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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

BULLETIN 123

LATEST LOWER TRIASSIC AMMONOIDS FROM ELLESMERE ISLAND AND NORTHEASTERN BRITISH COLUMBIA

E. T. Tozer

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PREFACE

In this bulletin ammonoid faunas of latest Lower Triassic age from British Columbia are described for the first time, and the known faunas of Ellesmere Island are increased from one to five species. A total of fifteen species, representing thirteen genera, are now recognized in the latest Lower Triassic of Canada. Three new genera are described.

The stratigraphic position of the faunas with respect to previously known assemblages of Lower and Middle Triassic age has been determined, and henceforth the ammonoids described in this bulletin may be used for precise palaeontological dating of strata.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, April 17, 1964

Bulletin 123 — Spät-Untertriassische Ammoniten von der Ellesmere-Insel und aus dem nordöstlichen Britisch-Kolumbien.

Von E. T. Tozer

БЮЛЛЕТЕНЬ 123 — Э. Т. Тозер. Новейшие аммониты нижнего триасового периода из острова Элсмира и северо-восточной части Британской Колумбии.

CONTENTS

Illustrations

LATEST LOWER TRIASSIC AMMONOIDS FROM ELLESMERE ISLAND AND NORTHEASTERN BRITISH COLUMBIA

Abstract

Ammonoids of latest Lower Triassic age are described from the Blind Fiord and Blaa Mountain Formations of Ellesmere Island and from the Toad Formation of northeastern British Columbia. These ammonoids represent a zone, or zones, younger than the *Wasatchites* and *Arctoceras* faunas, and older than the Lower Anisian fauna with *Parapopanoceras,* etc. The most characteristic ammonoid is *Keyserlingites subrobustus,* which occurs in both British Columbia and Ellesmere Island. The widely distributed pelecypod *Posidonia aranea* occurs with many of the ammonoids, and, like them, is apparently restricted to beds of latest Lower Triassic age. The following new species are described: from British Columbia, *Pseudosageceras bicarinatum, Preflorianites intermedius, Isculitoides minor, Popovites occidentalis, Monacanthites monoceros, Metadagnoceras pulcher, Svalbardiceras chowadei, Procarnites modestus;* from Ellesmere Island, *Popovites borealis, Zenoites arcticus,* and *Svalbardiceras freboldi.* The genera *Popovites, Monacanthites,* and *Metadagnoceras* are new.

Résumé

L'auteur décrit les ammonoïdes de la partie la plus jeune du Trias inférieur et qui proviennent des formations Fiord Blind et Mont Blaa sur l'île Ellesmere et de la formation Toad dans le Nord-Est de la Colombie-Britannique. Ces ammonoïdes représentent une ou plusieurs zones plus jeunes que les faunes *Wasatchites* et *Arctoceras,* et plus vieilles que la faune de l'Anisien inférieur avec *Parapopanoceras,* etc. L'ammonoïde le plus caractéristique est *Keyserlingites subrobustus,* que l'on trouve en Colombie-Britannique et dans l'île Ellesmere. Le pélécypode *Posidonia aranea* très répandu cohabite avec un grand nombre d'ammonoïdes et, comme eux, il est apparemment limité aux couches les plus jeunes du Trias inférieur. Les nouvelles espèces suivantes sont décrites par l'auteur: de la Colombie-Britannique, *Pseudosageceras bicarinatum, Preflorianites intermedius, Isculitoides minor, Popovites occidentalis, Monacanthites monoceros, Metadagnoceras pulcher, Svalbardiceras chowadei, Procarnites modestus;* de l'île Ellesmere, *Popovites borealis, Zenoites arcticus* et *Svalbardiceras freboldi.* Les genres *Popovites, Monacanthites,* et *Metadagnoceras* sont nouveaux.

INTRODUCTION

Recent field work in northeastern British Columbia, Ellesmere Island, and Axel Heiberg Island has yielded new stratigraphic data and large collections that provide an improved understanding of the sequence and composition of Canadian Lower Triassic (Scythian) faunas. As the faunas from the Arctic Islands and British Columbia include species in common, it is appropriate that they should be treated together, and this report is one of several in which it is proposed to describe these faunas. The youngest Lower Triassic ammonoids known in Canada are described here. These include species that are probably as young as any known in the Lower Triassic of the world. Hitherto only one ammonoid *(Olenikites canadensis)* of latest Lower Triassic age has been described from Canada. The fauna is now increased to fifteen species, assigned to: *Pseudosageceras, Preflorianites, Prosphingites, Isculitoides, Popovites* (new), *Zenoites, Monacanthites* (new), *Metadagnoceras* (new), *Keyserlingites, Olenikites, Svalbardiceras, Procarnites,* and *Leiophyllites.*

In order to place this fauna in stratigraphic perspective it is desirable to summarize briefly what is known regarding the succession of Lower Triassic faunas in Canada. It is now possible to recognize five time stratigraphic divisions characterized by distinctive ammonoid faunas. Two or three zones are present within some of these divisions.

The first division includes the beds characterized by *Otoceras,* Ophiceratidae, *Pachyproptychites,* and *Claraia* and is equivalent to the Otoceratan and earliest Gyronitan of Spath (1934, p. 27; 1935, p. 104). In Canada, well-preserved ammonoids representing this division are known only from the Arctic Islands (Tozer, 1961a), but *Claraia* is widely distributed in British Columbia and Alberta. There are at least three zones within this division: a lower zone with *Otoceras*; a middle zone, characterized by what is probably a new genus, related to *Glyptophiceras*; and an upper zone, with *Pachyproptychites strigatus* (Tozer). *Ophiceras* ranges throughout this division; *Claraia* is common in the middle and upper zones.

The second division, characterized by *"Meekoceras"* cf. *lilangense* Krafft and *Proptychites candidus* Tozer, is known from the Arctic Islands and British Columbia. The *proptychites* fauna of Dunedin River, British Columbia (Tozer, 1963a, pp. 2-4) is an approximate or exact correlative. These faunas appear to be of Gyronitan age.

A third faunal assemblage is characterized by a zone with *Paranorites sverdrupi* Tozer, followed closely by beds with *"Prionolobus" heibergensis* Tozer (1961a, p. 29; 1962) and other ammonoids. These faunas probably represent the Flemingitan age of Spath (1934).

The fourth division is characterized by *Arctoceras,* and includes the *Meekoceras* fauna of Ellesmere Island (Tozer, 1961a, p. 29), and the *Wasatchites* faunas of British Columbia (McLearn, 1945) and the Arctic Islands. *Arctoceras* is now known in British Columbia (Tozer, 1963a, p. 9). *Posidonia mimer* Oeberg seems to be characteristic of this division. Locally, and perhaps regionally, an upper zone with *Wasatchites,* and a lower zone with *Meekoceras,* may be distinguished (Tozer, 1963a, p. 9). The faunas of this division represent Spath's Owenitan age.

Finally, the fifth division, with which this report is concerned, is characterized by the pelecypod *Posidonia aranea* Tozer and the ammonoids described below. These fossils appear to be of latest Lower Triassic age, i.e., of Prohungaritan age in terms of Spath's chronology. Ammonoids are relatively rare in the *Posidonia aranea* beds, but *Posidonia aranea* itself is a common fossil, widely distributed geographically but limited stratigraphically. This pelecypod occurs with all the ammonoids recorded from Ellesmere Island and in all but the highest beds in British Columbia. In Canada, *Posidonia aranea* is known from northeastern British Columbia, Ellesmere Island, and Axel Heiberg Island. In the British Museum (Natural History) the writer has seen specimens of *Posidonia aranea* from Barents Island, on the east coast of Spitsbergen. Although the associated ammonoids are rare they are of considerable interest because they date the *Posidonia aranea* beds as latest Lower Triassic. The possibility that more than one zone is represented by the latest Lower Triassic ammonoids described in this bulletin is discussed below.

Kiparisova and Popov (1956, 1961) proposed the stage terms "Induan" and "Olenekian" for the lower and upper parts of the Lower Triassic (or Scythian) series. Divisions 1, 2 and 3 are Induan; 4 and 5, Olenekian.

On Ellesmere Island and in British Columbia the *Posidonia aranea* beds are followed by strata with ammonoids of Lower Anisian age. On Ellesmere and Axel Heiberg Islands the latest Lower Triassic fossils occur in the Blind Fiord Formation and the Lower Shale Member of the Blaa Mountain Formation. General accounts of these formations are available in reports already published (Tozer, 1961b, 1963b). The occurrences in northeastern British Columbia are in the Toad Formation, which has been described by McLearn and Kindle (1950), Pelletier (1961, 1963), and Tozer (1961a). The important locality at Otto Fiord, Ellesmere Island, was discovered in 1957 by R. Thorsteinsson and revisited by Thorsteinsson and the writer in 1961. The collections from the remaining localities were made by the writer in 1962 (Raanes Peninsula) and 1963 (British Columbia).

DESCRIPTION OF FOSSIL LOCALITIES

Ellesmere Island

1. *South side of Otto Fiord*

Good exposures of the Blaa Mountain and Blind Fiord Formations occur in the westerly dipping section on the south side of Otto Fiord, near the junction with Nansen Sound. The beds with *Posidonia aranea* are exposed on the bluffs immediately above the fiord, 2 miles east from the junction with Nansen Sound. This locality was first discovered by R. Thorsteinsson in 1957 (GSC loc. 32363). In 1961 Thorsteinsson and the writer revisited the locality and collected additional fossils, both from the original discovery locality, and from another place, on strike with locality 32363, but 1½ miles inland, to the south.

The beds containing *Posidonia aranea* at this locality were originally assigned to the Blind Fiord Formation (Tozer, 1961b, pp. 12, 74, 103) but later work has shown that these *P. aranea* beds are in a black shale unit, above typical Blind Fiord siltstones. The *P. aranea* beds in this section are now assigned to the Lower Shale Member of the Blaa Mountain Formation (Tozer, 1963b, pp. 4, 37). The Lower Shale Member in this section comprises dark grey and black shale with beds of orange weathering, calcareous siltstone and large concretions of calcareous mudstone. The total thickness of the member has not been accurately measured; it is probably about 1,500 feet.

The following late Olenekian fossils were collected from the section immediately adjacent to the coast.

1. 227 feet above base of Lower Shale Member (GSC loc. 47604):

Posidonia aranea Tozer

2. 255 feet above base of Lower Shale Member (GSC loc. 47603 = GSC loc. 32363):

Posidonia aranea Tozer

Popovites sp. indet.

Olenikites canadensis Tozer (Pl. IV, figs. 1, 5)

Svalbardiceras freboldi n. sp. (Pl. V, fig. 2).

Higher beds in this section, 425 and 434 feet above the base of the Lower Shale Member (GSC locs. 47550, 47580), have yielded ammonoids of Anisian age, which appear to represent a species of *Pearylandites*. Ammonoids that are

closely related to those from this locality occur in the Lower Anisian fauna of northeastern British Columbia (F. H. McLearn, pers. com.).

From the section 1½ miles inland fossils were obtained from two levels of concretions, 25 feet apart. The lower level, about 225 feet above the base of the Lower Shale Member (GSC loc. 47545), yielded:

Posidonia aranea Tozer

Keyserlingites subrobustus (Mojsisovics) (Pl. VI, fig. 2; Pl. VII, figs. 2, 3)

Olenikites canadensis Tozer (Pl. IV, fig. 4).

The upper level, about 250 feet above the base of the Lower Shale Member (GSC loc. 47544), provided:

Posidonia aranea Tozer

Popovites borealis n. sp. (Pl. III, fig. 1)

Zenoites arcticus n. sp. (Pl. II, figs. 6, 7)

Olenikites canadensis Tozer (Pl. IV, figs. 2, 3, 6, 7, 8)

Svalbardiceras freboldi n. sp. (Pl. IV, figs. 12, 13).

2. *Five miles northwest from entrance to Hare Fiord*

Although no determinable ammonites were obtained from this locality, the section is important because it provides more data than any other on the stratigraphic position of the *Posidonia aranea* beds. This section was originally studied by Thorsteinsson and the writer in 1956 (Tozer, 1961b, p. 12), when it yielded the fauna with *Meekoceras* and *Arctoceras*. Later work revealed the *Wasatchites* fauna (GSC locs. 47531, 47547) 220 feet above the *Meekoceras* bed (Tozer, 1963a, p. 9), and the *Posidonia aranea* fauna (GSC locs. 47549, 47563) 810 feet above the *Wasatchites* bed. Both the *Wasatchites* and *Posidonia aranea* beds lie within the Blind Fiord Formation as interpreted by Tozer (1961b, p. 12, Pl. IIA; 1963b, p. 4). In this section determinable Anisian ammonoids have now been obtained in the Lower Shale Member of the Blaa Mountain Formation, above the *Posidonia aranea* bed. *Sturia* sp. indet. and *Ussurites* cf. *U. yabei* Diener (GSC loc. 51676) were obtained 540 feet above *Posidonia aranea*; *"Gymnotoceras"* sp. cf. *"G." helle* McLearn (GSC loc. 51677) was collected 553 feet above *Posidonia aranea*. Broadly speaking, these ammonites indicate a correlation with the Lower Anisian fauna of the Toad Formation in northeastern British Columbia.

3. *Raanes Peninsula*

Excellent exposures of the upper Blind Fiord beds, and of the overlying Lower Shale Member of the Blaa Mountain Formation, occur 3½ miles west from the mouth of Willow River, which flows into the west side of Blind Fiord. In this section the beds containing late Olenekian fossils are assigned to the Blind Fiord Formation (Tozer, 1963b, p. 3). The following fossils were collected in this section:

1. 705 feet below the Blind Fiord-Blaa Mountain contact (GSC loc. 51600)

Posidonia aranea Tozer.

2. 715 feet below the Blind Fiord-Blaa Mountain contact (GSC loc. 51599), from large concretions

Keyserlingites subrobustus (Mojsisovics).

A talus collection was made from concretions unquestionably derived from the same bed as GSC locality 51599. These talus specimens have been assigned GSC locality 51603 (Pl. V, fig. 1; Pl. VI, fig. 1).

Northeastern British Columbia

In northeastern British Columbia the hard, dark coloured chert of the Fantasque Formation, apparently of Permian age (Harker, 1963), is overlain by relatively soft, recessive, shales and siltstones of Lower and early Middle Triassic age. In the northernmost part of the province, on Liard River, the Lower and early Middle Triassic beds are included within the Grayling and Toad Formations (McLearn and Kindle, 1950; Pelletier, 1961). To the south, in the Halfway River area, the division between the Grayling and Toad Formations becomes less distinct. Formal nomenclature for these beds has not yet been established. Pelletier (1963, p. 25) assigns them to the "Toad-Grayling Formation". *Posidonia aranea* and the associated late Olenekian ammonoids occur in the part of the section that undoubtedly represents the Toad Formation. Well-preserved fossils have been obtained from three localities in the Halfway River map-area. Detailed descriptions of these localities follow.

1. *Seven miles north of Mount Laurier*

Excellent Lower Triassic exposures occur on a prominent west-facing bluff, 7 miles north of Mount Laurier. The exposures examined occur in three gullies on the face of this bluff. In the account that follows they are referred to as the 'North', 'Middle' and 'South' gullies. North Gully is 7 miles N12°W of the summit of Mount Laurier (lat. 56°52′20″N, long. 123°30′50″W); Middle Gully is about 600 feet south of North Gully; South Gully is a further 500 feet south.

In the North Gully the Toad-Grayling siltstones and shales are 1,100 feet thick, and rest with a sharp contact on the dark chert of the Fantasque Formation. *Proptychites* cf. *P. candidus* Tozer and other ammonoids of Induan age occur between 50 and 100 feet above the chert. *Posidonia mimer* Oeberg, of early Olenekian age, occurs between 150 and 210 feet above the same datum. Higher beds in the North Gully yielded the following late Olenekian ammonoids and pelecypods:

1. 406 feet above the Fantasque Formation (GSC loc. 56238)

   Posidonia aranea Tozer

2. 414 feet above the Fantasque Formation (GSC loc. 56237)

   Posidonia aranea

   Procarnites modestus n. sp. (Pl. I, fig. 1)

3. 422.5 feet above Fantasque Formation (GSC loc. 56235)
   Keyserlingites subrobustus (Mojsisovics) (Pl. VIII, fig. 2)
4. 430 feet above Fantasque Formation (GSC loc. 56234)
   Popovites occidentalis n. gen., n. sp. (Pl. III, figs. 11, 12)
   Pseudosageceras bicarinatum n. sp. (Pl. II, fig. 8)
   Leiophyllites sp. indet. (Pl. II, fig. 10).

Fossils were obtained from two levels in the Middle Gully, as follows:

1. About 415 feet above Fantasque Formation (GSC loc. 56241)
   Posidonia aranea Tozer
   Prosphingites cf. *P. czekanowskii* Mojsisovics (Pl. II, fig. 5)
   Procarnites modestus n. sp.
2. About 430 feet above Fantasque Formation (GSC loc. 56240)

(Probably the same bed as GSC loc. 56234 in the North Gully.)

   Preflorianites intermedius n. sp. (Pl. II, fig. 9)
   Monacanthites monoceros n. gen., n. sp. (Pl. I, figs. 8, 10)
   Popovites occidentalis n. gen., n. sp. (Pl. III, figs. 4, 8).

In the South Gully the following two fossiliferous localities were found:

1. About 410 feet above Fantasque Formation (GSC loc. 56243)
   Posidonia aranea Tozer
   Isculitoides minor n. sp. (Pl. II, fig. 2)
2. About 420 feet above Fantasque Formation (GSC loc. 56242)
   Procarnites modestus n. sp.

2. *Headwaters of Chowade River*

This section is on a northwesterly facing bluff, west of upper Chowade River, 2½ miles S7°W of the summit of Mount Laurier (lat. 56°44′15″N, long. 123°29′00″W).

Proptychites cf. *P. candidus* Tozer, of Induan age, occurs 40 feet above the Fantasque Formation (Tozer, 1963a, p. 3).

Posidonia mimer Oeberg, of early Olenekian age, was obtained 110 feet, and also 123 feet, above the Fantasque.

The late Olenekian fauna was obtained from concretions between 320 and 335 feet above the Fantasque Formation. The beds are vertical at this locality and when following them along the strike it was not possible to determine the exact relative stratigraphic position of each concretion. Collections from concretions that yielded more than one species have been kept separate and given individual catalogue numbers. All available information on faunal associations has thus been preserved. However, the collections do not provide reliable evidence regarding the sequence of late Olenekian faunas within this 15-foot stratigraphic interval. The following collections were obtained at this locality:

1. GSC loc. 56194
   Monacanthites monoceros n. gen., n. sp. (Pl. I, fig. 9; Pl. II, fig. 4)
2. GSC loc. 56195, one concretion
   Popovites occidentalis n. gen., n. sp.
   Procarnites modestus n. sp. (Pl. I, fig. 2)
3. GSC loc. 56196, one concretion
   Posidonia aranea Tozer
   Metadagnoceras pulcher n. gen., n. sp. (Pl. I, fig. 11)
4. GSC loc. 56264
   Popovites occidentalis n. gen., n. sp. (Pl. III, fig. 10)
5. GSC loc. 56258
   Svalbardiceras chowadei n. sp. (Pl. IV, fig. 11)
6. GSC loc. 56265, from one concretion. The outer surface of this concretion bore a poor impression, apparently of *Keyserlingites subrobustus* (Mojsisovics)
   Posidonia aranea Tozer
   Popovites occidentalis n. gen., n. sp. (Pl. III, fig. 2)
   Isculitoides minor n. sp. (Pl. II, fig. 1)
   Svalbardiceras sp. (Pl. IV, fig. 9)
7. GSC loc. 56261
   Keyserlingites subrobustus (Mojsisovics) (Pl. VII, fig. 1)
8. GSC loc. 56263
   Svalbardiceras chowadei n. sp. (Pl. IV, fig. 10)
9. GSC loc. 56259, from one concretion
   Popovites occidentalis n. gen., n. sp. (Pl. III, fig. 6)
   Isculitoides minor n. sp. (Pl. II, fig. 3)
10. GSC loc. 56262
    Popovites occidentalis n. gen., n. sp. (Pl. III, fig. 7)
11. GSC loc. 56198, from several concretions
    Popovites occidentalis n. gen., n. sp. (Pl. III, figs. 3, 9)
    Keyserlingites subrobustus (Mojsisovics)
    Procarnites modestus n. sp. (Pl. I, figs. 5, 6).

At this section a single loose concretion, apparently derived from a bed 455 feet above the Fantasque Formation, contains a single specimen of *Parapopanoceras* cf. *P. tetsa* McLearn (GSC loc. 56199). This occurrence provides local confirmation that the *Posidonia aranea* beds are older than those with the Lower Anisian *Parapopanoceras* fauna.

3. *Needham Creek*

The Toad-Grayling beds are well exposed on the banks of Needham Creek, a tributary of Graham River. The exposures are in a gorge between 3 and 3½ miles

above the junction of Needham Creek and Graham River. This section has been studied by geologists of oil companies and by B. R. Pelletier of the Geological Survey (Pelletier, 1963, pp. 24-26). Induan, and early Olenekian fossils, obtained by Shell Oil Company and by Pelletier have already been described (Tozer, 1963a, p. 3).

In 1963 the writer visited this section and obtained *Paranorites sverdrupi* (Induan) 102 feet above the highest exposure of the Fantasque Formation. *Posidonia mimer* Oeberg, of early Olenekian age, was noted between 190 and 250 feet above the same datum. The *Posidonia mimer* beds at this locality also contain ammonoids, including *Arctoceras* cf. *A. blomstrandi* (Lindstrom), *Juvenites needhami* Tozer, *Euflemingites* cf. *E. cirratus* (White), and *Meekoceras* cf. *M. gracilitatis* White.

This ammonoid fauna amply confirms the early Olenekian (Owenitan) age of the *Posidonia mimer* beds. The outcrops yielding these faunas are on the south side of Needham Creek.

Beds with the late Olenekian fauna occur on the north side, at a prominent bend (lat. 56°30′00″N, long. 123°10′00″W). The following fossils were obtained at this locality:

1. About 400 feet above highest exposure of Fantasque Formation (GSC loc. 56179)

   Posidonia aranea Tozer

   crushed ammonoids, probably *Popovites* sp.

2. 27 feet above (1), GSC loc. 56178

   Posidonia aranea Tozer

   Popovites sp. indet.

   Procarnites modestus n. sp. (Pl. I, fig. 4)

3. 39 feet above (1), GSC loc. 56177

   Popovites sp. indet.

The section in Needham Creek is the only one in British Columbia where early Olenekian ammonoids are known to underlie the *Posidonia aranea* beds.

AGE AND CORRELATION

Stratigraphic Position of the Latest Lower Triassic Fossils

Before considering the time stratigraphic significance and affinities of the ammonoids described in this bulletin it seems appropriate to summarize what is known regarding their stratigraphic position with respect to beds with older and younger Triassic faunas. The available evidence indicates that *Posidonia aranea* and the associated ammonoids maintain a constant stratigraphic position throughout British Columbia and Ellesmere Island. This may be demonstrated by referring to the following sections.

Ammonoids of Anisian age occur above *Keyserlingites, Posidonia aranea,* etc., near the headwaters of Chowade River, British Columbia, and at Otto Fiord, Ellesmere Island. Anisian ammonoids also overlie *Posidonia aranea* near Hare Fiord, Ellesmere Island, and on Toad River, British Columbia (Tozer, 1961b, p. 7). Determinable ammonoids have not been obtained from the *Posidonia aranea* beds at these last two localities. The Anisian ammonoids from all these localities are now being studied by F. H. McLearn. According to both Dr. McLearn and N. J. Silberling of the U.S. Geological Survey (pers. coms.), the ammonoids from these localities evidently represent the Lower Anisian *Acrochordiceras* zone of Silberling (1962, p. 155). There is thus no doubt that *Posidonia aranea* and the associated ammonoids underlie beds of Lower Anisian age.

We also have sufficient data in Canada to show that the fauna characterized by *Keyserlingites* and *Posidonia aranea* is younger than the *Arctoceras* and *Wasatchites* faunas, of early Olenekian age. Near Hare Fiord, Ellesmere Island, *Posidonia aranea* occurs above *Wasatchites*; at Needham Gorge, British Columbia, *Posidonia aranea* and *Procarnites modestus* n. sp. occur above beds with *Posidonia mimer, Arctoceras, Euflemingites, Juvenites* and other early Olenekian ammonoids. Thus it is established that the fauna with *Posidonia aranea, Keyserlingites,* etc., apparently occupies a constant stratigraphic position, below beds with Lower Anisian ammonoids, and above *Arctoceras* and *Wasatchites*.

Affinities of Faunas

Of the thirteen ammonoid genera now recognized in the late Olenekian of British Columbia and Ellesmere Island, *Preflorianites* has relatively little strati-

graphic significance. *Pseudosageceras* has a long range in the Scythian but it is possible that *P. bicarinatum* n. sp. may be related to *Epihedenstroemia skipetarensis* (Arthaber) from the late Olenekian *Subcolumbites* fauna of Albania (*see* below). *Popovites* n. gen. provides a link between the late Olenekian faunas of British Columbia and Ellesmere Island but has not yet been positively identified elsewhere. *Leiophyllites* is typically an Anisian genus but it occurs in the *Subcolumbites* faunas of Kwangsi, China (Chao, 1959) and probably also of Primorye, Eastern Siberia. Furthermore, *Leiophyllites* occurs with *Keyserlingites* in Timor (*see* below). The new genus *Monacanthites* is known only from British Columbia. The remaining genera have a wide distribution in beds of late or latest Olenekian age and must be considered individually in more detail.

(1) ***Keyserlingites.*** The specimens of *Keyserlingites subrobustus* from British Columbia and Ellesmere Island appear to be identical with those from Siberia and Spitsbergen. The type locality for *Keyserlingites* is Siberia, where it occurs in the Olenek fauna described by Mojsisovics (1886, 1888) and Popov (1961, 1962). According to Popov (1960) the *Keyserlingites* fauna is now known to be widely distributed in northeastern Siberia, between eastern Taymyr and the eastern Verkhoyan region. In several sections (*see also* Sachs, *et al.*, 1959) Lower Anisian ammonoids (*Arctohungarites, Parapopanoceras,* etc.) have been recorded above the *Keyserlingites* beds.

Records of *Keyserlingites* from Spitsbergen have been somewhat confused. Spath (1921, pp. 298, 350) was the first to mention *Keyserlingites* from this area, but these specimens were later assigned to *Wasatchites* (Spath, 1934, p. 352). Frebold (1929a, p. 12) recorded *Keyserlingites* cf. *subrobustus* from Kap Thordsen, together with some unnamed ammonoids that he compared with *Lecanites? spitzbergensis,* the type species of *Svalbardiceras*. The specimens from Kap Thordsen were collected by an early Norwegian expedition and no exact stratigraphic information was available. Nevertheless, Frebold (1929a, p. 33) suggested that the beds with *Keyserlingites* cf. *subrobustus* were younger than the strata with *Arctoceras* and *"Keyserlingites"* (of Spath, 1921, i.e. *Wasatchites*). In 1930 Frebold himself examined sections in the Ice Fiord area that essentially confirmed this interpretation for he collected *Keyserlingites subrobustus* (Pl. VIII, fig. 1) from the *Grippia* bed, which overlies the beds containing the *Arctoceras* fauna (Frebold, 1931, p. 32). The assignment of the *Grippia* bed to the Lower Anisian (Frebold, 1951, p. 71) is evidently unjustified (Tozer, 1961b, p. 32). Several beds with Anisian fossils, including one with *Parapopanoceras* (presumably Lower Anisian), overlie the *Grippia* bed (Frebold, 1951, p. 76). The stratigraphic position of *Keyserlingites subrobustus* in Spitsbergen thus seems to be closely comparable with the occurrences in Siberia, Ellesmere Island, and British Columbia.

Keyserlingites n. sp. cf. *K. subrobustus* is recorded by Kummel (1954, p. 187) from the uppermost fauna in the Thaynes Formation of the Paris Canyon area, Idaho, in association with *Prohungarites, Isculitoides, Olenikites* (?), *Svalbardiceras,* etc. Dr. Kummel has kindly shown the writer these specimens of *Keyserlingites*. They are clearly not conspecific with those from British Columbia and Ellesmere

Island. Nevertheless, the genera in common between the faunas in Canada and Idaho provide some grounds for a correlation.

All the records of *Keyserlingites* considered so far consistently suggest that this genus occurs at or near the top of the Lower Triassic. However, the age significance of *Keyserlingites* is complicated by occurrences in the Himalayas and Timor. These representatives have been separated as a distinct genus, *Durgaites,* and have been dated as Lower Anisian (Diener, 1912, pp. 63, etc.; Spath, 1934, p. 357). As mentioned below, separation of *Durgaites* from *Keyserlingites* cannot be justified on morphological grounds.

The Himalayan *"Durgaites"* were first collected by Diener in 1892, from the Shalshal Cliff. They were first described as *"Ceratites subrobustus* Mojsisovics", later as *Keyserlingites dieneri* (Mojsisovics), eventually as *Durgaites dieneri* (Mojsisovics). Diener, from his own field observations, believed that his original specimen was derived from a bed below the Niti (or nodular) Limestone, above which occur ammonoids of Anisian age. Later, A. von Krafft visited the section at Shalshal Cliff, and also sections at Lilang, Lingti River, and Bambanag Cliff. Von Krafft maintained that in all these sections *Keyserlingites dieneri* occurs above the Niti Limestone, in beds that are classed as "Lower Muschelkalk", of Lower Anisian age. Diener (1912, p. 59) accepted von Krafft's correction. However, according to Diener's summary (1912), at Lilang and Shalshal Cliff *Keyserlingites dieneri* occurs below, and only below, unequivocal Anisian ammonoids. In these sections the situation of *Keyserlingites* is comparable with the occurrences in Siberia, Spitsbergen, and Canada; i.e. below beds with Anisian ammonoids. However, at Bambanag Cliff (Diener, 1912, p. 57) von Krafft reported *Keyserlingites* from two levels, in near association with *Dalmatites ropini* Diener, *Gymnites* sp., *"Monophyllites" hara* Diener and *"Monophyllites" kingi* Diener. The type and only other known species of *Dalmatites* is from the late Olenekian *Tirolites* fauna of Yugoslavia. Monophyllitids occur in both late Olenekian and Anisian beds, indeed Arthaber (1908, 1911) identified *"Monophyllites" kingi* from the *Subcolumbites* fauna of Albania, although Spath (1934, p. 302) renamed the ammonoid in question as *Ussurites*? *decipiens*. The *Dalmatites* and monophyllitids from Bambanag Cliff do not provide unequivocal evidence for the Anisian age of the *Keyserlingites dieneri* beds. This leaves only *Gymnites* sp., recorded by Diener (1912, p. 57, from bed 3d); but as this fossil is not described, nor even mentioned, in the palaeontological memoir (Diener, 1907, p. 129) this record can only be considered doubtful.

In view of the foregoing it seems reasonable to suggest that the *Keyserlingites*-bearing beds in the Himalayas may be of late Olenekian age, and correlative with the *Keyserlingites* beds of Siberia, Spitsbergen, and Canada.

The magnificent specimens of *Keyserlingites angustecostatus* Welter from Timor (assigned to *Durgaites* by Spath, 1934, p. 359) have generally been regarded as Anisian, and the association with *Sturia mongolica,* noted by both Welter (1915, p. 108) and Spath (1934, p. 359) at first sight makes this a reasonable conclusion. On the other hand, it must be remembered that the blocks of Triassic limestone at

Timor evidently represent extremely condensed deposits. Welter (1915, pp. 102-103) has described one block, with visible stratification, 190 cm thick. One part, 100 cm thick, yielded *Keyserlingites angustecostatus, Ussurites hara* (Diener), and *Leiophyllites indoaustralica* (Welter); the adjacent 30 cm provided *Sturia mongolica* Diener, etc.; and adjacent to this was 60 cm with *Acrochordiceras (Parachrochordiceras) anodosum* Welter, etc. The parts of this block containing *Sturia* and *Acrochordiceras* are undoubtedly Anisian, but the fossils associated with *Keyserlingites* do not establish an Anisian age.

In conclusion, it would appear that the occurrences of *Keyserlingites* in Canada, western United States, Siberia, and Spitsbergen indicate that it is restricted to beds of late Olenekian age. In the Himalayas and Timor the evidence is equivocal. In the past it has been interpreted as favouring a Lower Anisian age for *"Durgaites" (=Keyserlingites)* but it appears more probable that in these areas, as to the north, *Keyserlingites* occurs below Anisian beds.

Thus it is possible that not only *Keyserlingites subrobustus* but also its close allies *K. dieneri* and *K. angustecostatus* represent index fossils of the late Olenekian.

(2) ***Olenikites.*** Like *Keyserlingites, Olenikites* has its typical occurrence in the Olenek fauna of Siberia. As mentioned by Spath (1934, p. 360), *Olenikites* may also occur in the "highest beds of the Upper Ceratite Limestone" of the Salt Range, Pakistan (Waagen, 1895, p. 25).

Astachova (1960a, p. 150; 1960b, p. 148) has described *Olenikites mangyshlakensis* from the *Columbites* zone of Mangyshlak Peninsula, on the west side of the Caspian Sea. According to Astachova the Mangyshlak sequence comprises the following five zones, characterized by, in ascending order: *Doricranites, Pseudosageceras, Tirolites, Columbites,* and *Stacheites.* Astachova (1960b, p. 149) records *Tirolites cassianus* from the *Doricranites* zone, which would suggest a late Olenekian, post-Owenitan age, for the whole sequence. Shevyrev and Schlezinger (1960) claim that *Tirolites* does not occur with *Doricranites* and that ophiceratids occur between the *Doricranites* and *Pseudosageceras* zones. Accordingly, they date the *Doricranites* zone as "Lower Seisian", i.e., Lower Induan. Astachova correlates the *Pseudosageceras* zone with the *Hedenstroemia* zone of the Himalayas, and the so-called *Pseudosageceras multilobatum* zone of North America, which, as shown by Kummel and Steele (1962), is merely a manifestation of the *Meekoceras gracilitatis* zone. Astachova, and also Shevyrev and Schlezinger, record *Procarnites andrusovi* Kiparisova from the *Pseudosageceras* zone of Mangyshlak. *Procarnites,* of which *P. andrusovi* is a typical representative, seems to provide a better indication for the age of this zone than the long-ranging *Pseudosageceras.* As noted below, *Procarnites* appears to be a reliable guide to beds of post-Owenitan age. *Olenikites mangyshlakensis* in the *Columbites* zone, offers some grounds for correlation with the *Olenikites* beds of Ellesmere Island. At this point it should be noted that the *Columbites* species from Mangyshlak do not appear to be closely related to those from Idaho. On the evidence of *Olenikites* it would appear that the so-called *Columbites* zone of Mangyshlak is younger than the

Columbites zone of Idaho. This is also suggested by the occurrence of *Procarnites* below the Mangyshlak *Columbites* zone.

(3) ***Prosphingites.*** In the restricted sense advocated in this report, *Prosphingites* is known elsewhere only from the Olenek fauna of northeastern Siberia, where it is associated with *Keyserlingites, Olenikites,* etc. In northeastern British Columbia it is associated with *Posidonia aranea* and occurs at about the same level as *Keyserlingites subrobustus.*

(4) ***Zenoites.*** This genus is a member of the *Subcolumbites* fauna of Chios Island, Greece. *Zenoites arcticus* occurs in association with *Olenikites canadensis, Popovites borealis,* and *Svalbardiceras freboldi* on Ellesmere Island.

(5) ***Metadagnoceras*** n. gen. This interesting genus can be recognized in the *Prohungarites* fauna of Nifoekoko, Timor. It has also been found by Dr. Silberling in Nevada, associated with *Prohungarites. Metadagnoceras* may thus assume a useful role in correlating these latest Olenekian faunas. In British Columbia *Metadagnoceras pulcher* occurs with *Posidonia aranea,* but the precise position with respect to the beds with *Keyserlingites* and *Procarnites* is not yet known.

(6) ***Procarnites.*** The typical, large representatives of *Procarnites* are a characteristic component of the *Subcolumbites* faunas of Albania, and Chios Island (Renz and Renz, 1948) and are also recorded from the *Pseudosageceras* zone at Mangyshlak (Astachova, 1960b, p. 149), the *Prohungarites similis* fauna of Timor (Spath, 1934, p. 182), and from Kwangsi, China (Chao, 1959). *Procarnites modestus* n. sp., from British Columbia, is not one of these large typical species but is nevertheless very close to *"Megaphyllites" immaturus* Kiparisova, from the *Subcolumbites* fauna of Primorye (Kiparisova, 1961). In British Columbia *Procarnites modestus* lies a few feet below *Keyserlingites subrobustus.*

(7) ***Isculitoides.*** This genus occurs in the *Subcolumbites* faunas of Albania (Arthaber, 1911), Chios Island (Renz and Renz, 1948), and Kwangsi, China (Chao, 1959). It has also been reported by Kummel (1954, p. 187) from the *Prohungarites* fauna of Idaho, the highest fauna in the Thaynes Formation. In British Columbia *Isculitoides* apparently occurs with *Keyserlingites.*

(8) ***Svalbardiceras.*** This genus occurs with *Keyserlingites* in Spitsbergen (Frebold, 1931, p. 32), probably also in Siberia (Spath, 1934, p. 251), and in Idaho (Kummel, 1954, p. 251). *Svalbardiceras freboldi* n. sp. occurs with *Olenikites, Popovites,* and *Zenoites,* at a level 25 feet above *Keyserlingites* on Ellesmere Island. *S. chowadei,* from British Columbia, has no known direct associates.

Summary and Conclusions

Ammonoids of very late Lower Triassic age occur in the Toad Formation of northeastern British Columbia ('B.C.') and in the Blind Fiord and Blaa Mountain Formations of Ellesmere Island ('E.'). In each area the ammonoids are confined to

20 to 30 feet of beds. The following genera have been recognized: *Pseudosageceras* (B.C.), *Preflorianites* (B.C.), *Prosphingites* (B.C.), *Isculitoides* (B.C.), *Popovites,* new (B.C. and E.), *Zenoites* (E), *Monacanthites,* new (B.C.), *Metadagnoceras,* new (B.C.), *Keyserlingites* (B.C. and E.) *Olenikites* (E), *Svalbardiceras* (B.C. and E.), *Procarnites* (B.C.), and *Leiophyllites* (B.C.).

Posidonia aranea occurs with all the ammonoids recorded from Ellesmere Island, and with many of the genera recorded from British Columbia. The species of *Pseudosageceras, Preflorianites, Monacanthites,* and *Leiophyllites* occur a few feet above *Posidonia aranea. Posidonia aranea* first appears a few feet below the ammonoids, both in British Columbia and Ellesmere Island. This pelecypod appears to be a widely distributed index fossil of latest Lower Triassic age for it is known from Axel Heiberg Island and Barents Island, Svalbard, as well as from the ammonoid localities described above.

Local evidence from British Columbia and Ellesmere Island shows that *Posidonia aranea* and the associated ammonoids are younger than the *Arctoceras* and *Wasatchites* faunas (early Olenekian), and older than the beds with Lower Anisian faunas.

Keyserlingites, Olenikites, Prosphingites, and *Svalbardiceras* suggest correlation with the latest Lower Triassic faunas of Siberia and Spitsbergen. *Keyserlingites* also suggests correlation with beds hitherto, and probably incorrectly, regarded as Lower Anisian in the Himalayas and Timor; *Olenikites* with the *Columbites* zone of Mangyshlak Peninsula, on the Caspian Sea. *Isculitoides* and *Procarnites* suggest correlations with the *Subcolumbites* faunas of Albania, the Greek Island of Chios, China, and the Soviet Far East (Primorye). *Metadagnoceras* indicates affinity with the *Prohungarites* faunas of Timor and Nevada.

There is some evidence for zonation among the ammonoids described, but this zonation may be merely of local importance. The ammonoids are rare, and the composition of the zones may merely reflect collection failure.

In British Columbia *Keyserlingites* occurs above *Procarnites* and provides some grounds for regarding the *Keyserlingites*-bearing faunas as younger than those with *Subcolumbites,* as suggested by Spath (1934, p. 27). On the other hand, the probable direct association of *Keyserlingites* and *Isculitoides* (the latter is typically a member of the *Subcolumbites* faunas) suggests that these late Lower Triassic faunas are not widely separated in age, as already suggested by Kummel (1954, p. 187). The new genus *Monacanthites* apparently lies above *Keyserlingites* and *Posidonia aranea* and possibly characterizes the youngest zone among the faunas under consideration.

Metadagnoceras, the best link between the faunas from British Columbia and the *Prohungarites* fauna of Timor, cannot, at present, be placed with precision in the faunal sequence outlined here, but it is certainly associated with *Posidonia aranea.*

On Ellesmere Island *Olenikites* occurs with, and also above *Keyserlingites.* In this area *Svalbardiceras, Popovites,* and *Zenoites* are known only above *Keyserlingites.*

The faunas from British Columbia and Ellesmere Island have virtually nothing in common with the *Tirolites* and *Columbites* faunas of Idaho, described by Hyatt and Smith (1905) and Smith (1932). These Idaho faunas, from the evidence presented by Kummel (1954), and Silberling (*in* Hose and Repenning, 1959), appear to be older than the *Keyserlingites* and *Subcolumbites* faunas. However, Kummel (1954, p. 187, and pers. com.) has recently made additions to the *Columbites* fauna. Discussion of the relationship between the *Columbites* and younger Olenekian faunas, recently raised by Popov (1962, p. 177), must await full description of the *Columbites* fauna by Dr. Kummel.

SYSTEMATIC PALAEONTOLOGY

The measurements that follow are given in mm in the conventional manner for diameter (D), whorl height (H), whorl width (W), and umbilical width (U). Figured in parentheses are the proportions of H, W, and U expressed as a decimal fraction of D.

Family SAGECERATIDAE

Genus *Pseudosageceras* Diener 1895

Type species: *Pseudosageceras multilobatum* Noetling (Arkell, *et al.*, 1957, p. 75)

Pseudosageceras bicarinatum n. sp.

Plate II, figures 8a-d; Text-figure 1

Diagnosis. *Pseudosageceras* with relatively thick inner whorls, with wide venter, and rounded ventral shoulders; outer whorl with tabulate venter and raised keels on the ventral shoulders. Suture line imperfectly known; principal lateral lobe with three prominent teeth, and apparently three adventitious lobes.

TEXT-FIGURE 1. Suture line of *Pseudosageceras bicarinatum* n. sp., holotype, GSC No. 18814 (x4). The exact depth of the lobes is uncertain owing to approximation of the septa.

Type and dimensions

Specimen	Locality		D	H	W
18814 holotype	56234	at	42	28 (0.67)	14 (0.33)

Description. This species is known from one specimen comprising an uncrushed phragmocone, 42 mm in diameter, followed by about three-quarters of a whorl of crushed body chamber. The original diameter was probably about 85 mm. The phragmocone shows the abrupt change in the character of the venter. The last third of the outer whorl of the phragmocone has a tabulate venter, with distinctly raised keels, 0.2 mm high. The venter of the first third forms a low arch, with indistinct ventral shoulders. Growth lines on the phragmocone are sigmoidal: they are projected on the venter, form a sinus on the outer quarter of the whorl side, a salient near the middle, and another sinus adjacent to the closed umbilicus. The suture lines are not well preserved. They are closely approximated and it is difficult to follow the course of a single septum. There is no doubt, however, that the principal lateral lobe has three main points and there are certainly two and probably three adventitious lobes (text-fig. 1).

Comparisons. The suture line leaves little doubt that this species is referable to *Pseudosageceras* or *Cordillerites*. *Pseudosageceras bicarinatum* has proportionately thicker whorls and a much wider venter than all described species of *Pseudosageceras*; in these respects it resembles *Cordillerites* more than *Pseudosageceras,* but no species of *Cordillerites* have the ventral keels of *P. bicarinatum.* The venter of *P. bicarinatum* invites comparison with *Hedenstroemia skipetarensis* Arthaber (1911, pl. xvii, figs. 13a-c), from the *Subcolumbites* fauna of Albania, and type species of *Epihedenstroemia* Spath (1934, p. 222). Arthaber had only one specimen of his species, and Dr. Kummel has informed the writer that this specimen cannot be found among Arthaber's types. *Hedenstroemia skipetarensis* has relatively wide saddles and this evidently influenced both Spath and Arthaber in placing this species in the Hedenstroemiidae rather than in the Sageceratidae, but as noted by Spath (1934, p. 61) there is convergence between certain members of these two families and it is difficult to decide where some genera should be placed. The ventral keels and narrow saddles of *P. bicarinatum* seem to justify its attachment to the Sageceratidae, but it may, nevertheless, be related to *H. skipetarensis,* which, according to this interpretation, would be a sageceratid with unusually wide saddles. The significance of the peculiar curvature shown by the suture line of *H. skipetarensis* is hard to assess. Unfortunately the approximation of the septa of *P. bicarinatum* makes it impossible to decide whether a comparable curvature is developed. The possibility of affinity between *P. bicarinatum* and *H. skipetarensis* is of some stratigraphic interest (p. 10).

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56234: 430 feet above Fantasque Formation, North Gully, 7 miles north of Mount Laurier.

Family XENOCELTITIDAE

Genus *Preflorianites* Spath, 1930

Type species: *Danubites strongi* Hyatt and Smith

Preflorianites intermedius n. sp.

Plate II, figures 9a-c; Text-figure 2

Diagnosis. *Preflorianites* like *P. strongi* but with less prominent ribbing.

TEXT-FIGURE 2
External lobe of *Preflorianites intermedius* n. sp., holotype, GSC No. 18815 (x5).

Type and dimensions

Specimen	Locality		D	H	W	U
18815 holotype	56240	at	32	11 (0.34)	11 (0.34)	15 (0.47)
18815 holotype	56240	at	40	13 (0.33)	13 (0.33)	18 (0.45)

Description. This species is known from one specimen, an apparently complete phragmocone, just over 40 mm in diameter. The umbilical seam can be traced for just over half a whorl beyond the end of the phragmocone. The umbilicus attained a maximum width of 27 mm. If the proportions evident at 40 mm were maintained the maximum diameter was about 60 mm. The inner whorls are rather well preserved and show the protoconch. The phragmocone comprises just over seven whorls, of which the first three have smooth sides. At the end of the phragmocone the whorl section is U-shaped with the whorls higher than wide and the maximum width near the inclined umbilical wall. The umbilical shoulder is moderately distinct, but rounded. At the beginning of the last septate whorl the section is subcircular and the whorl is wider than high. The outer whorl of the phragmocone carries thirty-five low radial ribs, more distinct at the umbilical shoulder than on the outer part of the whorl side. The ribs fade on the outer half of the whorl side and the periphery is smooth. The suture line is not very clearly shown. The external lobe is shallow and the relative size of the two lateral lobes is essentially as on *P. strongi.*

Comparisons. Only the weaker ribbing distinguishes *P. intermedius* from *P. strongi* (Hyatt and Smith, 1905, pl. ix, figs. 4-6). *P. maritimus* Kiparisova (1961, pl. xxix, fig. 9), from the *Subcolumbites* fauna of Primorye, also resembles *P. intermedius* but has a proportionately smaller umbilicus and a different suture line with well-defined auxiliary lobes. The suture line of *P. maritimus* resembles that of *Leiophyllites* and probably the Primorye species should be assigned to that genus.

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56240: about 430 feet above Fantasque Formation, Middle Gully, 7 miles north of Mount Laurier.

Family PARANANNITIDAE

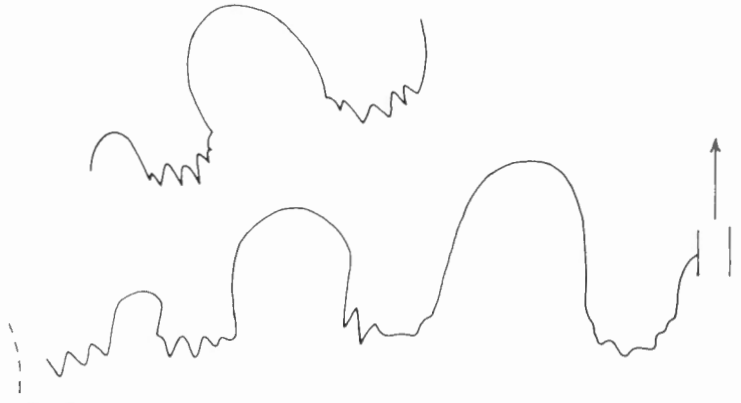
Genus *Prosphingites* Mojsisovics 1886

Type species: *Prosphingites czekanowskii* Mojsisovics

Prosphingites cf. *P. czekanowskii* Mojsisovics

Plate II, figures 5a-c; Text-figure 3

cf. *Prosphingites czekanowskii* Mojsisovics, 1886, p. 64, pl. XV, figs. 10-12; Kiparisova, 1937, p. 140, pl. i, fig. 2; Popov, 1961, p. 58. pl. xiii, fig. 4.



TEXT-FIGURE 3. Suture lines, below umbilical shoulder, of *Prosphingites* cf. *P. czekanowskii* Mojsisovics, GSC No. 18816 (x8).

Dimensions

Specimen	Locality		D	H	W	U
18816	56241	at	31	11 (0.35)	13 (0.42)	11 (0.35)

Description. This species is represented by one specimen showing a fragmentary, uncrushed, phragmocone and parts of one whorl of body chamber. The phragmocone whorl section is essentially oval, with a low, almost perpendicular umbilical wall. The whorl section of the body chamber is more compressed and the umbilical wall is inclined, and less prominent than on the phragmocone. The width of the initial part of the body chamber is certainly no more than the maximum width of the phragmocone, and probably a little less. Growth lines are essentially radial and on the body chamber there are low, irregular spiral lines, spaced at intervals of 0.7 mm. The external suture line is well exposed (text-fig. 3). The suspensive lobe is incised but there do not appear to be any auxiliary lobes.

Thanks to Dr. Kummel, the writer has had an opportunity to see a specimen of *P. czekanowskii* from the Lena delta identified by Dr. Popov, and donated to the Museum of Comparative Zoology. The compressed body chamber and low umbilical wall of this specimen from Siberia are very like those of GSC No. 18816. The presence of an angular venter characteristic of *P. czekanowskii* cannot be positively demonstrated on No. 18816 owing to crushing, but the body chamber is unquestionably more compressed than the inner whorls, and there is also a suggestion of sharpening on the venter. No. 18816 appears to be a true *Prosphingites,* close to the Siberian type species, and quite unlike older species such as *P. spathi* Frebold and *P. slossi* Kummel and Steele. These two species have radial constrictions and a thick body whorl with an arched venter and are very doubtful representatives of *Prosphingites* in the writer's opinion (Tozer, 1963a, p. 24). As already noted, the suspensive lobe of No. 18816 is incised, but in other respects the suture line closely resembles that of *P. czekanowskii.*

Occurrence. Toad Formation, Halfway River map-area, British Columbia. GSC locality 56241: about 415 feet above Fantasque Formation, Middle Gully, 7 miles north of Mount Laurier.

Genus *Isculitoides* Spath 1930

Type species: *Isculites originis* Arthaber

Isculitoides minor n. sp.

Plate II, figures 1-3; Text-figure 4

Diagnosis. Isculitoides about 30 mm in diameter, with completely sealed umbilicus on inner whorls and abruptly excentric, but small, umbilicus on outer whorl.

Types and dimensions

Specimen	Locality	D	H	W	U
18817 holotype	56265				
18818 paratype	56243				
18819 paratype	56259	18	6 (0.33)	12 (0.67)	3.5 (0.19)

TEXT-FIGURE 4
Suture line of *Isculitoides minor* n. sp., holotype, GSC No. 18817 (x5).

Description. The holotype, Plate II, figures 1a-e, is a well-preserved phragmocone extracted from a concretion. Crushed parts of the outer whorl are also preserved, but are not illustrated. The well-preserved part of the phragmocone is involute, with a sealed umbilicus, and in this involute stage attained a diameter of at least

13 mm. One shallow constriction is present. On the outer whorl the place of attachment of the succeeding, excentrumbilicate whorl is visible. The wrinkle layer is visible on parts of this specimen. The external suture line (text-fig. 4) comprises a narrow external lobe, a wide, prominently toothed lateral lobe and a second, not entirely visible, lobe adjacent to the umbilicus. The external saddle bears small subammonitic wrinkles. This specimen apparently lacks a well-defined second lateral saddle, unlike, for example, *Isculitoides originis* var. (Renz and Renz, 1948, pl. xiii, figs. 11a, b).

The two paratypes assigned to this species provide the rest of the information given in the diagnosis. Unfortunately, neither of these specimens shows suture lines, but other features, particularly the excentric umbilici, relate both specimens to the holotype. No. 18819 (Pl. II, figs. 3a-c), although sheared, is not crushed, and reveals barely appreciable lateral contraction in the early excentrumbilicate stage. No. 18818 (Pl. II, figs. 2a,b) is badly crushed but shows the excentric umbilicus and the peristome. The peristome has a moderately prominent ventral lappet and a constriction immediately behind the aperture. This constriction was evidently an internal flange for it is visible on the steinkern but not where the shell is preserved, adjacent to the umbilicus. Even taking the crushing into account, No. 18818 was probably less inflated than No. 18819 but in view of the variable inflation shown by *Isculitoides* from Albania, noted by Arthaber (1911) and Spath (1934, p. 198), it seems reasonable to assign these three specimens to one species.

Comparisons. The involute inner whorls of *Isculitoides minor* distinguish it from *Isculitoides originis* (Arthaber) (1911, pl. xxiii, figs. 1-10; Spath, 1934, pl. xiv, figs. 2a-d) from Albania, and the related species from Chios Island, described by Renz and Renz (1948, pls. xiii, xiv). The species from Albania and Chios have an open umbilicus for 2½ whorls, and probably more. *Isculitoides ellipticus* Chao (1959, pl. xxvi, figs. 24-28; pl. xxx, figs. 1-5) from Kwangsi, China, may resemble *I. minor* in mode of coiling but has a relatively narrow external saddle, devoid of the subammonitic wrinkles of *I. minor*.

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56265: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier. GSC locality 56259: talus, from beds between 320 and 335 feet above Fantasque Formation, 2½ miles south of Mount Laurier. GSC locality 56243: about 410 feet above Fantasque Formation, South Gully, 7 miles north of Mount Laurier.

Genus *Popovites* new

Type species: *Popovites occidentalis* n. sp.

Diagnosis. Inner whorls globose, outer whorl of approximately equal height and width, with a perpendicular umbilical wall, prominent, rounded umbilical shoulder, flat sides, and a broadly arched or slightly flattened venter. Sculpture consists of regular growth lines; radial wrinkles or faint ribs may also occur on the venter.

Constrictions are absent. Body chamber about one whorl in length. The suture line comprises a deep external lobe, with incised branches; two ceratitic lateral lobes; a suspensive lobe with one or more auxiliary incisions; and one internal lateral lobe.

Comparisons. The most closely related genus is probably the contemporary *Prosphingites* Mojsisovics, which differs by having an angular venter on the outer whorl. The so-called *Prosphingites* from the *Arctoceras* and *Meekoceras* faunas (*P. spathi* Frebold, *P. slossi* Kummel and Steele) differ in having (1) rather prominent, relatively widely spaced, radial constrictions; (2) depressed whorls, that are invariably wider than high, with sloping sides. *Paranannites* Hyatt and Smith, also of the *Meekoceras* fauna, has a simpler suture line, devoid of auxiliary elements. *Dunedinites* Tozer, from the Induan, is superficially similar but has more depressed whorls than *Popovites*. More important, *Dunedinites* has a short body chamber, and is probably not closely related to the macrodome *Popovites*. There is some resemblance between members of *Popovites* and *Czekanowskites inostranzeffi* (Mojsisovics), but this species, and also *C. decipiens* (Mojsisovics), have a well-differentiated auxiliary lobe, unlike *Popovites*. *C. decipiens* (type species of *Czekanowskites*) also differs from *Popovites* in having radial plications on the whorl side. Spath (1934, p. 264) assigned *Czekanowskites* to the Arctoceratinae, a group that retains the primitive short body chamber, from which *Popovites* is certainly excluded. This assignment seems questionable and it is possible that *Czekanowskites* and *Popovites* may be related.

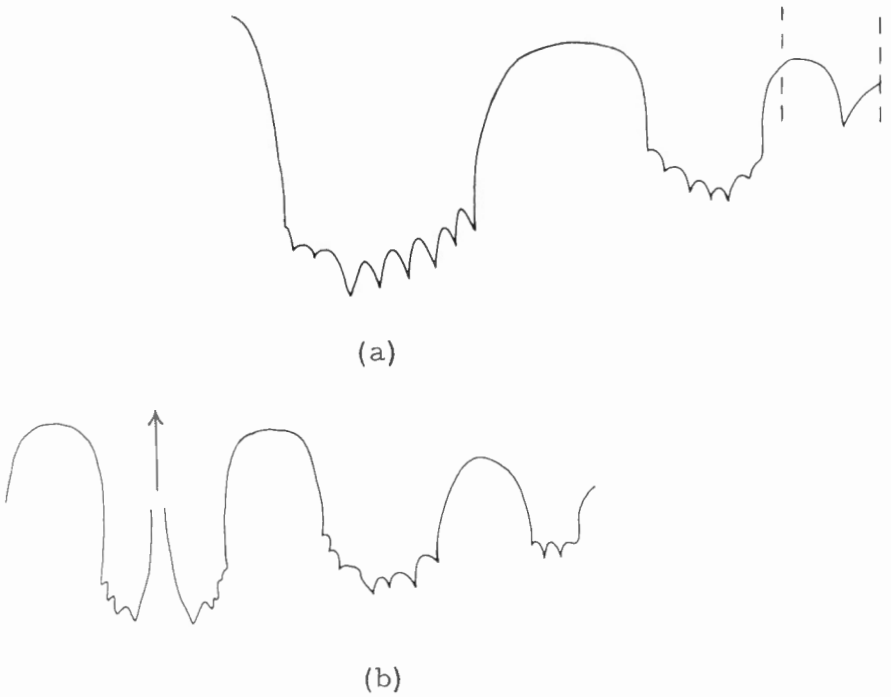
"Prosphingites" orientalis Kiparisova (1961, p. 117, pl. xxvi, figs. 1, 2) from Primorye is a possible representative of *Popovites,* but the suture line is imperfectly known.

This genus is named for Dr. Yu. N. Popov.

Popovites occidentalis n. sp.

Plate III, figures 2-12; Text-figure 5

Diagnosis. Popovites attaining a diameter of about 90 mm; umbilical width about one quarter the diameter; width slightly less than half the diameter. Growth lines essentially radial, slightly projected on venter. Faint radial ribs and irregular spiral ridges may be present, particularly on the venter.



TEXT-FIGURE 5. Suture lines of *Popovites occidentalis* n. gen., n. sp. (a) of paratype, GSC No. 18830; (b) of paratype, GSC No. 18824 (x8).

Types and dimensions

Specimen	Locality	D	H	W	U	Pl. III, fig. No.
18820 paratype	56234	10		10 (1.0)		5
18821 "	56240	14.5	6.5 (0.45)	10 (0.69)	3 (0.21)	8
18822 "	56234	18	8 (0.44)	12 (0.67)	4 (0.22)	11
18823 "	56265	at 25	10 (0.40)	12 (0.48)	6 (0.24)	2
18824 "	56262	27	13 (0.48)	11 (0.41)		7
18825 "	56259	27	12 (0.44)	16 (0.59)	7 (0.26)	6
18826 "	56195	28		13 (0.46)		—
18827 "	56198	29	13 (0.45)	18 (0.62)	7 (0.24)	9
18828 "	56240	30	15 (0.50)	14 (0.47)	6 (0.20)	4
18829 "	56240	36	16 (0.44)	16 (0.44)	9 (0.25)	—
18830 "	56264	at 39	18 (0.46)	18 (0.46)	10 (0.26)	10
18830 "	56264	45	20 (0.44)	22 (0.49)	11 (0.24)	10
18831 "	56198	at 44			ca. 10 (0.23)	3
18832 holotype	56234	at 43	19 (0.44)	20 (0.47)	11 (0.26)	12
18832 "	56234	at 64			14 (0.22)	12

Description. The holotype (Pl. III, figs. 12a,b) is the largest known specimen. Much of the outer whorl is slightly crushed but the character of the venter is accurately depicted by Plate III, figure 12b. From the extent of the umbilical seam, it can be seen that the minimum length of the body chamber was just under one whorl. The original diameter of this specimen was probably about 90 mm. The globose inner whorls are clearly shown by Nos. 18820 and 18821 (Pl. III,

figs. 5, 8). The collection includes specimens, such as No. 18831 (Pl. III, fig. 3), with rather prominent ribs crossing the center. At first sight this specimen seems unrelated to the type of *P. occidentalis*. However, the prominent ventral shoulders on the outer whorl of No. 18831 are due to crushing. Much of the penultimate whorl of this specimen is visible; it is identical with No. 18823 (Pl. III, fig. 2). No. 18823 has faint ribs on the venter, as does No. 18824 (Pl. III, fig. 7). No. 18824 also clearly shows that the globose inner whorls become proportionately higher with increasing age.

Provisionally all these specimens are attributed to one variable species. Specimens like Nos. 18823, 18824, and 18828 appear to have acquired the mature whorl section at a relatively small diameter and were perhaps small individuals. Others, exemplified by No. 18827 (Pl. III, fig. 9) are still globose at a relatively large diameter, and are interpreted as large, but immature, individuals.

The external suture line is well exposed on several specimens (text-fig. 5). The whorl section of No. 18829 (not figured) shows one internal lateral lobe.

Comparisons. Popovites occidentalis closely resembles *P. borealis* n. sp. *(see below).*

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56234: 430 feet above Fantasque Formation, North Gully, 7 miles north of Mount Laurier. GSC locality 56240: about 430 feet above Fantasque Formation, Middle Gully, 7 miles north of Mount Laurier. GSC localities 56195, 56264, 56256, 56265, 56259, 56262, 56198: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier.

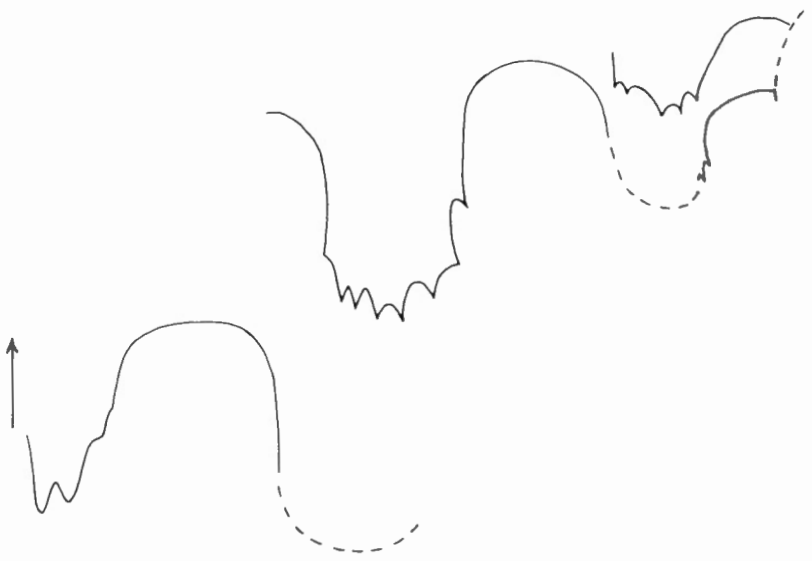
Popovites borealis n. sp.

Plate III, figures 1a, b; Text-figure 6

Diagnosis. Popovites attaining a diameter of 44 mm, with umbilical width about one third the diameter, otherwise like *P. occidentalis* n. sp.

Type and dimensions

Specimen	Locality	D	H	W	U
18833 holotype	47544	43	15.5 (0.36)	20 (0.47)	15 (0.35)
		at 31	11.5 (0.37)	17 (0.55)	9.5 (0.31)



TEXT-FIGURE 6. Suture lines of *Popovites borealis* n. gen., n. sp., below umbilical shoulder, holotype, GSC No. 18833 (x8).

Description. Only one well-preserved specimen, the holotype, is known. It has one whorl of body chamber and shows slight umbilical enlargement. On the venter the shell bears regular wrinkles. The suture line is well exposed below the umbilical shoulder (text-fig. 6). The part on the umbilical wall is not well exposed, but there is at least one auxiliary incision.

Comparisons. The sculpture, whorl section, high, perpendicular umbilical wall and suture line show that this species is closely related to *P. occidentalis* n. sp., which differs only in having a smaller umbilicus than *P. borealis*.

Occurrence. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island. GSC locality 47544: about 250 feet above base of Lower Shale Member, south side of Otto Fiord, 2 miles east from junction with Nansen Sound.

Genus *Zenoites* Renz and Renz 1948

Type species: *Prosphingites (Zenoites) helenae* Renz and Renz

Zenoites arcticus n. sp.

Plate II, figures 6,7; Text-figure 7

Diagnosis. Zenoites attaining a diameter of at least 25 mm with about twenty-five rather regular, closely spaced constrictions on the outer whorl. Umbilical width about one third the diameter.

Types and dimensions

Specimen	Locality	D	H	W	U
18835 paratype	47544	ca. 25	ca. 10 (0.40)	ca. 13 (0.50)	ca. 8 (0.32)
18834 holotype	47544	ca. 20			6 (0.30)

TEXT-FIGURE 7. Suture line of *Zenoites arcticus* n. sp., holotype, GSC No. 18834 (x8).

Description. This species is known from two specimens. The holotype (Pl. II, figs. 7a,b) is a well-preserved, fragmentary steinkern, septate except for the last three-quarters of a whorl. The umbilical wall is inclined and the umbilical shoulder rounded. The whorl section is very depressed, with no suggestion of ventral shoulders. The last half whorl carries twelve radial constrictions. The constrictions cross the venter but do not extend to the umbilical wall. At the umbilical shoulder, on the steinkern, there are delicate bullae corresponding with the ridges that separate the constrictions. On the penultimate whorl the constrictions are very faint. The external suture line (text-fig. 7) is well displayed. The two ceratitic lateral lobes lie below the umbilical shoulder and the ceratitic auxiliary lobe is on the umbilical wall. No. 18835 (Pl. II, fig. 6) is somewhat crushed. Parts of the test remain. The delicate bullae observed on the holotype steinkern are not visible on the surface of the test of No. 18835.

Comparisons. The depressed whorl section, constrictions, and suture line, with a well individualized auxiliary lobe, relate this species to *Zenoites helenae* Renz and Renz (1948, p. 41, pl. xvi, figs. 1a-c) from Chios Island. In dimensions, whorl section, and suture line *Z. helenae* and *Z. arcticus* are remarkably similar, but *Z. arcticus* has more numerous and regular constrictions.

Occurrence. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island. GSC locality 47544: about 250 feet above base of Lower Shale Member, south side of Otto Fiord, 2 miles east from junction with Nansen Sound.

Genus *Monacanthites* new

Type species: *Monacanthites monoceros* n. sp.

Diagnosis. Globose ammonoids with sculpture of widely spaced, unbranched ribs that are curved to form a sharp ventral sinus. On the outer whorl each rib, at the ventral mid-line, carries a single, solid, spine. Body chamber one whorl in length. Suture line ceratitic, with two lateral lobes, both internally and externally.

Comparisons. The single row of spines on the venter, and the *Bellerophon*-like curvature of the ribs, distinguish *Monacanthites* from all other ammonoids. The

inner whorls of *Monacanthites,* with their subdued sculpture, invite comparison with *"Prosphingites" globosus* Kiparisova (1961, p. 108, pl. xxv, figs. 1,2), but the outer whorl of that species is quite different. Provisionally *Monacanthites* is attached to the Paranannitidae.

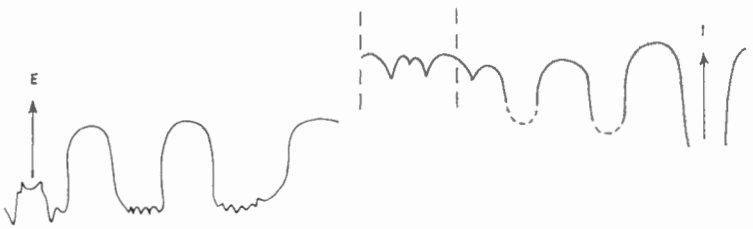
Monacanthites monoceros n. sp.

Plate I, figures 8-10; Plate II, figure 4; Text-figure 8

Diagnosis. Monacanthites about 23 mm in diameter; outer whorl with twelve ribs, of which the last seven (or nine) bear spines. Inner whorls with parabolae in place of spines.

Types and dimensions

Specimen	Locality	D	H	W	U
18836 paratype	56240	13		14 (1.1)	
18837 paratype	56240	20	9 (0.45)	20 (1.0)	4 (0.20)
18838 holotype	56194	23	11 (0.48)	21 (0.9)	ca. 4 (0.17)
18839 paratype	56240	(specimen broken to show suture line)			
18840 paratype	56240	(specimen sectioned to show inner whorls)			



TEXT-FIGURE 8. Suture lines of *Monacanthites monoceros* n. gen., n. sp., paratype, GSC No. 18839. Internal suture line is reversed (x8).

Description. The holotype (Pl. I, figs. 9a-c; Pl. II, fig. 4) preserves the test and shows the sculpture well. The ribs are rounded and between them are delicate growth lines, which, like the ribs, show a sinus at the ventral mid-line. On the outer whorl the points where ten ribs intersect the mid-line are visible. The nine closest to the aperture show broken, essentially circular, spine bases. At least two of the spines are preserved in the natural mould of the holotype. The third spine from the aperture is 2.5 mm long. The broken spine bases are solid calcite. Where the tenth spine would be expected the shell shows no sign of fracture and there is no spine; instead there is a single parabolic node (Pl. II, fig. 4) superimposed upon the rib at the point where the later spine bases occur. Similar parabolic nodes are shown by the small paratype (Pl. I, figs. 8a,b) and by the specimen broken to show the suture line (No. 18839). No. 18840, a fragmentary specimen about the same size as the holotype, was sectioned to show the inner whorls. There are seven in all and the length of the body chamber is one whorl. The last two septa show approximation. No specimens larger than the holotype and No. 18840 are known. It is therefore probable that the holotype is a

complete adult. As already mentioned, the inner whorls lack spines. Possibly these whorls originally bore spines which were later shed or resorbed, leaving scars in the form of parabolic nodes. Alternatively it is possible that spines were formed only on the outer whorl.

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56194: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier. GSC locality 56240: about 430 feet above Fantasque Formation, Middle Gully, 7 miles north of Mount Laurier.

Family DAGNOCERATIDAE
(ex Dagnoceratinae Spath 1930 (Kiparisova, 1961, p. 74))

Genus *Metadagnoceras* new

Type species: *Metadagnoceras pulcher* n. sp.

Diagnosis. Smooth or delicately strigate platycones with a relatively broad venter and rounded or angular ventral shoulders. Suture line with deep, lanceolate incisions in the external saddle and the wide single lateral lobe; lateral saddle rounded.

The type species is represented by one well-preserved specimen. Thanks to Drs. Kummel and Silberling the writer has had an opportunity to examine two other specimens, one from Timor, the other from Nevada, which appear to represent undescribed species congeneric with *Metadagnoceras pulcher.* The specimen from Timor is BM C 33701 (*see* Spath, 1934, p. 269, footnote) from the *Prohungarites similis* fauna of Nifoekoko. At the time of writing this specimen is on loan to Dr. Kummel, who will describe it in a report now being prepared. The specimen from Nevada occurs with representatives of *Prohungarites* (identified by Dr. Silberling, and also seen by the writer) and was obtained from "the base of the Star Peak Group in the Humboldt Range, separated from the overlying *Arochordiceras hyatti* beds by several hundred feet of unfossiliferous strata" (N. J. Silberling, *in litt.,* October 1963). The Nevada specimen has distinct ventral shoulders and an essentially tabulate venter.

Comparisons. The wide, single lateral lobe and the rounded lateral saddle of *Metadagnoceras* are interpreted as indicating affinity with *Dagnoceras* Arthaber. The type species of *Dagnoceras* is *D. nopscanum* Arthaber (1911, pl. xxi, figs. 6a-c), and this species has an entire external saddle, without the deep incisions that characterize *Metadagnoceras.* The external saddle of *"Dagnoceras" terbunicum* Arthaber (1911, pl. xxi, figs. 10a-c) shows some similarity with that of *Metadagnoceras,* but according to the drawing published by Arthaber (1911, pl. xxi, fig. 10c), *"D" terbunicum* has two lateral lobes. This drawing is hard to reconcile with the side view (pl. xxi, fig. 10a) given by the same author. If *"D." terbunicum*

really has two lateral lobes it should probably be assigned to a new genus rather than to *Dagnoceras* or *Metadagnoceras* (cf. Spath, 1934, p. 269).

The external saddle of *Metadagnoceras* recalls that of *Lanceolites*, but the inner part of the suture line, discoidal shape, and narrow, tabulate venter of *Lanceolites* are different. It is interesting to note that Spath (1934, p. 227), without knowledge of *Metadagnoceras*, noted similarities between the dagnoceratids and *Lanceolites*.

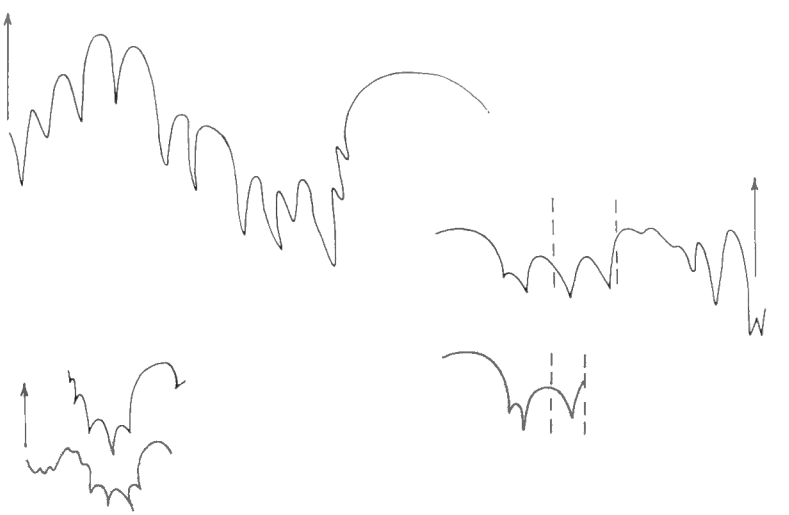
Metadagnoceras pulcher n. sp.

Plate I, figures 11a-e; Text-figure 9

Diagnosis. *Metadagnoceras* about 70 mm in diameter; width of umbilicus about one fifth the diameter. Umbilical shoulder rounded, whorl sides convex, ventral shoulders indistinct, venter gently arched. Surface with delicate strigate sculpture. The lanceolate incisions in external saddle and lateral lobe are very deep.

Type and dimensions

Specimen	Locality	D	H	W	U
18848 holotype	56196	63	32 (0.50)	22 (0.35)	12 (0.19)



TEXT-FIGURE 9. Suture lines of *Metadagnoceras pulcher* n. gen., n. sp., holotype, GSC No. 18848. Internal suture line, and suture line of inner whorls are reversed (x3).

Description. This species is represented by one well-preserved specimen. The last half whorl is body chamber. The septa at the end of the phragmocone show approximation, thus the holotype may be essentially complete and adult. On the outer whorl the umbilical wall is moderately high; the umbilical shoulder is rounded; and the maximum whorl width is at the inner third. The flanks are convex, the ventral shoulders rounded and the venter slightly arched. Much of the

test is well preserved on the outer whorl. Growth lines are slightly sinuous on the whorl side; they sweep forward from the umbilical shoulder and backward towards the venter, forming a gentle salient on the inner half of the flank, and a sinus on the outer half. Where they cross the venter they form another, shallow sinus. The entire surface bears delicate strigate sculpture. The complete suture line has been exposed (text-fig. 9). The external lobe is wider on the inner whorls than on the outer.

Comparisons. No described ammonoids resemble *Metadagnoceras pulcher* closely. The unnamed species from Nevada has more prominent ventral shoulders, relatively shallow incisions in the external saddle and a less retracted lobe on the umbilical shoulder. The species from Timor lacks the strigate sculpture of *M. pulcher*.

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56196: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier.

Family SIBIRITIDAE

Genus *Keyserlingites* Hyatt 1900

Type species: *Ceratites subrobustus* Mojsisovics

(=*Durgaites* Diener, 1905)

The nature of the inner whorls of specimens described below, and assigned to *Keyserlingites subrobustus,* casts doubt on the validity of the criteria used by Diener (1907, pp. 76-78) to distinguish between representatives of *Keyserlingites* and *Durgaites*. The type species of the latter is *Ceratites dieneri* Mojsisovics 1902 (="*Ceratites subrobustus* Mojsisovics" of Diener, 1897, pls. xvi, xix). The inner whorls of *"Durgaites" dieneri* have spines at the ventro-lateral shoulder and crescent-shaped ribs crossing the venter. Diener (1907, pp. 76-78) rightly pointed out that this arrangement of spines differed from that shown by the inner whorls of *Keyserlingites middendorfi* (Keyserling), in which the spines are near the middle of the whorl side. Diener believed that inner whorls of *Durgaites* were somewhat like those of *Tirolites*; those of *K. middendorfi* like *Olenikites*. The specimens of *Keyserlingites subrobustus* from Ellesmere Island and British Columbia have inner whorls essentially like those of *"Durgaites" dieneri*. This may be seen by comparing GSC No. 18847 (Pl. VIII, figs. 2b and 2d) with the specimen of *"Durgaites" dieneri* figured by Diener (1907, pl. XI, figs. 2a,b). *"Durgaites" dieneri* apparently has more prominent ventral ribs than *Keyserlingites subrobustus* but this alone seems insufficient justification for placing these species in different genera. The suture lines are similar. It would appear that inflated species of *Keyserlingites* (*K. subrobustus, K. dieneri,* and also *K. angustecostatus* Welter) have spines at the ventral shoulders on the inner whorls, whereas on the relatively

compressed *Keyserlingites middendorfi* they lie near the middle of the whorl side at small diameters.

Keyserlingites characterizes the late Olenekian faunas of Siberia, Spitsbergen, Ellesmere Island, and British Columbia; *"Durgaites"* has generally been considered Anisian. A review of the evidence indicates that this is by no means certain (p. 11), and it appears probable that *Keyserlingites* and *"Durgaites"* are not only synonyms, but also the same age, as suggested by Smith (1932, p. 18).

Keyserlingites subrobustus (Mojsisovics)

Plate V, figure 1; Plate VI, figures 1, 2; Plate VII, figures 1-3; Plate VIII, figures 1, 2

Ceratites middendorfi Keyserling, 1845, p. 169, pl. II, fig. 4 (only).
Ceratites subrobustus Mojsisovics, 1886, p. 44, pl. IV, fig. 2; pl. V; pl. VI, fig. 1.
Keyserlingites subrobustus (Mojsisovics); Hyatt, 1900, p. 559; Popov, 1961, p. 55, pl. XV, figs. la,b.
Keyserlingites cf. *subrobustus* (Mojsisovics); Frebold, 1929a, p. 12, pl. II, figs. 8, 9.
"Keyserlingites"; Frebold, 1931, p. 34 (*see* Pl. VIII, figs. la-c).

Specimens and dimensions

Specimen	Locality	D	H	W^1	W^2	U
18847	56235	75	32 (0.42)		42 (0.56)	26 (0.35)
18845	47545 at	78	35 (0.45)		42 (0.54)	24 (0.31)
18845	47545	104	43 (0.41)	74 (0.71)	56 (0.54)	31 (0.30)
18841	51603 at	200	90 (0.45)		110 (0.55)	ca. 60 (0.30)
18842	51603 (Pl. VI, figs. 1a, b)					
18843	47545 (Pl. VI, figs. 2a, b)					
18844	47545 (Pl. VII, fig. 2)					
18846	56261 (Pl. VII, fig. 1)					

W^1 — Measured at spine; W^2 — measured between spines.

Description. Specimens of large size occur in both British Columbia and Ellesmere Island. No. 18841 (Pl. V, fig. 1) is still septate at a diameter of 210 mm. The full size of this individual was probably at least 325 mm. A fragmentary specimen from GSC locality 56198 shows only the venter, with the ventral spine bases 76 mm apart.

No. 18847 (Pl. VIII, figs. 2a-h), entirely septate, with the umbilical seam of the succeeding volution attached, shows the inner whorls. The principal spines are at the ventro-lateral edge from a diameter of 7 mm to about 30 mm. At 40 mm they are at the middle of the whorl side and ventro-lateral tubercles have appeared. No. 18843 (Pl. VI, figs. 2a, b) shows the acquisition of ventro-lateral tubercles at a comparable diameter. At a diameter of 30 mm the venter of No. 18847 bears crescentic sulci, convex forwards. The lateral spines are seldom well preserved, but their true extent is shown by one specimen from Ellesmere Island (Pl. VII, figs. 3a,b) and another from British Columbia (Pl. VII, figs. 1a,b). The ribs connecting the lateral and ventro-lateral spines are of very low relief. On the outer whorls two or three ventro-lateral tubercles arise from each lateral spine.

No. 18845 (Pl. VII, figs. 3a, b) at a diameter of 80 mm has twelve lateral spines; and twenty-five at the ventro-lateral shoulder; at 105 mm there are eleven on the side, and twenty-four on the shoulder.

The distinctive wide external lobe is shown by several specimens from Ellesmere Island, notably by No. 18842 (Pl. VI, fig. 1a); the two ceratitic lateral lobes by No. 18844 (Pl. VII, fig. 2). The specimens from British Columbia do not show the external suture line well but the septal surface of No. 18847 clearly shows the wide external lobe adjacent to the siphuncle. The deep internal lobe is shown by No. 18846 (Pl. VII, fig. 1b).

In dimensions, sculpture, and suture line the specimens from Canada appear to be identical with those from the type locality, Olenek River, Siberia.

Occurrence

1. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island. GSC locality 47545: about 230 feet above base of Lower Shale Member, south side of Otto Fiord, 2 miles east from junction with Nansen Sound.

2. Blind Fiord Formation, Ellesmere Island. GSC locality 51599: 715 feet below contact with Blaa Mountain Formation, Raanes Peninsula, 3½ miles east from mouth of Willow River. GSC locality 51603: as locality 51599, talus collection.

3. Toad Formation, Halfway River area, British Columbia. GSC locality 56235: 422½ feet above Fantasque Formation, North Gully, 7 miles north of Mount Laurier. GSC localities 56261, 56198: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier.

Family Dinaritidae

Genus *Olenikites* Hyatt 1900

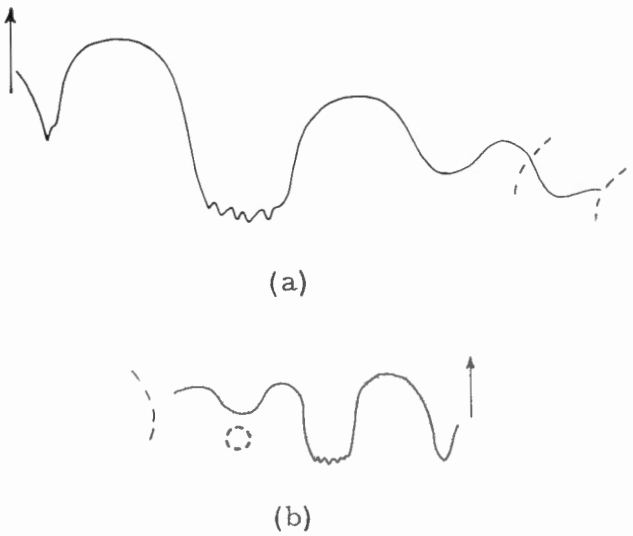
Type species: *Dinarites spiniplicatus* Mojsisovics

Olenikites canadensis Tozer

Plate IV, figures 1-8; Text-figure 10

Olenikites canadensis Tozer, 1961b, p. 73, pl. XVIII, figs. 1-3.

Diagnosis. *Olenikites* with rounded umbilical and ventral shoulders on the inner whorls; living chamber with prominent umbilical shoulder and a subtabulate venter. Early whorls have umbilical tubercles or bullae, which are replaced by ribs or striae on the body whorl. The ribs are straight, radial or slightly prorsiradiate, most prominent at the umbilical shoulder and they generally fade at the middle of the whorl side. Sculpture of both early and later whorls varies greatly in prominence, with from 10 to 30 ribs on the outer sculptured whorl. Suture line with two lateral lobes, of which the first is ceratitic or goniatitic, the second goniatitic.



TEXT-FIGURE 10. Suture lines of *Olenikites canadensis* Tozer (a) of GSC No. 18853; (b) of holotype, GSC No. 14094 (x8).

Types and dimensions

Specimen	Locality	D	H	W	U
Variety "A"					
14094 holotype	32363	15	7 (0.47)	6 (0.40)	4.5 (0.30)
18850	47544	ca. 13	ca. 6 (0.46)		4 (0.31)
Variety "B"					
18855	47545	25	10 (0.40)	9 (0.36)	7.5 (0.30)
18851	47544				
18852	47544	at 23	10 (0.43)	8 (0.35)	6 (0.26)
14095 paratype	32363	24	9.5 (0.39)	8.5 (0.35)	6.5 (0.27)
Variety "C"					
18853	47544	at 25	9 (0.36)	8 (0.32)	8.5 (0.34)
18853	47544	32	12 (0.37)	9 (0.28)	12 (0.37)
18854	47544	at 23	9.5 (0.41)	8.5 (0.37)	7 (0.31)

Description. When Mojsisovics (1886) first described the species now assigned to *Olenikites* he stated that in his experience no other group showed such variability. In all, Mojsisovics (1886, 1888) records eighty-four specimens and he assigned them to twelve species, placed in *"Dinarites"* and *"Ceratites* of the *obsoleti* group". For *"Dinarites" spiniplicatus* Mojsisovics records sixty-four specimens; for the remaining eleven species he had between one and four specimens only. Most of these specimens were obtained from one locality. There is no doubt that Mojsisovics (1886, p. 19) recognized the close affinity between the species assigned to *Dinarites* and those placed in *Ceratites*. It seems probable that the eleven species represented by very few specimens represent extreme variants amidst a very variable population.

Olenikites is a rare fossil in Canada. Several years collecting has yielded only eleven well-preserved specimens. The holotype, unquestionably a representative of *Olenikites,* can be matched fairly closely by one other specimen (Pl. IV, fig. 2), but the remaining specimens differ from the holotype and from one another in details of sculpture and mode of coiling. Particularly in view of Mojsisovics' observations on the variability of the *Olenikites* from Siberia, all these specimens from Ellesmere Island are assigned to one species. For purposes of description three varieties may be distinguished. The full range of variation was encountered in one bed of concretions, namely, at GSC locality 47544.

Variety "A" includes forms with widely spaced, prominent thorn-like tubercles; variety "B" has more closely spaced, less prominent tubercles or bullae; variety "C" includes specimens with closely spaced ribs that are only slightly bullate at the umbilical shoulder.

Variety "A". This variety is represented by the holotype (Pl. IV, figs. 1a-c) and one other specimen (No. 18850, Pl. IV, fig. 2). The inner whorls of the holotype have prominent, relatively widely spaced tubercles and on the body chamber there is an abrupt change to plication, then striation. The holotype, on re-examination, was found to include three quarters of a whorl of body chamber. The phragmocone of this specimen carries very prominent, thorn-like tubercles. The last sculptured whorl carries four tubercles, followed by four bullate ribs, then four ribs. The suture line has now been prepared (text-fig. 10) and the lateral lobe is seen to be delicately ceratitic, not goniatitic, as formerly stated. The abrupt change in sculpture suggests that this variety may have ceased to grow at a relatively small diameter.

Variety "B". This variety is represented by No. 14095 (Tozer, 1961b, Pl. XVIII, figs. 3a, b), and also by Nos. 18851, 18852, and 18855. Nos. 14095 and 18852 (Pl. IV, figs. 6a-c) have very faint umbilical bullae on the inner whorls. No. 14095 has thirteen ribs on the last whorl; No. 18852 has fourteen on the last sculptured whorl, followed by a quarter whorl of almost smooth shell. No. 18855 (Pl. IV, figs. 4a, b) has an outer whorl much like that of Nos. 14095 and 18852 but has more prominent bullae on both the inner and outer whorls. No. 18855 has fifteen bullate ribs on the outer whorl and about ten on the preceding whorl. This specimen links varieties A and B. The outer whorl of No. 18851 (Pl. IV, figs. 3a-c) has fourteen ribs. These ribs are more prorsiradiate and more distinctly bullate than on the other representatives of variety B. The ribs on Nos. 18851, 18852, and 18855 are strongest at the umbilical shoulder; they fade at the middle of the whorl side. No. 14095 is similar but has one relatively strong, long, prorsiradiate rib immediately behind the aperture. On No. 14095 the first lateral lobe is apparently truly goniatitic (Tozer, 1961b, p. 73, fig. 9b). The first lateral lobes of Nos. 18851, 18852, and 18855 have delicate ceratitic incisions. The suture line of No. 18852 is moderately well preserved and is like that of No. 18853 (text-fig. 10).

Variety "C". The characters of this variety are best shown by one well-preserved specimen with slight crushing on the outer whorl (No. 18853, Pl. IV,

figs. 7a-d). The outer whorl bears about thirty ribs, strongest at the umbilical shoulder and traceable on all but the outer quarter of the whorl side. This specimen is the most evolute in the collection. No. 18854 (Pl. IV, figs. 8a-c) has about twenty ribs on the outer whorl and they are relatively long, like those of No. 18853. At a diameter of 13 mm No. 18854 has ten weak umbilical bullae, confined to the inner third of the whorl side. The outer whorl of this specimen has an unusually prominent umbilical shoulder. Both Nos. 18853 and 18854 have a weakly ceratitic lateral lobe (text-fig. 10). No. 18856 (Pl. IV, figs. 5a-c) is probably an immature representative of this variety.

Comparisons. All specimens assigned to *Olenikites canadensis* have distinct ventral shoulders, a relatively deep external lobe, and two lateral lobes. These features distinguish *O. canadensis* from *O. spiniplicatus* and its allies. In other respects the specimens described as variety "A" resemble closely *O. spiniplicatus* (particularly Mojsisovics, 1886, pl. I, figs. 3,4). Varieties "B" and "C" invite comparison with *Olenikites glacialis* (Mojsisovics, 1886, pl. II, fig. 11), *O. hyperboreus* (Mojsisovics, 1886, pl. IX, figs. 16, 17) and *O. fissiplicatus* (Mojsisovics, 1886, pl. IX, figs. 18, 19c). Kummel (1961, p. 521) has assigned these three species to the Owenitan genus *Xenoceltites* Spath. There are some resemblances between *Xenoceltites* and the *Ceratites* of the *obsoleti* group, in which Mojsisovics placed *O. hyperboreus* and *O. fissiplicatus*. However, *Xenoceltites* differs from *Olenikites* (including the *"obsoleti"*) as follows (1) The ribs and bulges on the inner whorls of *Xenoceltites* show strong adorad projection; those of *Olenikites* are radial or only slightly prorsiradiate. (2) On the outer whorl of *Xenoceltites* the radial elements of sculpture are constrictions, not ribs, and these constrictions show abrupt adorad curvature where they cross the venter. The characteristic sculpture of the outer whorl of *Xenoceltites* is not found on any *Olenikites*. (3) Typical *Xenoceltites* are more compressed than any *Olenikites*. This interpretation of *Xenoceltites* is based on wax replicas of the types from Spitsbergen and on some unusually well-preserved specimens from British Columbia.

Occurrence. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island. South side of Otto Fiord, 2 miles east from junction with Nansen Sound. GSC locality 32363: about 255 feet above base of Lower Shale Member; GSC locality 47544: about 250 feet above the base; GSC locality 47545: about 225 feet above base.

Genus *Svalbardiceras* Frebold 1930

Type species: *Lecanites? spitzbergensis* Frebold, 1929b

(Spath, 1934, p. 251 designated *Svalbardiceras spitzbergensis* Frebold, 1930, pl. vi, figs. 1, 1a, as lectotype of the type species. *Lecanites? spitzbergensis* Frebold 1929b, pl. 1, fig. 1 is holotype by monotypy. Spath's designation is thus invalid.)

The two species described below are apparently closely related to *Svalbardiceras spitzbergensis*. The sculpture of the inner whorls of *Svalbardiceras freboldi* n. sp. is much like that of the associated *Olenikites canadensis*. *Olenikites canadensis,* with distinct ventral shoulders and two lateral lobes, apparently provides a link between *Olenikites* and *Svalbardiceras*; accordingly these genera are placed in the same family. Provisionally they are assigned to the Dinaritidae rather than to Tirolitidae (cf. Popov, 1961, p. 29) or Meekoceratidae (cf. Spath, 1934, p. 251).

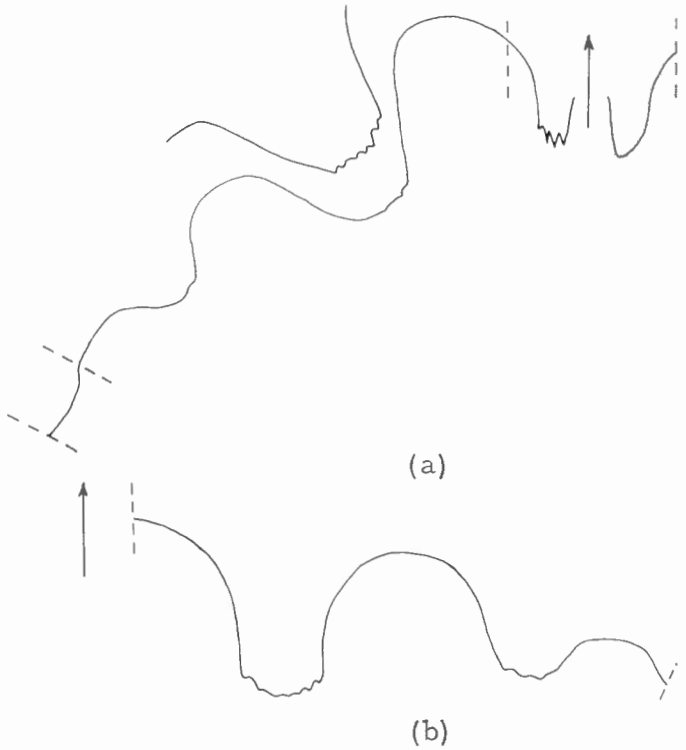
Svalbardiceras freboldi n. sp.

Plate IV, figures 12, 13; Plate V, figure 2; Text-figure 11

Diagnosis. *Svalbardiceras* with umbilical width about one fifth the diameter. Venter tabulate, with prominent ventral shoulders. Sculpture on inner whorls comprises seven to fifteen faint bullae which are later replaced by ribs that are confined to the inner half of the whorl side; body chamber smooth. Suture line comprises a deep external lobe, with incised branches; two ceratitic lateral lobes and a shallow unincised suspensive lobe.

Types and dimensions

Specimen	Locality		D	H	W	U
18857 holotype	47544	at	25	11 (0.44)		ca. 5 (0.20)
18858 paratype	47544	at	24	12 (0.50)	7 (0.29)	4.5 (0.19)
18858 paratype	47544		32	16 (0.50)	8 (0.25)	6 (0.19)



TEXT-FIGURE 11. Suture lines of *Svalbardiceras freboldi* n. sp. (a) of paratype, GSC No. 18858; (b) of holotype, GSC No. 18857 (x8).

Description. The holotype, Plate IV, figures 13a-c, attains a diameter of 29 mm. The body chamber, apparently complete, is five-eighths of a whorl long. The last third of the body chamber is crushed. The outer whorl may be detached, showing a full inner whorl, attaining a diameter of 12 mm. This whorl (Pl. IV, fig. 13c) bears seven, slightly prorsiradiate, bullate ribs, moderately prominent at the rounded umbilical shoulder and fading towards the middle of the whorl side. On the outer third of the whorl side the ribs are no longer visible. Umbilical bullae persist until the beginning of the last whorl. The outer whorl has a nearly perpendicular umbilical wall and a well-defined umbilical shoulder, and is sculptured with essentially radial growth lines only. Although much of the holotype is still embedded in rock the sharp ventral shoulders and flat venter are clearly visible.

The well-preserved paratype, No. 18858 (Pl. IV, figs. 12a-c) has five-eighths of a whorl of body chamber. The whole of the phragmocone and the initial part of the body chamber are sculptured. Where fully visible, the sculpture comprises slightly prorsiradiate, delicate ribs, strongest at the umbilical shoulder and fading at the middle of the whorl side. The last sculptured whorl (attaining a whorl height of 10 mm) has about fifteen ribs or bullae. Compared with the holotype, this specimen has more ribs per whorl and they persist to a larger diameter. The small paratype (Pl. V, fig. 2) has seven relatively strong ribs on the inner half of the flanks of the outer whorl.

Comparisons. "Meekoceras" sibiricum Mojsisovics (1886, p. 85, pl. XI, figs. 1-6) is probably congeneric with *Svalbardiceras freboldi,* but has a smaller umbilicus. Popov (1961, p. 7) listed *"M." sibiricum* as a representative of *Boreomeekoceras;* later (Popov, 1962, pp. 176, 186) he assigned this species to *Hemiprionites. Boreomeekoceras* Popov 1961 (type species, *Meekoceras keyserlingi* Mojsisovics) is quite unlike both *Svalbardiceras freboldi* and *"M." sibiricum. Hemiprionites,* and other Prionitidae, have inner whorls that are either smooth or provided with *Anasibirites*-like sculpture; on the outer whorl they acquire plications and bullae. The ontogenetic change in sculpture shown by the Prionitidae is thus the reverse of that found in *Svalbardiceras freboldi* and *"M." sibiricum. Hemiprionites* itself is probably a spurious genus (Tozer, 1961b, p. 72).

This species is named for Dr. Hans Frebold.

Occurrence. Blaa Mountain Formation, Lower Shale Member, Northern Ellesmere Island. South side of Otto Fiord, 2 miles east from junction with Nansen Sound. GSC locality 32363: about 255 feet above base of Lower Shale Member. GSC locality 47544: about 250 feet above the base.

Svalbardiceras chowadei n. sp.
Plate IV, figures 9-11

Diagnosis. Svalbardiceras with umbilical width about one third the diameter, about eleven ribs on the outer whorl, and an apparently goniatitic suture line.

Types and dimensions

Specimen	Locality	D	H	W	U
18861 holotype	56263	38	16 (0.42)	10 (0.26)	10.5 (0.28)
18862 paratype	56258	32			

Description. The holotype is septate to within half a whorl of the aperture. The outer whorl has a perpendicular umbilical wall; mildly convex flanks, widest at the inner third; prominent, but rounded ventral shoulders; and a flat venter. The ribs are almost perfectly radial; they start below the umbilical shoulder, soon achieve their greatest relief, and fade towards the venter. Adjacent to the ventral shoulders the ribs are very faint, but nevertheless perceptible. Sculpture is visible on a total of four whorls. The suture line is not completely exposed. The lateral lobes are visible; their proportions are as on the holotype of *Svalbardiceras spitzbergensis* (Frebold, 1929b, Pl. I, fig. 1). The lobes appear to be goniatitic and it is safe to say that if they were ceratitic the incisions were very delicate and shallow.

No. 18862, a crushed specimen (Pl. IV, fig. 11), has relatively delicate ribs and is interpreted as a weakly sculptured variant. No. 18860 (Pl. IV, fig. 9) has ribs on the inner whorls, growth lines only on the outer whorl, rather prominent ventral shoulders and is another possible representative of this species.

Comparisons. The holotype of *Svalbardiceras chowadei* has a slightly smaller umbilicus and fewer radial ribs than the otherwise similar *S. spitzbergensis* (Frebold, 1929b, p. 299, Pl. I, fig. 1; 1930, p. 24, Pl. VI, figs. 1-3).

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC localities 56263, 56265, 56258: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier.

Family MEGAPHYLLITIDAE

Genus *Procarnites* Arthaber 1911

Type species: *Parapopanoceras kokeni* Arthaber

Procarnites modestus n. sp.

Plate I, figures 1-6; Text-figure 12

Diagnosis. Procarnites about 45 mm in diameter, with a very small umbilicus, indistinct umbilical shoulder and whorls that are mildly inflated and thickest between the umbilicus and the middle of the flank. Venter arched. Inner whorls with constrictions. Growth lines sinuous, forming a pronounced salient near the middle of the flank. The suture line has eight or nine external lobes and is devoid of adventitious elements in the median saddle of the external lobe.

Types and dimensions

Specimen	Locality		D	H	W	U
18863 paratype	56178	at	13	7.5 (0.58)	7.5 (0.58)	1 (0.08)
18864 paratype	56280		16		7.5 (0.47)	
18865 paratype	56198		20		8 (0.40)	
18866 paratype	56237		27		10 (0.37)	
18867 holotype	56198	at	27		9.5 (0.35)	
18868 paratype	56198					
18869 paratype	56195					
18870 paratype	56242					

TEXT-FIGURE 12. Suture line of *Procarnites modestus* n. sp., paratype, GSC No. 18869 (x8).

Description. The holotype (Pl. I, figs. 6a,b) comprises an uncrushed phragmocone, 27 mm in diameter, followed by three quarters of a whorl of crushed body chamber. The complete diameter was about 45 mm. No phragmocones are known that exceed a diameter of 27 mm; this figure may represent the phragmocone end-size for *P. modestus*. The whorl section and small umbilicus are best shown by No. 18863 (Pl. I, fig. 4c). Crushed specimens from localities 56188 and 56241 seem to show that a small umbilicus was maintained to a diameter of at least 40 mm. The collection includes two small specimens showing pronounced constrictions. The outer whorl on No. 18864 (Pl. I, figs. 7a-c) has three constrictions. No. 18870 (an unfigured paratype) shows that these constrictions are internal ribs, for they are not visible on the surface of the test but only on the steinkern. No. 18869 (Pl. I, figs. 2a,b) shows a single, relatively faint constriction at a whorl height of 6 mm. The specimen also shows the suture line (text-fig. 12). Complete suture lines have not been exposed on larger specimens. No. 18866 (Pl. I, figs. 1a-c) shows the external lobe at a whorl height of 15 mm. As at smaller diameters, there are no adventitious elements in the median saddle of the external lobe.

Comparisons. Procarnites modestus closely resembles *"Megaphyllites" immaturus* Kiparisova (1947, Pl. 27, figs. 1, 2; 1961, p. 172, Pl. 35, figs. 3-5) from the *Subcolumbites* fauna of Primorye. *"Megaphyllites" immaturus,* on the outer whorl, has a distinct umbilical shoulder. The body chambers of *P. modestus* are crushed, but the phragmocones, at their end diameter, show no trace of umbilical shoulders. The umbilicus of *P. modestus* is deep and can be measured accurately only on the specimen that exposes the whorls in section. This specimen (Pl. I, fig. 4c) at a diameter of 13 mm has a proportionately smaller umbilicus than *"M." immaturus*. Judging from the crushed, larger, examples it would appear that the difference in umbilical width of *P. modestus* compared with *"M." immaturus,* is maintained at

larger diameters. It would also appear that *"M." immaturus* has two more auxiliary lobes than *P. modestus*. Nevertheless the general appearance, suture lines and growth lines of these two species are very similar and there can be no doubt that they are congeneric and closely related.

The type species of *Megaphyllites* has a closed umbilicus and this genus seems an inappropriate receptacle for evolute species, such as *Procarnites modestus, "Megaphyllites" immaturus,* and, also *"Megaphyllites" evolutus* Welter (1915, p. 114, Pl. 89, figs. 2a-c), from Timor. Provisionally these species are assigned to *Procarnites* despite the fact that they lack the adventitious elements in the median saddle of the external lobe, characteristic of the large, typical *Procarnites* such as *P. kokeni* (Arthaber), *P. andrusovi* Kiparisova, and *P. oxynostus* Chao. A case might be made for placing *Procarnites modestus* and *Megaphyllites immaturus* in *Neopopanoceras* Spath. *Neopopanoceras haugi* (Hyatt and Smith), the type and only known species of the genus, from the Anisian of California, is more inflated and has fewer auxiliary lobes, but otherwise the suture lines are very similar. These species apparently link *Procarnites* with the Megaphyllitidae. It therefore seems reasonable to class *Procarnites* in that family, as advocated by Popov (1962, p. 187) rather than in a family of its own, as proposed by Chao (1959, pp. 252-254).

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56178: about 427 feet above Fantasque Formation, Needham Creek, north side, 3½ miles above Graham River. GSC localities 56195, 56256, 56254, 56198: between 320 and 335 feet above Fantasque Formation, headwaters of Chowade River, 2½ miles south of Mount Laurier. GSC locality 56237: 414 feet above Fantasque Formation, North Gully, 7 miles north of Mount Laurier. GSC locality 56241: about 415 feet above Fantasque Formation, Middle Gully, 7 miles north of Mount Laurier. GSC locality 56242: about 420 feet above Fantasque Formation, 7 miles north of Mount Laurier. GSC locality 56280: talus collection, North Gully, 7 miles north of Mount Laurier.

Family USSURITIDAE

Genus *Leiophyllites* Diener 1915

Type species: *Monophyllites suessi* Mojsisovics

Leiophyllites sp. indet.

Plate II, figure 10

This record is based on a single individual, GSC No. 18871, with only one side preserved. The ribs on the inner whorls are distinctly rursiradiate and the outer whorl bears striae only. The full suture line is not visible, but the lateral saddle is distinctly phylloid. The specimen is too imperfect to bear a name but

probably represents a new species allied to *Leiophyllites indo-australica* (Welter, 1915, p. 129, Pl. XCIII, figs. 4a-c), an associate of *Keyserlingites* at Timor.

Occurrence. Toad Formation, Halfway River area, British Columbia. GSC locality 56234: 430 feet above Fantasque Formation, North Gully, 7 miles north of Mount Laurier.

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PLATE I

(Figures are natural size unless otherwise stated)

Procarnites modestus n. sp. (Page 38)

Figures 1a-c. Rear (1a), front (1b), and side (1c) views of paratype, phragmocone, GSC No. 18866, Toad Formation, British Columbia (GSC loc. 56237).

Figures 2a,b. Side view (2a) and venter (2b) of paratype, GSC No. 18869, Toad Formation, British Columbia (GSC loc. 56195).

Figures 3a,b. Rear (3a) and side (3b) views of paratype, GSC No. 18865, Toad Formation, British Columbia (GSC loc. 56198).

Figures 4a-c. Side view (4a), venter (4b), and whorl section, x2 (4c) of paratype, GSC No. 18863, Toad Formation, British Columbia (GSC loc. 56178).

Figure 5. Side view of paratype, GSC No. 18868, Toad Formation, British Columbia (GSC loc. 56198).

Figures 6a,b. Side view (6a) of holotype, GSC No. 18867, a well-preserved phragmocone with crushed body chamber; front view (6b) of same, showing phragmocone whorl section, Toad Formation, British Columbia (GSC loc. 56198).

Figures 7a-c. Side (7a), front (7b), and rear (7c) views of paratype, GSC No. 18864, Toad Formation, British Columbia (GSC loc. 56280).

Monacanthites monoceros n. gen., n. sp. (Page 27)

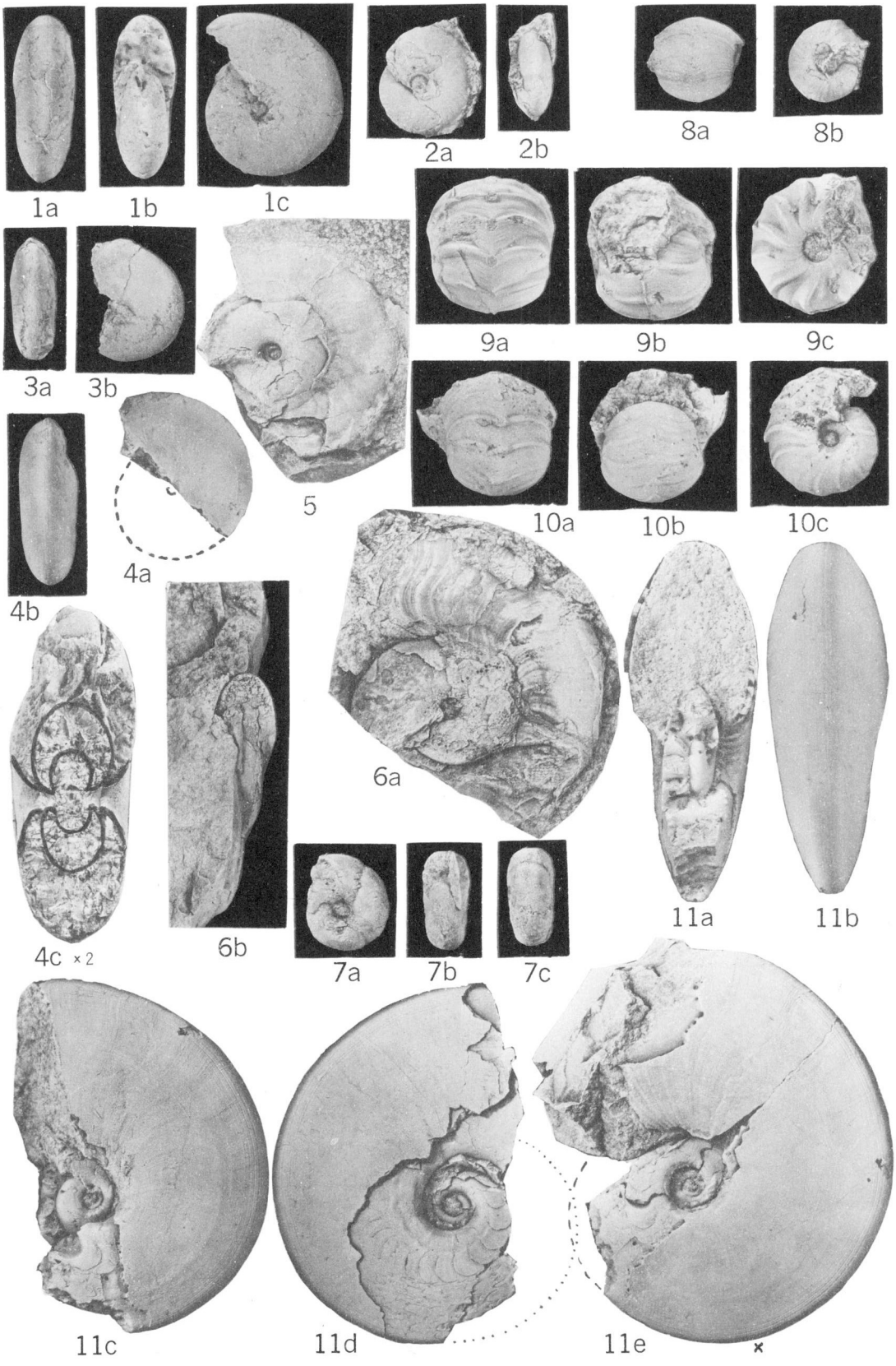
Figures 8a,b. Rear (8a) and side (8b) views of paratype, GSC No. 18836, Toad Formation, British Columbia (GSC loc. 56240).

Figures 9a-c. Rear (9a), front (9b), and side (9c) views of holotype, GSC No. 18838, Toad Formation, British Columbia (GSC loc. 56194) (*see also* Pl. II, fig. 4).

Figures 10a-c. Rear (10a), front (10b), and side (10c) views of paratype, GSC No. 18837, Toad Formation, British Columbia (GSC loc. 56240).

Metadagnoceras pulcher n. gen., n. sp. (Page 29)

Figures 11a-e. Whorl section (10a), venter (10b), and side views (10c-e) of holotype, GSC No. 18848, Toad Formation, British Columbia (GSC loc. 56196). X marks the position of the last septum.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4b
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7a
7b
7c
11c
11d
11e

PLATE II

(Figures are natural size unless otherwise stated)

X marks the position of the last septum

Isculitoides minor n. sp. (Page 20)

Figures 1a-e. Side view (1a), venter (1b), whorl section (1c), side view x3 (1d), venter x3 (1e), of holotype, GSC No. 18817. The part restored with a dashed line (1a) is based on crushed shell; the part with a dotted line is not preserved. The excentric umbilical seam is inked on 1a, but untouched on 1d. Toad Formation, British Columbia (GSC loc. 56265).

Figures 2a,b. Side (2a) and ventral (2b) views of paratype, GSC No. 18818, showing peristome. Toad Formation, British Columbia (GSC loc. 56243).

Figures 3a-c. Front (3a), oblique (3b), and side (3c) views of paratype, GSC No. 18819, Toad Formation, British Columbia (GSC loc. 56259).

Monacanthites monoceros n. gen., n. sp. (Page 27)

Figure 4. Front view of holotype, x2 showing parabolic node, GSC No. 18838, Toad Formation, British Columbia (GSC loc. 56194) (*see also,* Pl. I, figs. 9a-c).

Prosphingites cf. *P. czekanowskii* Mojsisovics (Page 19)

Figures 5a-c. Side view (5a), front view, as oriented (5c), and sectional view, in the plane of the arrow (5b), GSC No. 18816. The part restored with a dashed line (5a) is based on crushed shell; the part with a dotted line is not preserved. Toad Formation, British Columbia (GSC loc. 56241).

Zenoites arcticus n. sp. (Page 25)

Figure 6. Side view of slightly crushed paratype, GSC No. 18835, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 7a,b. Rear (7a) and side (7b) views of holotype, GSC No. 18834, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Pseudosageceras bicarinatum n. sp. (Page 16)

Figures 8a-d. Side (8a), rear (8b), and front (8c) views, and view from below, as oriented (8d), of holotype, GSC No. 18814, Toad Formation, British Columbia (GSC loc. 56234).

Preflorianites intermedius n. sp. (Page 18)

Figures 9a-c. Side view (9a), apertural view, as preserved (9b), and venter (9c) of holotype, GSC No. 18815, Toad Formation, British Columbia. Restored part indicates extent of umbilical seam. Toad Formation, British Columbia (GSC loc. 56240).

Leiophyllites sp. indet. (Page 40)

Figure 10. Rubber cast from natural mould, GSC No. 18871, Toad Formation, British Columbia (GSC loc. 56234).

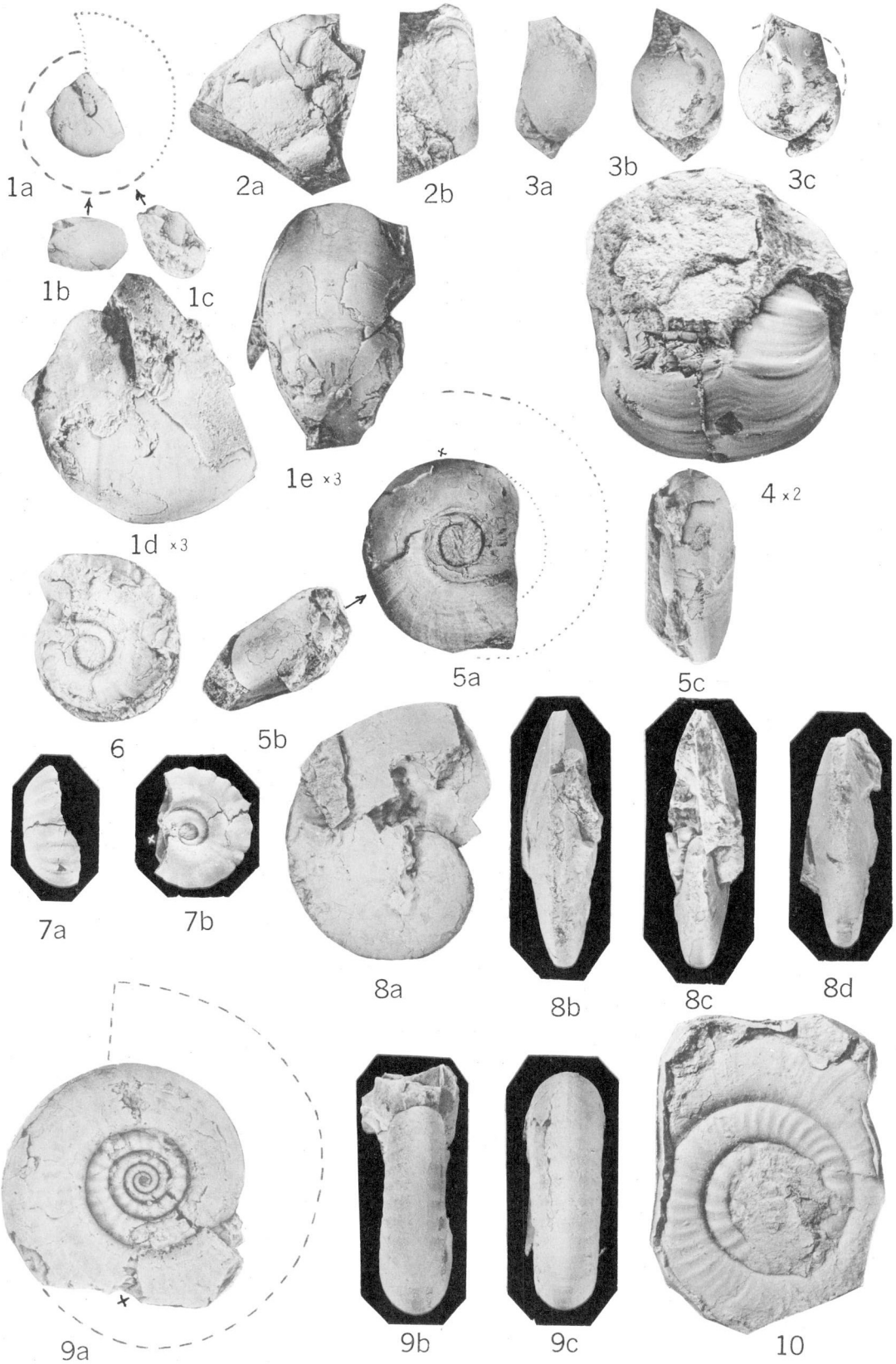
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PLATE III

(All figures are natural size)

X marks the position of the last septum

Popovites borealis n. gen., n. sp. (Page 24)

Figures 1a,b. Side (1a) and front (1b) views of holotype, GSC No. 18833, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Popovites occidentalis n. gen., n. sp. (Page 22)

Figures 2a-c. Side (2a), front (2b), and rear (2c) views of paratype, GSC No. 18823. Restored part indicates extent of umbilical seam. Toad Formation, British Columbia (GSC loc. 56265).

Figures 3a,b. Side (3a) and rear (3b) views of paratype, GSC No. 18831. Toad Formation, British Columbia (GSC loc. 56198).

Figures 4a-c. Side (4a), front (4b), and rear (4c) views of paratype, GSC No. 18828. Toad Formation, British Columbia (GSC loc. 56240).

Figures 5a,b. Side (5a) and rear (5b) views of paratype, GSC No. 18820, Toad Formation, British Columbia (GSC loc. 56234).

Figures 6a-c. Side (6a), front (6b), and rear (6c) views of paratype, GSC No. 18825. Toad Formation, British Columbia (GSC loc. 56259).

Figures 7a,b. Side view (7a) and view from below. as oriented (7b) of paratype, GSC No. 18824. Toad Formation, British Columbia (GSC loc. 56262).

Figures 8a-c. Side (8a), rear (8b), and front (8c) views of paratype, GSC No. 18821. Toad Formation, British Columbia (GSC loc. 56240).

Figures 9a-c. Side (9a), front (9b), and back (9c) views of paratype, GSC No. 18827. Toad Formation, British Columbia (GSC loc. 56198).

Figures 10a,b. Side (10a) and rear (10b) views of paratype, GSC No. 18830. Toad Formation, British Columbia (GSC loc. 56264).

Figures 11a-c. Front (11a), rear (11b), and side (11c) views of paratype, GSC No. 18822. Toad Formation, British Columbia (GSC loc. 56234).

Figures 12a,b. Side view (12a) and view from above, as oriented (12b) of holotype, GSC No. 18832. Toad Formation, British Columbia (GSC loc. 56234).

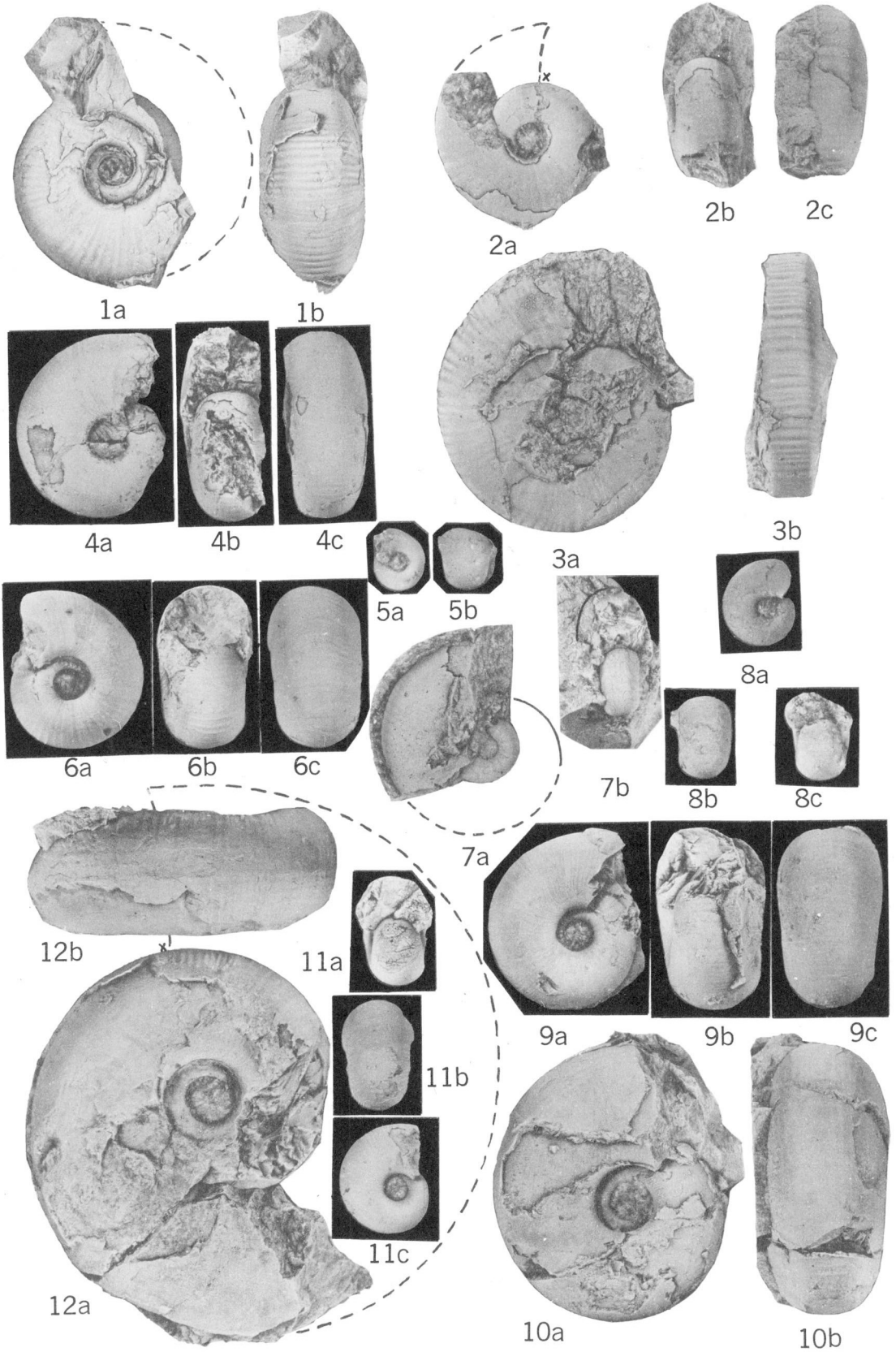
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PLATE IV

(Figures are natural size unless otherwise indicated)

X marks the position of the last septum

Olenikites canadensis Tozer (Page 32)

Figures 1a-c. Front (1a), rear (1b), and side (1c) views, variety A, holotype, GSC No. 14094. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 32363).

Figure 2. Side view, variety A, GSC No. 18850. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 3a-c. Side views (3a, 3c) and venter (3b), variety B, GSC No. 18851. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 4a-d. Side views (4a, 4b), rear (4c), and front (4d) views, variety B, GSC No. 18855, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47545).

Figures 5a-c. Rear view (5a), side view (5b), side view x2 (5c), variety C, topotype, GSC No. 18856. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 32363).

Figures 6a-c. Side views (6a, 6c) and front view (6b), variety B, GSC No. 18852, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 7a-d. Side view, illuminated to show inner whorls (7a), to show outer whorl (7b), front (7c), and rear (7d) views, variety C, GSC No. 18853. Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 8a-c. Front (8a) and side (8b, 8c) views, variety C, GSC No. 18854, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Svalbardiceras chowadei n. sp. (Page 37)

Figure 9. Side view of weakly sculptured specimen, doubtfully attributed to this species, GSC No. 18860, Toad Formation, British Columbia (GSC loc. 56265).

Figures 10a-c. Front view (10a), side view illuminated to show inner whorls (10b), to show outer whorl (10c), holotype, GSC No. 18861, Toad Formation, British Columbia (GSC loc. 56263).

Figure 11. Side view of paratype, GSC No. 18862, Toad Formation, British Columbia (GSC loc. 56258).

Svalbardiceras freboldi n. sp. (Page 36)

Figures 12a-c. Front (12a), rear (12b), and side (12c) views of paratype, GSC No. 18858, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

Figures 13a-c. Side view (13a), side view, with outer whorl removed (13b), inner whorl enlarged x2 (13c), holotype, GSC No. 18857, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47544).

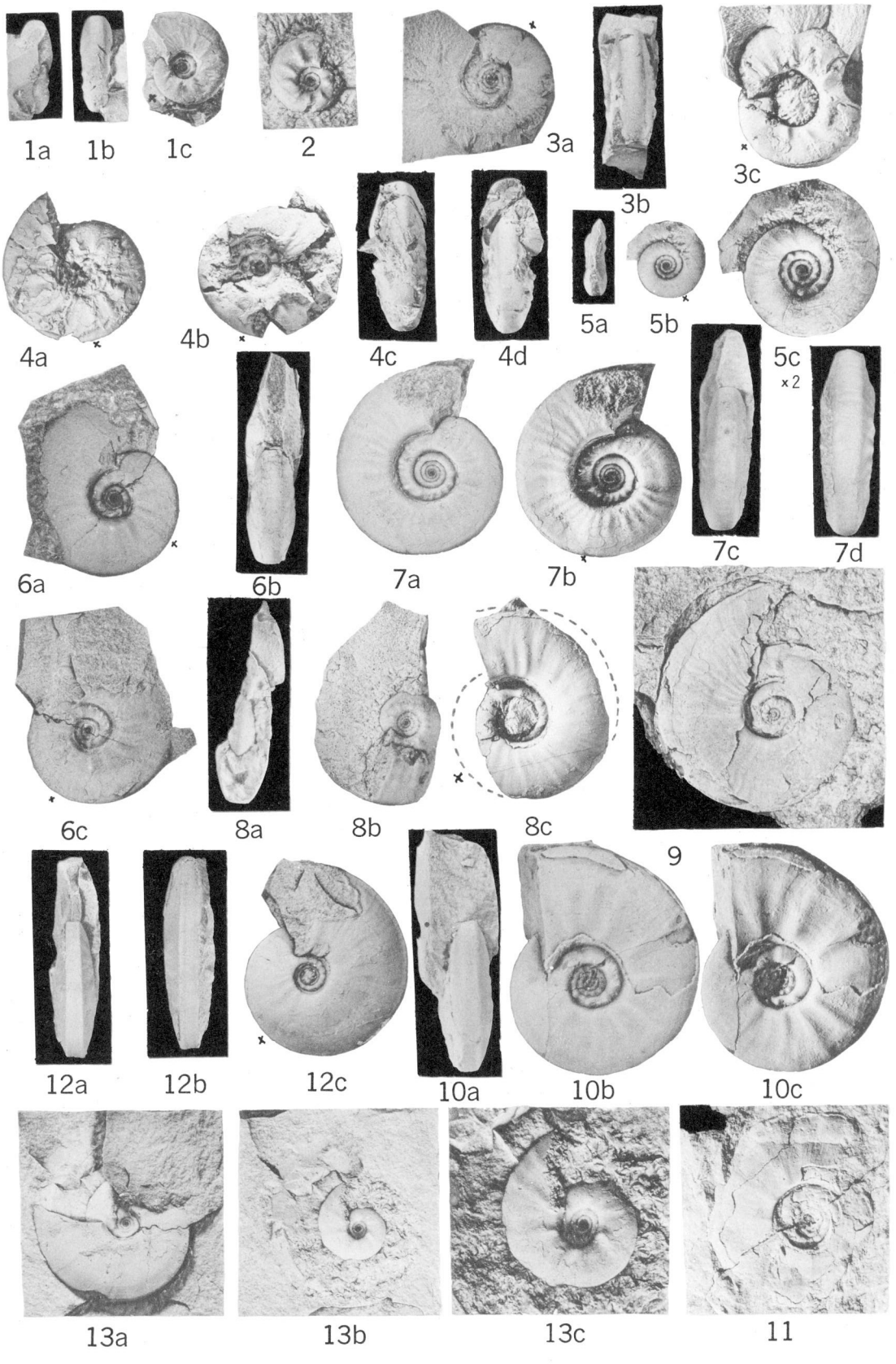
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PLATE V

(All figures are natural size)

Keyserlingites subrobustus (Mojsisovics) (Page 31)

Figure 1. Side view and whorl section of GSC No. 18841. Asymmetry of the whorl section is due to preservation of the test on one side only. Blind Fiord Formation, Ellesmere Island (GSC loc. 51603). Specimen is entirely septate.

Svalbardiceras freboldi n. sp. (Page 36)

Figure 2. Side view, paratype, GSC No. 18859, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 32363).

2

1

PLATE VI

(All figures are natural size)

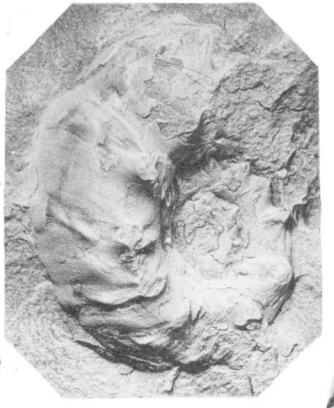
Keyserlingites subrobustus (Mojsisovics) (Page 31)

Figures 1a,b. Rear (1a) and side (1b) views of GSC No. 18842, Blind Fiord Formation, Ellesmere Island (GSC loc. 51603). Specimen is entirely septate.

Figures 2a,b. Oblique (2a) and side (2b) views of GSC No. 18843, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47545).

PLATE VI

1a



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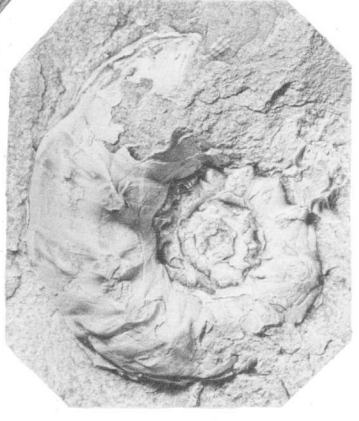

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1b

PLATE VII

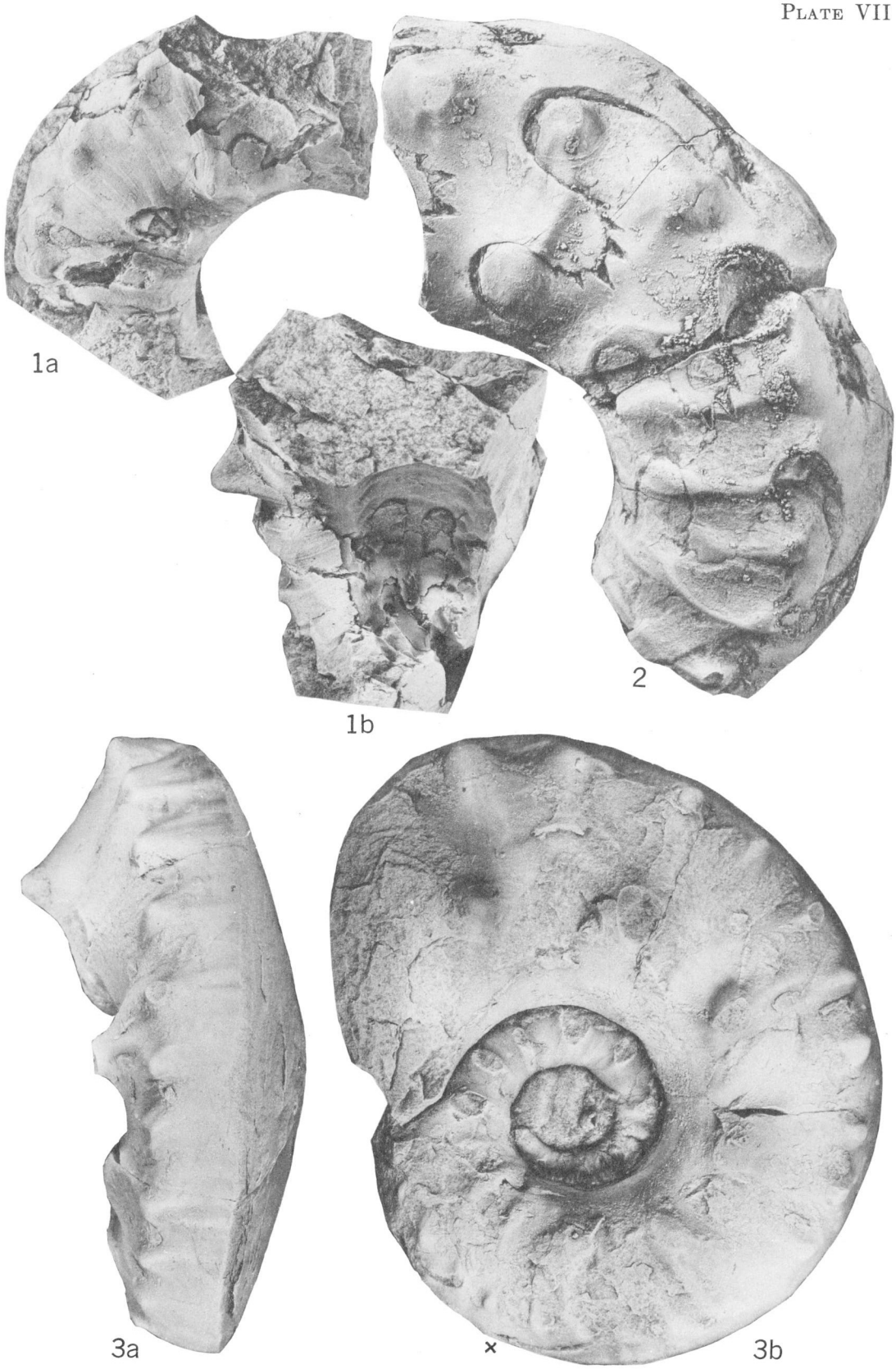
(All figures are natural size)

Keyserlingites subrobustus (Mojsisovics) (Page 31)

Figures 1a,b. Side (1a) and front (1b) views of GSC No. 18846, Toad Formation, British Columbia (GSC loc. 56261).

Figure 2. Side view of GSC No. 18844, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47545).

Figures 3a,b. Rear (3a) and side (3b) views of GSC No. 18845, Blaa Mountain Formation, Lower Shale Member, Ellesmere Island (GSC loc. 47545). X marks position of external lobe of last septum.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3b

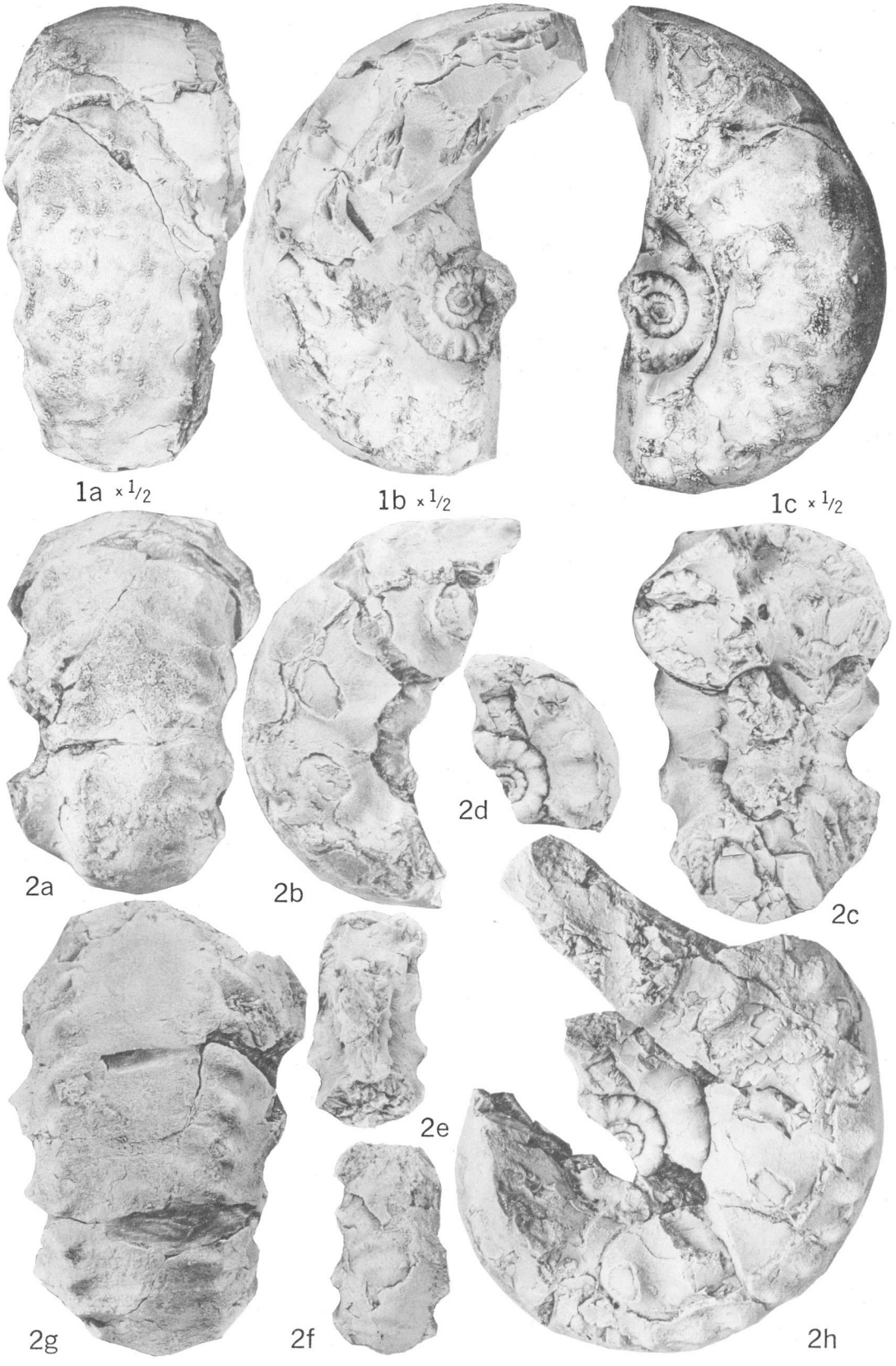
PLATE VIII

(Figures are natural size unless otherwise indicated)

Keyserlingites subrobustus (Mojsisovics) (Page 31)

Figures 1a-c — Rear (1a) and side (1b, 1c) views, ½ natural size, Hans Frebold collection, *Grippia* bed, Botneheia, south of Sassenfiord, Spitsbergen.

Figures 2a-h. — Rear views (2a, 2g), side views (2b, 2h), whorl section 2c, and inner whorls (2d-f), GSC No. 18847, Toad Formation, British Columbia (GSC loc. 56235).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