. 83) idea concerning the diagnostic value of: "a comparatively short, slightly subconical or subcylindrical" shape of the early guards does not seem to be valid at the generic level.

Pseudodicoelites aff. *P. bidgievi* (Saks 1961)
Pl. XIV, figs. 1A-1L

Material. One fragment of the alveolar part of the guard from GSC loc. 72595 containing a much deformed apical part of the phragmocone. A longitudinal, dorso-ventral, median thin-section (Pl. XIV, fig. 1F) was prepared from this fragment after preparation of the plaster cast reproduced in Pl. XIV, figs. 1A-1E.

Description. The only available fragment is about 31.5 mm long. It consists of an almost complete alveolar part and the adoral segment of the postalveolar part of an adult guard. The fragment matches closely the corresponding segment of the sturdy paratype of *Pseudodicoelites bidgievi* (Saks) (see Saks in Saks and Nalniaeva, 1975, Pl. XVI, figs. 2a, 2b, 2v), where most details of its shape, proportions, and sculpture are concerned. This comparison enables us to estimate that the length of the complete Canadian specimen was somewhere between 100 and 110 mm and that the fragment comprises between two-fifths and one-third of the complete guard.

Like *P. bidgievi,* the dorsal side of the Canadian fragment is ornamented by a deep and narrow mediodorsal alveolar groove (Pl. XIV, fig. 1B). This groove, which is narrowly V-shaped in cross-section, extends without any weakening, widening or shallowing to the broken apical and oral ends of the fragment. At the alveolar end of the fragment all layers of the guard are strongly bent inward at both sides of the groove and appear to be interrupted beneath its base. They are more feebly bent inward and do not seem to be interrupted beneath the groove at the apical end of the fragment. This suggests that only the anterior part of the groove, perhaps extending over the length of the alveolus, is underlain by a splitting surface and is a true alveolar canal as defined earlier in this paper (see p. 4).

Again like *P. bidgievi,* the ventral side of the fragment bears a poorly delimited, slightly depressed, rather round-bottomed medioventral alveolar groove. This slight groove is best developed at the broken oral end of the fragment (Pl. XIV, fig. 1A) and becomes rapidly more and more indistinct towards the apex. It disappears at a level 7.5 to 8 mm from the broken apical end of the fragment. Only the few outermost layers of the guard are slightly bent beneath this groove, which is obviously not accompanied by a splitting surface.

The oral cross-section of the fragment (Pl. XIV, fig. 1D) is markedly compressed and elliptical with distinctly flattened flanks. The apical cross-section is only slightly compressed and subcircular. The largest diameter of the apical end is situated within the adventral half of the cross-section producing an egg-shaped outline. The marked flattening of the upper flanks gradually decreases towards the apex and all but disappears at the apical end of the fragment. The apical line is only slightly displaced adventrally.

The fragment contracts gradually and evenly adorally throughout its length in dorsoventral and lateral aspects.

The oral half of the fragment encloses an almost complete alveolus as is shown by the 0.5 mm thickness of its walls at the broken oral end (Pl. XIV, fig. 1F). The apical angle of the alveolus is estimated to be between 20 and 21 degrees in dorsoventral aspect. There is no indication of imperfect calcification of the alveolar part of the guard, including its oralmost preserved part. The latter is built of densely packed, radially arranged crystals of calcite and is not deformed. None of the outer layers of the alveolar part are exfoliating. The walls of the alveolus are normally calcified throughout with no sign of a pseudoalveolus (Pl. XIV, figs. 1F, 1G). The estimated depth and orientation of the alveolus appear to be closely comparable to those of northern Siberian examples of *Pseudodicoelites bidgievi* (see Saks, 1961, p. 84, Figs. 7, 8 and in Saks and Nalniaeva, 1975, p. 97, Fig. 37).

The strongly deformed and badly broken septa (Pl. XIV, figs. 1G-1L) are sufficiently well-preserved to see that their dorsal parts have normal orthochoanitic septal necks indistinguishable from those of Belemnitina and Belemnopseina but utterly dissimilar to those of Duvaliidae. The somewhat better preserved ventral parts of these septa are orthochoanitic in the earliest 7 or 8 septa (see Pl. XIV, figs. 1G, 1H, 1I, 1J). Later they become suborthochoanitic and their connecting rings begin to adhere to the conotheca like those of Hastitidae (e.g. Jeletzky, 1966, Pl. 25, fig. 3), advanced Cylindroteuthididae (e.g. Jeletzky, 1966, Pl. 15, fig. 1A) and all studied Belemnopseidae (e.g. in *Somalibelus somaliensis* (Spath, 1935); see Jeletzky, 1972, Pl. 33, figs. 1b, 1d, 1e) in the interval between 10th and 15th septum. In this respect our phragmocone differs from that of Belemnitidae s. restr. where the connecting rings of the ventral side begin to adhere to the conotheca much later (Jeletzky, 1966, p. 119, Fig. 14). Neither the ventral nor the dorsal necks have any similarity to the double pronged necks of Duvaliidae. The broader taxonomic implications of the Belemnopseidae- and Belemnitina-like (especially Hastitidae-like) structure of the septa of pseudodicoelitid and dicoelitid belemnites have already been discussed in the general taxonomic section of this paper (p. 10-11).

The characteristic large protoconch seems to differ from the spheroidal protoconch of *Pseudodicoelites bidgievi* Saks (1961, Figs. 7, 8) in being almost regularly cup-like (Pl. XIV, fig. 1G). However, this unusual shape appears to have been caused by the apicalward pressure which deformed and broke all its septa during the lithification of the surrounding sediment.

So far as it is possible to see, all camerae of *P.* aff. *P. bidgievi*, including the earliest ones (Pl. XIV, fig. 1H), are devoid of cameral deposits. This suggests that this form, and the genus *Pseudodicoelites* in general, is more closely allied to *Dicoelites* (Pl. IX, figs. 1G-1I and Pl. X, figs. 1A-1E) and Belemnopseidae (Jeletzky, 1966, Pl. 9, fig. 1A; 1972, Pl. 33, fig. 1a; Pl. 34, fig. 1a, Pl. 35, figs. 1a, 1b; Pl. 36, fig. 1a, 1d; Pl. 37, figs. 1a-1d and unpublished), which do not have cameral deposits, than to Hastitidae, which do have them (Jeletzky, 1966, Pl. 25, fig. 3 and unpublished).

Remarks. So far as it is possible to tell, fragment 59026 differs from the more sturdily built representatives of *Pseudodicoelites bidgievi* (Saks) in:

1. The complete calcification of the alveolar part of the guard. Although Saks (1961 and in Saks and Nalniaeva, 1975, p. 97, 98) does not mention this specifically, his photographs and text-figures indicate a pronounced exfoliation of the outer layers of the guard at the alveolar end of *P. bidgievi* and considerable deformation of its alveolar walls (e.g. Saks in Saks and Nalniaeva, 1975, Pl. XVI, fig. 3a, Fig. 37). These features must reflect incomplete calcification of these parts of the guard of *P. bidgievi*.

2. An absence of widening and flattening of the mediodorsal alveolar groove on the alveolar part of the guard, which is characteristic of *P. bidgievi* (compare Saks in Saks and Nalniaeva, 1975, p. 97, Pl. XVI, figs. 1b, 2b, 3a); and

3. A markedly compressed, almost flat-flanked cross-section of the alveolar part of the guard. The cross-section of *P. bidgievi* is, in contrast, approximately equidimensional already at the base of the alveolus (Saks in Saks and Nalniaeva, 1975, Pl. XVI, fig. 3a).

The range of variation in the above morphologic features in *P. bidgievi* cannot be inferred from publications available to the writer. This leaves the taxonomic status of the Canadian fragment in doubt. However, the only fragment of the Canadian relative of *P. bidgievi* is not a suitable holotype for a new species in any case. Therefore, it is designated informally as *Pseudodicoelites* aff. *P. bidgievi* (Saks) pending the discovery of additional, better preserved material.

Stratigraphy and age. The only known representative of *Pseudodicoelites* aff. *P. bidgievi* (Saks) was collected by geologists of Elf Oil Company of Canada Ltd. in 1965 from the Wilkie Point Formation at the top of Wilkie Point, Prince Patrick Island, N.W.T. According to Hans Frebold (unpublished external fossil report J-4-66-HF), the associated fauna includes: *Pseudolioceras* sp., *Leioceras opalinum* (Reinecke) and indeterminate pelecypods. An early Bajocian (=Aalenian) age was assigned to this fauna by Hans Frebold. Other than *Pseudodicoelites* aff. *P. bidgievi* (Saks), the writer was able to identify only *Pachyteuthis?* sp. indet. and *Lenobelus?* sp. indet. among the poorly preserved belemnites of this collection.

The early Bajocian (=Aalenian) age of the fauna of GSC loc. 72595 places the Canadian *Pseudodicoelites* aff. *P. bidgievi* (Saks) in the upper part of the known time range of northern Siberian *Pseudodicoelites bidgievi* (see Saks in Saks and Nalniaeva, 1975, p. 98).

Pseudodicoelites canadensis sp. nov.

Pl. XII, figs. 4-8

Holotype. GSC Cat. No. 59016 reproduced in Pl. XII, figs. 4A-4H.

Derivation of name. From the occurrence of the species in the Canadian Arctic region.

Material. Fourteen readily identifiable but invariably fragmentary and weathered specimens from GSC loc. 72540. One fragmentary and weathered guard from GSC loc. 70381 and one well-preserved but fragmentary guard from GSC loc. 70053.

Diagnosis. *Pseudodicoelites* with a moderately slender, subcylindrical adult guard which combines a slightly depressed, rounded-rectangular cross-section with a short and obtuse, pronouncedly convex-sided apical region. Early and intermediate growth stages are, in contrast, distinctly subfusiform and have a considerably longer, straight-flanked and acute-pointed apical region. The apical line is pronouncedly displaced adventrally and is convex in this direction. Though all better preserved specimens lack a medioventral groove, preferential weathering along the medioventral zone commonly produces secondary, *Lenobelus*-like medioventral apical grooves.

Description. Guard medium-sized, the most nearly complete specimen (the holotype; see Pl. XII, fig. 4) is about 70 mm long. However, the considerably thicker, postalveolar parts of the adult guards occurring in the material (e.g. Pl. XII, figs. 5, 7) indicate that complete adult guards must have exceeded this length. Judging by the holotype and a few other fairly complete examples, *P. canadensis* sp. nov. has a moderately elongate guard with a coefficient of elongation in the order of 7 or 8. The alveolar and stem regions of the adult guard are subcylindrical to exactly cylindrical in lateral and dorso-ventral aspects when not markedly weathered. However, the ventral surfaces of nearly all the guards (e.g. Pl. XII, figs. 4A-4D, 5A-5D, 6A-6D, 7A-7D) are so strongly weathered and exfoliated in the alveolar region (or in the alveolar and apical regions) that they appear to be slightly to distinctly subfusiform in shape.

The alveolar and stem regions of most juvenile and half-grown guards are distinctly subfusiform in lateral and dorso-ventral aspects (Pl. XII, figs. 8A-8D). However, some of the half-grown guards are subcylindrically shaped like the adult guards (Pl. XII, fig. 7F-7H).

The apical region of the adult guard is short and obtuse (it comprises less than one-sixth of the estimated length of the guard) with the apical angle measuring 30 to 45 degrees (in lateral aspect) in the best-preserved specimens. The flanks of the adult apical region have a markedly convex appearance in lateral and dorso-ventral aspects (Pl. XII, figs. 4A-4D, 5A-5D).

The apical region of juvenile and half-grown guards is considerably longer than that of the adults. Furthermore, its flanks are either straight or only faintly convex and its apex acute in lateral and dorso-ventral aspects (Pl. XII, figs. 7F-7H, 8F-8H).

The alveolus is preserved only in the holotype (Pl. XII, fig. 4F).where it is about 12.5 mm deep and comprises about 18 per cent of its preserved length. However, the holotype is incomplete in the alveolar part. The complete depth of the alveolus is, therefore, estimated to be between one-fifth and one-quarter of the restored length of the guard. The alveolus is markedly displaced adventrally (Pl. XII, fig. 4F, 6E) so that its apex is situated much closer to the ventral side of the guard. So far as it is possible to tell, all of the preserved part of the alveolar cavity is normally calcified and no part of it is a pseudoalveolus. The dorsal side, as determined from the position and inclination of the alveolus and from the displacement of the apical line, is ornamented by a mediodorsal alveolar groove in all suitably preserved specimens (Pl. XII, figs. 4D, 5D, 6D, 7D, 8D). In the holotype, where most of this groove is preserved, it is 31 to 32 mm long and extends well beyond the apex of the alveolus, almost to the middle of the guard (Pl. XII, fig. 4D). The same is also true of other guards which have only the apicalmost part of alveolus preserved (e.g. Pl. XII, fig. 6D) or lack any part of the alveolus. The mediodorsal alveolar groove is deep and slit-like in cross-section throughout its length in all better preserved specimens (e.g. Pl. XII, figs. 4D, 5D, 7D). Wherever the groove is wide, it has been caused by deep weathering. This is clearly indicated by the preservation of a protruding, etched infilling of the groove in the middle of the widened groove of specimen 59017 (Pl. XII, fig. 6D, 6E). The groove is underlain by a well-developed splitting surface, in its alveolar part at least, as all the guard's layers are pronouncedly bent inward and are cut through by a very thin infilling right to the alveolar cavity in specimen 59017 (Pl. XII, fig. 6E). Furthermore, in the holotype, the weathered but still slit-like alveolar part of the groove cuts right through to the alveolar cavity (Pl. XII, fig. 4F). The postalveolar part of the groove appears to lack a splitting surface as the guard's layers are not bent inward beneath it in all specimens (e.g. Pl. XII, fig. 7E).

The ventral surface of all better-preserved specimens (e.g. Pl. XII, fig. 8A) is devoid of a medioventral groove. However, it has a strong tendency to weather more easily than the flanks with the layers becoming exfoliated throughout the mid-venter or in restricted areas along the mid-ventral zone (Pl. XII, figs. 4A, 5A, 6A, 7A). This selective weathering commonly produces secondary longitudinal grooves on the midventer. Whenever these grooves are narrow and restricted either to the apical region or to the apical and stem regions they resemble the medioventral apical grooves of a *Lenobelus* (Pl. XII, fig. 5A) and may be mistaken for them.

Plastic deformation of the guard resembling that occurring in *P. epigonos* sp. nov. has not been observed in *P. canadensis* sp. nov.

The surface of most guards studied is too strongly weathered to exhibit any traces of lateral longitudinal furrows or double lateral lines. The almost unweathered flanks of specimen 59021 (Pl. XII, figs. 8B, 8C) are ornamented by single, ventro-lateral, longitudinal furrows, which resemble closely those observed in the paratype of *Pseudodicoelites epigonos* sp. nov. (see p. 29, 30 and Pl. XV, fig. 2C).

Remarks. Of the northern Siberian *Pseudodicoelites* species only *P. primoris* Saks and *P. gustomesovi* Saks are superficially similar to *P. canadensis* sp. nov. in the cylindrical shape of their guards and their comparably sturdy proportions. Of these two species, *P. primoris* Saks resembles particularly closely the sturdy, half-grown representatives of *P. canadensis* (e.g. Pl. XII, figs. 7F-7H, 8) in these respects. However, it differs from the Canadian species significantly in the markedly depressed cross-section, the subcentral position of the alveolus, and the subcentral position of the apical line (see Saks in Saks and Nalniaeva, 1975, p. 109, Pl. XVI, figs. 4b, 5g). In combination with the much older, late early Toarcian age of the northern Siberian species, these features are judged to be ample for its specific differentiation from *P. canadensis* sp. nov. The northern Siberian *P. gustomesovi* Saks differs from *P. canadensis* sp. nov. in the distinctly compressed cross-section of the guard, an almost straight subcentral apical line, and a subcentrally situated alveolus (see Saks in Saks and Nalniaeva, 1975, p. 107, pl. XIX, figs. 6a, 6b; Fig. 41). Furthermore, all figured representatives of *P. gustomesovi* Saks (in Saks and Nalniaeva, 1975, Pl. XIX, figs. 4, 5) have considerably more elongate and slender guards than do representatives of *P. canadensis* n. sp. Finally, the guards of *P. gustomesovi* Saks do not exhibit the selective weathering and grooving of the ventral surface so characteristic of *P. canadensis* sp. nov. For these reasons the Canadian form is considered to be specifically distinct from *P. gustomesovi* Saks.

All other northern Siberian *Pseudodicoelites* are much more slender, fusiform to mace-like forms which are easily differentiated from *P. canadensis* sp. nov.

Among Canadian *Pseudodicoelites* forms, *P. canadensis* sp. nov. resembles only the sturdy holotype of *P. epigonos* sp. nov. However, the two are judged to be specifically distinct for reasons given in the description of *P. epigonos* sp. nov.

Stratigraphy and age. GSC loc. 72540 on Melville Island, N.W.T. yielded the bulk of the specimens of *Pseudodicoelites canadensis* sp. nov. associated with nondiagnostic belemnites *Dactyloteuthis?* sp. indet. and *Pachyteuthis?* sp. indet. This locality, which was discovered and collected by geologists of the Elf Oil Company of Canada Ltd. in 1965, occurs in their measured Marie Bay Section #65-MV-XI situated east of Cap Grassy. This locality did not yield any diagnostic zonal fossils.

GSC loc. 70381, which yielded the unfigured solitary guard of *P. canadensis* sp. nov., occurs in the Wilkie Point Formation on Prince Patrick Island. This locality, which was also found by geologists of the Elf Oil Company of Canada Ltd. in 1965, did not yield any diagnostic zonal fossils either. Therefore, these two localities have a general early to mid-Bajocian age, judging by regional time-range of the genus *Pseudodicoelites* in Arctic Canada. However, the solitary, well-preserved but fragmentary guard 59021 found in association with *Lenobelus aberrans* sp. nov. at GSC loc. 70053 can be assigned an early Bajocian (=Aalenian) age because of association with *Leioceras opalinum* (Reinecke) (see p. 24 for further details). It is inferred from there that the *P. canadensis* sp. nov. fauna of GSC locs. 70381 and 72540 is likewise early Bajocian in age.

Pseudodicoelites epigonos sp. nov.

Plate XV, figs. 1, 2

Synonymy

1966 *Hibolithes* Jeletzky, p. 162, Addendum (in part).

Derivation of name. From the Greek word, "epigonos", meaning a descendant. So named because of its younger age in comparison with all other representatives of the genus *Pseudodicoelites* in Arctic Canada.

Diagnosis. A *Pseudodicoelites hibolitoides*-like species characterized by a combination of a regularly rounded, approximately equidimensional cross-section of the guard with:

1. Considerably sturdier (coefficient of elongation varies from 7 to 11) proportions of the guard as compared with *Pseudodicoelites hibolitoides* Saks 1967; and

2. Incomplete calcification of the guard resulting in irregular postmortal deformation and formation of a *Hibolites*-like pseudoalveolus.

Material. Two almost complete, well-preserved guards from GSC loc. 24660.

Type specimen. The more sturdy guard 59027, which differs very much from the most closely related *Pseudodicoelites hibolitoides*, is here designated the holotype of *P. epigonos* sp. nov. (see Pl. XV, figs. 1A-1F).

Table of measurements (mm)

Measured features	GSC Cat. No. 59027 (Holotype)	GSC Cat. No. 59028 (Paratype)
Length of the guard	75 (almost complete)	89.5 (almost complete)
Maximum dorso-ventral diameter (at 40 mm level above apical end)	10.3	8.2
Maximum lateral diameter (same level as dorso-ventral diameter)	10.4	8.2
Length of mediodorsal alveolar canal	32	29
Preserved depth of alveolus (roughly approximate because of its pseudoalveolar character)	20	-
Coefficient of elongation (i.e. ratio of length over dorso-ventral diameter)	7.3 (appr.)	10.7 (appr.)

Description. Judging by the two specimens available, the shape and proportions of the guard of *Pseudodicoelites epigonos* are rather variable. However, no valid reason is seen to ascribe these morphologic distinctions to anything else but the infraspecific variation considering the close morphologic similarity of the two guards concerned in other, apparently taxonomically valuable morphologic features and their having been collected from the same *Arkelloceras*-bearing unit.

The length of the guard ranges from medium (75 mm in 59027) to fairly large (89.4 mm in 59028) and the shape varies from slightly to moderately subfusiform and from moderately (coefficient of elongation about 7) to strongly (coefficient of elongation about 11) elongate. The subfusiform shape is equally expressed in lateral and dorso-ventral aspect (see Pl. XV, figs. 1, 2). The guard expands faintly to moderately and more or less evenly adapically from the alveolar rim to the level of maximum diameters situated at or close to its middle. Farther adapically it contracts feebly to moderately and at a slightly increasing rate to the more or less deformed, moderately acute apex. This results in an approximately straight outline of the adoral half of the guard in dorso-ventral and lateral aspects and in a slightly to distinctly convex appearance of the apical half in the same aspects (see Pl. XV, figs. 1A-1D, 2A-2D). Because of the above shape, the guard has no "waist", such as occurs in many belemnopseid belemnitids at about the protoconch level (i.e. in *Lenobelus aberrans* sp. nov.; see Pl. XIII, figs. 2A-2D) and has a regularly symmetrical, moderately slender torpedo shape in dorso-ventral and lateral aspects. The lateral apical angle appears to vary from 11 to 20 degrees. These measurements appear to have been affected considerably by an irregular deformation of the apical region (especially in guard 59027; see Pl. XV, fig. 1E). The apex is approximately centrally situated. Because of the imperfect calcification of the apical region a 1 to 2 mm wide, approximately rounded to irregularly shaped (because of postmortal distortion) cavity is formed in its place in both specimens. The cross-section of the guard is approximately equidimensional (i.e. with subequal lateral and dorso-ventral diameters; see Table of measurements) and almost perfectly round wherever it is not postmortally distorted (see Pl. XV, fig. 2E)

The dorsal face of both guards (Pl. XV, figs. 1A, 2A) bears a deep and narrow medio-alveolar groove restricted to the anterior one-quarter to one-third of their preserved length. The groove is slit-like in the apparently unweathered guard 59027 while its broadly V-shaped cross-section in guard 59028 was apparently caused by weathering. The groove does not widen adorally to the alveolar rim of either specimen. Its apical end is abrupt also as the deep V-shaped groove merges into a level, regularly rounded ventral surface of the guard within an interval of 1 to 2 mm. This mediodorsal alveolar groove is a true mediodorsal canal as it is underlain by a well-developed splitting surface (Pl. XV, fig. 1E) in specimen 59027 and the same is assumed to be true of the specimen 59028.

The alveolar part of the guard is strongly and irregularly deformed in both specimens (Pl. XV, figs. 1A, 1D, 1F, 2A, 2D, 2G, 2F), evidently because of imperfect calcification. The original cross-section of the alveolar end is made unrecognizable by this deformation. In paratype 59028 the deformation of the almost completely preserved alveolar part of the guard is accompanied by an extensive peeling off of the outermost guard layers and by an irregular folding of the evidently pliable walls of the alveolus (Pl. XV, figs. 2F, 2G, 2H).

The alveolar part of the holotype is affected by plastic deformation (Pl. XV, figs. 1A, 1D, 1F) as expressed in its irregular lateral deformation. Unlike the paratype, this plastic deformation also affected the posterior half of the guard (Pl. XV, fig. 1D).

Other than the mediodorsal alveolar canal, the surface of both guards is ornamented only by shallow and poorly-delimited, apparently single ventro-lateral furrows. The best example of these single longitudinal furrows is visible on the right flank of paratype 59028 (Pl. XV, fig. 2C). There the furrow begins at the alveolar rim in the ventro-lateral position and extends along the oral half of the flank with a slight gradual shift towards mid-flank. The furrow is round-bottomed and about 1.5 mm wide throughout this interval. A faint suggestion of double lateral lines is seen at its bottom in strong lateral light. At mid-flank, the furrow narrows suddenly to less than one-half of its previous width, becomes somewhat deeper and better delimited, and is deflected slightly adventrally (Pl. XV, fig. 2C). Some 10 mm farther down-flank the furrow disappears, possibly because of increased weathering of the guard surface. Thereafter the flank appears to be furrowless up to the apex. The other flank of the paratype (Pl. XV, fig. 2B) bears a similar but less well-preserved single, ventro-lateral furrow. The oralmost part of this furrow is deep and V-shaped in cross-section because of the secondary folding of the alveolar part of the guard.

The writer was unable to obtain clear photographs of the very faint ventro-lateral furrows of holotype 59027 which do not seem to differ materially from the ventro-lateral furrows of the paratype (see Pl. XV, fig. 1B). Faint additional longitudinal furrows visible on the mid-flank of the holotype (Pl. XV, fig. 1C) may be the result of weathering.

Several fine, scratch-like, irregularly distributed, 5 to 7 mm long, longitudinal furrows cover the apical region of the paratype (Pl. XV, 2A, 2B). These furrows could have been caused by imperfect calcification of this part of the guard or be teeth- or claw-marks of a predator (a fish or a crustacean), inflicted when stripping flesh from the guard.

The well-defined, even splitting surface underlying the mediodorsal alveolar canal of the holotype (Pl. XV, fig. 1E) cuts right through to the alveolus in the oral third of its incompletely preserved dorsal side. If this side of the alveolus had been complete, the splitting surface would have cut through oral one-half to two-thirds of it. Farther adapically the straight bottom of the splitting surface becomes separated from the alveolar wall and is directed obliquely outward until it reaches the surface of the guard at about the level of the apex of the alveolus. The angle between the alveolar wall and the bottom of the splitting surface is about 20 degrees. The intervening triangular space has the same rough surface as the rest of the split part of the guard.

As preserved, the alveolar cavity of the holotype comprises almost one-third of the preserved length of the guard (see Pl. XV, fig. 1E and the Table of measurements). It must have measured fully one-third of its restored length. However, this alveolar cavity is a pseudoalveolus as is shown by the exfoliated edges of the growth layers of the guard exposed in its walls, the absence of a protoconch, and the improbably small apical angle (some 8 to 10 degrees) of its lower half (Pl. XV, fig. 1E). It is presumed accordingly that only the adoral two-thirds or less of the alveolar cavity represent the true alveolus. On this basis the true alveolus of the holotype would comprise from one-fifth to one-sixth of the restored length of the guard.

The exposed adoral part of the apical line of the holotype is markedly displaced adventrally so that the ventral radius comprises about 75 percent of the dorsal radius.

Paratype 59028 was not split and its internal morphology is unknown.

Remarks. Most of the hitherto described *Pseudodicoelites* species, such as *P. bidgievi* (Saks), *P. platyventriosus* Saks, *P. clavatoides* Saks, and *P. hibolitoides* Saks, differ from *P. epigonos* markedly in their much more fusiform shape and the distinctly to pronouncedly compressed cross-sections of their guards. Furthermore, all of these northern Siberian species have much more elongated guards than does the Canadian species. Of the above species, the shape and proportions of the guard of *P. hibolitoides* Saks resemble more closely those of the slender paratype of *P. epigonos* than do the others. However, the markedly compressed cross-section of its guard (see Saks in Saks and Nalniaeva, 1975, Pl. XIX, fig. 3b) is quite unlike the regularly rounded and equidimensional cross-section of the Canadian specimen (Pl. XV, fig. 2E).

The slightly subfusiform holotype of *Pseudodicoelites gustomesovi* Saks (in Saks and Nalniaeva, 1975, Pl. XIX, figs. 4a-4v) resembles closely the more subfusiform holotype of *P. epigonos*. However, like the other northern Siberian species, *P. gustomesovi* has a distinctly compressed guard (see Saks, in Saks and Nalniaeva, 1975, Pl. XIX, fig. 6a). Finally, *Pseudodicoelites primoris* Saks differs from *P. epigonos* in possessing a subcylindrical shape of the guard combined with a distinctly depressed cross-section (see Saks in Saks and Nalniaeva, 1975, Pl. XVI, figs. 4-6).

Of the Canadian species, *P. epigonos* resembles *P.* cf. *hibolitoides* Saks from the northern Yukon. However, this poorly known form differs from the slender paratype of *P. epigonos,* which it resembles most, in much lesser adoral tapering and the complete absence of deformation of the alveolar part of the guard. The holotype of *P. epigonos* is even more unlike *P.* cf. *hibolitoides* Saks because of much sturdier proportions of its guard.

The morphologically similar and possibly ancestral *Pseudodicoelites canadensis* resembles the holotype of *P. epigonos* in the general shape and proportions of the guard. However, it differs in possessing a much shorter and more obtuse apical region in the adult guard, a depressed cross-section of the guard, distinctly flattened flanks of the guard resulting in a rounded-rectangular (instead of regularly rounded) cross-section, a complete absence of plastic deformation of the guard, a much greater adventral displacement of the apical line in advanced growth stages, and preferential weathering of the middle part of the ventral face of the guard resulting in the appearance of *Lenobelus*-like medioventral grooves. In combination with the older age of *Pseudodicoelites canadensis* (see p. 28), these morphological distinctions are judged to be ample for its differentiation from *P. epigonos* as a separate species.

Stratigraphy and age. The two guards of *Pseudodicoelites epigonos* were found by E.T. Tozer in 1956 at GSC loc. 24660 in the Wilkie Point Formation. This fossil locality is situated on Prince Patrick Island on the east side of Intrepid Inlet, about 16.8 km (10 1/2 miles) north of Cape Canning. The fauna associated with *P. epigonos* at this locality includes *Arkelloceras tozeri* Frebold and *A. maclearni* Frebold (see Frebold, 1957, p. 20) which later proved to be diagnostic of the middle Bajocian (Frebold et al., 1967, p. 19, 20, 23).

Pseudodicoelites cf. *hibolitoides* Saks, 1967

Pl. XV, fig. 4

Material. One external cast of the oral half of a guard from GSC loc. C-6140. A rubber mould of the dorsal side of the guard was prepared from this cast (Pl. XV, fig. 4).

Description. The only fragment has a subcylindrical shape. Its non-furrowed, presumably postalveolar part expands but slightly in comparison with the furrowed, presumably alveolar part. In combination with its extremely slender proportions and restriction of the deep and narrow mediodorsal groove to the estimated oral third of the complete guard, these features indicate assignment of the fragment, 59029, to *Pseudodicoelites hibolitoides* Saks (see Saks in Saks and Nalniaeva, 1975, Pl. XIX, figs. 1, 2). The only other comparably slender *Pseudodicoelites*-*P. plativentriosus* Saks (see Saks in Saks and Nalniaeva, 1975, Pl. XVII, figs. 1-3) differs from the fragment in having much greater attenuation of the guard in its alveolar part combined with a much greater length of the mediodorsal alveolar groove which extends over the oral half of the guard.

Because of the fragmentary state of specimen 59029 the writer only compares it with the northern Siberian *P. hibolitoides* Saks.

Stratigraphy and age. Specimen 59029 was collected by D.K. Norris in 1970 from the Bug Creek Formation in the northern Yukon on the upper Bell River, Lat. 68°06'N; Long. 136°45'W. Long-ranging pelecypods, only, were found in association with the specimen. Because of restriction of *Pseudodicoelites hibolitoides* Saks to the lower to middle Bajocian of northern Siberia (see Saks in Saks and Nalniaeva, 1975, p. 104), the Canadian *P.* cf. *hibolitoides* Saks is presumed to be of that age also.

?Pseudodicoelites sp. nov. indet. A

Pl. XI, figs. 3A-3D

Material. One fragment of the stem region from GSC loc. 28913.

Description. The fragment GSC Cat. No. 59005 is about 28 mm long and tapers moderately and evenly adapically in lateral and dorsoventral aspects. It is almost regularly rounded and equidimensional in cross-section (the cross-section of Pl. XI, fig. 3D is misleading because of the strong obliquity of the break). The dorso-ventral diameter at the oral break is about 11 mm; the lateral diameter there is about 11.8 mm. The shape and proportions of fragment 59005 are similar to those of the stem region of *Conodicoelites* sp. nov. aff. *C. keeuwensis* (Boehm)(compare Pl. XI, figs. 4A-4D). However, this unambiguously oriented (see below and in Pl. XI, fig. 3D) fragment differs fundamentally in lacking a medioventral groove (Pl. XI, fig. 3A). As shown by all three representatives of *C.* n. sp. aff. *C. keeuwensis* (Boehm)(see Pl. XI, figs. 4A, 6A; Pl. XV, fig. 6A), this species is characterized by a medioventral groove which extends right across its stem and alveolar regions, including that part of the latter preserved in fragment 59005.

The wide and approximately round-bottomed mediodorsal alveolar groove is restricted to the oral half of the fragment (Pl. XI, fig. 3B). This groove, which gradually becomes more and more shallow and narrow apicalward until it completely disappears, does not appear to be underlain by a splitting surface even at the oral rim of the fragment.

The apical line is markedly displaced toward the grooveless side of the guard, which is thus the ventral side (Pl. XI, fig. 3D). The ventral radius comprises approximately one-third of the dorsoventral diameter at the oral end of the fragment.

Remarks. The presence of a short mediodorsal alveolar groove indicates that fragment 59005 is a dicoelitid. However, absence of a medioventral groove on the stem region prevents its reference either to *Conodicoelites* Stevens 1965 or to *Dicoelites* Boehm 1906 sensu Stevens 1965. The fragment appears, therefore, to be a peculiar representative of either *Pseudodicoelites* Saks 1967 or *Lenobelus* Gustomessov, 1966 emend. Saks 1967. Its *Pseudodicoelites* nature appears to be more probable as this genus is characterized by the absence of a medioventral groove on the stem region combined with the presence of a mediodorsal alveolar groove ending on the stem region. However, the placement of fragment 59005 in the genus *Lenobelus* Gustomessov 1966 emend. Saks 1967 cannot be entirely ruled out as some representatives of that genus have medioventral grooves which are restricted to the apical region of the guard (e.g. *Lenobelus minaevae* Saks; see Saks in Saks and Nalniaeva, 1975, Pl. XV, figs. 1a, 2a). It is possible, finally, that fragment 59005 belongs to a new dicoelitid genus which is characterized by the presence of a mediodorsal alveolar groove only in combination with a sturdy, conically-shaped guard.

Pending the discovery of better material the writer places the fragment 59005 tentatively in the genus *Pseudodicoelites*. Within that genus, the fragment does not resemble any hitherto described species and belongs indubitably to a new, morphologically peculiar species. Fragment 59005 is unsuitable as the holotype of a new species and is designated here as *?Pseudodicoelites* sp. nov. indet. A.

Stratigraphy and age. The only representative of *?Pseudodicoelites* sp. nov. indet. A was collected by L.H. Green in 1956 in unnamed Hazelton type sediments at GSC loc. 28913. The locality is situated on an unnamed ridge south of the head of Dawson River, Spatsizi map-area (104H), northwestern British Columbia. Other than *?Pseudodicoelites* sp. indet. A the fauna of GSC loc. 28913 includes only poor belemnite fragments which could belong either to *Dicoelites* s. str. or to *Belemnopsis* sp. indet. This fauna can, therefore, only be dated as of a general Toarcian to Bajocian age.

?Belemnopseidae Naef 1922 emend. Jeletzky 1946 (nomen correctum ex Belemnopsinae Naef 1922

?Belemnopseidae genus et species novum indet.

Pl. XI; figs. 10A-10E

Material. One external cast in rock from GSC loc. 91113. A rubber mould was prepared from it. GSC Cat. #59012.

Description. The median alveolar groove and the position of the apex of rubber mould 59012 is described first. The orientation of the guard depends on these features alone because nothing is known about the position of the siphuncle, of the alveolar cavity, or of the apical line.

The fairly long (preserved length about 24 mm), narrow and deep, medioalveolar groove appears to be V-shaped in cross-section, except at the apical end. However, it is mostly filled with matrix which precludes exact determination of its depth and profile (Pl. XI, fig. 10A). The greatest width of about 2 mm is at the alveolar rim and the groove gradually narrows and apparently shallows adapically from there. In the apicalmost 4 to 5 mm the groove is less than 1 mm wide, only slightly impressed into the surface of the ventral face and disappears gradually adapically (Pl. XI, fig. 10A). The exact nature of the groove is unknown. However, the inferred depth and V-shaped profile of the larger anterior part indicate that this part at least is a medioalveolar canal underlain by a splitting surface.

The above median alveolar groove appears to be a medioventral groove because of marked displacement of the mucronate apex to the opposite side of the guard, which does not exhibit either a medioalveolar groove or a medioapical furrow (Pl. XV, fig. 10B). So far as the writer knows, the apex is either subcentral or addorsally displaced in all presently known representatives of the suborder Belemnopseina to which guard 59012 belongs (see below). This is particularly true of *Conodicoelites* (Stevens, 1965b, p. 58) to which guard 59012 is most similar otherwise. The nongrooved face of guard 59012 is, therefore, interpreted to be its dorsal side. This orientation of the guard will be used throughout the following description.

The preserved part of guard 59012 is 59.4 mm long. The dorso-ventral diameter at a level 19.5 mm below the alveolar rim is 19.2 mm. The lateral diameter at the same level is 18.7 mm with a resulting compression ratio of about 0.97. The dorso-ventral diameter at a level 21 mm above apex is 14.4 mm. The lateral diameter at the same level (estimated) is about 17 mm with a resulting depression ratio of 1.18. The above ratios reflect a gradual transformation of the adorally slightly compressed cross-section into an adapically markedly depressed one. This gradual adapical change of the cross-section parallels closely that characteristic of the subgenus *Acroteuthis* in the Cylindroteuthididae.

So far as possible to tell from the external cast and rubber mould, the guard is almost complete in the alveolar part. The thickness of the alveolar wall at the alveolar break does not seem to exceed 2.5 mm. This tentative conclusion is supported by the presence of the already described long, medioventral alveolar groove. So interpreted, this sturdy and short (coefficient of elongation about 3.0), medium-sized, distinctly mucronate guard has the general proportions and shape of a sturdy, medium-sized to small, Late Jurassic *Acroteuthis* form, such as *Acroteuthis (Microbelus) russiensis* (d'Orbigny) (see Saks and Nalniaeva, 1966, Pl. XXXIV, figs. 6-7) or *Acroteuthis (Boreioteuthis) absoluta* (Fischer) (see Saks and Nalniaeva, 1966, Pl. XXXVI, figs. 3a, 6a, 6b). However, the presence of the medioventral alveolar groove (Pl. XI, fig. 10A) reveals the homoemorphic nature of this similarity in the guard's shape and proportions.

In dorso-ventral aspect the guard contracts very slowly but with a gradually increasing rate all the way from the alveolar rim to a point 15 to 16 mm from the apex (Pl. XI, figs. 10A, 10C). At the latter level the contraction increases sharply marking the boundary between the stem and apical regions. A slowly and gradually increasing adapical contraction throughout the alveolar and stem regions results in a faintly convex outline of their flanks in dorso-ventral aspect.

The pronounced adapical contraction of the guard maintains approximately the same rate throughout the apical region, except for a noticeable decrease in the apicalmost 2 to 2.5 mm (Pl. XI, figs. 10A-10C). This produces a straight appearance of the flanks of this region in dorso-ventral aspect, except at the apex where an ill-defined mucro is formed. The apical angle in dorso-ventral aspect is about 45 degrees and the apical region is moderately obtuse and short. The dorso-ventral outline is symmetric (Pl. XI, figs. 10A, 10C) and the marked but irregularly shaped swelling of the left flank (in ventral aspect; Pl. XI, fig. 10C) is caused by incompleteness of the external cast (loss of part of the surface) here.

In lateral aspect the guard contracts adapically slowly but slightly more rapidly than in dorso-ventral aspect. This contraction continues to a level about 11 to 12 mm from the apex (Pl. XI, fig. 10B) where the apical region begins. Unlike the dorso-ventral aspect, the ratio of this lateral contraction remains approximately the same throughout the alveolar and stem regions (except near the boundary with the apical region where it increases slightly). This produces a straight outline of both flanks of the guard within these regions. The lateral outline of the alveolar and stem regions is slightly asymmetric, the ventral side (flank) contracting slightly more rapidly than the dorsal side (Pl. XI, fig. 10B).

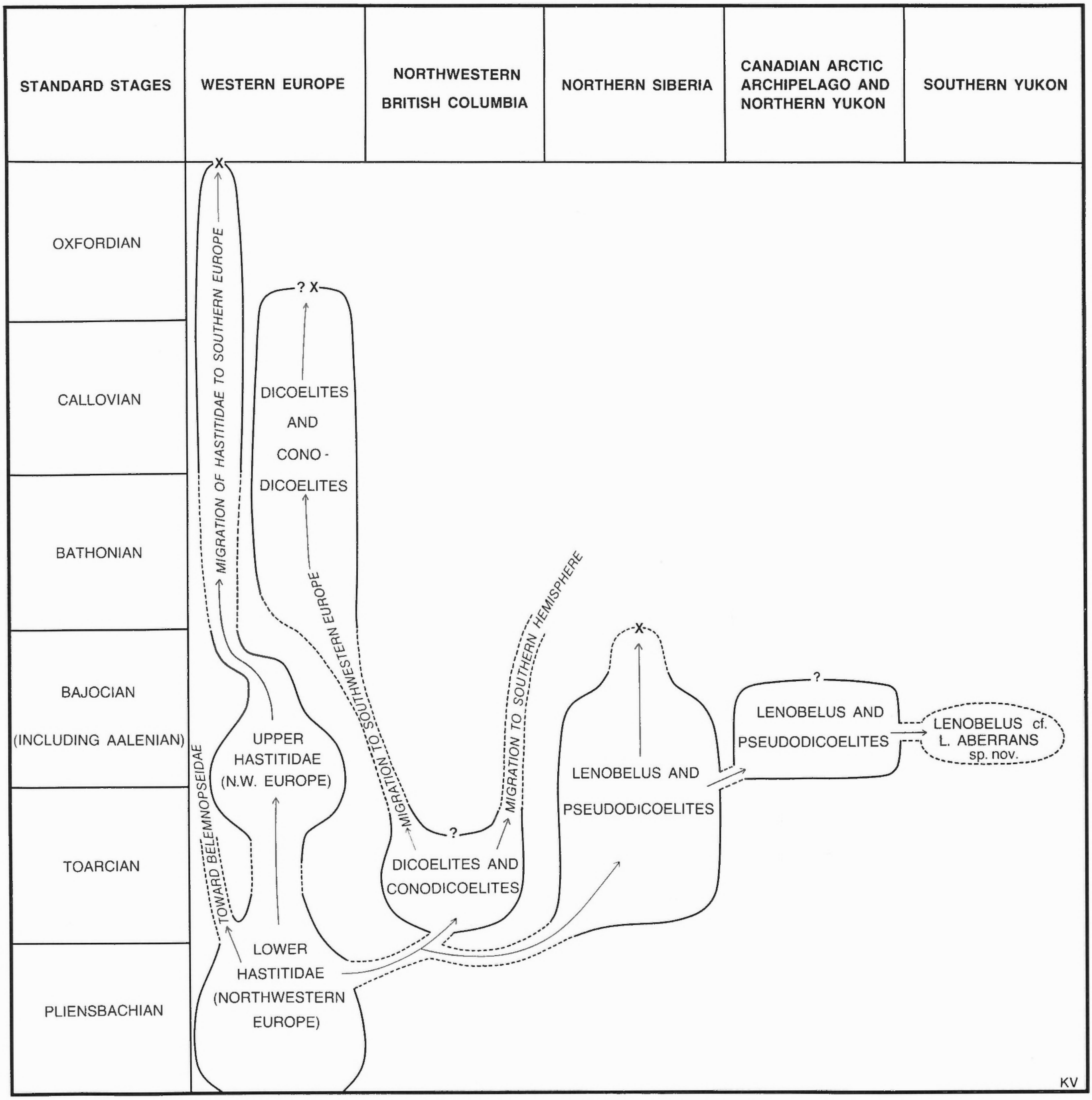

Fig. 4. Suggested phylogeny and migrations of Dicoelitidae emend.

The markedly increased (as compared with the stem region) adapical contraction of the ventral side of the apical region maintains approximately the same ratio except in the apicalmost 2 mm where it decreases noticeably (Pl. XI, fig. 10B). This results in an approximately straight but distinctly mucronate appearance of the ventral side of the apical region in lateral aspect. The slightly increased (again in comparison with the stem region) contraction of the dorsal side of the apical region maintains approximately the same rate to the apex. This side has accordingly an approximately straight, nonmucronate appearance (Pl. XI, fig. 10B). Because of the above, unequal increase of contraction in its ventral and dorsal sides, the apical region has a markedly asymmetrical profile with the apex strongly displaced addorsally (Pl. XI, fig. 10B). The apical angle in lateral aspect is about 55 degrees and the apical region is moderately short and obtuse.

The ventral side of the guard is fairly strongly flattened throughout compared to the flanks. The latter are mostly evenly rounded, except near the alveolar rim where there is marked flattening. The dorsal side is flat throughout. In combination with the maximum lateral diameter occurring close to the ventral side, a trapezoidal cross-section of the oral-most part of the guard is produced (Pl. XI, fig. 10E). This cross-section, however, changes rapidly to a rounded-rectangular cross-section which persists to the apex (Pl. XI, fig. 10D).

Where best-preserved, the surface of the guard is smooth. No traces of any longitudinal lateral grooves, double lateral lines or striae can be seen, except on both sides of the mucro where single, fine, 2.5 mm long dorso-lateral striae occur (Pl. XI, fig. 10B). The smooth surface of the guard is believed to be original and to be important taxonomically.

No information is available about the internal morphology of the here described guard.

Affinities and differences. The presence of a medioalveolar groove indicates that the superficially *Acroteuthis*-like guard 59012 is a representative of the suborder Belemnopseina Jeletzky, 1965. The inferred ventral position of this medioalveolar groove and the complete absence of either a medioalveolar groove or a medioapical furrow on the opposite (i.e. dorsal) side of the guard precludes its reference to the family Dicoelitidae Saks and Nalniaeva 1967 and indicates instead its reference to the family Belemnopseidae Naef 1922 emend. Jeletzky 1946. Within the Belemnopseidae, guard 59012 is not congeneric with any of the more typical, slender and subfusiform to subcylindrical representatives of the family (e.g. *Hibolithes* Montfort 1808, *Belemnopsis* Bayle 1878, *Neohibolites* Stolley 1911, and *Parahibolites* Stolley 1919) because of the different shape and much more slender proportions of their guards combined with the characteristic presence of double lateral lines and longitudinal lateral grooves. Even the sturdiest, earliest-known representatives of *Belemnopsis* ex gr. *apiciconus-angusta* from the late lower to middle Bajocian (inclusive of the Aalenian) of Normandy, France, are definitely not congeneric with guard 59012 because of the above great morphologic differences.

Such relatively shorter and sturdier, partly subcylindrical to slightly subconical belemnopseid genera as *Mesohibolites* Stolley, 1919, *Curtohibolites* Stoyanova-Vergileva, 1963, *Mucrohibolites* Nazarishvili, 1968 and *Somalibelus* Jeletzky, 1972 are much more similar morphologically to guard 59012 than the above genera.

Of these four genera, *Mesohibolites* includes forms (e.g. *M. minaret* Raspail, *M. uhligi* Schwetzow, *M. brevis* Schwetzow) closely comparable with the Canadian form in the shape and elongation of the guard. However, like all other better known representatives of *Mesohibolites,* the best-preserved representatives of these forms are characterized by the presence of double lateral lines and longitudinal lateral grooves which seem to be absent in guard 59012.

The poorly described and figured genus *Mucrohibolites* Nazarishvili, 1968 (see Nazarishvili, 1973, pp. 47-51, Pl. V, figs. 11-19 as the original 1968 publication was not available to the writer) appears to be very closely related to *Mesohibolites,* and is probably no more than a subgenus of the latter. The presence of double lateral lines is not mentioned in the generic and specific descriptions of *Mucrohibolites* (see Nazarishvili, 1973). Nor are these lines visible in the poor illustrations. However, the guards of typical representatives of the genus are similar and appear to grade imperceptibly into those of sturdy, subconical representatives of *Mesohibolites* (e.g. *M. brevis* Schwetzow, 1913; *M. minareticus* Krimholts, 1939, and *M. uhligi* Schwetzow 1913) some of which are known to possess double lateral lines (e.g. Krimholts, 1939, p. 15).

The mid-Lower Cretaceous (Barremian) genus *Curtohibolites* likewise includes some species (e.g. *C. rasgradensis* and *C. wernsdorfensis*; see Stoyanova-Vergileva, 1963, Pl. I, fig. 4; Pl. II, fig. 7) very similar to guard 59012 in their shape and proportions of the guard, the length of the medioventral alveolar groove and some other external morphologic features. However, like the above, more sturdy representatives of *Mesohibolites*, all known representatives of *Curtohibolites* are characterized by the presence of double lateral lines.

The one known species of the Kimmeridgian genus *Somalibelus* is closely similar to guard 59012 in the shape and proportions of the guard and the length of the medioventral alveolar groove. It includes an extreme variant (Jeletzky, 1972, Pl. 30, figs. 6c, 6d) which contracts slightly adapically in dorso-ventral and lateral aspects at a comparable rate with the Canadian guard. Unlike *Mesohibolites* and *Mucrohibolites, Somalibelus* appears to lack double lateral lines. However, it appears to differ from the smooth guard 59012 in the possession of single mediolateral longitudinal ridges flanked by flattened to slightly depressed, narrow longitudinal zones (Jeletzky, 1972, p. 158).

At present, the guard 59012 can only be differentiated generically from the above four belemnopseid genera because it lacks lateral longitudinal grooves and ridges and double lateral lines. All the other features of its external morphology described above are not of generic or subgeneric rank.

Were it possible to verify the total lack of longitudinal lateral grooves and ridges and double lateral lines in guard 59012, this extremely stable and taxonomically important (see Gustomessov, 1962 and in the previous sections of this paper) distinction would be sufficient to erect a new belemnopseid genus. This conclusion finds support in the much older (pre-Middle Bajocian) age of guard 59012 in comparison with that (Kimmeridgian to Aptian) of the four genera above mentioned. However, the preservation of the surface of the flanks of the one external cast is too poor to rely on this morphologic feature alone. Therefore, and because of an otherwise unsatisfactory (lack of data about the internal morphology) preservation of the only specimen available, the apparently generically new guard 59012 is left unassigned generically for the present.

On the specific level the above combination of known external morphologic features of guard 59012 is unique in the family Belemnopseidae Naef 1922 emend. Jeletzky 1946. However, the guard is inadequate to serve as the type specimen of a new species. Therefore, erection of a new species must await discovery of better-preserved material.

Stratigraphy and age. The one representative of ?Belemnopseidae, genus and species novum indet. was found in the Haselton Group of the Haselton E 1/2 map-area. The fossil locality is situated in the south-eastern corner of the area at Lat. 55°12.1'N and Long. 126°13.8'W. No diagnostic fossils were found in the volcaniclastic beds that yielded this belemnite. However, these beds occur stratigraphically below middle Bajocian beds containing *Sonninia* sp. and are correlative on a lithologic basis with palaeontologically dated upper Toarcian to lower Bajocian (=Aalenian) rocks outcropping elsewhere in the area (T. Richards, personal communication of May 1974).

REMARKS ON PHYLOGENY OF THE DICOELITIDAE

The discovery of what appears to be typical representatives of *Dicoelites* s. str. and *Conodicoelites* in Toarcian (mostly mid-Toarcian) rocks of northwestern British Columbia necessitates a somewhat drastic re-interpretation of the phylogeny and origin of the family Dicoelitidae (i.e. including Pseudodicöelitinae Saks 1967) compared with the proposals of Gustomessov (1966, p. 69 and in the unnumbered Text-fig. on this page) and Saks (in Saks and Nalniaeva, 1975, p. 135-139, Text-fig. 43). These data run counter to Gustomessov's (loc. cit.) proposal that *Lenobelus* sensu Gustomessov 1966 (i.e. including *Pseudodicoelites* Saks 1967) is ancestral to either *Dicoelites* Boehm 1906 sensu Stevens 1965 or *Conodicoelites* Stevens 1965. The oldest known typical representatives of *Lenobelus* s. str. (i.e. *L. lenensis*; see Gustomessov, 1966, p. 70; Saks in Saks and Nalniaeva, 1975, p. 86, 137, Text-fig. 43) and *Pseudodicoelites* (i.e. *P. primoris*; see Saks in Saks and Nalniaeva, 1975, p. 111, 137, Text-fig. 43) appear in only slightly older upper lower Toarcian rocks of northern Siberia, than do the definitively dated mid-Toarcian *Dicoelites* and *Conodicoelites* of northwestern British Columbia. Furthermore, there are some less precisely dated representatives of the *?Dicoelites* in British Columbia which could be early Toarcian in age. Therefore, it is more likely that *Dicoelites* s. str., *Conodicoelites*, *Lenobelus* and *Pseudodicoelites* all are diverging evolutionary offshoots from a common late Pliensbachian hastitid root-stock (Fig. 4). It is not certain which of the Pliensbachian hastitid genera of northwestern Europe is the ancestor of the Dicoelitidae but the writer favours the still undescribed Pliensbachian *Parahastites* forms of that region as the most probable ancestors.

The above data are equally incompatible with derivation of *Dicoelites* s. lato from those Bajocian (including Aalenian) *Belemnopsis* provided with weak to moderately strong mediodorsal canals (Stolley, 1919, p. 28, 47; 1927, p. 121, 122). Because of their younger age in comparison with the mid-Toarcian *Dicoelites* and *Conodicoelites* forms of northwestern British Columbia, the mediodorsal alveolar canals of these Bajocian and later *Belemnopsis* forms appear to be atavistic features reflecting derivation from *Dicoelites*-like hastitids which have both mediodorsal and medioventral alveolar grooves (compare Fig. 4).

It seems likely that the *Lenobelus* s. str. and *Pseudodicoelites* lineages, which are very closely related to the *Dicoelites* and *Conodicoelites* forms of northwestern British Columbia, arose in northern Siberia in response to their climatic isolation from these Tethyan dicoelitid genera. This evolution of the Boreal dicoelitids apparently happened after northward migration in the earliest Toarcian of the above latest Pliensbachian or earliest Toarcian hastitid root-stock from the marginal Tethyan basins of western North America which were inhabited by *Dicoelites* s. str. and *Conodicoelites* (see Fig. 4 and the following section; p. 36, 37).

Saks' (in Saks and Nalniaeva, 1975, p. 135-139, Text-fig. 43) attempt to derive *Lenobelus* s. str. and *Pseudodicoelites* from such representatives of Belemnitida s. restr. as *Holcobelus* is unconvincing, in the writer's opinion. When claiming that the lateral furrows of these two genera are unlike those of Hastitidae, Saks (ibid., p. 136) overlooks the fact that the flanks of the guard of *Parahastites* (see Nalniaeva in Saks and Nalniaeva, 1970, p. 124, Pl. XXII, fig. 1b, 6b) are ornamented by: "well-developed double furrows which are situated close to each other in the alveolar part but diverge in the expanded part" (of the guard; writer's comment). A similar arrangement of lateral furrows is recorded in other Hastitidae genera (see Gustomessov, 1962). Furthermore, some primitive hastitids (e.g. *Hastites? araris* (Dumortier 1869) are known to possess triple lateral furrows similar to those of the Belemnitidae s. restr. These lateral double furrows, the more adventral of which harbours the double lateral lines, do not seem to differ significantly from those of *Lenobelus* s. str. and *Pseudodicoelites*.

The claim of Saks (in Saks and Nalniaeva, 1975, p. 136) that Belemnitina (i.e. his Cylindroteuthacea), including Hastitidae, do not possess any mediodorsal or medioventral alveolar grooves equivalent to those of *Lenobelus* s. str. and *Pseudodicoelites* is erroneous. As pointed out by Jeletzky (1966, p. 143, 144), such alveolar grooves (both medioventral and mediodorsal) do exist in some representatives of the Hastitidae. However, their phylogenetic significance was overlooked by most, although not all (e.g. Naef, 1922, p. 229; Roger, 1952, p. 714), belemnite workers. Some of these grooves are underlain by splitting surfaces and so represent incipient alveolar canals, while others are not and so are simple alveolar grooves. The same variable relationship between grooves and splitting surfaces characterizes *Lenobelus* and *Pseudodicoelites*. There is, therefore, good reason to derive these two genera from such grooved Hastitidae together with the Tethyan Dicoelitidae and all representatives of the Belemnopseidae (Jeletzky, 1966, p. 144).

The medioventral apical grooves also occur in some representatives of the Hastitidae, such as *Pleurobelus* and *Rhabdobelus*, and the medioventral apical groove of *Lenobelus* can be derived from such hastitid grooves.

The combined evidence of the above morphologic similarities certainly outweighs that of the presence of a strongly developed medioventral apical groove in *Holcobelus*, which is similar to that of *Lenobelus*, and indicates the latter to be a homoeomorphic feature.

NOTES ON BIOGEOGRAPHY AND MIGRATION ROUTES OF THE DICOELITIDAE

The presence of a varied dicoelitid fauna, including what appears to be typical representatives of *Dicoelites* s. str. and *Conodicoelites*, in Toarcian (mostly mid-Toarcian) rocks of northwestern British Columbia is of great palaeobiogeographic interest. It necessitates a rather drastic revision of previous ideas (e.g. Stevens, 1965b, p. 169-174, Fig. 35, 39; 1973, p. 261-263, Plates 1B, 2A; Jeletzky, 1966, p. 144) on place of origin and the migration routes of dicoelitid belemnites.

Western and Arctic Canada is the only region in the world where Tethyan, presumably warm-water, representatives of the Dicoelitidae (i.e. *Dicoelites* s. str. and *Conodicoelites* Stevens 1965) occur close to its Boreal, presumably cold-water, representatives (i.e. *Lenobelus* Gustomessov, 1966 s. restr. and *Pseudodicoelites* Saks 1967). Furthermore, there appears to be some overlap of the geographic ranges of the Tethyan and Boreal representatives of the Dicoelitidae in western and Arctic Canada (Figure 1).

Generally speaking, the above Tethyan genera of Dicoelitidae and the closely related but generically indeterminate dicoelitid forms associated with them are restricted to western (i.e. Taseko Lakes map-area; Jeletzky unpublished) and northwestern (i.e. Bowser Basin) British Columbia (Fig. 4). The Boreal dicoelitid genera are, in general, restricted to more northerly areas such as the northern Yukon and the northwestern part of the Canadian Arctic Archipelago (Fig. 4). Furthermore, no definitively identifiable representatives of these two groups of genera have yet been found in direct association in any of the collections studied. However, the palaeogeographic overlap of the two groups of genera is indicated by discovery of an isolated dicoelitid apparently belonging to the genus *Dicoelites* s. str. (i.e. *?Dicoelites* sp. nov. indet. B; see Pl. XV, fig. 5) in the ?lower Bajocian of the northern Yukon where *Pseudodicoelites* and *?Lenobelus* only are otherwise known. Furthermore, a couple of fragments of *Lenobelus* cf. *L. aberrans* sp. nov. (see Pl. XV, figs. 7, 8) were found in the southern Yukon (Lake Labarge area) where no other Boreal dicoelitids are known. These *Lenobelus* cf. *L. aberrans* sp. nov. are associated with *Myophorella* ex gr. *dawsoni* (Whiteaves) (T.P. Poulton, personal communication in 1975) which is otherwise known only from the geosynclinal seas of northwestern and western British Columbia. It is concluded accordingly that these *Lenobelus* cf. *L. aberrans* sp. nov. occur in the northernmost part of the geosynclinal basin of northwestern British Columbia, which was connected with the Richardson Mountains-Porcupine Plain Trough of northern and central Yukon by the Bajocian generation of Dawson Strait (Imlay and Detterman, 1973, p. 4, 17, Fig. 4). Finally, a fragment apparently belonging to a new species of *Pseudodicoelites* (i.e. *?Pseudodicoelites* sp. indet. A; see Pl. XI, fig. 3) has been found in the Bowser Basin of northwestern British Columbia.

Despite factors such as: (i) close affinities of the Tethyan and Boreal dicoelitid genera (see p. 35); (ii) availability of a seaway connecting the Toarcian-Bajocian geosynclinal seas of northwestern British Columbia to the contemporary Boreal seas of the northern Yukon and the Canadian Arctic Archipelago (Jeletzky, 1975, p. 3; Imlay and Detterman, 1973, p. 3, 4, 17, Figs. 3, 4); and (iii) geographic overlap of Tethyan and Boreal dicoelitid genera in western and Arctic Canada (Fig. 1) - no northward migrations of the Tethyan dicoelitids are evident in western and Arctic Canada in the Toarcian. This is indicated by total absence of Toarcian dicoelitids in the Richardson Mountains-Porcupine Plain Trough and the Sverdrup Basin. Therefore, the previously inferred (p. 35) derivation of the Boreal dicoelitids (i.e. *Lenobelus* and *Pseudodicoelites*) must have been achieved from those members of the earliest Toarcian to latest Pliensbachian Tethyan hastitid root-stock which migrated into the Boreal Realm via a different seaway. The above data combined with the presence of late early Toarcian *Lenobelus* and *Pseudodicoelites* in northern Siberia (Saks in Saks and Nalniaeva, 1975, p. 83, 111) suggest that these hypothetical ancestral hastitids migrated northward either along the present Alaska Panhandle into the Chukotka-Anadyr' region of eastern Siberia and then into the Lena-Khatanga region of northern Siberia or directly across the site of the present day Pacific Ocean into the Soviet Far East and then into northeastern Siberia (Fig. 5). The descendant North Siberian *Lenobelus* and *Pseudodicoelites* were apparently unable to migrate into the present Canadian Arctic prior to the earliest Bajocian (Aalenian).

Because of the above, and the inferred or established Bajocian age of all above occurrences of the Canadian representatives of *Pseudodicoelites* and *Lenobelus* (see Fig. 4), their geographic overlap with the southern dicoelitid faunas in western and Arctic Canada is ascribed tentatively to a southward migration of such Bajocian Boreal forms as *Lenobelus* cf. *L. aberrans* sp. nov. and *?Pseudodicoelites* sp. nov. indet. A from the Canadian Arctic region into the geosynclinal seas of the southern Yukon and northwestern British Columbia (Fig. 6).

The above Toarcian (mainly mid-Toarcian) age of the Tethyan dicoelitids of northwestern British Columbia presents another paleobiogeographic problem. Superficially, the discovery of *Dicoelites* and *Conodicoelites* in Jurassic rocks of northwestern British Columbia does not seem to be a surprising palaeobiogeographic event. These belemnite genera are common fossils in the northern border areas of the Tethyan Realm in Europe and the southern USSR (e.g. Switzerland, southern France, southwestern Poland, Crimea, Caucasus; see Pugaczewska, 1961, Krimgolts, 1931; Stevens, 1973, p. 262, Plates 2A, 2B). Hence, their presence in northwestern British Columbia seems merely to add to the long-known, close western European affinities of the Early (Hettangian to Toarcian) and early Middle (Bajocian) Jurassic cephalopod faunas (compare Frebold and Tipper, 1970, p. 1-10 for ammonites). However, these Canadian dicoelitids are too old to be treated as migrants from Europe as the oldest European dicoelitids are of Bathonian and ?Bajocian age (Stevens, 1965b, p. 170; 1973, p. 262, Plate 2A, 2B).

The Toarcian (mainly mid-Toarcian) dicoelitid forms of northwestern British Columbia are also much older than any of the *Dicoelites* s. str. and *Conodicoelites* forms found in the Himalayan Ranges (Stoliczka, 1886), Indonesia (Stolley, 1929), New Zealand (Stevens, 1965, 1973), South America (Stevens, 1965b, p. 158-159) and Antarctida (Stevens, 1967). None of these dicoelitids of the Southern Hemisphere are older than Bathonian and most are Callovian to Kimmeridgian in age. The *Dicoelites* and *Conodicoelites* from British Columbia are, thus, by far the oldest known representatives of these genera in the world.

The much older age of the *Dicoelites* and *Conodicoelites* forms of northwestern British Columbia compared with congeneric dicoelitids known elsewhere suggests strongly that this region was the evolutionary center for these two dicoelitid genera. This idea was endorsed in the preceding section dealing with phylogeny of the Dicoelitidae (see p. 35 and Fig. 5). Regardless of whether *Dicoelites* and *Conodicoelites* arose in northwestern British Columbia out of some still unknown but supposedly *Parahastites*-like hastitid ancestors or arose out of that stock elsewhere and migrated there in the earliest Toarcian or latest Pliensbachian (see in preceding section and Fig. 5 for further details), it appears as if all younger representatives of *Dicoelites* and *Conodicoethites* known elsewhere are their descendants which arose via migration(s) out of northwestern British Columbia in post mid-Toarcian time.

The close affinities (see p. 35) of the mid-Toarcian *Dicoelites* s. str. and *Conodicoelites* forms of northwestern British Columbia with the Pliensbachian hastitid faunas of northwestern Europe, particularly of southern and central England, suggests that their earliest Toarcian or latest Pliensbachian ancestors are of northwest European origin. Of the two possible migration routes, the northern one passing through the eastern coastal regions of Greenland, the Sverdrup Basin and the Porcupine Plain-Richardson Mountain Trough appears to be highly unlikely. Although these regions were flooded by the Pliensbachian-Toarcian seas (Saks, 1961; Jeletzky, 1972, 1975; Imlay and Detterman, 1973), they formed part of a relatively cool Boreal Realm where *Dicoelites* and *Conodicoelites* are unknown. Furthermore, no belemnitids have been found in the pre-Toarcian rocks of the Sverdrup Basin (Jeletzky, unpublished) and the Richardson Mountains-Porcupine Plain Trough (Jeletzky, 1967, p. 8). This suggests that the purely northwestern European belemnitid faunas of the Pliensbachian-Toarcian of eastern Greenland (Rosenkrantz, 1934, 1942; and unpublished observations of the writer on collections in the Geological-Mineralogical Museum in Copenhagen) were unable to migrate through these basins.

An entirely Tethyan migration route extending from northwestern Europe across the site of the present-day Atlantic Ocean (which definitely did not exist as such at that time; Fig. 5) and then across either the southern part of North America (i.e. Louisiana, Florida, Texas and northern Mexico) or the Caribbean region and Central America appears to be much more likely and is favoured by the writer. There is ample evidence that the Tethyan Belt was flooded throughout in the Early Jurassic and that the north-south-trending Pacific geosynclinal troughs of North and South America were connected with its Caribbean and Mexican segment (Hallam, 1975, Figs. 8-3, 8-4). The apparent absence of either hastitid or dicoelitid belemnites in Pliensbachian-Toarcian rocks of the Caribbean region, Mexico, and Central America is readily explained by the complete lack of special studies of Jurassic belemnites in these regions. Furthermore, the same applies to the Pacific Coast states of the U.S.A. Finally, the existence of this route is indicated by the northwestern European affinities of Early Jurassic ammonite faunas of all the above regions, combined with the presence of hastitid and dicoelitid belemnites in Toarcian rocks of northwestern British Columbia (this paper and unpublished) and of European-type *Hastites* (s. lato), *Holocobelus* and *Acrocoelites* in Toarcian rocks of the mid-continent Fernie Basin (Jeletzky in Frebold, 1969, p. 83, Fig. 1). It is also significant that the Pacific geosynclinal troughs of South America are known to contain Toarcian and Bajocian belemnopseids, hastitids and *Holcobelus* closely related to those of northwestern Europe (Steinmann, 1881; Stolley 1927, p. 115, 116; Stevens, 1965b, p. 158, 159, 169 and unpublished observations of the writer).

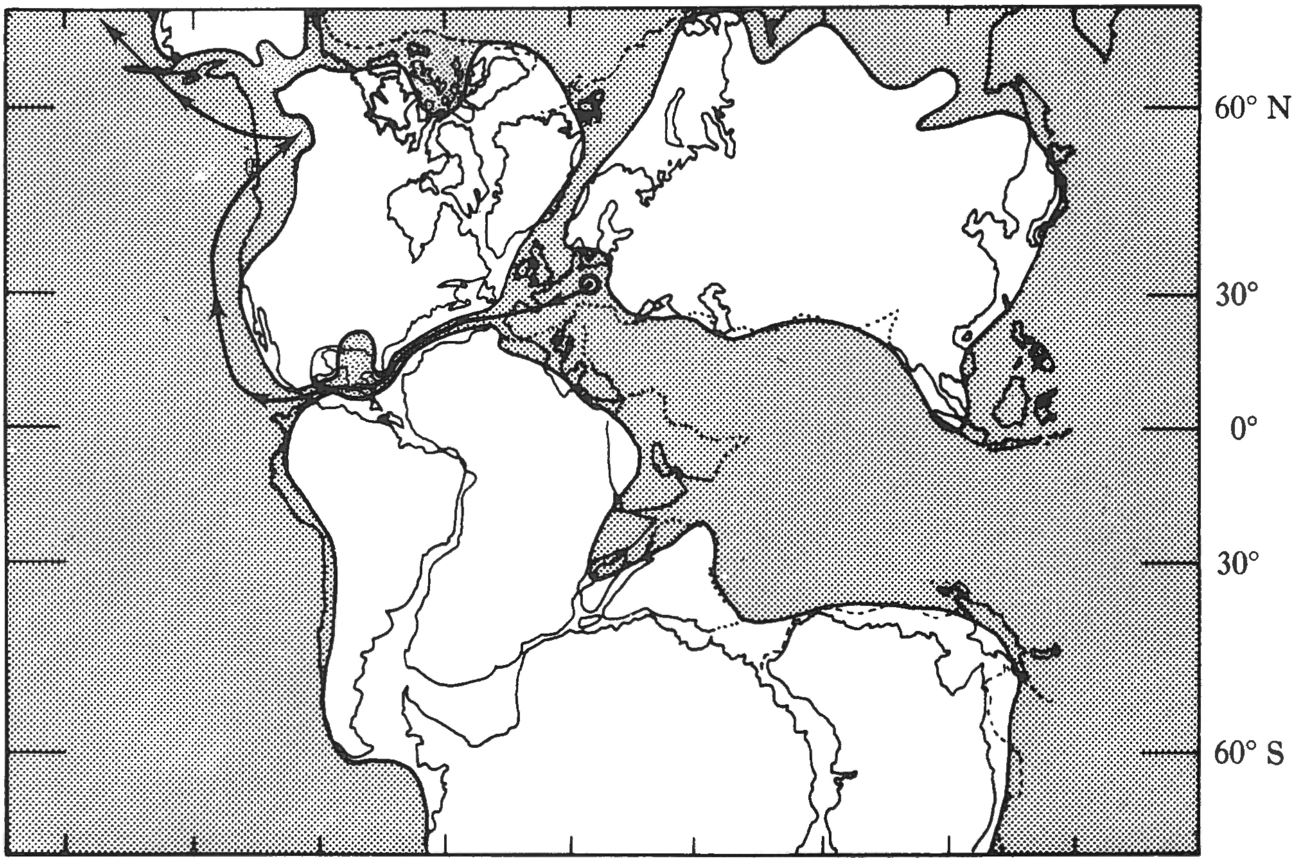

Fig. 5. Suggested migration routes (solid line with arrows) of the latest Pliensbachian or? earliest Toarcian hastitid ancestors of Dicoelitidae from northwestern Europe to northwestern British Columbia and northern Siberia. Circled dot ⊙ indicates center of origin in northwestern European Basin. Positions of lithospheric plates and distribution of sea (stippled) and land modified from Hallam (1975, Fig. 8-3).

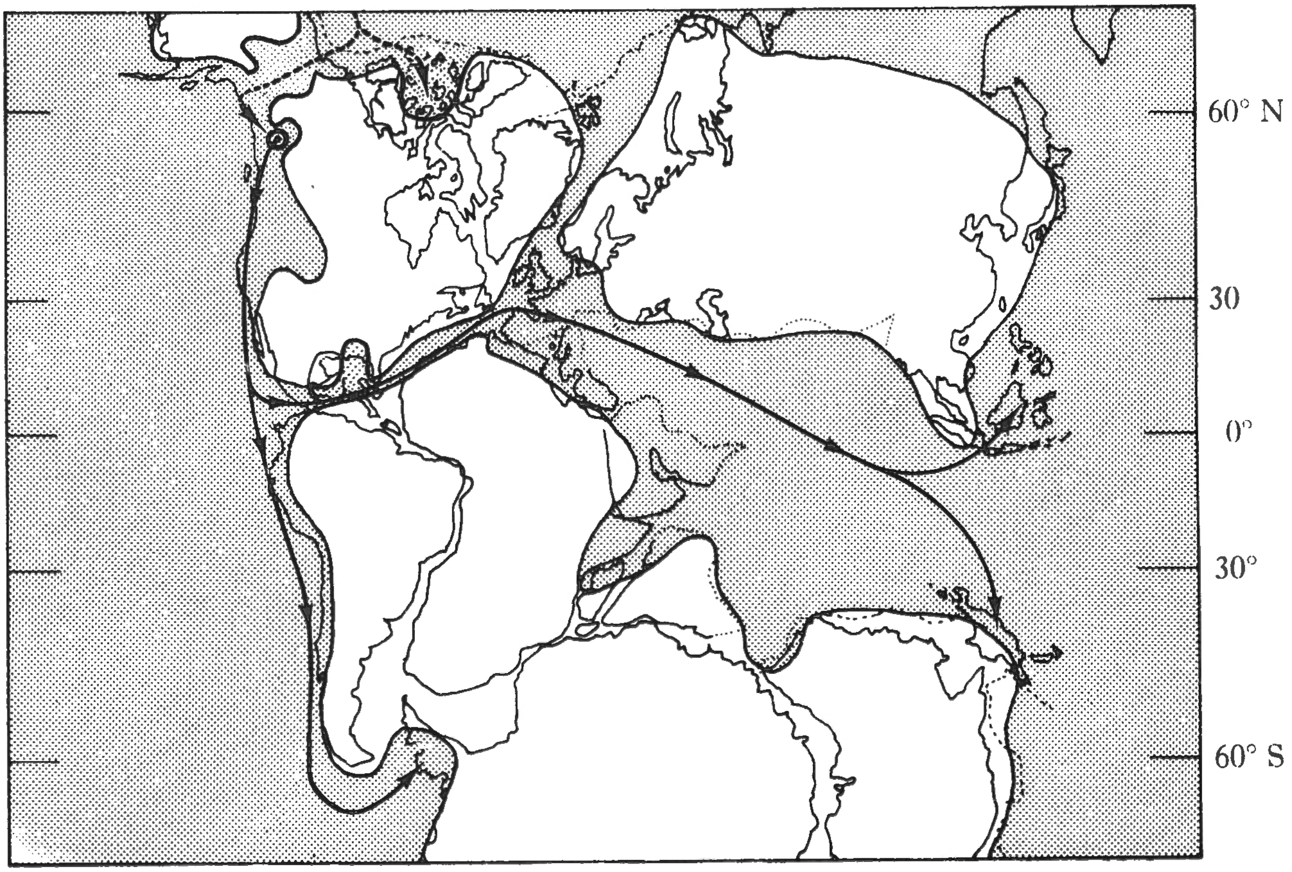

Fig. 6. Suggested migration routes of the Tethyan (solid line with arrows) and Boreal (dashed line with arrows) dicoelitids in the Bajocian. Circled dot ⊙ indicates center of origin in northwestern British Columbia. Positions of lithospheric plates and distribution of sea (stippled) and land modified from Hallam (1975, Fig. 8-4).

The distances involved in the above migration of the latest Pliensbachian hastitid ancestors of *Dicoelites* s. str. and *Conodicoelites* of northwestern British Columbia must have been much shorter in the Pliensbachian than they are now as, according to all data available, the Atlantic Ocean did not exist then. This is true regardless of whether one favors the hypothesis of the expanding earth, as the writer does, or the hypothesis of the global plate tectonics as the majority of recent workers do. According to the latest reconstructions of Early Jurassic palaeogeography (e.g. Hallam, 1975; this paper, Figs. 5, 6) the Jurassic epicontinental basins of northwestern Europe were situated close to the Florida-Louisiana embayment of the contemporary epicontinental sea of North America. These clusters of epicontinental basins were connected via the Tethyan geosynclinal belt, the European and Caribbean segments of which were then juxtaposed.

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Plates I to XV

All fossils are reproduced at natural size unless otherwise indicated in the descriptions of corresponding figures. All ventral faces of belemnite guards are marked with "v" while their dorsal faces are marked with "d". The oral ends of belemnite guards and phragmocones are always directed upward.

PLATE I

Figures 1A-1H. *Duvalia graziana* (Duval-Jouve, 1841). Aptian. St. Paul 3 Châteaux (Drôme), France. Original in palaeontological collections of the Museum de l'Histoire Naturelle de Genève, Switzerland.

1A. Right lateral view of the fragment before sectioning.

1B. Dorsal view of the same;

1C. Ventral view of the same;

1D. Oral cross-section of the same.

1E. Overall view of the postalveolar and most of the alveolar (except for adoral six septa shown in fig. 1G) parts of the longitudinal dorsoventrally oriented, median thin-section prepared from the fragment in figs. 1A-1D. The saucer-shaped Belemnitina-like character of the earliest visible growth stage of the guard appears to be an artifact caused by postmortal deformation (*see* under the discussion of Fig. 1H). Note silicification of the early growth stages of the guard around the protoconch, x5.

1F. Adapical part of the phragmocone and earliest growth stages of the guard (compare Fig. 1E) showing fine structural detail. Note the ontogenetic change of the dorsal parts of the septal necks from generally loxochoanitic (already showing incipient adoral protuberances) in the earliest thirteen or fourteen septa to distinctly double pronged (better collared), adventrally sloping shapes in all subsequent septa. The loxochoanitic shape of the earliest eight to nine septal necks is obscured by ferruginous fillings of the corresponding camerae and is not visible in Fig. 1H. However, it is discernible in other larger scale, photomicrographs of this thin-section (Pl. II, figs. 1D, 1B and 1A), x12.

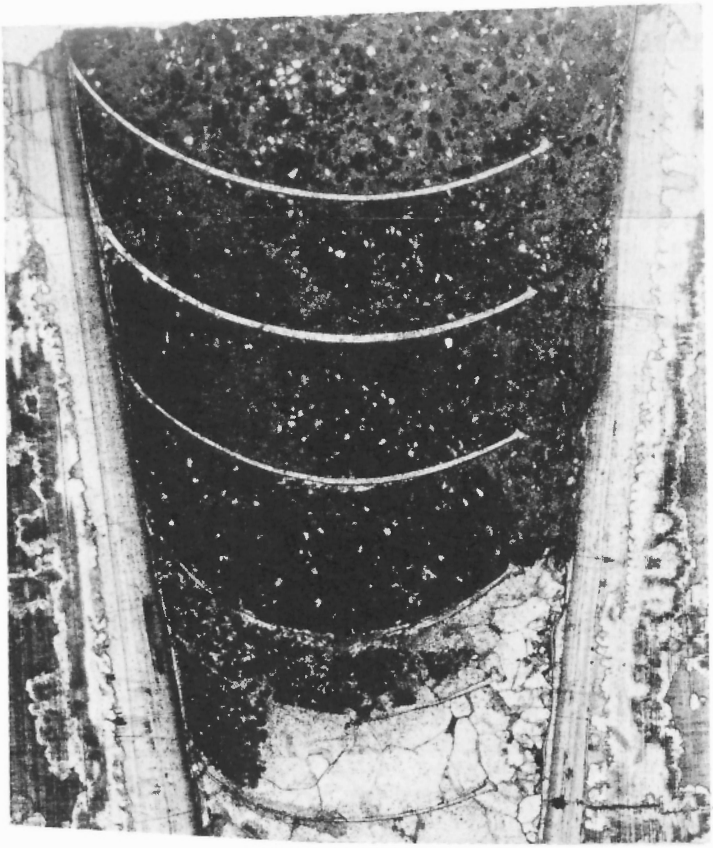
1G. Oralmost preserved part of the phragmocone adjoining that shown in figs. 1E and 1F. Dorsal parts of all septal necks (22nd to 27th inclusive) have double-pronged, adventrally sloping shapes. The ventral parts of all septa are Aulacocerida-like in being directly superimposed on and partly impressed into the conotheca (without any residual ventral parts of camerae similar to those of *Somalibelus*; *see* Jeletzky, 1972, p. 177, pl. 38, figs. 1b-1e), except for the adapical parts corresponding to the septal necks of the dorsal side. These ventral parts of septal necks are markedly bent, first inward and then adapically, narrowing the siphuncular tube at the septal foramina. However, they are distinctly orthochoanitic, in contrast to the dorsal necks. Though poorly preserved, the mural segments of the dorsal parts of the septa appear to have long spicular adoral flanges (e.g. on the oralmost septum reproduced), x12.

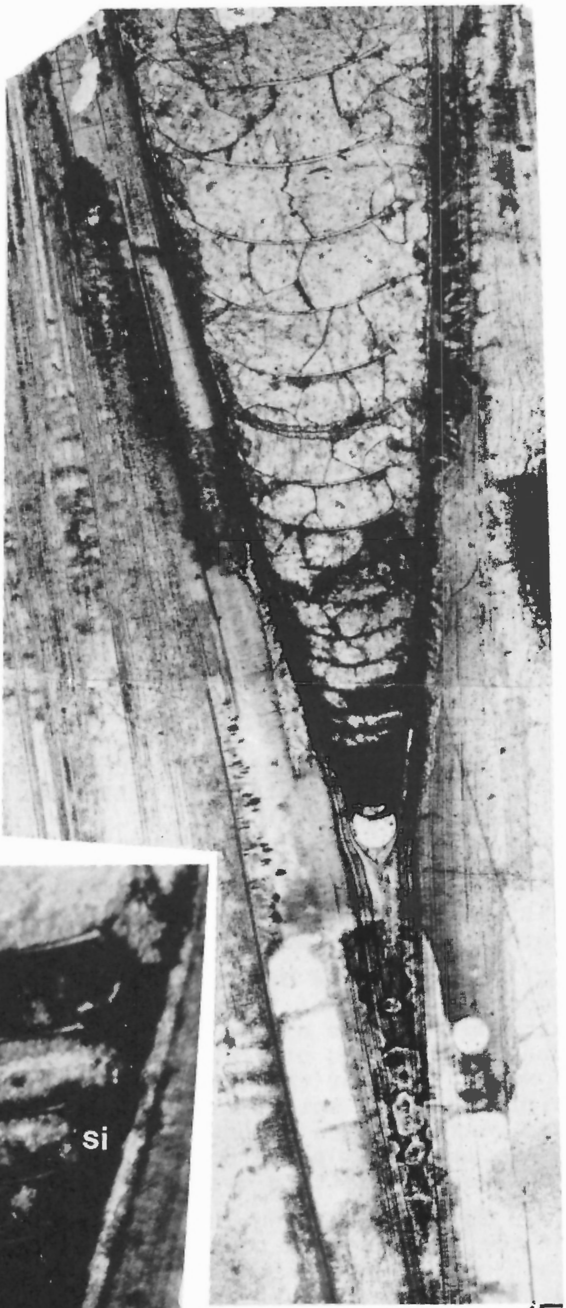
1H. Enlarged view of the protoconch, earliest nine septa (the ninth septum is numbered 9), and the earliest growth stages of the guard of the same thin section as in figs. 1E-1G. Though markedly loxochoanitic, the seventh to ninth dorsal septal necks (oralmost three necks shown), exhibit clearly defined adoral protuberances representing incipient adoral prongs (better collars if viewed in three dimensions) which gradually increase in subsequent septa (see figs. 1F, 1G). Though very poorly preserved, the ventral parts of the seventh to ninth septa appear to be already contiguous with the surface of the conotheca, except for the inward deflected apicalmost segments.

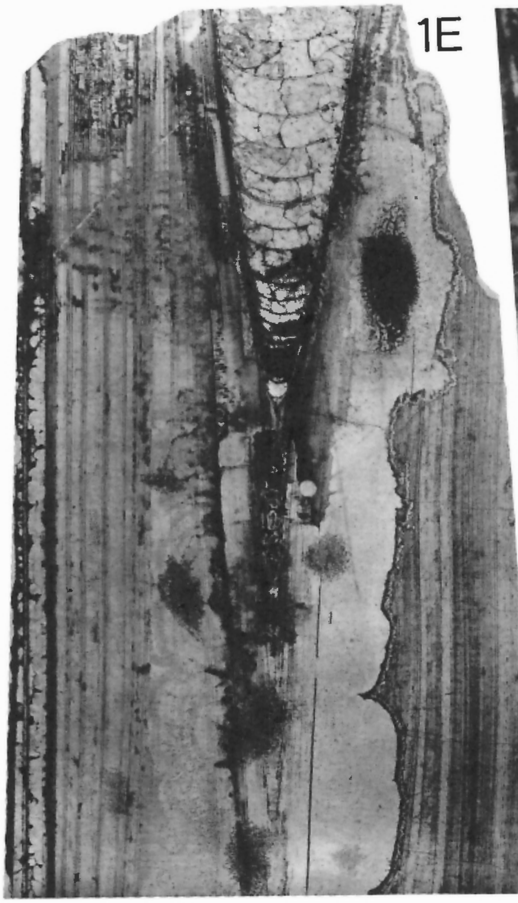
The earliest visible juvenile guard (jg), seemingly extremely broad and short-conical (almost *Coeloteuthis*-like), appears to be completely disfigured. This guard is not a primordial guard as it surrounds completely the protoconch and at least the early parts of the conotheca. It is presumed that this juvenile guard was originally like the apparently correlative earliest juvenile guard of *Duvalia emerici* shown in Pl. V, figs. 1A, 1B.

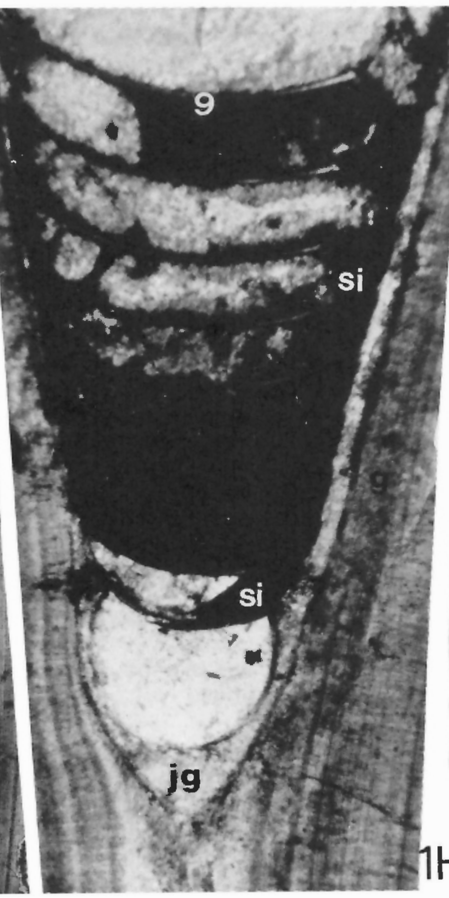
The black-coloured first segment of the siphuncle (si) is situated strongly adventrally as in other Belemnitida families. However, it is directed strongly obliquely adventrally so that it has migrated into a marginal ventral position by the second segment and remains in this position thereafter (compare figs. 1E, 1F, 1G). See Pl. II, figs. 1A-1D for structural details of the first to sixth septa which are almost invisible in this small scale photomicrograph, x45.

PLATE I


1G


1F


1E



1H


1A


1B


1C


1D

PLATE II

Figures 1A-1D. *Duvalia graziana* (Duval-Jouve, 1841). Structural detail of thin-section reproduced in Pl. I, figs. 1E, 1F, 1H. All photomicrographs, x260.

1A. Dorsal parts of the fourth, fifth, and sixth septal necks (marked dn_4, dn_5 and dn_6), adjacent dorsal parts of corresponding septa, and the poorly preserved ventral parts of the fourth and fifth septa (marked vs_4 and vs_5). The poorly-preserved, free septal neck (marked vn_6) of the sixth ventral septum is visible in the extreme upper right corner. The loxochoanitic shape of the dorsal parts of all necks is clearly visible. All three necks exhibit slightly protruding, broadly rounded oral prongs marked op). Dorsal parts of connecting rings are not preserved. Component layers of dorsal parts of septa cannot be definitively identified anywhere. The ventral parts of septa are already typically duvaliid in all their diagnostic features, except for the presence of slit-like residual ventral camerae (marked rvc). Adoral flanges marked af_4 and af_5. Free ventral necks (marked vn_4, vn_5 and vn_6) are considerably longer than those of subsequent septa and are much more strongly deflected inward (compare Pl. IV, figs. 2B, 2C). All structural detail of the conotheca (con) and the innermost layers of the guard is lost because of a strong overexposure used to bring out the structural detail of septa, etc.

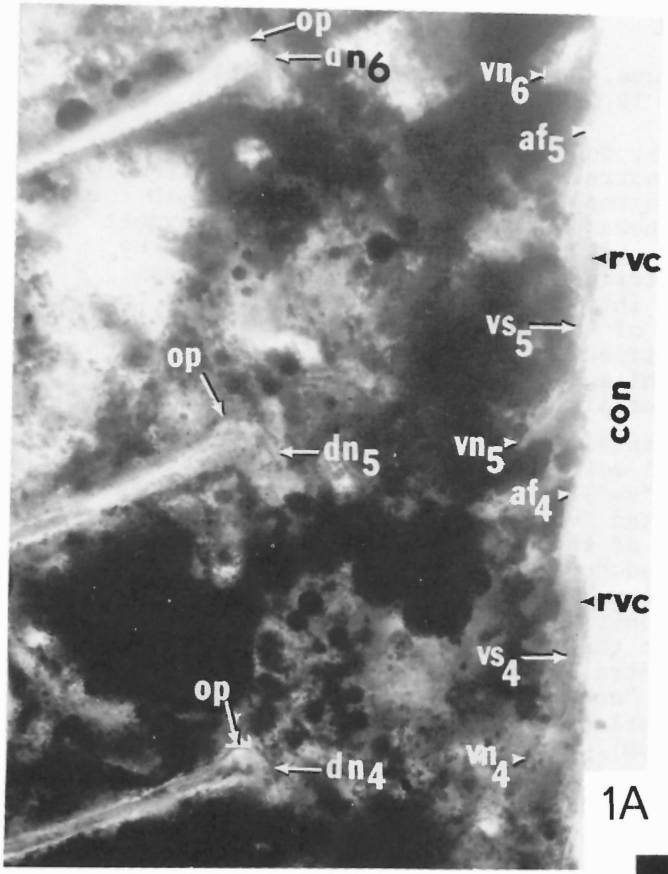
1B. Dorsal parts of the second, third and fourth septal necks (marked dn_2, dn_3, and dn_4), adjacent dorsal parts of the corresponding septa, and the poorly preserved ventral parts of the second, third, and fourth (apical part only) septa marked vs_2, vs_3, and vs_4 respectively. The oral prong (op) is barely suggested in the dorsal part of the second neck, in contrast to that in the third and fourth necks where it is already clearly visible. A fragment of the second segment of the dorsal part of connecting ring (cn_2) is preserved. Elsewhere the connecting rings cannot be seen. The second ventral camera (vc_2) is fairly wide and irregularly oval rather than slit-shaped. The ventral part of this second septum does not adhere to the conotheca anywhere. This camera is closely comparable to the first to tenth ventral camerae of Belemnopseidae (compare Jeletzky, 1972, Pl. 33, fig. 1b; Pl. 34, fig. 1c; this paper Pl. VII, fig. 1c; Pl. VIII, figs. 1D, 1E). However, this Belemnopseidae-like morphology disappears in the third (rvc_3) ventral camera of *Duvalia graziana* which is already slit-like, completely closed and thus residual. All structural detail of conotheca (con) and innermost parts of the guard (not differentiated) is lost because of a strong overexposure used to bring out structural detail of septa, etc. See Fig. 1A for the explanation of other abbreviations.

1C. Dorsal parts of the earliest three camerae. The photomicrograph also includes the addorsal corner of the protoconch (pr), adjacent parts of the conotheca (con), the innermost layers of the guard (gi) filling out the waist of the protoconch, and the innermost layers of the guard proper (g). The mural parts of septa are poorly preserved. However, that of the first septum seems to exhibit a partly dissolved adoral flange (af) similar to the spicular adoral flanges occurring in all better preserved subsequent dorsal and ventral septa of the specimen (see Pl. I, fig. 1G; Pl. III, figs. 1A-1C). Other abbreviations: psd - dorsal part of proseptum; cm - dorsal part of closing membrane (apparently split in two layers by strong postmortal deformation).

1D. The first segment of the siphuncle showing structural detail of the dorsal part of the first septal neck (dn_1), adjacent parts of the first dorsal septum, the ventral part of the first septum (vs_1), the adventral corner of the protoconch (pr), the completely recrystallized and indivisible conotheca and innermost layers of the guard (con & gi) and the innermost layers of the guard proper (g). Other abbreviations: cm - fragment of closing membrane in the adoral corner of protoconch; psd - tip of dorsal part of the proseptum; psv - the ventral part of the proseptum postmortally displaced adapically and superimposed on the preserved part of the closing membrane; cn_1 - the dorsal part of the first segment of the connecting ring; vn_1 - the poorly preserved ventral part of the first septal neck apparently similar to that of Belemnopseidae and other non-duvaliid belemnitids in its pronounced s-shaped adventral deflection; vc_1 - the ventral part of the first camera closely similar to the ventral part of the second camera (see in discussion of Fig. 1B for further details); af - spicular adoral flange of the first septum; op - incipient adoral prong of the dorsal part of the first septal neck.

Note the pronouncedly adventrally inclined orientation of the first siphuncular segment which is discussed in greater detail in the text.

PLATE II



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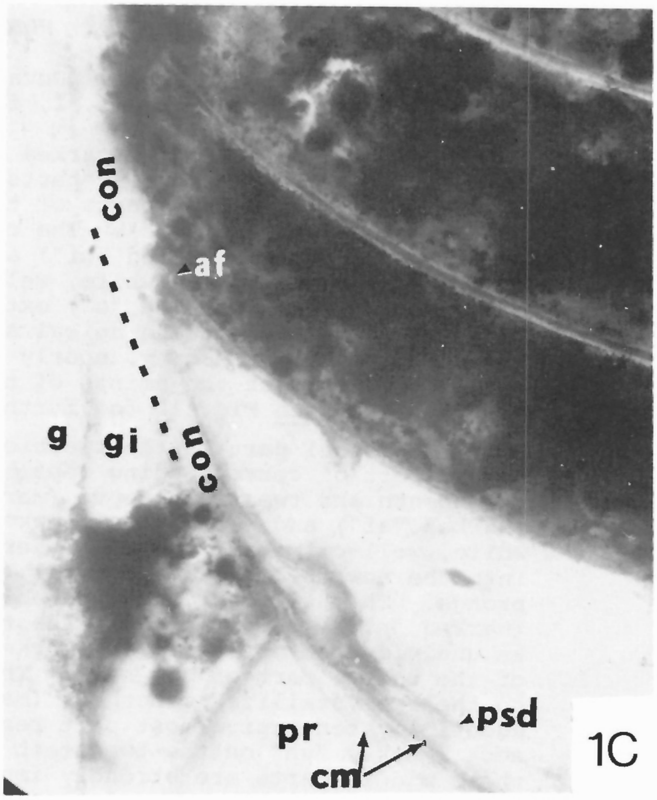

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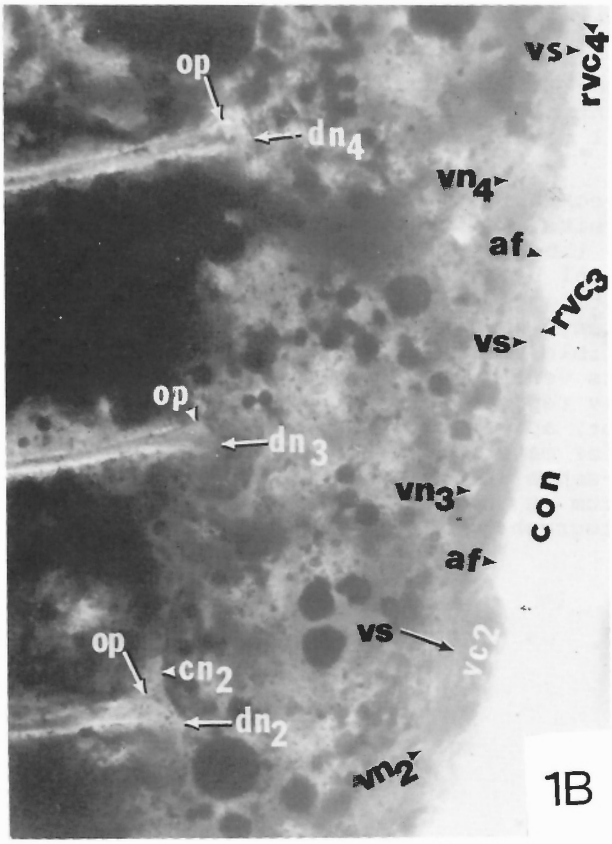

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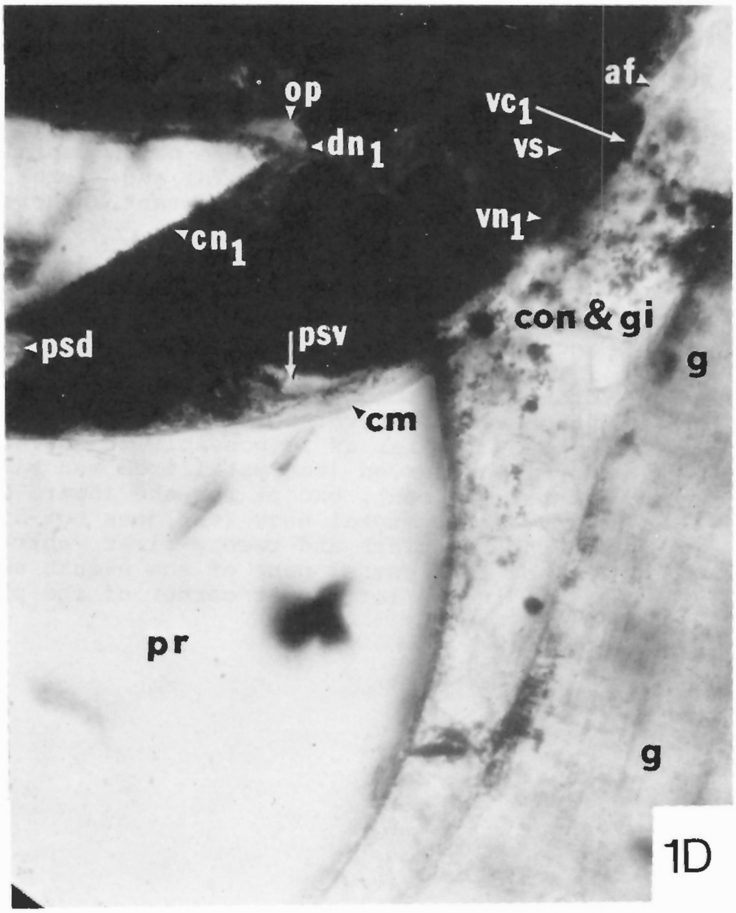


1D

PLATE III

Figures 1A-1D. *Duvalia graziana* (Duval-Jouve, 1841). Structural detail of thin-section reproduced in Pl. I, figs. 1E, 1F, 1G.

1A. Dorsal parts of ninth (marked "dn"), tenth, and eleventh (marked "dn") septal necks, adjacent dorsal parts of corresponding septa, and the extremely poorly preserved ventral parts of the corresponding septa (see in Fig. 1D for further structural details). The conotheca (marked "con") and the innermost layers of the guard (marked "gi") are recrystallized and partly replaced by ferruginous matter. The white, well-calcified central layer of the dorsal parts of the septa (marked "c") extends into the incipient protuberances on the oral side, but not the apical side, of the dorsal necks. The apical sides are built of the dark-grey, poorly calcified, undivided outer layer "n" which is dimly visible at the points of the white arrows in the ninth and eleventh septal necks (see Fig. 1D for further details), x130.

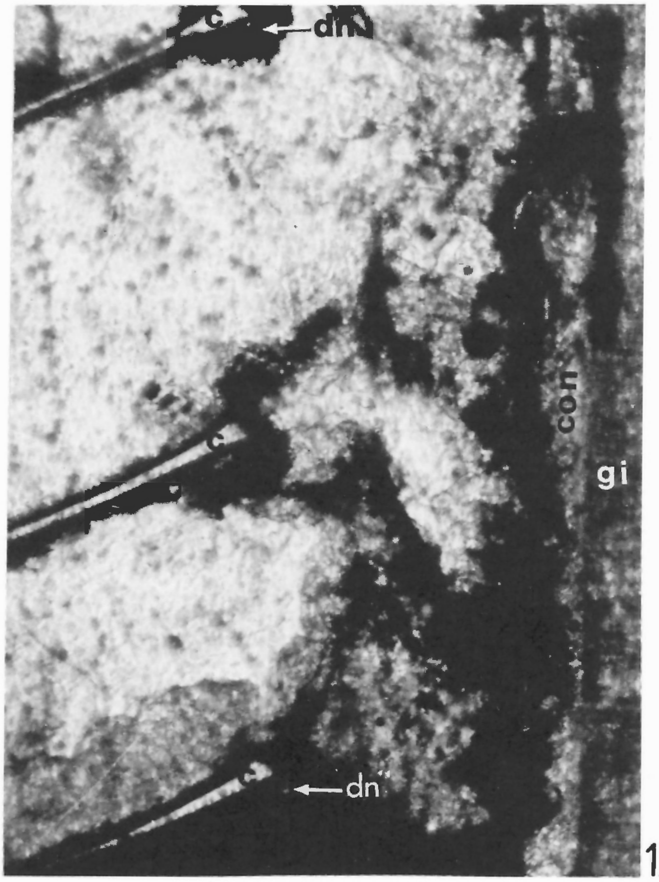
1B. The dorsal part of the twentieth septal neck (marked "dn"), the adjacent dorsal part of corresponding septum, and well-preserved ventral parts of the nineteenth and twentieth septa (marked "vs") including their adoral flanges (marked "af") and the ventral neck (marked "vn") of the twentieth septa. The white, well-calcified central layer "c" of the dorsal part of the septum extends into the now fully developed oral (marked "op") and apical (marked "ap") prongs. The dull-grey, considerably thinner upper (marked "n.1") and lower (marked "n.2") outer layers flank the central layer throughout and merge into an undivided outer layer (not marked) at the tips of the oral and apical prongs of the dorsal part of the neck. The ventral parts of both septa shown adhere to the recrystallized conotheca (marked "con"), except in the inward (i.e. addorsally) bent apicalmost part representing the ventral part of the septal neck (marked "vn" on the twentieth septum). The mural parts of the septa and their middle parts are strongly impressed into the recrystallized conotheca. No residual ventral parts of the camerae appear to be present behind the inward bulging upper parts of the septa (at the letters "vs"). The thin black band covering the conotheca between the tip of the twentieth ventral neck and the oral end of the nineteenth adoral flange may be the connecting ring, x72.

1C. The dorsal part of the twenty-first septal neck, etc. showing exactly the same structural detail as does the twentieth septal neck (see Fig. 1B). Lettering as in Fig. 1B, x72.

1D. The dorsal part of the ninth septal neck (also shown in Fig. 1A of this plate and in Pl. I, fig. 1H) and the ventral parts of the ninth and eighth septa. Enlargement of important structural detail not clearly visible in Fig. 1A, x280.

dn = loxochoanitic dorsal part of septal neck built of dull-grey, poorly calcified undivided outer layer "n"; c = white, well-calcified central layer forming most of the septum and the core of the incipient oral prong of the neck but not extending into the dorsal septal neck proper. The upper and lower outer layers (n_1 and n_2) are not distinguishable; op = incipient oral prong; cr = remnants of torn and twisted tenth connecting ring; vs = poorly preserved but nevertheless clearly discernible ventral part of the ninth septum. So far as is possible to see, this ventral septum adheres to the poorly preserved (recrystallized and partly replaced by ferruginous matter) conotheca (con), except for the inward bent, apicalmost part. This ventral part of the septal neck (vn) does not differ materially from equivalent parts of the twentieth and twenty-first ventral septa (see Figs. 1B, 1C). The oral end of the ventral part of the eighth septum is somewhat dimly visible (marked "vs") in the left lower corner of the photograph.

PLATE III



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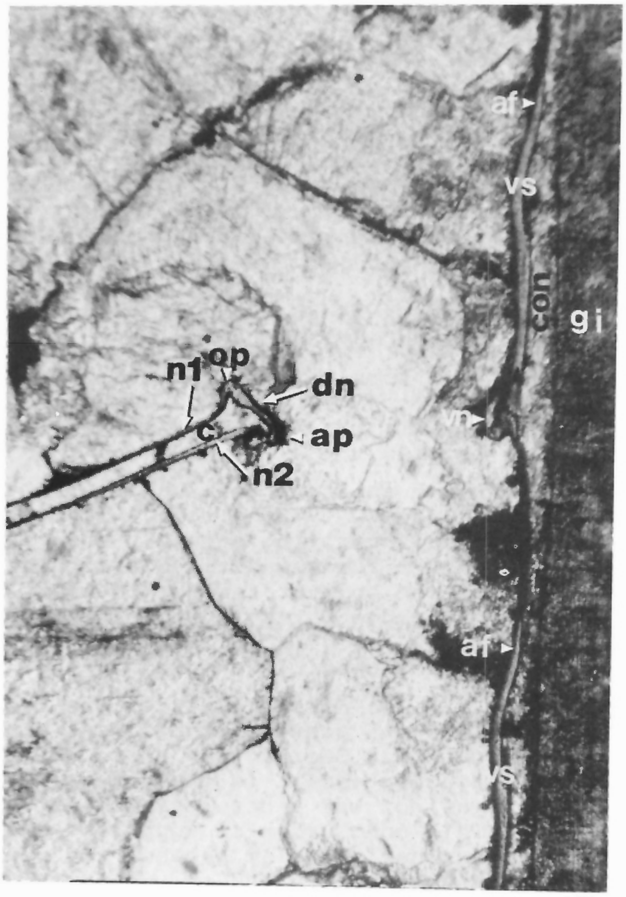

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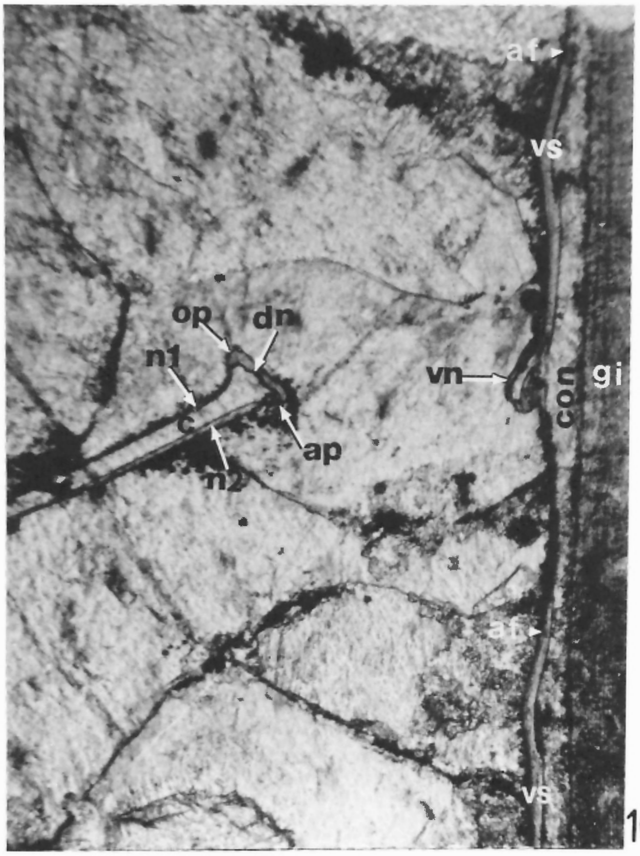

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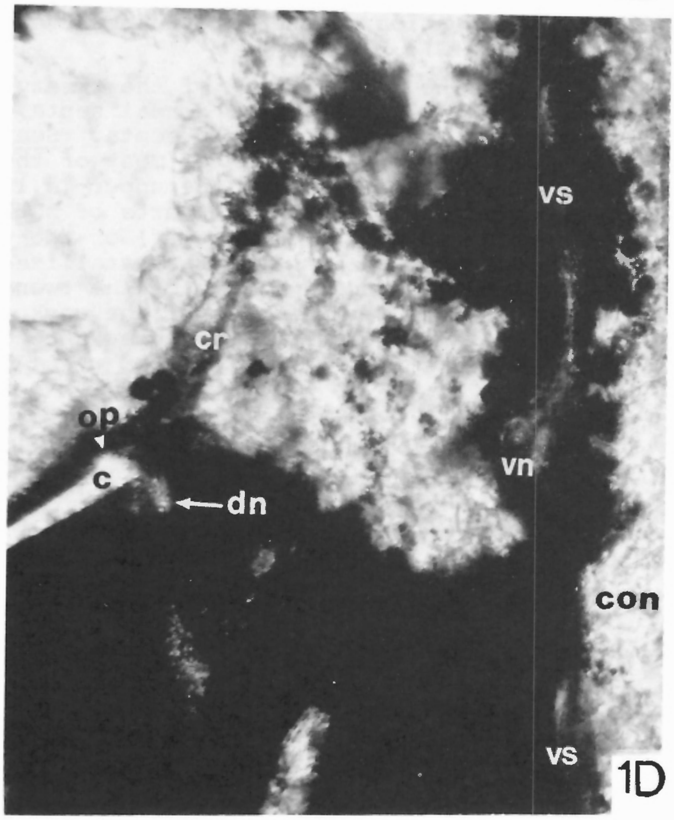

1D

PLATE IV

Figure 1. *Duvalia emerici* (Raspail, 1829). ?Valanginian. Castellane, southern France. Original in collections of Museum of Comparative Zoology, Harvard University, Cambridge, Mass. U.S.A., #3758/1. Longitudinal, dorso-ventral median polished section, x3. Ventral side left (marked "v"). Note the same characteristic duvaliid ontogeny as in *Duvalia graziana* (see Pl. I, figs. 1E, 1F). Some poorly preserved septa with oral and apical pronged dorsal septal necks are dimly visible in the oralmost part of the alveolar cavity.

Figures 2A-2C. *Duvalia graziana* (Duval-Jouve, 1841). Structural detail of the phragmocone shown in Pl. 1, figs. 1E-1F.

2A. Dorsal part of the eighth septal neck, adjacent parts of the septum, and poorly preserved ventral parts of the seventh and eighth septa. See Pl. II, fig. 1D for explanation of most of the abbreviations shown on this figure.

rvc = apparent residual ventral camera similar to that of *Somalibelus* (see Jeletzky, 1972, p. 177, Pl. 38, figs. 1b-1e); gi = innermost layers of the guard overlying strongly recrystallized conotheca. Strong recrystallization of the loxochoanitic dorsal part of the septal neck (marked "dn") has almost obliterated the boundary between the central layer "c" and the undivided outer layer "n" clearly visible in the ninth dorsal neck (see Pl. II, fig. 1D). However, the upper (n.1) and lower (n.2) outer layers are discernible on the adjacent parts of the dorsal septum, x260.

2B. The dorsal parts of the twenty-fourth and twenty-fifth septal necks, adjacent parts of the dorsal septa and the ventral part of the twenty-fourth septum. See Pl. II, figs. 1B, 1C for explanation of abbreviations. The apparent break in the conotheca immediately adorally from the adoral flange (af) of the ventral septum appears to be a result of postmortem distortion. This conclusion is supported by the complete absence of the conotheca farther adorally between the ventral parts of the twenty-fifth to twenty-seventh septa and the innermost layers of the guard (see Pl. I, fig. 1G). This photomicrograph overlaps with that of Fig. 2C. It illustrates the pronouncedly double pronged and strongly adventrally inclined (about 45°) orientation of the latest preserved dorsal necks of *Duvalia* (compare Pl. I, fig. 1G), x76.

2C. The dorsal parts of the twenty-third and twenty-fourth septal necks, adjacent parts of the dorsal septa, and the ventral parts of the twenty-third and twenty-fourth septa. See Pl. II, fig. 1D and fig. 2B of this plate for explanation of most of the abbreviations shown in this figure. Note the presence of the upper (n.1) and lower (n.2) and undivided (n) outer layers on distal parts of both the dorsal septa and necks. The spicular adoral flange (af) of the ventral part of the twenty-third septum is impressed into the recrystallized conotheca (con) but does not "pierce" it as the adoral flange of the twenty-fourth septum seems to. The well-preserved ventral part of the neck (vn) of the twenty-third septum retains the same loxochoanitic appearance of all the preceding ventral necks, x76.

PLATE IV

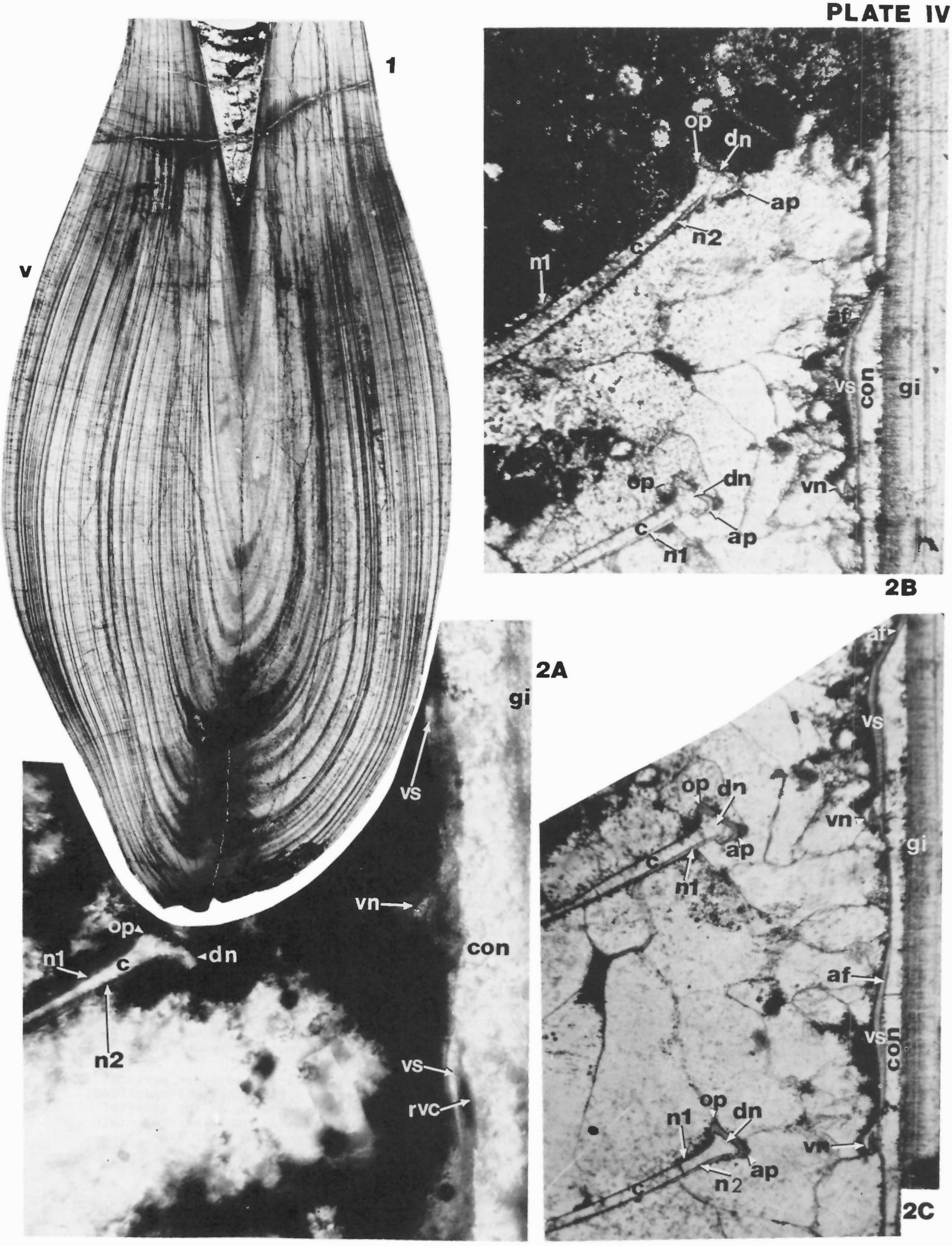
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PLATE V

Figures 1A-1B. *Duvalia dilatata* (Raspail, 1829) var. *majoriana* Stoyanova-Vergileva 1965. Hauterivian (probably lower), Aiglun, Vascogne, southeast France. Collected by J.A. Jeletzky, 1967. GSC Cat. No. 59018.

1A. Inside view of longitudinal, dorso-ventral, polished section ground to the plane of symmetry, x1.

Note the same characteristic duvaliid, basically belemnitine ontogenetic development of the guard as in *D. graziana* (see Pl. I, figs. 1E, 1F) and *D. emerici* (see Pl. III, fig. 1).

1B. Enlarged view of the more diagnostic parts of the polished section in Fig. 1A, x4. Enlargement shows the distinct double-pronged dorsal parts of the six adoral septal necks, the fusion of the ventral parts of the same septa with the conotheca (except for the inward deflected apicalmost parts representing the ventral parts of the septal necks) and the short-conical, almost *Coeloteuthis*-like earliest visible juvenile guard (jg). Unlike the "adult" dorsal necks of *D. graziana* (Pl. I, fig. 1G), those of *D. dilatata* are only slightly adventrally inclined and exhibit long, finger-like oral prongs (op). In these respects they resemble closely the "adult" dorsal necks of *Conobelus (Conobelus) conophorus* (see Pl. VI, figs. 1B, 1D).

Figures 2A-2D. *Conobelus (?Conobelus) orbignyanus* (Duval-Jouve, 1841). Upper Valanginian. Arnayon, Drôme, southeastern France. Original in palaeontological collections of the Institute Dolomieu, Université Scientifique et Médicale de Grénoble, France.

2A. Overall view of longitudinal, dorso-ventral, median thin-section, x4. Ontogenetic development resembles closely that of other duvaliids sectioned by the writer, except that the long-conical (*Acrocoelites*-like) growth-stage ends much earlier (i.e. at one-fifth to one-sixth of the total preserved length of the guard) and is followed by a feebly fusiform, slender, acutely apicate growth stage similar to intermediate growth stages of the belemnopseid guard (see Pl. VII, fig. 1A; Pl. IX, fig. 1A). The homeomorphic character of this ontogenetic development is, however, revealed by the essentially duvaliid structure of most other features of the phragmocone (see figs. 2B, 2C, 2D).

2B. The dorsal parts of the twelfth (dn_{12}) and thirteenth (dn_{13}) septal necks, adjacent dorsal parts of the septa, ventral parts of the twelfth (vs_{12}) and thirteenth (vs_{13}) septa (including their necks marked vn_{12} and vn_{13} respectively), the ventral side of the conotheca (con), and the innermost layers of the guard (gi), x130.

The poorly preserved, partly dissolved dorsal parts of both necks appear to consist of the central layer (c) only. The twelfth neck (dn_{12}) appears to be distinctly loxochoanitic and to exhibit short adapical (ap) and adoral (op) prongs filled by the central layer. The ventral parts of the twelfth (vs_{12}) and thirteenth (vs_{13}) septa adhere to the conotheca only in their adapical two-thirds. Slit-like residual ventral camerae (rvs_{12} and rvs_{13} respectively) separate their adoral thirds from the strongly recrystallized conotheca (con). The apicalmost part of these ventral septa is abruptly bent inward forming short septal necks (marked vn_{12} and vn_{13} respectively). Though generally similar to the ventral parts of the septal necks of other Duvaliidae (see in Pls. I-III and V), and situated almost opposite the dorsal parts of the necks, these necks are peculiar in their distinctly double-pronged appearance. The double-pronged appearance of all the preserved (first to at least fifteenth) ventral parts of the septal necks and the preservation of slit-like, residual ventral camerae in the early growth stages appear to be phylogenetically primitive features diagnostic of the genus *Conobelus* and absent in other Duvaliidae genera.

The adoral flanges of the ventral septa cannot be clearly seen but are believed to be similar to those of the other *Conobelus* (see Pl. VI, fig. 1C).

2C. The apicalmost part of the siphuncle (S) and the adjacent parts of the protoconch (PR), conotheca (con), and innermost parts of the guard (gi and g) on the ventral side, x350.

psd = dorsal part of the proseptum; psv = ventral part of the proseptum; cm = closing membrane; fs = foot of siphuncle; gi = poorly calcified, spongy innermost layers of the guard filling out the "waist" of the protoconch (see Jeletzky, 1972, p. 173, Pl. 37, figs. 1b, 1c for further details); g = normal innermost layers of the guard discordantly overlying the recrystallized conotheca and the spongy innermost layers of the guard filling out the protoconch's waist; cr_1 = first segment of the connecting ring (black); vn = very poorly preserved, inward deflected apicalmost part (i.e. ventral neck) of the first ventral septum. The adoral parts of this septum were obliterated by recrystallization of the conotheca. However, the character of the first ventral neck and the immediate superposition of the first and second segments of the siphuncle on the conotheca leave no doubt that the bulk of the first ventral septum was fused with the conotheca.

Note that the apex of the siphuncle is strongly adventral as it is in all other Belemnitida families. However, unlike the latter, the first segment is strongly inclined ventralwards and the ventral side of the first segment of the connecting ring is superimposed on the ventral part of the proseptum. This orientation results in the characteristic duvaliid marginal ventral position of the first and all subsequent segments of the *Conobelus (?Conobelus) orbignyanus* siphuncle.

2D. The dorsal parts of the ninth (dn_9) and tenth (dn_{10}) septal necks and adjacent parts of the septa consisting largely of the light-grey, almost homogeneous, apparently well-calcified central layer (c). The thin, dark-grey outer layer (n2) is only discernible on the adapical surface of the ninth septal neck. Because of the partly dissolved and strongly altered state of the septal necks proper, it is not possible to differentiate the central layer from the outer layer. Note the apparently regular short orthochoanitic appearance of both septal necks and the apparent absence of an adoral prong in both of them. If not simulated by postmortem deformation and/or alteration, this indicates the Belemnitina- and Belemnopseidae-like appearance of the dorsal parts of the early septal necks in subgenus *Conobelus*. This apparently primitive feature agrees well with the other primitive morphologic features of the *Conobelus (?Conobelus) orbignyanus* phragmocone mentioned in the description of Fig. 2B, x196.

PLATE V

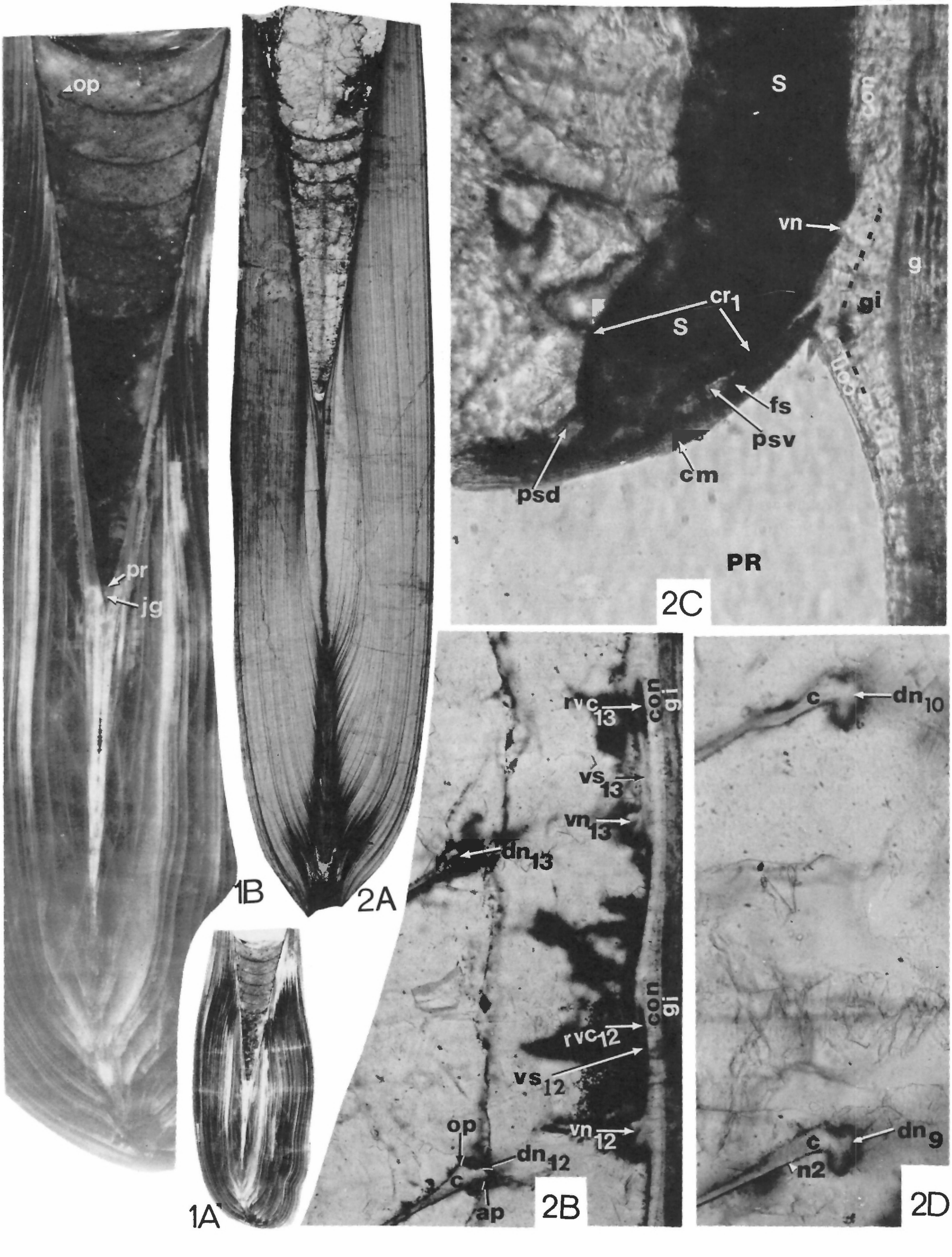
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PLATE VI

Figures 1A-1E. *Conobelus (Conobelus) conophorus* (Oppel, 1856). Upper Tithonian, Stramberg beds, Stramberg, Czechoslovakia. Original in collections of the Geological Institute of the Vienna University, Austria. Cat. #1901-VII-88.

1A. Overall view of longitudinal, dorso-ventral, median thin-section of a fragment of the alveolar part of the guard. Only three septa in the oralmost part of the thin-section (estimated to be thirty-first to thirty-third from the protoconch) are well-preserved. All earlier and later septa are strongly recrystallized and consequently do not exhibit most of the critical structural details, x5.

1B. The adoral part of the thin-section reproduced in Fig. 1A, x10.

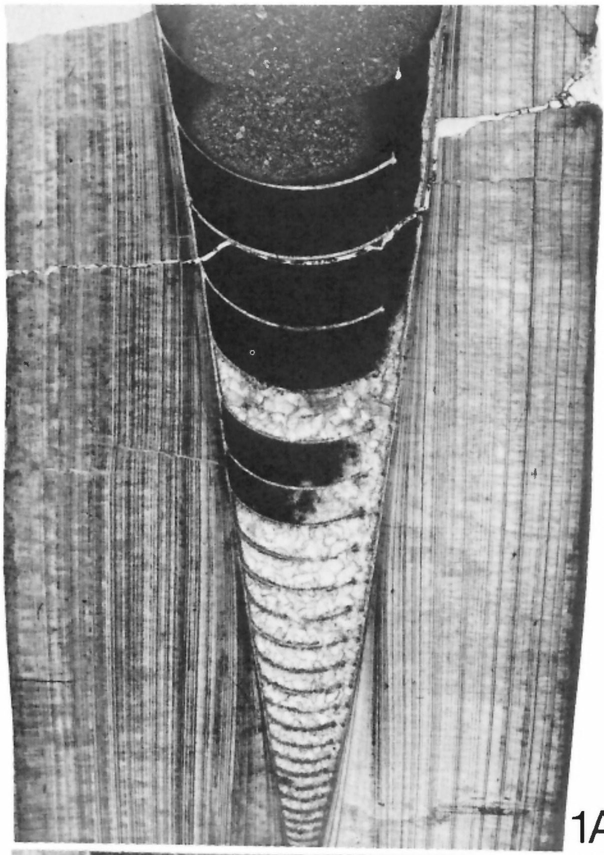
The double pronged character of the dorsal parts of the septal necks of the estimated thirty-first to thirty-third septa (marked "ds") are clearly visible. The same is true of the less well-preserved thirtieth (lowermost visible) and thirty-fourth (uppermost visible) septa. Unlike the strongly adventrally sloping dorsal parts of the twenty-third to twenty-fifth septal necks of *Duvalia graziana* (see Pl. I, fig. 1G), the corresponding parts of the necks (dn) of *Conobelus (Conobelus) conophorus* are approximately aligned with the direction of the siphuncular tube. Though poorly preserved, the ventral parts of the septa (vs indicated by arrow) are contiguous with the surface of the conotheca except for the apicalmost part. The latter is bent obliquely inward the phragmocone just as are the corresponding parts of the advanced septa of *Duvalia graziana* (Pl. I, fig. 1B; Pl. II, figs. 1B, 1A; Pl. III, figs. 1B, 1C), x10.

1C. Mural part of the ventral part of the estimated thirty-fourth septum (uppermost in figs. 1A, 1B) showing the long, Belemnitina-like (e.g. Jeletzky, 1966, p. 123, Fig. 14, Pl. 12, figs. 3A-3D) adoral flange (afc) The boundary between the oral flange and the conotheca (con) is clear adorally but is partly obscured by recrystallization adapically where its approximate position is indicated by a dashed line. This addorsally flanged mural part of the dorsal septum (ds) is quite unlike the flangeless mural parts of the dorsal septa of Belemnopseidae (see Jeletzky, 1972, p. 177-178, Pl. 36, figs. 1b, 1c; Pl. 35, figs. 2b, 2c; this paper, Pl. VII, fig. 1B), x35.

1D. Dorsal part of the thirty-third (est.) septal neck and the adjacent part of the thirty-third ventral septum (vs). The completely recrystallized conotheca (con) is sharply delimited from the well-preserved innermost layers of the guard (gi). The whitish-grey, well-calcified, short inner parts of the adapical (ap) and oral (op) prongs of the dorsal neck are built of the central layer (c). The elongated finger- to wedge-like outer parts of the same prongs are built of a medium- to dark-grey, poorly calcified undivided outer layer (n). No parts of the connecting rings appear to be preserved. The very poorly preserved inward deflected ventral part of the septal neck (vn) is dimly visible at the apical end of the ventral septum, x35.

1E. The mural part of the dorsal side of the thirty-third septum (est.) showing the same diagnostic adoral flange as the mural part of the thirty-fourth septum (see Fig. 1C). However, unlike the latter, the boundary of the thirty-third septum with the adjacent parts of the conotheca has been obliterated by recrystallization. The dotted line delimiting the two structural elements was drawn using the example of the thirty-fourth septum (see Fig. 1C). Abbreviations as in Fig. 1C, x90.

PLATE VI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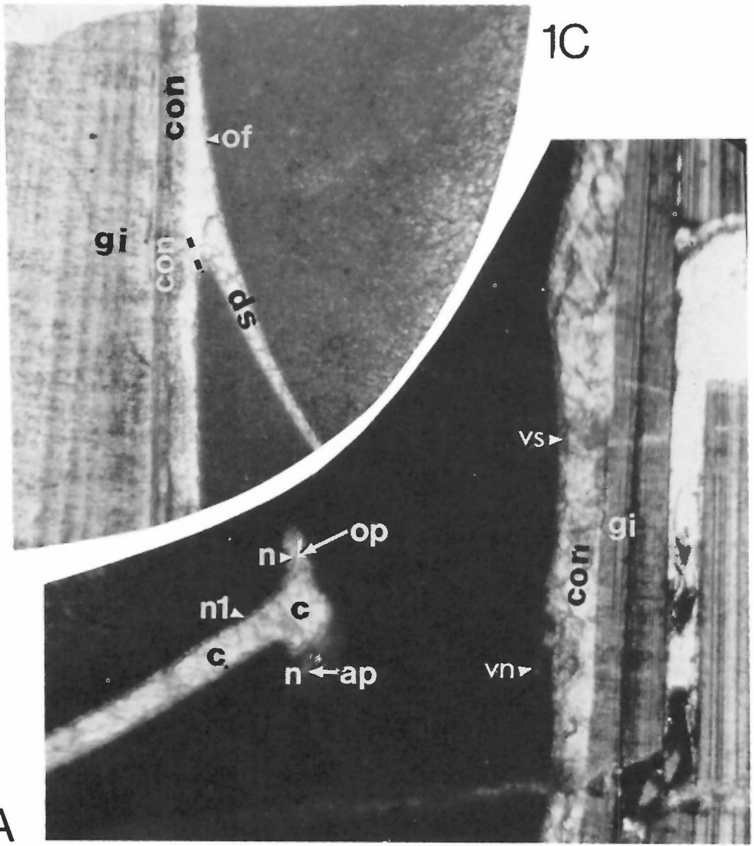

1C
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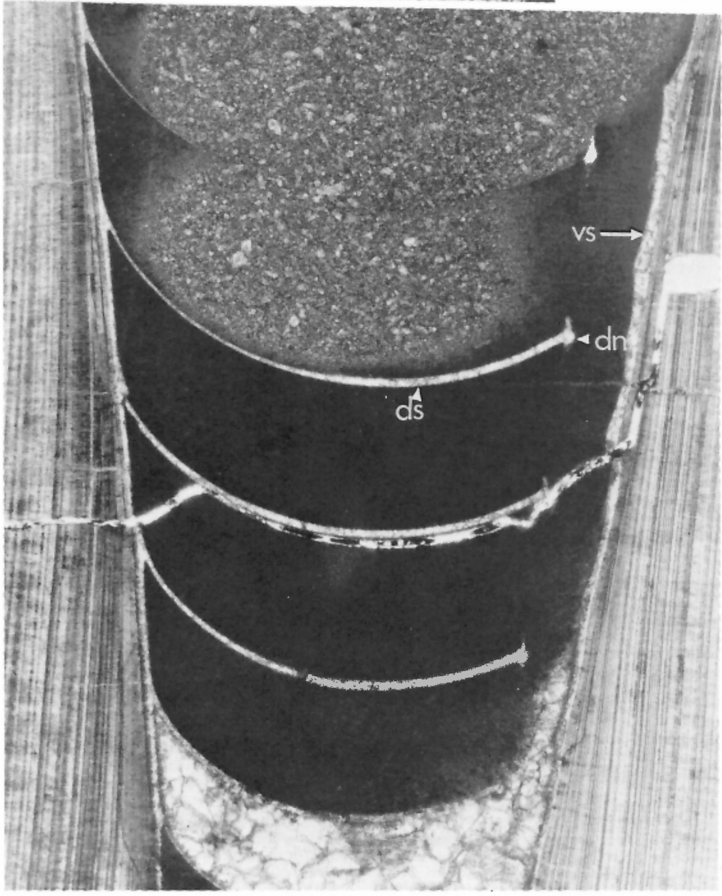

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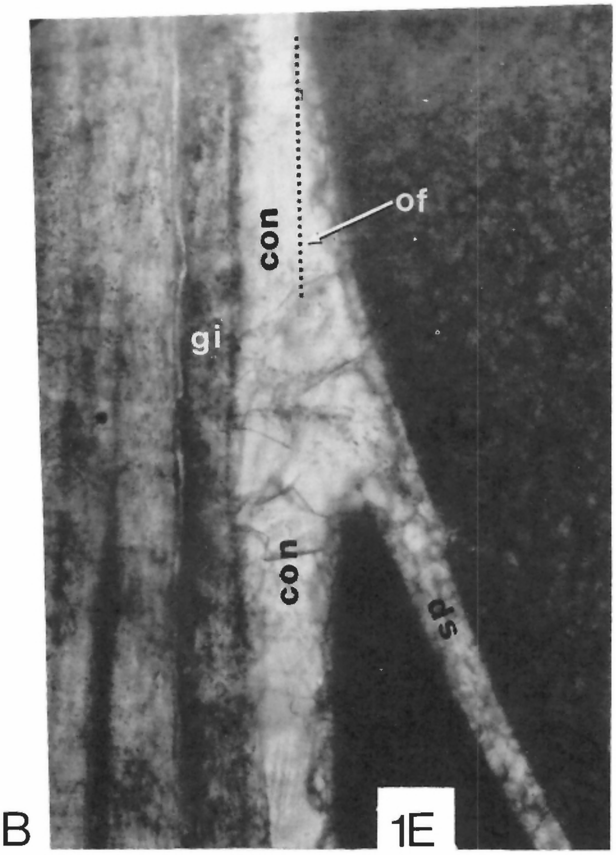


1E

PLATE VII

Figures 1A-1C. *Hibolithes hastatus* (de Blainville, 1827). White Jura alpha-beta (Oxfordian), Wuerttemberg. Southwest Germany. No exact locality. GSC loc. 62300, GSC Cat. No. 59001.

1A. Overall view of longitudinal dorso-ventral, median thin-section prepared from the alveolar part of a large, typical representative of the species. The phragmocone and protoconch are slightly deformed (expanded). The indistinctly delimited primordial guard (pg) is narrow and long-conical. The adventrally situated first segment of the siphuncle is only feebly inclined adventrally unlike that of all sectioned duvaliids, x15.

1B. Mural parts (ms) of the sixth and seventh dorsal septa, adjacent parts of free septa (ds), conotheca (con), and innermost layers of the guard (gi).

The mural parts of the septa (ms) appear to abut directly against a marked bulge of the innermost layer of the conotheca (bc) without forming any spicular adoral flange or thickening similar to that characteristic of duvaliids (see in Pls. I-VI inclusive). The contact plane (= adnation surface) is marked by adn.

The conotheca is overlain by thin inorganic pellicular layer (p) which overlaps the adoral surfaces of mural parts of the septa before disappearing. The unusually well-preserved conotheca appears to exhibit the four component layers (marked 1 to 4 from the inside toward the outside) observed in *Somalibelus* (see Jeletzky, 1972, p. 171-172, Pl. 35, figs. 2b, 2c), in other Belemnopseidae and in other Coleoidea (e.g. Aulacocerida), x260.

1C. Dorsal parts of the third to seventh septa (marked ds3 to ds7 inclusive), their necks (marked dn3 to dn7 inclusive), dorsal parts of the intervening connecting rings (marked cn4 to cn8 inclusive) and adnation surfaces of successive segments of the connecting rings (marked adn). Dorsal parts of the septa exhibit a well-preserved central layer (c), upper outer layer (n$_1$), lower outer layer (n$_2$) and undivided outer layer (n). The latter is restricted to the septal necks only. The ventral parts of the second to seventh septa are marked vs2 to vs7 inclusive, their necks are marked vn3 to vn7 inclusive, ventral parts of the intervening connecting rings are marked cn2 to cn8 inclusive. Also shown are the ventral wall of the conotheca (con) and the innermost guard layers (gi) on the ventral side.

The well-preserved ventral wall of the conotheca mostly exhibits the same four component layers (marked 1 to 4 inclusive from the inside toward the outside) as the dorsal wall shown in Fig. 1B (see there for further details).

The connecting rings locally (especially in the eighth segment on the dorsal side and in the seventh segment on the ventral side) exhibit the well-defined bilayered structure described by Jeletzky (1966, p. 127, Pl. 7, figs. 1B-1E; Figs. 6A, 6B). The inner component layer is marked 1 while the outer layer is marked 2.

The reproduced segment of this *H. hastatus* phragmocone differs from the corresponding growth stages of duvaliid phragmocones (see Pls. I-III, V) in every taxonomically significant morphologic detail while being morphologically indistinguishable from the corresponding growth stages of *Somalibelus somaliensis* Spath (see Jeletzky, 1972, Pl. 33, figs. 1a-1e, Pl. 34, figs. 1a-1g; Pl. 35, figs. 2a-2d) and other Belemnopseidae genera studied by the writer (see Pl. VIII).

The dorsal necks dn$_3$ to dn$_7$ inclusive are quite unlike the corresponding dorsal necks of the Duvaliidae in remaining longitudinal, long orthochoanitic, and devoid of adoral prongs. The ventral parts of necks and connecting rings of the second to seventh septa are even more dissimilar to the corresponding elements of the Duvaliidae phragmocone. They all remain separated from the ventral wall of the conotheca by narrow but well-developed ventral parts of the camerae (marked vc2 to vc7 inclusive). As in other Belemnopseidae genera studied (see Jeletzky, 1972, p. 175-177, Pl. 33, 1a-1d, Pl. 35, fig. 1a, Pl. 36, fig. 1a; Pl. VIII, figs. 1B,1D,1F) the ventral wall of the *Hibolithes hastatus* siphuncle migrates ventralward only gradually in the course of ontogeny. This results in a correspondingly gradual reduction in width of the ventral camerae which only become slit-shaped in the twelfth to fifteenth camerae and do not completely disappear in the youngest camerae studied (i.e. twentieth to twenty-second; see Jeletzky, 1972, p. 180). The siphuncle of all Duvaliidae genera migrates abruptly into a marginal ventral position in the first camera. This produces an almost complete disappearance of the ventral parts in the next two to four camerae in all the duvaliid genera studied. The third to seventh ventral necks (marked vn3 to vn7 inclusive) of the figured phragmocone of *H. hastatus* are long orthochoanitic to suborthochoanitic and lack completely the inward-bent secondary ventral necks characteristic of all studied Duvaliidae genera (see Pls. I-V).

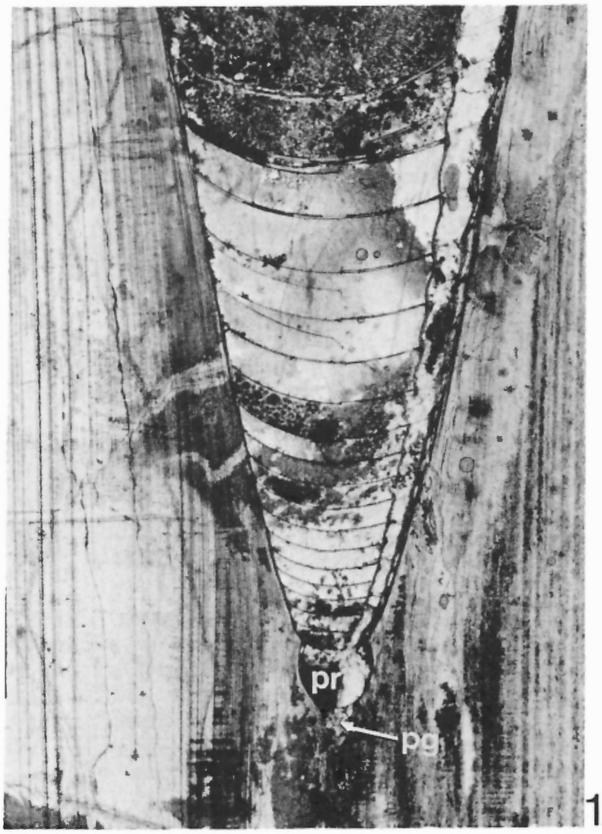
The mural parts of the ventral septa (marked ms in the fifth septum) are built exactly like those of the dorsal parts of the sixth and seventh septa reproduced in Fig. 1B (see there for further details).

Other abbreviations are: dorsal parts of camerae = dc$_3$ to dc$_8$; adnation surfaces of connecting rings and septal necks and those of the mural parts of ventral septa and conothecal bulges = adn; conothecal bulges = bc; most pronounced secondary fractures of connecting rings and septa (including septal necks) = f, x280.

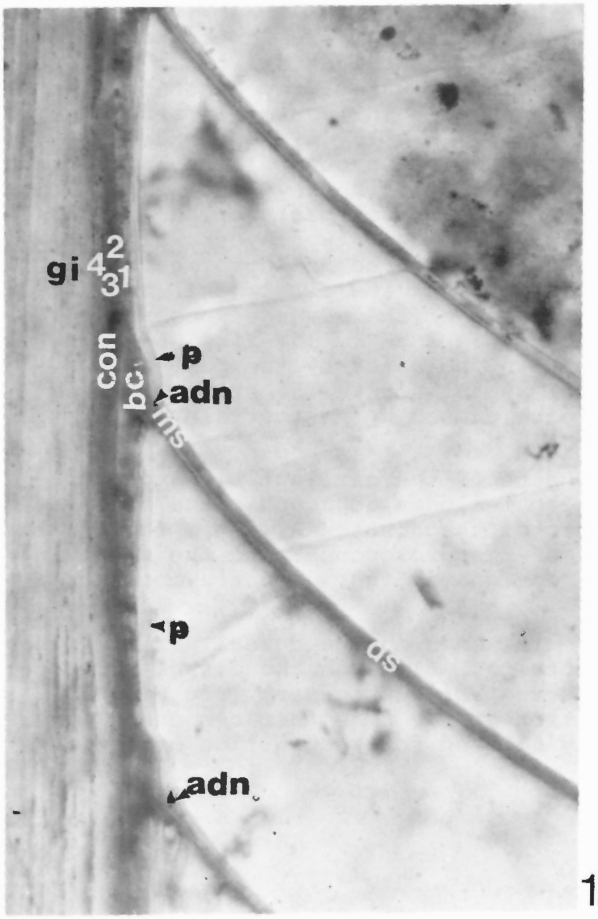
The dorsal necks dn$_3$ to dn$_7$ inclusive are quite unlike the corresponding dorsal necks of the Duvaliidae in remaining longitudinal, long orthochoanitic, and devoid of adoral prongs. The ventral parts of necks and connecting rings of the second to seventh septa are even more dissimilar to the corresponding elements of the Duvaliidae phragmocone. They all remain separated from the ventral wall of the conotheca by narrow but well-developed ventral parts of the camerae (marked vc2 to vc7 inclusive). As in other Belemnopseidae genera studied (see Jeletzky, 1972, p. 175-177, Pl. 33, 1a-1d, Pl. 35, fig. 1a, Pl. 36, fig. 1a; Pl. VIII, figs. 1B, 1D, 1F), the ventral wall of the *Hibolithes hastatus* siphuncle migrates ventralward only gradually in the course of ontogeny. This results in a correspondingly gradual reduction in width of the ventral camerae which only become slit-shaped in the twelfth to fifteenth camerae and do not completely disappear in the youngest camerae studied (i.e. twentieth to twenty-second; see Jeletzky, 1972, p. 180). The siphuncle of all Duvaliidae genera migrates abruptly into a marginal ventral position in the first camera. This produces an almost complete disappearance of the ventral parts in the next two to four camerae in all the duvaliid genera studied. The third to seventh ventral necks (marked vn3 to vn7 inclusive) of the figured phragmocone of *H. hastatus* are long orthochoanitic to suborthochoanitic and lack completely the inward-bent secondary ventral necks characteristic of all studied Duvaliidae genera (see Pls. I-V).

The dorsal necks dn$_3$ to dn$_7$ inclusive are quite unlike the corresponding dorsal necks of the Duvaliidae in remaining longitudinal, long orthochoanitic, and devoid of adoral prongs. The ventral parts of necks and connecting rings of the second to seventh septa are even more dissimilar to the corresponding elements of the Duvaliidae phragmocone. They all remain separated from the ventral wall of the conotheca by narrow but well-developed ventral parts of the camerae (marked vc2 to vc7 inclusive). As in other Belemnopseidae genera studied (see Jeletzky, 1972, p. 175-177, Pl. 33, 1a-1d, Pl. 35, fig. 1a, Pl. 36, fig. 1a; Pl. VIII, figs. 1B, 1D, 1F), the ventral wall of the *Hibolithes hastatus* siphuncle migrates ventralward only gradually in the course of ontogeny. This results in a correspondingly gradual reduction in width of the ventral camerae which only become slit-shaped in the twelfth to fifteenth camerae and do not completely disappear in the youngest camerae studied (i.e. twentieth to twenty-second; see Jeletzky, 1972, p. 180). The siphuncle of all Duvaliidae genera migrates abruptly into a marginal ventral position in the first camera. This produces an almost complete disappearance of the ventral parts in the next two to four camerae in all the duvaliid genera studied. The third to seventh ventral necks (marked vn3 to vn7 inclusive) of the figured phragmocone of *H. hastatus* are long orthochoanitic to suborthochoanitic and lack completely the inward-bent secondary ventral necks characteristic of all studied Duvaliidae genera (see Pls. I-V).

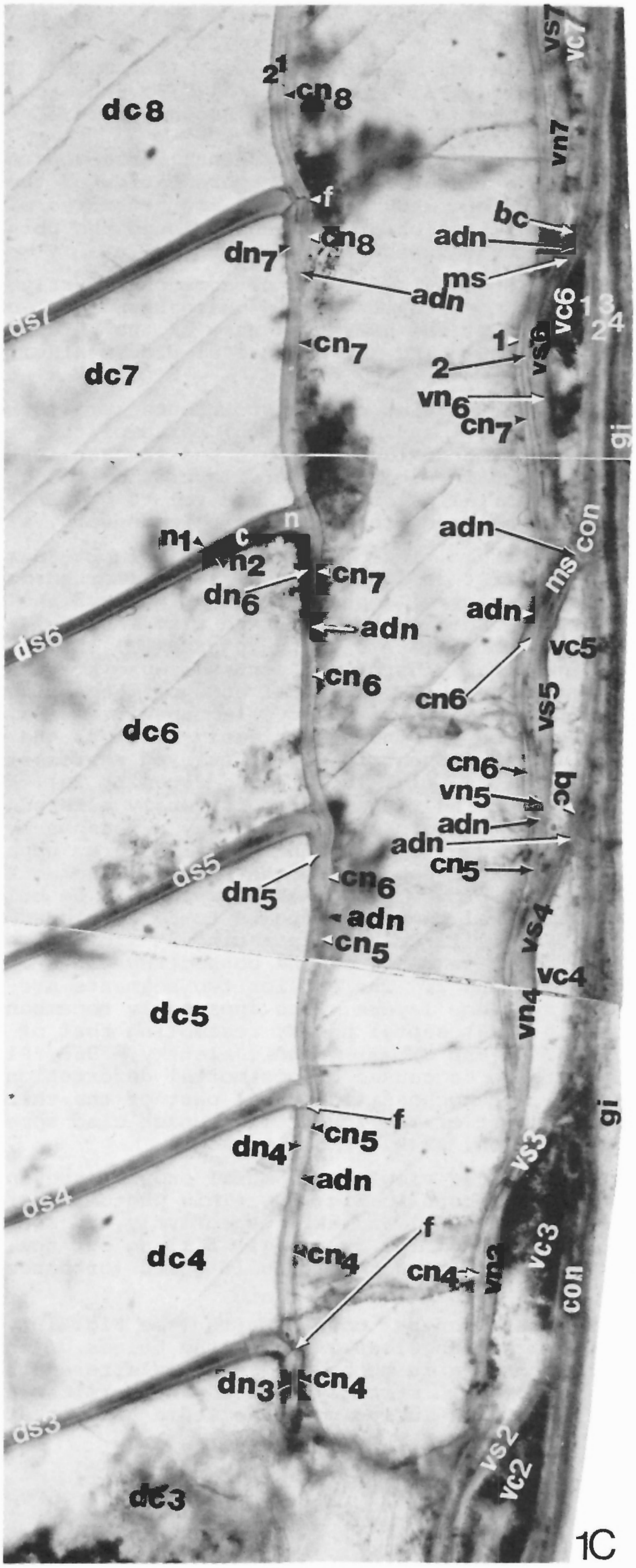
PLATE VII



1A



1B



1C

PLATE VIII

Figures 1A-1E. *Mesohibolites ewaldi* (Strombeck, 1861). Museum of Natural History, Basel, Switzerland, Pal. coll. loc. J17776, Cat. No. J17776/2. Aptian. Central Switzerland, Engelbergertal, E Dallenwil, Buochserhorn, Luitere Zug.

1A. Overall view of longitudinal dorso-ventral, median thin-section of the alveolar part of a large, typical representative of the species. The earliest eight chambers of the undeformed phragmocone are preserved within the guard. Note strong to total recrystallization of the guard around the phragmocone expressed in partial to complete loss of concentric growth layers, x4.

1B. Enlarged view of the phragmocone, partly recrystallized primordial guard (pg) and the innermost layers of the guard proper (g) of the thin-section reproduced in 1A. The structure of the preserved part of the phragmocone is belemnopseid in every discernible detail, including the gradual displacement of the siphuncle (si) in the earliest camerae, etc., x30.

1C. Enlarged view of the protoconch (pr), strongly deformed closing membrane (cm), ventral (prv) and dorsal (prd) parts of the proseptum, earliest, saucer-like shaped part of the primordial guard (pg1) and the earliest three camerae of the thin-section reproduced in Fig. 1B. Dorsal parts of the camerae are marked dc1 to dc3 inclusive while their ventral parts are marked vc1 to vc3 inclusive. The structure of the siphuncle (si) and the camerae are typically belemnopseid, x120.

1D. Enlarged view of the four apicalmost segments of the siphuncle (si), adjacent parts of the first to fourth dorsal septa (marked ds1 to ds4 inclusive) and the complete first to third ventral septa (marked vs1 to vs3 inclusive) of the thin-section reproduced in Fig. 1B. This photomicrograph also includes the ventral wall of the conotheca (con) and the innermost layers of the guard (gi) on the ventral side. The adnation surfaces (adn) of the mural ends of the ventral septa are entirely flangeless and abut the bulges (b) of the conotheca. These mural ends of the septa do not differ materially from those of equivalent septa of other belemnopseid genera, including *Somalibelus* Jeletzky 1972. The well-preserved conotheca clearly displays the same four component layers (marked 4 to 1 inclusive) present in well-preserved representatives of *Somalibelus somaliensis* (see Jeletzky, 1972, Pl. 33, fig. 1b, Pl. 35, fig. 2b, 2c). The ventral parts of the septa and those of the connecting rings are too strongly altered for their structural detail to be seen. However, the dorsal parts display a reasonably well-defined lighter-grey central layer (c) flanked by equally thick, darker grey upper (n1) and lower (n2) outer layers. The central layer appears to the brims of the necks and to end abruptly without entering the necks proper. The latter appear to be built of the undivided outer layer (n). The transitional zone (m) appears to be developed only as a thin, dark-grey line surrounding the central layer and separating it from the outer layers. Dorsal parts of the third and fourth segments of the connecting rings appear to be built of two layers which are marked 1 and 2. The earlier two segments are too strongly altered and deformed to display these layers. The apparently recumbent dorsal part of the first (dn1) and second (dn2) septal necks, resembling that of dorsal parts of the advanced necks of *Megateuthis* and *Cylindroteuthis* (Jeletzky, 1966, Pl. 7, figs. 3A-3E; Pl. 15, figs. 1A-1E) appears to be caused by postmortal deformation. This is indicated by the perfectly normal, orthochoanitic dorsal part of the third (dn3) septal neck. The cyrtochoanitic dorsal part of the fourth (dn4) neck also appears to be caused by postmortal deformation, x240.

1E. Enlarged view of the mural ends of the dorsal parts of the earliest two septa of the phragmocone in Fig. 1B. This photomicrograph also includes adjacent parts of these septa marked ds1 and ds2 respectively, adjacent parts of the conotheca (con), the innermost layers of the guard (gi) filling out the waist of the protoconch, and the overlying, inner layers of normally built guard (orthorostrum) designated "g". Other symbols as in Figs. 1C and 1D.

Like their ventral counterparts (see Fig. 1D), the mural ends of the dorsal parts of the septa are flangeless and abut the bulges of the conotheca. Although the dorsal wall of the conotheca is much more strongly altered than its ventral counterpart (see Fig. 1D), this wall is distinctly layered and permits recognition of the same four component layers marked 1 to 4 inclusive. The septa are too strongly altered for recognition of their component layers, x210.

PLATE VIII

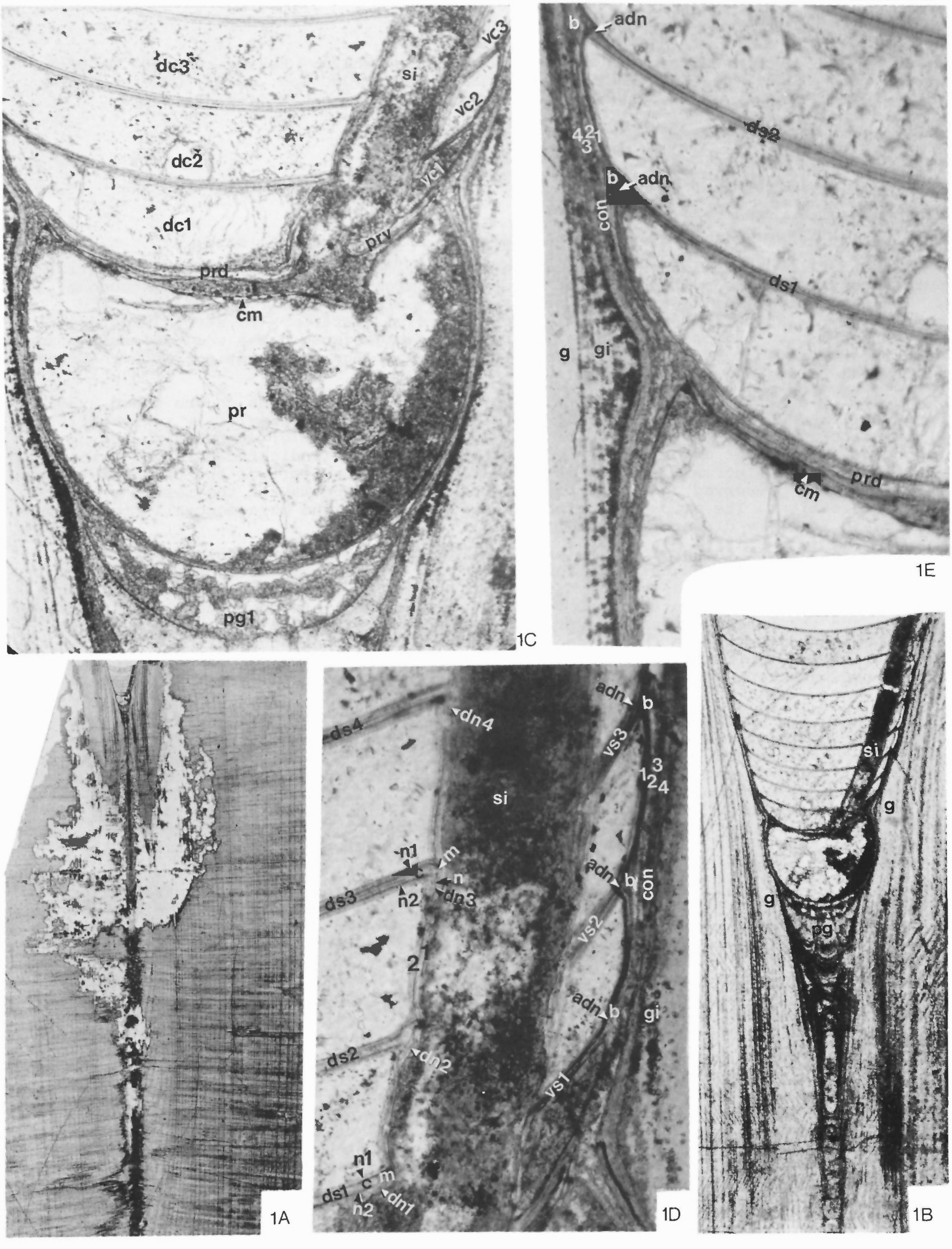

dc3
si
vc3
vc2
dc2
vc1
dc1
prv
prd
cm
pr
pg1
1C
b
adn
ds2
4 2 1
3
b
adn
con
ds1
g
gi
prd
cm
1E
1A
adn
b
ds4
dn4
vs3
si
3
1 2 4
n1
m
c
n
ds3
n2
dn3
adn
b
con
2
1
vs2
adn
b
gi
ds2
dn2
vs1
n1
c
m
ds1
n2
dn1
1D
si
g
g
pg
1B

PLATE IX

Figures 1A-1I. *Conodicoelites meyrati* (Ooster). Callovian shale. Beside road 104 on both sides of pass at Col de l'Escrinet, Ardeche, SE France. GSC loc. 82182, GSC no. 59002, coll. by J.A. Jeletzky, 1973. A somewhat deformed, incomplete, half-grown guard.

1A. Ventral view of specimen before sectioning;

1B. Left lateral view of same;

1C. Right lateral view of same;

1D. Dorsal view of same;

1E. Alveolar cross-section of same. Photographs 1A-1E are natural size;

1F. Overall view of the longitudinal, dorso-ventral, median thin-section of the entire specimen containing the protoconch and the earliest eight chambers of the phragmocone, x3. The earliest juvenile guards are poorly preserved but appear to be clavirostrid (i.e. *Hastites* s. str.-like) throughout. The primordial guard (pg) is strongly deformed and its presumably longconical original shape is unrecognizable. The well-defined outline of the intermediate guard indicates more slender proportions in comparison with those of the terminal half-grown guard.

1G. Overall view of the early part of the phragmocone preserved inside the guard, x28. The saucer-like, earliest part of the primordial guard (pg1) is completely recrystallized and structureless. The same is true of that part of the guard (g) surrounding the phragmocone, except for a thin band adjoining the conotheca (indicated by an arrow) and the protoconch where normal layering is preserved. The later part of the primordial guard (pg 2) is poorly preserved and its apparent subfusiform shape may be the result of post-mortal deformation. The structure of the preserved part of the phragmocone is typically belemnopseid in every discernible detail.

1H. Enlarged view of the protoconch (pr), closing membrane (cm), proseptum, and the earliest two camerae of the thin-section in Fig. 1G. The dorsal parts of these camerae are marked dc1 and dc2 while their ventral parts are marked vc1 and vc2. The protoconch, closing membrane, and the dorsal part of the proseptum (psd) are completely torn off the conotheca and the innermost guard layers (gi). The ventral part of the proseptum (psv) is still attached to the conotheca (con) and appears to be continuous with it. The siphuncle (si) is typically belemnopseid in its gradual adventral displacement in the earliest two camerae. See Pl. X, fig. 1A for details of component layers of the septa, x130.

1I. Enlarged view of the adoral part of the siphuncle (si), adjacent parts of the fifth to eighth dorsal septa (marked ds5 to ds8 inclusive), and the fourth to eighth ventral septa (marked vs4 to vs8 inclusive) of the thin-section in Fig. 1G. All septal necks are orthochoanitic and do not differ materially from the corresponding septal necks of the belemnopseid genera reproduced in this paper (e.g. Pl. VII, fig. 1C; Pl. VIII, fig. 1D) and elsewhere (Jeletzky, 1966, Pl. 9, fig. 1B; Pl. 10, fig. 2C; 1972, Pl. 33, figs. 1b; Pl. 34, fig. 1c, 1f). They are totally unlike those of all the duvaliid genera reproduced in this paper. The same is true of the arrangement of the ventral parts of the septa and camerae.

The dorsal parts of the septa exhibit a well-preserved, uniformly white central layer (c) flanked by very thin, light-grey upper (n1) and lower (n2) outer layers. The central layer thins out gradually ventrally and then pinches out shortly before reaching the brims of the septal necks. Its place is taken by a moderately to strongly clouded transitional zone (m). This zone persists through the remaining distance to the brims of the necks between the even more-attenuated, dark-grey upper and lower outer layers. It forms short, beak-like protuberances within the uppermost parts of all necks before pinching out. The rapidly widening upper and lower outer layers then merge into an undivided outer layer (n) which fills out the remainder of the fairly short (about one-fifth of the height of their camerae), orthochoanitic necks.

The extent and arrangement of the component layers in the ventral parts of the septa appear to be the same as in the better preserved ventral parts of the first three septa in Pl. X, figs. 1A, 1B. They are lettered as in these figures. The apparent oral flanges of the mural parts of all ventral septa (i.e. vs4 to vs8 inclusive) are actually bulges of the conotheca (con) which for some reason did not become recrystallized like the rest of it. These bulges are separated from the mural ends of the septa (vsm) by adnation surfaces (adn) the positions of which are the same as in Pl. X, figs. 1A, 1B, x196.

PLATE IX


1A
d
v
1B
v
d
1C
1D
pg
v
d
1F
d
v
1E
g
g
pg1
pg 2
1G
vs8
vs7
si
con
adn
vsm
vs6
cr
m
n2
n1
c
ds8
ds7
ds6
ds5
vs5
vs4
1I
dc2
vc2
vc1
con
si
dc1
gi
psv
psd
cm
pr
1H

PLATE X

Figures 1A-E. *Conodicoelites meyrati* (Ooster). Structural detail of the thin-section in Pl. IX, fig. 1G. All photomicrographs, x196.

1A. Enlarged view of the three apicalmost segments of the siphuncle (si) of the phragmocone in Pl. IX, fig. 1G. This large-scale photomicrograph also includes parts of the first to third dorsal septa adjacent to the siphuncle (marked ds1 to ds3 inclusive), ventral (psv) and dorsal (psd) parts of proseptum, ventral parts of the first and second septa (marked vs1 and vs2) and the adjacent ventral part of the conotheca (con).

The dorsal parts of the first to fourth camerae are marked dc1 to dc4 inclusive while the ventral parts of the first to third camerae are marked vc1 to vc3 inclusive. The only moderately well-preserved and rather deformed (the first neck is pushed through the connecting ring) dorsal parts of all three necks are marked dsn1 to dsn3 inclusive. These orthochoanitic necks comprise about one-fifth of the height of their respective camerae and are similar morphologically to the equivalent dorsal necks of other belemnopseid genera (e.g. Pl. VIII, fig. 1D and Jeletzky, 1972, Pl. 35, fig. 1b; Pl. 36, fig. 1d; Pl. 37, fig. 1b).

The dorsal parts of all three septa exhibit a clearly delineated white central layer (c) flanked by grey upper (n1) and lower (n2) outer layers. The central layer pinches out shortly before reaching the dorsal parts of the septal necks and is replaced by the transitional zone (m). The latter persists through the remaining distance to the brims of the necks between the upper and lower outer layers. Then the transitional zone ends without entering the necks which are built exclusively of the undivided outer layer (n).

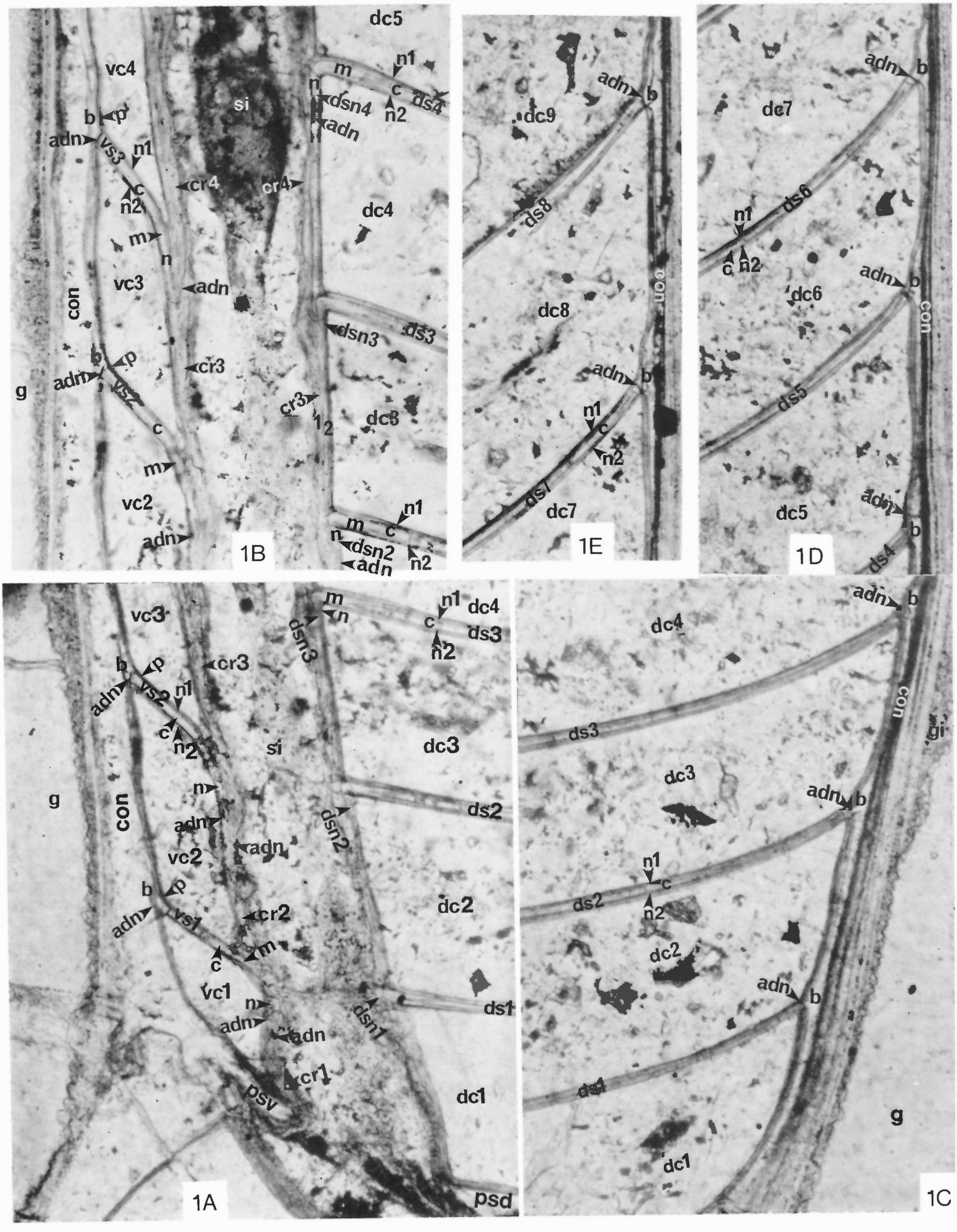
Ventral parts of the first (vs1) and the second (vs2) septa appear to be largely built of the transparent central layer (c). This layer, which is considerably less calcified than that of the dorsal parts of the septa, extends from the mural ends to the brims of the necks. It pinches out at the brims. The upper outer (n1) and lower outer (n2) layers are thin wherever they flank the central layer but thicken rapidly at the brims of the necks. It is not possible to identify the transitional zone (m), except at the brim ends of the central layer where it forms a thin wedge. The distinctly flexuous but still orthochoanitic ventral parts of the first (vs1) and second (vs2) septal necks are built entirely of the undivided outer layer (n). These necks extend through about one-third of the heights of their camerae. The indifferently preserved connecting rings (marked cr1 to cr3 inclusive) appear to be unilayered. The adnation surfaces of septal necks and those of the mural ends of the septa are marked "adn". The mural ends of the septa are entirely flangeless and abut the bulges (b) of the conotheca (con). In these respects they are like those of *Somalibelus somaliensis* (compare Jeletzky, 1972, Pl. 34, figs. 1d-1g; Pl. 35, figs. 2b, 2c; Pl. 36, figs. 1b, 1c) and other belemnopseids reproduced in this paper (Pl. VIII, figs. 1C, 1D; Pl. VII, fig. 1C) but differ sharply from the flange-bearing dorsal septa of the Duvaliidae (e.g. Pl. III, figs. 1B, 1C; Pl. IV, fig. 2C; Pl. VI, fig. 1C, 1E). The appearance of the conothecal bulges contrasts with that of the adjacent mostly recrystallized conotheca. This contrast and sharp delimitation of the bulges from the rest of the conotheca are believed to be secondary features caused by a differential recrystallization of the latter. The guard (g) adjoining the ventral side is almost entirely recrystallized. The ventral walls of the second and third ventral camerae are overlain by inorganic pelliculae (p) which overlap the mural parts of the septa.

1B. Enlarged view of middle segments of the siphuncle (si) of the phragmocone in Pl. IX, fig. 1G. This photomicrograph includes the same additional morphological elements of the phragmocone as does Fig. 1A. The morphology of all structural elements displayed in this photomicrograph does not differ from that of their equivalents in Fig. 1A. The photomicrographs of Figs. 1A, 1B and of Pl. IX, fig. 1I overlap, displaying the extent of the ventral part of the preserved phragmocone of specimen 59002. Except as indicated above, the morphologic elements of the phragmocone displayed in photomicrograph 1B are lettered as in Fig. 1A.

1C. Enlarged view of mural ends of the dorsal parts of the earliest three septa of the thin-section of the phragmocone in Pl. IX, fig. 1G. This photomicrograph also includes adjacent dorsal parts of these septa marked ds1 to ds3 inclusive, adjacent parts of the conotheca, and the innermost layers of the guard (gi). The white central layer is considerably thinner than in the adsiphonal parts of the same dorsal septa displayed in Fig. 1A. It is about as thick as either of the flanking upper and lower outer layers in the central parts of all three septa (e.g. on the extreme left of the photomicrograph). The central layer gradually becomes more and more attenuated farther addorsally but persists to the apparently flangeless mural ends of the septa. The adnation surfaces are poorly preserved while the conotheca is deeply weathered and deformed in part. Only the innermost part of the guard (gi) adjacent to the conotheca retains the original layering. The outer part of the guard (g) is completely recrystallized. Except as indicated above, all morphological elements of the phragmocone displayed in the photomicrograph are lettered like their equivalents in Fig. 1A.

1D. Enlarged view of mural ends of dorsal parts of the fourth to sixth septa (marked ds4 to ds6 inclusive) of the phragmocone in Pl. IX, fig. 1G. These mural ends and other structural details of the dorsal side of the phragmocone represented in 1D mostly do not differ materially from the equivalent details of the earliest three septa in Fig. 1C. However, the adnation surfaces and the bulges of the conotheca of all three septa are much better preserved. The flange-like structure within the conothecal bulge of the sixth septum is interpreted tentatively to be the result of partial recrystallization of the conotheca. However, it could also be interpreted as the earliest oral flange appearing on the oral adnation surface of this phragmocone (see under Fig. 1E). Except as indicated above, all morphologic elements of the phragmocone in the photomicrograph are lettered as in Fig. 1A.

1E. Enlarged view of mural ends of dorsal parts of the seventh and eighth septa of the phragmocone in Pl. IX, fig. 1G. These mural ends and other structural details of the dorsal side of the phragmocone represented in 1E do not differ materially from the equivalent details of the earliest three septa in Fig. 1C. However, the flange-like structures within the conothecal bulges adjoining the poorly preserved adnation surfaces are similar to the flange-like structure adjoining the mural end of the sixth septum in Fig. 1D. They are interpreted tentatively as the latter structure. The central layer of the eighth septum is almost entirely destroyed and its lower outer layer is preserved only in part. Except as indicated above, all morphologic elements of the phragmocone are lettered as in Fig. 1A.


1B
dc5
vc4
si
m
n1
c
n
dsn4
ds4
n2
adn
b
p
vs3
n1
c
n2
cr4
cr4
dc4
m
n
vc3
adn
con
dsn3
ds3
g
b
adn
p
vs2
cr3
cr3
1
2
dc3
c
m
vc2
adn
n1
m
c
n
dsn2
n2
adn
1E
adn
b
dc9
ds8
dc8
con
adn
b
n1
c
n2
ds7
dc7
1D
adn
b
dc7
ds6
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m
vc1
n
ds1
adn
adn
dsn1
cr1
psv
dc1
psd
1C
adn
b
dc4
con
gi
ds3
dc3
adn
b
n1
c
ds2
n2
dc2
adn
b
ds1
g
dc1

PLATE XI

Figure 1. *?Dicoelites* sp. nov. indet. A. GSC loc. 91125, GSC No. 59003. Haselton Group, mid-Toarcian. Southern Bait Range, north of head of Frypan Creek, Lat. 55°33'N; Long. 126° 23.7'W, northwestern British Columbia. Ventral view of a latex cast prepared from a natural external mould.

Figures 2A-2E. *?Dicoelites* sp. nov. indet. A. GSC loc. 91125, GSC No. 59004. Same locality, unit and age as for specimen GSC No. 59003. Latex cast of a natural external mould.

2A. Ventral view.

2B. Dorsal view.

2C. Lateral view.

2D. Cross-section of oral end.

2E. Same view as in Fig. 2D but X2 to elucidate structural details.

Figures 3A-3D. *?Pseudodicoelites* sp. nov. indet. A. GSC loc. 28913. GSC No. 59005. Unnamed Haselton type sediments of Toarcian to Bajocian age. Unnamed ridge south of head of Dawson River. Spatsizi map-area (104H), northwestern British Columbia.

3A. Ventral view.

3B. Dorsal view.

3C. Lateral view.

3D. Cross-section of oral end, X2. Note the excentric position of the apical line which identifies the ventral and dorsal sides of the guard.

Figures 4A-4D. *?Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm 1906). GSC loc. 91078. GSC No. 59006. Haselton Group. Mid-Toarcian beds. Ridge 4.8 km (3 miles) NNW of Sitlika Pass and due east of Iktlake Peak. Lat. 55° 52.6'N; Long. 126°3.1'W. Latex cast of a natural external mould.

4A. Ventral view.

4B. Left lateral view.

4C. Right lateral view.

4D. Dorsal view.

4E. Apical view. The ventral side has a wide median groove extending close to the apex.

Figure 5A-5E. *Conodicoelites* sp. aff. *C. meyrati* (Ooster 1857). GSC loc. 86273, GSC No. 59007. Unnamed Jurassic rocks (presumably of mid-Toarcian age). Approx. Lat. 56°44'00"N; Long. 130°35'30"W. Iskut-Bowser area, B.C. collected by B.C. Dept. of Mines, 1970.

5A. Ventral view.

5B. Lateral view.

5C. Dorsal view.

5D. View of polished cross-section of the apical end, X2.

5E. Cross-section of the somewhat deformed oral end.

Figures 6A-6C. *Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm 1906). GSC loc. 93268, GSC No. 59008. Haselton Group. Toarcian (probably mid-Toarcian) beds. Section 11TD75 on ridge bearing 178° from Mount Carruthers, Lat. 56°12.5'N; Long. 126°21'W. McConnell map-area, B.C., 94D. Collected in talus.

6A. Ventral view.

6B. Lateral view.

6C. Dorsal view.

Figures 7A-7D. *Conodicoelites* sp. aff. *C. meyrati* (Ooster, 1857). GSC loc. 90963, GSC No. 59010, Haselton Group. Toarcian part. On Driftwood River. Lat. 55°58.2'N; Long. 126°53.0'W. Haselton map-area (E½), B.C.

7A. Ventral view.

7B. Lateral view.

7C. Dorsal view.

7D. Apical cross-section of fragment.

Figures 8A-8D. *Conodicoelites* sp. aff. *C. meyrati* (Ooster 1857). GSC loc. 90963, GSC No. 59009. Same locality etc. as for specimen in Figs. 7A-7D.

8A. Ventral view.

8B. Lateral view.

8C. Dorsal view.

8D. Cross-section of oral end.

Figures 9A-9D. *Conodicoelites* sp. aff. *C. meyrati* (Ooster 1857). GSC loc. 90963, GSC No. 59011. Same locality, etc. as for specimen in Figs. 7A-7D.

9A. Ventral view.

9B. Lateral view.

9C. Dorsal view.

9D. Cross-section of oral end.

Figures 10A-10E. ?Belemnopseidae genus et species novum indet. GSC loc. 91113, GSC No. 59012. Haselton Group. Volcaniclastic beds underlying middle Bajocian beds with *Sonninia* sp. and apparently equivalent (on a lithological basis) with paleontologically-dated upper Toarcian to Lower Bajocian rocks outcropping elsewhere in the area. Lat. 55°12.1'N; Long. 126°13.8'W; in SW corner of Haselton E½ map-area. Latex cast of a natural external mould.

10A. ?Ventral view.

10B. Lateral view.

10C. ?Dorsal view.

10D. Apical view.

10E. Cross-section of oral end.

PLATE XI

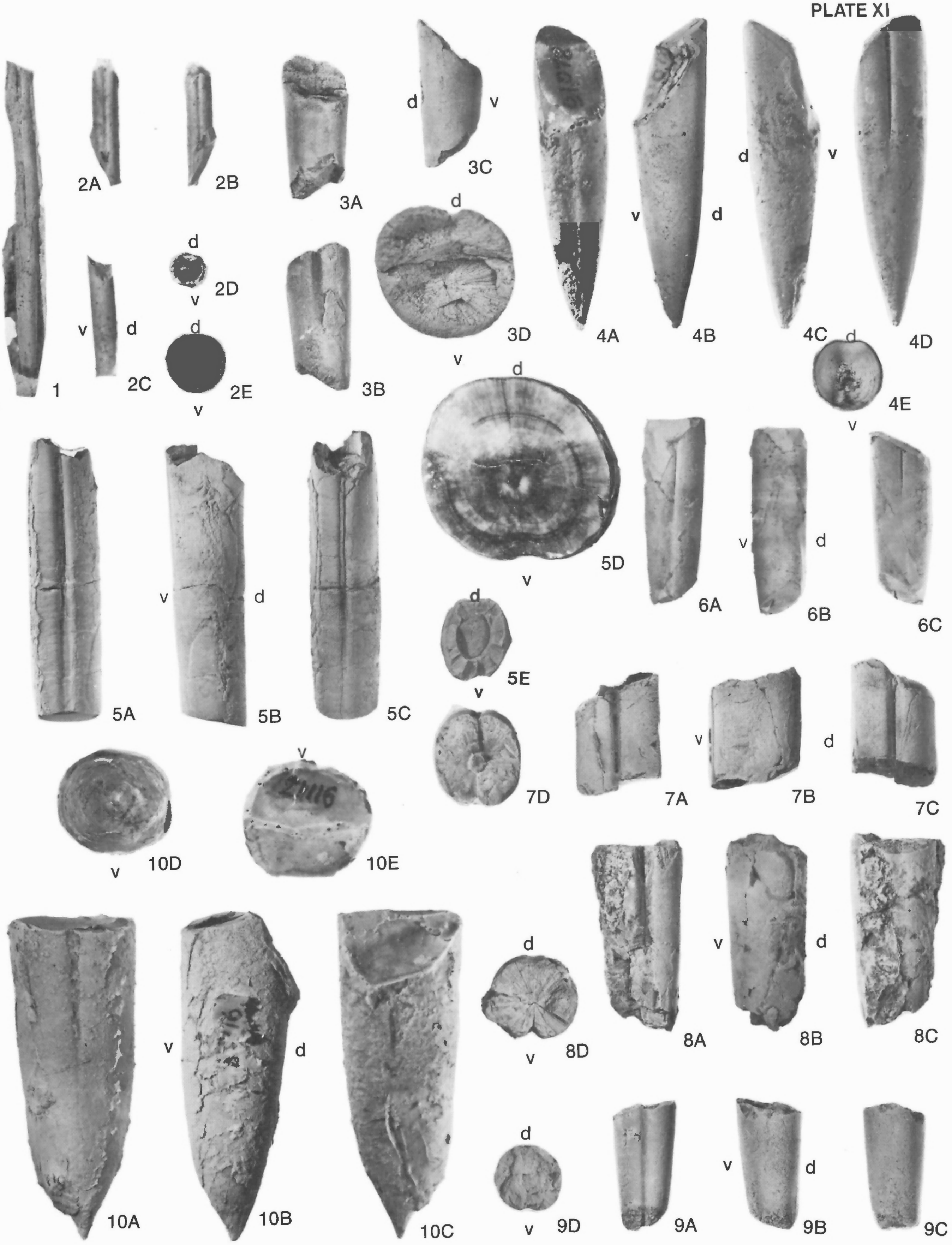
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PLATE XII

Figures 1A-1D. *Lenobelus plauchuti* sp. nov. Holotype. GSC loc. 72654. GSC No. 59013. Wilkie Point Formation, Lower Bajocian (=Aalenian) beds. Prince Patrick Island. Canadian Arctic Archipelago, N.W.T. Measured section of Elf Oil Co. Ltd., Canada, at top of Wilkie Point.

1A. Ventral view.

1B. Lateral view.

1C. Dorsal view.

1D. View of apical end.

Figures 2A-2D. *Lenobelus plauchuti* sp. nov. Topotype. A half-grown representative. GSC loc. 72654. GSC No. 59014. Same locality, etc. as for the specimen reproduced in Fig. 1.

2A. Ventral view.

2B. Lateral view.

2C. Dorsal view.

2D. View of apical end.

Figures 3A-3D. *Lenobelus plauchuti* sp. nov. Topotype. GSC loc. 72654. GSC No. 59015. Same locality, etc. as for specimen in Fig. 1.

3A. Ventral view.

3B. Lateral view.

3C. Dorsal view.

3D. Apical view.

Figures 4A-4F. *Pseudodicoelites canadensis* sp. nov. Holotype. GSC loc. 72540, GSC No. 59016. Wilkie Point Formation, presumably from early Bajocian (=Aalenian) beds. Melville Island, Canadian Arctic Archipelago, N.W.T. In Marie Bay Section #65-MV-XI, measured by Elf Oil Co. Ltd., Canada east of Cap Grassy.

4A. Ventral view. Note the more slender earlier guard with an acute apex partly exposed inside the differently shaped, strongly weathered terminal guard.

4B. Lateral view.

4C. Lateral view of other flank.

4D. Dorsal view.

4E. Apical view.

4F. Cross-section of alveolar end.

Figures 5A-5F. *Pseudodicoelites canadensis* sp. nov. Topotype. GSC loc. 72540, GSC No. 59017. Same locality etc. as for specimen in Fig. 4. A sturdy variant of the species lacking all of the alveolar part of the guard.

5A. Ventral view. Note the groove-like weathering of the median zone of the ventral surface.

5B. Lateral view.

5C. Lateral view of other flank.

5D. Dorsal view.

5E. Cross-section of oral end. Note the extremely strongly adventrally displaced position of the half-grown guard within the terminal guard.

5F. Cross-section of the apical end.

Figures 6A-6F. *Pseudodicoelites canadensis* sp. nov. Topotype. GSC loc. 72540, GSC No. 59019. The same locality etc. as for specimen in Fig. 4. An adult guard with a well-preserved apical part of the ventral face (Fig. 6A) lacking any median apical groove. Only the adapical part of the alveolus is preserved (Fig. 6E).

6A. Ventral view.

6B. Lateral view.

6C. Lateral view of other flank.

6D. Dorsal view.

6E. Cross-section of alveolar end.

6F. Apical view.

Figures 7A-7J. *Pseudodicoelites canadensis* sp. nov. Topotype. GSC loc. 72540, GSC No. 59020. The same locality etc. as for specimen in Fig. 4. A fragmentary, sturdy adult guard enclosing a much more slender, differently shaped half-grown guard.

7A. Ventral view of the complete specimen. Note the same groove-like weathering of the median zone of the ventral surface as in Fig. 5A.

7B. Right lateral view of same. Note the strong adventral displacement of the half-grown guard.

7C. Left lateral view.

7D. Dorsal view.

7E. Cross-section of alveolar end of complete specimen. Note the strong adventral displacement of the half-grown guard.

7F. Ventral view of half-grown specimen.

7G. Lateral view of same.

7H. Dorsal view of same.

7I. Cross-section of alveolar end of same.

7J. Apical view of same.

Figures 8A-8E. *Pseudodicoelites canadensis* sp. nov. Hypotype. GSC loc. 70053, GSC No. 59021. Wilkie Point Formation, early Bajocian (=Aalenian) beds. Melville Island, Canadian Arctic Archipelago, N.W.T. Approx. Lat. 76°6 1/2'N; Long. 112°56 1/2'W. A fragmentary but otherwise well-preserved, three-quarter grown guard. The guard appears to belong to the very sturdy variety of the species.

8A. Ventral view.

8B. Lateral view.

8C. Lateral view of other flank.

8D. Dorsal view.

8E. Cross-section of alveolar end. The alveolar part is completely absent.

8F. Apical view.

PLATE XII

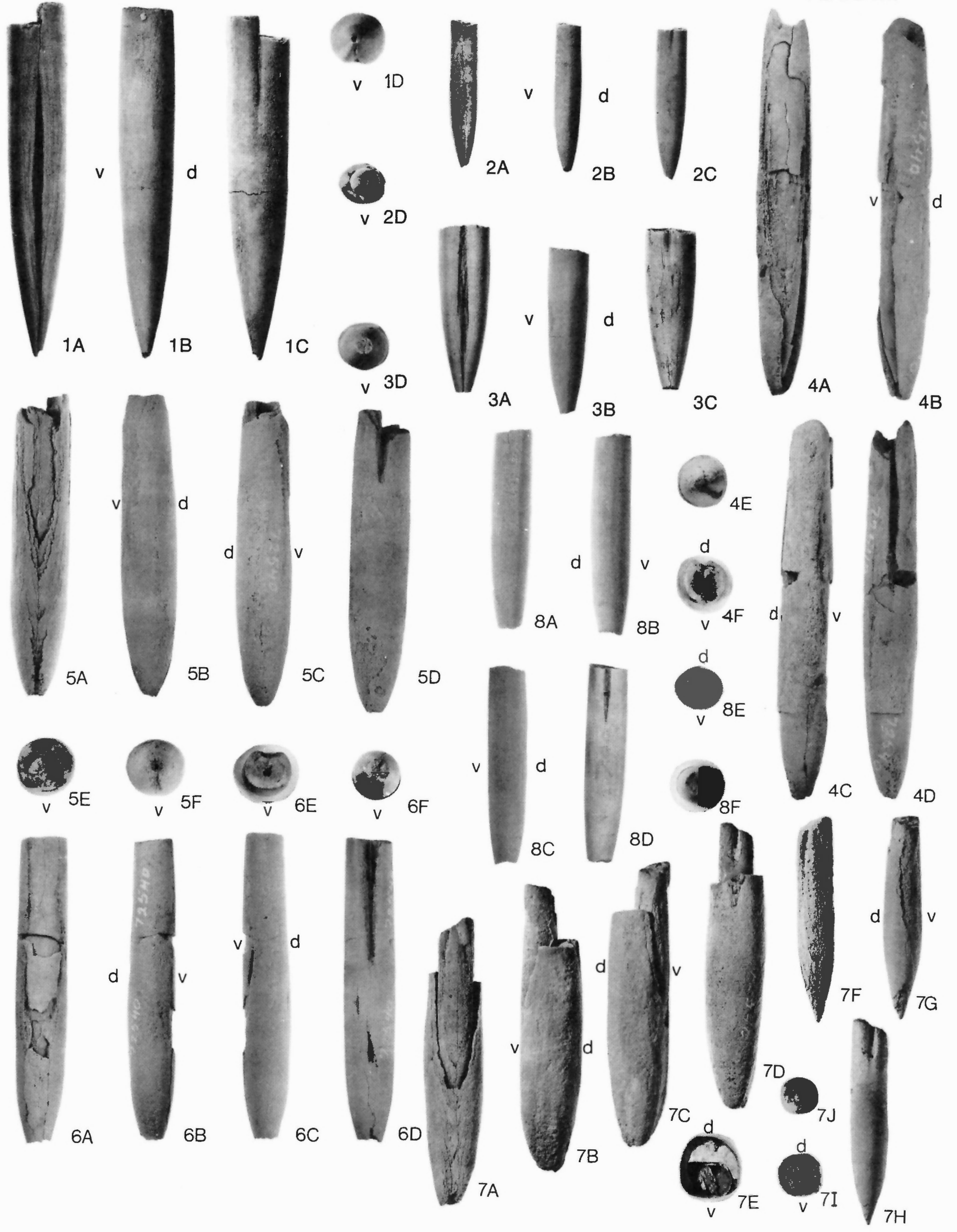
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PLATE XIII

Figures 1A-1F. *Lenobelus aberrans* sp. nov. Topotype. GSC loc. 70053, GSC No. 59022. Wilkie Point Formation, early Bajocian (=Aalenian) beds. Melville Island, Canadian Arctic Archipelago, N.W.T. Approximate Lat. 76°6 1/2'N; Long. 112°56 1/2'W. A typical medium-sized adult specimen.

1A. Dorsal view. This photograph is of the plaster cast which is appreciably smaller than the actual specimen and does not reproduce its shape exactly. See polished section in Figs. 1B, 1D for the true dimensions and shape of the specimen.

1B. Lateral view of the flank after preparation of the polished section.

1C. Ventral view of plaster cast. See in explanation of Fig. 1A for further details. Note the presence of a short medioventral groove near the apex.

1D. Dorso-ventral, longitudinal median polished section.

1E. Cross-section of alveolar end.

1F. Apical view. Note the medioventral apical groove.

Figures 2A-2F. *Lenobelus aberrans* sp. nov. Topotype. GSC loc. 70053. GSC No. 59023. The same locality, etc. as for specimen in Fig. 1.

A two-thirds grown guard of the same slender variant as the adult in Fig. 3.

2A. Dorsal view.

2B. Right lateral view.

2C. Left lateral view. Note the fairly clearly visible lateral longitudinal furrows which are morphologically similar to those of *Parahastites* Nalniaeva 1967.

2D. Ventral view. In spite of good preservation, this ventral side appears to be devoid of any trace of a medioventral apical groove such as occurs in other representatives of *L. aberrans* sp. nov. (e.g. Fig. 1C).

2E. Cross-section of oral end. The alveolar part of the specimen is nearly complete, as attested by the thinness of the alveolar walls at the oral end.

2F. Apical view.

Figures 3A-3F. *Lenobelus aberrans* sp. nov. Topotype. GSC loc. 70053, GSC No. 59024. The same locality, etc. as for specimen in Fig. 1. A typical adult representative of the slender variant of the species.

3A. Dorsal view. Note the pronounced shallowing and widening of the mediodorsal alveolar groove on he oralmost part of the guard.

3B. Right lateral view. The longitudinal lateral furrows appear to be irregularly (?pathologically) deepened on the apical third of this flank.

3C. Left lateral view. The well-developed adventral lateral longitudinal furrow seems to harbour double lateral lines on the oral third of the flank. Farther adapically it narrows and is developed as a single furrow.

3D. Ventral view. No trace of a medioventral apical groove is visible on this well-preserved ventral face.

3E. Cross-section of alveolar end. The wide and shallow appearance of the mediodorsal alveolar groove is clearly visible. The alveolar part of the guard is almost complete as the walls of the alveolus are paper-thin at its oral end.

3F. Apical view. The deeply impressed adventral longitudinal lateral furrow is clearly visible on the right flank.

Figures 4A-4I. *Lenobelus aberrans* sp. nov. Holotype. GSC loc. 70053. GSC No. 59025. The same locality, etc. as for specimen in Fig. 1. The largest representative of the species known. The holotype is an adult representative of the same sturdy variant as the guard in Fig. 1.

4A. Dorsal view. The mediodorsal alveolar groove is deep and narrow throughout. However, this is probably simulated by the incompleteness of the alveolar part of the holotype (see Figs. 4E-4G). Note the presence of strong apical striae.

4B. Right lateral view.

4C. Left lateral view. Only faint traces of lateral longitudinal furrows are visible on this flank. The adventral furrow is wide on the oral third of the guard and probably harbours double lateral lines there.

4D. Ventral view. Unlike the guard in Fig. 1C, the short medioventral apical groove is developed as a somewhat irregularly shaped double groove surrounded by several apical striae. This aberration may be pathologically caused.

4E. Cross-section of alveolar end. The considerable thickness of the alveolar walls indicates that only the apical third of the alveolus is preserved (compare Fig. 1D).

4F. Same view as in 4E but X2 to display the normal, radially prismatic calcification of the alveolar walls and their interruption by the splitting surface underlying the mediodorsal alveolar groove.

4G. Same view as in Fig. 4E but X2 and smeared by monochlornaphtalene to reveal the sharp inward bends of concentric growth layers underneath the mediodorsal alveolar groove.

4H. Apical view.

4I. Same view as in 4H but X2 to elucidate the appearance and exact location of the double medioventral apical groove and apical striae.

4J. Cross-section of the guard at the break which occurs in its apical third (see Figs. 4A-4D), X2. Note that the apical line is strongly displaced adventrally.

PLATE XIII

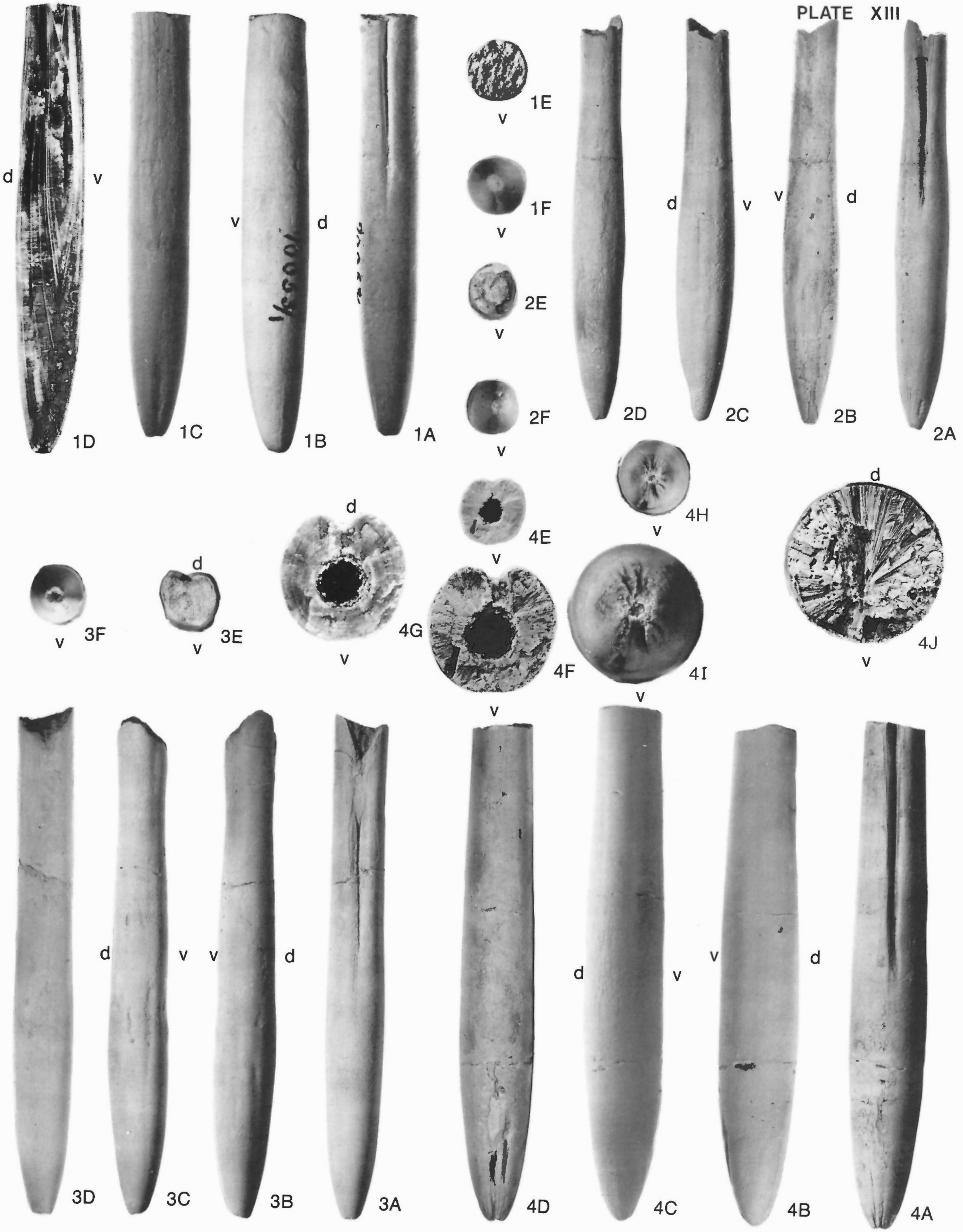

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PLATE XIV

Figures 1A-1L. *Pseudodicoelites* aff. *P. bidgievi* (Saks 1961). GSC loc. 72595, GSC No. 59026. Wilkie Point Formation, lower Bajocian (=Aalenian) beds. Prince Patrick Island, Canadian Arctic Archipelago, N.W.T. Collected at the top of Wilkie Point. Fragment of the oral part of the guard containing a strongly deformed but nevertheless diagnostic early part of the phragmocone.

1A. Ventral view.

1B. Dorsal view.

1C. Lateral view.

1D. Cross-section of alveolar end. The alveolar part of the guard is seen to be almost completely preserved because of the paper-thin alveolar walls there.

1E. Cross-section of apical end. Photographs 1A to 1E inclusive were taken of the plaster cast of specimen GSC No. 59026 after preparation of the thin-section in Fig. 1F.

1F. Overall view of the longitudinal, dorso-ventral, median thin-section prepared from the fragment of the guard in 1A-1E. The phragmocone and the alveolar part of the guard are strongly deformed. Most of the postalveolar part of the guard is completely recrystallized so as to produce the so-called "Spitzenkegel" of Christensen (1925), X3.

1G. Enlarged view of the phragmocone and the enclosing innermost layers of the guard (g) of the thin-section reproduced in 1F. Although the septa are almost invariably broken and deformed, their structure is belemnopseid rather than duvaliid in every discernible detail, X15.

1H. Enlarged view of the oral part of the protoconch (pr), earliest two segments of the siphuncle (si), and the ventral (prv) and dorsal (prd) parts of the proseptum of the thin-section in 1G. Closing membrane and connecting rings are not discernible and were apparently destroyed throughout. The ventral (vn1) and dorsal (dn1 and dn2) parts of the septal necks are typically orthochoanitic and do not differ materially from the equivalent septal necks of such belemnopseid genera as *Hibolithes* (Jeletzky, 1966, Pl. 9, fig. 1A) and *Somalibelus* (Jeletzky, 1972, Pl. 36, fig. 1d; Pl. 37, fig. 1b) and such hastitid genera as *Gastrobelus* (Jeletzky, 1966, Pl. 25, fig. 3). Structures resembling the recrystallized hyposeptal (?hd) and episeptal (?ed) cameral deposits of hastitid (see Jeletzky, 1966, Pl. 25, fig. 3) type are present in the first dorsal camera (dc1). Similar structures resembling hyposeptal cameral deposits (?hd) occur in the second dorsal (dc2) and first ventral (vc1) camerae. However, all above structures were more likely caused by post-mortal displacement of septa from their original positions in a semi-consolidated mineral gel which was filling the buried phragmocone and was capable of retaining the casts of septa (i.e. ds1 and ds2) in their original positions (see in description of Figs. 1K and 1L for further details), X85.

1-I. Enlarged view of the second to fourth segments of the siphuncle (si), adjacent parts of the second to fourth dorsal septa (numbered ds2 to ds4 inclusive) and first to third ventral septa (numbered vs1 to vs3 inclusive) of the thin-section in Fig. 1G. The dorsal (numbered dn2 to dn4 inclusive) and ventral (numbered vn2 and vn3) parts of the septal necks remain belemnopseid- and hastitid-like. The structures (see in description of Fig. 1H) resembling completely recrystallized hyposeptal cameral deposits (?hd) are present in the dorsal parts of the second to fourth camerae (numbered dc2 to dc4 inclusive). The second ventral septum (vs2) is badly damaged and displaced apicalward from its original position producing a rather similar structure resembling a hyposeptal cameral deposit. This suggests strongly that none of the previously discussed similar structures are, in fact, attributable to cameral deposits, X120.

1J. Enlarged view of the fourth to seventh segments of the siphuncle (si), adjacent parts of the fourth to sixth dorsal septa (numbered ds4 to ds6 inclusive) and third to fifth ventral septa (numbered vs3 to vs5 inclusive) of the thin-section in Fig. 1G. The dorsal part of the fourth camera (dc4) exhibits a previously discussed structure resembling a hyposeptal cameral deposit (?hc) while all other camerae are free of such ?cameral deposits. All septal necks remain just as belemnopseid- and hastitid-like as the earlier necks in Figs. 1H and 1I, X120.

1K. Enlarged view of the ninth and tenth segments of the siphuncle (si), adjacent parts of the tenth and eleventh dorsal septa (numbered ds10 and ds11 respectively) and the tenth ventral septum (vs10) of the thin-section in Fig. 1G. All septal necks in this photomicrograph remain just as belemnopseid- and hastitid-like as the earlier necks in Figs. 1H to 1J inclusive. The duplication of tenth and eleventh dorsal septa apparently was caused by their having been displaced from original positions in a semi-consolidated mineral gel which was filling the buried phragmocone. The gel must have been sufficiently solid to preserve the cast of the displaced septa in their original positions, X120.

1L. Enlarged view of the ninth to thirteenth camerae of the thin-section in Fig. 1G. Although all septa are badly damaged and were partly squeezed out of their original positions in a semi-consolidated mineral gel, they remain just as belemnopseid- and hastitid-like in all their structural details as the earlier septa of Figs. 1H to 1K inclusive, X120.

PLATE XIV

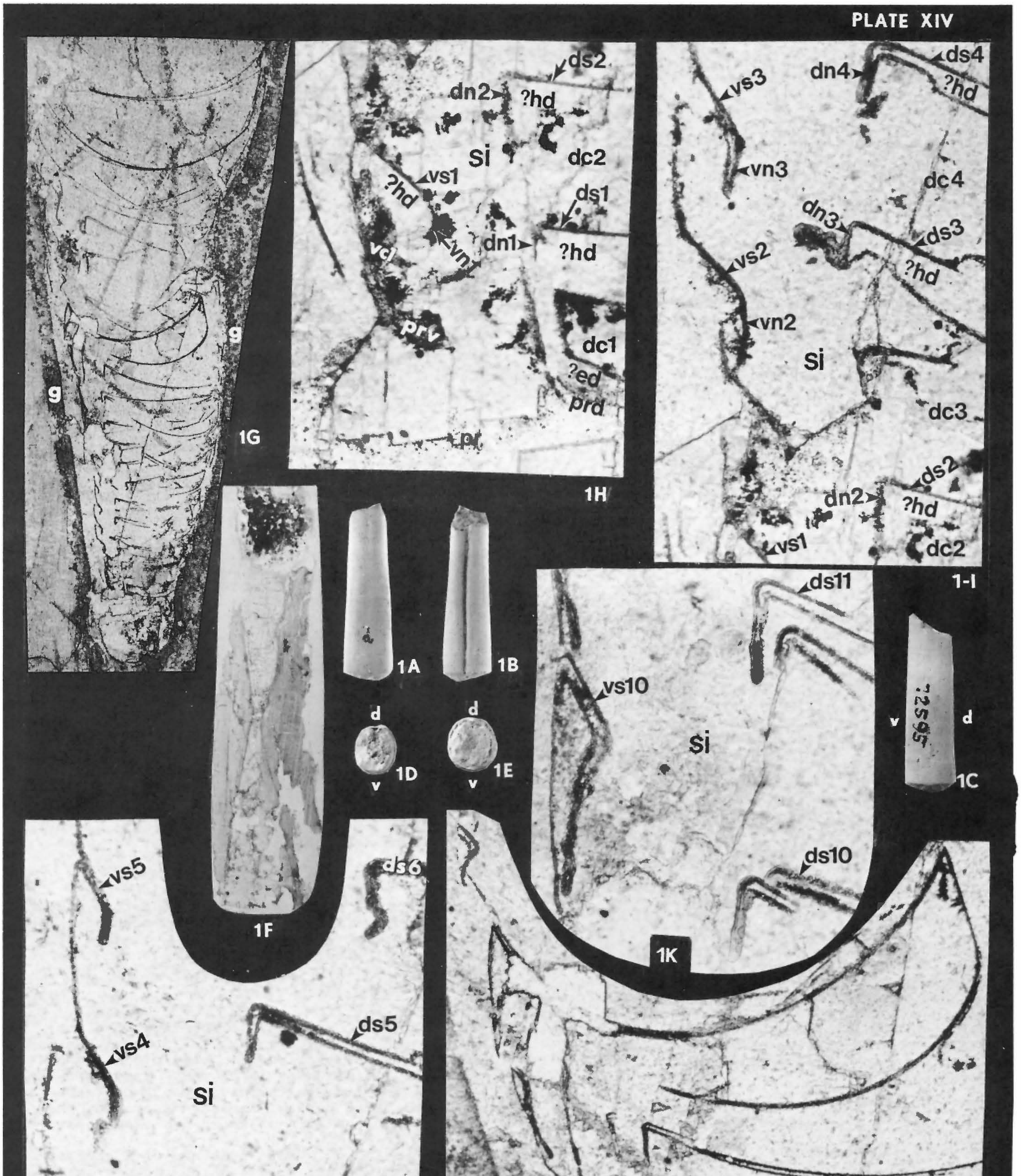
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PLATE XV

Figures 1A-1F. *Pseudodicoelites epigonos* sp. nov. Holotype. GSC loc. 24660, GSC No. 59027. Wilkie Point Formation, *Arkelloceras* beds, middle Bajocian. Prince Patrick Island, Canadian Arctic Archipelago, N.W.T., northeast side of Intrepid Inlet, about 16 km (10½ miles) north of Cape Canning. A sturdy representative of the species.

1A. Dorsal view.

1B. Right lateral view.

1C. Left lateral view.

1D. Ventral view.

1E. Same lateral view as in 1B but with the alveolar part of the guard removed to show the mediodorsal splitting surface (painted white) and the pseudoalveolus.

1F. Cross-section of alveolar end, X3. Note strong deformation of alveolar walls caused by their imperfect calcification.

Figures 2A-2H. *Pseudodicoelites epigonos* sp. nov. Topotype. GSC loc. 24660, GSC No. 59028. The same locality, etc. as for specimen in Fig. 1. A slender representative of the species.

2A. Dorsal view.

2B. Left lateral view.

2C. Right lateral view.

2D. Ventral view.

2E. Cross-section of the apical third of the guard. The position of the break where this cross-section was photographed is indicated by an arrow in 2A.

2F. Cross-section of alveolar end, X2. Note strong deformation of alveolar walls caused by their imperfect calcification. The guard is almost complete in its alveolar part as indicated by the paper-thin alveolar walls at its oral end.

2G. Ventral view of alveolar third of the guard, X3 to elucidate its strong exfoliation and deformation.

2H. Right lateral view of alveolar third of the guard, X3 to elucidate its strong exfoliation and deformation. Orientation as in 2C.

Figures 3A-3F. *Belemnopsis* ex aff. *canaliculatus* (Schlotheim 1820). Museum of Comparative Zoology, Cambridge, Mass., U.S.A. OMC No. 9132, OMC Cat. 9132/1. Inferior Ferruginous Oolite. Presumably from middle Bajocian beds (? *Stephanoceras humphresianum* Zone), St. Vigor (Calvados), Normandie, France. A morphologically extreme form characterized by the presence of a short mediodorsal alveolar groove (3D) in addition to a typically-developed, long, medioventral alveolar groove (3A). All photographs were taken of a plaster cast prepared prior to the preparation of a thin-section of the oral half of this specimen.

3A. Ventral view.

3B. Right lateral view.

3C. Left lateral view.

3D. Dorsal view.

3E. Cross-section of alveolar end. The alveolar part of the guard is almost completely preserved as indicated by the paper-thin alveolar walls at its alveolar rim.

3F. Apical view.

Figure 4. *Pseudodicoelites* cf. *hibolitoides* Saks 1967. GSC loc. C-6140, GSC 59029. Bug Creek Formation, presumably from lower to middle Bajocian beds. Northern Yukon, upper Bell River, Lat. 68°06'N; Long. 136°45'W. Dorsal view of oral half of guard. A rubber mould prepared from a natural external cast.

Figures 5A-5F. *?Dicoelites* sp. nov. indet. B. GSC loc. 86555, GSC No. 59030. Kingak Shale (restr.), presumably from lower Bajocian (=Aalenian) beds. Northern Yukon, Sleepy Mountain in headwaters of Driftwood River, Lat. 68°03'N; Long. 137°54'W. Fragment of anterior part of stem region.

5A. Ventral view.

5B. Dorsal view.

5C. Right lateral view.

5D. Left lateral view.

5E. Cross-section of oral end, X2. All of the alveolar part of the guard is broken off.

5F. Cross-section of apical end of fragment, X2. The apical line is markedly displaced adventrally and the proposed orientation of the fragment depends on this morphologic feature.

Figures 6A-6C. *Conodicoelites* sp. nov. aff. *keeuwensis* (Boehm 1906). GSC loc. 93268, GSC No. 59031. Haselton Group, from Toarcian (probably mid-Toarcian) beds. Section 11TD measured on ridge bearing toward 178° from Mt. Carruthers, Lat. 56°12.5'N; Long. 126°21'W. Collected from talus. Rubber mould of a natural external cast of a particularly slender, regularly conical guard resembling *Conodicoelites sulcacutus* (Stoliczka).

6A. Ventral view.

6B. Lateral view.

6C. Dorsal view. Only the shallow and wide, apical part of the mediodorsal alveolar groove is preserved.

Figure 7. *Lenobelus* cf. *aberrans* sp. nov. GSC loc. 83477, GSC No. 59032. ?Labarge Group. Presumably derived from Bajocian beds. Southern Yukon, Toric Mountain, 11.2 km (7 miles) west of Robinson. South Yukon. Polished cross-section of the oral end of a fragment of the typically shaped, alveolar part of the guard which is still enclosed in hard sandstone, X2. The mediodorsal position of the pronounced alveolar groove accompanied by a well-developed (deeply weathered) splitting surface is indicated by its being situated opposite to the siphuncle (si).

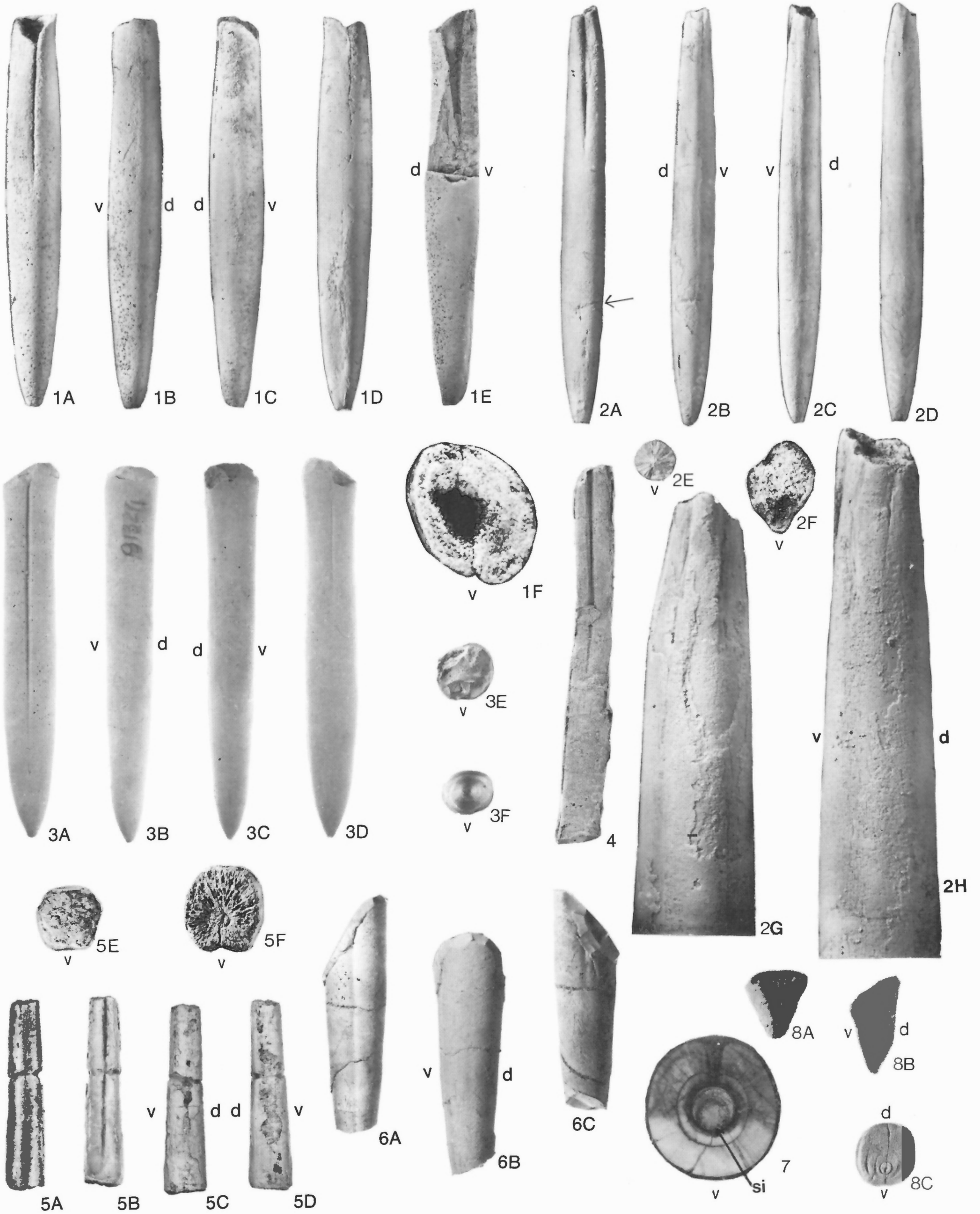
Figures 8A-8C. *Lenobelus* cf. *aberrans* sp. nov. GSC loc. 83477, GSC No. 59033. The same locality, etc. as for specimen in Fig. 7. Strongly weathered apical fragment preserved in same piece of rock with alveolar fragment in Fig. 7. Judging by their original relative positions, these two fragments may have formed part of the same specimen, the intervening stem part of which has been destroyed.

8A. Ventral view. Note presence of a shallow medioventral apical groove which closely resembles that of the specimen of *Lenobelus aberrans* sp. nov. in Pl. XIII, figs. 1C, 1F.

8B. Lateral view.

8C. View of naturally weathered oral cross-section. The plane of this cross-section is markedly sloping adventrally. Note marked adventral displacement of the apical line which attests the medioventral position of the apical groove in 8A.

PLATE XV


1A
v
1B
d
d
1C
v
1D
d
v
1E
2A
d
2B
v
v
2C
d
2D
1F
v
2E
v
2F
v
3A
v
3B
d
d
3C
v
3D
3E
v
3F
v
4
2G
v
d
2H
5E
v
5F
v
5A
5B
v
5C
d
d
5D
v
6A
v
d
6B
6C
8A
v
d
8B
7
si
v
d
8C
v