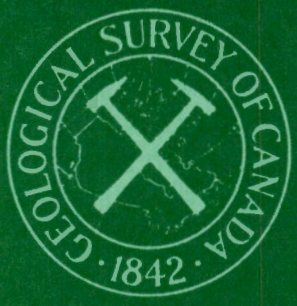

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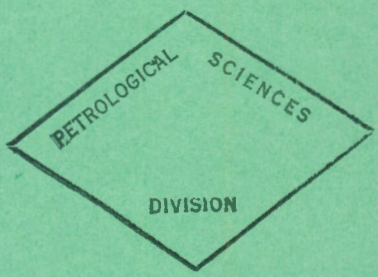

CONTRIBUTIONS TO CANADIAN PALAEONTOLOGY

PART I — Lower Triassic ammonoids from Tuchodi Lakes and Halfway River areas, northeastern British Columbia

PART II — *Liardites* and *Maclearnoceras*, new Triassic ammonoids from the *Nathorstites* zone of British Columbia

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PREFACE

Increasing refinement in the palæontological dating of strata is becoming imperative as the knowledge of Canadian stratigraphy advances. This can only be accomplished by studies of fossils carefully collected from precisely determined stratigraphic positions.

This bulletin records the results of two such studies, and in it three new genera and eight new species are described and figured.

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

OTTAWA, June 18, 1962

Bulletin 96 — Beiträge zur kanadischen Paläontologie.
Von E. T. Tozer

I. Teil: Die Ammonoiden der unteren Trias aus den Gebieten der Tuchodi-Seen und des Halfway-Flusses im Nordosten der Provinz Britisch-Kolumbien.

II. Teil: *Liardites* und *Maclearnoceras*, neue triassische Ammonoiden aus der *Nathorstites*-Zone der Provinz Britisch-Kolumbien.

Бюллетень 96 — К познанию канадской палеонтологии.
Автор: Е. Т. Тозер.

Часть I. Нижне-триасовые аммониты из окрестностей озер Тучоди и реки Халфуэй, северовосточной Британской Колумбии.

Часть II. Liardites и Maclearnoceras, новые триасовые аммониты из зоны Nathorstites Британской Колумбии.

CONTENTS

Illustrations

Part I

LOWER TRIASSIC AMMONOIDS FROM TUCHODI LAKES AND HALFWAY RIVER AREAS, NORTHEASTERN BRITISH COLUMBIA

Abstract

Ammonoids of early Lower Triassic (Induan) age are recorded from the Grayling and equivalent formations of northeastern British Columbia. These ammonoids evidently represent faunas of Gyronitan or Flemingitan age, and not earliest Triassic (Otoceratan) time.

Arctoceras and *Juvenites* of late Lower Triassic (Olenekian) age are also recorded from equivalents of the Toad Formation. These fossils indicate an approximate correlation with the previously known *Wasatchites* fauna.

One new genus (*Dunedinites*) and six new species of Induan ammonoids are described (*Paranorites sverdrupi, Koninckites columbianus, Proptychites mulleri, Proptychites newelli, Proptychites kummeli,* and *Dunedinites pinguis*). The type locality of *Paranorites sverdrupi* is Ellesmere Island, the remainder are from British Columbia. One new Olenekian ammonoid (*Juvenites needhami*) is also described.

Résumé

On a relevé l'existence, dans la formation Grayling et les formations équivalentes qui se trouvent dans le Nord-Est de la Colombie-Britannique, d'ammonoïdes d'âge Induen (début de l'Éotriasique). Il est évident que ces fossiles représentent une faune caractéristique du Gyronitien ou du Flemingitien, et non de l'Otoceratien (tout au début de l'Éotriasique).

On a trouvé aussi, dans des formations correspondantes à la formation Toad, les fossiles *Arctoceras* et *Juvenites*, d'âge Olenekien (fin de l'Éotriasique), qui s'apparentent de bien près à la faune déjà connue des *Wasatchites.*

L'auteur décrit un nouveau genre (*Dunedinites*) et six nouvelles espèces d'ammonoïdes d'âge Induen: *Paranorites sverdrupi, Koninckites columbianus, Proptychites mulleri, Proptychites newelli, Proptychites kummeli,* et *Dunedinites pinguis.* La localité type des *Paranorites sverdrupi* est l'île Ellesmere. Les cinq autres proviennent de la Colombie-Britannique. L'auteur décrit aussi une nouvelle ammonoïde d'âge Olenekien (*Juvenites needhami*).

INTRODUCTION

The Triassic System is unusually well represented in northeastern British Columbia. Ammonoid faunas of late Lower, Middle, and Upper Triassic age have been made known by F. H. McLearn. Full reference to this work will be found in reports by McLearn and Kindle (1950)[1], McLearn (1953, 1960), and Tozer (1961a). During the past few years relatively well preserved ammonoids of early Lower Triassic (Induan) age have been collected in this area, apparently for the first time. The principal object of this paper is to describe these fossils and to assess their stratigraphic significance. It will be shown that these ammonoids, which were collected near the base of the Triassic sequence, are apparently of Gyronitan or Flemingitan age (middle or late Induan) and are not representative of earliest Triassic (Otoceratan) time. The paper also includes the description of some late Lower Triassic (Olenekian) ammonoids that are new to British Columbia.

Lower Triassic fossils were collected on Liard River by R. G. McConnell as long ago as 1887. These fossils were described by Whiteaves (1889), but the exact age of many of the specimens was not known at that time, and it was not realized that Lower Triassic faunas were represented. The recognition of Lower Triassic faunas in British Columbia really dates from F. H. McLearn's study of collections made on Liard and Toad Rivers by E. D. Kindle in 1943 (Kindle, 1944; McLearn, 1945). McLearn recognized that both the upper and lower divisions of the Lower Triassic (Scythian) Series were represented. Pelecypods comparable with *Claraia stachei* Bittner established the presence of early Lower Triassic rocks in the Grayling Formation. An upper Scythian fauna, characterized by *Wasatchites,* was described by McLearn from collections obtained by Kindle in the Toad Formation, which overlies the Grayling. Some of the pelecypods obtained by McConnell, now classed as *Pseudomonotis occidentalis* (Whiteaves) (Tozer, 1961b, p. 98) were found to belong to the *Wasatchites* zone.

Most of the fossils described below were collected by B. R. Pelletier of the Geological Survey, and the writer. Shell Oil Company of Canada have kindly donated collections from the Halfway River area, and some of these are also described.

[1] Names and/or dates in parentheses are those of References, p. 28.

DESCRIPTION OF FOSSIL LOCALITIES

Dunedin River

An unusually well exposed section of Lower Triassic rocks is exposed on upper Dunedin River, 4½ miles north of mile 384 on the Alaska Highway, in Tuchodi Lakes map-area (94K), northeastern British Columbia. The coordinates of the base of this section are latitude 58°44′05″N, longitude 124°28′W. A geological map of this area has been prepared by Pelletier (1959).

In 1960, B. R. Pelletier and the writer visited this section. The Triassic rock succession has been described by Pelletier (1961, p. 27), who recognized the presence of both the Grayling and Toad Formations. The underlying beds are black chert, evidently the Fantasque Formation of Harker (1961, p. 8). The contact between the Fantasque and Grayling Formations is sharp and is probably disconformable. At this locality the Fantasque chert contains a single specimen resembling *Helicoprion*. It was found impossible to extract this specimen from the rock, but photographs taken in the field were shown to Wann Langston Jr., Curator of Vertebrate Palæontology of the National Museum of Canada. Dr. Langston reports that the fossil is almost certainly *Helicoprion* or *Lissoprion*, and of late Pennsylvanian or early Permian age, more probably the latter. There is, therefore, no doubt that the sharp contact between the Fantasque and Grayling Formations represents the Palæozoic-Triassic boundary.

Three fossil collections were obtained from this section. In ascending order they are:

1. Grayling Formation, 101 feet above base (GSC locality 42371):
   Claraia stachei Bittner

2. Grayling Formation, from a single concretion 117 feet above base (GSC locality 42372):
   Xenodiscoides cf. *X. radians* (Waagen)
   Koninckites columbianus n. sp.
   Proptychites mulleri n. sp.
   Proptychites kummeli n. sp.
   Proptychites newelli n. sp.
   Dunedinites pinguis n. sp.

3. Toad Formation, 913 feet above base of Triassic section (GSC locality 42373):
   Posidonia mimer Oeberg

The higher beds of the Toad Formation are not preserved in this section. In sections nearby these higher beds contain fossils of late Lower Triassic age, with *Posidonia aranea* (Tozer, 1961a, p. 7), and, even higher, early Middle Triassic (Anisian) ammonoids (McLearn, 1946).

Needham Creek

This section is exposed on Needham Creek, 2 miles west of the junction with Graham River, in Halfway River map-area (94B), northeastern British Columbia. A geological map of this area has been prepared by Irish (1962). The section was studied by B. R. Pelletier in 1961, and he has provided full lithological details (1962, p. 26).

Lower Triassic fossils were obtained by Pelletier at two levels.

1. "Toad-Grayling Formation", 55 feet above the contact with the underlying Palæozoic chert (GSC locality 46470):
   Paranorites sverdrupi n. sp.

2. "Toad-Grayling Formation", 140 feet above the underlying Palæozoic chert (GSC locality 46471):
   Arctoceras cf. *A. blomstrandi* (Lindstrom)
   Juvenites needhami n. sp.

Fragments of fossil fish were obtained by Pelletier at locality 46471.

In this section, 515 feet above the Palæozoic rocks, Pelletier collected *Daonella* and poorly preserved ammonoids. These fossils are certainly Middle Triassic and are probably Anisian.

Fossils from this area, apparently from the same section as that studied by Pelletier, were collected by Shell Oil Company geologists in 1960. *Juvenites needhami* n. sp. is well represented in beds said to be 180 feet above the Permian (Shell locality PZ30N60-28; now GSC locality 48850). It is not known whether there are two beds with *Juvenites needhami* or whether the two collections were obtained from one bed exposed at slightly different localities. The matrix and fossils at locality 46471 are exactly the same as those at locality 48850. The Shell Oil Company collection also contains some fragmentary ammonoids collected 90 feet below the *Juvenites needhami* bed. These ammonoids (Shell locality PZ30N60-17; now GSC locality 48849) have tabulate venters and are probably of lower Scythian age but their preservation precludes identification.

Mount Laurier

The Lower Triassic fossils from the Mount Laurier area were obtained by a field party of Shell Oil Company of Canada. Both collections were obtained about 3 miles south of the summit of Mount Laurier, in Halfway River area (94B), northeastern British Columbia.

The data provided for these collections are as follows:

1. "Toad-Grayling Formation", 40 feet above top Permian. (Shell Oil Company locality PZ29N60-2; now GSC locality 48847):
   Proptychites cf. *P. candidus* Tozer
   Ammonite with tabulate venter, indet.

2. "Toad-Grayling Formation" 70 feet above top Permian (Shell Oil Company locality PZ29N60-3; now GSC locality 48848):

Proptychites cf. *P. candidus* Tozer

Ammonite with tabulate venter, indet.

The lithology and preservation of the fossils in these two collections are identical.

AGE AND CORRELATION OF FAUNAS

All described Lower Triassic sections provide only a partial sequence of faunas, although the lower part may be essentially complete in the Salt Range (Pakistan), and the upper part in the sections studied by Bernhard Kummel in the western United States. Spath (1934) was the first to appreciate fully the incompleteness of the individual sections and in order to divide Scythian time he chose divisions characterized by faunas. He used every scrap of stratigraphic data available and where data were lacking he attempted to fit the faunas in place from his theories on the phylogeny of the ammonites. Spath's Lower Triassic ages are as follows:

(Youngest)

Upper Scythian (Olenekian)	Prohungaritan
	Columbitan
	Owenitan
Lower Scythian (Induan)	Flemingitan
	Gyronitan
	Otoceratan

Owing to the absence of a complete, standard section these terms are still very useful, and are used in the discussion that follows. Kiparisova and Popow (1956, 1961) have proposed the stage terms "Induan" and "Olenekian" for the lower and upper Scythian, respectively.

Lower Scythian (Induan)

Dunedin River Fauna

Under this heading the age and correlation of the ammonoid fauna in the lower part of the Grayling Formation of Dunedin River is considered.

This ammonoid fauna occurs 16 feet above a bed containing *Claraia stachei* Bittner. *Claraia stachei* is widely distributed in beds of lower Scythian age. In East Greenland ammonoids occur in association with *Claraia stachei* and this species ranges from the upper *Glyptophiceras* beds (of Otoceratan age) to the *Proptychites* beds (of Gyronitan age) (Spath, 1935, p. 105). The age of the beds beneath the ammonoid horizon on Dunedin River cannot be precisely established but they are presumably not younger than Gyronitan.

The ammonoid fauna is listed on page 2. As already mentioned, these fossils were obtained from a single concretion and can be justly treated as contemporaries. One of the ammonoids has been assigned to *Xenodiscoides* cf. *X. radians* (Waagen). Spath (1934, p. 119) gives the age of *Xenodiscoides* as Flemingitan, but it would appear that several Gyronitan species, originally assigned to *Gyronites, Prionolobus,* and *Xenodiscus,* should be placed in *Xenodiscoides. Xenodiscoides* cf. *X. radians* probably indicates a Gyronitan or Flemingitan age for the Dunedin River fauna. Several species that are probably related to *Xenodiscoides* cf. *X. radians* occur in Gyronitan beds of the Salt Range and the Himalayas (*see* p. 12). There is certainly nothing like *Xenodiscoides* cf. *X. radians* in the Otoceratan faunas of East Greenland, Ellesmere Island, and Axel Heiberg Island. Furthermore, the *"Vishnuites"* fauna of East Greenland, which lies above the *Otoceras* zone, and is classed as early Gyronitan by Spath (1935), contains no ammonoids like *Xenodiscoides* cf. *X. radians.* This would perhaps seem to exclude, positively, the possibility that the Dunedin River fauna is of earliest Scythian (Otoceratan) age. However, *Xenodiscoides* cf. *X. radians* is very close to *"Xenodiscus" radians* of Krafft (1909, p. 95, pl. 25, figs. 2a–c) which is said to be from the horizon of *Ophiceras sakuntala* at Spiti in the Himalayas. This bed is generally regarded as Otoceratan, although *Otoceras* itself is apparently restricted to a level 2 feet lower in the section. With regard to the Himalayan lower Scythian ammonoids it may be mentioned that acceptance, at face value, of their stratigraphic situation, can vitiate almost any correlation. The difficulty seems to stem from the remarkably condensed sequence of Lower Triassic faunas in the Himalayas. At Spiti ammonoid faunas of Otoceratan, Gyronitan, and Flemingitan age occur in no more than 13 feet 5 inches of strata (Diener, 1912, p. 16). Diener (1909, p. 167) admitted that the exact provenance of some of the fossils was uncertain and this introduces an element of doubt about the faunas as a whole.

Koninckites columbianus, suggests a Gyronitan age. *K. columbianus* is probably closely related to *K. kraffti* Spath from the *"Meekoceras"* beds (Gyronitan) of the Himalayas, but the species from Dunedin River is also close to members of the Otoceratan genus *Discophiceras* (*see* p. 16).

The *Proptychites* species from Dunedin River suggest a Gyronitan or Flemingitan age. This genus is apparently very abundant in the typical Gyronitan and Flemingitan deposits of the Salt Range but it must be admitted that the species from Dunedin River do not resemble closely the Salt Range proptychitids. Furthermore, *Proptychites scheibleri* has been described from the *Otoceras* zone of Painkhanda, in the Himalayas (Diener, 1912, p. 23).

Proptychites kummeli n. sp. may be identical with a specimen from Montana identified as *"Discophiceras subkyokticum* Spath" by Newell and Kummel (1942, p. 959) (*see* p. 21). They believed that their fossil was of Otoceratan age, but this seems open to question (p. 8).

Proptychites mulleri n. sp. from Dunedin River may be related to *P. candidus* Tozer from Axel Heiberg Island, which is known to be younger than the *Otoceras,*

Ophiceras, and *Pachyproptychites* zones (Otoceratan and early Gyronitan) of that area (Tozer, 1961b).

The new genus *Dunedinites* does not assist in determining the age of this fauna at present.

On the whole, evidence points to a Gyronitan or Flemingitan age for the Dunedin River fauna particularly as there is no resemblance to the early Induan faunas of Greenland, or to the *Otoceras, Ophiceras,* and *Pachyproptychites* faunas of Ellesmere and Axel Heiberg Islands. The available evidence suggests that Lower Triassic faunas were remarkably cosmopolitan and the differences between the Dunedin River assemblage and those mentioned above from the Arctic almost certainly points to a difference in age. The Dunedin River fauna is clearly not older than these Arctic faunas and is almost certainly younger, and thus with fair confidence can be assigned to the Gyronitan or Flemingitan.

Lower Scythian Beds of Needham Creek

The age of the bed with *Paranorites sverdrupi,* which occurs about 55 feet above the base of the Triassic at Needham Creek, is evidently Gyronitan or Flemingitan. At the type locality of this species on the north side of Otto Fiord, Ellesmere Island, *P. sverdrupi* lies about 700 feet above *Otoceras boreale* and 400 feet below an upper Scythian (Olenekian) bed with *Euflemingites romunderi* Tozer, *Juvenites crassus* Tozer, and *Pseudomonotis boreas* Oeberg. South of Bunde Fiord, in northwest Axel Heiberg Island, *Paranorites sverdrupi* occurs at approximately, and perhaps exactly, the same level as *Proptychites candidus* Tozer (*see* Tozer, 1961b, p. 29). In the Arctic Islands *Paranorites sverdrupi* therefore lies well above the base of the Induan, in beds of Gyronitan or Flemingitan age. The occurrence in British Columbia is presumably the same age.

Specimens of *Paranorites* cf. *P. inflatus* Spath, which may be identical with *P. sverdrupi*, have been recorded from northeastern Siberia by Popow (1961, p. 47) (*see* p. 14). In the Kulu River area (in the headwater region of Kolyma River) Popow reports *Hedenstroemia, "Anahedenstroemia",* and *Pseudosageceras* together with *P.* cf. *P. inflatus*. Popow (1960, p. 11; 1961, p. 6) dates this occurrence as Flemingitan, probably correctly, because hedenstromiids have never been collected from Gyronitan or older deposits. However, as noted on page 14, *Paranorites sverdrupi* may be closely related to *Proptychites markhami* Diener and *Pachyproptychites turgidus* Popow, and both these species are believed to be of the older, Gyronitan age. All the evidence suggests a Gyronitan or Flemingitan age for the *Paranorites sverdrupi* bed, but at present, dealing with only one species it appears impossible to offer a more precise dating.

The ammonoids collected by Shell Oil Company from the lower Scythian of Needham Creek do not assist in establishing a precise age determination.

Proptychites *cf.* P. candidus *Beds of Mount Laurier*

These occurrences suggest a correlation with the *Proptychites candidus* bed of the Blind Fiord Formation of Axel Heiberg Island, of Gyronitan or Flemingitan age (Tozer, 1961b, p. 29).

Summary of Lower Scythian (Induan) correlations

It appears that the Induan ammonoids from Dunedin River, Needham Creek, and Mount Laurier are of Gyronitan or Flemingitan age. There is no good evidence that beds of lowermost Triassic (Otoceratan) age, such as occur in East Greenland, the Queen Elizabeth Islands, and northern Alaska, are present in these sections, although the *Claraia stachei* beds of Dunedin River and the *Claraia stachei* occurrences elsewhere in British Columbia and Alberta (Tozer, 1961a, p. 3) could be of Otoceratan age. This was suggested by Warren (1945), but apparently the ammonoids that led to this correlation are not well preserved. As *Claraia stachei* is not confined to Otoceratan beds, there seems to be no definite evidence that beds of this age occur in British Columbia and Alberta.

Newell and Kummel (1942) have dated some ammonoids from the Dinwoody Formation of Montana as Otoceratan. They record two species: *Discophiceras subkyokticum* and *Metophiceras subdemissum*, both of which were originally described from Otoceratan beds in East Greenland. The writer believes (*see* p. 21) that the specimen referred to *Discophiceras subkyokticum* is misidentified, and may in fact be conspecific with *Proptychites kummeli* n. sp. from Dunedin River. Their specimen of *Metophiceras subdemissum* is not well preserved, and this is apparently true of the early Induan ammonoids from Montana recorded by Kummel (1954, p. 183). It seems that there are no really satisfactory records of Otoceratan ammonoids from western North America.

Fossils dated as Gyronitan or Flemingitan have been recorded from the Dinwoody Formation at several localities in Montana by Kummel (1954, p. 184). For the Gyronitan he records species of *Gyronites, Prionolobus*, and *Koninckites*; for the Flemingitan, *Xenodiscoides, Koninckites*, and *Kymatites*. These fossils have not been described. The species of *Xenodiscoides* and *Koninckites* from Dunedin River may be related to those of the Flemingitan fauna in the Dinwoody Formation. The Montana and British Columbia beds could include correlative strata but this cannot be established at present. It must be remembered that no less than 117 species have been named to accommodate the Gyronitan and Flemingitan ammonoids of the Salt Range, and although this high figure partly reflects the typological systematic approach practiced by Waagen (1895), a rich and varied fauna certainly flourished during these ages. The Otoceratan faunas, although known from very few localities, appear to be extraordinarily cosmopolitan. If the Gyronitan and Flemingitan faunas were equally widespread it is probable that the eight species now recorded from British Columbia provide only a very partial glimpse of the local ammonoid fauna of the time.

Muller and Ferguson (1939, p. 1584) have listed a fauna, which they date as Gyronitan, from the Candelaria Formation of Nevada. Their fauna lies about 40 feet above a bed with *Claraia*. This fauna has also been discussed by Kummel (1954, p. 184). The genera present evidently include *Proptychites* and *Prionolobus* but judging from the names used there are no species in common with the fauna from British Columbia.

As already mentioned the faunas from Dunedin River, Needham Creek, and

Mount Laurier have no species in common with one another. Possibly these assemblages are of slightly different ages or they may represent faunal facies of a middle or late Induan fauna which is as yet imperfectly known. It has been suggested that the *Paranorites sverdrupi* bed of Needham Creek may be the same age as *Paranorites sverdrupi* and *Proptychites candidus* in the Arctic Islands. A similar correlation may be suggested for the *Proptychites* cf. *P. candidus* beds of Mount Laurier. *Proptychites mulleri* from Dunedin River bears some resemblance to *P. candidus*. The fossils from all three localities seem to have some relationship with the Arctic Gyronitan or Flemingitan fauna. With the Needham Creek and Mount Laurier fossil beds this affinity seems fairly well defined; with the Dunedin River collection the relationship is less marked.

Upper Scythian (Olenekian)

Juvenites *Beds of Needham Creek*

The occurrence at Needham Creek of *Arctoceras* cf. *A. blomstrandi* (Lindstrom), *Juvenites needhami* n. sp., and *Posidonia mimer* Oeberg, indicates a correlation with the *Arctoceras* beds of Spitsbergen and Ellesmere Island, and the *Meekoceras* beds of the western United States. The *Euflemingites* beds of the Sulphur Mountain Member (Spray River Formation) of Alberta evidently represent another equivalent. All these faunas are now known to be of early Olenekian (Owenitan) age (Kummel, 1961; Tozer, 1961b, pp. 29-31). *Posidonia mimer* is now known from several sections in British Columbia, and seems to mark a distinct zone of Owenitan age (Tozer, 1961a, p. 6). As already mentioned, this zone is present in the Dunedin River section. Determinable ammonoids are known with *Posidonia mimer* at only one other locality in British Columbia, namely, in the *Wasatchites* bed of the Toad Formation, exposed on Toad and Liard Rivers (Kindle, 1944; McLearn, 1945). The *Wasatchites* fauna, like the assemblage from Needham Creek, is of Owenitan age. The relative age of *Wasatchites* and *Arctoceras* presents a problem. In Spitsbergen, according to both Spath (1930, p. 82) and Frebold (1930, p. 33), *Arctoceras* occurs above *Wasatchites*. There is also some evidence to suggest that locally these ammonoids occur together in Spitsbergen (Spath, 1921, p. 350; Tozer, 1961b, p. 310). In Utah and Idaho, according to Mathews (1931) and Kummel (1954, p. 185), the *Wasatchites* fauna overlies the *Meekoceras* zone, in which *Arctoceras* is also found. Both the *Arctoceras* and *Wasatchites* faunas occur in the Queen Elizabeth Islands. Until recently, they were only known in different sections (Tozer, 1961a, p. 31). In 1961, *Wasatchites* was found 220 feet above the bed containing *Arctoceras* and *Meekoceras*, in the section of the Blind Fiord Formation northwest of Hare Fiord, Ellesmere Island.[1] A faunal list published by Silberling (1959, p. 2194) suggests that *Wasatchites* occurs together with *"Submeekoceras"* (i.e., *Arctoceras*) and

[1] In 1962 *Wasatchites* and *Arctoceras* were found in direct association in a section 6 miles southeast of the entrance to Otto Fiord, Ellesmere Island (GSC locality 51672).

Meekoceras in the Confusion Range, Utah. If all these records are correct they would appear to show that the *Arctoceras, Wasatchites* and *Meekoceras* faunas are essentially of the same age, and superposition of one genus above the other is related to local conditions rather than an indication of a world-wide faunal change (Tozer, 1961b, p. 27). The available evidence does not seem to establish that the *Arctoceras* fauna of Spitsbergen is younger than the *Meekoceras* fauna of the western United States, as suggested by Kummel (1961, p. 529).

SYSTEMATIC PALÆONTOLOGY

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). Figures in parentheses are the proportions of H, W, and U expressed as a decimal fraction of D.

Family FLEMINGITIDAE

Genus *Xenodiscoides* Spath 1930

Type species: *Xenodiscus perplicatus* Frech

Xenodiscoides cf. *X. radians* (Waagen)

Plate I, figures 5a–c

A single specimen from Dunedin River may be referable to *"Gyronites" radians* Waagen (1895, p. 302, pl. 38, figs. 6–8) which was originally described from the Salt Range and is evidently a representative of *Xenodiscoides*.

The dimensions are

Specimen	Locality	D	H	W	U
14269	42372	at 32	11 (0.34)	8.5 (0.27)	14 (0.44)

Description. The specimen is mainly steinkern and the figured part is entirely septate. Another quarter whorl is known but is poorly preserved and is not shown. The whorl sides are convex and widest near the umbilical shoulder. The venter is narrow and tabulate, with well-defined ventral shoulders. The umbilical wall is visible only at the aperture. It is inclined and meets the whorl side to form a round, but distinct umbilical shoulder. Sculpture consists of rather prominent, almost perfectly radial, plications. These plications do not occur on the umbilical wall. They arise, and are most pronounced, at the umbilical shoulder, and occupy about two thirds of the whorl side. They are completely obsolete on the outer third of the whorl side. There are eleven plications on the last half whorl. Plications are also present on the last, unfigured, quarter whorl.

Most of the external suture line is well preserved. The ventral lobe is narrow and the branches have one incision. The lateral lobes are very finely serrated. The suspensive lobe is not well displayed but near the aperture weak serrations are visible.

Comparisons. This specimen resembles closely *"Xenodiscus" radians* (Waagen) (Krafft and Diener, 1909, p. 93, pl. 25, figs. 1–3) from the Himalayas. The Dunedin specimens agree in the character of the venter, the whorl section, width of umbilicus, sculpture and septal sutures. The Dunedin specimen is rather wider (27 per cent) than those from the Himalayas (20–22 per cent). However, the width of one of Waagen's specimens from the Salt Range is 25 per cent of the diameter. Waagen (1895, p. 302), in his original description of *Gyronites radians*, stated that the periphery changed, in ontogeny, from tabulate to rounded. Krafft (1909, p. 94) examined Waagen's types and reported that although the ventral

shoulders become less prominent towards the aperture, they do not disappear entirely. On the specimens described by von Krafft the sculpture is less pronounced on the body chamber than it is on the phragmocone. The comparable part of the Dunedin River specimen is not known. Unfortunately there seems to be some doubt about the exact stratigraphic position of the specimens from the Salt Range and the Himalayas (*see* Krafft and Diener, 1909, p. 95).

Several other species from the Himalayas and the Salt Range are probably closely related to the Dunedin River specimen. From the Himalayas related forms include *"Xenodiscus" lilangensis* Krafft (Krafft and Diener, 1909, p. 97, pl. 25, figs. 6–11) from the *"Meekoceras"* beds; *Xenodiscus* cf. *X. plicosus* (Waagen) (op. cit., p. 101, pl. 25, fig. 4) of uncertain exact horizon; and *"Xenodiscus" rotula* (Waagen) (op. cit., p. 93, pl. 23, figs. 4, 5; pl. 27, figs. 4, 5). Two species from the Salt Range, in addition to *G. radians* and *G. rotula* should also be mentioned: *Prionolobus buchianus* (de Koninck) of Waagen (1895, p. 320, pl. 35, figs. 5a–c) from the Lower Ceratite Limestone; and *Prionolobus compressus* Waagen (1895, p. 313, pl. 35, figs. 3a–c), also from the Lower Ceratite Limestone. Most of the species mentioned above are of Gyronitan age or of uncertain exact position. Spath (1934, p. 122) has already suggested assignment of some of these species to *Xenodiscoides* and it would appear that all these species have the tabulate venter, radial plications, and relatively simple suture line characteristic of this genus.

The figures of the suture line of *Xenodiscoides perplicatus* given by Spath (copied from illustrations by Frech) show rather pronounced lobe incisions. However, the suture lines of the specimens in the British Museum (Natural History) for example of BM No. C10425, are not appreciably different from those of the specimen from Dunedin River.

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway, Tuchodi Lakes map-area, British Columbia (GSC locality 42372, E. T. Tozer, 1960).

Family PARANORITIDAE

Genus *Paranorites* Waagen 1895

Type species: *Paranorites ambiensis* Waagen

Paranorites sverdrupi n. sp.

Plate IV, figures 1–6

Diagnosis. Paranorites with unusually thick whorls (up to 36 per cent of the diameter); up to 26 per cent umbilicate on the outer whorls, more tightly coiled within. Maximum diameter evidently at least 200 mm. Umbilical wall high and vertical; umbilical shoulder rounded; whorl sides gently convex, widest at the inner quarter of whorl height; periphery gently convex, separated from whorl sides by well-defined ventral shoulders. Surface with fine lines of growth and obscure spiral sculpture on outer part of whorls.

Types and Dimensions

Specimen	Locality	D	H	W	U
14275 paratype	47543	at 75	36 (0.48)	27 (0.36)	15 (0.20)
		155	72 (0.46)	45 (0.29)	35 (0.23)
14276 paratype	47543	at 163	73 (0.45)	46 (0.28)	42 (0.26)
14277 holotype	47543	at 65	34 (0.52)	20 (0.31)	12 (0.18)
		at 110	47 (0.43)	30 (0.27)	28 (0.25)
14278 paratype	47543	110		40 (0.36)	
14279 paratype	47543	72	34 (0.47)	21 (0.29)	15 (0.21)
14280 paratype	47543	100	48 (0.48)	36 (0.36)	20 (0.20)
14281 paratype	47621	60	28 (0.47)	17 (0.28)	10 (0.17)
14282 hypotype	46470	28	14 (0.50)	8 (0.29)	6 (0.21)
14283 hypotype	46470	at 87	41 (0.47)	28 (0.32)	20 (0.23)

Description. This species is known from two widely separated areas: the Queen Elizabeth Islands and northeastern British Columbia. The material from Otto Fiord, Ellesmere Island, is abundant and relatively well preserved and the types have been selected from that area.

The holotype, No. 14277, is a broken specimen about 150 mm in diameter, only part of which is figured here. The phragmocone at a diameter of 65 mm is well preserved steinkern with a relatively small umbilicus. The whorl section, as given in the diagnosis, is clearly shown. An identical whorl section is definitely maintained to a diameter of 105 mm, but at this diameter the umbilicus has widened to 25 per cent of the diameter. The largest known specimen was originally about 200 mm in diameter (Pl. IV, fig. 1). It has half a whorl of body chamber and approximation of the last four septa. There is a suggestion of a flared aperture but as the preservation of the body chamber is indifferent this is not certain. It is possible, however, that this specimen represents the remains of a complete adult. There are several large fragments of body chambers in the collection; they show that the ventral shoulders are retained at a whorl height of at least 65 mm. It is improbable that the ventral shoulders were lost at any stage of growth.

Most of the specimens from the type area are preserved as steinkerns, but one (No. 14281, locality 47621) preserves most of the test. Growth lines are faint rursiradiate on the umbilical wall and sinuous, but essentially radial, on the whorl side. Obscure, low, spiral, ridges occur on the outer third of the whorl side.

The external suture shows the high narrow lobes and saddles, and deeply incised lobes, characteristic of *Paranorites*. The suspensive lobe is incised to form numerous auxiliaries. The largest specimen shows a relatively large, well individualized auxiliary lobe at the outer edge of the suspensive lobe but on the holotype and paratype there are no well-defined auxiliary lobes. The material from British Columbia comprises two specimens. In dimensions, whorl section, and nature of the umbilicus, specimen No. 14283 agrees perfectly with material from the type locality. The surface of this specimen is unusually well preserved, and it shows sinuous growth lines and low irregular spiral ridges on the outer quarter of the

whorl side. Low spiral ridges also occur on the periphery. No. 14282 represents the involute inner whorls taken from a broken individual identical with No. 14283. At a diameter of 28 mm this small specimen has a relatively angular umbilical shoulder and sharp ventrolateral edges. The larger specimen shows no trace of septa or sutures, for the internal features have apparently been destroyed by the enclosed coarsely crystalline calcite. The small specimen shows traces of septa. The sutures are definitely ceratitic, with moderately marked auxiliary teeth. The internal lobe of the next whorl can be seen on the venter of the small specimen.

This species is named in memory of Captain Otto Sverdrup.

Comparisons. The whorl section, mode of coiling and suture leave little doubt that this new species is congeneric with *Paranorites ambiensis* Waagen from the Salt Range. *P. sverdrupi* has thicker whorls than *P. ambiensis.* Of all the Salt Range *Paranorites,* only *P. inflatus* Spath approaches *P. sverdrupi* in whorl thickness, but *P. inflatus* has a very narrow venter compared with *P. sverdrupi.* Several new species of *Paranorites* have recently been recorded from northeastern U.S.S.R. by Popow (1961). *P. tzaregradskii* Popow, *P. kolymensis* Popow, and *P. kolymensis* var. *P. costata* Popow have costate inner whorls, unlike *P. sverdrupi.* The specimens identified as *Paranorites* cf. *P. inflatus* by Popow (1961, p. 47, pl. 12, fig. 7), from northeastern Siberia, are probably very close to *P. sverdrupi* and may be referable to the new species.

Proptychites markhami Diener (1895, p. 75, pl. 6, figs. 4, 6; Krafft and Diener, 1909, p. 20, pls. 11–14) from the Himalayas includes specimens with proportions virtually identical with *Paranorites sverdrupi.* The external part of *Proptychites markhami,* according to Krafft (1909, p. 22), is "at first highly rounded, becoming gradually broadly rounded, with very obtuse marginal edges. Sometimes however, the highly rounded siphonal area persists up to the adult stage." The prominent ventral shoulders on the inner whorls of *Paranorites sverdrupi* evidently distinguish it from *Proptychites markhami.*

Pachyproptychites turgidus Popow (1961, p. 52, pl. 10, fig. 5) from northeastern Siberia may be related to *Paranorites sverdrupi. Pachyproptychites turgidus* has a flattened venter, like the outer whorls of *Proptychites markhami.* Assignment of these species to *Proptychites* and *Pachyproptychites* seems questionable, for the types of both genera have arched venters. Popow (1961, p. 53) gives the dimensions of only one specimen of *Pachyproptychites turgidus* and it is more inflated than all the specimens of *Paranorites sverdrupi.* Furthermore, *Pachyproptychites turgidus* at 150 mm has an umbilical width 17 per cent of the diameter. All specimens of *Paranorites sverdrupi* that are more than 100 mm in diameter have umbilical widths more than 22 per cent of the diameter. The available evidence suggests that *Paranorites sverdrupi* is more compressed and more evolute than *Pachyproptychites turgidus.*

The species discussed above reveal the close relationship between the paranoritids and proptychitids stressed by Popow (1961, p. 44).

Occurrence. 1. Blind Fiord Formation, about 700 feet above *Otoceras boreale* zone, about 900 feet above base of formation, north side of Otto Fiord,

Ellesmere Island, 10 miles from entrance to fiord (GSC locality 47543; R. Thorsteinsson and E. T. Tozer, 1961).

2. Blind Fiord Formation, same bed as at locality 47543, 1 mile north of locality 47543 (GSC locality 47621; R. Thorsteinsson and E. T. Tozer, 1961).

3. "Toad-Grayling Formation", 55 feet above Triassic-Palæozoic contact, Needham Creek, 2 miles west of junction with Graham River, Halfway River map-area, British Columbia (GSC locality 46470; B. R. Pelletier, 1961).

Genus *Koninckites* Waagen 1895

Type species: *Koninckites vetustus* Waagen

Koninckites columbianus n. sp.

Plate V, figures 7, 8

Diagnosis. Excentrumbilicate *Koninckites* at least 107 mm in diameter. Umbilical wall inclined on outer whorls, vertical within. Whorl sides convex, periphery narrowly rounded, ventral shoulders rounded. Suture line with rounded lobes, flat-topped second lateral saddle, and feebly incised suspensive lobe. Denticulation of lobes more delicate than in typical species of *Koninckites*.

Types and Dimensions

Specimen	Locality	D	H	W	U
14266 holotype	42372	at 65	31 (0.48)	17 (0.26)	13 (0.20)
14267 paratype	42372	at 107	45 (0.42)	25 (0.23)	27 (0.25)

Description. This species is based on two specimens. The holotype is septate except for the last half volution. The last septa are approximated. The umbilical wall is essentially vertical on the penultimate whorl and inclined at about 45 degrees on the outer whorl. The umbilical shoulder is rounded but nevertheless fairly distinct. The whorls have convex sides and are thickest one third of the distance between the umbilical shoulder and the venter. On the outer whorl the venter is narrowly rounded and separated from the sides by round, but fairly distinct, shoulders. On the inner whorls the ventral shoulders appear, in section, to be more pronounced than where they are exposed. Much of the holotype preserves the test, which is about 1 mm thick on the outer whorl. The surface carries only growth lines, rursiradiate (45 degrees) on the umbilical wall and convex on the whorl side. Most of the external suture is well displayed (Pl. V, fig. 7c). The lateral lobes have round bases and delicate incisions, and these delicate incisions also characterize the visible part of the suspensive lobe.

The paratype, No. 14267, is partly body chamber. The whorl height of the phragmocone reaches 34 mm but the last septum is not preserved. The septa are

approximated. At a whorl height of 65 mm the umbilicus is the same size as that of the holotype. The proportionately larger umbilicus evident at 107 mm presumably indicates progressive umbilical enlargement. The enlarged umbilicus and approximated septa may mean that this specimen is a fragmentary adult. Weathered suspensive lobes are visible on one side of this specimen (Pl. V, fig. 8c). These lobes, visible for a full whorl, are feebly denticulate or smooth. Despite the weathering, it seems safe to conclude that no prominent auxiliary lobes were present.

Comparisons. *Koninckites columbianus* seems to be a passage form, intermediate between several lower Scythian genera. The new species has characters of *Discophiceras* Spath, *Koninckites* Waagen, and also the closely related *Paranorites* Waagen. As noted below there is also some resemblance to a species that has been placed in *Prionolobus* by Spath. However, the type species of *Prionolobus* has a tabulate venter and a wide umbilicus (0.31). Schindewolf (1954, p. 158) evidently considered that *Prionolobus* is inseparable from *Gyronites,* and this may be correct. The whorl shape and involution of the new species recall that of both *Koninckites* and *Paranorites.* The type species of *Koninckites* is said to have a narrowly rounded venter; that of *Paranorites* is described as tabulate on the surface of the test, but rounded on the steinkern. The new species, with round ventral shoulders, is therefore assigned to *Koninckites.* The suture line of *K. columbianus* is unlike that of the type species of both *Paranorites* and *Koninckites.* Both these genera have the pronounced lobe incisions that characterize so many of the Gyronitan and Flemingitan ammonoids. The denticulation of the lobes of *K. columbianus* is very delicate, like that of the Ophiceratidae, of earliest Scythian (Otoceratan) age. The ophiceratids, on both stratigraphic and morphological grounds, are generally regarded as the source of younger genera, such as *Koninckites* and *Paranorites.* However, the suture line of *K. columbianus* differs from that of ophiceratids in one important respect: the branches of the external lobe on *K. columbianus* are wide, with many teeth, unlike the narrow, feebly toothed branches that characterize ophiceratids. For this reason the new species is assigned to *Koninckites* rather than to *Discophiceras.*

Koninckites columbianus is probably closely related to *K. kraffti* Spath (1930, p. 28, =*Meekoceras varaha* Diener, of Krafft and Diener, 1909, p. 17, pl. 2, figs. 4a–d). *Koninckites kraffti* is a little more involute and inflated and apparently has more pronounced ventral shoulders than *K. columbianus. Koninckites kraffti* is from the *"Meekoceras"* beds of the Himalayas, of Gyronitan age. *Koninckites kyokticum* (Krafft), also from the Himalayas, but of uncertain exact position, resembles *K. columbianus* in whorl section and mode of coiling, but *K. kyokticum* has a narrow, ophiceratid external lobe and a more compressed shell. *Koninckites kraffti* and *K. kyokticum,* like *K. columbianus*, are excentrumbilicate. *"Meekoceras" hodgsoni* Diener, also from the Himalayas, is probably also related. The suture lines of *"Meekoceras" hodgsoni* seems to be identical with that of *K. columbianus*, but *"M." hodgsoni* has a truncate periphery, and this feature led Spath (1934, p. 96) to assign it to *Prionolobus.* All the species mentioned above have a distinctive

depressed second lateral saddle, with a flat top, a feature shared with *Discophiceras subkyokticum* (Spath) (Spath, 1930, p. 27).

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway, Tuchodi Lakes map-area, British Columbia (GSC locality 42372; E. T. Tozer, 1960).

Family PROPTYCHITIDAE

Genus *Proptychites* Waagen 1892

Type species: *Ceratites lawrencianus* de Koninck

Spath (1934, p. 166) considered that inflation of the inner part of the whorl sides was a leading feature of *Proptychites*, despite the fact that *P. lawrencianus*, the type species, has an essentially oval whorl section. It now appears that proptychitids in which pronounced thickening of the umbilical region results in whorls that are essentially trigonal in section should be assigned to *Pachyproptychites* Diener. Until recently the name *Pachyproptychites* has been applied only to the unique specimen of *Proptychites otoceratoides* Diener, from the Primorsk region of eastern U.S.S.R. Diener's description of this species was illustrated by drawings that show an elevated umbilical rim and a funnel-shaped umbilicus. In describing the trigonal-whorled *Proptychites strigatus* Tozer, the writer mentioned the superficial similarity with *Pachyproptychites otoceratoides,* but the absence of the distinctive rim and umbilicus, shown on Diener's illustration, seemed to exclude the possibility that *P. strigatus* was congeneric with *P. otoceratoides*. In a recent paper by Popow (1961) a new species of *Pachyproptychites* is described. This species, *P. turgidum* Popow, lacks the raised umbilical rim and *Otoceras*-like umbilicus shown on Diener's illustrations of *P. otoceratoides*. Popow's assignment of his new species to *Pachyproptychites* led to the suspicion that Diener's drawing might be incorrect. In response to a request by the writer, Madame L. Kiparisova of the Geological Institute, Leningrad, has kindly provided a description of the original of *Pachyproptychites otoceratoides*. In a letter to the writer she states:

"Original of *Pachyproptychites otoceratoides* Dien. is depicted not quite correct. Umbilicus of original is of bad preservation and filled by rock, the elevated umbilical rim is absent and whorl section is the same as the *Proptychites strigatus* shells. . . ." Madame Kiparisova considers that *Proptychites strigatus* is congeneric with *Pachyproptychites otoceratoides*.

The new species described below have the arched venter and more or less oval whorl section of *Proptychites* but in other respects these species are not typical representatives of the genus. *Proptychites mulleri* n. sp. is unusually evolute. The loose coiling and arched periphery of this species are reminiscent of the Ophiceratidae but the characters of the suture line; namely, a wide external lobe, prominently toothed lateral lobes, and auxiliary teeth of high amplitude certainly exclude *Proptychites mulleri* from that family. The distinctive suture lines of the ophiceratids (*see* Spath, 1934, pp. 124, 253) have narrow, feebly

incised branches on the external lobe; delicately incised lateral lobes, with round bases; and an equally delicately serrated suspensive lobe, lacking the sharp auxiliary teeth of the paranoritids and proptychitids. Newly obtained collections from the Arctic Islands include some unusually well preserved large ophiceratids, up to 120 mm in diameter. On these specimens the maximum height of the auxiliary teeth, on the last septum, is 0.5 mm. On *Proptychites mulleri* the auxiliary teeth are at least 2.5 mm high at a comparable whorl height. *Proptychites newelli* n. sp. and *P. kummeli* n. sp. have narrow external lobes, like the ophiceratids. However, the well-defined auxiliary lobe of *P. newelli* clearly excludes this species from the Ophiceratidae. *P. kummeli* has more convex whorls than any ophiceratid of comparable involution. Each of these three species, in its own way, seems to be a "passage form" linking the proptychitids with the ophiceratids. This suggests that several stocks of *Ophiceras* were ancestral to the host of proptychitids and paranoritids that occur in the overlying formations.

Proptychites mulleri n. sp.

Plate II, figures 1a–d

Diagnosis. Very evolute (umbilicus 31 per cent of diameter), rather compressed, *Proptychites* with a moderately prominent, nearly vertical, umbilical wall. Umbilical shoulder rounded; whorl sides flat near the umbilicus and gradually arching towards the siphonal area, with no trace of ventral shoulders. Surface sculptured with growth lines and faint spiral sculpture. Suture line with broad external lobe; high, narrow, deeply incised lateral lobes and a second lateral saddle with an ill-defined inner boundary.

Dimensions

Specimen	Locality	D	H	W	U
14268 holotype	42372	at 35	16 (0.45)	13 (0.38)	11 (0.31)
		at 72	28.5(0.40)	21 (0.29)	22 (0.31)
		at 132	54 (0.41)	36 (0.27)	40 (0.30)

Description. This species is represented by one specimen from the Dunedin River concretion.

A quarter whorl of body chamber is preserved. The last few septa are not very well displayed but the last septum is definitely approximated. The specimen was probably approaching, or had reached, maturity.

The test is 0.8 mm thick where preserved at the periphery of the outer whorl. Sculpture consists of growth lines, with, at the periphery, obscure spiral lines as well. The growth lines are rursiradiate (45 degrees) on the umbilical wall; at the umbilical shoulder they bend adorad and follow an essentially radial course.

Most of the external suture may be seen, although no single line has been

traced (Pl. II, fig. 1d). The ventral lobe is clearly seen near the end of the phragmocone, at a whorl height of 43 mm; it is broad and rather deeply incised. The first lateral lobe is high and narrow, with deep incisions. The inner side of the second lateral saddle is not well differentiated from the suspensive lobe. This rather unusual feature is shown clearly on both the outer and penultimate whorls. The serrations of the suspensive lobe are prominent but there are no individualized auxiliary lobes.

This species is named for Professor Siemon W. Muller, of Stanford University, California.

Comparisons. The very wide umbilicus distinguishes *P. mulleri* from all the Salt Range *Proptychites* species that are known from complete specimens. *Proptychites magnumbilicatus* (Waagen, 1895, p. 173, pl. 19, figs. 1a–c), based on a single fragment of less than a quarter whorl, was estimated by Waagen to be 30 per cent umbilicate. Whether or not Waagen's estimate is correct, *P. magnumbilicatus* has relatively inflated whorls, and a high second lateral saddle, unlike *P. mulleri*. *Proptychites latumbilicatus* Chao (1959, p. 234, pl. 19, figs. 2, 3) from Western Kwangsi, China, shares the wide umbilicus of *P. mulleri* but has more inflated whorls. *Proptychites candidus* Tozer from Axel Heiberg Island has a similar whorl section and a fairly open umbilicus, but *P. candidus* has a distinctive suture line, with a narrow external lobe. Of the *Proptychites* species described from the Primorsk region (Eastern U.S.S.R.) (Kiparisova, 1961), none resembles *P. mulleri*.

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway (GSC locality 42372; E. T. Tozer, 1960).

Proptychites newelli n. sp.

Plate I, figures 4a–d

Diagnosis. Rather evolute, thin-whorled *Proptychites*. Umbilical wall high and vertical, umbilical shoulder abruptly rounded. Whorl sides feebly inflated, thickest near the umbilical shoulder. Periphery arched. Inner whorls with widely spaced, slightly rursiradiate, folds. Surface of test with obscure spiral sculpture. Suture line with narrow external and lateral lobes and a well-defined auxiliary lobe below the umbilical shoulder.

Types and Dimensions

Specimen	Locality	D	H	W	U
14270 holotype	42372	at 22.5	10 (0.44)	8 (0.35)	5 (0.22)
		at 60	27 (0.45)	18.5(0.31)	15 (0.25)
14271 paratype	42372	at 32	14 (0.44)	12 (0.37)	8 (0.25)
		at 73	31 (0.42)	25 (0.34)	20 (0.27)

Description. The holotype is moderately well preserved. It is mainly steinkern with small fragments of the test adhering. It is broken and can be studied from a diameter of 22 mm to 60 mm. The well-preserved part is entirely phragmocone. The position of what appears to be the last septum is shown on Plate I, figure 4a. At 22 mm the whorl has five distinct, slightly rursiradiate, plications. At a whorl height of 28 mm (diameter of 60 mm) these plications have disappeared completely. Growth lines appear to be essentially radial on the whorl side and periphery. The paratype shows the test at a whorl height of 25 mm; fine spiral sculpture is present with eight spiral lines in 5 mm on the venter. The holotype also shows obscure spiral sculpture. The suture line is known only below the umbilical shoulder. The surface of the septum is shown on the holotype at a whorl height of 13 mm. Apparently there is only one pronounced auxiliary lobe and saddle; the remainder of the umbilical lobe is incised with the usual proptychitid saw-tooth auxiliaries.

This species is named for Dr. Norman D. Newell of the American Museum of Natural History.

Comparisons. Several species of *Proptychites* with plicated whorls have been described but none agrees closely with *P. newelli. Proptychites undatus* Waagen (1895, p. 180, pl. 24, figs. 4a, b) from the Ceratite Marls of the Salt Range is more compressed and has prorsiradiate folds. *P. plicatus* Waagen (1895, p. 182, pl. 24, figs. 3a, b) from the Ceratite Sandstone, founded on a single specimen 26 mm in diameter, has the following proportions: D. 26; H. 46%; W. 33%; U. 27%; proportions that are close to those of *P. newelli.* However, the folds of *P. plicatus* are more numerous and show an adorad falciform flexure, unlike the straight folds of *P. newelli. Eoptychites evolutus* Spath (1934, p. 178; Diener, 1895, pl. 17, figs. 3a–c) from the Himalayas is more evolute and has plications at a larger diameter than *P. newelli.*

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway, Tuchodi Lakes map-area, British Columbia (GSC locality 42372; E. T. Tozer, 1960).

Proptychites kummeli n. sp.

Plate I, figures 1–3

Diagnosis. Compressed *Proptychites*, with a vertical umbilical wall, rounded umbilical shoulder and feebly convex whorl sides. Whorls are widest just below the umbilical shoulder; venter arched. Suture line with narrow ventral lobe, rather feebly incised lateral lobes and an ill-defined boundary between the lateral and suspensive lobes. Suspensive lobe with numerous small auxiliaries.

Types and Dimensions

Specimen	Locality	D	H	W	U
14272 holotype	42372	32	15 (0.47)	10 (0.31)	6.5 (0.20)
14273 paratype	42372	at 32	15 (0.47)	11 (0.34)	6 (0.19)

Description. This specimen is known from two well-preserved specimens. The smaller specimen (the holotype) is entirely septate; the larger one, which attains a diameter of 38 mm, is probably also entirely phragmocone. The collection also includes a third specimen, No. 14274 (Pl. I, figs. 3a, b), representing the remains of an individual about 65 mm in diameter. This specimen is slightly crushed. The periphery appears to be proportionately wider than that of the small specimens but it is tentatively assigned to *Proptychites kummeli.*

Comparisons. A specimen from the Dinwoody Formation of Montana, described by Newell and Kummel (1942, p. 959, text fig. 4, pl. 2, fig. 6) as *Ophiceras* (*Discophiceras*) *subkyokticum* Spath, is probably conspecific with *P. kummeli.* The suture line of the Montana specimen shares the narrow external lobe and the distinctive suspensive lobe of *P. kummeli.* The whorl section of the Montana specimen also appears to be identical with that of *P. kummeli.* Specimens of *Discophiceras subkyokticum* from Greenland have nearly flat whorl sides, compressed whorls, and a narrowly rounded venter and do not closely resemble either *P. kummeli* or the specimen from Montana. The similarity between the specimen from Montana and *P. kummeli* may be of stratigraphic importance.

Proptychites mulleri n. sp. has a suspensive lobe like that of *P. kummeli.* However, the very wide umbilicus of *P. mulleri* is known to have been established at a diameter of 35 mm and this seems to dismiss the possibility that *P. kummeli* represents immature examples of *P. mulleri.*

In the Himalayan fauna *"Meekoceras" solitarium* von Krafft (1909, p. 52, pl. 3, figs. 1a–e), from the *"Hedenstroemia"* beds of Spiti, is probably closest to *P. kummeli.* Spath (1934, p. 158) considered that *"M." solitarium* represented a passage form between *Proptychites* and *Kingites. P. solitarium* shares the distinctive suspensive lobe of *P. kummeli*; also the ventral lobe is narrow, as on *P. kummeli.* However the ventral lobe of *P. solitarium* is unusually shallow. *P. solitarium* is also more compressed and has a different whorl section.

Some of the Salt Range proptychitids, such as *P. discoides* Waagen (1895, p. 174, pl. 20, figs. 1, 2) from the Lower Ceratite Limestone, and *P. Khoorensis* Waagen (1895, p. 176, pl. 20, figs. 4a–c) from the basal Ceratite Marls, have compressed whorls like *P. kummeli.* However these Salt Range species have wide, serrated, external lobes, unlike *P. kummeli. Proptychites aberrans* Waagen (1895, p. 179, pl. 10, figs. 2a–d), from the Ceratite Sandstone, has a simple external lobe but the inflated whorls immediately distinguish it from *P. kummeli. "Meekoceras" koninckianum* Waagen (1895, p. 245, pl. 26, figs. 6a–d), based on a single phragmocone from the Ceratite Marls, may be related to *P. kummeli.* Like *P.*

kummeli, "M." koninckianum has a narrow external lobe. The suspensive lobe of *"M." koninckianum* is said to be smooth, but this may be due to weathering. Although the sutures may be the same, *"M." koninckianum*, with proportions D. 45; H. 47%; W. 27%; U. 22%, is more evolute and compressed than *P. kummeli.*

A case might be made for assigning *Proptychites kummeli* to the subgenus *Discoproptychites* Kiparisova (type species, *Proptychites walcotti* Hyatt and Smith, from the upper Scythian of California). However, *Discoproptychites walcotti* has narrow, almost phylloid saddles, unlike those of *P. kummeli,* and appears to be transitional between *Proptychites* s.s. and the uppermost Scythian *Proptychitoides.*

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway, Tuchodi Lakes map-area, British Columbia (GSC locality 42372; E. T. Tozer, 1960).

Proptychites cf. *P. candidus* Tozer

Plate III, figures 1–3

Specimens and Dimensions

Specimen	Locality	D	H	W	U
14284	48848	102	44 (0.43)	37 (0.36)	24 (0.23)
14285	48847	at 81	38 (0.47)	31 (0.38)	18 (0.22)
14286	48848		70	57	

The collection from Mount Laurier includes three specimens that in whorl section and involution appear to be very close to *Proptychites candidus* Tozer (1961b, p. 57, pl. 11, figs. 1a–c), which occurs in beds of Gyronitan or Flemingitan age on Axel Heiberg Island. The Mount Laurier specimens at diameters of 81 mm and 102 mm agree closely in inflation with the holotype at 61 mm. Specimens of *P. candidus* that exceed a diameter of 100 mm are not known to have a proportional width more than 30 per cent of the diameter. The species from Mount Laurier thus appears to be rather more inflated than the types of *P. candidus.* Unfortunately, the Mount Laurier specimens, perfectly preserved in all other respects, do not show the septal sutures. No. 14284 shows what appears to be the last first lateral saddle, on the boundary between matrix-filled body chamber and the coarsely crystalline phragmocone. This saddle is rounded but none of the lobes is visible. The lack of septal sutures prevents definite identification. The Mount Laurier specimens show faint spiral sculpture on the outermost layer of the test. This feature is not known on the types of *P. candidus* for they do not show the surface of the test. The surface of the steinkern of *P. candidus* and also the specimens from Mount Laurier are perfectly smooth.

Occurrence. "Toad-Grayling Formation", 40 feet above top of Permian, 3 miles south of Mount Laurier, Halfway River area, British Columbia (GSC locality 48847; Shell Oil Company 1960).

"Toad-Grayling Formation", 70 feet above top of Permian, 3 miles south of Mount Laurier, Halfway River area, British Columbia (GSC locality 48848; Shell Oil Company, 1960).

Genus *Dunedinites*, new

Type species: *Dunedinites pinguis* n. sp.

Diagnosis. Unsculptured, moderately involute, thick-whorled ammonoids with depressed, kidney-shaped whorl section, a steep sided umbilicus, abruptly rounded umbilical shoulder and a short (half whorl) body chamber. Sutures ceratitic with relatively narrow, incised, external lobe, and two large moderately incised lateral lobes. Suspensive lobe imperfectly known, partly, and probably entirely incised with feebly individualized auxiliaries.

Age. Lower Triassic, lower Scythian (Induan), probably Gyronitan.

Ammonoids with thick depressed whorls are rare in lower Scythian deposits and there are very few species that resemble *Dunedinites*. The rare genus *Anotoceras*, known only from the *Otoceras* zone of the Himalayas, has some similarities. The type species of *Anotoceras* is *Prosphingites nala* Diener (1897, p. 54, pl. 1, fig. 4, pl. 7, figs. 13a–c). The inner whorls of *Anotoceras nala* have an arched periphery, like those of *Dunedinites*. According to Diener's description, but not apparent from the drawing that accompanies his report, the outer whorl of *A. nala* has "a very obtuse, marginal ridge", a feature not shown by *Dunedinites*. Only one other species of *Anotoceras* has been described. This is *A. kama* Diener, which was obtained from the same locality as *A. nala*. *A. kama* has a sharp, slightly elevated, possibly keeled ridge upon the venter. Diener believed that *A. nala* and *A. kama* were closely related. If he was right, and he probably was as these species occur together, it seems probable that the angular venter is a diagnostic feature of *Anotoceras*. The type specimen of *Dunedinites pinguis* is apparently adult and shows no trace of an angular venter. The umbilical margin of *Anotoceras nala* is described as perfectly sharp, unlike the abruptly rounded umbilical shoulder of *Dunedinites*. The sharp umbilical rim and angular periphery of *Anotoceras* led Hyatt and Spath to relate this genus to the Otoceratidae. The absence of these features excludes *Dunedinites* from *Anotoceras* and from the Otoceratidae. It may also be significant that the holotype of *Anotoceras nala* is said to have a full whorl of body chamber. The full length of the *Dunedinites* body chamber is apparently one half whorl.

There is some resemblance between *Dunedinites* and certain Paranannitidae, a mainly upper Scythian family. *Paranannites* Hyatt and Smith has a different suture, with no auxiliary lobes outside the umbilical seam. The inner whorls of *Paranannites* also have constrictions, unknown, and probably absent, in *Dunedinites*.

The type species of *Prosphingites, P. czekanowskii* Mojsisovics, has an unincised suspensive lobe and is markedly macrodome, with at least 1¼ whorls on body chamber. The inner whorls are globose and the outer whorl has a more or less sharp edge. *Prosphingites czekanowskii* is therefore quite distinct from *Dunedinites*. *Prosphingites spathi* Frebold, from the upper Scythian of Spitsbergen and Ellesmere Island has a suture line rather like that of *Dunedinites*, but *P. spathi has* constricted whorls and at least one whorl of body chamber. The constrictions, auxiliary lobes and rounded periphery of *P. spathi* distinguish it from *P. czekanowskii*, and the writer is no longer satisfied that these species are congeneric.

The suture line of *Dunedinites*, as far as known, seems to be that of a primitive Triassic ceratitid with an unusually large second lateral lobe and is easily related to that of the ancestral Ophiceratidae. The short body chamber of *Dunedinites* is also an ophiceratid character. Both the suture line and short body chamber distinguish *Dunedinites* from Paranannitidae. *Dunedinites* may be regarded as an early, semiglobose development, analogous to the Paranannitidae but retaining the primitive suture line and short body chamber. The thick whorls and arched periphery of *Dunedinites* probably indicate affinity with *Proptychites*.

Dunedinites pinguis n. sp.

Plate I, figures 6, 7

Diagnosis. See generic diagnosis.

Types and Dimensions

Specimen	Locality	D	H	W	U
14288 paratype	42372	at 10	5 (0.50)	6 (0.60)	2 (0.20)
		at 22	9 (0.41)	14 (0.64)	6 (0.27)
		at 40	16 (0.40)	23 (0.57)	12 (0.30)
14287 holotype	42372	54	21 (0.39)	26 (0.48)	18 (0.33)

Description. This species is represented by two specimens. The holotype is septate to within half a volution of the aperture. At the aperture the steinkern is slightly, but distinctly flared. The specimen is therefore probably complete and adult. The septa are visible for about the last quarter whorl of the phragmocone. The septa do not show appreciable approximation. The paratype has been sectioned to show the whorl section (Pl. I, fig. 7). The whorls are kidney shaped in section, and the outer part forms a perfect arch. The umbilical wall is flat and steeply inclined to vertical; umbilical shoulders are rounded. The surface of the test is partly preserved on the holotype. Sculpture consists of delicate growth lines only. The surface of the steinkern is perfectly smooth. The growth lines are rursiradiate (45 degrees) on the umbilical wall. The aperture shows a slightly adorad projection at the periphery.

The external suture, beyond the umbilical shoulder, is well shown by the holotype (Pl. I, fig. 6d). The suture line on the umbilical wall has not been seen.

Comparisons. *See* discussion of genus.

Occurrence. Grayling Formation, 117 feet above base, Dunedin River, 4½ miles north of mile 384, Alaska Highway, Tuchodi Lakes map-area, British Columbia (GSC locality 42372; E. T. Tozer, 1960).

Family PARANANNITIDAE

Genus *Juvenites* Smith 1927

Type species: *Juvenites kraffti* Smith

Juvenites needhami n. sp.

Plate V, figures 1–5

Diagnosis. Relatively compressed *Juvenites* attaining a diameter of at least 17 mm. Umbilical wall vertical or steeply inclined; umbilical shoulder abruptly rounded, whorl sides flat, periphery broadly arched, ventral shoulders rather distinct. Inner whorls with constrictions, outer whorls with rather irregular costae. Suture line with very delicately serrated lateral lobes.

Types and Dimensions

Specimen	Locality	D	H	W	U
14291 paratype	48850	10	4 (0.40)	5 (0.50)	2.5 (0.25)
14289 paratype	48850	at 13	5 (0.38)	6 (0.46)	3.5 (0.27)
14292 holotype	48850	at 12.5	5 (0.40)	5.5 (0.44)	3.5 (0.28)
14290 paratype	48850	at 14	6 (0.43)	8 (0.57)	3.5 (0.25)
14293 paratype	48850	17	7.5 (0.44)	8 (0.47)	5 (0.29)

Description. Ten fairly well preserved specimens are known. The holotype is a phragmocone with half a whorl of body chamber. The maximum diameter of the phragmocone is about 9 mm. The last septa show slight progressive approximation. With a whorl of body chamber this specimen would have been about 17 mm in diameter, and this is the diameter of the largest specimen known (paratype 14293). Unfortunately most of the specimens do not show sutures and it is not possible to confirm that the outer whorl of the larger specimens is entirely body chamber. Proportional width varies from 44 per cent of the diameter to 57 per cent. The inner part of the umbilical wall, on all specimens, is essentially vertical. The outer part curved abruptly to form a rather prominent umbilical shoulder. Paratype No. 14290 shows a deep, perfectly radial constriction at a diameter of about 4 mm. Constrictions are not known at larger diameters. The outer whorls

show delicate growth lines and low folds. Growth lines are rursiradiate on the umbilical shoulder; on the whorl sides and venter the growth lines and folds have slight adorad projection. The folds are rather more prominent at the umbilical shoulder than on the outer part of the whorls. On paratype 14293 there are about twenty folds on the outer whorl. The inflated paratype (No. 14290) is entirely steinkern; this specimen shows more pronounced folds, five in the last half whorl, than the relatively compressed variants.

Sutures are clearly shown by only two specimens (*see* Pl. V, fig. 4c). There are two delicately serrated lobes between the umbilical seam and the ventral lobe. The ventral lobe shows one small incision. The septal surfaces of paratype 14290 reveal a single internal lateral lobe.

Comparisons. *Juvenites needhami* is probably closely related to *J. sanctorum* Smith (1932, p. 110, pl. 31, figs. 22–27) from the *Meekoceras* zone of Idaho. The proportions of the type of *Juvenites sanctorum* (D. 13.7; H. 44%; W. 45%; U. 25%) fall within the range shown by *J. needhami* but the suture lines of the two species show differences. On *J. sanctorum* the lobes appear to be smooth, unlike the serrated lobes of *J. needhami.* On *J. sanctorum* the lobe situated on the umbilical shoulder is relatively shallow; on *J. needhami* the corresponding lobe is very deep. The specimens of *J. hindostanus* (Diener) figured by Krafft and Diener (1909, p. 139, pl. 27, figs. 8a, b, 9a, b) from the "*Hedenstroemia* beds" of the Himalayas are probably very close to *J. needhami* but the ventral shoulders of the Himalayan species appear to be less distinct.

Occurrence. 1. "Toad-Grayling Formation", 180 feet above the top Palæozoic exposures, Needham Creek, 2 miles west of junction with Graham River, Halfway River map-area, British Columbia (GSC locality 48850; Shell Oil Company, 1960).

2. Locality and sections as (1), 140 feet above top Palæozoic exposures (GSC locality 46471; B. R. Pelletier, 1961).

The preservation and matrix of the fossils from these collections is identical.

Family Meekoceratidae

Genus *Arctoceras* Hyatt 1900

Type species: *Ceratites polaris* Mojsisovics 1886, a subjective junior synonym of *Ceratites? blomstrandi* Lindström 1865 (Kummel, 1961, p. 500).

Arctoceras cf. *A. blomstrandi* (Lindström)

Plate V, figure 6

A single crushed specimen (GSC No. 14294) from Needham Creek has the distinctive sculpture shown by a well-preserved specimen from Ellesmere Island, determined by the writer as *Arctoceras oebergi* (Mojsisovics) (Tozer, 1961b, p. 68, pl. 15, figs. 5a, b). Kummel (1961) has revised the taxonomy of the Spitsbergen arctoceratids and regards all the named species (of which *A. oebergi* is

one) as variants of one species, namely *Arctoceras blomstrandi*. The distinctive sculpture shared by the Needham Creek and Ellesmere specimens consists of spiral rows of delicate pits and elevations. These small pits and projections have a radial orientation, and they might be termed miniature bullae. On parts of the shell, particularly on the venter, the pits are more or less fused together to form raised spiral ridges. The umbilical shoulder of both specimens shows rather delicate, bullate, tubercles. The close correspondence in sculpture leaves little doubt that the Needham Creek and Ellesmere specimens are conspecific, but as the former lacks the suture line a positive identification is not proposed. Dr. Kummel has kindly provided a plaster replica of the holotype of *"Arctoceras oebergi"*. Parts of the test of this specimen show the radial sculpture described above.

Occurrence. "Toad-Grayling Formation", 140 feet above Triassic-Palæozoic contact, Needham Creek, 2 miles west of junction with Graham River, Halfway River area, British Columbia (GSC locality 46471; B. R. Pelletier, 1961).

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Part II

LIARDITES AND *MACLEARNOCERAS,* NEW TRIASSIC AMMONOIDS FROM THE *NATHORSTITES* ZONE OF NORTHEASTERN BRITISH COLUMBIA

Abstract

Two new ammonoids, *Liardites whiteavesi* n. gen., n. sp., and *Maclearnoceras maclearni*, n. gen., n. sp., are described from the *Nathorstites* zone (Ladinian) of Liard River, British Columbia. *Liardites* is assigned to the Trachyceratidae. The systematic position of *Maclearnoceras* is uncertain but this genus is tentatively assigned to the same family.

Résumé

L'auteur décrit deux nouveaux genres et espèces d'ammonoïdes, *Liardites whiteavesi* et *Maclearnoceras maclearni,* trouvés dans la zone à *Nathorstites* (d'âge Ladinien) dans la région de la rivière aux Liards (Colombie-Britannique). Le *Liardites* fait partie des Trachyceratidae. On ne sait pas au juste où placer le genre *Maclearnoceras,* mais on le classe provisoirement dans la même famille.

INTRODUCTION

The ammonoids now known as *Nathorstites* were first collected by R. G. McConnell, in the course of his descent of Liard River, in 1887. Since that time *Nathorstites* has been discovered in several Arctic areas, namely, Bear Island, Spitsbergen, Kotelnyi Island, northeastern Siberia, the Canadian Arctic Islands, and possibly also Alaska (*see* Tozer, 1961b, p. 34, for full references). In 1917, F. H. McLearn discovered the rich *Nathorstites* locality at Beattie Ledge, on Peace River, and in several papers he has described ammonoids from the *Nathorstites* zone of this, and other localities in northeastern British Columbia (McLearn, 1930, 1937a, b, 1943, 1947). During the last few years collections from new localities have been obtained, and study of this material is now in progress. This study has already revealed the presence of two distinctive ammonoids that apparently represent new genera. These ammonoids, *Liardites* and *Maclearnoceras*, were obtained from a section on Liard River, 3 miles upstream from Hades (Hell) Gate, and they are described below. *Liardites* and *Maclearnoceras* were found in association. Other members of the associated fauna include *Protrachyceras* cf. *P. archelaus* (Laube), *Anolcites* sp., *Clionitites*? sp. and *Nathorstites* sp. Typical examples of *Nathorstites mcconnelli* (Whiteaves) were collected 150 feet above the bed with *Liardites*, etc. The new ammonoids thus appear to be from the lower part of the *Nathorstites* zone. This zone is relatively thick in northeastern British Columbia; on Peace River the thickness is about 400 feet (McLearn, 1947, p. 4). The age of the *Nathorstites* fauna has been discussed recently by McLearn (1947) and Tozer (1961a, p. 34; 1961b). There appears to be little doubt that this fauna is of Ladinian age, not Karnian, as formerly believed.

[1] Names and/or dates in parentheses are those of References, p. 38.

SYSTEMATIC PALÆONTOLOGY

AMMONOIDEA

Family TRACHYCERATIDAE

Genus *Liardites*, new

Type species: *Liardites whiteavesi* n. sp.

Diagnosis. Relatively evolute trachyceratid with non-tuberculate, falcoid ribs, most of which bifurcate between the ventral shoulder and the ventral furrow. The divided ribs, adjacent to the ventral furrow, are no more elevated than on the whorl sides; *Liardites* thus lacks the ventral keels of the sirenitids. Suture line ceratitic.

Comparisons. The ribs on *Liardites*, which divide near the ventral furrow, invite a comparison with certain Upper Triassic sirenitids, particularly *Sirenites* Mojsisovics 1893 and *Striatosirenites* Popow 1961. Although the manner of rib division near the venter is similar, there are nevertheless differences between the venters of *Liardites* and those of these sirenitids. On *Sirenites* and *Striatosirenites* the ventral furrow is bordered by raised tuberculate keels and the tubercles on these keels outnumber the ribs at the ventral shoulder. The lateral ribs are tuberculate. On *Liardites* the ribs are smooth all the way from the umbilical shoulder to the ventral furrow. Where the ribs divide near the ventral furrow they are not elevated. In no sense can the rib terminations of *Liardites* be described as tuberculate. On all true sirenitids the whorl section, at the venter, is abruptly interrupted on both the inner and outer sides of each ventral keel. On *Liardites* the ribs simply bend at the ventral shoulder and are interrupted only at the ventral furrow. Both *Sirenites* and *Striatosirenites* have ammonitic suture lines, unlike *Liardites*.

The smooth ribs of *Liardites* suggest affinity with another trachyceratid genus, namely *Paratrachyceras* Arthaber 1915 (type species *Trachyceras hofmanni* Boeckh). According to Mojsisovics (1882, p. 135), *Paratrachyceras hofmanni*, like *Liardites*, lacks ventral tubercles and raised ventral keels. However, *P. hofmanni* and its close allies do not show the ventral rib division of *Liardites* and *Sirenites*. *P. hofmanni* also differs from *Liardites* in having an ammonitic suture line.

The taxon *Meginoceras* McLearn 1930 (type species *Paratrachyceras* (*Meginoceras*) *meginae* McLearn) must also be considered. In 1930 McLearn regarded *Meginoceras* as a subgenus of *Paratrachyceras*; later on he (McLearn, 1937b, p. 128) treated it as a subgenus of *Sirenites*. Spath (1951, p. 42) assigned *Meginoceras meginae* to *Paratrachyceras*. However, *Meginoceras*, as stressed by McLearn (1953), shows a beginning of the characteristic nature of *Sirenites*, namely splitting of the ribs near the venter. *Meginoceras* also has raised keels, like *Sirenites*. Neither of these characters is shown by *Paratrachyceras hofmanni*. *Meginoceras* lacks the lateral tuberculation and ammonitic suture line of *Sirenites*.

The writer believes that *Meginoceras* should be retained, at least as a subgenus, for the reception of ammonoids with sculpture intermediate between that of *Paratrachyceras* and *Sirenites*. Although *Meginoceras* and *Liardites* share ventral rib-splitting, lack of tuberculation and ceratitic suture lines, the former differs from *Liardites* in the possession of *Sirenites*-like ventral keels.

Liardites whiteavesi n. sp.

Plate VI, figures 6–8

Diagnosis. *Liardites* with falcoid ribs which are flat and unbranched on the whorl side, these ribs show frequent bifurcation at the ventral shoulder.

Types and Dimensions

Specimen	Locality	D	H	W	U
14300 paratype	42355	25	10 (0.40)	8 (0.32)	8 (0.32)
14301 paratype	42355	30	11.5(0.38)	8 (0.27)	10 (0.33)
14302 holotype	42355	44	16 (0.36)	11 (0.25)	16 (0.36)

Description. The collection includes eight specimens, three of which are sufficiently complete to provide measurements.

The holotype has a maximum diameter of 45 mm and is septate, with approximated septa, to within half a whorl of the aperture. The umbilicus has steep sides. The umbilical shoulder is abruptly rounded on the surface of the test and angular on the steinkern. Where the shell is well preserved, on the initial part of the last whorl, sixteen ribs on the whorl side produce twenty-five ribs adjacent to the ventral furrow. Paratype 14301 (Pl. VI, figs. 8a, b), between whorl heights of 7.5 and 9 mm, has ten ribs on the side and fifteen on the venter. One paratype, No. 14300 (Pl. VI, figs. 7a, b), has ribs that are much broader than those of the holotype. On this specimen ten lateral ribs produce twenty adjacent to the ventral furrow. Specimen 14300 might be interpreted as a different species but it was obtained from the same locality as the holotype, and is provisionally interpreted as a coarsely sculptured variant. Entire saddles are shown by several specimens but none shows a complete external suture line. The external lobe is shown by the holotype (Pl. VI, fig. 6d) and paratype 14301 shows the lateral lobes (Pl. VI, fig. 8c).

This species is named in memory of Dr. J. F. Whiteaves, who was the first to describe Triassic fossils from British Columbia.

Comparisons. *See* discussion of the genus.

Occurrence. Liard Formation, from nodules between 294 and 298 feet below top of formation, Liard River, north side, 3 miles upstream from Hades (Hell) Gate, latitude 59°16′30″N, longitude 125°18′00″W, Toad River area, British Columbia. GSC locality 42355, E. T. Tozer, 1960. The rock succession at this locality has been described by Pelletier (1961, p. 25).

Genus *Maclearnoceras*, new

Type species: *Maclearnoceras maclearni* n. sp.

Diagnosis. Moderately involute platycones with ceratitic suture line, tuberculate inner whorls, and dense, smooth ribs on the outer whorls. The ribs on the outer whorls branch at the umbilical shoulder and on the whorl side, and pass over the arched venter with adorad projection, but no interruption.

Remarks and comparisons. Several families of Middle and Upper Triassic ammonoids have ribs that cross the venter but none resembles *Maclearnoceras* closely. The Celtitidae and Choristoceratidae have simple, unbranched ribs and need no further consideration. The genus *Martolites* Diener, from the Norian of the Himalayas, and assigned to the Buchitidae by Spath (1951, p. 79) is superficially similar to *Maclearnoceras* but is distinguished by periodic constrictions and a smooth siphonal band. There is no close resemblance to other Buchitidae; *Buchites* itself has strong, undivided ribs on the whorl side, with secondaries appearing near the venter. There is some resemblance between *Parachrochordiceras* (Acrochordiceratidae) and the inner (but not innermost) whorls of *Maclearnoceras*. The relatively simple suture line of *Maclearnoceras* is quite unlike the phylloid and ammonitic suture lines of Acrochordiceratidae and it seems probable that any resemblance is purely superficial. The ribbing and whorl section of *Maclearnoceras* is rather like that of certain Haloritidae, particularly *Juvavites* Mojsisovics. There are obvious differences however, such as the ammonitic suture line and tight coiling of *Juvavites*. The inner tuberculate whorls are also suggestive of certain Haloritidae, for example *Trachysagenites*, but the later, tuberculate, ribs of *Maclearnoceras* are more suggestive of affinity with *Anolcites* (Trachyceratidae). The Haloritidae appear for the first time in Upper Triassic strata; they have no obvious Middle Triassic forerunners. Spath (1951, p. 113) suggested that the Haloritidae were derived from a smooth stock; the discovery of *Maclearnoceras* in rocks of Middle Triassic age introduces the alternative possibility that the Haloritidae may be connected with the Trachyceratidae. This ammonoid is named for Dr. Frank H. McLearn, of the Geological Survey of Canada.

Maclearnoceras maclearni n. sp.

Plate VI, figures 1–5

Diagnosis. Maclearnoceras with four successive ontogenetic stages. In the first stage (e.g., at 4 mm) the whorls are rounded and sculptured with radially arranged tubercles on barely perceptible ribs. At intermediate stages (stages 2 and 3) the whorl section is unchanged but ribbing appears. Ribbing at these stages is essentially radial on the whorl side and slightly rursiradiate on the venter. Initially (e.g., at 7 mm) the ribs are single and tuberculate (stage 2); they later become smooth with bifurcation near the ventral shoulder (stage 3). On the outer whorls (stage 4), at diameters more than 20 mm, the whorls are relatively com-

pressed, with a vertical umbilical wall and a well-defined umbilical shoulder. On these whorls the ribs branch at the umbilical shoulder and again near the middle of the whorl side. Where they cross the venter the ribs are projected, with slightly depressed summits.

Types and Dimensions

Specimen	Locality	D	H	W	U
14295 paratype	42355	at 11	4 (0.36)	5 (0.45)	4 (0.36)
14296 paratype	42355	at 14.5	6 (0.41)	6.5(0.45)	5 (0.34)
14297 holotype	42355	at 41	16 (0.39)	13 (0.32)	14 (0.34)
14298 paratype	42355	at 41.5	17 (0.41)	14 (0.34)	14 (0.34)
14299 paratype	42355	47.5	20 (0.42)		16 (0.34)

Description. This species is known from eight specimens, all obtained from one locality on Liard River. Paratypes 14298 and 14299 attain the maximum known diameter of 48 mm. At this diameter No. 14298 has a body chamber comprising three-quarters of a whorl and a phragmocone with approximated septa.

The earliest stage of sculpture is shown only by No. 14296 (Pl. VI, figs. 4a–c). Half a whorl, about 4 mm in diameter, shows this stage. The whorl sides carry three rows of tubercles, radially arranged. There is no ventral furrow but at the siphonal line the tubercles are more widely spaced (0.5 mm) than on the whorl side (0.25 mm). These tubercles, although radially arranged, are not deployed on well-defined ribs.

The holotype (No. 14297, Pl. VI, figs. 1a–e) has been broken to reveal the inner whorls, and shows the later ontogenetic stages. At a diameter of 6 mm the whorl bears nineteen ribs at the umbilical shoulder and about twenty-three on the venter. Poor preservation prevents an exact count. Initially the ribs are unbranched, on the later part of this whorl they branch once, at the outer edge of the whorl side. These ribs bear small, delicate tubercles, preserved only on the surface of the test, not on the steinkern. There are at least four tubercles on each rib and probably five in all, but exfoliation of the test prevents a complete count. On this whorl the venter is preserved only as steinkern; where the ribs cross the venter they are slightly flattened.

The holotype also shows the half a whorl that attains a diameter of 17 mm. This half whorl bears fifteen ribs at the umbilical shoulder and about thirty at the venter. Branching is still confined to the outer part of the whorl side but is now the rule rather than the exception. The test is well preserved on the whorl side at a height of 6 mm; the ribs are clearly seen to be without tubercles. On the whorl side the ribs are elevated with rounded summits. On the steinkern surface these ribs are more elevated on the whorl side than on the periphery. The whorl section at this stage is still rounded, and the whorl is widest at the middle of the side.

On the holotype the adult condition, with branching of the ribs at the

umbilical shoulder, is first visible at a whorl height of 9 mm (equivalent to a diameter of about 22 mm). Adorad projection of the ribs is first apparent at a whorl height of 10 mm. Between a whorl height of 9 and 12.5 mm (about one-third of a whorl) there are twelve ribs at the umbilical shoulder, twenty-two near the middle of the whorl side and thirty-six on the venter. The ribs on the outer whorls have essentially flat tops, with steep-sided interspaces, unlike the relatively sharp ribs of the inner whorls. The adult whorls are elliptical in section and widest at the umbilical shoulder.

On all steinkerns showing adult sculpture the ribs are more elevated on the whorl side than on the venter. Some steinkerns (e.g., No. 14296, Pl. VI, figs. 4a–c) show a suggestion of bullae where the ribs divide, both on the umbilical shoulder and on the whorl side. Specimens showing the shell surface show no true bullae. Where the ventral part of the adult shell is perfectly preserved the summit of the rib is slightly depressed where it crosses the venter. This feature is shown best by No. 14298 (Pl. VI, fig. 5b) but it is also apparent on No. 14299 (Pl. VI, fig. 2b).

The suture line (Pl. VI, fig. 1d) is ceratitic with a narrow, feebly incised external lobe and relatively broad lateral lobes.

Comparisons. *See* discussion of genus.

Occurrence. Liard Formation, from nodules between 294 and 298 feet below top of formation; Liard River, north side, 3 miles upstream from Hades (Hell) Gate, latitude 59°16′30″N, longitude 125°18′00″W, Toad River area, British Columbia. GSC locality No. 42355, E. T. Tozer, 1960. The rock succession at this locality is described by Pelletier (1961, p. 25).

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PLATES I to VI

PLATE I

(Figures are natural size unless otherwise stated)

All specimens illustrated on this plate are from the Grayling Formation, 117 feet above base, Dunedin River, British Columbia (GSC locality 42372).

Proptychites kummeli n. sp. (Page 20)

Figures 1a–c. Side view (1a), venter (1b), and external suture line (1c, x2) of holotype, GSC No. 14272.

Figures 2a, b. Side view (2a) and venter (2b) of paratype, GSC No. 14273.

Figures 3a, b. Side view (3a) and venter (3b) of GSC No. 14274, tentatively assigned to this species.

Proptychites newelli n. sp. (Page 19)

Figures 4a–d. Side view (4a), arrow indicates position of last septum. Whorl section (4b) from sectioned plaster cast. Inner whorls (4c), showing plications. Figure 4d represents the suture line, x2, below the umbilical shoulder. The auxiliary lobe is incised with five small teeth. All of holotype, GSC No. 14270.

Xenodiscoides cf. *X. radians* (Waagen) (Page 11)

Figures 5a–c. Side view (5a), venter (5b), and part of external suture line (5c, x2). All of GSC No. 14269.

Dunedinites pinguis n. gen., n. sp. (Page 24)

Figures 6a–d. Both sides (6a, b) and apertural view (6c). Figure 6d represents the suture line below the umbilical shoulder (x2); the figure is composite, not determined from a single suture line. All of holotype, GSC No. 14287.

Figure 7. Whorl section of paratype, GSC No. 14288, from cellulose peel of cut specimen.

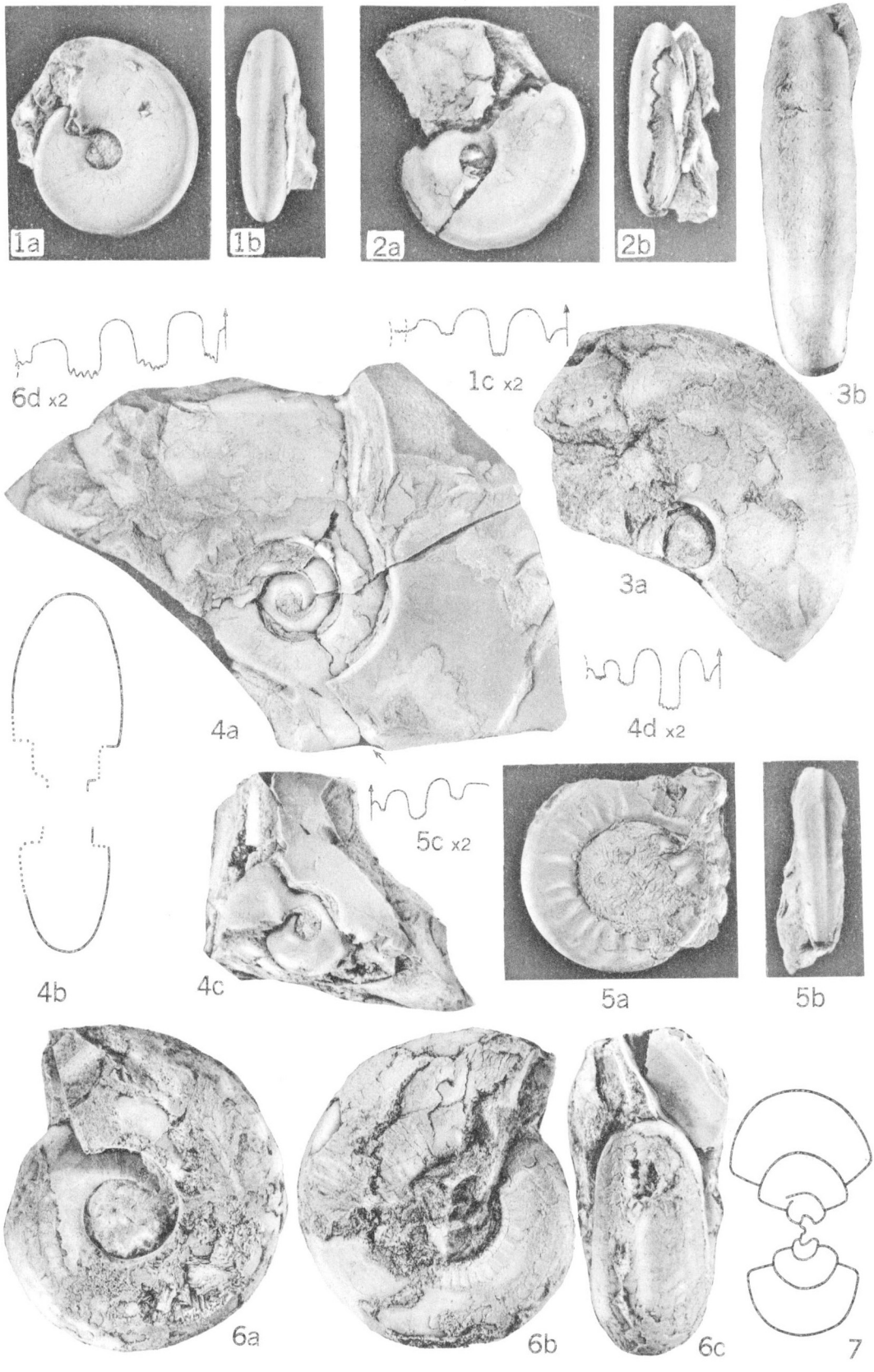

1a
1b
2a
2b
3b
6d x2
1c x2
3a
4a
4d x2
4b
5c x2
4c
5a
5b
6a
6b
6c
7

Plate II

(All figures are natural size)

Proptychites mulleri n. sp. (Page 18)

Figures 1a–d. Side view (1a), the arrow indicates the position of the last septum; venter (1b); and whorl section (1c). The upper part of figure 1c is a natural radial section and reveals the true whorl section. Figure 1d represents parts of the external suture line on the penultimate whorl (lower figure); about half a whorl from the last septum (middle figure) and near the last septum (upper figure). Parts of the suture lines indicated by interrupted lines are imperfectly shown. Holotype, GSC No. 14268, Grayling Formation, 117 feet above base, Dunedin River, British Columbia (GSC locality 42372).

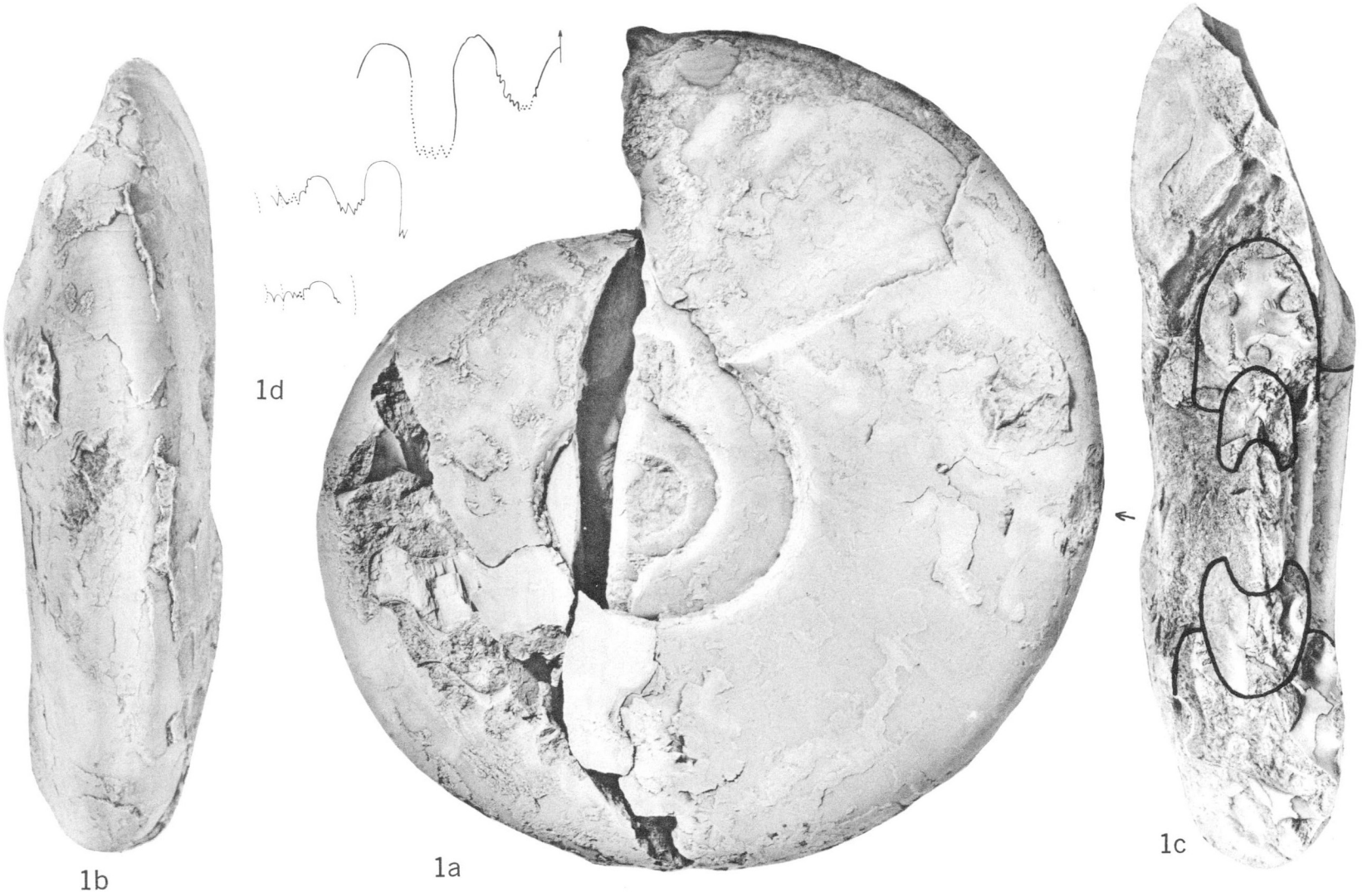

1d
1b
1a
1c

PLATE III

(Figures are natural size)

Proptychites cf. *P. candidus* Tozer (Page 22)

Figures 1a–c. Side (1a) and apertural (1b) views, and venter (1c) of GSC No. 14285, "Toad-Grayling Formation", 40 feet above base, 3 miles south of Mount Laurier, British Columbia (GSC locality 48847).

Figure 2. Side view of GSC No. 14284, "Toad-Grayling Formation", 70 feet above base, 3 miles south of Mount Laurier, British Columbia (GSC locality 48848).

Figure 3. Large fragmentary specimen (GSC No. 14286) showing whorl section, "Toad-Grayling Formation", 70 feet above base, 3 miles south of Mount Laurier. British Columbia (GSC locality 48848).

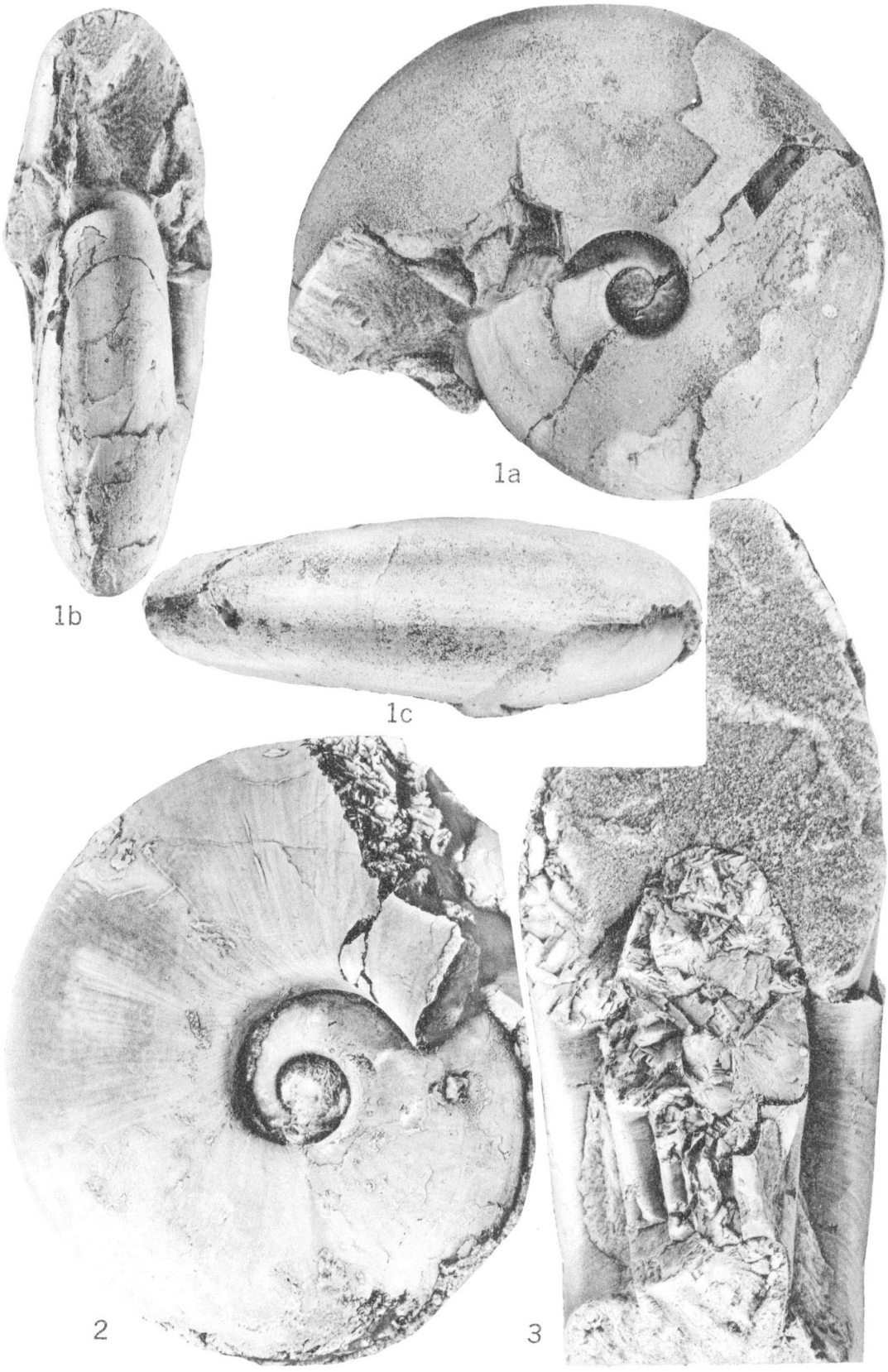

1a
1b
1c
2
3

PLATE IV

(Figures are natural size unless otherwise stated)

Paranorites sverdrupi n. sp. (Page 12)

Figure 1. Side view of the largest specimen known, one half natural size, paratype, GSC No. 14276. Blind Fiord Formation, about 900 feet above base, north side of Otto Fiord, Ellesmere Island (GSC locality 47543).

Figures 2a–d. Side view (2a), whorl section (2b), venter (2c), and suture line (2d, x2) below umbilical shoulder. Figure 2a shows the involute inner whorls and the umbilical seam of the next whorl. All of holotype, GSC No. 14277, horizon and locality as figure 1.

Figure 3. External lobe of paratype, GSC No. 14280, horizon and locality as figure 1.

Figure 4. Suspensive lobe of paratype, GSC No. 14275, horizon and locality as figure 1.

Figures 5a, b. Side view (5a) and venter (5b) of compressed, involute, inner whorls, with pronounced ventral shoulders. GSC No. 14282, "Toad-Grayling Formation", 45 feet above base, Needham Creek, British Columbia (GSC locality 46470).

Figures 6a–c. Side view (6a), whorl section (6b), and venter (6c) of GSC No. 14283, showing perfectly preserved surface of the test, horizon and locality as figures 5a, b.

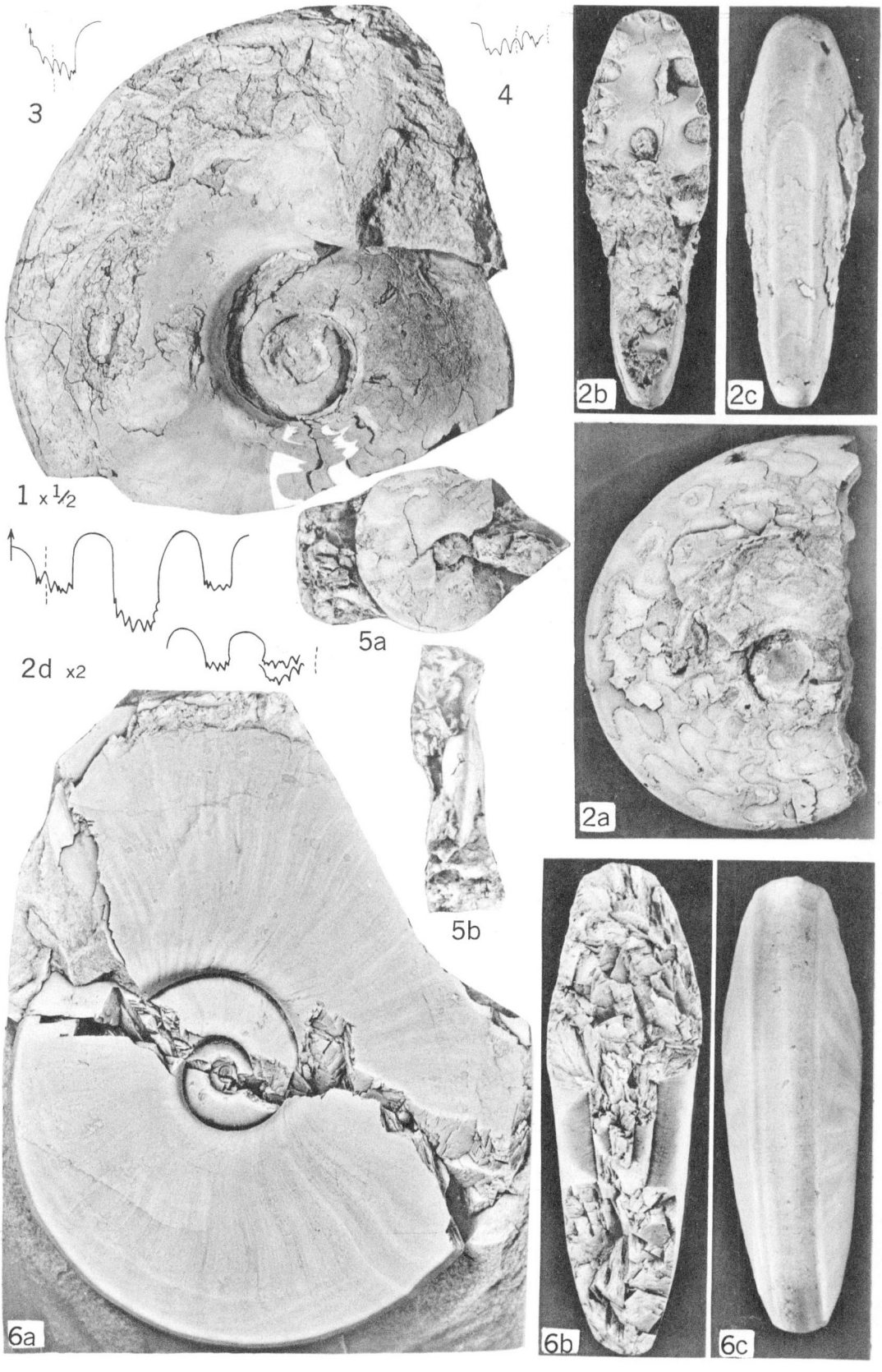

3
4
1 x ½
2b
2c
2a
5a
2d x2
5b
6a
6b
6c

PLATE V

(Figures are natural size unless otherwise stated)

Juvenites needhami n. sp. (Page 25)

Figures 1a, b. Side (1a) and apertural view (1b) of paratype, GSC No. 14289, "Toad-Grayling Formation", 180 feet above base, Needham Creek, British Columbia (GSC locality 48850).

Figures 2a–c. Side view (2a), venter (2b), and whorl section (2c) of paratype, GSC No. 14290, showing constriction on inner whorl, horizon and locality as figure 1.

Figures 3a, b. Side view (3a) and venter (3b) of paratype, GSC No. 14291, horizon and locality as figure 1.

Figures 4a–c. Side view (4a) and venter (4b) of holotype, GSC No. 14292, showing phragmocone and half a whorl of body chamber, horizon and locality as figure 1. Figure 4c is x2 and shows external suture line (solid line). Dashed line is restoration of internal suture line based on 14290.

Figures 5a–c. Side view (5a), venter (5b), and apertural view (5c) of paratype, GSC No. 14290, horizon and locality as figure 1.

Arctoceras cf. *A. blomstrandi* (Lindström) (Page 26)

Figure 6. Crushed specimen showing surface of test and association with *Posidonia mimer* Oeberg, GSC No. 14294, "Toad-Grayling Formation" 140 feet above base, Needham Creek, British Columbia (GSC locality 46471).

Koninckites columbianus n. sp. (Page 15)

Figures 7a–c. Side view (7a), venter (7b), and major part of external suture line, x2 (7c) of holotype, GSC No. 14266, Grayling Formation, 117 feet above base, Dunedin River, British Columbia (GSC locality 42372).

Figures 8a–c. View of one side (8a), outer whorl in section (8b), and partial view of the other side (8c), showing the weathered, but apparently almost smooth, suspensive lobes. Paratype GSC No. 14267. Horizon and locality as figure 7.

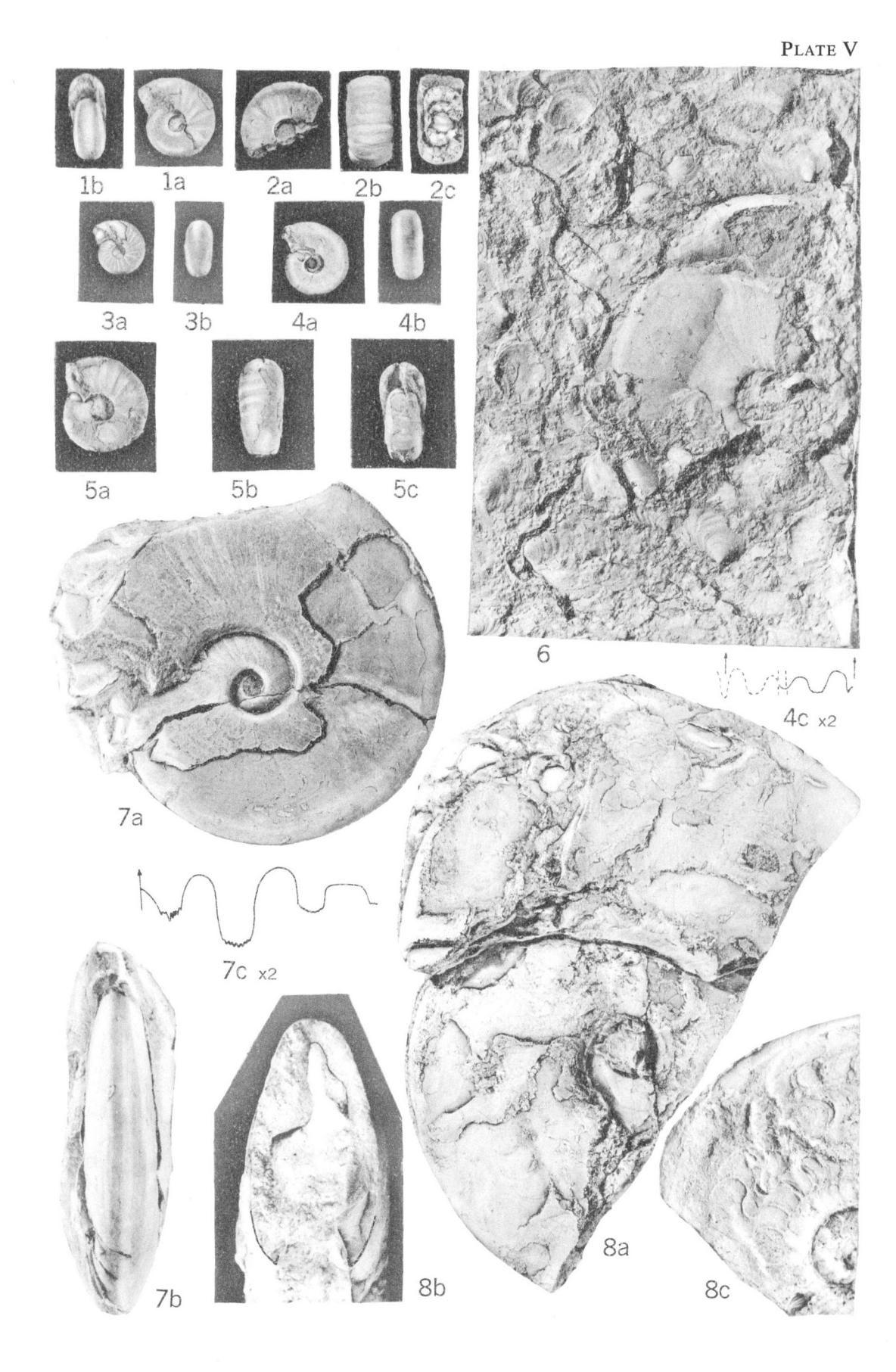

1b
1a
2a
2b
2c
3a
3b
4a
4b
5a
5b
5c
6
4c x2
7a
7c x2
7b
8b
8a
8c

PLATE VI

(Figures are natural size unless otherwise stated)

All specimens illustrated on this plate are from the Liard Formation, Liard River, 3 miles upstream from Hades (Hell) Gate, British Columbia (GSC locality 42355).

Maclearnoceras maclearni n. gen., n. sp. (Page 35)

Figures 1a–e. Side views (1a, b), venter (1c), suture line, x2 (1d), and inner whorls at 8 mm x3 (1e) of holotype, GSC No. 14297. The whorl fragment (1b) fits with(1a) but has been removed to show the preceding whorl, with rursiradiate ribs. The view of the venter (1c) is mainly steinkern; the feature at the midline is apparently the impression of the siphuncle and is of very low relief. The test is preserved at the beginning and near the end of the inner whorl illustrated (1e); at both places the ribs are tuberculate.

Figures 2a, b. Side view (2a) and venter (2b) of paratype, GSC No. 14299. The inner whorls preserve the shell.

Figures 3a, b. Side view (3a) and venter (3b) of inner whorls, steinkern, paratype, GSC No. 14295.

Figures 4a–c. Side view (4a), whorl section and inner whorls x1 (4b) and x2 (4c), paratype, GSC No. 14296. Inner whorls preserve the shell, outer whorls are mainly steinkern.

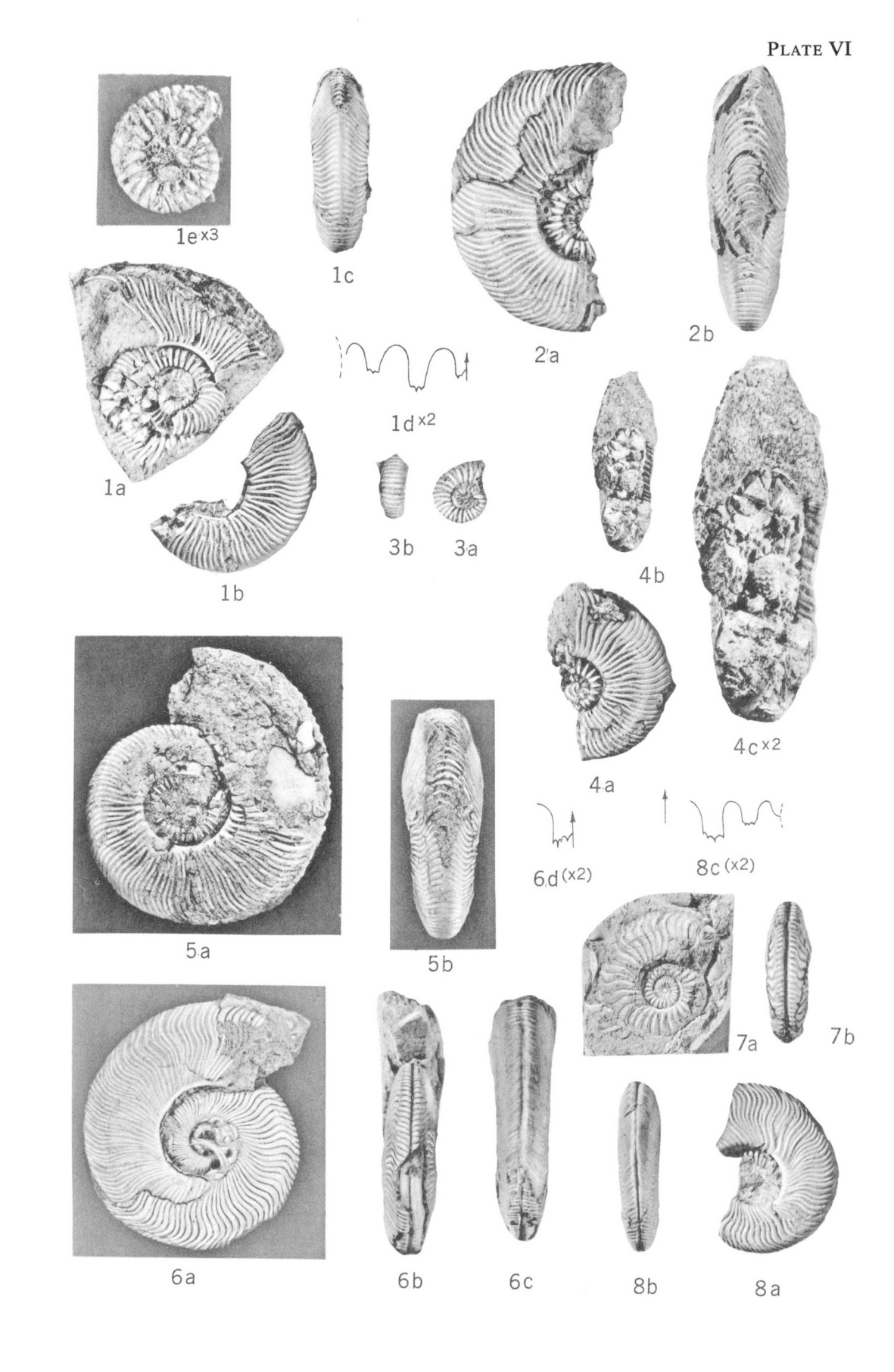
Figures 5a, b. Side view (5a) and venter (5b) of paratype, GSC No. 14298. Parts of the venter preserve the shell intact, and show the depressed ribs summits.

Liardites whiteavesi n. gen., n. sp. (Page 34)

Figures 6a–d. Side (6a), apertural (6b), and ventral (6c) views, and external lobe, x2 (6d), holotype, GSC No. 14302.

Figures 7a, b. Side view, rubber mould (7a), and venter (7b) of paratype, GSC No. 14300, a coarsely ribbed variant.

Figures 8a–c. Side view (8a), venter (8b), and part of suture line below umbilical shoulder, x2 (8c) of paratype, GSC No. 14301.


1e x3
1c
2a
2b
1d x2
1a
1b
3b
3a
4b
4c x2
4a
6d (x2)
8c (x2)
5a
5b
7a
7b
6a
6b
6c
8b
8a