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A MIDDLE TRIASSIC (ANISIAN) FAUNA IN HALFWAY, SIKANNI CHIEF, AND TETSA VALLEYS, NORTHEASTERN BRITISH COLUMBIA

(REPORT, FIGURE, TWELVE FOSSIL PLATES, AND PRINTED SUPPLEMENT)

BY

F. H. McLEARN

OTTAWA

1948

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By

E.D. Kindle

OTTAWA
1948

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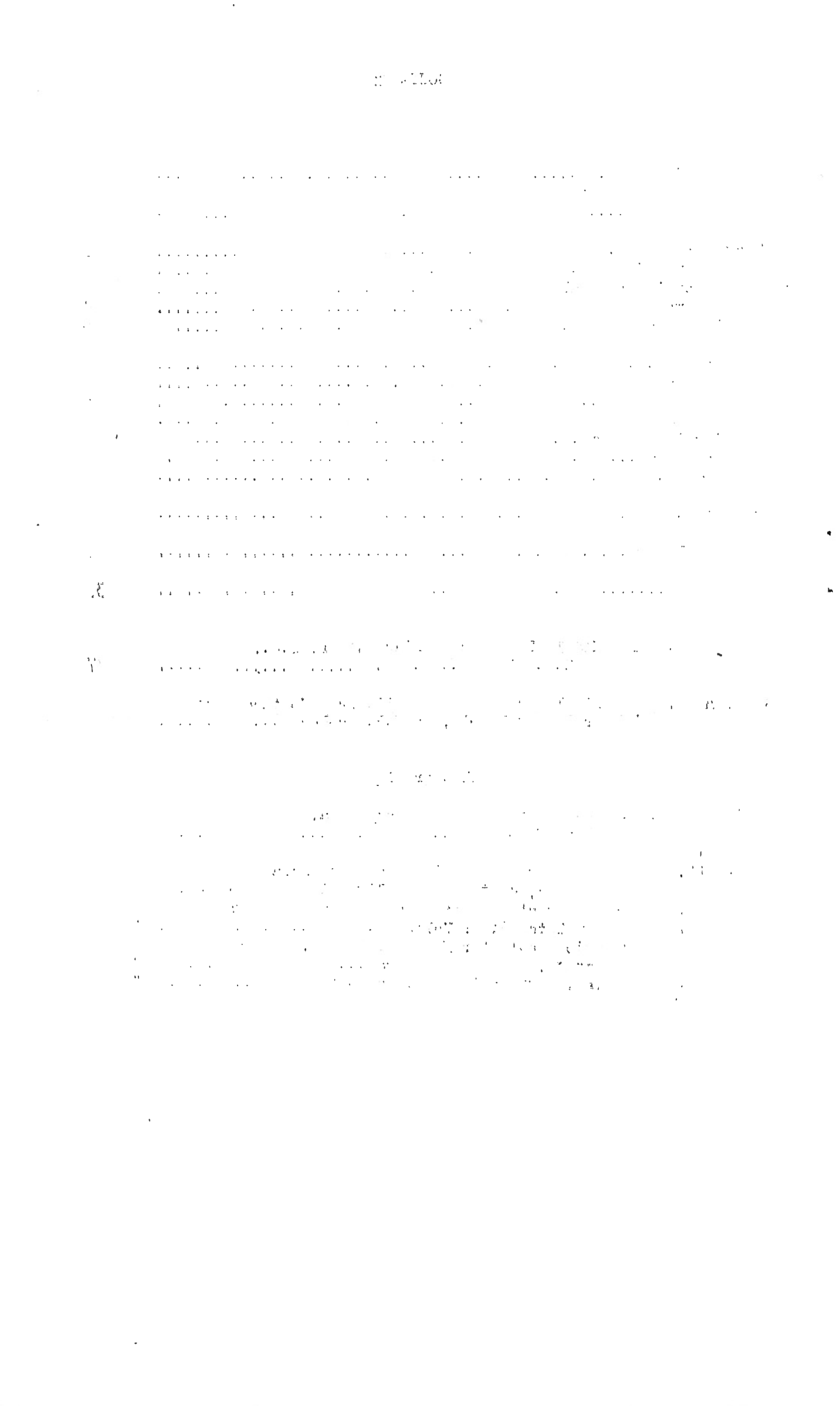

A MIDDLE TRIASSIC (Anisian) FAUNA IN HALFWAY, SIKANNI CHIEF, AND TETSA VALLEYS, NORTHEASTERN BRITISH COLUMBIA

(Second Edition)

INTRODUCTION

During the field season of 1944 the writer made a detailed study of the Triassic in Halfway, Sikanni Chief, and Tetsa Valleys in northeastern British Columbia. The greater part of the season was spent in collecting a Middle Triassic fauna equivalent in age to the Anisian faunas of Europe and Asia. The stratigraphic position of this fauna with respect to that of the Middle Triassic Nathorstites fauna was also investigated.

Efficient assistance in the field was given by K.C. McTaggart, who ran the telemeter surveys that formed the basis for the accompanying plans and structure-sections (See Figure 1). Acknowledgment is made to the geologists of oil exploration companies for collections of this fauna made in the Muskwa drainage basin and other parts of the district. Professor P.S. Warren of the University of Alberta loaned a small collection. Dr. John B. Reeside of the United States Geological Survey kindly furnished plaster casts of some type specimens in the United States National Museum. Dr. F.N. Johnston kindly identified specimens of Longobardites from Nevada in the Washington collections.

The first edition, in 1945, included a mimeographed main report, a mimeographed Appendix I, by E.D. Kindle, a printed Appendix II, on New Middle Triassic Species from Northeastern British Columbia, by F.H. McLearn, dated February 1946, and Plates I to III and Figure 1. In September 1946, a printed 'Supplement to Appendix II, Additional New Middle Triassic Species from Northeastern British Columbia', by F.H. McLearn, was issued, together with Plates IV to VII, and a copy forwarded to all who had received the February 1946 edition. Also, the September supplement was thereafter included in all copies of Paper 46-1 issued.

In this second edition the stratigraphy and faunal lists are revised; the section on palaeontology is extended; the maps and diagrams of Figure I are revised; and Plates VIII to XII are added. The Appendix II and Supplement to Appendix II of the first edition are omitted; as printed papers they have served their purpose to establish the species described in them; moreover all the information they contained is now included in the body of the second edition under the heading 'Palaeontology'. A new supplement (in print) is added to this second edition with the title, 'New Middle Triassic Ammonoids from Northeastern British Columbia'; this will establish the new species described in the second edition.

PREVIOUS WORK

C.O. Hage (1941)[1] discovered this fauna on what is here called

1. Dates, or names and dates, within parentheses refer to dates of publications and authors, and appear in the list of references at the end of the report.

Hage Mountain in Sikanni Chief Valley, where he collected the following: Danubites? sp., Paraceltites? sp., and Trigonodus? sp. From Mount Withrow he reported Ptychites sp. and Daonella sp. 100 feet below beds carrying Nathorstites.

M.Y. Williams (1944) discovered this fauna in Tetsa Valley on the Alaska Highway, near Mile 378. There he collected species of 'Gymnotoceras', 'Parapopanoceras', Monophyllites, Trigonodus, and Daonella.

In the same year E.D. Kindle (1944) found this fauna on Liard River. His 1944 report, and also Appendix I of this report, should be consulted for information on stratigraphy, structure, and distribution.

STRATIGRAPHY

The stratigraphy of the Triassic of northeastern British Columbia has been recently described (McLearn, 1946).

The Middle Triassic (Anisian) Beyrichites-Gymnotoceras fauna occurs in the upper part of the Toad formation, the Lower Triassic Wasatchites fauna being in the lower part. The Toad is overlain by the 'Flagstones' in the Halfway and Sikanni Chief Valleys, by the Liard formation in the western parts of Tetsa and Liard Valleys, and by dark shales of Jurassic or early Cretaceous age in the eastern part of Liard Valley; in the eastern part of Tetsa Valley, a small thickness of beds at the top of the Triassic may be a last remnant of the Liard formation, representing basal Liard beds.

The Toad formation consists principally of dark, calcareous siltstones and dark limestones.

Halfway Valley

The Middle Triassic fauna, hereafter referred to as the Beyrichites-Gymnotoceras fauna, appears to be present, although very poorly preserved, in Halfway Valley. The succession, in natural order of beds, exposed on Mount Wright on the north side of the valley about 35 to 40 miles west of the Alaska Highway (See Figure 1B) and in a deep gully on the axis of a flat-topped anticline, is as follows:

	Approximate thickness Feet
'Grey beds'	
Massive, fine, calcareous sandstone, limestone -------	300 +
'Dark siltstones'	
Dark, shaly siltstone, limestone and shale with Nathorstites ----------	300
'Flagstones'	
Massive, grey, calcareous, fine sandstone and limestone ----------	180
Flaggy, calcareous siltstone and fine sandstone -------	200
Toad formation	
Dark, shaly, calcareous siltstone with Beyrichites or Gymnotoceras ? ----------	200

The lithological succession is much like that on Hage and McTaggart Creeks, draining the western slopes of Hage Mountain in Sikanni Chief Valley, which will be described later. The poor specimens of Beyrichites or Gymnotoceras in the dark, shaly, calcareous siltstones occur in the same kind of strata and apparently at the same stratigraphic level as the Beyrichites-Gymnotoceras fauna in Sikanni Chief Valley, and probably represent this fauna.

Sikanni Chief Valley

Farther north, the Middle Triassic beds are well exposed on the south side of Sikanni Chief Valley and on Hage and McTaggart Creeks.

The section exposed on Hage and McTaggart Creeks (See Figure IA), in eastwardly dipping beds, is from the top to bottom as follows:

	Approximate thickness Feet
'Grey beds'	
Thick-bedded, grey, massive, fine, calcareous sandstone and some limestone	
Grey, thick-bedded, massive, fine, calcareous sandstone with Nathorstites at top ----------	50
Concealed ----------	20
'Dark siltstones'	
Dark, friable, shaly siltstone with Nathorstites -----	30
Dark, calcareous siltstone with Nathorstites ? -------	45
Concealed ----------	30
'Flagstones'	
Thin-bedded, flaggy and massive siltstone ----------	235
Toad formation	
Dark, somewhat shaly, calcareous siltstone, with some harder, more massive layers of calcareous siltstone with Beyrichites-Gymnotoceras fauna-------	150 +

The dark, shaly, calcareous siltstones of the Toad formation are exposed on Hage and McTaggart Creeks. The basal part outcropping on McTaggart Creek was not measured. The lowest beds are exposed far up the creek, and higher and higher beds appear downstream towards the junction of this creek with Hage Creek. The overlying 150 feet of measured beds are exposed on Hage Creek from Locality I upstream to a little beyond Locality II. These dark, shaly siltstones on Hage and McTaggart Creeks carry the Beyrichites-Gymnotoceras fauna. The lowest beds, far up McTaggart Creek, carry poor specimens of what appear to be Gymnotoceras. Somewhat higher beds a little farther downstream carry Ptychites wrighti, Ptychites sp., and Trigonodus sp. Higher beds, farther downstream where the creek runs along the strike of ledges of the dark, calcareous siltstone, yielded Parapopanoceras normale, P. obesum, P. medium; P. selwyni, Longobardites canadensis, Beyrichites aff. tenuis Smith, Hollandites ? humi, and Gymnotoceras ? sp. Still higher beds at Locality I (See Figure IA), below the junction of Hage and McTaggart Creeks in a ledge on the west bank of the stream, yielded small specimens of Gymnotoceras? and mature specimens of Daonella cf. moussoni Merian. Yet higher beds at Locality II on Hage Creek, above the confluence of the two creeks, yielded: Longobardites sp., Gymnotoceras? sp., and Daonella sp.

The overlying 'Flagstones', consisting of 80 feet of dark, rather massive, calcareous siltstone and the 155 feet of flagstones, are exposed on Hage Creek upstream from near Locality II almost to Locality III. These beds are barren of fossils or contain only rare, obscure, indeterminate remains.

The 45 feet of dark, fairly thick-bedded, calcareous siltstone is exposed near Locality III on Hage Creek, and extends along the creek and along the north bank for a long distance up the valley, possibly beyond Locality VI. At Locality III talus, apparently from the highest ledge of this zone, carried poorly preserved specimens of Nathorstites?. The 30 feet of dark, friable, shaly siltstone is exposed on and along the north side of Hage Valley. Near the top of this lithological zone, at Locality VI (See Figure IA), specimens of the Nathorstites fauna were collected. All these beds are included in the 'Dark siltstones'.

Ledges and cliffs of the 50 feet of grey, massive, calcareous, fine sandstone of the 'Grey beds' appear on the higher slopes on the north side of Hage Valley. At Locality V, the highest beds of this zone carry Nathorstites sp. and other species of the Nathorstites fauna.

It is thus established that the Nathorstites fauna overlies the Beyrichites-Gymnotoceras fauna of northeastern British Columbia. It is not

established, however, that the one fauna immediately overlies the other, for more than 265 feet of barren strata intervene.

Muskwa River Basin

From south of Tetsa Valley, in other tributary valleys of the Muskwa River basin (See Figure ID), several collections of the Beyrichites-Gymnotoceras fauna have been obtained by geologists of oil companies, and this fauna is evidently preserved over a wide area in the northeast corner of British Columbia.

Among the species collected are: Parapopanoceras normale, P. medium, Gymnites hagi, 'Hungarites' dawsoni, 'H'. ovinus, 'H'. mackenzii, Longobardites canadensis, Beyrichites deleeni, Gymnotoceras beachi, G. liardense, Frechites kindli, Orthoceras sp., 'Nautilus' sp., Sphaera cf. whitneyi Meek, Trigonodus sp., and 'Rhynchonella' sp.

Tetsa Valley

The section of the Triassic exposed in Tetsa River Valley (See Figure ID) along the Alaska Highway between Miles 375 and 378 shows several anticlines and synclines (See Figure IB). Triassic beds are exposed on the anticlines, and dark, friable shales of Jurassic or Cretaceous age occur along the synclines. It is thought that the formation names, Toad and Liard, described by Kindle for the Liard River section (See Kindle, 1944, and Appendix I of this report) can be used in Tetsa Valley. The Toad formation is exposed on Cameron, Smith, and Shaw Hills on the axes or inner flanks of the anticlines. It consists of dark grey, thin-bedded, calcareous shales, shaly siltstones, siltstones, and thin, lenticular beds of limestone. About 500 feet of beds were measured on the east side of Shaw Hill, along the highway. Probably only the upper part of the formation is exposed in this part of Tetsa Valley, and the lower part of the Toad, together with the underlying Grayling formation, is concealed below river level along the highway between Miles 375 and 378. A part of the Liard formation outcrops on the west limb of the Williams Valley anticline on Williams Hill, on a high and abandoned road above and north of the highway, west of Mile 378. It consists of massive, thick-bedded, slightly calcareous, fine- to medium-grained sandstones and grey limestone. It thins rapidly to the east. It is possible that some fine sandstone at the top of the Triassic section on Shaw and Smith Hills and on the east flank of Cameron Hill should be referred to the Liard formation. The Triassic in Tetsa Valley is overlain by dark friable shales with clay-ironstone concretions of Jurassic or Cretaceous age.

The Beyrichites-Gymnotoceras fauna occurs in the Toad formation, that is, in the dark, shaly siltstones and thin limestones. These beds on the axis of the Shaw anticline, at Locality VI on the Alaska Highway (See Figure IB), carry the following species: Parapopanoceras normale, P. obesum, P. medium, Longobardites canadensis, L. internatus, L.? larvalis, Gymnotoceras columbianum, G. varium, G. moderatum, G. helle, and Trigonodus sp. In the vicinity of Locality VI the following were collected from talus and from blocks of rock dislodged during construction of the road: Parapopanoceras tetsa, P. normale, P. medium, Ussurites arthaberi var, cameroni, Gymnites hagi, Anagymnites via-alaska, Longobardites canadensis, L. internatus, Beyrichites deleeni, Hollandites? mcconnelli, 'Ceratites' hayesi var. angulatus, 'C.' hayesi var. pinquis, Orthoceras sp., Trigonodus sp., and Sphaera cf. whitneyi Meek.

Where the highway passes around the south slope of Smith Hill at Locality V (See Figure IB), and near the crest of the anticline, numerous blocks of rock, partly local talus and partly fragments from road construction, carry the following: Parapopanoceras tetsa, P. normale, P. obesum, Longobardites canadensis, L. internatus, 'Ceratites' hayesi, Beyrichites deleeni, B. aff. tenuis Smith, and Orthoceras sp. The strata at Locality V are fine grained as at Locality VI, are at about the same horizon in the Toad formation, and are similarly on the axis of an anticline.

The Beyrichites-Gymnotoceras fauna is also found at several localities on Cameron Hill in the dark, calcareous, shaly siltstones and rare thin limestones of the Toad formation. Parapopanoceras tetsa was collected in place at Locality IV (See Figure IB) on the river bank. Talus at the same locality and blocks of rock dumped from above during highway construction yielded: Parapopanoceras normale, P. medium, P. praematurum, Longobardites canadensis, Beyrichites cf. osmonti Smith, 'Ceratites' hayesi, Sphaera cf. whitneyi Meek, and Trigonodus sp. At about the same horizon, at Locality III (See Figure IB), Parapopanoceras medium, P. selwyni, and Longobardites internatus were collected at a small culvert on the north side of the highway. Talus nearly in place at this locality yielded Parapopanoceras normale, P. medium, P. praematurum, P. selwyni, and Trigonodus sp. At a higher level on the same hill, at Locality II (See Figure IB), in ledges at about the same horizon as the beds at Localities III and IV, the following were collected in place: Parapopanoceras normale, P. obesum, P. praematurum, Ussurites muskwa, Longobardites canadensis, Gymnotoceras ino n.sp., 'Ceratites' hayesi, Acrochordiceras (Paracrochordiceras) americanum, Orthoceras sp., Sphaera cf. whitneyi Meek, and Trigonodus sp. Talus on the same slope and in the vicinity of the ledges of Locality II (See Figure IB) carried: Parapopanoceras normale, P. medium, P. selwyni, P. praematurum, Longobardites canadensis, L. internatus, Tropigastrites (Celtites?) sp., 'Ceratites' hayesi, 'C.' hayesi var. angulatus, Acrochordiceras (Paracrochordiceras) sp., Beyrichites deleeni, Hollandites? spivaki, Gymnotoceras hello, G. wrighti, Sphaera cf. whitneyi Meek, Trigonodus sp., and 'Rhynchonella' sp.

Beds on the axis of the Williams Valley anticline, a structure recognized by Williams (1944), are mostly concealed. It is true that some barren shaly siltstones are exposed at Locality I (See Figure IB), but the exposure is small and the beds may have slumped from their original position. Just east of Locality I, however, talus blocks are numerous on either side of the highway. These blocks may have come from the higher slopes of Cameron Hill, or they may have been thrown up during road construction. They supplied the following species: Parapopanoceras normale, P. medium, P. selwyni, Ussurites arthaberi var. cameroni, Longobardites canadensis, L. internatus, 'Ceratites' hayesi, 'C.' hayesi var. angulatus, 'C.' hayesi var. pinguis, Beyrichites cf. falciformis Smith, Sphaera cf. whitneyi Meek, Trigonodus sp., and 'Rhynchonella' sp. It is probable that the beds on the axis of the Williams Creek anticline, but concealed there, are lower down in the Toad formation than those exposed on the axis of the anticlines on Smith and Shaw Hills.

A talus block in a drainage ditch west of Mile 378, and probably dumped during highway construction, contained Paraceratites? sp.

CORRELATION

In the European and Asiatic chronology the Middle Triassic is divided into two stages, the lower, Anisian, and the upper, Ladinian. The Anisian has recently been divided by Spath (1934) into two stages or substages, the Beyrichitan (Nicomeditan ?) and Paraceratitan (See Figure IC).

Canada

Except in northeastern British Columbia very little is known of the Middle Triassic in Canada. A small fauna, possibly coeval with the Beyrichites-Gymnotoceras of northeastern British Columbia, has recently been reported by Warren (1945) from the upper or Whitehorse member of the Spray River formation in the central Canadian Rockies. It contains species of Lingula, Daonella, Hoernesia, Trigonodus?, Gymnotoceras, etc. It is doubtful if any part of the Nicola group of southern British Columbia is of Middle Triassic age, and there is no definite evidence of the presence of Middle Triassic rocks on Graham Island. Further, no Middle Triassic fossils have yet been collected in the Triassic Lewes group in the Yukon (Lees, 1934).

United States

The Middle Triassic fauna in the lower part of the Star Peak formation in the West Humboldt Range of Nevada has been listed from various localities by Smith (1914). The collection from Forest Hill in the American Canyon is the one that most resembles the Canadian Beyrichites-Gymnotoceras fauna. It contains many species absent in the Canadian fauna, in particular species of Paraceratites, Nevadites, Anolcites, and Protrachyceras. The resemblances are in other genera. Thus the specimens of the Canadian species Longobardites canadensis with almost smooth inner whorls, resemble Longobardites nevadanus Hyatt and Smith and may prove to be of that species; a specimen from Nevada of Longobardites has inner whorls much like those of the Canadian species L. internatus; the Canadian specimen of Beyrichites cf. falciformis resembles Beyrichites falciformis Smith; Beyrichites aff. tenuis closely resembles Beyrichites tenuis Smith; Sphaera cf. whitneyi recalls Sphaera whitneyi Gabb; and Daonella cf. moussoni resembles Daonella moussoni Merian. As the fauna from Nevada is of Paraceratitan age it makes possible a tentative Paraceratitan dating for the Canadian fauna.

In the Hawthorne and Tonopah quadrangles, Nevada, the Excelsior and Grantsville formations have been assigned to the Middle Triassic (Muller and Ferguson, 1939). The known fauna of the Excelsior formation includes only brachiopods and pelecypods that form no source of comparison with the Canadian fauna, which is largely made up of ammonoids. Muller and Ferguson propose a tentative dating of early Middle Triassic for this formation, and possibly a little earlier part of the Middle Triassic than the Canadian Beyrichites-Gymnotoceras fauna. The fauna of the Grantsville, consisting of a few ammonoids and pelecypods and a brachiopod, affords no means of comparison except that both are of Middle Triassic time.

Faunas of Middle Triassic age are rare in California. The fauna of the Parapopanoceras beds in Inyo county is small, and has no species in common with the Canadian Beyrichites-Gymnotoceras fauna. It is probably somewhat earlier in age. The fauna of the Pit shale in Shasta county, with Nevadites, is also a small fauna, and may be of similar age, but has nothing actually in common with the Canadian fauna.

Alaska

Fossiliferous beds of Middle Triassic age are rare in Alaska. However, the slates of Brooks Mountain, Seward Peninsula, bear Daonella cf. lommeli Wissmann and Gymnotoceras sp. (Martin, 1926, p. 117). The Canadian fauna is probably of similar date, but no comparison can be made with so few species.

Arctic Regions

Parapopanoceras tetsa and related species resemble P. malmgreni (Lindstrom) and P. verneuili (Mojsisovics) in the Daonella beds of Spitzbergen. Species like Gymnotoceras columbianum, G. wrighti, and G. helle recall Spitzbergen G. nathorsti (Mojsisovics) and G. rominatum (Mojsisovics). The resemblance of a variety of G. liardense to G. laqueatum (Lindstrom) from Spitzbergen should also be noted.

Kiparisova (1937) has recently described a Middle Triassic fauna from the mouth of Olenek River and other localities in northern Siberia. This fauna contains some species, such as Hungarites grumulus Kiparisova, which resemble the inner whorls of Longobardites internatus in the Canadian Beyrichites-Gymnotoceras fauna.

Dalmatia

Gymnites hagi in the Canadian fauna resembles Gymnites subclausus var. as figured by Salopek (1911) in a fauna from Od Dreninì, near Spizza in southern Dalmatia. This Dalmatian fauna is said to contain Paraceratites trinodosus, and so is of Anisian and Paraceratitan age.

India

Anagymnites lamarcki Opbel occurs in the Muschelkalk of the Himalayan Mountains, and is presumably of Paraceratitan age. It resembles A. cf. lamarcki found in the Canadian Beyrichites-Gymnotoceras fauna.

COMMENTS

The Anisian fauna of the Middle Triassic is well developed in northeastern British Columbia. Except for the Middle Triassic faunas of the West Humboldt range in Nevada it is probably now the largest known fauna of this age in North America, at least in the United States, Canada and Alaska.

Outstanding features of the Beyrichites-Gymnotoceras fauna in northeastern British Columbia are: the considerable expansion in size and form of the genus Parapopanoceras; the presence in abundance of a species of Beyrichites with the unusual feature of bullate tubercles on the inner whorls, the extensive radiation in the species group of Gymnotoceras columbianum, with rounded, variably inflated whorls with convergent sides, strong umbilical bullae or tubercles, and no keel; and smooth or nearly smooth oxycones in the Hungaritidae with carinate-costate inner whorls. Apparently missing are the typical carinate and non-tuberculate species of Gymnotoceras and the genera Protrachyceras, Anolcites, Nevadites, true Hungarites, Eutomoceras, and Halilucites, all conspicuous in beds of similar age in Nevada. The genera Judicarites and Balatonites, so prominent in many places in beds of Middle Triassic age, are absent. Even the widely distributed genus Paraceratites is only recorded by one, poor, somewhat doubtful specimen; it has not yet been reported from Spitzbergen.

This fauna resembles in some degree faunas of similar age in both Nevada and Spitzbergen. It resembles the Nevada fauna particularly in species of Longobardites and Beyrichites, but not B. deleeni, and the Spitzbergen fauna in similar species of Parapopanoceras and in the peculiar group of rather inflated, rounded, non-carinate, bullate or tuberculate group of Gymnotoceras.

The Canadian fauna is correlated with the Paraceratites trinodosus, Upper Anisian or Paraceritittan faunas of the world.

No record of an earlier Anisian fauna, of Beyrichitan (Nicomeditan?) age has yet been found in northeastern British Columbia.

The beds containing the Beyrichites-Gymnotoceras fauna in northeastern British Columbia definitely underlie those containing the Nathorstites fauna and are separated from them by barren beds.

PALAEONTOLOGY

This paper records a preliminary study of the Beyrichites-Gymnotoceras fauna of northeastern British Columbia. It is hoped that it will be possible later to treat the subject more thoroughly. No attempt is made to erect new genera, although some new genera among the ammonoids do seem necessary. Family and generic revision of Triassic ammonoids in general is being undertaken by Spath in his 'The Ammonoidea of the Trias', the first part of which has already been issued (Spath, 1934).

The following abbreviations are used in the following pages and in the printed Supplement:

Pl.	for plate
fig.	for figure
EL	for external lobe
L1	for first lateral lobe
L2	for second lateral lobe
ES	for external saddle
S1	for first lateral saddle
S2	for second lateral saddle
aux.	for auxiliary lobe or saddle
meas.	for measurements
G.S.C.	for Geological Survey collections
hol.	for holotype
par.	for paratype

Measurements of ammonoids are given in the established order; diameter in millimetres; height of whorl as percentage of diameter; thickness of whorl as percentage of diameter; and width of umbilicus as percentage of diameter. Unless otherwise stated, measurements of ammonoids are of the holotype specimen, and are taken at the anterior end, that is at what is mostly the maximum diameter.

The classification of Triassic ammonoids proposed by Spath (1934) is closely followed.

Comparison of Canadian with foreign species is based on illustrations and descriptions in foreign publications and not on the direct comparison of Canadian with foreign specimens. It is possible that some illustrations, particularly those that are reproduced from drawings, are not always faithful reproductions, and so errors may enter into interpretations based on them. It is also possible that comparison of Canadian specimens with actual foreign specimens would result in the recognition of more foreign and fewer new species in the Canadian faunas. It is not known what percentage of species would be so effected, but it is expected that this percentage would be small.

Rare examples will be found where a name is recorded as a species in the text, and as a variety on the plate. This means that it was described as a variety in the first edition and raised to species rank in the second. The text has been revised, but not the plates. It should be noted that via-alaska, for example, is now raised to species rank as Anagymnites via-alaska, and that praematurum is similarly raised in rank as Parapopanoceras praematurum. Longobardites mctaggarti is now listed as 'Hungarites' mctaggarti.

Many specimens are incomplete, with only a part of the living chamber remaining or only the septate part. To speak of the last whorl of these specimens as the ultimate whorl is hardly correct. In the text the term 'ultimate whorl, as preserved' is used for the last or outermost whorl of incomplete specimens.

Family, Megaphyllitidae Mojsisovics

Genus, Parapopanoceras Haug

A fairly large collection of specimens of this genus is available for study. The variation is extended, but not too involved to permit arrangement of the specimens into definite varieties or closely related species.

The specimens vary in size, degree of compression, stage of growth at which umbilical expansion begins, rate of expansion of umbilicus, degree of angulation of venter on ultimate whorl, the presence of an umbilical shoulder

on the ultimate whorl, and to some extent in suture line. Small species are the result partly of dwarfing, that is to reduction in thickness and height of whorl, and partly to an early appearance in the ontogeny of umbilical expansion and other mature characters.

In complete specimens, the venter widens and flattens at the very anterior end of the ultimate whorl. The surface of the shell is almost smooth, marked at the most by fine striae.

The inner whorls are involute, rounded and of varying stoutness.

The suture line is ceratitic, multisellate, with rather slender, lobate principal saddles and small, low, auxiliary saddles. Details of the suture line are described under Parapopanoceras normale, P. medium, and P. selwyni. As compared with other local species, the suture line of P. selwyni seems to be the most distinctive.

The species of Parapopanoceras in the Toad formation have their closest affinities with species of this genus in the Middle Triassic of Spitzbergen. Two of these Spitzbergen species have costate ornament, which is lacking in the Canadian species. A third, however, Parapopanoceras malmgreni (Lindstrom), has almost smooth whorls and is somewhat similar to our species; unfortunately only the inner whorls are preserved, so that the details of umbilical enlargement on the ultimate whorl are unknown. Complete specimens of the Spitzbergen species Parapopanoceras verneuili (Mojsisovics), however, are illustrated and described by Mojsisovics, and, if faithfully reproduced, admit of comparison with the species from the Canadian Toad formation.

The species Parapopanoceras normale, P. obesum, P. medium, and P. praematurum are all very close to P. tetsa; larger collections may reveal all gradations in form between them and prove that they are all merely varieties of the one species, P. tetsa, P. selwyni, however, appears to be more distinct and more set apart from the other species.

Parapopanoceras tetsa McLearn
Plate II, figure 6; Plate IX, figure 1

1946. Parapopanoceras tetsa McLearn: Geol. Surv., Canada, Paper 46-1, p.8 (mimeograph); same, Appendix II, p. 1 (in print), Pl. II, fig. 6.

This is a large, compressed species, with rapid umbilical expansion occurring at the beginning of the ultimate whorl; almost angular venter on the ultimate whorl, except at the anterior end where the venter is broadly rounded; no well-defined umbilical shoulder on the ultimate whorl; and somewhat uneven, slightly flexuous surface striae.

The inner whorls are fairly stout, are involute, and have a rounded venter.

This species differs from Parapopanoceras verneuili (Mojsisovics) in the more angular venter and greater length of whorl involved in the umbilical enlargement, that is, in a slower rate of umbilical expansion.

Measurements of the holotype: 60; 35; 23.5; 28.5.

Tetsa, a geographic name.

Type. Geological Survey collections: holotype, Cat. No. 6440.

Parapopanoceras normale n.sp.
Plate VIII, figures 7,8; Plate IX, figures 5,6

This species is very close to Parapopanoceras tetsa of which it may be only a variety. It is more abundant than P. tetsa.

This large species is compressed like P. tetsa, though somewhat less than the known specimens of that species. Narrowing and angulation of the venter on the ultimate whorl is pronounced in the more compressed specimens, less so in the thicker specimens. Many specimens are complete, with broadening of the venter at the anterior end of the ultimate whorl. No well-defined umbilical shoulder is present on the ultimate whorl. Thicker specimens show some gradation towards Parapopanoceras obesum.

The species differs from P. tetsa in the even slower rate of expansion of the umbilicus; that is, the umbilical expansion involves more than one whorl.

The ceratitic, multisellate suture line has a high ventral saddle in EL, high, rather slender, lobate ES and S1, with rounded tops and indentations running at least halfway up the sides; smaller, but high and fairly slender lobate S2, with indentations high on sides; small, numerous, low, rounded auxiliary saddles, the sixth being on the slope into the umbilicus.

EL has wide, indented lobules; L1 is wide, long, and deeply indented; L2 is smaller, but deeply indented; the short, first auxiliary lobe is deeply indented at base; and the remaining lobes are short and small, at least two having two or three indentations.

The compressed specimens resemble Parapopanoceras verneuili (Mojsisovics), as figured by Mojsisovics, but the venter is more angular and the umbilical expansion is at a much slower rate.

Measurements of the paratype are: 60+; - ; - ; - ; 58.5; 41.0; 26.3; 21.0.

Types. Geological Survey collections: holotype, Cat. No. 9574; paratype, Cat. No. 9575.

Parapopanoceras obesum n.sp.
Plate VIII, figures 5,6

A few specimens resemble Parapopanoceras normale, but have thicker and more inflated whorls. They are large, but not all are as large as the holotype. The rate of expansion of the umbilicus is slow, involving about one and one-half whorls, as in P. normale, much slower than in P. tetsa and very much slower than in P. verneuili. The ultimate whorl has a very narrowly rounded venter, as in P. tetsa and the more compressed specimens of P. normale. The venter widens at the anterior end of the ultimate whorl in complete specimens. The umbilical shoulder disappears or is ill-defined on the ultimate whorl.

Measurements just behind the anterior end of the ultimate whorl are: 55; 30.5; 31.8; 43.5.

Type. Geological Survey collections: holotype, Cat. No. 9576.

Parapopanoceras medium n.sp.
Plate VIII, figures 1 to 3

This common species is of moderate size, mostly compressed, with chiefly more than a whorl of umbilical expansion. Angulation of the venter on last whorl variable, but definitely narrowed in all specimens. The venter widens at the anterior end of the ultimate whorl in all complete specimens.

Some variation in thickness of whorl is noted. Most specimens are, however, as compressed as the holotype.

The surface is nearly smooth, having only fine striations and evenly spaced varices of growth.

In size and stage of growth at which umbilical expansion begins, this species is intermediate between Parapopanoceras normale and Parapopanoceras praematurum. It is smaller than Parapopanoceras tetsa, and the umbilical expansion proceeds at a slower rate.

The suture line is like that of P. normale and is illustrated on Plate VIII.

Approximate measurements of holotype: 43; 38; 25.5; 30.

Types. Geological Survey collections: holotype, Cat. No. 9577; paratype, Cat. No. 9578.

Parapopanoceras praematurum n.sp.
Plate III, figure 2; Plate VIII, figure 4

1946. Parapopanoceras tetsa var. praematurum McLearn; Geol. Surv., Canada, Paper 46-1, p.9 (mimeograph); same, Appendix II, p.1 (in print), Pl. III, fig. 2.

The shells referred to this species were described as a variety of Parapopanoceras tetsa in the first edition of 1946.

This rather rare species is small and compressed in most specimens. The umbilical expansion begins on the penultimate whorl. The venter of the ultimate whorl is narrowly rounded to almost angular. No specimen is sufficiently complete to show the entire widening of venter at the anterior end of the ultimate whorl. The suture line is somewhat simpler than in the larger species.

The species differs chiefly from P. medium and other Toad species in the smaller size and earlier stage of beginning of umbilical expansion.

Measurements of holotype: 31; 40; 24; 26.

Type. Geological Survey collections: holotype, Cat. No. 6441.

Parapopanoceras selwyni n.sp.
Plate IX, figures 7 to 9

This species is of medium size; is compressed; has narrow, almost angular venter on the last whorl; has almost flattened sides; has a well-defined, rounded umbilical shoulder on last whorl; and has evenly spaced striations. The umbilical expansion continues for more than a whorl, that is it begins on the penultimate whorl.

This species differs from all others in the Toad formation in having a well-defined umbilical shoulder on the ultimate whorl. It is smaller and the narrowing of the venter of the ultimate whorl is less marked than in P. tetsa and P. normale.

The suture line is simpler than those of P. normale and P. medium, the septa are more crowded; the saddles are lower, and the lobes shorter and wider and the auxiliary lobes and saddles fewer. L1 has larger indentations at the base than L2.

This species differs more from the other species of Parapopanoceras in the Toad formation than the other species do from one another.

Approximate measurements of the holotype, made a little behind the anterior end of ultimate whorl, are: 47.5; 44; 27.5; 21.

Types. Geological Survey collections: holotype, Cat. No. 9579; paratype, Cat. No. 9580.

Family, Ptychitidae Mojsisovics
Genus, Ptychites Mojsisovics
Ptychites wrighti McLearn
Plate IV, figure 5

1946. Ptychites wrighti McLearn: Geol. Surv., Canada, Paper 46-1, p. 9 (mimeograph); same, Supplement to Appendix II, p. 3 (in print), Pl. IV, fig. 5.

The whorls are much thicker than high, the venter is rounded, and the maximum thickness is at the umbilical shoulder. The surface is ornamented with low, irregular, recurved (rursiradiate) ribs or folds. The umbilicus is deep, the umbilical wall is nearly vertical, and the umbilical shoulder is abruptly rounded. The suture line is comparatively simple; the small second auxiliary lobe is on the umbilical shoulder.

Compared with Ptychites rugifer Oppel the Canadian species has relatively thicker whorls, larger umbilicus, more recurved and less regular ribs, a somewhat simpler suture line, and the maximum width is at the umbilical shoulder. Ptychites latifrons Mojsisovics has even thicker whorls, more broadly rounded venter, and smaller umbilicus.

Measurements of the holotype are: 60.0; 47.5; 66.5; 20.0

The species name is given for Dr. W.I. Wright.

Type. Geological Survey collections: holotype, Cat. No. 6442.

Family, Monophyllitidae Smith emend. Spath
Genus, Leiophyllites Diener
Leiophyllites? kindli McLearn
Plate II, figure 4

1946. Leiophyllites? kindli McLearn: Geol. Surv., Canada, Paper 46-1, p. 10 (mimeograph); same, Appendix II, p. 1, (in print), Pl. II, fig. 4.

The holotype is a very much compressed, evolute shell, with narrow, rounded venter, rounded umbilical shoulder, and, on the core of the anterior part of the umbilical whorl preserved, a concave umbilical area. EL is wide and short; ES is entire and somewhat lobate; L1 is indented and is longer than EL; S1 is entire, higher than ES, and slightly lobate; L2 is indented at the base and shorter than L1; and S2 is entire and a little smaller than S1; a shallow, serrated lobe extends across the umbilical area.

Compared with Leiophyllites? middlemissi (Diener), L.? kindli is as compressed, has a concave umbilical area, a somewhat simpler suture line, and less lobate or constricted saddles.

Measurements of the holotype are: 43.5; 34.5; 15.0; 41.5.

The species name is given for E.D. Kindle.

Type. Geological Survey collections: holotype, Cat. No. 6443.

Genus, Ussurites Hyatt

Ussurites muskwa McLearn
Plate III, figures 3, 4

1946. Ussurites muskwa McLearn: Geol. Surv., Canada, Paper 46-1, p. 10 (mimeograph); same, Appendix II, p. 1 (in print), Pl. III, figs. 3, 4.

This is a compressed, evolute species with high, rounded venter, almost flattened sides, and rounded umbilical shoulder. It is ornamented with evenly spaced, regular radial striae that are almost straight across the venter. In addition are narrow, radial folds, more distantly and less regularly spaced on outer than on inner whorls.

This species is intermediate in compression of whorls between Ussurites hara (Diener) and Ussurites kingi (Diener); EL of the suture line is shorter than in either; and the ventral area is narrower than in U. hara. Compared with Ussurites ? decipiens Spath, the Canadian species is not so compressed, the radial folds are more numerous and regularly spaced, the suture line is more complex, EL is shorter, and L1 is definitely trifid. Compared with Ussurites yaboi (Diener) the radial folds are more narrow and more subdued.

Measurements of the holotype are: 51.0; 40.5; 27.0; 37.0.

Muskwa, a geographic name

Type. Geological Survey collections: holotype, Cat. No. 6444.

Ussurites arthaberi var. cameroni McLearn
Plate I, figure 3; Plate I[1], figure 1

1946. Ussurites arthaberi var. cameroni McLearn: Geol. Surv., Canada, Paper 46-1, p. 10 (mimeograph); same, Appendix II, p. 10 (in print), Pl. I, fig. 3; Pl. II, fig. 1.

The penultimate whorl is stout, is as thick as high, and has a broadly rounded venter and somewhat flattened sides. The surface is only preserved on and near the venter, where it is ornamented by fine striae. The crushed ultimate whorl of the holotype has radial striae and low, irregular, radial folds. In the suture line ES has a rounded anterior lobe; L1 is wide, long, and trilobate; and S1 is high and deeply notched on its inner side.

The paratype also has stout whorls, about as thick as high and flattened on the sides. It is ornamented with radial striae and faint folds.

The whorls are relatively thicker than those of Ussurites arthaberi Welter.

Measurements near end of septate part of shell of holotype are: 37.0; 39.0; 39.0; 38.

The name is given for Pat Cameron, trapper and guide.

Types. Geological Survey collections: holotype, Cat. No. 6494; paratype, Cat. No. 6445.

Family, Gymnitidae Waagen

The family Gymnitidae is represented in the Canadian fauna by four species and varieties, assigned to two genera. Although only four genera have as yet been erected in this complex family no attempt is made in this preliminary paper to describe any new ones. In order, however, to demonstrate

the place of the Canadian species in the family a preliminary study is made of generic relations within it. This study is not claimed to be complete and cannot be accepted as an entirely satisfactory basis for the erection of new genera. Moreover, the study is not based on the examination of foreign specimens, but on th literature and illustrations of shells and suture lines.

The species included in the family Gymnitidae exhibit a great and complex range of variation. There are variations in form and proportions: thus whorls vary from stout and thick to compressed; the umbilicus from wide to narrow or almost completely closed; the venter from rounded to sharp; and the umbilical shoulder from rounded to angular. The ornament is of many different kinds: more growth lines; folds and coarse ribs; fine, curved ribs, strongest near the middle of the sides; stiff, little curved, fine ribs; and one or two rows of nodes. Folds or coarse ribs, strongest near the umbilical shoulder, mostly curved and even recurved or rursiradiate are present in some species, particularly those of the genus Japonites; they usually appear at an early stage of growth. Strong, slightly curved ribs or folds appear on the living chamber at a late, mature stage of growth in some species, following an extended smooth stage. Accentuation of, or change in, ornament on the middle of the sides occurs in some species groups. For example: accentuated ribs on the middle of the sides occur in G. jollyanus; one or two lateral rows of nodes occur in G. alexandrae and G. bollunensis; and a change in the strength of the ornament takes place near the middle of the sides in G. hagi. The suture line varies in complexity from shallow to deep and ramified indentations; in width and division of ES; and in degree of dependence of the auxiliaries.

These many characters of form, ornament, and suture line are combined in a very complex way, with little co-ordination or 'linking' of character with character, to form a great number of species. The combinations are much too complex to admit of a simple classification. The following arrangement of a few species in the form of a key will demonstrate the variety of combinations in which the characters are cast and how difficult it is to resolve this family into well-defined species groups or genera. It will also serve to show the relation of the Canadian to other species in various parts of the world.

Canadian species are marked with an #

I. Compressed whorls with deeply cut to, rarely, moderately cut suture lines with dependent auxiliaries, and wide, divided ES or narrow undivided ES
  a. Smooth whorls or at maturity strong ribs or folds of Japonites pattern. Gymnites Mojsisovics
    A. Rounded venter
      1. Moderately to quite evolute
        G. ankara (wide, divided ES)
        G. gibbornalis (narrow, undivided ES)
        G. incultus (narrow, undivided ES)
      2. Involute
        G. subclausus
    B. Sharp venter
      1. Evolute
        G. volujakensis
      2. Involute
        # G. hollandi (suture line not very complex)
  b. Curved ribs, accentuated on middle of sides (Buddhaites Diener)
    A. Rounded venter
      1. Moderately involute
        G. (Buddhaites?) jollyanus
    B. Sharp venter
      1. Involute
        G. (Buddhaites) rama
  c. One or two lateral rows of spines or nodes. Mostly deeply cut suture lines with divided ES. Aux. variously dependent
    A. Rounded venter
      1. Fairly evolute
        G. alexandrae

d. Radial costae
A. Sharp venter
1. Involute
G. subclausus Hauer var. Salopek (n.sp.?)
G. hagi

II. Evolute, with stout to moderately compressed whorls. Suture line of complexity intermediate between Gymnites and Anagymnites; undivided ES and non-dependent aux.
a. Recurved ribs or folds, strongest near umbilical shoulder.
A. Angular venter. Japonites Mojsisovics
J. planiplicatus
J. chandra
J. sugriva
J. ganghoferi (very simple suture line)
B. Rounded venter
J. ugra (very simple suture line - compressed. To IIIa B ? but non-dependent aux.)

III. Fairly stout to compressed whorls. Very simple suture line, undivided ES, dependent aux.
a. Smooth whorls
A. Angular venter
1. Moderately involute. Anagymnites Hyatt
A. lamarcki
A. cf. lamarcki
2. Involute
A. involutus (compressed)
A. via-alaska (compressed)
B. Rounded venter
1. Fairly evolute
A. depauperatus (compressed)

Genus, Gymnites Mojsisovics
Gymnites hagi McLearn
Plate I, figure 4

1946. Gymnites hagi McLearn: Geol. Surv., Canada, Paper 46-1. p. 13 (mimeograph); same, Appendix II, p. 1 (in print), Pl. I, fig. 4.

This is a compressed, involute species with sharp venter and rounded umbilical shoulder. Low, straight, radial ribs extend from the umbilical shoulder to the middle of the side of the whorl. Outside this the ribs are fainter and either straight or slightly projected near the venter. A few faint, radial furrows are seen on the surface of the shell. The suture line is complex and of the Gymnites pattern; the ES is deeply divided; the auxiliary series of lobes and saddles is dependent, but not so much so as in some other species of Gymnites.

This species is very close to a variety of Gymnites subclausus Hauer figured by Salopek (1911) from Dalmatia; the suture line is not so complex, however. Gymnites subclausus Hauer has a rounded, not sharp, venter. The surface ornament is quite different from that of the genus Buddhaites.

Measurements of the holotype are: 40.0; 53.5; 17.5; --.

The species name is given for C.O. Hage.

Type. Geological Survey collections: holotype, Cat. No. 6447.

Gymnites hollandi McLearn
Plate VI, figure 1

1946. Gymnites hollandi McLearn: Geol. Surv., Canada, Paper 46-1, p. 14 (mimeograph); same, Supplement to Appendix II, p. 3 (in print), Pl. VI, fig. 1.

This is a large, sharp ventered, involute and compressed species. The surface is nearly smooth.

Compared with Gymnites hagi it has a smoother surface, a simpler suture line, and an undivided, not divided, ES.

Measurements taken one-quarter whorl from the anterior end of the holotype are: 200.0; 58.0; 19.5; 0.0.

The name is given for Dr. S.S. Holland.

Type. Geological Survey collections: holotype, Cat. No. 6448.

Genus, Anagymnites Hyatt
Anagymnites via-alaska McLearn n.sp.
Plate VII, figure 1

1946. Anagymnites involutus var. via-alaska McLearn: Geol. Surv., Canada, Paper 46-1, p. 14 (mimeograph); same, Supplement to Appendix II, p. 3 (in print), Pl. VII, fig. 1.

Compared with Anagymnites involutus Gugenberger the specimens of this variety are similarly involute, very compressed, have a sharp venter, and a simple suture line with very small indentations. The saddles of the suture line are wider, however, and the surface has small, irregular varices of growth.

It is proposed that via-alaska be used as a species name.

Measurements taken at about the middle of the penultimate whorl are: 56.0; 43.0; 21.5; 26.5.

via, highway; Alaska, a geographic name.

Type. Geological Survey collections: holotype, Cat. No. 6446.

Family, Hungaritidae Waagen

The Middle Triassic shells of the family Hungaritidae include, on the one hand, carinate, highly ornate shells, as in the genera Judicarites, Eutomoceras, Halilucites, and Hungarites, and on the other oxycones or near oxycones as in the genus Longobarditès and as in Middle Triassic species that have been referred, probably incorrectly to the Lower Triassic genus Dalmatites. Of the carinate-ornate genera Hungarites has the weakest costate ornament and probably is the closest of them to the oxyconic genus Longobarditès; it may be noted, in this regard, that both Spath (1934) and J. Perrin Smith (1932) recognize the close relation of Hungarites and Longobarditès.

Neither typical Hungarites nor any of the carinate-strongly ornate genera of the family are present in the Beyrichites-Gymnotoceras fauna of northeastern British Columbia. There the most common shell is the smooth or

almost smooth oxycone, compressed, involute, and with sharp venter. Some of these oxycones have smooth inner whorls; others have carinate-ornate, evolute, fairly stout inner whorls; and some have carinate-ornate, cadiconic, thick, depressed, inner whorls. These oxycones with both carinate-ornate and with smooth inner whorls show considerable variation in suture line, which together with the nature of the inner whorls, must be considered in assigning them to species and genera. Oxycones with smooth inner whorls and with a Longobardites pattern of suture line of course belong to the genus Longobarditos. Oxycones with carinate-ornate inner whorls are considered to be developments parallel with Longobarditos and Hungarites; those with Longobarditos pattern of suture line are, for the present, retained in Longobarditos, and it happens that these include the shells with evolute carinate-ornate inner whorls. All others, that is those not placed in Longobarditos, those with non-Longobarditos style of suture line and with smooth or carinate-ornate inner whorls are, for the present, included tentatively in 'Hungarites'.

The early carinate-ornate stage in the oxyconic species persists later in the ontogeny of some specimens than in others, producing an ontogenetic variation or 'variation in ontogenetic time' as it has been called.

The suture lines of the oxycones show a considerable range of variation. Some have a Longobarditos pattern. Others have, what may be called for our present purpose, a non-Longobarditos suture line. Some are of a pattern intermediate between the two. The intermediate style occurs in some typical species of Hungarites.

The Longobarditos suture line has typically deep, slender saddles and long lobes. S1 is in many specimens larger than ES; S2 may or may not be as large as S1 and is situated on, or near, the middle of the side of the whorl; the first auxiliary saddle is fairly large in some specimens, but mostly smaller than S2; at least three auxiliary saddles of fair size lie between S2 and the umbilical shoulder. L2 is as large as, and in some specimens larger than L1; the first auxiliary lobe is large in some specimens; and all lobes are indented at the base. The inner whorls at a diameter of about 10 mm. have a simpler suture line with only two auxiliary saddles between S2 and the umbilical shoulder; S2 is inside the middle of the side of the whorl; the saddles are not so deep and slender as at later stages of growth; ES is larger than S1 and S1 larger than S2; and L1 is larger than L2. With growth, S1 and S2 increase in size so that S1 equals or exceeds ES in size and S2 is as large as S1; L2 increases in length and width to equal or exceed L1 in size; the auxiliary saddles increase in number and S2 moves out to a position on or near the middle of the side of the whorl; the saddles become deeper and more slender in outline.

Smith (1914) noted changes in the suture line with the growth of the shell, for he states that "even in the early mature stages there is no differentiation into an adventitious and a lateral series".

Species currently included in Hungarites show considerable variety of pattern of suture line. Some typical species have a suture line intermediate between the Longobarditos and what will be defined below, for the purpose of this report, a non-Longobarditos line; they have a large S1, even in some specimens as large or larger than ES; have in some specimens a large S2, always farther inside the centre of the side of the whorl than in Longobarditos; have lower and less slender saddles than those of Longobarditos; and have smaller auxiliary than principal saddles; L2 is almost, or as large as L1 and the lobes are indented at the base. Variations occur away from this pattern to what is here called the non-Longobarditos suture line, in which the saddles and lobes decrease in size from venter to umbilical margin. This pattern of suture line resembles to some extent that of Discoceratites. It, however, does not have the very large ES of Coratites nodosus (Bruguiere).

Typical species of Hungarites have compressed, fairly involute whorls, with narrow venter, strong ventral keel, shallow ventral furrows in some species, angular or even square-angled ventro-lateral shoulder, and costate or costate-tuberculate to smooth surfaces; the costae may be long or short and on the inner part of the sides of the whorl; the costation is weaker than in other carinate-ornate genera of the family, however. The group of 'H.' caurus has a venter nearest to that of Hungarites; the ventro-lateral shoulder is not so well defined and the keel at maturity is weaker and thin, somewhat as in the species of Hungarites described by Kiparisova from the mouth of Olenek River. The rapid change in growth, however, from stout carinate-costate inner whorls to compressed outer whorl is unknown in species currently referred to Hungarites.

The Hungaritidae of the Lower Triassic include smooth or nearly smooth oxycones as in Dalmatites; evolute, carinate-costate shells as in Pseudharpoceras; evolute, tuberculate, costate and weakly carinate shells as in Prohungarites tuberculatus (Welter); and fairly involute, weakly costate, compressed shells with fastigate venter or weak keel and ventro-lateral shoulders as in typical Prohungarites Spath.

Middle Triassic Hungaritids have more elements in the suture line, on the average, than Lower Triassic shells of the same family.

Due caution must be exercised and too positive statements cannot be made in seeking among these Lower Triassic genera and species the progenitors of the Middle Triassic species and genera of this family, considering: that the known Lower Triassic genera and species may not represent a complete record of Lower Triassic Hungaritids; that oxycones may arise in any stock; that carinae or keels, costae, tubercles, and angular ventro-lateral shoulders may arise independently and at different times in closely related stocks; and that any characters may make their first appearance in early stages of the ontogeny (coenogenesis). Spath (1934) notes that the Hungaritids are keeled derivatives of the Meekoceratids and Ceratitids. Smith (1932) has suggested that the Middle Triassic genus Longobardites may have developed out of Triassic Dalmatites.

Except for the following observations the subject of the derivation of the Middle Triassic genera will not be pursued further. A combination of characters, namely of evolute, compressed shell, lateral costae, ventral keel, and ventral furrows, found in the Middle Triassic genus Judicarites (group of arietiformes, Mojsisovics) occurs also in the Lower Triassic genus Pseudharpoceras, but is accompanied in the Lower Triassic by a somewhat simpler suture line with fewer lobes and saddles. The style of venter and ventro-lateral shoulder found in the Middle Triassic genus Hungarites is to some extent forecast in the Lower Triassic genus Prohungarites Spath, for example in P. similis Spath; the keel is not the strong elevated keel of typical Hungarites, however. The oxyconic shell, well known in Middle Triassic Longobarditos and other genera, first appears in this family in the Lower Triassic, in the genus Dalmatites. In seeking the origin of the oxycones with carinate-costate inner whorls in the Middle Triassic Beyrichites-Gymnotoceras fauna, the hypothesis of origin from an oxycone with introduction of the carinate-ornate whorl in the early stage of growth, that is, coenogenetically, should be considered among the hypotheses.

The Middle Triassic species in northeastern British Columbia can be classified according to the ornament of the inner whorls:

A. Carinate-costate to smooth inner whorls
  a. Oxycones
    1. Longobarditos suture line
      L. canadensis
      L. internatus
      ? L. larvalis
    2. Intermediate to non-Longobarditos suture line.
      'H.' mctaggarti
      'H.' mackenzii

b. Hungarites-like venter
'H.' caurus
'H.' boreas
'H.' dawsoni

B. Weakly costate inner whorls
a. Near oxycones
'H.' bufonis

C. Smooth inner whorls
a. Oxycones
'H.' nahwisi
'H.' ovinus

They can also be classified according to the form of the outer whorls:

A. Ventral keel and ventro-lateral shoulder (Hungarites venter)
a. carinate-costate inner whorls
'H.' caurus
'H.' boreas
'H.' dawsoni

B. Oxycones
a. Intermediate to non-Longobardites suture line
1. Smooth inner whorls
'H.' nahwisi
'H.' ovinus
2. Carinate-costate inner whorls
'H.' mctaggarti
'H.' mackenzii
b. Longobardites suture line
1. Carinate-costate-tuberculate to smooth inner whorls
L. canadensis
L. internatus
? L. larvalis

C. Near oxycone
a. Faintly costate inner whorls
'H.' bufonis

Genus, Longobardites Mojsisovics
Longobardites canadensis McLearn
Plate III, figures 1, 5, 6; Plate X, figure 3

1946. Longobardites canadensis McLearn: Geol. Surv., Canada, Paper 46-1, p. 14 (mimeograph); same, Appendix, p. 1 (in print), Pl. III, figs. 1, 5, 6.

The mature shell is a nearly smooth oxycone with flattened outer part of sides and well-defined umbilical shoulder. The inner whorls have a narrow, rounded venter with or without keel, and are finely costate, as in the holotype, to nearly smooth. The suture lines of the paratype and a plesiotype are figured; the first saddle, interpreted to be ES, is mostly narrower than the second, interpreted to be S1. L2 in some specimens is longer and wider than L1.

The costate inner whorls distinguish this species from Longobardites nevadanus Hyatt and Smith. Specimens with nearly smooth inner whorls are very close to L. nevadanus and may prove to be of that species. Indeed further studies may show L. canadensis and L. internatus to be varieties of L. nevadanus. The whorls ar thicker, the inner whorls more ornate, and the auxiliary lobes are fewer than in L. zsigmondyi Boeckh. The venter is sharper than that of Hungarites solomani Toula and the suture line has more of a Longobardites pattern.

Measurements of holotype are: 36.8; 59.5; 24.5; 8.0.

Canada, a geographic name.

Types. Geological Survey collections: holotype, Cat. No. 6449; paratype, Cat. No. 6450; plesiotype, Cat. No. 9581.

Longobardites internatus McLearn
Plate I, figure 1; Plate XI, figures 7 to 10

1946. Longobardites internatus McLearn: Geol. Surv., Canada, Paper 46-1, p. 15 (mimeograph); same, Appendix, II, p. 1 (in print), Pl. I, fig. 1.

The holotype is an entirely septate specimen. Posterior part of ultimate whorl preserved is about as thick as high; has rounded, wide, low keel bordered by narrow, shallow furrows; and has sides ornamented with weak costae and fairly strong tubercles. At anterior end passes to almost smooth oxycone with compressed whorl, sharp venter, small umbilicus, and well-defined umbilical shoulder. With these changes the suture line increases in numbers of saddles and lobes and attains a Longobardites-like pattern. The ultimate whorl of larger specimens is an almost smooth oxycone, and at this 'Longobardites' stage of growth it can with difficulty be distinguished from L. canadensis, either with carinate-costate or smooth inner whorls, for at this stage the inner whorls are completely enclosed. In the earlier carinate-ornate stage, however, it can be distinguished by the stage of growth to which this carinate-ornate shell persists, and in specimens close to the holotype by the presence of tubercles as well as costae. In practice the writer has placed in L. internatus shells in which the carinate-ornate whorls persist beyond a diameter of about 15 mm. Actually L. internatus is little more than a variety of L. canadensis.

The ceratitic, multisellate suture line is like that of Longobardites canadensis. The saddles are high and slender; S2 is close to the middle of the side of the whorl; S1 and S2 are at least as large as ES; L2 is as large as L1 and in some specimens a little larger.

Compared with specimens of Hungarites solimani Toula, with ornate inner whorls, L. internatus has keeled-costate-tuberculate inner whorls, not merely costate inner whorls, the venter is apparently sharper and the suture line is somewhat more of a Longobardites-like pattern, the S2 being farther out on the side of the whorl; Arthaber's figure of the suture line of H. solimani shows a high, slender ES and S1.

The inner whorls of L. internatus resemble shells of Hungarites grumulus Kiparisova. At the same stage of growth, however, the Siberian species has fewer and less slender lobes and saddles and the ornament differs in detail.

Measurements of the holotype are: 33.5; 56.5; 26.5; 17.5.

inter, within; ornatus, embellished.

Types. Geological Survey collections: holotype, Cat. No. 6466; plesiotype, Cat. No. 9582.

Longobardites larvalis n.sp.
Plate IX, figures 3, 4

The holotype is a small specimen, probably not of mature growth, and may represent the inner whorls of an oxycone like Longobardites internatus, the inner whorls of which it resembles.

About one quadrant of living chamber is preserved, the remainder of the ultimate whorl, as preserved, being septate. It is evolute, with thick whorl, rounded umbilical shoulder, rounded sides and distinct keel, which is bordered

by small furrows. On the sides of the whorl are large, irregular tubercles, spines, and bullae; a faint strigate ornament is observed.

The suture line is ceratitic, with deep, slender saddles; ES is wider, but not deeper, than S1; L1 is indented at the base and longer and wider than L2.

It is a reasonable hypothesis that this shell belongs to a species resembling L. internatus, but one in which the volute, carinate-ornate stage persisted longer in the ontogeny. It has not grown to the oxycone stage with its Longobarditos suture line.

Type. Geological Survey collections: holotype, Cat. No. 9583.

Genus, Hungarites Mojsisovics
Hungarites mctaggarti (McLearn)
Plate II, figure 5; Plate X, figures 1, 2

1946. Longobarditos mctaggarti McLearn: Geol. Surv., Canada, Paper 46-1, p. 16 (mimeograph); same, Appendix II, p. 2 (in print), Pl. II, fig. 5.

The holotype and only known specimen is entirely septate.

In the first quadrant of the penultimate whorl, as preserved, the whorl is much thicker than high, about as 7 to 4, and the umbilicus is wide. The sides of the whorl are crossed by stout ribs, the broad venter has a well-defined keel, bordered by shallow furrows and a low ridge dorsal to each furrow; faint, distant ribs, directed forward at an angle, extend from the ends of the strong lateral ribs on the ventro-lateral shoulder to the low ridges bordering the ventral furrows. The anterior end of the penultimate whorl has a more or less triangular section, a little higher than thick, with fairly sharp venter. It is smooth and has gently convex, convergent sides and narrow umbilicus; the maximum width is near the umbilical border.

The ultimate whorl preserved is entirely septate, involute, sharo-ventered, a little more than twice as high as thick with rounded, umbilical shoulder and smooth, gently convex sides. The shell thus passes from keeled and ribbed cadicone to smooth oxycone.

In the penultimate whorl of the holotype, as preserved, the suture line is ceratitic and simple. The saddles are low and relatively broad; S1 is much lower (shorter) than ES; S1 is on the ventro-lateral shoulder; and S2 is smaller than S1 and on the umbilical wall. L1 is much larger than L2 and has a few indentations at the base. The suture line on the ultimate whorl preserved is very different. Six saddles lie between EL and the umbilical shoulder; S1 is larger than ES; L2 is almost as large as L1. S2 is much smaller than S1 and is inside the middle of the side of the whorl, thus having a different position than in the suture lines of Longobarditos internatus and L. canadensis. Also the saddles are not so deep and slender as in these species. The suture line is closer to that of some species of Hungarites than to Longobarditos.

It is probable that in a complete specimen of this species, that is with the living chamber intact, the inner carinate-costate whorls would be completely invisible. It could, however, be distinguished from Longobarditos internatus and L. canadensis by the somewhat less compressed whorl and by the suture line. The important difference, however, lies in the inner whorls, which are much thicker, have only short lateral ribs, and have lateral low keels, marginal to the ventral furrows, in addition to the ventral keel.

The species name is given for K.C. McTaggart.

Type. Geological Survey collections: holotype, Cat. No. 6474.

'Hungarites' mackenzii n.sp.
Plate XII, figure 3

The holotype and only specimen is imperfect, but is sufficiently well preserved to establish the species. It is entirely septate.

The antepenultimate whorl preserved is evolute and depressed, being much thicker than high, and it has a low keel. The ornament is unknown.

The penultimate whorl is moderately evolute, about as high as thick, rounded on the sides, with abruptly rounded umbilical shoulder, small ventral keel, and distant, faint ribs.

The ultimate whorl, as preserved, is compressed, being much higher than thick, involute, with sharp venter and smooth, gently convex sides; an oxycone.

Six saddles are seen between EL and the umbilical shoulder. ES is somewhat larger than S1 and S1 is much larger than S2, which is inside the middle of the side of the whorl; other saddles are small. L1 is larger than L2; the bases of both are finely indented, as are also the first and second auxiliary lobes.

This species has less stout and less ornate inner whorls and has a different suture line than 'Hungarites' mctaggarti; S1 is not larger than ES, and the saddles are not so deep or slender in outline as in that species.

Type. Geological Survey collections: holotype, Cat. No. 9584.

'Hungarites' caurus n.sp.
Plate XI, figures 1, 2

The holotype and only specimen is fairly well preserved.

The posterior end of the ultimate whorl is almost as high as thick, has a well-defined keel and fairly stout ribs on the sides. The anterior part of the same whorl is more compressed, being much higher than thick, having somewhat flattened sides, greatly reduced keel, narrow venter, rounded ventro-lateral shoulder, rounded umbilical shoulder, and greatly reduced ribbing.

This species is much smaller than 'Hungarites' boreas, the passing from stout, strongly ribbed whorl to compressed shell coming at an earlier stage of growth.

Approximate measurements are: 20.5; 49.5; 32.5; 25.

Type. Geological Survey collections: holotype, Cat. No. 9585.

'Hungarites' boreas n.sp.
Plate XI, figures 3, 4

Only part of the holotype is known, including the first and last quadrants of the ultimate whorl, as preserved, and at least a quadrant of living chamber.

The first quadrant has a whorl about as high as thick, is moderately involute, has rounded sides and venter, a low, but distinct ventral keel, and fairly strong, rather approximate, radial ribs on the sides of the whorl. These ribs do not extend to the keel and the surface is rather smooth on either side of the keel.

On the last quadrant, the shell is moderately involute and somewhat compressed, the whorl being higher than thick, somewhat flattened on the sides, with narrow venter, low, narrow, ventral keel, with ventro-lateral shoulders becoming distinct near the anterior end and with well-defined umbilical shoulder. The ornament is declining, consisting of low, narrow, somewhat sigmoidal ribs, becoming weaker and finally disappearing as they approach the venter where only growth lines are present and extend almost straight across the venter.

Although the holotype specimen may not have reached full size, it is smaller than 'H.' dawsoni and larger than 'H.' caurus, and the compression of whorl and reduction in keel and ribbing come at an earlier stage of growth than in 'H.' dawsoni and at a later stage than in 'H.' caurus.

Measurements at beginning of last quadrant are: 25.5; 49; 40; 25.

Type. Geological Survey collections: holotype, Cat. No. 9586.

'Hungarites' dawsoni n.sp.
Plate X, figures 8, 9

More than half a whorl of living chamber is preserved.

The last quadrant of the penultimate and the first quadrant of the ultimate whorl of the holotype, as preserved, are fairly stout, somewhat higher than thick, with narrow fastigate venter and strong ribs on inner side of whorl; the ribs flatten and disappear before reaching the venter.

The last quadrant of the ultimate whorl, as preserved, is fairly involute and compressed, being much higher than thick. The venter is fastigate, and well-rounded ventro-lateral shoulders are present. The umbilical shoulder is rounded. The ribbing is declining, consisting of low flat ribs or folds, somewhat sigmoidal in outline.

The suture line is not fully known; it is simple and ceratitic. ES is larger than S1 and L1 is much larger than L2.

The inner whorls are not known. However, it seems to be a sound deduction that 'H.' dawsoni belongs to the series 'H.' boreas and 'H.' caurus, the outer whorl being so similar. 'H.' dawsoni seems to differ from the other two in the larger size and postponement of compressed whorl to a later stage of growth. Keeled-costate inner whorls may be inferred as a reasonable hypothesis.

The species was listed in the first edition as Hungarites cf. triformis Mojsisovics. The resemblance in the living chamber stage to H. triformis is considerable. However, the growth in 'H.' dawsoni is definitely from stout to more compressed whorls and not from thin to stouter whorls. It is inferred that the ornament is from strongly ribbed to weak-ribbed, and not from smooth to rather weak ribs as in H. triformis.

The species 'H.' caurus, 'H.' boreas, and 'H.' dawsoni are closer in general appearance to true Hungarites than any of the foregoing species provisionally referred to this genus. They have fairly well developed ventro-lateral shoulders on the living chamber, and the ribbing of the inner part of the sides is much like that of some species of Hungarites, although unlike the longer, although weak, ribbing of species like H. mojsisovicsi. The keel at the adult stage, however, is not prominent, being very small or replaced by merely the angulation of a fastigate venter.

Hungarites involutus Kiparisova has venter and ventro-lateral shoulder much like that of the living chamber of 'H.' dawsoni and related species, but is more compressed and involute and has compressed inner whorls.

Estimated measurements taken near the anterior end of the ultimate whorl: 48; 55; 33; 14.5.

Type. Geological Survey collections: holotype, Cat. No. 9587.

'Hungarites' bufonis n.sp.
Plate X, figures 4 to 6

This species includes compressed, involute shells with fairly sharp venter: at anterior end of ultimate whorl, as preserved, the venter widens and is merely fastigate with weak ventro-lateral shoulders. Surface has irregular varices of growth and sigmoidal uneven faint folds.

Inner whorls at diameter of about 4 mm. is round, evolute, with faint, lateral costae.

The suture line is simple and ceratitic. ES and S1 are fairly high, S2 is smaller than either, and auxiliary saddles are very small. L1 is wide and is longer than L2; both are indented at the base.

The holotype of 'Dalmatites' parvus Smith somewhat resembles the inner whorls of 'H.' bufonis, but the curve of the growth lines is different; the suture line may not be similar and it may not be congeneric with 'H.' bufonis.

Approximate measurements of holotype: 44.5; 56; 27; 6.7.

Types. Geological Survey collections: holotype, Cat. No. 9588; paratype, Cat. No. 9589.

'Hungarites' nahwisi n.sp.
Plate XII, figures 4, 5

Only the holotype is known, of which about one-half whorl of living chamber is preserved.

The antepenultimate whorl, at a diameter of about 14 mm. is compressed involute, with narrowly rounded venter and smooth surface.

The penultimate whorl is involute, compressed, sharp-ventered, and smooth.

The ultimate whorl, as preserved, is involute, compressed, sharp-ventered, and almost smooth; the surface has fine sigmoidal lines of growth.

The saddles of the suture line are low and wide, the lobes are short and wide, very finely indented at their bases. L1 is larger than L2; ES is not much larger than S1, but S1 is larger than S2; about three auxiliary lobes and saddles are present.

The venter is sharper and the number of auxiliary lobes and saddles is greater than in Hungarites involutus var. laevis Kiparisova.

Approximate measurements are: 81; --; --; --: 60; 51.5; 24.5; 4.5.

Type. Geological Survey collections: holotype, Cat. No. 9590.

'Hungarites' ovinus n.sp.
Plate XII, figures 1, 2

The holotype, entirely septate, is the only known specimen.

The antepenultimate whorl is moderately compressed, with somewhat fastigate venter and smooth surface at least on the outer part of the whorl, near the venter.

The penultimate whorl, seen in cross-section, is compressed, with sharp venter.

The ultimate whorl, as preserved, is compressed, involute, and sharp-ventered. Near the posterior end are about three distant, low folds on the middle of the side of the whorl.

The saddles are moderately deep; LS and S1 are of about the same size; L1 is very wide and larger than L2 and is finely indented.

The saddles are deeper and the lobes longer than in 'Hungarites' nahwisi, and the inner whorls are thicker and have a fastigate, not rounded, venter.

The smooth oxycones of the outer whorls and the smooth, compressed inner whorls of 'Hungarites' nahwisi and 'H.' ovinus recall the similar whorls of Longobarditos, but the suture lines are quite different.

Approximate measurements are: 70; --; --; --; 56; 57; 25; 7.

Type. Geological Survey collections: holotype, Cat. No. 9591.

Family, Acrochordiceratidae Arthaber emend. Spath
Genus, Acrochordiceras Hyatt
Subgenus, Paracrochordiceras Spath
Acrochordiceras (Paracrochordiceras) americanum McLearn
Plate V, figure 1

1946. Acrochordiceras (Paracrochordiceras) americanum McLearn: Geol. Surv., Canada, Paper 46-1, p. 16 (mimeograph); same, Supplement to Appendix II, p. 3 (in print), Pl. V, fig. 1.

The anterior part of the ultimate whorl is stout, a little thicker than high, somewhat flattened on sides, gently arched on venter, and has gently rounded umbilical shoulder. Posterior part of same whorl is much thicker than high. Surface of this whorl covered with broad, single ribs that are of maximum width on the venter; ribs are a little projected on the sides, but are straight across the venter. Innermost whorls smooth or with widely spaced, broad undulations on sides.

The ribs appear at a later stage of growth, and are finer and more numerous than in Acrochordiceras (Paracrochordiceras) anodosum Welter.

Measurements of the holotype are: 38.0; 34.0; 37.0; 43.5.

America, a geographic name.

Type. Geological Survey collections: holotype, Cat. No. 6475.

Family, Beyrichitidae
Genus, Beyrichites Waagen

The Canadian species referred to this genus have weak ornament at all stages of growth or have ornament of various degrees of strength, which declines on outer whorls.

They include:
A. Weak ornament at all stages
Beyrichites cf. osmonti Smith

B. Ornament declining or modified on outer whorls
  a. ribbed or costate inner whorls
    Beyrichites aff. tenuis Smith
    Beyrichites cf. falciformis Smith
  b. ribbed and bullate inner whorls
    Beyrichites deleeni

Beyrichites deleeni departs from the normal genus, for it has umbilical bullae and a keel, although a weak one, on the inner whorls. It lacks the lateral and ventral tubercles of Gangadharites Diener.

Beyrichites cf. osmonti Smith

This is a large, compressed, involute shell, having an almost smooth surface at least as far back as the middle of the penultimate whorl, an almost angular umbilical shoulder, a narrow venter, except at the anterior end where the venter is broad and flat and has a rounded ventro-lateral shoulder.

It is somewhat more compressed and has a better defined, more angular umbilical shoulder than the type of B. osmonti.

Beyrichites aff. tenuis Smith

Specimens so designated have compressed, fairly involute whorls, with narrow, almost fastigate venter, angular umbilical shoulder, and flexiradiate low ribs or costae on the inner whorls, passing to a yet more reduced ornament with faint, low folds, strongest near the ventral shoulder.

Beyrichites cf. falciformis Smith

A large specimen resembles Beyrichites falciformis Smith; on the posterior part of the ultimate whorl, it has low, even, single ribs, only curved a little on the sides and on the anterior part of the same whorl; it is nearly smooth, with only faint undulations. The Canadian specimen is larger and the stage of even ribbing persists to a later stage of growth than in the type specimen of B. cf. falciformis.

Beyrichites deleeni McLearn
Plate I, figure 5; Plate II, figure 3; Plate IX, figure 2

1946. Beyrichites deleeni McLearn: Geol. Surv. Canada, Paper 46-1, p. 16 (mimeograph); same, Appendix II, p. 2 (in print), Pl. I, fig. 5, Pl. II, fig. 3.

This is a compressed, moderately involute species. The inner whorls are higher than thick, have convergent sides, a somewhat flattened, lowly convex venter, a distinct but rounded ventro-lateral shoulder, an abruptly rounded umbilical shoulder, and an indistinct keel; rather stout ribs branch from stout, short, elevated 'primary' ribs or 'bullae' and are projected forward on the ventro-lateral shoulder. At maturity the whorl is relatively much higher than thick, is more involute, has a broader, more rounded venter, a less distinct ventro-lateral shoulder, and weaker, declining ribbing; only low, distant folds remain on the surface, particularly at the very anterior end, or the surface becomes smooth. The suture line has a high ES and high S1 with small indentations, a rather low S2, with small indentations, and a very low, but broad first auxiliary saddle. Four lobes are present on the side of the whorl between ES and the umbilical shoulder; L1 is long, L2 some-

what shorter than L1, although about as wide; the first auxiliary lobe is smaller than L2 and the second auxiliary lobe is very small and about on the umbilical shoulder.

This species is quite variable. It varies in stage of growth at which decline in ornament occurs; in kind of ornament after decline, including low, radial, curved folds or nearly smooth surface; in retention of distinct ribbing on ventro-lateral shoulders after decline of ornament on sides of whorl; in strength of 'bullae'; in compression of whorl; and in degree of involution.

Although most specimens do not attain a mature stage of growth, a mature feature of the living chamber is a widening and rounding of the venter.

The inner whorls at a diameter of about 15 to 20 mm. are easily recognized; they are fairly compressed; rather evolute, at first having fine single ribs and a little later strong bullae or short ribs near the umbilical shoulder; this is followed by a stage in which the ribs branch from these bullae; with the early bullae appear ventro-lateral auriculoids.

Varieties of this species with faint 'bullae' pass towards Beyrichites falciformis Smith, which lacks the 'bullae' or short primary ribs. Branching of the ribs is more common than in Smith's species, that is, single ribs are less common. The ribbing of the inner whorls is more pronounced than in most other species of Beyrichites.

Measurements of holotype are: 38.0; 52.5; 37.0; 22.5.
Measurements of paratype are: 61.0; 55.0; 33.0; 16.5.

The name is given for J.L. DeLeen.

Types. Geological Survey collections: holotype, Cat. No. 6479; paratype, Cat. No. 6480.

Genus, Hollandites Diener

Many specimens in the collections are moderately evolute, somewhat compressed, with some tendency to formation of a ventro-lateral shoulder, narrow to somewhat broad, but mostly narrow, venter, mostly well-defined umbilical shoulder, with sigmoidal ribs of varying degree of curvature or 'stiffness', and with no keel, bullae, or tubercles. They exhibit a fair degree of differentiation, and evidently belong to at least several species. Many specimens appear to be incomplete, that is, they have not grown to full size. For this reason only three of the larger and better preserved specimens are described. They are tentatively referred to Hollandites. None has reached the stage of more or less evolute, compressed whorl, with single, lateral ribs or folds, of the Himalayan species. Some of the British Columbian species seem to approach, in some degree at least, Smith's 'group of Ceratites rotuloides', which Spath includes in Frechites.

Hollandites ? mcconnelli McLearn
Plate IV, figure 2

1946. Hollandites ? mcconnelli McLearn: Geol. Surv. Canada, Paper 46-1, Supplement to Appendix II, p. 3 (in print), Pl. IV, fig. 2.

Much higher than thick whorls, rounded smooth venter, almost angular umbilical shoulder. Low, rather wide ribs, slightly convex on sides, are projected forward on poorly defined ventral shoulders; a few ribs bifurcate

near middle of sides; at anterior end, a few broad ribs bifurcate high on the sides of whorl; others are single. Ceratitic suture line. Smaller and with wider umbilicus, broader ribs, and shorter saddles than H. voiti (Oppel), and no tubercles are present.

Measurements near anterior end: 49; 44.5; 28; 27.5.

Type. Geological Survey collections: holotype, Cat. No. 9481.

Hollandites? humi McLearn
Plate IV, figure 1

1946. Hollandites? humi McLearn: Geol. Surv., Canada, Paper 46-1, Supplement to Appendix II, p. 3 (in print), Pl. IV, fig. 1.

Rather stout whorls, a little higher than thick, with convergent, gently convex sides, rounded ventro-lateral shoulders, rounded, smooth venter, and almost angular umbilical shoulders. Ribs slightly convex on sides, projected a little on ventral shoulders; some single, some short and intercalated, some bifurcating from short, elevated 'primary ribs'. Ceratitic suture line, but small notches extend high up on saddles; ES much wider than S1 or S2. Has lower and thicker whorls and stronger and more single ribs than H.? mcconnelli.

Approximate measurements: 65; 38.5; 34.5; 25.

Type. Geological Survey collections: holotype, Cat. No. 9482.

Hollandites? spivaki McLearn
Plate V, figure 2

1946. Hollandites? spivaki McLearn: Geol. Surv., Canada, Paper 46-1; Supplement to Appendix II, p. 3 (in print), Pl. V, fig. 2.

Whorls higher than thick, with convergent, gently convex sides, narrowly rounded, smooth venter, well-rounded umbilical shoulder. Short, elevated 'primary ribs' divide below middle of sides into two ribs that are strongest where projected forward near venter. Suture line subammonitic with only small, distant indentations on saddles. Lacks the broad flattened venter and ventral 'knots' of H. organi Smith, and the umbilicus is larger; not likely congeneric.

Measurements at beginning last quadrant: 49.5; 45.5; 36.5 est.; 30.5.

Type. Geological Survey collections: holotype, Cat. No. 9485.

Genus, Gymnotoceras Hyatt

The strongly ribbed, nontuberculate, carinate or subcarinate, fairly involute shells of typical species of the genus, like Gymnotoceras blakei (Gabb), so well represented in the Middle Triassic of Nevada, have not yet been located in northeastern British Columbia. If present they must be rare.

Two other stocks or species groups are present, however.

A. Strongly ribbed, tuberculate, carinate, fairly involute, compressed shells with ventro-lateral shoulders are included in the species Gymnotoceras beachi and G. liardense. The tubercles, although lateral, are not far removed from the umbilical shoulder and may disapoear on the last whorl. They have ceratitic to subammonitic suture lines. They show some resemblance to Spitzbergen shells like those of Gymnotoceras laqueatum.

B. Another group of species includes more or less inflated, evolute to moderately evolute, non-carinate shells with convergent sides, rounded or flattened venter with variable formation of rounded ventro-lateral shoulder, without ventral tubercles, but with strong umbilical bullae. They have an earlier stage, up to about 15 mm. diameter, of rounded, evolute whorls with single costae, but no bullae or tubercles. They are a marked feature of this fauna in northeastern British Columbia, and exhibit a considerable radiation in form and ornament. Unfortunately they are too poorly preserved for a satisfactory separation into species and varieties. Only a few specimens are good enough for description and illustration.

The species with rounded whorls recall the Spitzbergen species Gymnotoceras nathorsti (Mojsisovics), but lack the keel and ventral tubercles. Spath (1924) has noted in shells like G. nathorsti a convergence towards the Stephanatids and the genus Keyserlingites. The shells with flatter venter and ventro-lateral shoulder show some resemblance to Frechites, but lack the ventral tubercles of that genus.

As already noted, these shells exhibit considerable radiation in form and ornament. What may, for convenience, be called the shell of 'Keyserlingites aspect' is fairly evolute, has a rounded, robust whorl, no ventro-lateral shoulder, and umbilical bullae. Other shells are more or less evolute, some are more compressed, some have flattened venters and ventro-lateral shoulder. They vary in width of venter, size, shape, strength, and spacing of bullae, and in number of ribs to each bulla. Rarely, the umbilical bulla moves out into somewhat of a lateral position. The ribbing declines on the outer whorls of at least one species.

In other species a stage of 'Keyserlingites aspect' gives place on the living chamber to a stage of compressed, elevated whorl with or without definite ventro-lateral and umbilical shoulders and with loss of the umbilical bullae. The stage of 'Keyserlingites aspect' may be brief.

In both the A and B species groups the suture line is ceratitic to subammonitic. Only three large saddles occur between EL and the umbilical shoulder; the auxiliary lobes and saddles are small; S2 may be equal to or smaller than ES or S1 and is situated on the bulla as in Frechites; it moves out on the side of the whorl when the bulla so moves. In one species the first auxiliary lobe is on the umbilical shoulder; in another the second auxiliary saddle has this position.

The Canadian species of Gymnotoceras can be classified as follows:

A. Ribbed, tuberculate, carinate, compressed shells
   - Gymnotoceras beachi
   - G. lairdense

B. Stage of 'Keyserlingites aspect'
   a. This stage the mature shell
      - Gymnotoceras columbianum
      - G. wrighti
      - G. helle
      - G. ino
   b. This stage followed by compressed, non-bullate stage
      - Gymnotoceras varium
      - G. moderatum

Gymnotoceras beachi McLearn
Plate V, figure 5.

1946. Gymnotoceras beachi McLearn: Geol. Surv., Canada, Paper 46-1, p. 18 (mimeograph); same, Supplement to Appendix II, p. 4 (in print), Pl. V, fig. 5.

This is a moderately involute species with whorls much higher than thick; convergent, gently convex sides; broad venter; well-rounded ventro-lateral

shoulders; abruptly rounded umbilical shoulder; small tubercles at end of faint, short 'primary' ribs from which branch two to three ribs; some single intercalated ribs, curved forward on sides, projected on ventro-lateral shoulder; and low, ventral keel. On posterior part ultimate whorl, ribs stouter, whorls thicker, venter wider, sides flat, less convergent; better defined keel-like ridge, no umbilical shoulder, and faint tubercles or bullae from which almost straight ribs extend to faint tubercles on ventral shoulder. The suture line is subammonitic, with very small frilling on the top of ES; deep indentations run, however, from the base of the lobes high up on the sides of ES, S1, and even S2; S2 is much smaller than S1, is on the umbilical tubercle, and moves out with it when it takes a lateral position; the very small first auxiliary saddle is on the umbilical shoulder. L2 is much smaller and shorter than L1; and the first auxiliary saddle is very small and just outside the umbilical shoulder.

The tubercles, although lateral, are not far removed from the umbilical shoulder.

At mature stage of growth Gymnotoceras laqueatum (Lindstrom) has apparently lost the inner tubercles, has better defined ventro-lateral shoulders, the ribs are thickened on the ventro-lateral shoulders, and the suture line may be simpler; the first auxiliary lobe, not the first auxiliary saddle, is on the umbilical shoulder.

Measurements at the beginning of the last quadrant of the ultimate whorl are: 38.5; 46.5; 36.5; 20.5.

The species name is given for H.H. Beach.

Type. Geological Survey collections: holotype, Cat. No. 6592.

Gymnotoceras liardense McLearn
Plate V, figure 3

1946. Gymnotoceras liardense McLearn: Geol. Surv., Canada Paper 46-1; Supplement to Appendix II, p. 4 (in print), Pl. 5, fig. 2.

The holotype is not a full-sized specimen. It is mostly septate; a small crushed fragment of the living chamber adheres to the septate part. Moderately involute, compressed, whorls much higher than thick, with convergent, somewhat flattened sides, narrow, somewhat rounder venter, well-defined, rounded ventro-lateral shoulders, abruptly rounded umbilical shoulders, high umbilical wall, and faint keel (sub-carinate). The ribs are a little curved on the sides of the whorl, and are projected forward a little on the ventro-lateral shoulder; they divide in twos and threes from tubercles, or somewhat bullate tubercles, at the ends of short, 'primary ribs'; some single ribs are present. In the posterior part of the last septate whorl the ribs are strong on the sides of the whorl; on the anterior part they are weaker on the sides, but are strong on the ventro-lateral shoulder. The tubercles are lateral in position, but not far from the umbilical shoulder. The crushed fragment of the living chamber indicates nothing more than loss of the lateral tubercles at this stage.

The suture line is ceratitic, but the small indentations occur high on the sides of the saddles. ES and S1 are deep and of almost equal width; S2 is much more shallow, but broad, and is on the lateral tubercle; a very small first auxiliary saddle is outside the umbilical shoulder, and a minute second auxiliary saddle is on the umbilical shoulder of the holotype specimen. Both L1 and L2 are long and wide.

Two other specimens are fairly close to the genotype, allowing for some variation in width of umbilicus and in the suture line, but in both S2 is on

the lateral tubercles, and the first auxiliary lobe is outside of the umbilical shoulder. Both are compressed, even on the inner whorls.

All three mentioned specimens show some resemblance to Gymnotoceras laqueatum (Lindstrom) in presence of tubercles on inner whorls, on loss of tubercles at maturity, and on reduction in strength of ribbing on sides, though retaining their strength on the umbilical shoulder. They, however, have much more compressed inner, that is, penultimate and antepenultimate, whorls, probably have a somewhat simpler suture line, and the first auxiliary lobe is outside the umbilical shoulder. They have higher whorls, weaker ribbing, with loss of tubercles at maturity and a somewhat simpler suture line, than Gymnotoceras beachi. They can be easily distinguished from the inner whorls of Beyrichites deleeni by the presence of lateral tubercles rather than bullae, by their finer ribbing, and by the simpler suture line.

Two other specimens have somewhat thicker and stouter penultimate and antepenultimate whorls and less well-defined tubercles than the holotype. They also retain more of the living chamber than the holotype, on which they record the loss of the lateral tubercles, decline in ribbing on the sides of the whorls, and the retention of considerable strength of ribbing on the ventro-lateral shoulder. It is possible that these two specimens are very close to Gymnotoceras laqueatum (Lindstrom), certainly closer than the holotype. Only comparison with actual specimens or photographs of G. laqueatum could establish the degree of their affinity with that Spitzbergen species.

Measurements of the holotype at about the middle of the last quadrant of the septate shell are: 31.5; 50.5; 35; 25.5.

Type. Geological Survey collections: holotype, Cat. No. 9485.

Gymnotoceras columbianum McLearn
Plate III, figure 7

1946. Gymnotoceras columbianum McLearn: Geol. Surv., Canada, Paper 46-1, p. 17 (mimeograph); same, Appendix II, p. 2 (in print), Pl. III, fig. 7.

This is a stout-whorled, moderately evolute species. The whorl is about as high as thick, has gently rounded, convergent sides; wide, lowly rounded venter; and well-rounded not very distinct ventro-lateral and well-rounded umbilical shoulder. Ornament on posterior half of ultimate whorl consists of closely spaced, broad, rounded, nearly straight ribs. On anterior part large tubercles appear, from each of which three to four ribs branch; the ribs are slightly curved on sides and projected a little near the venter. Venter smooth, with no trace of a keel. Inner whorls, seen in umbilicus, are rounded, evolute, and ornamented with single radial ribs.

The ribbing is 'stiffer', less projected, the tubercles are coarser and appear at a later stage of growth than in Gymnotoceras nathorsti Mojsisovics.

Approximate measurements of holotype are: 46.5; 45.0; 47.0; 28.0.

British Columbia, a geographic name.

Type. Geological Survey collections: holotype, Cat. No. 6691.

Gymnotoceras wrighti McLearn
Plate V, figure 4

1946. Gymnotoceras wrighti McLearn: Geol. Surv., Canada, Paper 46-1; Supplement to Appendix II; p. 4 (in print), Pl. V, fig. 4.

About one quadrant of living chamber of holotype is preserved. Whorls are higher than thick; have nearly flat, very convergent sides; narrow, rounded, smooth venter; rounded umbilical shoulder; and high, steep umbilical wall. Low ribs are slightly curved on the sides and projected a little at their ventral ends. Three ribs branch from strong, elevated, umbilical bullae, or two branch and one is intercalated.

The suture line is subammonitic, the indentations on the tops of the saddles being much smaller than those at the base of the lobes. Three large saddles lie between EL and the umbilical shoulder; S1 is almost as large as ES; S1 is smaller than S2; and the auxiliary saddles are small and are on the umbilical wall. L1 is long and wide; L2 is smaller than L1; the first auxiliary lobe is very small and on the umbilical shoulder.

Compared with Gymnotoceras columbianum, the venter is more narrowly rounded, the sides of the whorl are more convergent, and the number of ribs per each bulla is less.

Measurements at the beginning of the last quadrant of the ultimate whorl of the holotype are: 54.5; 48; 40; 28.5.

Type. Geological Survey collections; holotype, Cat. No. 9484.

Gymnotoceras helle n.sp.
Plate X, figure 7

This is an evolute, somewhat compressed phase of the species of 'Keyserlingites aspect'.

The holotype is entirely septate. The whorls are higher than thick, have somewhat flattened sides and venter, rounded ventro-lateral shoulder, somewhat convergent sides, and, at the anterior end, an abruptly rounded umbilical shoulder. On the core, the ribs are narrow, distantly spaced, bifurcating from narrow bullae, or single and short, and projected a little on the ventro-lateral shoulder. The venter is smooth.

The posterior part of the ultimate whorl, as preserved, of the holotype, is more rounded than the anterior part described above. Inner whorls, at a diameter of about 20 mm. are evolute, and have fairly distant, fine, mostly single ribs without the umbilical bullae.

The suture line is ceratitic, but the indentations run high up on the sides of ES and S1. ES is wide and deep, S1 is large, S2 is small, and the auxiliary saddles are small. On posterior part of the ultimate whorl of the holotype, S2 is on the umbilical shoulder; on the anterior part, the second auxiliary saddle is on the umbilical shoulder. L1 is wide, L2 much smaller than L1, and the auxiliary lobes are small.

This species varies in degree of evolution, compression, rounding of sides of whorl, and definition of umbilical shoulder.

It is more evolute and compressed than Gymnotoceras columbianum or G. wrighti. It has more distantly spaced ribs and more evolute inner whorls than Gymnotoceras geminatum Mojsisovics.

Approximate measurements are: 44.5; 40; 28 est; 35.

Types. Geological Survey collections: holotype, Cat. No. 9593; paratype, Cat. No. 9592.

Gymnotoceras ino n.sp.

The holotype is not perfectly preserved, but has conspicuous features that warrant description. Only about half a whorl is preserved, but all of the living chamber is known.

The shell is fairly evolute. The whorl is a little higher than thick, convergent, somewhat flattened sides, flattened venter, rounded ventro-lateral shoulder, rounded umbilical shoulder. The bullae are large and projecting. Although mostly adjacent to the umbilical shoulder, they move to a position a little outside this shoulder at the anterior end of the shell. In the posterior part of the holotype and probably at about the beginning of the living chamber, the ribs are fine and branching, about three to a bulla; at the anterior end the ribs are disappearing, but the bullae remain large and prominent.

Several larger specimens appear to belong to the anterior end of the living chamber of this species or are part of the living chamber of a very similar species. They have smooth, convergent sides; low, rounded, and flat venters; rounded ventro-lateral shoulders; and large projecting bullae near the umbilical shoulder.

The bullae are much larger than those of helle or of any other Canadian species. The loss of ribs is also distinctive. The venter is much broader than in G. wrighti.

Approximate measurements are: 52; 41; 35 est; 31.

Type. Geological Survey collections: holotype, Cat. No. 9594.

Gymnotoceras varium n.sp.
Plate XI, figures 5, 6

The antepenultimate whorl is evolute, rounded, about as high as thick, and has single ribs.

The penultimate whorl is evolute, inflated, rounded, about as high as thick, with convergent rounded sides, rounded venter, and, for a part of this whorl, strong umbilical bullae from which branch strong, somewhat distant ribs; intercalated single ribs are also present, and all ribs are projected somewhat at their ventral ends; the venter is smooth.

The ultimate whorl is much more compressed, more involute, has more flattened sides and venter, has a rounded ventro-lateral shoulder, has a rounded umbilical shoulder, loses the umbilical bullae, and has single ribs, thickest on the middle of the side of the whorl.

The suture line is ceratitic, but the indentations run up high on the sides of the saddles. ES is wider than S1. L1 is much larger than L2. The second auxiliary saddle is on the umbilical shoulder.

This species differs from both Gymnotoceras columbianum and G. wrighti. having a final stage of compressed whorl with single ribs and no umbilical bullae. It recalls to some degree a Hollandites. However, it has stouter and thicker inner whorls, with strong umbilical bullae, than any species of this genus.

Estimated measurements: 70; 43; 30; 33.

Type. Geological Survey collections: holotype, Cat. No. 9595.

Gymnotoceras moderatum n.sp.
Plate X, figure 10

The posterior part of the ultimate whorl of this small species is moderately evolute and rounded, and has closely spaced ribs, partly branching from umbilical bullae; ribs projected at their ventral ends; the venter is smooth. This is a brief stage of 'Keyserlingites aspect'.

The remainder and anterior part of the ultimate whorl is compressed, is much higher than thick, has flattened sides, gently arched, narrow venter, rounded ventro-lateral shoulders, and rounded umbilical shoulders. The somewhat sigmoidal ribs are projected forward on the ventro-lateral shoulders, the venter is smooth, and the umbilical bullae disappear.

This species is much smaller than Gymnotoceras varium, is more compressed, has more sigmoidal ribs, has only a brief stage of 'Keyserlingites aspect', and is, apparently, more involute. It lacks the keel of G. laqueatum, and the ribbing does not become weak on the sides of the whorl.

Approximate measurements: 39; 50; 18 est.; 24.5

Type. Geological Survey collections: holotype, Cat. No. 9596.

Family, Ceratitidae Mojsisovics emend Spath
Genus, Frechites Smith
Frechites kindli McLearn
Plate IV, figure 4

1946. Frechites kindli McLearn: Geol. Surv., Canada, Paper 46-1, p. 18 (mimeograph); same, Supplement to Appendix II, p. 4 (in print), Pl. IV, fig. 4.

The holotype includes the septate part of the shell only. Considerable change takes place in the ultimate whorl of this specimen; in the second quadrant the whorl is higher than thick, with somewhat quadrangular section; nearly flat, somewhat convergent sides; nearly flat venter; well-defined but rounded ventro-lateral shoulder; rounded umbilical shoulder; and very faint, indistinct keel. Tubercles near the umbilical shoulder move out from the umbilical shoulder with growth; two ribs branch from each tubercle; an intercalated rib lies between each branched pair; ribs curved and weaker on sides, stronger and a little projected on ventro-lateral shoulder. Anteriorly the whorl is higher, the venter more rounded, the ventro-lateral shoulders are less distinct, the tubercles disappear, the ribbing becomes weaker, and no keel is present. The suture line is subammonitic with very small indentations on the saddles.

Compared with Frechites nevadanus Smith, F. kindli is smaller, has thinner, more rectangular whorls, weaker lateral tubercles that disappear at an early stage of growth, and no well-defined ventro-lateral tubercles.

Measurements of the holotype are: 51.5; 48.5; 37.0; 27.0.

The species is named for E.D. Kindle.

Type. Geological Survey collections: holotype, Cat. No. 6093.

Genus uncertain

'Ceratites' hayesi McLearn

Plate I, figure 2

1946. 'Ceratites' hayesi McLearn: Geol. Surv., Canada; Paper 46-1 (mimeograph); same; Appendix II, p. 2 (in print), Pl. I, fig. 2.

The holotype is moderately evolute, with stout whorls slightly higher than thick. At anterior end of ultimate whorl the ventral and lateral areas are almost flat, and the ventro-lateral shoulder is distinct and rounded. At posterior end of same whorl the venter is narrowly rounded, the sides are flatly convex, and the ventro-lateral shoulder is poorly defined. On the sides are stout, straight ribs extending to and projected a little on the ventro-lateral shoulders. The wide ventral area is smooth, with a faint, thread-like keel. The suture line is ceratitic. Var. angulatus McLearn (G.S.C., holotype 6475) is more compressed and has a more angular ventral shoulder; some ribs do not reach this shoulder. Var. pinguis McLearn (G.S.C., holotype 6477) has thicker whorls than typical species and attains a stage of flat venter at earlier stage of growth; the ribs are mostly short and stout.

The generic position of 'Ceratites' hayesi n.sp. is not clear. It does not seem to belong to any established genus. The angular ventral shoulder and faint keel are found in the Ceratitidae, but the single non-branching ribs at all stages of growth are not so characteristic of that family. Probably a new genus is required.

Measurements of holotype are: 27.5; 40.0; 35.0; 31.5.

The species name is given for A.O. Hayes.

Type. Geological Survey collections: holotype, Cat. No. 6478.

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APPENDIX I

The Middle Triassic of Liard River, B.C.

By E.D. Kindle

In Paper 44-16 (1944) the writer applied the name Toad formation to a series of thin-bedded siltstones, shales, and thin, lenticular limestone beds of Lower and Middle Triassic age that outcrop along Liard and Toad Rivers near the mouth of the Toad, the type locality of the formation. The name was used in mapping similar siltstones, limestones, and shales that outcrop along Liard River 11 miles upstream from the mouth of the Toad, together with some overlying massive limestone and sandstone beds and minor shale beds. It was also used to include some thick, massive sandstone and grey limestone beds that outcrop at Hell Gate, 16 miles upstream from the Toad. It is now proposed that all these massive beds of grey limestone and sandstone be mapped together as a separate lithological unit to be known as the Liard formation, the type locality being at Hell Gate on Liard River.

The Toad formation, near the mouth of Toad River, is comprised of brown and black, platy shales, and grey to brown and yellowish, thin-bedded siltstone, with a few, thin, lenticular beds of grey to black, fossiliferous limestone. These strata are particularly well exposed in steep, 400-foot rock bluffs on the north side of Liard River between 1 mile and 2 miles downstream from the mouth of the Toad, where the Liard cuts easterly across the formation. The beds strike northerly, and dip from 20 to 35 degrees east. They rest upon soft, thin-bedded, light grey shales of the Grayling formation, and are overlain on the east by dark, crumbly, marine shales of the Garbutt formation (Lower Cretaceous). Three miles up Toad River the easterly dipping beds are interrupted by a small anticline, the axial plane of which also strikes northerly. On the north bank of the Liard, about 2 miles below the mouth of the Toad, a highly fossiliferous, 6-inch limestone bed occurs in black shales about 400 feet above the base of the formation. The fossils collected by the writer from this bed were identified by F.H. McLearn (1945) as representing a Lower Triassic Wasatchites fauna. His published list records the fauna as follows: 'Prionites' hollandi McLearn, Wasatchites canadensis McLearn, W. meeki var. deleeni McLearn, Anawasatchites tardus McLearn, A. merrilli McLearn, Xenoceltites robertsoni McLearn, X. cf. hannai Mathews, X. warreni McLearn, Pseudomonotis ovalis Whiteaves, P. ovalis var. kindli McLearn, and Orthoceras sp. and Wasatchites procurvus McLearn probably from this locality.

Another thin limestone band on the northeast bank of Toad River, 2 miles upstream from its confluence with the Liard, contained Wasatchites meeki var. deleeni McLearn, Pseudomonotis ovalis Whiteaves, and P. ovalis var. kindli McLearn. A few feet below this band some specimens of Posidonomya sp. were collected.

About 1,000 feet downstream from the 6-inch Wasatchites zone described above, on the south bank of the Liard and 300 feet higher in the section, or about 80 feet below the top of the formation, are several narrow beds of black limestone associated with dark argillaceous shales. Both limestone and shale beds contain abundant fossils within a thickness of 20 feet, and concretions found in the shales are also fossiliferous. McLearn reports the collection from here to be the Beyrichites-Gymnotoceras or Parapopanoceras fauna of Middle Triassic age. It included the following: Leiophyllites? kindli McLearn, Gymnites hollandi McLearn, Longobardites canadensis McLearn 'Hungarites' metaggarti McLearn, 'Hungarites' boreas McLearn, 'H.' caurus McLearn, 'H.' bufonis McLearn, 'H.' nahwisi McLearn, Acrochordiceras (Paracrochordiceras) sp., Sturia sp., and Nautilus sp.

On ascending the Liard, the Toad formation is next seen about 11 miles upstream or 8 miles southwest of the mouth of Toad River, where it forms part of the west limb of the Toad anticline, previously described by the

author (1944, p. 17). An assemblage of thin-bedded shales, sandstones, and siltstones, about 1,800 feet thick, is well exposed along the north bank of the river. These strata strike northwesterly and dip from 30 to 70 degrees southwesterly. The shales range from brown to black, and are interbedded with narrow, grey and brown sandstone and siltstone beds. Towards the upper part of the formation the sandstone beds are calcareous and contain a few fossils. A 40-foot band of black, sandy limestone that occurs 150 feet below massive calcareous sandstones of the overlying formation (Liard) is highly fossiliferous. It is underlain by 35 feet of black, platy shale that contains fossil-yielding concretions up to 1 foot in diameter. The fossils collected by the author from the 40-foot limestone zone are reported by McLearn to belong to the Beyrichites-Gymnotoceras or Parapopanoceras fauna of Middle Triassic (Anisian) age. The species from this zone are listed by McLearn as follows: Parapopanoceras normale McLearn, P. obesum, P. medium, Anagymnites aff. lamarcki Oppel, Gymnites hagi McLearn, Longobarditos canadensis McLearn, 'Ceratites' hayesi McLearn, Sphaera cf. whitneyi Meek, Ostrea? sp., Trigonodus sp., and Spiriferina sp.

Part of an ichthyosaur specimen taken from the same 40-foot limestone zone was examined by C.M. Sternberg of the Geological Survey, who compares it with the Middle Triassic species Cymbospondylus piscocus Leidy.

The drift-covered interval, 150 feet across the strike that separates the 40-foot limestone band from overlying massive grey beds of calcareous sandstone, is underlain by shales and thin-bedded sandstones. These are exposed on the south bank of the river, and are presumed to be the topmost beds of the Toad formation in this locality. To the west there is a conformable succession of about 600 feet of sandstones with minor shale beds, and one 6-foot bed of hard grey limestone 130 feet from the top of the section. The sandstones are generally thick, massive, calcareous beds, but are thinly laminated in places. Grey is the most common colour, but some beds are brown and others a light straw-yellow. The upper 50 feet consists of grey, massive, argillaceous sandstone beds that are very like those seen at the rapid on the north side of Liard River 2 miles farther upstream, and again at Hell Gate, another 2 miles farther west. At the rapid, the water falls over a bed 30-feet thick packed with the brachiopod Coenothyris?. This band is underlain by about 500 feet of limestone, sandstone, and shale, east of which bedrock is drift covered. At 200 feet below the brachiopod zone is 10 feet of grey limestone, underlain by 50 feet of shale and sandy limestone, 100 feet of massive sandstone, and 15 feet of massive grey limestone.

The island at Hell Gate is part of the crest of an anticline that trends northwesterly. Beds dip 43 degrees northeast on the northeast side of the island and 15 degrees southwest on the southwest side. The island is comprised largely of beds of hard grey limestone and sandy limestone that exhibit a total thickness of 50 feet at the crest of the fold. These beds contain plentiful Nathorstites mcconnelli Whiteaves and Daonella of late Middle Triassic age. Southwest of the island the Nathorstites beds are overlain by at least 200 feet of sandstone and limy beds, above which are black shales of the overlying Garbutt formation. Similar hard grey limestone and sandy limestone beds outcrop for half a mile east of Hell Gate Island on the south side of the river, where they are brought up into view by two anticlinal folds. McConnell (1891) found Triassic strata at the next canyon above Hell Gate and at the Rapids of the Drowned, and, judging from aerial photographs, thick sections of Triassic strata should be present.

All of the more massive beds of grey sandstones and grey limestones, mentioned in the paragraph above, were originally included by the writer with the siltstones, sandstones, and shales of the Toad formation for convenience in preliminary mapping, but it is now felt that it would be advantageous to map them as a separate lithological unit. As these beds are well exposed along Liard River at Hell Gate, the latter place might be regarded as the type locality, and the name Liard formation is proposed for them.

It is McLearn's observation from field work done during the 1944 season (personal communication) that a similar line might be drawn between fine-bedded siltstones and sandstones below, and more massive Middle Triassic strata above, in the vicinity of the Alaska Highway some 50 miles south of Hell Gate. In that locality he noted that the upper, Liard-like strata were comparable to the lower part of the Grey member of the Triassic Schooler Creek formation of the Peace River foothills, previously described (McLearn, 1940).

The Lower and Middle Triassic strata thicken considerably towards the west from the confluence of Liard and Toad Rivers. Near the mouth of the Toad the Toad formation is about 800 feet thick, and no beds of the Liard formation are present. Eight miles due southwest the Toad formation has increased to an estimated 1,800 feet in thickness, and overlying beds of Liard formation have made their appearance with a minimum thickness of 600 feet. At Hell Gate the lower beds of the Liard formation are concealed, but the limestone beds are much thicker, suggesting that the total thickness of the formation is increasing.

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SUPPLEMENT. NEW MIDDLE TRIASSIC AMMONOIDS from Northeastern British Columbia, by F. H. McLearn

Parapopanoceras normale n. sp. Pl. VIII, figs. 7, 8; Pl. IX, figs. 5, 6. Large, mostly compressed species with almost angular venter; venter widens at anterior end. Umbilical expansion involves more than one whorl and proceeds at slower rate than in *P. tetsa* and *P. verneuili* (Mojsisovics). Meas. par.: approx. 60; - ; - ; - : 58.5; 41.0; 26.3; 21.0. G.S.c.: hol., 9574; par., 9575.

Parapopanoceras obesum n. sp. Pl. VIII, figs. 5, 6. Has thicker, more inflated whorls than *P. normale*. Rate umbilical expansion slow, as in *P. normale*. Venter narrowly rounded except at anterior end where it broadens. Meas.: 55; 30.5; 31.8; 43.5. G. S. c.: hol., 9576.

Parapopanoceras medium n. sp. Pl. VIII, figs. 1 to 3. Of moderate size, mostly compressed, more than whorl of umbilical expansion. Angulation of venter, variable. Venter broadens at anterior end. In size and stage of growth at which umbilical expansion begins, is intermediate between *P. normale* and *P. praematurum*. Approx. meas.: 43; 38; 25.5; 30. G. S. c.: hol., 9577; par., 9578.

Parapopanoceras praematurum n. sp. Pl. III, fig. 2; Pl. VIII, fig. 4. Described in first edition, Append. II, p. 1, as var. of *P. tetsa;* now raised to species rank. Smaller than *P. medium,* with much earlier appearance of umbilical expansion. Venter narrowly rounded. Approx. meas.: 31; 40; 24; 26. G. S. c.: hol., 6441.

Parapopanoceras selwyni n. sp. Pl. IX, figs. 7 to 9. Medium size, compressed, narrow venter; flattened sides; umbilical expansion continues more than one whorl. Evenly spaced striations. Differs from other Toad species, having well defined umbilical shoulder on ultimate whorl and has more crowded septa, shorter lobes. Aprox. meas.: 47.5; 44; 27.5; 21. G. S. c.: hol., 9579; par., 9580.

Anagymnites via alaska n. sp. Pl. VII, fig. 1. Described as var. of *A. involutus* Gugenberger in first edition, Suppl. to Append. II, p. 3; now raised to species. Has wider saddles and surface not so smooth as *A. involutus,* having irregular varices of growth. Involute, compressed. Meas.: 56; 43; 21.5; 26.5. G. S. c.: hol., 6446.

Longobardites larvalis n. sp. Pl. IX, figs. 3, 4. Holotype is small, evolute, with thick, rounded whorl, distinct ventral keel, bordered by small furrows. Irregular tubercles, spines, bullae on sides; faint strigate ornament. Probably an inner whorl of a large oxycone like *L. internatus,* but one in which keeled ornate stage persists longer. G. S. c.: hol., 9583.

'Hungarites' mackenzii n. sp. Pl. XII, fig. 3. Inner whorls evolute, stout, with rounded sides, ventral keel, distant, faint ribs that are not as stout as, and are less ornate than, *H. mctaggarti*. Outermost whorl oxycone with different suture line than *H. mctaggarti*. G. S. c.: hol., 9584.

'Hungarites' caurus n. sp. Pl. XI, figs. 1, 2. Beginning ultimate whorl about as high as thick, with keel and stout ribs; end same whorl compressed, with rounded ventrolateral shoulder, greatly reduced keel, and ornament. Smaller than *H. boreas,* stage of compression comes earlier. Approx. meas.: 20.5; 49.5; 32.5; 25. G. S. c.: hol., 9585.

'Hungarites' boreas n. sp. Pl. XI, figs. 3, 4. Beginning last whorl about as high as thick, with rounded, ventral keel and fairly strong ribs; end last whorl more compressed, has ventro-lateral shoulders, narrow ventral keel. Fine sigmoidal ribs on inner side of whorls. Smaller than *H. dawsoni*, compressed stage coming earlier. Meas.: 25.5; 49; 40; 25. G.S.c.: hol., 9586.

'Hungarites' dawsoni n. sp. Pl. X, figs. 8, 9. End penultimate whorl fairly stout, with narrow, fastigate venter, strong ribs inner part sides. End ultimate whorl fairly involute and compressed, with fastigate venter, and ventro-lateral shoulder; with growth of shell, whorl shape passes from thick to compressed and ribs from strong to weak, not the reverse as in *H. triformis* Mojsisovics. Estimated meas.: 48; 55; 33; 14.5. G. S. c.: hol., 9587.

'Hungarites' bufonis n. sp. Pl. X, figs. 4 to 6. This species differs chiefly from *Dalmatites parvus* Smith in larger size and broadening of venter at anterior end. Irregular varices of growth and sigmoidal, uneven, faint folds. Approx. meas. hol.: 44.5; 56; 27; 6.7. G. S. c.: hol., 9588; par., 9589.

'Hungarites' nahwisi n. sp. Pl. XII, figs. 4, 5. Inner whorls compressed, involute, and smooth, with narrowly rounded venter. Last whorl oxycone. Venter sharper, more auxiliary lobes and saddles than in *Hungarites involutus* var. *laevis* Kiparisova. Approx. meas.: 81; -; - ; - : 60; 57.5; 24.5; 4.5. G. S. c.: hol., 9590.

'Hungarites' ovinus n. sp. Pl. XII, figs. 1, 2. Inner whorls apparently smooth and compressed, with fastigate venter. Last whorl, an oxycone, smooth, except a few folds. Longer lobes, deeper saddles than *H. nahwisi*. Approx. meas.: 70; - ; - ; - : 56; 57; 25; 7. G. S. c.: hol., 9591.

Gymnotoceras helle n. sp. Pl. X, fig. 7. Evolute, compressed, with rounded ventro-lateral shoulder, somewhat convergent sides and umbilical bullae; rather distant ribs, smooth venter. More distantly spaced ribs, more evolute inner whorls than *G. geminatum* Mojsisovics. Approx. meas.: 44.5; 40; 28 est.; 35. G. S. c.: hol., 9593; par., 9592.

Gymnotoceras ino n. sp. Fairly evolute, whorl a little higher than thick, with convergent, rather flattened sides, almost flat venter, rounded ventro-lateral and umbilical shoulders. Bullae large. Ribs declining to smoothness on living chamber. Bullae much larger than those of *G. helle*. Loss of ribs distinctive. Venter broader than in *G. wrighti*. Meas.: 52; 41; 35 est.; 31. G. S. c.: hol., 9594.

Gymnotoceras varium n. sp. Pl. XI, figs. 5, 6. Penultimate whorl of *'Keyserlingites* aspect', with strong umbilical bullae, lateral ribs, smooth venter. Ultimate whorl compressed, with flattened sides and venter, rounded ventro-lateral shoulder, single lateral ribs; no umbilical bullae. Differs from *G. columbianum* in final stage of compressed whorl. Est. meas.: 70; 43; 30; 33. G. S. c.: hol., 9595.

Gymnotoceras moderatum n. sp. Pl. X, fig. 10. Beginning of last whorl is of '*Keyserlingites* aspect'. Remainder same whorl compressed, with flattened sides, narrow venter, rounded ventro-lateral shoulder, no umbilical bullae, sigmoidal ribs, smooth venter. Much smaller than G. *varium*, more compressed, ribs more curved, briefer stage of '*Keyserlingites* aspect'. Approx. meas.: 39; 50.5; 18 est.; 24.5. G.S.c.: hol., 9596.

Pecten tetsa new name. For *Pecten ? sarsiana* McLearn: Geol. Surv., Canada, Paper 47-24, Appendix, p. 1, Pl. VII, figs. 3, 4. The name *sarsiana* is preoccupied by *Pecten sarsianus* McLearn (1937, p. 131). G. S. c.: hol., 8781; par., 8780.

CORRECTION. Substitute Cat. No. 9597 for Cat. No. 9553, plesiotype of *Hoernesia woyoniana* McLearn: Geol. Surv., Canada, Paper 47-24, Appendix, Pl. VII, fig. 7.

Ottawa, Canada,
May, 1948.

BEYRICHITES—GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 1)

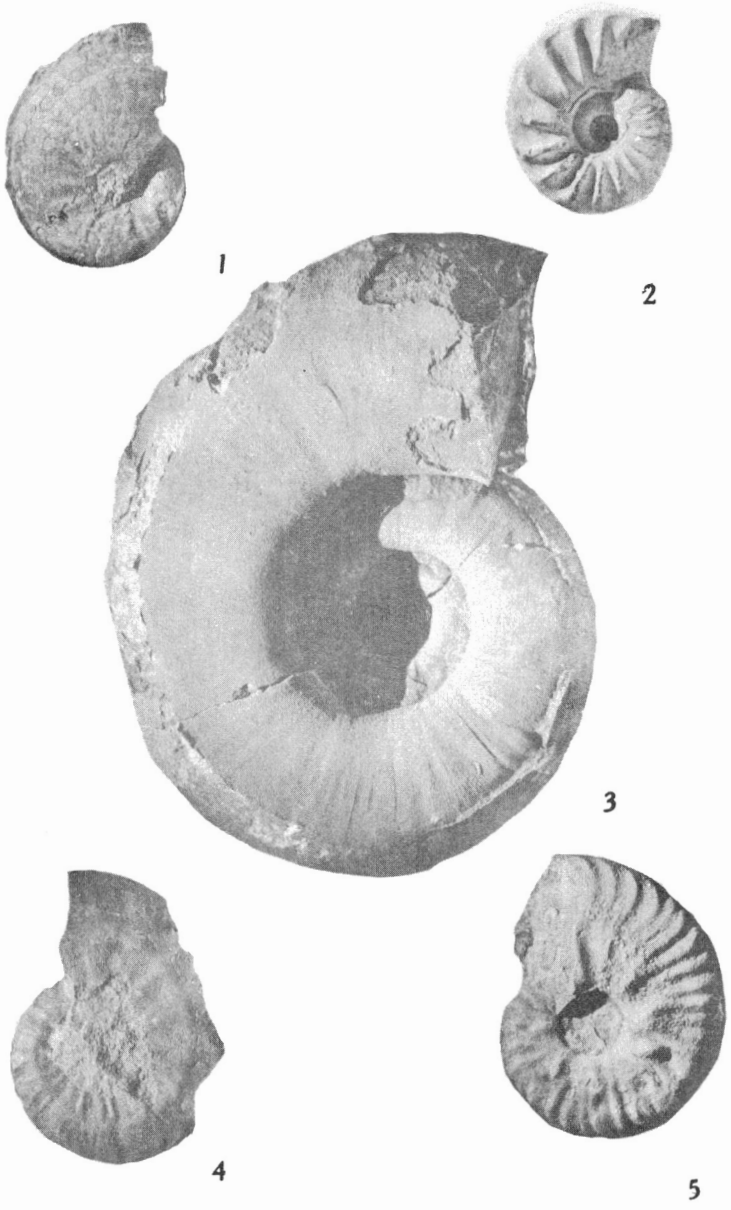


Figure 1. *Longobardites internatus* McLearn n. sp. Holotype

Figure 2. *'Ceratites' hayesi* McLearn n. sp. Holotype

Figure 3. *Ussurites arthaberi* var. *cameroni* McLearn n. var. Paratype

Figure 4. *Gymnites hagi* McLearn n. sp. Holotype

Figure 5. *Beyrichites deleeni* McLearn n. sp. Holotype

PLATE I

BEYRICHITES—GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 2)

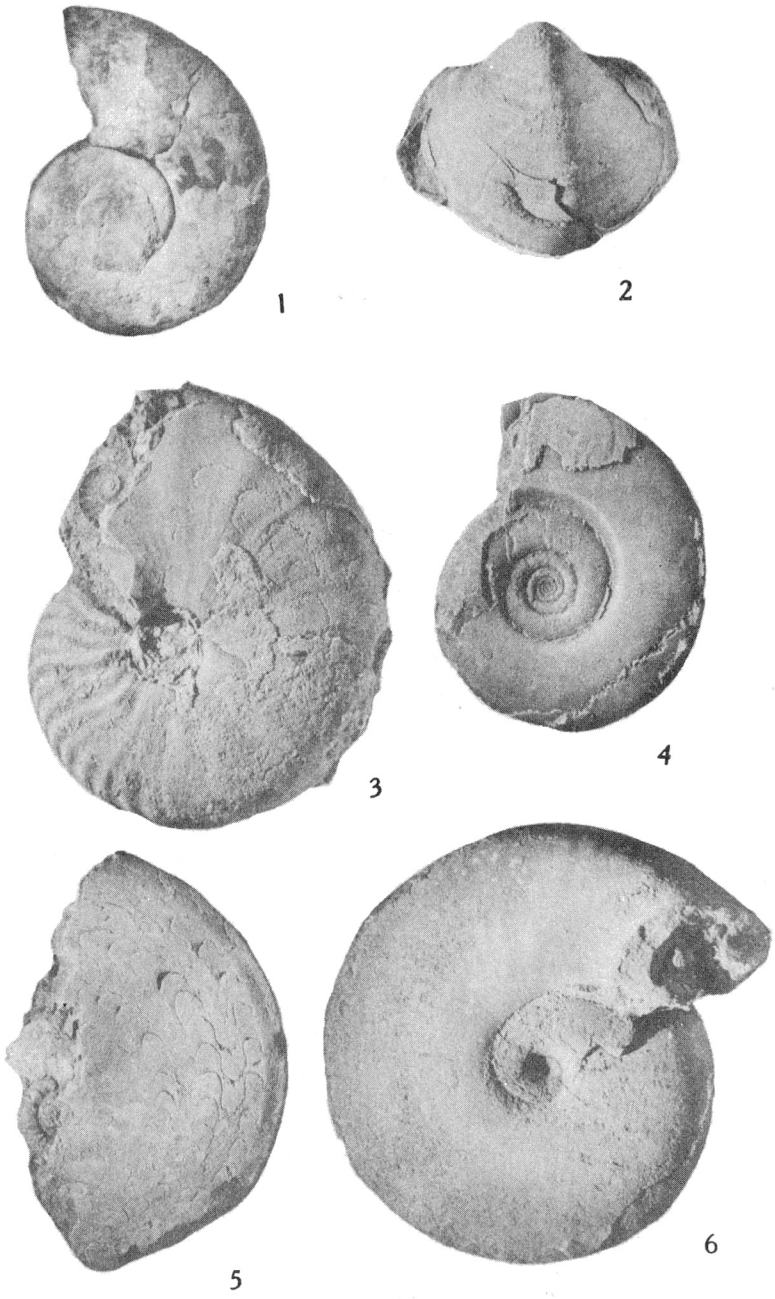


Figure 1. *Ussurites arthaberi* var. *cameroni* McLearn n. var. Holotype

Figure 2. *Sphaera* cf. *whitneyi* Meek

Figure 3. *Beyrichites deleeni* McLearn n. sp. Paratype

Figure 4. *Leiophyllites ? kindli* McLearn n. sp. Holotype

Figure 5. *Longobardites mctaggarti* McLearn n. sp. Holotype

Figure 6. *Parapopanoceras tetsa* McLearn n. sp. Holotype

PLATE II

BEYRICHITES—GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 3)

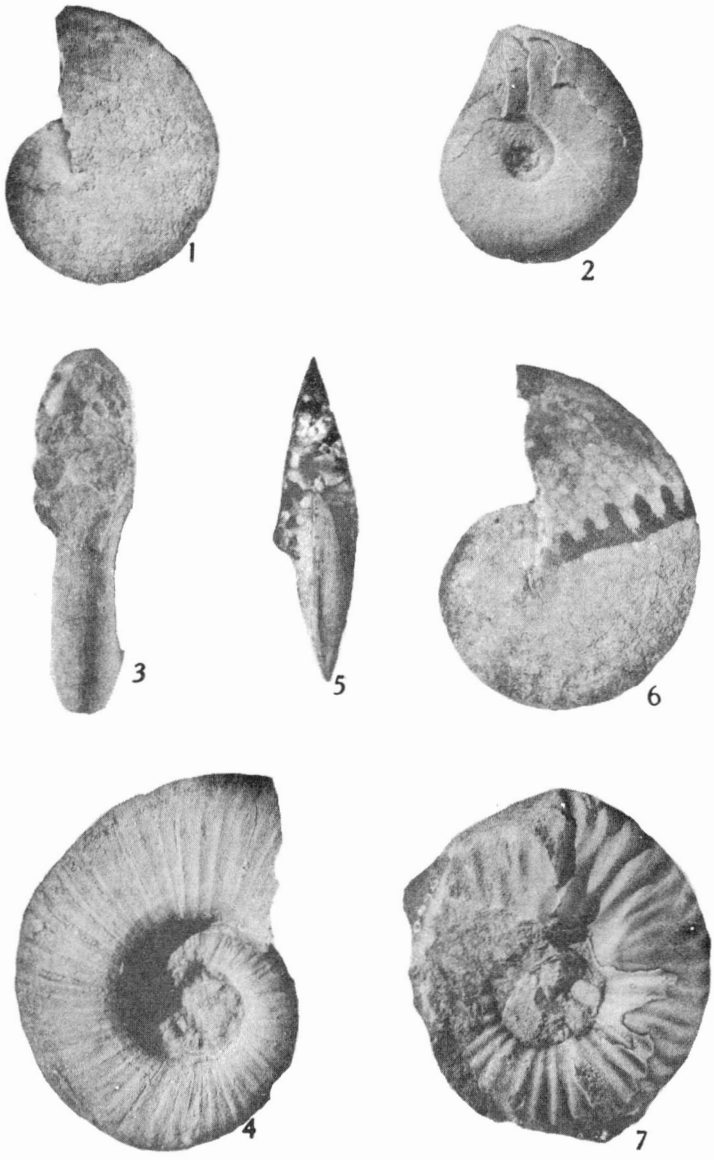


Figure 1. *Longobardites canadensis* McLearn n. sp. Holotype

Figure 2. *Parapopanoceras tetsa* var. *praematurum* McLearn n. var. Holotype

Figures 3, 4. *Ussurites muskwa* McLearn n. sp. Holotype

Figures 5, 6. *Longobardites canadensis* McLearn n. sp. Paratype

Figure 7. *Gymnotoceras columbianus* McLearn n. sp. Holotype

PLATE III

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 4)

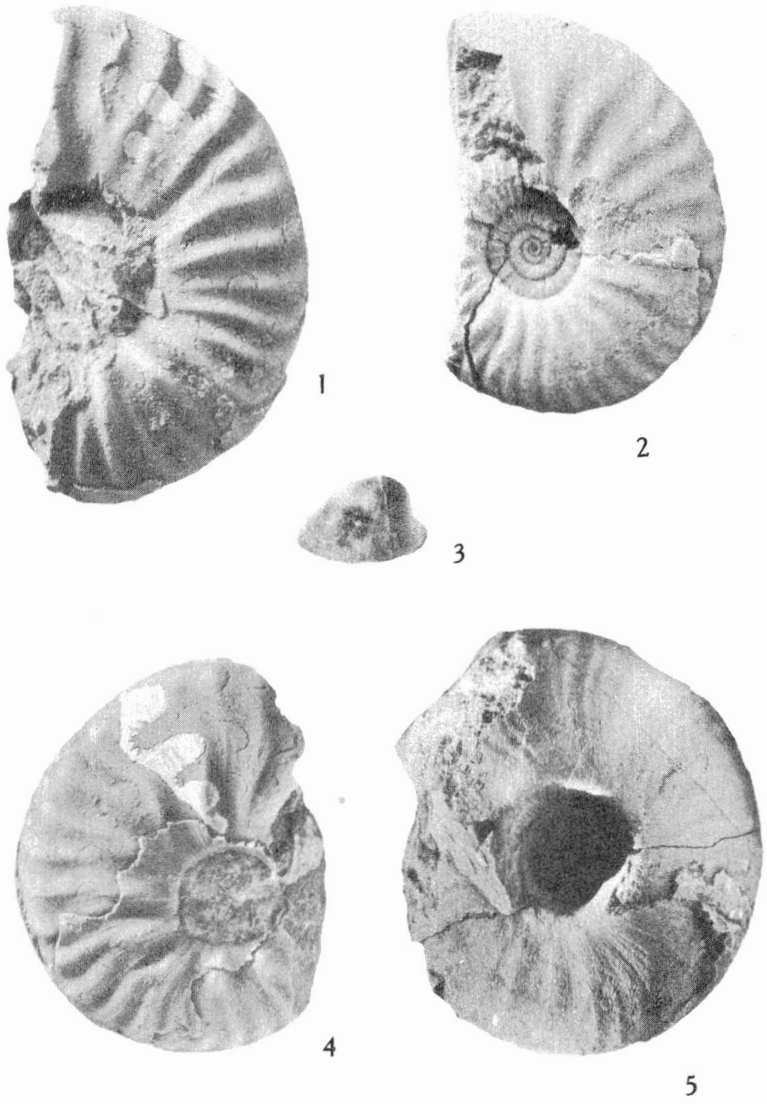


Figure 1. *Hollandites ? humi* McLearn n. sp. Holotype
Figure 2. *Hollandites ? mcconnelli* McLearn n. sp. Holotype
Figure 3. *Trigonodus ?* sp.
Figure 4. *Frechites kindli* McLearn n. sp. Holotype
Fiaure 5. *Ptychites wrighti* McLearn n. sp. Holotype

PLATE IV

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 5)

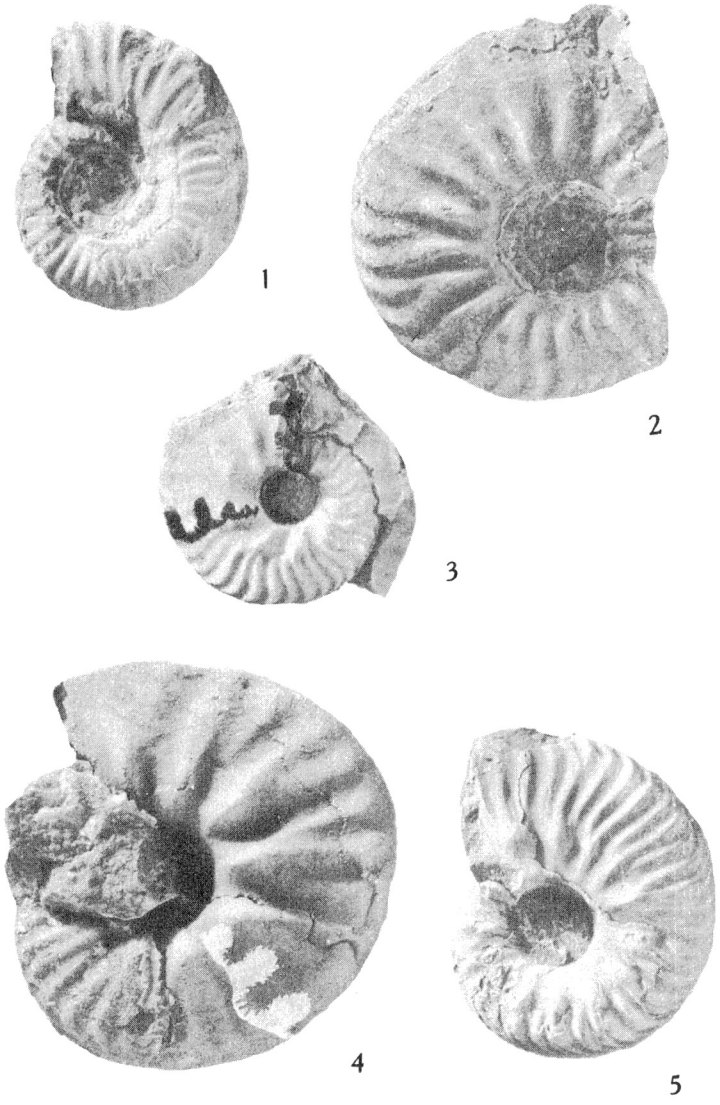


Figure 1. *Acrochordiceras (Paracrochordiceras) americanum* McLearn n. sp. Holotype

Figure 2. *Hollandites ? spivaki* McLearn n. sp. Holotype

Figure 3. *Gymnotoceras liardense* McLearn n. sp. Holotype

Figure 4. *Gymnotoceras wrighti* McLearn n. sp. Holotype

Fiaure 5. *Gymnotoceras beachi* McLearn n. sp. Holotype

PLATE V

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 6)

Figure 1. *Gymnites hollandi* McLearn n. sp. Holotype X ½

PLATE VI

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 7)

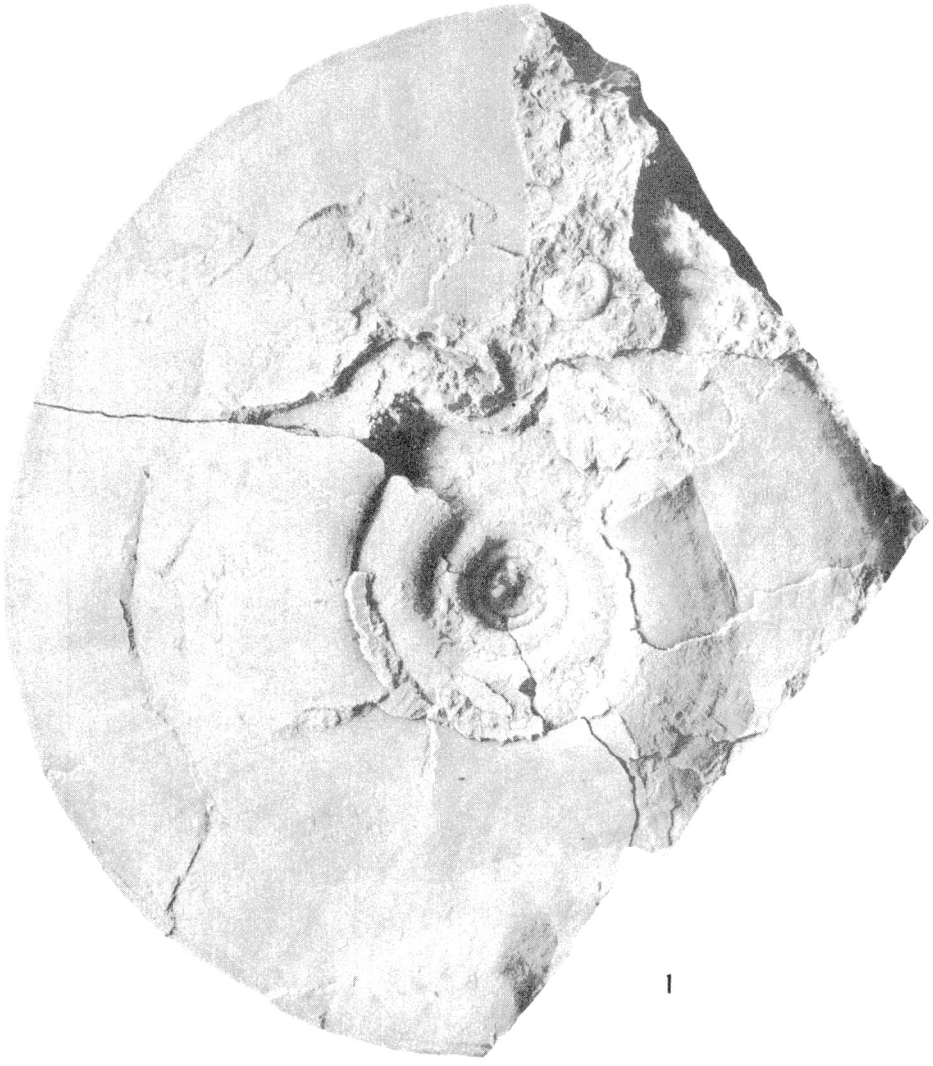


Figure 1. *Anagymnites involutus* var. *via-alaska* McLearn n. var. Holotype

PLATE VII

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 8)

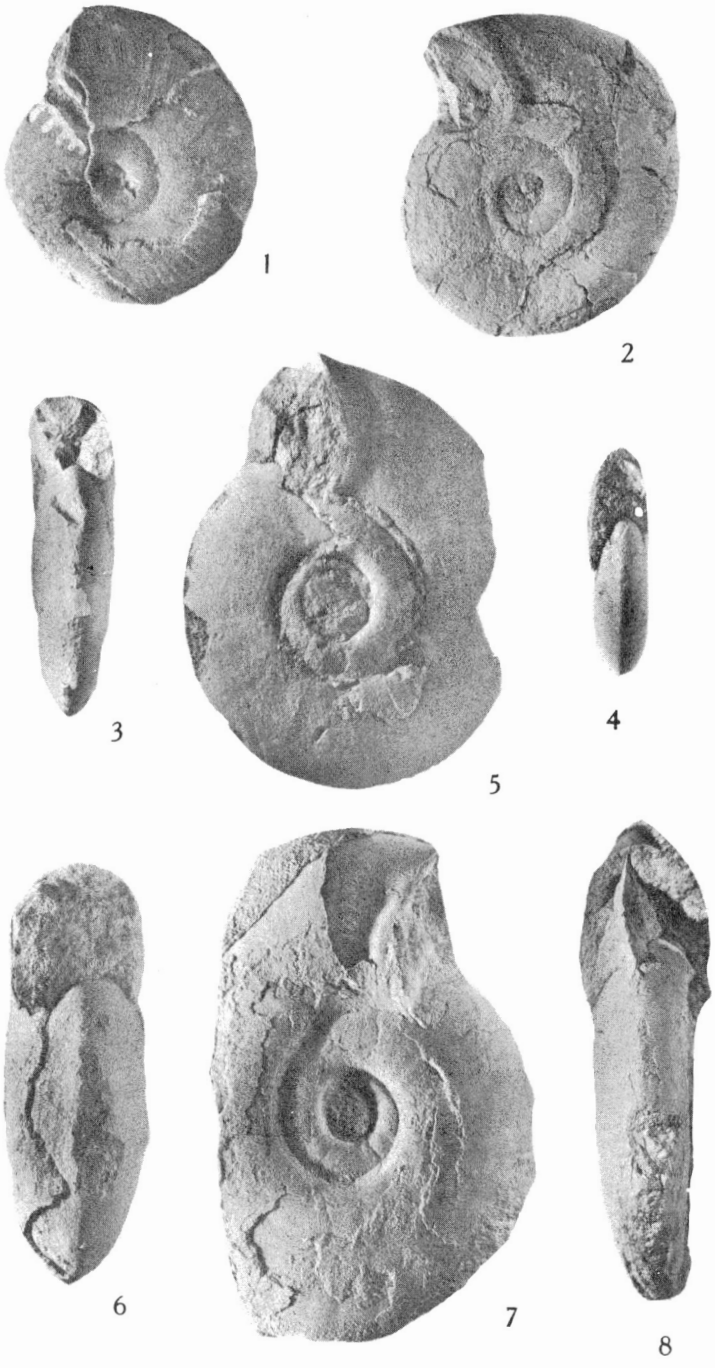


Figure 1. *Parapopanoceras medium* n. sp. Paratype
Figures 2, 3. Same species. Holotype
Figure 4. *Parapopanoceras praematurum* n. sp. Holotype
Figures 5, 6. *Parapopanoceras obesum* n. sp. Holotype
Figures 7, 8. *Parapopanoceras normale* n. sp. Holotype

PLATE VIII

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 9)

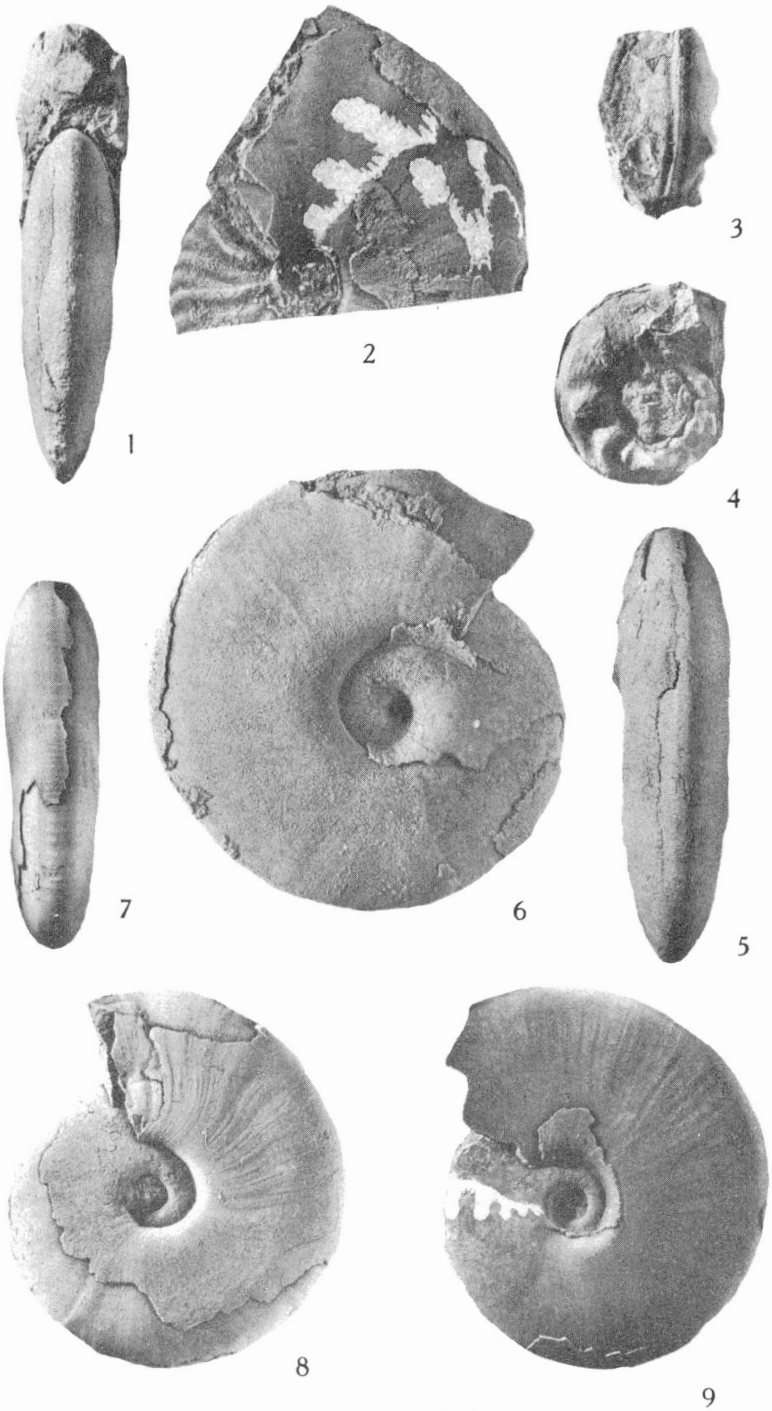
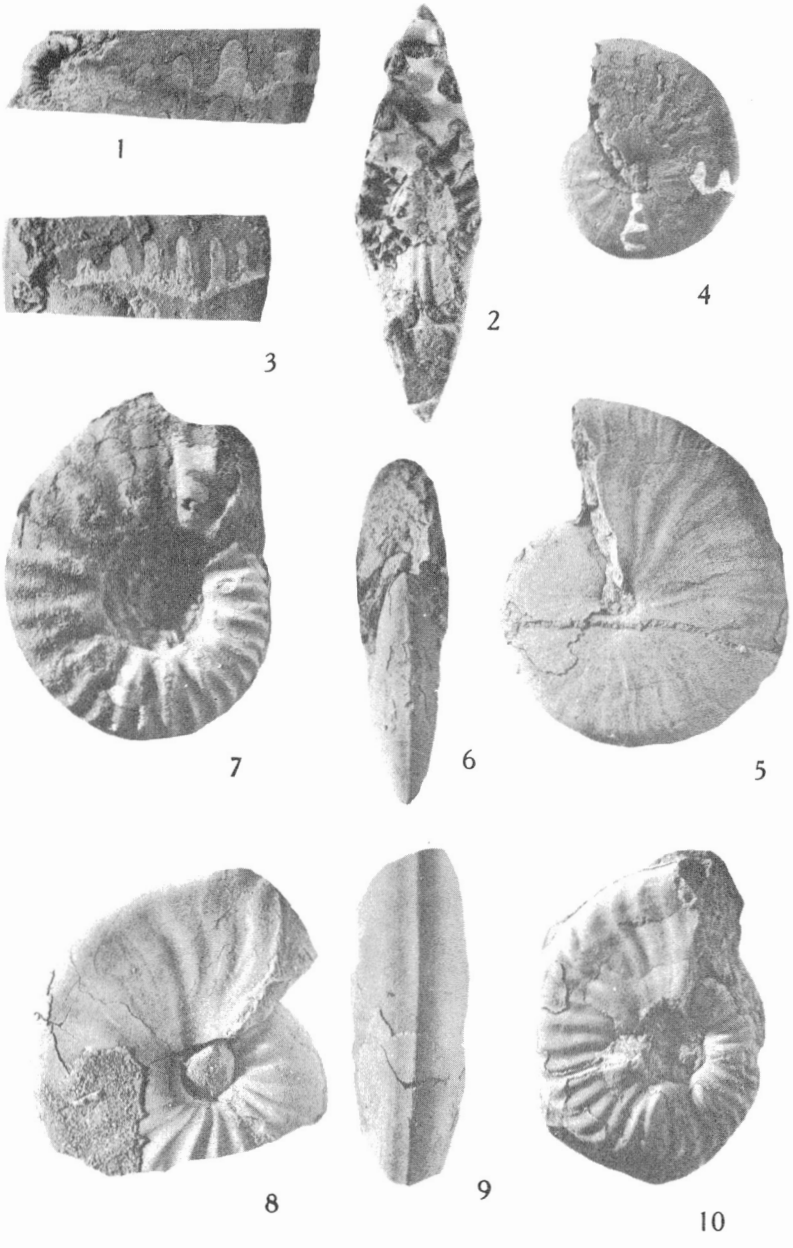


Figure 1. *Parapopanoceras tetsa* McLearn. Holotype
Figure 2. *Beyrichites deleeni* McLearn. Paratype
Figures 3, 4. *Longobardites larvalis* n. sp. Holotype
Figures 5, 6. *Parapopanoceras normale* n. sp. Paratype
Figures 7, 8. *Parapopanoceras selwyni* n. sp. Holotype
Figure 9. Same species. Paratype

PLATE IX

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 10)

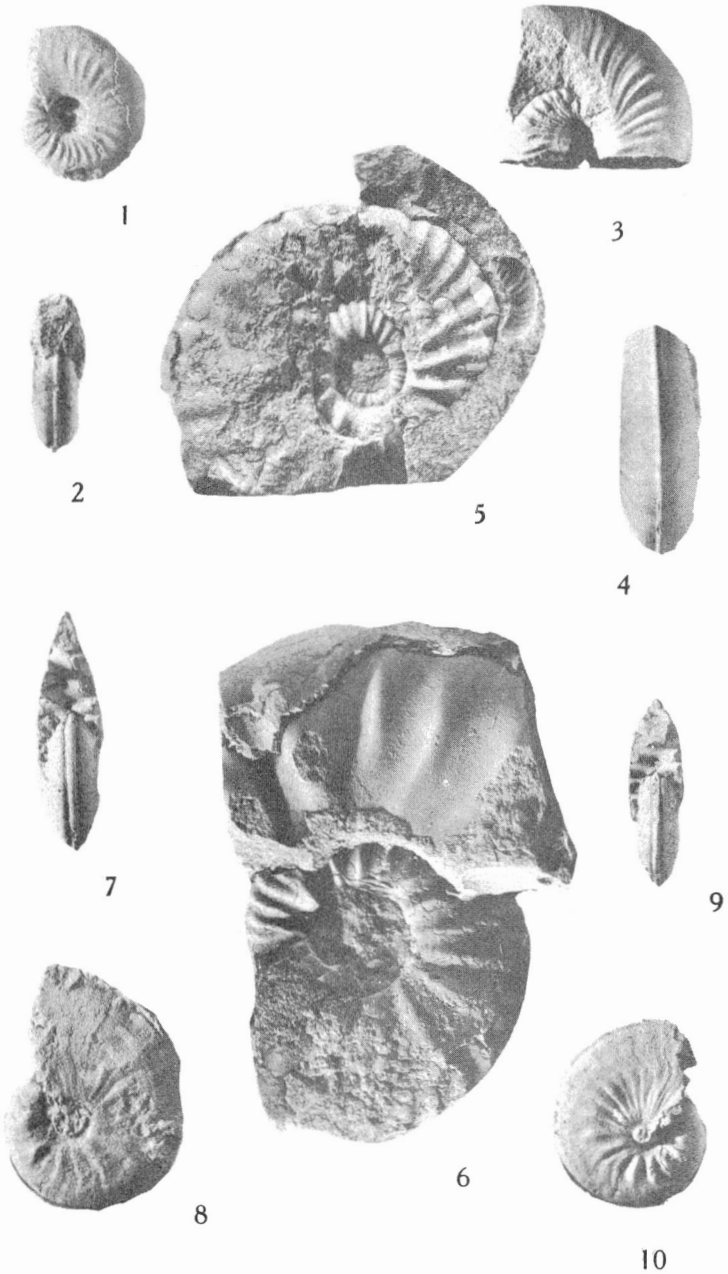


Figures 1, 2. *'Hungarites' mctaggarti* McLearn. Holotype
Figure 3. *Longobardites canadensis* McLearn. Plesiotype
Figure 4. *'Hungarites' bufonis* n. sp. Paratype
Figures 5, 6. Same species. Holotype
Figure 7. *Gymnotoceras helle* n. sp. Holotype
Figures 8, 9. *'Hungarites' dawsoni* n. sp. Holotype
Figure 10. *Gymnotoceras moderatum* n. sp. Holotype

PLATE X

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 11)

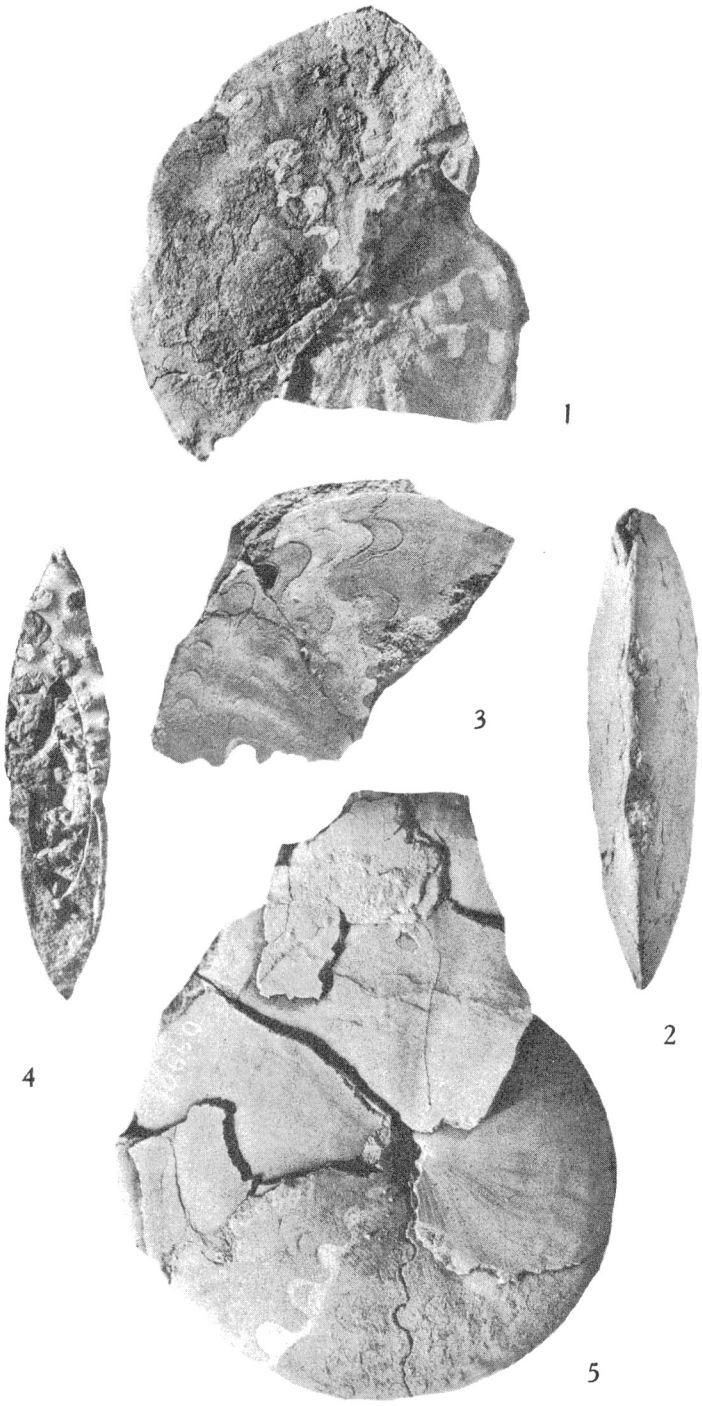


Figures 1, 2. *'Hungarites' caurus* n. sp. Holotype
Figures 3, 4. *'Hungarites' boreas* n. sp. Holotype
Figures 5, 6. *Gymnotoceras varium* n. sp. Holotype
Figures 7, 8. *Longobardites internatus* McLearn. Holotype
Figures 9, 10. Same species. Plesiotype

PLATE XI

BEYRICHITES-GYMNOTOCERAS FAUNA

TOAD FORMATION (SHEET 12)



Figures 1, 2. *'Hungarites' ovinus* n. sp. Holotype
Figure 3. *'Hungarites' mackenzii* n. sp. Holotype
Figures 4, 5. *'Hungarites' nahwisi* n. sp. Holotype

PLATE XII