



GEOLOGICAL
SURVEY
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CANADA

DEPARTMENT OF MINES
AND TECHNICAL SURVEYS

MEMOIR 311

AMMONOID FAUNAS OF THE
UPPER TRIASSIC PARDONET FORMATION,
PEACE RIVER FOOTHILLS,
BRITISH COLUMBIA

F. H. McLearn

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**Pardonet Hill
type section
Pardonet formation**



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PREFACE

Stratigraphy plays an outstanding part in the geological investigation of any region and its study is a prerequisite for all geological mapping. Because Triassic rocks underlie large areas in northeastern British Columbia, a knowledge of their stratigraphy and the means of recognizing individual formations are important. Some Triassic formations resemble one another very closely lithologically and the contained faunas offer the only ready means of separation or correlation. The ammonoid faunas of one Triassic formation, the Pardonet, are described in this memoir.

The Pardonet formation is well exposed in the western part of the Peace River Foothills and is abundantly fossiliferous at some horizons. Both the lithological and faunal succession have been studied in detail. The results have been recorded from time to time in the Preliminary Series of the Geological Survey of Canada, the "Transactions of the Royal Society of Canada" and the "Canadian Field-Naturalist". This dispersed information has been brought up to date, revised and is here presented in a single volume to make it readily available to geologists working in the region.

This memoir provides a documented record of the succession and occurrence of the ammonoid faunas with maps showing the important localities.

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

OTTAWA, June 3, 1959

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AMMONOID FAUNAS OF THE
UPPER TRIASSIC PARDONET FORMATION,
PEACE RIVER FOOTHILLS,
BRITISH COLUMBIA

Abstract

The purpose of this memoir is to assemble, coordinate and revise information published in many short papers in the "Transactions of the Royal Society of Canada", the "Canadian Field-Naturalist" and the Preliminary Series of the Geological Survey of Canada. Ammonoid faunal zones, correlation and systematic palæontology are treated. The stratigraphic succession, based mainly on an integration of ammonoid sequences on Pardonet and Brown Hills and on sequences at many other localities, comprises, in ascending order, the *Stikinoceras* zone, *Tropites* bed, *Styrites ireneanus* zone, *Pterotoceras-Cyrtoleuroides magnificus* beds, *Drepanites* beds, *Cyrtoleuroides* beds, *Parathisbites oineus* beds, *Himavatites* zone, *Monotis subcircularis* zone, and the *Rhacophyllites* beds. The *Stikinoceras* and *Styrites ireneanus* zones, contain a number of species in common. Together with the *Tropites* bed they are incorporated into a *Gonionotites-Malayites* major zone. The *Monotis subcircularis* zone contains few ammonoids and is named for a pelecypod. *Rhacophyllites* is not confined to the *Rhacophyllites* beds, but ammonoids are poorly represented in Triassic beds above the *M. subcircularis* zone.

The *Gonionotites-Malayites* major zone is correlated with the Upper Karnian stage of the Hallstatt Alpine succession, although the diagnostic genus *Tropites* is only recorded at one locality in the Peace River Foothills and only by a single specimen in place. *Malayites* suggests correlation with the Karnisch-norischen Mischfaunal zone of the Hallstatt region. The Peace River zone, however, lacks any diagnostic Norian elements and the Mischfaunal zone is not recognized by all authorities. The *Pterotoceras-Cyrtoleuroides magnificus* fauna is tentatively dated Norian and the *Drepanites* and *Cyrtoleuroides* beds are definitely Norian. The *Himavatites* zone is correlated with the Lower Norian *Cyrtoleuroides bicrenatus* zone of the Hallstatt zone and the *M. subcircularis* zone and *Rhacophyllites* beds are dated Upper Norian.

Forty-nine genera are recognized; fifty-three species are identified, nineteen are compared with foreign species, twenty-seven are not specifically identified, but merely generically. No new genera or species are proposed.

Résumé

Le présent mémoire a pour objet de rassembler, coordonner et reviser des renseignements parus dans de courtes communications publiées dans les "Transactions" de la Société royale du Canada, dans le "Canadian Field-Naturalist", ainsi que dans la série des rapports provisoires de la Commission géologique du

Canada. On y traite de zones fauniques d'ammonitidés, de corrélation et de paléontologie systématique. La succession stratigraphique, qui est fondée surtout sur une intégration des successions d'ammonitidés qu'on rencontre sur les collines Pardonet et Brown ainsi qu'en plusieurs autres endroits, comprend, par ordre ascendant, la zone à *Stikinoceras*, la couche à *Tropites*, la zone à *Styrites ireneanus*, les couches à *Pterotoceras-Cyrtoleurites magnificus*, les couches à *Drepanites*, les couches à *Cyrtoleurites*, les couches à *Parathisbites oineus*, la zone à *Himavatites*, la zone à *Monotis subcircularis*, et les couches à *Rhacophyllites*. Les zones à *Stikinoceras* et à *Styrites ireneanus* renferment un certain nombre d'espèces qui leur sont communes. Réunies à la couche à *Tropites*, on les incorpore en une zone majeure à *Gonionotites-Malayites*. La zone à *Monotis subcircularis* contient quelques ammonitidés et doit son nom à un pélécy-pode. Le *Rhacophyllites* ne se confine pas aux couches à *Rhacophyllites*, mais les ammonitidés sont mal représentés dans les couches triasiques supérieures à la zone à *M. subcircularis*.

On établit une corrélation entre la zone majeure à *Gonionotites-Malayites* et le Carnien supérieur de la succession alpine Hallstatt, même si le genre caractéristique *Tropites* ne se retrouve qu'à un seul endroit des avant-monts dans la région de la rivière de la Paix, et encore n'a-t-on trouvé qu'un seul échantillon en place. Le *Malayites* permet de supposer qu'il existe une corrélation avec la zone Karnisch-norischen Mischfaunal de la région d'Hallstatt. Cependant, la zone de la rivière de la Paix ne contient pas d'éléments noriens caractéristiques, et la zone Mischfaunal n'est pas admise par tous les paléontologues. La faune *Pterotoceras-Cyrtoleurites magnificus* est provisoirement rattachée au Norien, et l'on a établi de façon définitive que les couches à *Drepanites* et à *Cyrtoleurites* remontent au Norien. On établit une corrélation entre la zone à *Himavatites* et la zone à *Cyrtoleurites bicrenatus*, du Norien inférieur, de la zone d'Hallstatt. On établit que la zone à *M. subcircularis* et les couches à *Rhacophyllites* remontent au Norien supérieur.

On a reconnu quarante-neuf genres de fossiles; cinquante-trois espèces ont été identifiées et dix-neuf comparées avec des espèces étrangères. Vingt-sept autres sont identifiées non par espèces mais par genres. On ne propose aucun nouveau genre ni aucune nouvelle espèce.

Chapter I

INTRODUCTION

The Triassic of the Peace River Foothills and other parts of northeastern British Columbia has been summarized in a memoir on the geology of that region (McLearn and Kindle, 1950).¹ The descriptions and illustrations of ammonoid faunas appear in various publications, including the "Transactions of the Royal Society of Canada", the "Canadian Field-Naturalist" and the Preliminary Series of the Geological Survey of Canada. For the convenience of those who study the Triassic of northeastern British Columbia this dispersed information in so far as it concerns one formation, the Pardonet, is brought together with appropriate revision into a single publication.

Triassic rocks have been known in the Peace River Foothills for more than 80 years. The beds on Peace River from which Selwyn in 1875 collected *Monotis subcircularis* comprise, in most places, the highest part of what is now included in the Pardonet formation (*see* Selwyn, 1877).

After years of neglect the study of the Triassic was resumed in 1917 when *M. subcircularis* was found in exposed ledges at Rapide-qui-ne-parle-pas and at Little Parle Pas Rapids (McLearn, 1919). Two years later the Triassic beds of the Peace River Foothills were placed in a new formation, the Schooler Creek, which was later discarded. The two highest faunal zones recognized, the *Halobia* and *Monotis subcircularis* (McLearn, 1921), together span what is now called the Pardonet formation.

In 1930, in a preliminary paper, the Schooler Creek formation was divided into two lithological units; the upper one, of chocolate-brown to purplish grey, calcareous sandstone (siltstone) and impure limestone, corresponds closely to the Pardonet formation. Two faunal zones were recognized, the *Drepanites-Stikinoceras* and *M. subcircularis*² zones. New species and genera were described, but were inadequately illustrated (McLearn, 1930). At about this time Williams and Bock (1932) collected *M. subcircularis*, *Drepanites* and other fossils at several places along Peace River; they also found marine reptilian bones at the mouth of Nabesche River. All were found in what is now called the Pardonet.

Field work was resumed by the Geological Survey of Canada in 1937, and new species of ammonoids and pelecypods were described (McLearn, 1937a, b). After further field work in 1938 more species of ammonoids and pelecypods were described (*see* McLearn, 1939a, b, c, 1940a, b and 1941a). In a general paper (McLearn, 1940c) the higher beds of the Schooler Creek formation comprising the upper lithological unit of the 1930 paper were separated and designated the Pardonet member and distinguished from a lower or grey member. Four ammonoid zones were recognized, in ascending order the *Stikinoceras*, *Drepanites*,

¹ Names and dates in parentheses are those of references listed in the Bibliography at the end of this report.

² In some earlier papers this species was placed in the genus *Pseudomonotis*.

Distichites and *Diphyllites*; two pelecypod zones were recognized, the *Halobia* and *Monotis subcircularis*.

In 1941 the succession on Brown Hill was described. The ammonoid zones or beds with *Stikinoceras*, *Juvavites* (*Malayites*) sp., *J. (Gonionotites) belli*, *Pterotoceras*, *Drepanites*, *Cyrtopleurites* and *Distichites-Himavatites* were recorded. The pelecypod zones, including the *M. subcircularis* zone, were listed, but were fewer in number than the ammonoid zones, because the pelecypod species are longer-ranging than the ammonoid species (McLearn, 1941b). In another paper, in 1941, some faunal zones were plotted on a contour map of an area between Mahaffy Cliffs and Red Rock Spur (McLearn, 1941c). Later, lithological units and faunal zones on Pardonet Hill were recorded (McLearn, 1947).

The Pardonet formation has also been studied north of the Peace River. Hage (1944) collected Triassic fossils from the Pardonet on Sikanni Chief River below Chicken Creek and also from Pink Mountain; Holland made collections from Klingzut Mountain and from below Chicken Creek; P. K. Sutherland located beds of this formation on Prophet River; W. I. Wright made collections from Pink Mountain. McLearn (1946) described the section on Sikanni Chief River below Chicken Creek in detail and also a few species.

South of the Peace River Foothills, Dawson (1881) collected *Monotis subcircularis* near the "outer boundary of the limestone ranges" along Pine River. Williams and Bocock (1932) recorded this species on Pine River near the mouth of Mountain Creek and reptilian bones and other fossils from about the same locality, that is on Mountain Creek near its confluence with Pine River.

McLearn and Kindle (1950, p. 34) listed the faunal zones of the Pardonet formation and suggested that the Schooler Creek formation, comprising the beds now referred to the Dark siltstones, Grey beds and Pardonet formation, be discarded as a stratigraphic term. The Pardonet is included in the Triassic correlation chart published by the Geological Society of America (McLearn, 1953a). Some genera and species were discussed in a publication issued in the same year (McLearn, 1953b). In March, 1959, a very brief statement was made concerning some generic assignments (McLearn, 1959).

In this report principal attention is devoted to the succession of Triassic ammonoid faunas, which is described in detail for each individual section where ammonoids occur. The location of specimens collected from the talus is carefully recorded and where justified the source of the specimens in the actual succession is inferred. Ammonoids occur in only a few places. The best successions of ammonoid zones in the Pardonet are in the Peace River Foothills, on Brown Hill, Pardonet Hill and Black Bear Ridge. Even in these sections the ammonoid succession is incomplete; the full succession of Pardonet zones can only be inferred and is based mainly on an integration of the sequences on Pardonet and Brown Hills. In many sections ammonoids are rare or even absent and only pelecypod or brachiopod biotas occur. A distinction is made between faunal zone and "beds", thus *Himavatites* zone and *Drepanites* beds. Here beds is used

in the sense of *Drepanites*-bearing beds merely as a local occurrence and not as a well-defined faunal zone, recognizable in more than one section.

Correlation with foreign sections is not entirely satisfactory, as no world-wide standard succession has yet been established for the Upper Triassic. That of Spath (1934), based mainly on the Alpine succession, is used where possible. The actual status of the Mischfauna or *Heinrichites paulcke* fauna, as part of a standard sequence is not fully understood. Unfortunately, a long succession of Karnian and Norian zones is compacted in a 4-foot bed at Byans, India, and the actual zonal arrangement of ammonoids in the Timor and Palermo sequences is as yet unknown.

Comparison with foreign species is based mainly on descriptions and illustrations in the literature, which of course has not the value of direct comparison with specimens in foreign museums. A very considerable resemblance of some species of the *Gonionotites-Malayites* major zone to species in the Palermo fauna, Sicily, and of some species of the *Himavatites* zone to species in the Timor and Himalayan faunas are noted in the text. It is possible that more direct comparisons with foreign specimens would result in placing a few Peace River species in synonymy with foreign ones. A full set of casts of North American type specimens in the U.S. National Museum has been obtained, for which acknowledgment is made to the late Dr. J. B. Reeside, Jr. Some specimens from Sicily, on loan to the Geological Survey through the kindness of Dr. R. Ruggieri, have also been studied, as well as some of Mojsisovics' types, on loan to the Geological Survey through the kindness of Dr. H. Küpper, Director of the Geologische Bundesanstalt, Vienna.

The arrangement of families and genera follows that of Spath (1934, 1951) and Kummel *in* Arkell, *et al.* (1957). No attempt is made to erect any new genera and all genera are used in a broad sense. A few species described in earlier papers have been discarded. The more specimens available, the more variation and intergradation are observed and the fewer species recognized.

The nomenclature of Arkell, *et al.* (1957), that is of the "Treatise on Invertebrate Palaeontology" (L4), is followed closely. Phragmocone is used for septate part of shell and internal mould for core. Living chamber is retained. Ultimate whorl is used in the sense of last or anterior whorl preserved in a given specimen.

In the systematic section measurements are recorded in the order of: diameter in mm; height of whorl in percentage of diameter; thickness of whorl as percentage of diameter; width of umbilicus as percentage of diameter. The degree of involution is recorded as follows:

| | Width of umbilicus % of diameter |
|--------------------------|-------------------------------------|
| Very involute..... | 1-8 |
| Involute..... | 8-17 |
| Moderately involute..... | 17-34 |
| Moderately evolute..... | 34-60 |
| Very evolute..... | 60+ |

Chapter II

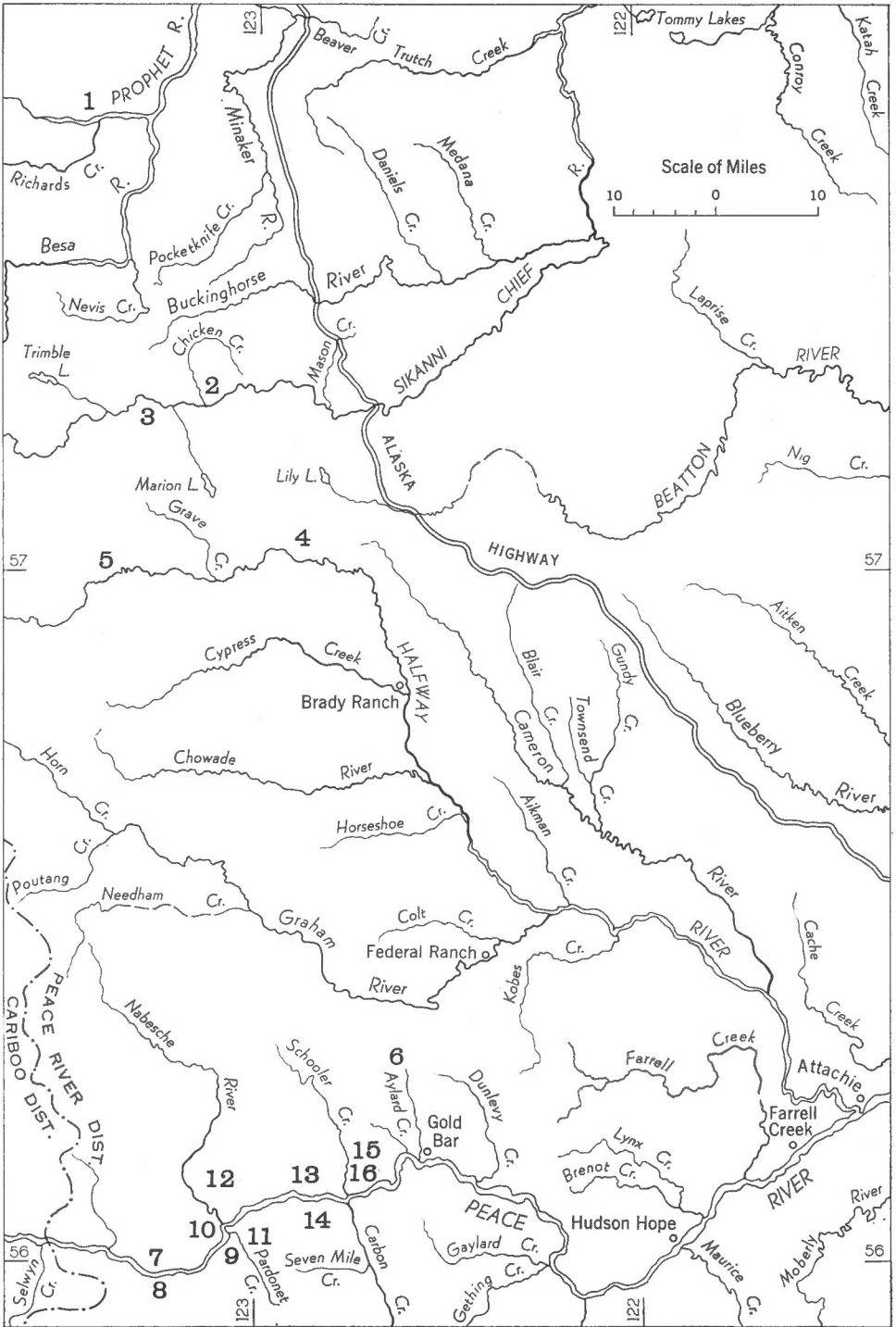
STRATIGRAPHY

Pardonet Formation

The Triassic of northeastern British Columbia has been segregated into seven lithological or rock-units, based mainly on a recurrent succession of two distinct lithologies, the one dominated by dark calcareous shale and siltstone with some dark limestone, the other dominated by rather massive beds of grey calcareous sandstone and grey limestone. Some of them have been given temporary lithological, not permanent geographic, names. The highest unit, however, and the one which concerns us, has been called the Pardonet beds. As this rock-unit has a definite lithology distinct from overlying and underlying strata, has definite lithological boundaries and a wide geographic extension, namely, from Prophet River to Peace River within the Foothills and probably at least as far south as Wapiti Lake, it is reasonable to give it the status of a formation and recommend it as a good mapping unit. It is not definitely known, however, whether this formation will maintain its identity when traced westward into the mountains.

The Pardonet, the uppermost Triassic formation in northeastern British Columbia, consists mostly of dark, somewhat carbonaceous, calcareous siltstone and some shale with, in places, dark crystalline or shelly limestone, argillaceous limestone and more rarely grey limestone. Calcareous sandstone is very rare except in one part of the Pardonet Hill section. At some horizons and in some places there are beds of fissile, dark, carbonaceous limestone or argillaceous limestone that owe their fissility to packing of flattened shells of *Halobia* lying prone on the plane of bedding. Some dark, carbonaceous limestones consist almost entirely of small immature shells of *Halobia*. Shells of *Monotis* also lie packed along the bedding. The thickness of the Pardonet formation is from about 260 to 2,000+ feet.

The Pardonet formation outcrops in many parts of the west half of the Peace River Foothills, at Rapide-qui-ne-parle-pas, mouth of Nabesche River, Pardonet Hill, Black Bear Ridge, west slope of west spur of Brown Hill, West Glacier Spur, Schooler Hill, Stelck Ridge, Jewitt Spur, north bank Peace River below Jewitt Spur, Childerhose Coulee, McLay Spur, Bell Spur, Horseshoe Hill, Horseshoe Hill valley, Branham Ridge, east of Aylard Creek and doubtless at other localities. It has also been observed in the eastern part of the Rocky Mountains on Clearwater River and on the north bank of Peace River above Point Creek. Farther north it has been observed on Mount Wright and in other parts of the Halfway Valley, on Pink Mountain, on Mount Hage and below the mouth of Chicken Creek on Sikanni Chief River and on Klingzut Mountain. The best



G.S.C.

Figure 1. Map of northeastern British Columbia showing localities mentioned in text.

Upper Triassic Ammonoids of the Peace River Foothills

sections in the Peace River Foothills are on Pardonet Hill and on the west slope of the west spur of Brown Hill, and the best section north of the Peace River Foothills is that below the mouth of Chicken Creek.

The Pardonet is underlain by the "Grey beds" of previous reports (McLearn, 1941c, 1947; McLearn and Kindle, 1950; McLearn, 1953a). The contact with these subjacent beds is gradational and conformable; the contact with the overlying Jurassic Fernie group is disconformable.

The stratigraphy of individual sections is described in the following pages.

Above Point Creek

On the north side of Peace River, above the mouth of Point Creek, and just inside the Rocky Mountains (*see* 7, Fig. 1), dark siltstones and limestones are exposed and are like those of the Pardonet formation in the Foothills. They contain *Discotropites sandlingensis* (Hauer), *Discotropites* sp. and *Halobia*.

Clearwater River

On Clearwater River, *Monotis subcircularis* Gabb occurs in dark siltstone and limestone. *Halobia* was also collected. No ammonoids were found (*see* 8, Fig. 1).

Rapide-qui-ne-parle-pas

The uppermost beds of the Pardonet formation are exposed in ledges at Rapide-qui-ne-parle-pas, in about the western limit of the Foothills (*see* 9, Fig. 1). They consist mostly of dark calcareous siltstone and dark limestone. The lower part of the section contains numerous packed shells of *Monotis subcircularis* Gabb and at one horizon flattened specimens of the ammonoid *Indoclonites* ? sp., *Rhacophyllites* sp. and *Placites* sp. Overlying the *M. subcircularis* zone are beds with the ammonoids *Rhacophyllites* sp., "*Arcestes*" sp. and *Placites* sp. Yet higher, are calcareous beds with an indeterminate ammonoid, probably of early Lower Jurassic age. There is thus a disconformity between the Triassic and Jurassic of a magnitude measured probably by lack of occurrence of the Triassic Rhaetian stage and some very early Lower Jurassic stages.

Mouth of Nabesche River

On the north bank of Peace River, at the mouth of Nabesche River, are dark calcareous siltstones with bones of the marine reptile *Ichthyosaurus* (Williams and Bocoek, 1932). No ammonoids have been found there (*see* 10, Fig. 1).

Pardonet Hill

Location and structure. A good section of the Pardonet formation is exposed on Pardonet Hill (*see* 11, Fig. 1) on the south bank of the river, immediately east

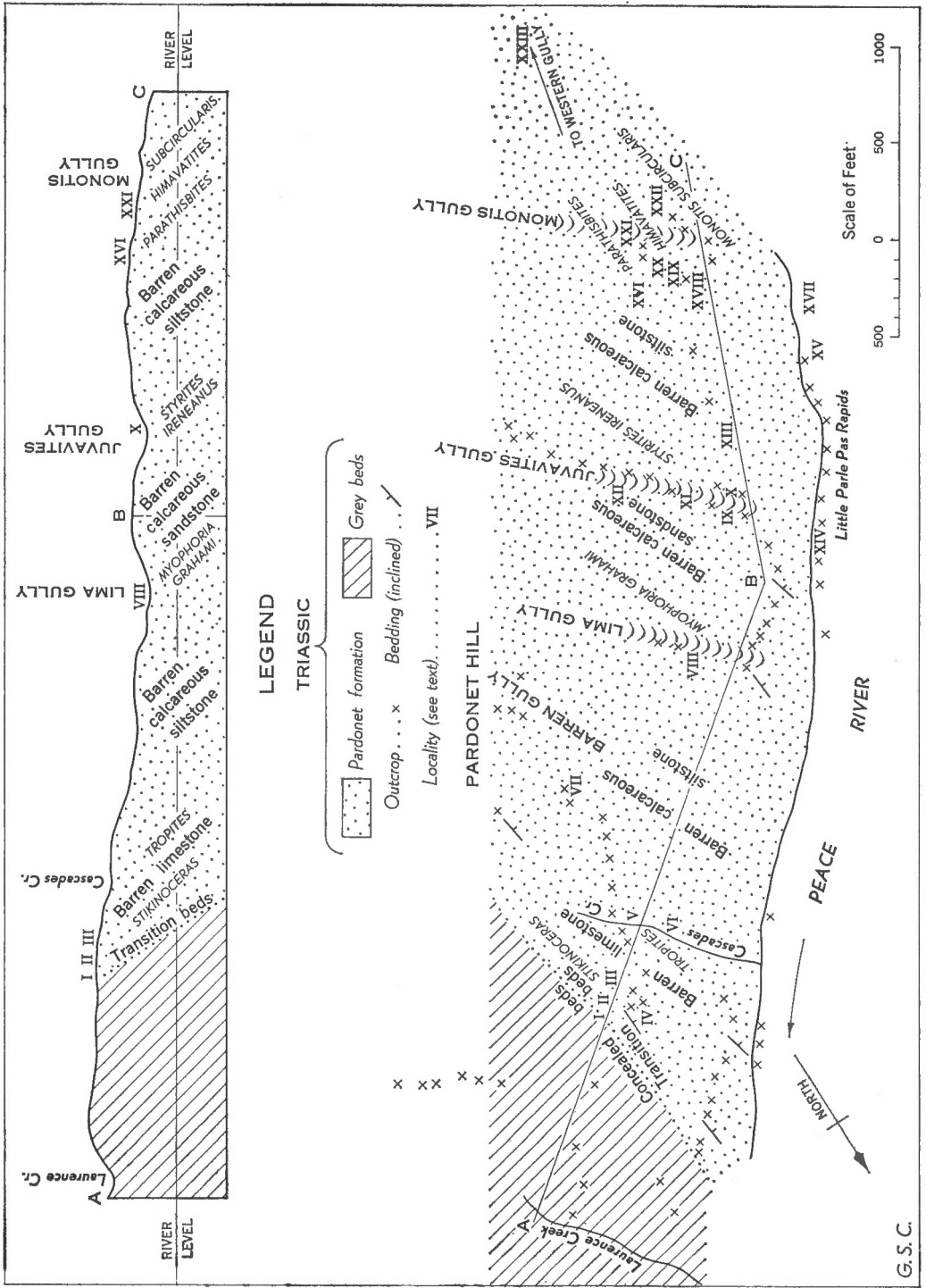


Figure 2. Plan and structure section showing faunal and lithological zones, Pardonet Hill, British Columbia.

Upper Triassic Ammonoids of the Peace River Foothills

of Pardonet Creek and overlooking Little Parle Pas Rapids (*see* McLearn, 1947). On this conspicuous hill are steeply west-dipping ledges which, at low elevations facing the river, are in places concealed by sand and gravel of partly dissected old terraces and old river flats. Where these ledges have been uncovered and extend out into the bed of the river they obstruct the flow of water and give rise to Little Parle Pas Rapids. The slopes of the hill are furrowed by creek valleys and gullies. Laurence Creek, issuing as a spring, is at the east end of the hill. Cascades Creek, also issuing as a spring, is a little farther west. Barren Gully is farther west and somewhat higher. Lima and Juvavites gullies are yet farther west and Monotis and Western gullies are at the far western end of the hill. The more important localities on Pardonet Hill have been designated by roman numerals (*see* Fig. 2).

Most of the beds exposed on Pardonet Hill are part of the steep west limb of an asymmetric anticline, whose axis lies at the east end, near Laurence Creek, where the attitude is nearly flat. The very low-dipping to nearly flat beds of the east limb are on a low eastern extension of Pardonet Hill.

The Pardonet formation underlies the greater part of the hill, on the west limb of the anticline. The underlying Grey beds outcrop on the axis of the fold at the east end of the hill and on the east limb of the structure on the eastern extension. The section was studied on the lower slopes of the hill facing the river, above the relict terraces and in the creek valleys and gullies. The lowest beds, transitional to the beds of the subjacent Grey beds, are exposed near the east end of the hill between localities II and III (*see* Fig. 2), and the highest beds outcrop at the west end, near and in Monotis and Western gullies. The contact with the overlying Jurassic has not been found there.

Succession. Eight lithological units, designated by letters a-h in ascending order, five of dominant limestone, two of dominant siltstone and one of sandstone are present in this section of the Pardonet formation on Pardonet Hill. Eight faunal zones and faunules, including the small pelecypod faunule in the transitional beds can be recognized. Most of the zones are ammonoid zones. Outstanding features of this section are the great total thickness and the thick, barren siltstone and thick sandstone units. All thicknesses are approximate.

| Thickness (feet) | Lithological Units | Faunal Zones and Beds |
|---------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 180 | h. Limestone, dark; siltstone, dark, calcareous; XVI to XXII, XXIII ¹ | <i>Monotis subcircularis</i> <i>Himavatites</i> <i>Parathisbites oineus</i> |
| 250 | g. Siltstone, barren, dark, calcareous; X and XI to XVI | |
| 100 | f. Limestone, dark; siltstone, dark, calcareous; IX to XII, Juvavites Gully | <i>Styrites ireneanus</i> |

¹ Roman numerals refer to fossil localities shown on Figure 2.

| Thickness (feet) | Lithological Units | Faunal Zones and Beds |
|---------------------|--------------------------------------------------------------------------|----------------------------------------|
| 360 | e. Sandstone, somewhat calcareous; VIII to IX | |
| 90 | d. Limestone, dark; some siltstone, calcareous; VIII, Lima Gully | <i>Myophoria grahami</i> |
| 1,000 | c. Siltstone, dark, calcareous; two small lenses limestone; V to VIII | |
| 240 | b. Limestone, grey and dark grey; III to V | <i>Tropites</i> <i>Stikinoceras</i> |
| 185 | a. Limestone; siltstone; sandstone; transitional beds; II to III | pelecypods |
| 160 | Concealed; I to II | |
| | Grey beds | |

Details of the section are as follows:

| | Thickness (feet) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Limestone, dark; and siltstone, dark, calcareous; with <i>Monotis subcircularis</i> Gabb. In and near Monotis Gully | 10+ |
| Limestone, dark, argillaceous; siltstone, dark, calcareous; with <i>Himavatites</i> fauna, comprising <i>Pseudosirenites pardoneti</i> (McLearn), <i>P. pressus</i> (McLearn), <i>Sandlingites</i> ? sp., <i>Alloclionites</i> sp., <i>Steinmannites</i> sp., <i>Himavatites columbianus</i> McLearn, <i>Himavatites</i> sp., <i>Distichites</i> cf. <i>mesacanthus</i> Diener, <i>Thetidites exquisitus</i> (McLearn), <i>Placites</i> sp. and <i>Pinacoceras</i> sp., <i>Monotis alaskana</i> and <i>Halobia</i> . At XVIII, XIX, XX, XXI, XXII, XXIII, near and in Monotis and Western gullies | 80 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Parathisbites oineus</i> McLearn. At XVI | 90 |
| Siltstone, dark, calcareous. Between XVI and Juvavites Gully | 250 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Styrites ireneanus</i> fauna, comprising <i>Sirenites nabeschi</i> McLearn, <i>Cyrtopleurites</i> sp., <i>Thisbites custi</i> (McLearn), <i>T. dawsoni</i> (McLearn), <i>T. charybdis</i> (Gemmellaro), <i>T. cf. pyrami</i> (Gemmellaro), <i>Choristoceras</i> ? sp., <i>Styrites ireneanus</i> McLearn, <i>Tropiceltites columbianus</i> (McLearn), <i>Juvavites selwyni</i> McLearn, <i>Juvavites</i> sp., <i>J. (Anatomites)</i> cf. <i>edithae</i> Mojsisovics, <i>J. (Anatomites)</i> sp., <i>Gonionotites clavatus</i> (McLearn), <i>Gonionotites gethingi</i> (McLearn), <i>G. cf. italicus</i> Gemmellaro, <i>Gonionotites</i> sp., and <i>Halobia</i> . IX to XII, in and adjacent to Juvavites Gully | 100 |
| Sandstone, dark, somewhat calcareous. VIII to IX | 360 |
| Limestone, dark; some siltstone, dark, calcareous; <i>Halobia</i> , <i>Myophoria grahami</i> McLearn and <i>Lima</i> . At VIII, Lima Gully | 90 |
| Siltstone, dark, calcareous; two thin grey limestone lenses carry <i>Spiriferina</i> . V, Cascades Creek to VIII, Lima Gully | 1,000 |
| Limestone, grey; with <i>Tropites</i> sp. at V, Cascades Creek | 10 |

Upper Triassic Ammonoids of the Peace River Foothills

| | Thickness (feet) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Limestone, dark grey; III to V, barren | 160 |
| Limestone, grey, impure; <i>Halobia</i> -bearing limestone; <i>Stikinoceras</i> fauna with <i>Sirenites nabeschi</i> McLearn, <i>Stikinoceras kerri</i> McLearn, <i>Tropicelites columbianus</i> (McLearn), <i>Juvavites</i> sp., <i>J. (Anatomites) humi</i> McLearn, <i>J. (Anatomites)</i> cf. <i>edithae</i> Mojsisovics, <i>Dimorphites pardonetiensis</i> (McLearn), <i>Gonionotites clavatus</i> (McLearn), <i>Gonionotites rarus</i> (McLearn), <i>G. cf. rarus</i> (McLearn), <i>Gonionotites</i> sp., " <i>Arcestes</i> " sp., and <i>Halobia</i> sp. at III | 70 |
| Limestone, partly crystalline and shelly; siltstone; sandstone, dark grey, calcareous; transitional beds; with many small shells, <i>Halobia</i> , <i>Lima</i> and other pelecypods, crinoid stems. II to III | 185 |
| Concealed; I to II | 160 |

A section of the uppermost part of the formation is exposed on the shore of the river at Little Parle Pas Rapids at XV and XVII (see Fig. 2):

| | Feet |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Limestone, dark; siltstone, dark, calcareous; with <i>Monotis subcircularis</i> Gabb | 90 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Pseudosirenites pardoneti</i> (McLearn), <i>Vredenburgites</i> sp., <i>Himavatites burlingi</i> McLearn, <i>H. cf. watsoni</i> Diener, <i>Placites</i> sp., <i>Monotis alaskana</i> Smith and <i>Halobia</i> sp. | 20 |

Talus. In addition to the species collected in place on Pardonet Hill and recorded in the foregoing, many were collected from talus. Some of these species are identical with those found in place and their source is obvious. Others are not identical with those in place and their source can only be inferred.

Talus from lower part of section. Talus was collected near the east end of the hill in the vicinity of III, IV, V and VI (see Fig. 2) and on outcrops of limestone unit b that is on the surface of the *Stikinoceras* zone and *Tropites* bed. Mixed talus northwest of III yielded *Juvavites (Anatomites)* sp., *Malayites* cf. *antipatris* Diener, *Placites* sp., pelecypods and an ichthyosaurian vertebra. A single talus block also northwest of III carried *Miltites* ? sp. and *Placites* sp. Talus at IV, downhill from III, contained *Sirenites nabeschi* McLearn and *Gonionotites clavatus* (McLearn). A single talus block near V yielded *Gonionotites rarus* (McLearn), *G. fuscus* (McLearn) and *Malayites butleri* (McLearn). Mixed talus at V gave *Sirenites nabeschi* McLearn, *Tropites* sp., *Juvavites* cf. *subinterruptus* Mojsisovics, *Gonionotites spiekeri* (McLearn) and an ichthyosaurian vertebra. A talus block near VI yielded *Malayites* sp. It is reasonable to assume that *Sirenites nabeschi* and *Gonionotites rarus* are from the *Stikinoceras* zone as they occur in place in that zone. It is also reasonable that *Gonionotites fuscus* and *Malayites butleri* associated with *G. rarus* in a single block are from the same

zone. The source of the other species in the talus is less readily established. It is probable that the remaining species in the talus are from limestone unit b and probably from the *Stikinoceras* zone because the talus occurs on the outcrops of limestone b, and these species and genera do not occur in the subjacent Grey beds.

The occurrence of *Monotis subcircularis* Gabb in a drift or talus block in Barren Gully is difficult to explain.

Talus, Juvavites Gully. Farther west collections were made from talus in and close to Juvavites Gully; in the gully from X to XII; close to the gully at IX; between the gully and XIII; and on the bank of the river at XIV. Much of this talus contains species also found in place in the *Styrites ireneanus* zone in the gully and so is undoubtedly local. Other talus contains species not identified in place at this locality. It is thought also to be local and from the *Styrites ireneanus* zone, because: it is associated with talus proved to be local; it lies on outcrops of this zone; the species contained in the talus are not found in lower and subjacent beds along the hillside, not for example in the calcareous sandstone; no talus with ammonoids was found between VII and Juvavites Gully; and these ammonoids do not occur in the overlying barren siltstone. This talus may have come from a high elevation up Juvavites Gully and from a high cliff there.

One talus block in Juvavites Gully yielded "*Tibetites*" sp., *Juvavites mackenzii* McLearn, *Juvavites* sp., *Malayites parvus* (McLearn), *M. bococki* (McLearn) and *Malayites* sp. Another single block yielded "*Tibetites*" sp., *Malayites custi* (McLearn) and *Malayites* sp. Most of these species have not been found in place in the gully. Examples of talus carrying species also found in place are: a single talus block with *Tropiceltites columbianus* (McLearn), *Sirenites nabeschi* McLearn, *Thisbites custi* (McLearn) and *Juvavites* sp., and one with *J. (Anatomites) cf. edithae* Mojsisovics. Other examples could be given.

A talus block above IX, just east of Juvavites Gully, yielded *Malayites custi* (McLearn), *Malayites bococki* (McLearn) and *Juvavites* sp. Other talus at IX yielded *Thisbites dawsoni* (McLearn) also known in place in the gully.

A large talus block just west of Juvavites Gully near XIII yielded *Juvavites* sp., *Malayites bococki* (McLearn) and *Malayites* sp. Another talus block at XIII yielded *Malayites parvus* (McLearn) and another near XIII, *Juvavites (Anatomites) cf. edithae* Mojsisovics.

On the south bank of the river at XIV below Juvavites Gully and at Little Parle Pas Rapids one talus block carried *Gonionotites spiekeri* (McLearn) and *G. rarus* (McLearn). Another had "*Tibetites*" sp. and *Juvavites* sp. Another carried "*Tibetites*" sp., *Juvavites mertoni* McLearn, *Juvavites* sp. and *Malayites bococki* (McLearn). Other species of ammonoids collected here are identical with species in place in Juvavites Gully.

Talus, west end of hill. Talus east and higher than XX with *Parathisbites oineus* McLearn and *Placites* sp. is obviously from the *Parathisbites oineus* beds.

Also at the west end of the hill and lying on outcrops of the *Himavatites* zone is talus of local origin from that zone. One talus block at XX yielded *Pseudosirenites pardoneti* (McLearn), *Thetidites equisitus* (McLearn), *Placites* sp. and *Pinacoceras* sp. A single block at XIX gave *Pseudosirenites pardoneti* (McLearn), *P. pressus* (McLearn), and *Pinacoceras* sp. Other species found in talus comprise *Alloclionites* sp., *Himavatites columbianus* McLearn and "*Arcestes*" sp.

Lying also on outcrops of the *Himavatites* zone near XIX, is some alien talus obviously from a different and lower faunal zone. One talus block yielded *Juvavites* sp. and "*Arcestes*" sp. Other talus yielded *Juvavites* sp., *Malayites parvus* (McLearn) and *Halobia*. It can reasonably be inferred that this talus has come from an outcrop high on the hill, of the same faunal zone that furnished the talus in Juvavites Gully, because of the species in common.

The source of a talus block in Monotis Gully with *Discotropites* sp. is unknown.

Black Bear Ridge

Location and structure. Black Bear Ridge (see 12, Fig. 1) is north of Pardonet Hill on the opposite side of Peace River valley. The crest is narrow and rounded and about 800 feet above river level. The west slope, descending into Black Bear valley, is steep and in part precipitous; the east slope is not so steep. This ridge is cut off on the north side by the valley of a southeastward-flowing stream into which, west of Black Bear Ridge, the Black Bear valley heads. This stream appears to have captured the headwaters and main source of Black Bear Creek, an act of stream piracy. The south slope of Black Bear ridge is fairly steep and sends out two low ridges or buttresses to the south where they overlook a 550-foot terrace, carved mostly out of sand. The east buttress is pierced by a small dry canyon with rock walls. In front of and below the 550-foot terrace is a 200-foot terrace and between it and the river, at a low level, is a broad, low flat.

The structure is that of a steep west limb of an asymmetrical anticline and a northward-prolongation of the structure of Pardonet Hill. The highest beds are on the top and highest parts of the ridge and the lowest beds are on the east side near and above the dry canyon.

The best section is on the higher part of the hill above the 550-foot terrace. Unfortunately most of this section is barren of ammonoids. This is not true of the highest beds in the section, however, for a large fauna was found in the *Himavatites* zone. No measurements were made, but the succession was carefully recorded. Another section was studied at a lower elevation, near the bottom of the steep face of the 550-foot terrace and only a little above the 200-foot terrace.

Succession. The lowest beds exposed in the section above the 550-foot terrace are in the small dry canyon and consist of limestone and siltstone with in places small shells, including pelecypods, and resembling transitional beds at the

base of the Pardonet formation on Pardonet Hill. Higher stratigraphically and at a higher elevation on the hillside are siltstones and limestones with, at one horizon, the ammonoid *Malayites parvus* (McLearn). Yet higher stratigraphically and much farther up the ridge *Juvavites biornatus* McLearn ? and *Juvavites* (*Anatomites*) cf. *brocchii* Mojsisovics were collected. At a yet higher stratigraphic level and near the top of the west slope, species of the *Himavatites* zone were collected, comprising *Pseudosirenites pardoneti* (McLearn), *P. pressus* (McLearn), *Steinmannites* sp., *Himavatites* sp., *Helictites* cf. *subgeniculatus* Mojsisovics, *H. decorus* McLearn, *Distichites canadensis* (McLearn), *D. palliseri* McLearn, *D.* cf. *celticus* Mojsisovics, *Parajuvavites* sp., *Episculites browni* (McLearn), *E. ornatus* (McLearn), *E. teres* (McLearn), *E. corpulentus* (McLearn), "*Arcestes*" sp., *Placites* sp. and *Proclydonautilus natosini* McLearn. Talus from this zone contains most of the species in this list of those collected in place. It contains in addition the following species not in the above list and found only in the talus: *Himavatites columbianus* McLearn, *H. multiauritus* McLearn, *H.* cf. *watsoni* Diener, *Distichites gethingi* McLearn, *D.* cf. *megacanthus* Mojsisovics, and *D.* cf. *hacqueti* Mojsisovics. Higher stratigraphically and high on the west slope of the hill are "*Arcestes*" sp., *Placites* sp. and *Monotis alaskana* Smith. A little farther down the west slope and in high cliffs above Black Bear valley are siltstones and limestones with numerous specimens of *Monotis subcircularis* Gabb. At the upper end of Black Bear valley the contact with the overlying Jurassic beds can be observed. The *Monotis subcircularis* beds are abruptly overlain by shale and calcareous beds with specimens of an indeterminate ammonoid, probably of early Lower Jurassic age. The *Rhacophyllites* beds that follow the *Monotis subcircularis* zone at Rapide-qui-ne-parle-pas are missing here.

The section at a lower level, just above the 200-foot terrace and exposed in the front of the 550-foot terrace is disappointing, for ammonoids are not abundant. Beds, however, with *Himavatites* sp., *Steinmannites* sp., *Placites* sp. and *Monotis alaskana* Smith occur and are overlain by beds with *Monotis subcircularis* Gabb. Talus on this slope yielded *Malayites bococki* (McLearn) and is evidently from a much lower horizon.

West Slope, West Spur, Brown Hill

Location and structure. Brown Hill is on the north side of Peace River near Tepee Rocks, between Tepee Rocks Coulee and Folded Hill Creek (see 13, Fig 1; Fig. 3). It is a high hill with steeply west-dipping ledges, flanked on the front facing the river by a 280-foot terrace carved out of gravel and sand, so that it is necessary to climb this terrace to gain access to bedrock. It is extended in a southward direction by two spurs separated by a wide embayment.

Most of the hill is underlain by the Grey beds which occupy the east spur and a large part of the west spur. The Pardonet formation underlies the west slope of the west spur from near the crest down into the side of Tepee Rocks Coulee, and is best exposed in a shallow gully on this slope called Twin Spruce

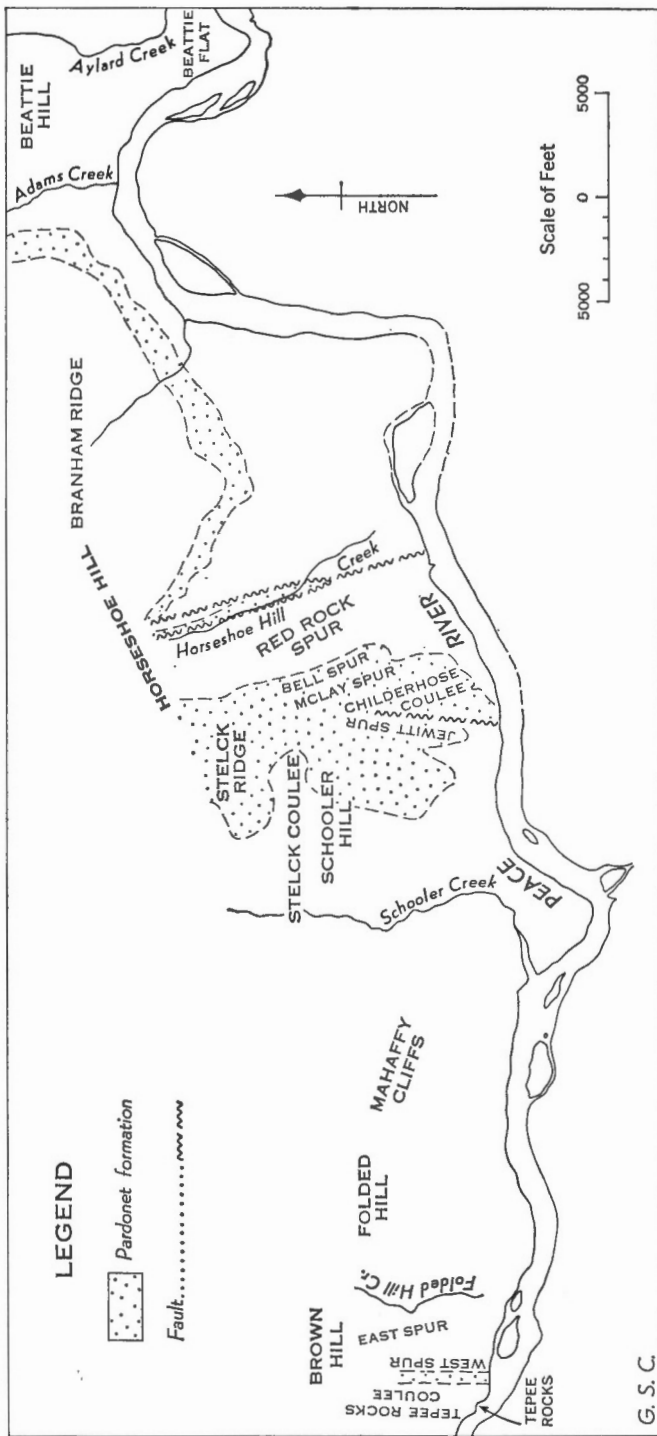


Figure 3. Distribution of Pardonet formation, Brown Hill to Branham Ridge.

Gully in earlier reports. The lowest beds occur near the top of the slope where they pass down through transitional beds into the Grey beds. The highest beds occur low down on the west slope and are overlain by shales of the Jurassic Fernie group which occupy the floor of Tepee Rocks Coulee; the contact, however, is concealed.

Succession. There is no well-defined segregation into lithological units as on Pardonet Hill, although the proportion of dark, calcareous siltstone to dark limestone varies at different horizons. No sandstone unit comparable with that on Pardonet Hill below the *Styrites ireneanus* zone has been observed here. The total thickness is very much less than that on Pardonet Hill, being only about 265 feet.

The faunal succession is as follows:

| | Thickness (feet) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Limestone, dark; siltstone, dark, calcareous; with abundant <i>Monotis subcircularis</i> Gabb | 60 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Monotis alaskana</i> Smith | 20 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Pseudosirenites pardoneti</i> (McLearn), <i>Himavatites columbianus</i> McLearn, <i>Hypisculites stelcki</i> (McLearn), <i>Placites</i> sp., <i>Halobia</i> sp. | 20 |
| Limestone, dark, fissile; siltstone, dark, calcareous; with <i>Halobia</i> sp. | 15 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Cyrtopleurites</i> sp., <i>Acanthinites</i> cf. <i>eusebii</i> Diener ?, <i>Metacarnites</i> sp., <i>Placites</i> sp., <i>Oxytoma</i> cf. <i>mucronata</i> Gabb, <i>Halobia</i> | 10 |
| Limestone, dark, fissile; siltstone, dark, calcareous; with <i>Drepanites hyatti</i> subsp. <i>rutherfordi</i> (McLearn), <i>Oxytoma</i> cf. <i>mucronata</i> Gabb, <i>Halobia</i> cf. <i>dilatata</i> Kittl, <i>Halobia</i> | 10 |
| Limestone, dark, fissile; siltstone, dark, calcareous; with <i>Halobia</i> | 5 |
| Limestone, dark, fissile; siltstone, dark, calcareous; with <i>Cyrtopleurites magnificus</i> McLearn, <i>Pterotoceras caurinum</i> McLearn, <i>Juvavites bionatus</i> McLearn, <i>J. magnus</i> McLearn, <i>J. (Anatomites)</i> cf. <i>brocchii</i> Mojsisovics, <i>Guembelites</i> sp., <i>Oxytoma</i> cf. <i>mucronata</i> Gabb, <i>Halobia</i> cf. <i>lepsiusi</i> Gemmellaro, <i>Halobia</i> | 10 |
| Limestone, dark grey; siltstone, dark, calcareous; with <i>Gonionotites belli</i> (McLearn), <i>Halobia</i> | 5 |
| Limestone, dark grey; siltstone, dark, calcareous; with <i>Malayites</i> sp., <i>Gonionotites rarus</i> (McLearn), <i>Oxytoma</i> cf. <i>mucronata</i> Gabb, <i>Gryphaea</i> , <i>Pecten</i> | 10 |
| Concealed | 20 |
| Limestone, dark grey; siltstone, dark, calcareous; with <i>Halobia</i> | 20 |
| Concealed | 5 |
| Limestone, grey; siltstone, calcareous | 15 |
| Concealed | 15 |
| Limestone, dark; siltstone, dark, calcareous; with <i>Stikinoceras kerri</i> McLearn, <i>Juvavites schoolerensis</i> McLearn, <i>J. (Anatomites)</i> <i>humi</i> McLearn, <i>J. (Anatomites)</i> cf. <i>edithae</i> Mojsisovics, <i>Dimorphites pardonetiensis</i> (McLearn), <i>Gonionotites rarus</i> (McLearn), <i>G.</i> cf. <i>rarus</i> (McLearn), <i>Gonionotites</i> sp., <i>Lima</i> , <i>Pecten</i> , <i>Halobia</i> | 5 |
| Concealed | 10 |
| Limestone, dark; siltstone, calcareous; with <i>Thisbites dawsoni</i> (McLearn), <i>Halobia</i> | 10 |
| Concealed | 50 |
| Limestone, grey; siltstone; including transitional Grey beds | |

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In this section *Monotis alaskana* Smith overlies beds with *Himavatites*. They mostly, however, occur together in the same bed and faunal zone. Pelecypods are more common than in the Pardonet Hill section.

Talus. A talus block in Tepee Rocks Coulee yielded *Alloclionites* sp., *Sandlingites* cf. *idae* Mojsisovics, *Sagenites* sp., *Placites* sp. and *Monotis alaskana* Smith. As *Alloclionites* is known only in the *Himavatites* zone, the *Sandlingites* and *Sagenites* can be added to the *Himavatites* fauna. A talus block on the west slope yielded *Himavatites canadensis* McLearn and *Placites* sp. A second talus block also contained *Himavatites canadensis*. As these blocks likely have a source in the *Himavatites* zone, this species can be tentatively added to the *Himavatites* fauna, although it has not been found in place. One talus block yielded *Malayites dawsoni* McLearn and *M. butleri* (McLearn). Another single block gave *Gonionotites fuscus* (McLearn) and *Malayites butleri* (McLearn) and pelecypods. Another yielded *Malayites* sp. This talus with *Malayites* and *Gonionotites* is no doubt from the lower part of the section and from beds below the *Pterotoceras-Cyrtopleurites magnificus* beds. A talus block contained *Waldthausenites* cf. *leophanis* Diener and species of pelecypod genera, including *Lima* and *Gryphaea*. The associated species do not define the horizon, but the position of the block indicates that it could not have come from an horizon higher than the *Drepanites* beds. *Gonionotites spiekeri* (McLearn) and *G. belli* (McLearn) apparently from the lower part of the section below the *Pterotoceras* zone were also found in talus. *Juvavites* sp. was found only in talus. *Parathisbites oineus* McLearn ? occurs in a talus block with *Placites* sp. which does not indicate its exact horizon. It may come from high in the section.

The source of other talus yielding ammonoids is obvious, because the ammonoid species occur in place on this hill. Thus the source of a talus block with *Cyrtopleurites magnificus* McLearn, *Pterotoceras caurinum* McLearn and *Juvavites biornatus* McLearn is evident, as is one with *Dimorphites pardonetiensis* (McLearn) and *Dimorphites* sp., another with *Stikinoceras kerri* McLearn and one with *Drepanites hyatti* subsp. *rutherfordi* (McLearn). Other examples could be given. Some of the talus yielded pelecypods only. The exact source of talus with *Monotis alaskana* Smith or *M. subcircularis* Gabb is easy to locate, but that of other talus with long-ranging pelecypod species is uncertain.

West Glacier Spur

Directly south of the west spur of Brown Hill and on the opposite and south side of Peace River is West Glacier Spur (see 14, Fig. 1). Most of this spur is underlain by the Pardonet formation. Where studied the west-dipping dark siltstones and limestones contain only *Halobia* and *Gryphaea* in place. Talus, however, yielded the ammonoids *Juvavites biornatus* McLearn, *Juvavites* sp., and *Dimorphites* sp. and the pelecypods *Oxytoma* cf. *mucronata* Gabb and *Halobia*. In the

Brown Hill section *J. biornatus* has been found in the *Pterotoceras-Cyrtopleurites magnificus* beds and the *Dimorphites* is probably from the lower part of the formation.

Stelck Ridge

The high Stelck Ridge is east of Schooler Creek and north of Schooler Hill from which it is separated by a deep gully (*see* 15, Fig. 1; Fig. 3). Structurally it is on the east limb of a southward-pitching syncline. The dip however is low. The Grey beds underlie the lower part of this ridge, but the Pardonet formation occurs on the higher parts.

A few fossils were found including the ammonoids *Juvavites* sp., *Gonionotites* sp. and *Malayites bococki* (McLearn). A low but not the lowest part of the formation is inferred.

Schooler Hill

Schooler is a high, north-south trending hill east of the Schooler Creek valley, south of Stelck Ridge and on the north side of the Peace River valley (*see* 16, Fig. 1; Fig. 3). In a high ledge, above exposures of the Grey beds, at the south end, overlooking the Peace River valley, are southerly, low-dipping dark siltstones and limestones with *Halobia* and *Gryphaea*. On the west side in high ledges above Schooler Creek valley are similar beds with *Discotropites* sp. and *Oxytoma* cf. *mucronata* Gabb. Near the north end on a high eminence and high above the gully between Stelck Ridge and Schooler Hill are ledges containing *Monotis alaskana* Smith and *Halobia* in beds equivalent to the *Himavatites* zone.

Jewitt Spur

Jewitt Spur is east of Schooler Hill on the north side of the river (*see* Fig. 3). Ledges are exposed in places on the steep south slope and also on the river bank below. The low dip is to the south and an almost vertical north-south-trending fault occurs on the east slope. Adjacent to the fault and on the west side of it are the steeply dipping beds of a drag-fold.

On the west side of the fault, both above and below the pack-trail and extending to at least 200 feet above river level, are ledges of the Grey beds, including those of the *pozana* zone. Yet higher and at about 600 feet above river level are the dark siltstones and limestones of the Pardonet formation with *Halobia*, *Gryphaea* and other pelecypods, but no ammonoids. Several hundred feet higher topographically and farther up the slope are ledges with *Halobia*.

East of the fault, the base of the Pardonet formation is below river level. Ledges on the bank of the river, east of the fault, carry *Halobia* and *Gryphaea*, but no ammonoids. Talus, however, lying on these ledges has yielded *Malayites dawsoni* McLearn, *M. bococki* (McLearn), *Malayites* sp. and *Discotropites* cf. *acutus* (Mojsisovics) and pelecypods. The origin of this talus can only be inferred. It is possible that it has not come very far, for the ammonoids indicate a

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low position in the formation and the beds in these ledges must be in the lower part of the formation. It may be that the source is in the river bed and the talus has been brought up by ice action.

Also east of the fault, but at a higher stratigraphic level, in ledges above the pack-trail are beds typical of the formation, carrying species of pelecypod genera, including *Oxytoma*, *Halobia* and *Gryphaea*. Unfortunately no ammonoids have been found.

Childerhose Coulee

Childerhose Coulee is situated on the north side of Peace River, between Jewitt Spur and McLay Spur (*see* Fig. 3). In its lower part it is a narrow, deep ravine, rather than a coulee, through which a small stream flows. Bedrock is exposed in places on the walls of this ravine. In its upper part it is a wide, shallow coulee with low ledges in places.

In the ravine dark siltstones and limestones of the Pardonet formation carry *Halobia*, *Oxytoma* cf. *mucronata* Gabb and other pelecypods. In ledges in the upper shallow part are beds with *Monotis subcircularis* Gabb. No ammonoids were found.

Southern End of McLay Spur

East of Childerhose Coulee is McLay Spur (*see* Fig. 3). At the southern end a low cliff and high ledges of the Pardonet formation rise above a long slope, partly of talus and with some ledges protruding through it. On the east side is a long, high and precipitous cliff with the Grey beds below and a veneer of Pardonet beds above. The dip is to the southwest and the structure is rising up to the faulted anticline on Horseshoe Hill and Horseshoe Hill Creek. Collections were made at the south end of the spur.

Ammonoids are rare. One collection contains *Juvavites mclayi* McLearn and *Dimorphites pardonetiensis* (McLearn), another *Metacarnites* sp., *Drepanites hyatti* subsp. *rutherfordi* (McLearn), *Lecanites mundus* McLearn, *L. beattii* McLearn and *Hannaoceras* sp.; another *J. (Anatomites)* sp. and *Indojuvavites* cf. *angulatus* (Diener) and another *Discotropites* sp. The zoning was not recorded in this section. Numerous pelecypods were also collected.

Bell Spur to Branham Ridge

Bell Spur is northeast of the south end of McLay Spur (*see* Fig. 3). The Pardonet formation extends from McLay Spur to the west half of this spur, and, as on McLay Spur, the dip is west to southwest. Only low beds of the formation with *Halobia* outcrop.

The Pardonet formation outcrops on the west side of Horseshoe Hill and in the fault block that extends down Horseshoe Hill Creek. The pelecypods *Halobia* and *Oxytoma* cf. *mucronata* Gabb were collected.

It is inferred that a band of outcrop of the Pardonet formation occurs on the lower slopes of Branham Ridge.

This formation also outcrops on a hill east, but not immediately east of Aylard Creek. It contains there *Halobia* and other pelecypods.

North of the Peace River Foothills

Aylard Summit. The Pardonet formation has been recognized outside the Peace River Foothills in northeastern British Columbia. Very few ammonoids have been found, however, so that the sections studied have added little to our knowledge of ammonoid zones.

Beach and Spivak collected *Halobia*, evidently from this formation, on Aylard Summit in the headwaters of Aylard Creek (see 6, Fig. 1). No ammonoids have been collected.

Mount Wright. On the north side of Halfway River, west of Pink Mountain, is a prominent topographic feature called Mount Wright (see 5, Fig. 1). On the west limb of an asymmetric anticline, about 380 feet of dark siltstone and limestone can be referred to the Pardonet formation.

The upper 30 feet carry *Monotis subcircularis* Gabb. The underlying 40 feet carry *Monotis alaskana* Smith, *Halobia* and *Placites* sp., presumably the equivalent of the *Himavatites* zone. Below are beds with pelecypods and rare brachiopods, including species of *Halobia*, *Gryphaea*, *Myophoria*, *Lima*, *Modiolus* and *Spiriferina*.

Pink Mountain is a long, high ridge west of the Alaska Highway and between the Halfway and Sikanni Chief rivers (see 4, Fig. 1). About 3½ miles north of Halfway River, Hage (1944) collected *Monotis alaskana* Smith and *Halobia* from beds equivalent to the *Himavatites* zone. He also collected *Gryphaea* and *Pecten* presumably from a lower horizon. About 9 miles north of the Halfway River on this mountain, Hage collected *Monotis alaskana* and other pelecypods. W. I. Wright found the ammonoid *Juvavites* (*Anatomites*) sp.

Mount Hage. On the south side of Sikanni Chief River and east of Mount Withrow is Mount Hage (see 3, Fig. 1). On the western slope of the eastern summit, and on the east limb of an anticline a section of the Pardonet formation is exposed:

| | Thickness (feet) |
|--------------------------------------------------------------------------------------------------------------------------|---------------------|
| Jurassic shales ? | |
| Limestone, dark, shaly; with abundant <i>Monotis subcircularis</i> Gabb | 15+ |
| Shale, dark; siltstone; limestone; with common <i>Monotis alaskana</i> Smith, <i>Gryphaea</i> and <i>Pecten</i> | 25 |
| Concealed | 170 |
| Limestone, dark, carbonaceous | 150 |
| Concealed | 10 |
| Shale, fissile, carbonaceous; siltstone, dark, calcareous; with <i>Halobia</i> | 30 |

Upper Triassic Ammonoids of the Peace River Foothills

No ammonoids were found, but the *Himavatites* zone is indicated by the pelecypod *M. alaskana* and the *Monotis subcircularis* zone is recorded.

Below mouth of Chicken Creek. The Sikanni Chief River, near the mouth of Chicken Creek (see 2, Fig. 1), has excavated a steep-walled channel in Triassic, Jurassic and Cretaceous rocks. There on the west limb of an anticline, on the north bank of the river, below the mouth of Chicken Creek is a good exposure of the Pardonet formation. Ammonoids occur only in the upper part where there is a good section of the *Himavatites* zone. It has been studied by Hage (1944) and by Holland, and in considerable detail by McLearn in 1944.

McLearn's section is as follows (see McLearn, 1946; McLearn and Kindle, 1950):

| | Thickness (feet) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Shale, dark, Jurassic ? | |
| Siltstone, dark grey, shaly, hard; with <i>Alloclionites</i> sp., <i>Monotis alaskana</i> Smith, <i>Spiriferina</i> | 12 |
| Siltstone, massive, dark grey, calcareous; siltstone, shaly, calcareous; in beds up to 2 feet; with <i>Himavatites columbianus</i> McLearn, <i>Monotis alaskana</i> Smith, and other pelecypods | 13 |
| Siltstone and limestone, shaly, to fissile, dark, calcareous; "knobs" of <i>Halobio-coquina</i> and shells of <i>Monotis alaskana</i> Smith and reptilian bones | 7 |
| Siltstone, limestone, hard but somewhat fissile with abundant <i>Monotis alaskana</i> Smith; "knobs" with <i>Halobia</i> and marine reptilian vertebrae; about base of common <i>M. alaskana</i> | 9 |
| Siltstone, shaly to massive, calcareous; in places "knobs" of pelecypod coquina; <i>Himavatites columbianus</i> McLearn, <i>Parajuvavites</i> cf. <i>buddhaicus</i> Mojsisovics, <i>Monotis alaskana</i> Smith and other pelecypods | 10 |
| Limestone, dark grey; limestone, <i>Halobia-coquina</i> ; siltstone, shaly, calcareous; with <i>Halobia</i> cf. <i>dilatata</i> Kittl | 7 |
| Siltstone, dark, shaly to massive, calcareous; limestone, massive to shaly and in part coquina; with <i>Halobia</i> | 75 |
| Siltstone, dark, shaly, calcareous, with <i>Gryphaea</i> above | 65 |
| Limestone, grey; top of Grey beds | |

Collections from talus include the ammonoids *Alloclionites* sp., *Himavatites* sp., *Placites* sp., and *Pinacoceras* sp. Hage collected *Alloclionites* sp. from the top 5 feet and Holland collected *Steinmannites* ? and *Himavatites* sp. from the upper part of this section.

No *Monotis subcircularis* zone has been found and shales of probable Jurassic age rest directly on the *Himavatites* zone, locally on beds with *Alloclionites* sp. and *Monotis alaskana*. No ammonoids occur below the *Himavatites* zone. The beds with *Halobia* cf. *dilatata* may be close to the horizon of the *Drepanites* beds however.

The Pardonet beds outcrop in other parts of the Sikanni Chief valley, but so far have not yielded any ammonoids.

Klingzut Mountain

Triassic has been recognized on Klingzut Mountain and in the Prophet River valley by S.S. Holland, P. K. Sutherland and others. Holland collected ammonoids of the *Himavatites* zone, comprising *Allocionites* sp., *Steinmannites* sp. and *Himavatites* sp., and pelecypods including *Monotis alaskana* Smith and species of *Gryphaea* and *Modiolus* (see 1, Fig. 1).

Ammonoid Zones and Local Correlation

(See Tables I and II)

Despite the great variety of Upper Triassic ammonoids collected from the Pardonet formation and the number of species and genera represented in the collections, ammonoids are not common and this is obviously an obstacle to good ammonoid zonation. Some beds are almost entirely unfossiliferous like the thick units of barren dark siltstones and the thick sandstone on Pardonet Hill. Others are fossiliferous but contain only pelecypods or pelecypods and brachiopods. The ammonoids collected are mostly from Pardonet and Brown Hills and from the upper part of the section on Black Bear Ridge. The sections of this formation on Schooler Hill, Jewitt Spur, Childerhose Coulee, McLay Spur and Bell Spur yielded pelecypods almost exclusively. Another obstacle to the establishment of good ammonoid zones is that a total or complete succession of ammonoid zones cannot be found in any one section. To obtain a complete succession, data from more than one section are required.

With few exceptions the pelecypods have a much longer vertical range than the ammonoids and so are not suited to refined zoning. *Monotis subcircularis*, however, has a restricted vertical range and wide geographic extension and forms a definite faunal zone. *Monotis alaskana* also has a restricted range and one which in northeastern British Columbia mostly coincides with the ammonoid *Himavatites* zone. In some sections it extends a little higher. *Halobia* cf. *dilatata* Kittl also may have a restricted range in northern British Columbia. The *Monotis subcircularis* zone is an example of the necessity of resort to a pelecypod for zonal segregation where diagnostic ammonoids are not available.

A search north of the Peace River Foothills failed to find a section where an ammonoid succession could be established in the Pardonet formation. Indeed common ammonoids have only been recorded in one section, namely on Sikanni Chief River, below the mouth of Chicken Creek. Even there the ammonoids are of only one, the *Himavatites* zone. The few ammonoids found on Klingzut Mountain are also only from this zone.

Stikinoceras Zone

This ammonoid zone is only known in the sections on Pardonet and Brown Hills, where it occurs at or very near the base. The total ammonoid fauna compiled from lists at the two localities is as follows: *Sirenites nabeschi* McLearn, *Stikinoceras*

Table II
Ammonoid Zones, Northeastern British Columbia

| STAGE | | ALPINE ZONES | ABOVE POINT CREEK | RAPIDE-QUI-NE-PARLE-PAS | PARDONET HILL | BLACK BEAR RIDGE | BROWN HILL | SOUTH END McLAY SPUR | BELOW MOUTH CHICKEN CREEK | KLINGZUT MOUNTAIN |
|-----------------------------|------------|----------------------------------|-------------------|----------------------------|-----------------------------|----------------------------|----------------------------|----------------------|---------------------------|--------------------------------|
| UPPER TRIASSIC (Upper part) | RHAETIAN | <i>Choristoceras marshi</i> | | | ? | ? | ? | | | |
| | | <i>Sirenites argonautae</i> | | Rhacophyllites | | | | | | |
| NORIAN | Upper | <i>Pinacoceras metternichi</i> | ? | Monotis subcircularis zone | Monotis subcircularis zone | Monotis subcircularis zone | Monotis subcircularis zone | ? | ? | ? |
| | | <i>Cyrtopleurites bicrenatus</i> | | | Himavatites zone | Himavatites zone | Himavatites zone | | Himavatites zone | Steinmannites Alloclionites |
| KARNIAN (Upper part) | Lower | <i>Sagenites giebeli</i> | | | Barren calcareous siltstone | <i>J. cf. brocchii</i> | | | | |
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| KARNIAN (Upper part) | Upper part | <i>Tropites subbullatus</i> | | | | | | | | |
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kerri McLearn, *Thisbites dawsoni* (McLearn), *Tropiceltites columbianus* (McLearn), *Juvavites schoolerensis* McLearn, *Juvavites* sp., *J. (Anatomites) humi* McLearn, *J. (Anatomites)* cf. *edithae* Mojsisovics, *Dimorphites pardonetiensis* (McLearn), *Gonionotites clavatus* (McLearn), *Gonionotites rarus* (McLearn), *G.* cf. *rarus* (McLearn), *Gonionotites* sp., and "*Arcestes*" sp. The following identified species appear to be confined to this zone: *Stikinoceras kerri* McLearn, *Juvavites schoolerensis* McLearn, *Juvavites (Anatomites) humi* McLearn and *Dimorphites pardonetiensis* (McLearn).

It has already been stated that most, if not all, of the talus collected near III, IV, V and VI on Pardonet Hill has probably come from the *Stikinoceras* zone or *Tropites* bed. If this is true, the following species can be added to the contents of the *Stikinoceras* zone, or at least to the faunal contents of the lower part of the formation, that is from limestone b on Pardonet Hill: *Juvavites* cf. *subinterruptus* Mojsisovics, *J. (Anatomites)* sp., *Gonionotites fuscus* (McLearn), *G. spiekeri* (McLearn), *Malayites butleri* (McLearn), *M.* cf. *antipatris* Diener, *Miltites* ? sp. and *Placites* sp.

Dimorphites pardonetiensis (McLearn) in the unzoned McLay Spur section probably indicates an horizon equivalent to the *Stikinoceras* zone on Pardonet and Brown Hills or at least beds very low in the formation. The occurrence of *Dimorphites* sp. in talus on West Glacier Spur may indicate the presence of the *Stikinoceras* zone there or at least beds very low in the formation. Neither *Stikinoceras kerri* nor any species diagnostic of this zone, however, has been found in place on this spur.

Tropites Bed

Only a single specimen of *Tropites* is recorded in place on Pardonet Hill. It was found near the top of limestone b at V. Other specimens of *Tropites* are mere fragments and in talus at the same locality.

Beds of *Tropites* age are probably represented in ledges on the north side of the river above Point Creek, where *Discotropites sandlingensis* (Hauer) occurs. No *Tropites*, however, has been collected at this locality.

Myophoria grahami Beds

No ammonoids have been found in the thick section of mostly unfossiliferous strata between the *Tropites* and *Styrites ireneanus* zones on Pardonet Hill. Brachiopods occur in two small lenses of limestone in the barren siltstones and a small fauna, chiefly of pelecypods, is in the limestones, that is in the *Myophoria grahami* beds, at VIII, Lima Gully. These fossiliferous beds, of course, make no contribution to ammonoid zoning.

The barren sandstones follow in the Pardonet Hill section.

Styrites ireneanus Zone

As already noted the barren sandstones are followed by dark limestones and siltstones with ammonoids of the *Styrites ireneanus* zone at Juvavites Gully. This

zone, which is only known on Pardonet Hill contains the following ammonoids: *Sirenites nabeschi* McLearn, *Cyrtopleurites* sp., *Thisbites custi* (McLearn), *T. dawsoni* (McLearn), *T. cf. pyrami* (Gemmellaro), *T. charybdis* (Gemmellaro), *Choristoceras* ? sp., *Styrites ireneanus* McLearn, *Tropiceltites columbianus* (McLearn), *Juvavites selwyni* McLearn, *Juvavites* sp., *J. (Anatomites) cf. edithae* Mojsisovics, *J. (Anatomites) sp.*, *Gonionotites clavatus* (McLearn), *G. gethingi* (McLearn), *G. cf. italicus* Gemmellaro and *Gonionotites* sp. Five of the identified species have come up from the *Stikinoceras* zone: *Sirenites nabeschi* McLearn, *Thisbites dawsoni* (McLearn), *Tropiceltites columbianus* (McLearn), *J. (Anatomites) cf. edithae* Mojsisovics and *Gonionotites clavatus* (McLearn).

It has been inferred, at least tentatively, that talus in Juvavites Gully on the shore of Little Parle Pas Rapids at XIV and a little west of Juvavites Gully at XIII and even some of the talus from the west near XIX is from the *Styrites ireneanus* zone or from beds very close to the beds of that zone. If this is so, the following species can be added tentatively to the fauna of this zone: "*Tibetites*" sp., *Juvavites mertoni* McLearn, *J. mackenzii* McLearn, *Gonionotites spiekeri* (McLearn), *G. rarus* (McLearn), *Malayites parvus* (McLearn), *M. custi* (McLearn) and *M. bococki* (McLearn).

Gonionotites-Malayites Major Zone

In a sense it can be said that on Pardonet Hill the *Stikinoceras* zone, the *Tropites* bed and the *Styrites ireneanus* zone together constitute one major zone, despite the great thickness of mostly barren siltstone and the barren sandstone between the *Tropites* bed and *Styrites ireneanus* zone. As already pointed out some ammonoid species occur in both the *Stikinoceras* and *Styrites ireneanus* zones and moreover there are some species in common between the talus from Juvavites Gully and from talus of the lower part of the section or from in place in the lower part of the section. This major zone is particularly marked by the ammonoid genera *Gonionotites* and *Malayites*, although the latter on Pardonet Hill is only known in talus. An appropriate name for it is the *Gonionotites-Malayites* major zone.

In proposing a major zone of this order of magnitude for the Pardonet Hill section in a previous report (*see* McLearn, 1947) it was suggested that this major zone could represent the *Tropites* zone of other regions. The single specimen of *Tropites* in place on Pardonet Hill of course does not record the total range of the genus. It is not known how much of the major *Gonionotites-Malayites* zone is equivalent to the total *Tropites* zone elsewhere and whether equivalent beds of the total *Tropites* zone even extend below the Pardonet formation.

As now known this major zone does differ to some degree in its upper and lower parts, being marked below by species already cited as confined to the *Stikinoceras* zone and above by species confined to the *Styrites ireneanus* zone.

Gonionotites belli and *Malayites* Beds

It is not proposed that the *Gonionotites belli* and the *Malayites* beds in the Brown Hill section be considered faunal zones. It is furthermore not proposed that

all specimens of *Malayites* collected from talus have a source as restricted in stratigraphic range as that defined by the local *Malayites* beds on Brown Hill. Only two ammonoids are recorded from the *Malayites* beds and only one ammonoid species from the *Gonionotites belli* beds. Their occurrence and the succession of these beds are only local. In the Pardonet Hill section *Gonionotites* has a long range, from *Stikinoceras* to the *Styrites ireneanus* zone and *Malayites* is considered to have an equally long range, although only found in talus.

The *Malayites* and *Gonionotites belli* beds on Brown Hill, however, do represent a part of the major *Gonionotites-Malayites* zone, but not the lowest part, because they are underlain by the *Stikinoceras* zone which is included in the major zone.

The species of *Malayites* collected on the north bank of Peace River, below the Jewitt Spur, including *Malayites dawsoni* and *M. bococki* are from some part of the *Gonionotites-Malayites* major zone and *M. bococki* may indicate a higher part of it.

The small ammonoid fauna collected on Stelck Ridge, including *Gonionotites* sp. and *Malayites bococki* are from beds of this major zone. The *M. bococki* indicates an upper part of that zone.

The beds on Black Bear Ridge with *Malayites parvus* are also of the major *Gonionotites-Malayites* zone and probably of the upper part. The talus collected on the terrace slope at a lower elevation on this ridge is probably also from an upper part of this zone.

Pterotoceras-Cyrtopleurites magnificus Beds

The ammonoid fauna of these beds is best known in the Brown Hill section and comprises, in place, *Cyrtopleurites magnificus* McLearn, *Pterotoceras caurinum* McLearn, *Juvavites biornatus* McLearn, *J. magnus* McLearn, *J. (Anatomites)* cf. *brocchii* Mojsisovics and *Guembelites* sp. The *Guembelites* is typical of the genus. This fauna was also collected in talus on the west slope of the west spur of Brown Hill, but the talus has not yielded any species not found in place.

This zone was not found in place on West Glacier Spur, but equivalent beds appear to be present for *Juvavites biornatus* was collected from talus.

This zone is also represented by the beds on Black Bear Ridge a little below the *Himavatites* zone. They contain *Juvavites biornatus* ? and *Juvavites (Anatomites)* cf. *brocchii*.

Drepanites Beds

The beds with *Drepanites hyatti* subsp. *rutherfordi* (McLearn) overlie the *Pterotoceras-Cyrtopleurites magnificus* beds on Brown Hill. No other ammonoids occur. This species was also collected on McLay Spur but the section there has not been separated into ammonoid faunal zones. It is possible that strata on Sikanni Chief River below Chicken Creek with *Halobia* cf. *dilatata* are at an equivalent horizon.

Cyrtopleurites Beds

The fauna of these beds in the Brown Hill section contains *Cyrtopleurites* sp., *Acanthinites* cf. *eusebii* Diener ?, *Metacarnites* sp. and *Placites*. This association of species is not known elsewhere in the Peace River Foothills. The *Cyrtopleurites* sp. in the *Styrites ireneanus* zone on Pardonet Hill is of a different species than the one in this fauna and probably of an earlier age. *Metacarnites* is represented in the unzoned McLay Spur section.

Parathisbites oineus Beds

Only one species of an ammonoid has been collected in place from these beds which underlie the *Himavatites* zone on Pardonet Hill. Talus included this species and *Placites* sp. The source of the specimens from talus on Brown Hill, doubtfully identified as *P. oineus*, is not established.

Himavatites Zone

This well-defined ammonoid zone has been found at many localities in the Peace River Foothills and in other parts of northeastern British Columbia. The pelecypod *Monotis alaskana* Smith has almost the same restricted range as the ammonoids of this zone, but in places extends a little higher. The zone is recognized by typical ammonoids on Pardonet Hill, Black Bear Ridge, Brown Hill and in the north on Sikanni Chief River below the mouth of Chicken Creek, and by *Monotis alaskana* alone at the north end of Schooler Hill, on Mount Wright, Pink Mountain and Mount Hage.

The comparatively large fauna collected in place and compiled from all localities comprises: *Pseudosirenites pardoneti* (McLearn), *P. pressus* (McLearn), *Vredenburgites* sp., *Sandlingites* ? sp., *Alloclionites* sp., *Steinmannites* sp., *Himavatites* cf. *watsoni* Diener, *Himavatites columbianus* McLearn, *H. burlingi* McLearn, *Himavatites* sp., *Helicites* cf. *subgeniculatus* Mojsisovics, *H. decorus* McLearn, *Distichites* cf. *mesacanthus* Diener, *Distichites canadensis* McLearn, *D. palliseri* McLearn, *D. cf. celticus* Mojsisovics, *Thetidites exquisitus* (McLearn), *Parajuvavites* cf. *buddhaicus* Mojsisovics, *Parajuvavites* sp., *Episculites browni* (McLearn), *E. ornatus* (McLearn), *E. teres* (McLearn), *E. corpulentus* (McLearn), *Hypisculites stelcki* (McLearn), "*Arcestes*" sp., *Placites* sp. and *Pinacoceras* sp. The following in talus, known to be from this zone, can be added to this fauna: *Sandlingites* cf. *idae* Mojsisovics, *Himavatites multiarutilus* McLearn, *H. canadensis* McLearn, *Distichites gethingi* McLearn, *Distichites* cf. *megacanthus* Mojsisovics, *D. cf. hacqueti* Mojsisovics, and *Sagenites* sp.

Monotis subcircularis Zone

As ammonoids are very rare in this zone, poorly preserved and not diagnostic, it is defined by a short-ranging pelecypod, *Monotis subcircularis* Gabb. This pelecypod is very common. Only at Rapide-qui-ne-parle-pas have ammonoids been found and they are mostly poorly preserved: *Rhacophyllites* sp., *Indoclionites* ? sp., and *Placites* sp.

In the Peace River Foothills this zone has been located on Clearwater River, Rapide-qui-ne-parle-pas, Pardonet Hill, Black Bear Ridge, Brown Hill and Childerhose Coulee. North of the Peace River Foothills it has been observed on Mount Wright and Mount Hage. It does not appear to occur on Sikanni Chief River below the mouth of Chicken Creek.

Rhacophyllites Beds

Fossiliferous Triassic beds above the *Monotis subcircularis* zone are known only at Rapide-qui-ne-parle-pas. There they contain the ammonoids *Rhacophyllites* sp., "*Arcestes*" sp. and *Placites* sp. These are long-ranging genera and *Rhacophyllites* is not confined to this zone, even at Rapide-qui-ne-parle-pas. No diagnostic ammonoids occur in these beds.

The *Rhacophyllites* beds are directly overlain by beds with an indeterminate Lower Jurassic ammonoid.

Species of Unknown Horizon

The source of a few species is obscure. Either they have been collected from talus, the origin of which is unknown, or they are from a section that has not been zoned.

Waldthausenites cf. *leophanis* Diener is known only in talus on the west slope of the west spur of Brown Hill. The associated species in the same talus block are long ranging and afford no clue to the horizon from which this ammonoid has come. The position of the talus block on the slope indicates a stratigraphic level not higher than the *Drepanites* beds.

The source of *Discotropites* cf. *acutus* (Mojsisovics) found in mixed talus on the bank of the river below Jewitt Spur cannot be determined. Other talus at this locality contained *Malayites* presumably from the major *Gonionotites-Malayites* zone.

The exact horizon of *Juvavites mclayi* McLearn, *Lecanites mundus* McLearn, *L. beattii* McLearn, *Hannaoceras* sp., *Indojuvavites* cf. *angulatus* Diener and *Discotropites* sp., remains unsolved. These species come from a comparatively thin section where ammonoids are rare and have not been zoned, that is from McLay Spur.

Pardonet Hill and Brown Hill as Complementary Ammonoid Successions

There is some fairly good evidence that the ammonoid successions of Pardonet Hill and Brown Hill sections complement each other. Although some zones are in common, one section apparently furnishes zones not found in the other. It

is hoped that between them they provide a more or less complete succession for the Pardonet formation (*see* McLearn, 1947; McLearn and Kindle, 1950).

The Pardonet Hill and Brown Hill sections share the ammonoid *Stikinoceras* and *Himavatites* zones and the pelecypod *Monotis subcircularis* zone. *Tropites* and the *Styrites ireneanus* fauna have not been located on Brown Hill and the *Pterotoceras-Cyrtopleurites magnificus*, *Drepanites* and *Cyrtopleurites* faunas have not been recorded from Pardonet Hill. It has been already inferred that the *Stikinoceras* to *Styrites ireneanus* zones form a major zone on Pardonet Hill and that the *Stikinoceras* zone plus the *Malayites* plus *Gonionotites belli* beds on Brown Hill are more or less equivalent to this *Gonionotites-Malayites* major zone on Pardonet Hill. The real issue seems to be where the equivalent of the *Pterotoceras-Cyrtopleurites magnificus* beds is to be found in the Pardonet Hill section. There is certainly some evidence that this equivalent is in beds above the *Styrites ireneanus* zone on Pardonet Hill: none of the ammonoid species of the *Pterotoceras-Cyrtopleurites magnificus* beds occurs in the *Styrites ireneanus* zone or in any part of the major *Gonionotites-Malayites* zone; and the *Pterotoceras-Cyrtopleurites magnificus* beds definitely overlie beds of the *Gonionotites-Malayites* zone on Brown Hill. Although this does not constitute absolute proof it lends a high degree of probability to this hypothesis of equivalent beds in the Pardonet section. If this is so, then the *Pterotoceras-Cyrtopleurites magnificus* beds are equivalent to some part of the barren siltstones overlying the *Styrites ireneanus* zone in the Pardonet Hill section. It follows further that the *Drepanites* and *Cyrtopleurites* beds of the Brown Hill section are equivalent to some higher part of these barren siltstones on Pardonet Hill. The *Parathisbites oineus* beds have not been located on Brown Hill. A specimen doubtfully referred to *P. oineus* was found in talus on Brown Hill, but its source was not indicated by associated specimens.

If the ammonoid successions on Pardonet and Brown Hills do complement each other, the zonal arrangement of ammonoid faunal zones and the ammonoid-bearing beds is as follows:

| | | |
|----------------------------------------------------|---|---------------------------------------------|
| <i>Monotis subcircularis</i> zone | | |
| <i>Himavatites</i> zone | | |
| (<i>Parathisbites oineus</i> beds) | | |
| <i>Cyrtopleurites</i> beds | | |
| <i>Drepanites</i> beds | | |
| <i>Pterotoceras-Cyrtopleurites magnificus</i> beds | | |
| <i>Styrites ireneanus</i> zone | } | <i>Gonionotites-Malayites</i> major zone |
| <i>Tropites</i> bed | | |
| <i>Stikinoceras</i> zone | | |

The relative position of zones in the various sections are shown in Table II, which can also be consulted for local correlations.

Relative Status of Faunal Zones

The *Monotis subcircularis* and *Himavatites* zones, the one a pelecypod and the other an ammonoid zone, are the best defined and most widely extended of the zones in the Pardonet formation. The *Monotis subcircularis* zone is delimited by a single species of short vertical range and has a considerable geographic extension in all of the area of the outcrop of the Pardonet formation except to the north or northeast on Sikanni Chief River near the mouth of Chicken Creek where it appears to be absent. The *Himavatites* zone maintains a uniform content of ammonoid species in many parts of the Peace River Foothills and northeastern British Columbia and where the ammonoids fail can be recognized by the presence of a pelecypod, namely, *Monotis alaskana* Smith, of almost as restricted a vertical range as the ammonoids.

Next in order of restricted ammonoid contents and geographic extension is the major *Gonionotites-Malayites* ammonoid zone, best developed on Pardonet Hill, but recognized in part at least over a fairly large area in the Peace River Foothills. It has been shown that of its three components on Pardonet Hill the lowest, the *Stikinoceras* zone, as a well-defined zone, occurs in only one other section, namely that on Brown Hill, and the other two the *Tropites* bed, recorded by only one specimen, and the *Styrites ireneanus* zone are not known in any other section. The validity of the *Stikinoceras* and *Styrites ireneanus* zones, as anything more than local faunal zones or local associations of species is as yet by no means established. The record of *Tropites* is a meagre one. As already pointed out the *Malayites* and *Gonionotites belli* beds of the Brown Hill section have no claim to the status of zones, but are merely local occurrences and form a fragmentary part of the major *Gonionotites-Malayites* zone.

Next in order of status are the *Pterotoceras-Cyrtoleaurites magnificus* beds (or zone), known only in full ammonoid composition in the Brown Hill section, where six ammonoid species have been collected. They may have some claim as a local zone because they contain six restricted ammonoid species. They also appear to have some degree of geographic extension, being recorded by one diagnostic species as far away from Brown Hill as Black Bear Ridge and by another diagnostic species in talus on West Glacier Spur.

No claim is made that either the *Drepanites* beds or the *Cyrtoleaurites* beds of the Brown Hill section are faunal zones. *Drepanites* is of very rare occurrence in this formation and a subspecies is the only ammonoid in the *Drepanites* beds on Brown Hill and is found elsewhere only in the unzoned McLay Spur section. *Cyrtoleaurites* is a long-ranging genus and occurs also down in the *Styrites ireneanus* zone but in the form of a very different species from the one in the *Cyrtoleaurites* beds on Brown Hill. Possibly the *Drepanites* and *Cyrtoleaurites* beds record fragments of an unknown and undeveloped faunal zone.

The status of the *Parathisbites oineus* zone or beds is obscure. It may be only part of the *Himavatites* zone.

Chapter III

CORRELATION OF PEACE RIVER SECTION WITH UPPER TRIASSIC DEPOSITS OF OTHER REGIONS

The correlation of Upper Triassic stratigraphic units (*see* Table III) would be comparatively simple if a standard faunal chronology of world-wide scope, defined by a universal succession of well-defined Upper Triassic ammonoid zones, were established. This objective, unfortunately, has not yet been entirely realized. In some areas where Upper Triassic ammonoids are well known the succession has not been zoned. The Alpine ammonoid succession, particularly that of the Hallstatt region (Mojsisovics, 1893), has made the most important contribution to the erection of such a standard (*see* Spath, 1934; Muller and Ferguson, 1939; Kummel *in* Arkell, *et al.*, 1957). The three upper Triassic stages, Karnian, Norian and Rhaetian, have a more or less wide extension, although the Rhaetian is known in only about two areas in North America.

Hallstatt, Austria. The Hallstatt succession is considered first. A somewhat abbreviated table of Upper Triassic faunal zones follows:

| Stage | | Faunal Zone |
|----------|-------|----------------------------------|
| Rhaetian | | <i>Choristoceras marshi</i> |
| Norian | Upper | <i>Sirenites argonautae</i> |
| | | <i>Pinacoceras metternichi</i> |
| | Lower | <i>Cyrtopleurites bicrenatus</i> |
| | | <i>Sagenites giebeli</i> |
| Karnian | | <i>Tropites subbullatus</i> |
| | | <i>Carnites</i> |
| | | <i>Trachyceras</i> |

Ammonoids of the *Stikinoceras* zone sufficiently resemble those of Karnian age in the Hallstatt region to infer a Karnian age of this zone. *Sirenites nabeschi* is a Karnian *Sirenites*, having a well-defined umbilical shoulder common in both the Karnian *senticosi* and *striatofalcati* species groups. *Tropicelites columbianus* appears to resemble the Karnian *Tropicelites ceciliae* Mojsisovics. *Juvavites* with the

Table III.
Correlation Table

| STAGE | ALPINE ZONES | PEACE RIVER FOOTHILLS | KYUQUOT SD. TO ESPERANZA INLET | NEVADA | SPIITI | PAINKHANDA | BYANS | TIMOR |
|-----------------------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| UPPER TRIASSIC (Upper part) | RHAETIAN | <p>Choristoceras marshi</p> <p>Sirenites argonautae</p> <p>Pinacoceras metternichi</p> <p>Cyrtopleurites bicrenatus</p> <p>Sagenites giebeli</p> | <p>?</p> <p><i>M. subcircularis</i></p> <p>Para-cochloceras</p> <p>Himavatites - Distichites</p> <p>?</p> | Choristoceras marshi | ? | ? | ? | ? |
| | | | | <p>Upper</p> <p>NORIAN</p> | <p>Pinacoceras metternichi zone</p> <p>GABBS</p> <p>Sagenites giebeli zone</p> <p>Guembelites-Syrites</p> | <p>Kioto ls. (Lower part)</p> <p>Quartzite series</p> <p>Monotis shale</p> <p>Corall. ls.</p> <p>Juvavites beds with Metacarnites</p> <p>limestone with Procydonautilus griesbachi, Metacarnites</p> | <p>Kioto ls. (Lower part)</p> <p>Quartzite series</p> <p>Anodontophora beds</p> <p>Sp. griesbachi beds</p> <p>Halorites beds with Steinmannites, P. metternichi</p> <p>Indochlorites</p> <p>Himavatites</p> | <p>Kioto ls. (Lower part)</p> <p>Grey ls., sh.</p> <p>Black sh.</p> |
| KARNIAN (Upper part) | <p>Tropites subbullatus</p> | <p>Gonionites - Malayites zone</p> <p>Syrites ireneanus zone</p> <p>Tropites zone</p> <p>Stikinoceras zone</p> | <p>Limestones</p> | <p>GABBS</p> | <p>Tropites subbullatus zone</p> | <p>Tropites beds</p> | <p>Halobia beds with Jovites, Juvavites, Sagenites etc</p> | <p>Tropites</p> |
| | | | | | | | | |

intermittens style of ornament is mostly Karnian in the Hallstatt sections. Although Mojsisovics recorded no species of *Gonionotites* from the Hallstatt region, Diener (1921) described one, and the possible occurrence of another in the *Tropites subbullatus* beds. Part at least of the *Gonionotites-Malayites* major zone, together with the *Tropites* bed, can be correlated with the Upper Karnian *Tropites subbullatus* zone in the Hallstatt region.

The general appearance of the fauna of the *Styrites ireneanus* zone is Karnian and indeed it has species in common with, or very close to, species in the *Stikinoceras* zone, for example *Sirenites nabeschi* and *Tropiceltites columbianus*. *Styrites* occurs in the Karnian of the Hallstatt region. The new elements, not present in the *Stikinoceras* zone, are not specifically Norian. The genus *Cyrtoleuroides*, appearing for the first time, is known in the Karnian elsewhere, although more characteristic of the Norian. Indeed the entire *Gonionotites-Malayites* major zone may be of Upper Karnian age.

The beds carrying *Discotropites sandlingensis* (Hauer) on Peace River above Point Creek, those with *Dimorphites pardoniensis* in the unzoned McLay Spur section, those with *Malayites parvus* on Black Bear Ridge and the ammonoid-bearing beds on Stelck Ridge may also be of Upper Karnian age.

The Karnisch-norischen Mischfauna of the Feuerkogel in the Hallstatt region is a peculiar mixed fauna of both Karnian and Norian affinities (see Heinrich, 1909; Diener, 1920a, 1921) and is difficult to understand. Spath (1934) included it in his Triassic standard chronology as a basal Norian zone, with the name of *Heinrichites paulckeii* zone. If such a zone does exist, it should contain a sufficient number of diagnostic Norian genera to establish its Norian age. The Karnian components could be considered "holdovers". The faunal list of this zone is of interest because it records the genera *Pterotoceras* and *Malayites* in the Hallstatt region. No part of the Peace River *Gonionotites-Malayites* major zone could be compared with the "Mischfauna" because it lacks the diagnostic Norian genera.

The fauna of the *Pterotoceras-Cyrtoleuroides magnificus* beds in the Brown Hill section has no marked resemblance to any of the Hallstatt faunas described by Mojsisovics. An inflated *Anatomites* such as *Juvavites (Anatomites) cf. brocchii* Mojsisovics with ribs continuous across the venter may occur in either the Karnian or Norian of the Hallstatt area. *Guembelites* has not yet been reported from the Alps. *Pterotoceras* was not recorded by Mojsisovics but has been listed in the "Mischfauna". Because these beds have nothing in common with the earlier and probably Karnian *Gonionotites-Malayites* major zone, they are tentatively dated Norian.

Drepanites is recorded by Mojsisovics from the *Cyrtoleuroides bicrenatus* zone of the Hallstatt section. Specimens of *Cyrtoleuroides* in the *Cyrtoleuroides* beds resemble species in the *Cyrtoleuroides bicrenatus* zone. The *Drepanites* and *Cyrtoleuroides* beds are correlated with a part of the *Cyrtoleuroides bicrenatus* zone of the Hallstatt region.

The species *Pseudosirenites pardoneti* in the *Himavatites* zone is of a Norian genus represented in the *Sagenites giebels* and *Cyrtopleurites bicrenatus* zones of the Hallstatt area. *Himavatites* has not been recorded from Alpine sections. *Alloclionites* occurs in the *Cyrtopleurites bicrenatus* zone, *Steinmannites* in both the *Sagenites giebels* and *Cyrtopleurites bicrenatus* zones, *Helictites* cf. *subgeniculatus* resembles a species in the *Sagenites giebels* zone and *Distichites* cf. *megacanthus* Mojsisovics, *Distichites* cf. *celticus* Mojsisovics and *Distichites* cf. *hacqueti* Mojsisovics resemble species in the *Cyrtopleurites bicrenatus* zone. The weight of evidence favours a correlation of the *Himavatites* zone with the *Cyrtopleurites bicrenatus* zone in the Hallstatt region.

Ammonoids of the *Monotis subcircularis* zone and immediately overlying beds are too poorly preserved and not sufficiently diagnostic to afford an exact comparison with the Hallstatt ammonoid zones. For discussion of the age of these beds see page 36.

Sicily. The faunas of the major *Gonionotites-Malayites* zone resemble the fauna from Sicily described by Gemmellaro.

| Peace River | Sicily |
|------------------------------------------|-----------------------------------------|
| <i>Thisbites charybdis</i> | <i>Thisbites charybdis</i> (Gemmellaro) |
| <i>Thisbites custi</i> | <i>Thisbites charybdis</i> (Gemmellaro) |
| <i>Styrites ireneanus</i> | <i>Styrites disciformis</i> Gemmellaro |
| <i>Tropicellites columbianus</i> | <i>Styrites haugi</i> Gemmellaro |
| <i>Gonionotites gethingi</i> | <i>Gonionotites italicus</i> Gemmellaro |
| <i>G.</i> cf. <i>italicus</i> Gemmellaro | <i>G. italicus</i> Gemmellaro |
| <i>G. spiekeri</i> | <i>G. discus</i> Gemmellaro |
| <i>G. belli</i> | <i>G. maurolicoi</i> Gemmellaro |

The Sicilian is generally accepted as a late Karnian fauna of the *Tropites subbullatus* zone. It is, however, unknown whether other zones are represented.

Spiti, India. A good section has been studied at Lilang near Spiti and the faunas have been described by Diener (1908). The Pardonet zones have nothing in common with the *Halobia* limestone or Grey shales of Spiti, the latter carrying *Trachyceras* of early Karnian age. The Pardonet *Tropites* zone shares that genus with the late Karnian *Tropites* zone of Lilang.

The *Juvavites* beds of Lilang carry the genus *Indojuvavites* which appears to be represented in specimens from the unzoned beds of McLay spur. The genus *Metacarnites* occurs both in the Pardonet *Cyrtopleurites* beds and the *Juvavites* beds of Lilang. The Coral limestone and *Monotis* shales overlying the *Juvavites* beds at Lilang contain no ammonoids and so afford no comparison with the Pardonet ammonoid zones (see Krishnan, 1949).

Painkhanda, India. It is unlikely that any part of the Pardonet formation can be exactly correlated with the Karnian *Halobia* beds of Painkhanda. The *Cyrto-pleurites* beds, however, in the Brown Hill section, appear to share the genus *Metacarnites* with the *Proclydonautilus griesbachi* zone of Painkhanda. The fauna of the *Himavatites* zone resembles that of the *Halorites* beds of Bambanag and other Painkhanda sections. The genera *Parajuvavites*, *Alloclionites*, *Steinmannites* and *Pseudosirenites* are in common, but they are long-ranging genera in the Lower Norian. *Pinacoceras metternichi* is Upper Norian.

The genus *Guembelites* which occurs in the *Pterotoceras-Cyrto-pleurites magnificus* beds has been reported in talus from the *Halorites* beds of the Janda Pass.

Ammonoids are absent or extremely rare in the higher beds of the Painkhanda sections and no correlation is attempted with them.

Byans, India. The so called *Tropites*-limestone of Kalapani and other localities in Byans is said to be only 3 or 4 feet thick. It has not been zoned and the constituent faunas have not been segregated. It contains faunas ranging from late Karnian to at least late Norian, so that the time-stratigraphic range recorded in this thin limestone is not unlike that recorded by the entire Pardonet formation. The *Tropites* bed on Pardonet Hill shares the late Karnian genus *Tropites* with this thin limestone in Byans. Some species of the *Himavatites* zone are close to species from this limestone.

| <i>Himavatites</i> zone | <i>Tropites</i> -limestone of Byans |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Helicites</i> cf. <i>subgeniculatus</i> Mojsisovics <i>Himavatites</i> cf. <i>watsoni</i> Diener } <i>H. multiauritus</i> McLearn } <i>Pseudosirenites pardoneti</i> (McLearn) <i>Vredenburgites</i> sp. | <i>Helicites subgeniculatus</i> Mojsisovics <i>Himavatites watsoni</i> Diener <i>Pseudosirenites</i> aff. <i>vredenburgi</i> (Diener) <i>Vredenburgites vredenburgiformis</i> (Diener) |

The genera *Distichites*, *Steinmannites* and *Parajuvavites* are also shared by the *Himavatites* zone and *Tropites*-limestone (see Diener, 1906; Krishnan, 1949).

Indoclionites ? sp. in the *Monotis subcircularis* zone may resemble to some extent *Indoclionites gracilis* Diener in the *Tropites*-limestone.

Nepal. The fauna described by Jeannet (1958) from the Nepal-Tibet frontier contains some genera in common with the *Himavatites* fauna. These genera include *Steinmannites*, *Alloclionites*, *Parajuvavites* and *Episculites*.

Timor, Indonesia. The genus *Tropites* is found in Timor sections. The genus *Guembelites* is common to the Pardonet *Pterotoceras-Cyrto-pleurites magnificus* beds and to Timor.

The following species of the *Himavatites* zone are close to species in Timor sections (*see* Welter, 1914; Diener, 1923; Pakuckas, 1928):

| <i>Himavatites</i> zone | Timor |
|----------------------------------------------|--------------------------------------------------------|
| <i>Pseudosirenites pardoneti</i> (McLearn) | <i>Pseudosirenites elegantiformis</i> (Diener) |
| <i>Himavatites</i> cf. <i>watsoni</i> Diener | <i>Himavatites watsoni</i> Diener |
| <i>H. multiauritus</i> McLearn | |
| <i>Distichites gethingi</i> McLearn | <i>Distichites pudens</i> var. <i>fatuensis</i> Welter |
| <i>D.</i> cf. <i>mesacanthus</i> Diener | <i>D. mesacanthus</i> Diener |
| <i>D.</i> cf. <i>megacanthus</i> Mojsisovics | <i>D. megacanthus</i> Mojsisovics |
| <i>D.</i> cf. <i>hacqueti</i> Mojsisovics | <i>D. hacqueti</i> Mojsisovics |
| <i>Hypisculites stelcki</i> (McLearn) | <i>Hypisculites dieneri</i> (Pakuckas) |

The genera *Alloclionites*, *Steinmannites* and *Parajuvavites* in the *Himavatites* zone of the Pardonet formation are also found in Timor sections.

Waldthausenites is common to the Pardonet formation and to Timor. Its exact stratigraphic position, however, in the Pardonet is unknown.

California. A correlation of the whole *Gonionotites-Malayites* major zone with the *Juvavites* subzone of the "Hosselkus limestone" of Shasta county, California is suggested. *Gonionotites* and *Anatomites* with the *intermittens* style of ornament are in common with this subzone and very rare *Tropites* with strong ribbing occurs at one horizon in the Peace River major zone.

The Coral zone and *Spiriferina* zone in the upper part of the "Hosselkus limestone" contain no ammonoids, and no correlation can be attempted with Pardonet ammonoid zones. *Monotis subcircularis* affords a correlation of the top of the Pardonet formation with the Brock shale. The uppermost Pardonet can be correlated possibly with a lower part of the Modin formation, said to contain Norian fossils. There is no equivalent of the upper part of the Modin, said to be of Rhaetian age (*see* Sieberling in Reeside, *et al.*, 1957, p. 1471).

Nevada. The *Stikinoceras* zone of the Pardonet formation and the *Trachyceras* zone of the Star Peak formation of New Pass (*see* Johnston, 1941) have no species in common. It is doubtful whether any part of the Pardonet is of early Karnian age.

Three ammonoid zones, *Carnites*, *Tropites subbullatus* and *Guembelites-Styrites*, are recorded by Muller and Ferguson (1939) in the Luning formation of the Hawthorne and Tonopah quadrangles. *Carnites* is unknown in any Pardonet zone. It is possible that at least a part of the *Gonionotites-Malayites* major zone can be correlated with the *Tropites subbullatus* zone of Nevada. *Styrites* occurs in Nevada, above the *Tropites* zone but as species quite different from *Styrites ireneanus*. *Guembelites* in the *Guembelites-Styrites* zone at the very top of the Luning suggests a correlation with the Pardonet *Pterotoceras-Cyrtopleurites magnificus*

beds. *Styrites*, *Palicites* and *Mojsisovicsites* are unknown in the *Pterotoceras-Cyrtopleurites magnificus* beds and *Pterotoceras* is unknown in the *Guembelites-Styrites* zone of Nevada.

In the overlying Gabbs formation, Muller and Ferguson record three ammonoid zones, named in ascending order the *Sagenites giebeli*, *Pinacoceras metternichi* and *Choristoceras marshi* zones. The known *Sagenites giebeli* fauna, of only five ammonoid species, has nothing in common with any Pardonet fauna. The *Pinacoceras metternichi* fauna is unknown in the Pardonet sections, although some fragmental specimens in the *Himavatites* fauna may be close to *Pinacoceras metternichi*. Muller and Ferguson propose that the *P. metternichi* and *Monotis subcircularis* faunas are of the same age but of different facies. The Rhaetian *Choristoceras marshi* fauna has not yet been recognized in Canada. Nothing comparable with the *Drepanites* beds, *Cyrtopleurites* beds or *Himavatites* zone can be recognized in the Nevada section.

Western Canadian Cordillera. Triassic correlations in the western Canadian Cordillera are reviewed in the text accompanying the Canadian Triassic correlation chart published by the Geological Society of America (see McLearn, 1953a). Ammonoid zones are of little significance and the faunas are dominated by pelecypods and even by corals and brachiopods.

On the west coast of Vancouver Island a faunal zone with *Distichites* (Jeletzky, 1950, and oral communication) can probably be correlated with the late Lower Norian *Himavatites* zone of the Pardonet formation. Jeletzky has also collected *Paracochloceras* above beds with *Monotis subcircularis* and presumably of Upper Norian age (Tozer, 1954).

In the Cowichan Lake area, Clapp and Shimer collected *Choristoceras* in the Sutton limestone. Later Tozer (1954) found Upper Norian *Cyclocelites* cf. *arduini* Mojsisovics in this limestone.

Juvavites knowltoni Smith, found by Crickmay (1928) in the lower part of the Parson Bay formation on Parson Bay, Harbledown Island, is of Karnian age and may record beds equivalent to the lower part of the Pardonet formation. Higher beds with *Monotis alaskana* Smith may be correlated with the *Himavatites* zone. The *M. subcircularis* zone can be correlated with beds very high in the Parson Bay formation.

In argillaceous limestone at Open Bay on Quadra Island, Gunning collected *Hannaoceras*, *Trachysagenites*, *Tropites* and *Discotropites* (see Mathews, 1947). It is possible that this Karnian fauna is comparable with a part or all of *Gonionotites-Malayites* major fauna of the Pardonet formation. No species, however, are in common. In the lower part of the Texada formation on the west shore of Texada Island, Mathews (1947) recorded species of *Paratropites* and *Hannaoceras*. These species have not been found in any Pardonet fauna, but a correlation of this part of the Texada formation with some lower part of the Pardonet formation may be possible.

The only ammonoid recorded by Lees (1934) in the Laberge area in the southern Yukon was *Juvavites subinterruptus* Mojsisovics, presumably of Karnian age. Later Tozer (1958) collected the late Norian genus *Paracochloceras* from beds above the *Monotis subcircularis* zone. This genus has not been found in the Pardonet formation, but a correlation of the *Paracochloceras* beds with the highest part of the Pardonet appears reasonable.

The upper and sedimentary group of the Triassic in the Lower Stikine area contains *Stikinoceras*. It is correlated with *Stikinoceras* zone at the base of the Pardonet formation.

In the Tyaughton group of the Bridge River area in southern British Columbia, Tozer (1954) correlated the pelecypod fauna, collected by Cairnes and others and described by McLearn (1942), with the *Paracochloceras* fauna in the Yukon, thus dating it late Norian.

In the Ashcroft area of southern British Columbia, late Karnian *Tropites* occurs in limestone interbedded with volcanic rocks (Crickmay, 1930; Duffell and McTaggart, 1947). A correlation of these beds with a lower part of the Pardonet formation can be made.

Eastern Cordillera. As recorded in Chapter II, the Pardonet formation extends as far north as the Prophet Valley, and Klingzut Mountain where the *Himavatites* zone has been recorded. This zone also has been identified in the upper part of the formation on Sikanni Chief River below Chicken Creek. Other ammonoid zones have not been satisfactorily traced this far north.

To the south, the Pardonet formation apparently extends at least as far south as Wapiti Lake. No ammonoids as yet have been recorded from there.

Summary. The faunas of the *Stikinoceras* zone, *Tropites* bed and *Styrites ireneanus* zone of the Pardonet Hill section and the *Stikinoceras* zone and *Malayites* and *Gonionotites belli* beds of the Brown Hill section appear to represent a major faunal zone, namely the *Gonionotites-Malayites* zone. A probable late Karnian age is proposed.

The *Pterotoceras-Cyrtolepurites magnificus* beds are tentatively dated early Norian. If *Guembelites* is a Norian genus they are undoubtedly Norian. The age of this genus has not, however, been definitely established either in the Painkhanda or Timor section. In Nevada it occurs with Karnian *Styrites*.

The *Drepanites* and *Cyrtolepurites* beds of the Brown Hill section are Norian, as well as the *Parathisbites oineus* beds. The *Himavatites* zone is late Lower Norian, together with the *Drepanites* and *Cyrtolepurites* beds.

In a less abbreviated standard ammonoid succession a zone or zones between the *Tropites subbullatus* and *Sagenites giebeli* zones must be considered.

Chapter IV

SYSTEMATIC PALAEOONTOLOGY

Family DISCOPHYLLITIDAE Spath

Genus *Rhacophyllites* Zittel

Rhacophyllites sp.

Plate XIX, figures 2a, b

Material. The figured specimen, GSC 13490¹, is from Pardonet beds above the *Monotis subcircularis* zone at Rapide-qui-ne-parle-pas (9778²).

Other specimens are in 9319², 9322, 9323, 9776, 9778, 9779, 9780, in and above *M. subcircularis* zone.

Description. The figured specimen, diameter 12.5 mm, is small, involute, has somewhat compressed, smooth whorls and rounded venter and sides. Saddles diphyllic. Some specimens attain a larger size, maximum about 26 mm, but all are poorly preserved. They lack the ventral ribs on the outer whorl of *Tragorhacoceras* Spath.

Family TRACHYCERATIDAE Haug

Genus *Sirenites* Mojsisovics

Sirenites nabeschi McLearn

Plate I, figures 1 to 5

Sirenites nabeschi McLearn, Trans. Roy. Soc. Can., 3rd ser., vol. 33, sec. 4, p. 3, Pl. I, fig. 7 (1939).

Material. The holotype, GSC 9410, is from talus at V on Cascades Creek, Pardonet Hill (9686). The hypotype GSC 12562 is from talus at same locality, but different collection (9687). The hypotype GSC 12564 is from *Stikinoceras* zone at III, east of Cascades Creek, Pardonet Hill (9719). The hypotype GSC 12565 is from talus block between X and XI, Juvavites Gully, Pardonet Hill (9638). The hypotype GSC 12563 is from talus block at XII, Juvavites Gully, Pardonet Hill (9664).

Other specimens are in 9638, 9663, 9664, 9672, 9686, 9687, 9697, 9719 and 9725 from *Stikinoceras* and *Styrites ireneanus* zones.

¹ Type catalogue number, Geological Survey of Canada collections.

² Faunule catalogue numbers, Geological Survey of Canada collections. See Appendix.

Measurements. Hypotype, GSC 12564; 31; 53; 28; 18.¹

Description. The holotype, consisting of less than half a whorl, partly phragmocone and partly living chamber, is compressed, about moderately involute², has somewhat flattened converging sides, fairly wide ventral sulcus, steep umbilical wall and abruptly rounded, nearly angular umbilical shoulder. The numerous, rather faint, lateral ribs are stiffly curved. Six rows, including an umbilical row, of small tubercles occur on the ribs. The spirally or longitudinally extended bases of these tubercles almost unite to form a strigate ornament. Outside the outermost row of tubercles numerous, fine, closely spaced low costae are projected forward. The ventral "keels" or elevated borders of the smooth, ventral sulcus bear closely set, numerous small tubercles, about two to each tubercle of the outermost lateral row.

The hypotype GSC 12564 a small, fairly well-preserved specimen, is compressed, about moderately involute and has almost flattened sides, smooth ventral sulcus, steep umbilical wall, almost angular umbilical shoulder and moderately curved, well-defined lateral ribs, dividing or intercalated on the sides. Outside the rows of lateral tubercles the low ribs are projected forward. Longitudinal extension of bases of lateral tubercles does not occur at this stage of growth. The ventral "keels" each bear a row of small, closely set tubercles, at this stage of growth about thirteen ventral tubercles to eleven tubercles of the outermost lateral row.

Hypotype GSC 12565, larger than hypotype GSC 12564 but similar in form, is entirely phragmocone. It is illustrated to show the steep, umbilical wall and nearly angular umbilical shoulder of this species. The ribs on the anterior part of the ultimate³ whorl at this stage of growth are fainter than in the earlier stage of the smaller hypotype GSC 12564 and faint strigation is noted.

The suture line of hypotype GSC 12562 and a part of that of GSC 12563 are illustrated. ES⁴ is best defined in GSC 12563, which has eleven rows of lateral tubercles, an abnormal number.

Most of the specimens are imperfectly preserved. Some variation, however, is evident in degree of compression, width of ventral sulcus, strength and number of ribs and degree of strigation. Ribbing declines in strength with growth, but at different rates according to the specimen. The strigate ornament, absent at early stages of growth, is marked by longitudinal extension of bases of the tubercles

¹Dimensions throughout this report are in the following order: diameter in mm, height of whorl as percentage of diameter, thickness as percentage of diameter, width of umbilicus as percentage of diameter. In some instances complete dimensions are not given but the order is retained.

²Very involute forms, width of umbilicus is 1 to 8 per cent of the diameter, involute 8 to 17 per cent, moderately involute 17 to 34 per cent, moderately evolute 34 to 60 per cent, and very evolute more than 60 per cent.

³In the sense of last or outermost preserved whorl of a specimen.

⁴ES = external saddle between EL and L1, S1 = first lateral saddle, S2 = second lateral saddle, EL = external lobe, L1 = first lateral lobe, L2 = second lateral lobe.

rather than by even longitudinal striation. Six lateral rows of tubercles occur in nine specimens, seven in one specimen, six or seven in two, and eleven in one abnormal specimen. Diagnostic features of this species are: compressed form, moderate involution, wide and smooth ventral sulcus, steep umbilical wall, almost angular umbilical shoulder, decline of ribs on the outer whorls, kind of strigation, normal six or seven rows of lateral tubercles, including the umbilical row and the small and numerous tubercles on the ventral keels, approximately twice the number of tubercles on the outermost lateral row. Only rarely, in very large specimens, is there any tendency towards lengthening of the tubercles of the ventral rows to form clavate tubercles there.

Comparisons. Compared with typical *Sirenites*, that is species close to the genotype, this species has more lateral rows of tubercles, more ventral tubercles relative to the number on the lateral rows, is more involute and has an ammonitic, not a ceratitic suture line. It is more involute than most Karnian species of the genus, although *Sirenites junonis* Mojsisovics and *Sirenites dionysii* Mojsisovics approach it in this respect. Distinguishing features are the considerable width of the ventral sulcus, the faint ribs at maturity, the well-defined umbilical shoulder which is lacking in Norian *Pseudosirenites*, the degree of involution and the ammonitic suture line. The suture line lacks the divided ES common in Norian *Pseudosirenites*.

Genus *Pseudosirenites* Arthaber

Pseudosirenites pardoneti (McLearn)

Plate I, figures 6a, b; Plate II, figures 7a-c, 8

Sirenites pardoneti McLearn, Can. Field-Naturalist, vol. 54, p. 115, Pl. I, fig. 2; Pl. IV, fig. 4 (1940); Geol. Surv., Canada, Paper 47-14, Appendix, Pl. V, figs. 8, 9 (1947).

Sirenites inaequiornatus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 2, Pl. VI, fig. 3 (1947).

Material. The holotype, GSC 8844, is from the *Himavatites* zone, very high on west slope of Black Bear Ridge (9741). The paratype, GSC 8845, of this species and the holotype, GSC 9502, of *Sirenites inaequiornatus* are from the same faunal zone and locality (9741).

Other specimens are in collections 9478, 9632, 9741, 9744, 9745, 9756, 9757, 9758, 9759, 9760, 9767, 9781, 9782 and 9784, all from *Himavatites* zone.

Measurements. Paratype: 46.5; 60.5; 31; 6.5.

Description. The holotype, comprising more than a quadrant of living chamber, is compressed, very involute and has gently convex, converging sides, narrow ventral sulcus excavated out of the venter with low keels on either side. Over most of the surface the ribs are only faintly outlined and bear about ten rows of low, rather flat tubercles, but no umbilical row. At the anterior end are rather delicate ribs bearing small bullae. Set at an angle across the low keels are short, stout bullae which give a corded appearance.

The paratype, entirely phragmocone, smaller and at an earlier stage of growth than the holotype, is compressed, very involute and has a well-rounded, umbilical shoulder, gently convex, converging sides, narrow venter, narrow ventral sulcus and low, corded keels. The ribs, numbering thirty to half whorl, are low and wide, but distinct in the posterior part of the ultimate whorl. They, however, decline almost to extinction in the anterior part of this whorl. About nine rows of low, rather wide tubercles occur on the ribs. There is no row of what might be called umbilical tubercles. Short bullae set aslant the keels form a corded or rope-like ornament. The suture line is ammonitic. A fairly deep indentation or lobule divides the ES. S1 is large, S2 small, L1 longer than EL and L2 is short.

This is a somewhat variable species. At the stage of growth of the paratype, most specimens have rather broad flat ribs, but a few have finer and narrower ribs. Per half whorl, they range in number from twenty-eight to thirty-six, but mostly about twenty-eight to thirty. In some specimens the tubercles are smaller and less distinct than in the holotype and paratype, such specimens are transitional towards *Pseudosirenites pressus*. The corded ornament of the ventral keels varies from coarse to fine. In all large specimens, the ribs on the living chamber decline in strength to or almost to, extinction, but the low tubercles persist. A final stage of very fine ribs with slender bullae occurs, as in the holotype. The stage of growth at which the mature ornament appears varies. A rare variant, with alternating coarser and finer ribs, was described as *Sirenites inaequiornatus*.

Comparisons. This species belongs to a group of very involute, mostly compressed species with well-rounded umbilical shoulder, many lateral rows of low tubercles, narrow venter and ventral sulcus, and mostly divided external saddles, incorporated in the genus *Pseudosirenites* by Arthaber. It has, however, fewer rows of lateral tubercles and a less deeply divided ES than *Pseudosirenites stachei* (Mojsisovics), *P. elegans* (Mojsisovics) or *P. elegantiformis* (Diener), and larger tubercles than *P. evae* (Mojsisovics) or *P. richteri* (Mojsisovics). It differs from all of these species in its peculiar ornament at maturity, much like that of a specimen figured by Diener as *Sirenites* aff. *vredenburgi* Diener.

Pseudosirenites pressus (McLearn)

Plate II, figures 6a, b

Sirenites pressus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. V, fig. 7 (1947).

Material. The holotype, GSC 9501, is from talus of *Himavatites* zone very high on the west slope of Black Bear Ridge (9745). Other specimens are in collections 9632, 9729, 9741, 9744?, 9745, 9781 and 13522.

Measurements. Holotype: 38; —; —; —: 31; 58; 32; 7.7.

Description. The holotype is compressed, very involute with gently convex sides, rounded umbilical shoulder, narrow venter, ventral sulcus and low, corded

keels. Numerous, rather slender ribs curve a little on the sides and project forward ventrally. No distinct tubercles occur. The suture line is unknown. Some variation in strength of ribbing occurs, the ribs in a few specimens being wider than in holotype.

Comparisons. This species is very close to *Pseudosirenites pardoneti* (McLearn), variants of which, with fine ribbing and reduced tubercles, approach it.

Genus *Vredenburgites* Diener

Vredenburgites sp.

Plate I, figure 7

Material. The figured specimen, GSC 12566, is from the *Himavatites* zone at XV, Little Parle Pas Rapids (9784). A second specimen is in the same collection.

Description. Two very involute, crushed specimens apparently including the living chamber, bear lateral, very fine, thread-like ribs with long, slender bullae. The keels are finely corded or plaited. The bullae are faint or absent on the posterior part of the living chamber.

Comparisons. The bullae are smaller and the ribs fewer than in *Vredenburgites vredenburgiformis* (Diener).

Family CLYDONITIDAE Mojsisovics

Genus *Sandlingites* Mojsisovics

Sandlingites cf. *idae* Mojsisovics

Plate II, figures 4a, b, 5a, b

cf. *Sandlingites idae* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 714, Pl. CLXVII, figs. 20a, b (1893).

Material. The figured specimens, GSC 12567 and GSC 12568, are from a talus block in Tepee Rocks Coulee (9471). A third specimen is in the same collection.

Measurements. Figured specimen GSC 12567: 10.2; 40; 39.5; 33.5.

Description. The figured specimen GSC 12567 is small, moderately involute, almost moderately evolute, and has square, almost flat-sided whorls, rounded umbilical shoulder, angular ventral shoulder and almost flat venter. The sides have rather flat ribs, which mostly branch from each umbilical tubercle. Low wide ribs are almost straight across the venter where they are interrupted by a very shallow, ventral sulcus. Stout clavi occur on the ventral shoulder and marginal to the ventral sulcus.

The figured specimen GSC 12568 is larger than GSC 12567, is not so complete and has reached a more mature stage of growth. The inner whorls resemble those of GSC 12567, but the ultimate and outer whorl is higher than wide, the

lateral ribs are slender and in places form a button-and-loop ornament. Clavi occur on ventral shoulder. The ribs are straight across the venter, the ventral sulcus is very shallow and is bordered by clavi.

The lateral ribs of a third and imperfect specimen are not as slender as those of GSC 12568 and the button-and-loop ornament is rare.

Comparisons. The inner whorls resemble those of *Sandlingites idae* Mojsisovics, but the fine ribs and button-and-loop ornament of the ultimate whorl do not appear to occur in *Sandlingites idae*.

Sandlingites ? sp.

Plate II, figures 3a, b

Material. The figured and only specimen, GSC 12569, is from the *Himavatites* zone above XX at west end of Pardonet Hill (9781).

Description. A poorly preserved specimen, of about 24 mm diameter, is moderately evolute, has rather flat-sided whorls, about as high as thick, rounded ventral shoulders and very shallow ventral sulcus. The ribs are thin and elevated on the sides of the whorl. Bases of spines are preserved on the umbilical shoulder, somewhat clavate spines on the ventral shoulder, and low, clavate spines border the ventral sulcus. The imperfectly preserved suture line includes an entire ES, and L1 is longer than EL.

Comparisons. This specimen is more evolute than *Sandlingites* cf. *idae* and has more spinose ornament and more elevated ribs.

Family CLIONITIDAE Arabu

Genus *Alloclionites* Spath

Alloclionites sp.

Plate II, figures 1a, b, 2a, b; Plate III, figure 6

Material. The figured specimen GSC 12570 is from talus of the *Himavatites* zone, north bank Sikanni Chief River, below the mouth of Chicken Creek (10740). The figured specimen GSC 12571 is from talus at XXIII, in Western Gully, Pardonet Hill (9771). The figured specimen GSC 12573 is from *Himavatites* zone, near XXIII, in Western Gully, Pardonet Hill (9768).

Other specimens are in 9471, 9768, 9771, 10740, 10743, 10750 and 10767, from *Himavatites* zone.

Description. The figured specimen GSC 12570, probably comprising the inner whorls of a much larger shell, is the best preserved in the Survey collections. It is moderately evolute, with stout whorls, higher than thick, gently convex sides, rounded ventral shoulders, well-rounded umbilical shoulders, somewhat flattened

venter and shallow ventral sulcus. Thick ribs, some single and some uniting on the umbilical shoulder, are curved a little on the sides, curved forward at the ventral shoulder and arched very little across the venter where they are interrupted to some extent by the ventral sulcus. A row of tubercles borders this sulcus and an inner row of ventral tubercles is poorly defined.

The figured specimen GSC 12571 is slightly larger than GSC 12570 and is so flattened that the form of its whorls is unknown. Lateral ribs resemble those of GSC 12570. The ventral sulcus is very shallow, if not merely a smooth band. It is bordered by a row of tubercles smaller and more numerous than those of 12570. An inner ventral row of very small tubercles is not very well defined. This belongs to a different species than 12570 and appears to be the more common one in the Survey collections.

Some specimens show a decline in strength of ventral sulcus and tubercles. The large figured specimen GSC 12573 appears to have a rounded venter without tubercles and a fine strigate ornament. It may be closer to *Buchites* Mojsisovics than to *Alloclionites*. It is, however, included in the latter genus.

In some former publications (McLearn, 1946, 1947) the shells here referred to *Alloclionites* were designated *Clionites* (group of *C. ares*). In 1951, however, Spath proposed the genus *Alloclionites* for this species group.

Genus *Steinmannites* Mojsisovics

Steinmannites sp.

Plate II, figures 9a, b

Material. The figured specimen, GSC 12572, is from the *Himavatites* zone, upper 100 feet of Pardonet beds on west side of Klingzut Mountain (10767).

Other specimens are in 9728, 9741, 9770, 10685? and 10767, from *Himavatites* zone.

Description. Several species are evidently represented, but the preservation is too poor for discrimination.

The figured specimen, GSC 12572, is a distorted and flattened fragment of the living chamber. Strong, stiffly curved ribs, on the sides of the whorl, curve forward as they approach the ventral keels and each bears a marginal tubercle. The keels are well defined and continuous, but detail of ornament, if any, is obscure.

A fragment of a living chamber in collection 10767 has strong nearly straight lateral ribs ending in tubercles and thick continuous ventral keels. A very highly compressed, discoid, very small specimen in this same collection has nearly straight lateral ribs, narrow ventral keels and ventral sulcus. A small specimen in collection 9741 is evolute, compressed, flat sided, with narrow, apparently partly rursiradiate lateral ribs, narrow continuous ventral keels, narrow ventral sulcus

and furrows between the ventral keels and the abruptly rounded ventral shoulder. This specimen could comprise the inner whorls of a species like *Steinmannites multinodosus* Welter. A fragment in 9728 has much thicker lateral ribs than the specimen in collection 9741. A much larger fragment in collection 9770 has ventral keels having the appearance of fused clavi. A large evolute imperfect specimen in collection 10685 is not well enough preserved to identify as an *Alloclionite* or a *Steinmannites*. Another specimen in collection 10685 may be a fragment of a shell of *Steinmannites* and has a large lateral spine on either side of the preserved whorl.

It is unfortunate that the specimens of *Alloclionites* and *Steinmannites* are not better preserved as they evidently comprise a considerable radiation in form and ornament and represent a fair range of species.

Genus *Indoelionites* Diener

Indoelionites ? sp.

Plate XXI, figures 2, 3, 4

Material. The figured specimens, GSC 13496, GSC 13497 and GSC 13498, are from the *Monotis subcircularis* zone, at Rapide-qui-ne-parle-pas (9325). Other specimens are in the same collection.

Description. The numerous specimens of this species are poorly preserved, being crushed out of all shape. They are evidently of a very involute, possibly compressed shell, with possibly a well-defined ventral shoulder and rather flattened sides. The numerous ribs, moderately curved forward on the sides, are strongly curved forward as they approach the venter. Some ribs appear to be long and single, some short and intercalated and many divide on both the inner and outer parts of the sides. Some specimens have finer and more numerous ribs than others. Variation is also exhibited in the ventral ornament. In some, the ribs end in small tubercles bordering a smooth ventral band; in others, the ribs extend across the venter, where they are definitely arcuate. It is not known whether the tuberculate-smooth venter is an early stage preceding the stage with ribs continuous across the venter, or whether only one kind of ventral ornament occurs in one specimen and more than one species is represented.

Comparisons. The specimens with tubercles bordering a smooth ventral band show at least some resemblance to *Indoelionites gracilis* (Diener). They may be even more involute and there does not appear to be any bundling of the ribs on the umbilical border. The ribs too are more projected forward near the venter. The material, however, is too poor for exact identification and the reference to *Indoelionites* is only tentative.

Upper Triassic Ammonoids of the Peace River Foothills

Family ARPADITIDAE Hyatt

Genus *Drepanites* Mojsisovics

Drepanites hyatti subsp. *rutherfordi* (McLearn)

Plate III, figures 10a, b, 11; Plate XXI, figure 6

Drepanites rutherfordi McLearn, Can. Field-Naturalist, vol. 51, p. 98, Pl. I, fig. 13 (1937).

Material. The holotype, GSC 8817, is from the Pardonet beds, just west of south face of McLay Spur (9146). The hypotypes GSC 12575 and 13493 are from the same locality. Other specimens are in 9146, 9842 and 9843, from *Drepanites* beds and talus.

Measurements. Holotype: 41; 59.5; 25; 5.8 (specimen somewhat distorted).

Description. This is a compressed, very involute species with more or less flat sides, rounded umbilical shoulders, well-defined ventral shoulders, narrow ventral area and ventral sulcus. The narrow ventral area on either side of the ventral sulcus bears a very narrow furrow, on the inner side of which is a row of very small bead-like tubercles. Curved, distant costae forming incomplete crescents occur on the outer part of the side of the whorl.

The suture line is ammonitic, with very small indentations on the saddles. ES is fairly wide, L1 longer than EL, S1 smaller than ES, and L2 and S2 are small.

Comparisons. These Peace River shells are too close to *Drepanites hyatti* Mojsisovics to separate as a species. It may, however, be considered a geographic variety or subspecies. The outline of the lateral costae is not so completely crescentric as in typical *D. hyatti*.

Family LECANITIDAE Hyatt

Genus *Lecanites* Mojsisovics

Lecanites mundus McLearn

Plate III, figures 7a-c, 8

Lecanites mundus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. IV, figs. 2-5 (1947).

Material. The holotype, GSC 9498, and the paratype, GSC 9499, are from Pardonet beds, just west of the south face of McLay Spur (9146). Other specimens are in the same collection.

Measurements. Holotype: 18.5; 34.5; 25; 41; paratype: 14.3; 37.5; 28; 35.2.

Description. The holotype is small, compressed, moderately evolute, with somewhat flattened whorls, rounded venter and rounded ventral shoulders. Near the anterior end of the ultimate whorl are low, faint costae strongly bent forward on the sides and on the venter.

The paratype is smaller than the holotype, but a little larger than the measured diameter of 14.3 mm. It has a smaller umbilicus. The venter is somewhat flattened at the anterior end. The suture line is goniatitic. EL has a small ventral saddle, ES is wide, L1 is wide, S1 is smaller than ES, but fairly wide, L2 is fairly wide but short, and S2 is very low.

The venter is mostly rounded and flattening is rare. The surface ornament is more irregular and fainter in some shells than in the holotype.

Comparisons. Compared with *Lecanites glaucus* Munster, the whorls appear to be a little thicker. The growth lines and costae are more strongly projected forward. The suture line resembles that of *Lecanites trauthi* Johnston, but the surface ornament is weaker, less regular and more strongly projected forward.

Lecanites beattii McLearn

Plate III, figures 9a, b

Lecanites beattii McLearn, 'Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. IV, fig. 6 (1947).

Material. The holotype, GSC 9500, is from Pardonet beds, just west of south face of McLay Spur (9146).

Measurements. Holotype: 13.5; 33.5; 35; 44.5.

Description. The holotype, the only known specimen, is moderately evolute, smooth, with fairly thick, stout whorls. In the goniatitic suture line ES is about as high as wide, L1 fairly wide, S1 wide and low and smaller than ES, L2 is wide and short and S2 wide and low.

Comparisons. This species has thicker and more rounded whorls than *Lecanites mundus* McLearn.

Family CYRTOPLEURITIDAE Diener

Genus *Cyrtopleurites* Mojsisovics

Cyrtopleurites sp.

Plate III, figures 4a, b, 5

Material. The figured specimen GSC 12576 is from the *Cyrtopleurites* beds on the west slope of the west spur of Brown Hill (9840). The figured specimen GSC 12577 is from just below the *Styrites ireneanus* zone near IX, about 50 feet east of Juvavites Gully (9380). Other specimens are in 9466, 9840 and 9841, from *Cyrtopleurites* beds, Brown Hill.

Description. The small figured specimen GSC 12576 has fairly coarse ribs, a row of very fine umbilical tubercles, a row of lateral tubercles, a row of very fine tubercles outside the lateral row and a ventro-lateral row of clavate tubercles.

The external ears, bordering the ventral sulcus are finely fringed. Two larger, but poorly preserved, specimens in the same collection are of the same or very similar species.

The small specimens in collections 9466 and 9841 have finer and more numerous ribs and are probably of a second species.

The small figured specimen GSC 12577 may belong to a third species. It has an unusual style of ribbing on the anterior part of the ultimate whorl, a pair of short ribs bearing only the ventro-lateral row of tubercles alternate with long ribs bearing umbilical, lateral and ventro-lateral rows.

The foregoing specimens are all of the typical or *bicrenatus* group of species of this genus.

Cyrtopleurites magnificus McLearn

Plate IV, figures 1a, b, 2

Cyrtopleurites magnificus McLearn, Trans. Roy. Soc. Can., 3rd ser., vol 33, sec. 4, p. 55, Pl. I, fig. 5 (1939).

Material. The holotype, GSC 9414, is from the *Pterotoceras-Cyrtopleurites magnificus* beds on the west slope of the west spur of Brown Hill (9836). The hypotype, GSC 12578, is from a talus block, from the same beds, in Tepee Rocks Coulee (9473).

Other specimens are in 9473, 9833, 9836 and 9848, from *Pterotoceras-Cyrtopleurites magnificus* beds and talus.

Measurements. Holotype: 23; 47; 26; 23. Hypotype (distorted): 40.5; 49; —; 19.

Description. The holotype is a small specimen of which about half a whorl is preserved. It is compressed, moderately involute, has whorls much higher than thick and a rounded umbilical shoulder. The ribs are rather broad, stiffly curved and only thirteen to the half whorl. One row of tubercles is on the umbilical shoulder. A second, a little higher on the sides, may correspond to the lateral row in the *bicrenatus* group of the genus, as a few ribs divide at this row. A third lies outside the "lateral" row, and a fourth is of short clavate tubercles, each bearing two small tubercles or denticles. A fifth or ventro-lateral row consists of clavate tubercles, that is of clavi. All tubercles are on the ribs. The narrow, deep ventral sulcus is bordered by narrow, elevated keels on which are borne coarsely fringed or denticulate external ears. There are commonly four denticles to each ear.

The crushed and incomplete hypotype, much larger than the holotype and nearer to a mature stage of growth, is a little more involute, but similarly has a deep, narrow ventral sulcus, elevated keels bearing denticulate ears and low, wide and stiffly curved ribs. All tubercles increase in size with growth: those of the second row increase very rapidly and a few ribs divide there; those of the third,

at a much slower rate than those of any other row; those of fourth row are clavate and bituberculate; those of fifth or ventro-lateral row are large and clavate. A second specimen in the same collection as the hypotype resembles it and is of about the same size.

Incomplete specimens in collection 9836 vary in size between holotype and hypotype. The tubercles and clavi of the lateral rows increase similarly in size and those of the third row increase at a relatively slower rate than the others. In one specimen small tubercles appear on the clavi of the fourth row and in another the clavi of the fifth row are denticulate. A very large, incomplete specimen, much larger than the hypotype, may be of this species. The tubercles of the fourth row are large, but not clavate and those of the fifth row are non-clavate, and low ribs extend forward from them.

Among specimens in 9833, one about the size of the holotype has three inner rows of partly bullate tubercles, a fourth row of partly clavate and partly paired tubercles and a ventro-lateral row of clavi. The long external ears, borne on elevated keels each carry four denticles. The specimens in 9848, small and of an early stage of growth, have four lateral rows of mostly simple tubercles and a fifth or ventro-lateral row of clavi.

Comparisons. This species differs from others of the genus in the greater number of lateral rows of tubercles, the larger size of tubercles, the clavate form of those of the outer rows, the wider ribs, the denticulate rather than fringed ears, the high, narrow ventral keels, on which the external ears are borne, and the very narrow and deep ventral sulcus.

Genus *Himavatites* Diener

Himavatites cf. *watsoni* Diener

Plate IV, figures 6, 7

cf. *Himavatites watsoni* Diener, Pal. Indica, ser. XV, vol. 5, Mem. 3, p. 72, Pl. IX, figs. 1, 2 (1915); Jaarb. Mijn. Ned.-Oost-Ind., 1920, p. 202, Pl. XII, figs. 1, 2 (1923).

Material. The figured specimens GSC 12579 and 12580 are from talus, *Himavatites* zone, very high on the west slope of Black Bear Ridge (9744). A specimen fairly close to those figured is in 9374, from *Himavatites* zone.

Description. The figured specimen GSC 12579 is a fragment of one side of a quadrant of a living chamber. The lateral ribs are numerous, rather flat and curved. Three inner rows consist of tubercles or clavi, one to each rib. The remaining fourth to sixteenth rows consist of small tubercles two on each rib. In addition, bases of large spines occur at widely spaced intervals on the seventh row of small tubercles and on ribs a little stouter than the others, forming a lateral row of spines. Widely spaced spines are also interposed along the thirteenth row of fine tubercles forming a ventro-lateral row of spines. The narrow, ventral sulcus

is bordered on either side by two rows of external clavi, bearing small denticles and in addition some widely spaced fringed external ears interposed on the inner row.

The figured specimen GSC 12580 is a fragment of a large shell, comprising one side of a quadrant of living chamber. It has broad, low, curved ribs, four inner rows of tubercles or bullae, single on each rib, and twelve outer rows of fine tubercles, commonly two on each rib. One spine occurs on the second row of tubercles, probably part of a row of widely spaced spines. Large, widely spaced spines are on the seventh, and large, rather clavate spines are interposed on the thirteenth row of tubercles. A large denticulate external ear, probably part of a widely spaced row, is found on the inner row of external clavi. The ventral area is not, however, well preserved.

A specimen in 9374, from the *Himavatites* zone at Little Parle Pas Rapids, consists of half a whorl of phragmocone. It has numerous, low, broad ribs to the half whorl and about nineteen rows of tubercles, mostly two, but some single, on each rib. A faint base of a spine is on the eighth row and poorly defined bases of ventro-lateral spines occur. Poorly preserved external ears are also present.

Comparisons. The figured specimens are very close to one of *Himavatites watsoni* Diener illustrated by Diener from Timor. It may not be so close to the holotype from the Byans fauna, also figured by Diener. The poorly preserved specimen from 9374 is sufficiently like the Timor illustrated specimen to be included in *H. cf. watsoni*.

Himavatites multiauritus McLearn

Plate IV, figures 8a, b

Himavatites multiauritus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 2, Pl. VI, figs. 5, 6 (1947).

Material. The holotype, GSC 9503, is from talus of the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9745).

Measurements. Holotype: 47.5; 57; 53.5; 12.5.

Description. The only known specimen is well preserved, involute, with thick, stout whorls, rounded umbilical shoulders, rounded sides, poorly formed ventral shoulders, about thirty ribs to the half whorl and about seventeen rows of small tubercles, commonly two to each rib. Lateral spines are small and not very distinct and the ventro-lateral "spines" are not very well defined. The narrow, ventral sulcus is bordered by an inner row of closely spaced denticulate external ears and an outer row of low denticulate clavi.

Comparisons. The apparently poor illustration of the holotype of *Himavatites watsoni* Diener from Byans and the apparently good figure of a specimen of this species from Timor do not resemble each other very closely, although both are published by Diener. The holotype of *H. multiauritus* is certainly distinct from the

Timor specimen, having more numerous and more closely spaced external ears, fainter lateral spines and no periodic strong ribs. If the figure of this Timor specimen is an accurate rendering of *H. watsoni*, the erection of *H. multiauritus* as a separate species is justified.

Himavatites columbianus McLearn

Plate V, figures 6a, b, 7

Himavatites columbianus McLearn, Trans. Roy. Soc. Can., 3rd ser., vol. 33, sec. 4, p. 55, Pl. I, fig. 1 (1939); Geol. Surv., Canada, Paper 46-25, Appendix, p. 1, Pl. I, figs. 1, 2 (1946).

Material. The holotype, GSC 9411, is from talus of *Himavatites* zone, near XXII, just west of Monotis Gully, west end Pardonet Hill (9767). The hypotype, GSC 9265, is from the same zone on north bank Sikanni Chief River, below mouth of Chicken Creek (10739).

Other specimens are in 9478, 9745, 9761, 9767, 9781, 9839, 10739, 10741 and 13520, from *Himavatites* zone and talus.

Measurements. Hypotype: 79; —; —; —: 75; 57.3; 31.3; 9.5.

Description. The holotype, part of the living chamber at a whorl height of 54 mm, has narrow ribs bearing five inner rows of single bullae, four of single tubercles and an outermost row of single tubercles or clavi. Two rows of denticulate external clavi border the ventral sulcus on either side. Two large spines of a lateral row are on ribs little stouter than others.

The hypotype is a large, moderately compressed, involute specimen with rounded umbilical shoulders, flattened sides, rounded ventral shoulders and nearly flattened venter. The ribs number about sixty on the last half of the ultimate whorl, are narrow in the anterior part of this whorl and wider, flatter and more closely spaced in the posterior part of it. Periodic stouter ribs begin at a stage corresponding to a height of whorl of 26 mm. Near the anterior end the ribs are so spaced that eight finer ribs are interposed after each stout rib, each of which bears a lateral spine. Here are about ten rows of tubercles, clavi and bullae. The inner rows are of bullae, the middle of tubercles or clavi and the outer of clavi. Each clavus bears two small tubercles. The narrow, ventral sulcus is bordered by two external rows of denticulate clavi.

This is a very variable species. In larger specimens of a diameter of from 60 to 80 mm the ribs vary from about forty to sixty-five per half whorl. The ribs become more slender and increase in number with growth. This increase is not uniform, however, and no exact relation exists between number of ribs and diameter. The ribs are mostly more slender on the inner than on the outer part of the sides. The number of rows of tubercles, bullae and clavi varies from nine to twenty. The bullae tend to occur on the more slender ribs on the inner part of the sides, the simple tubercles outside them on the middle part of the sides,

and double tubercles or clavi, each bearing two tubercles, occur in the outer rows. The stage at which large lateral spines first appear varies from 25 to 50 mm diameter.

Ventro-lateral spines are very rare and were observed in only two specimens, which of course approach *Himavatites watsoni* Diener in ornament.

Comparisons. This species lacks the external ears and, almost without exception, the ventro-lateral rows of spines of *H. watsoni*. It has commonly fewer lateral rows of bullae, tubercles and clavi than that species. It has, however, the external rows of denticulate clavi, the lateral row of large spines, and the periodic strong ribs of *H. watsoni* and of the typical genus *Himavatites*.

Himavatites burlingi McLearn

Plate IV, figures 9a, b

Himavatites burlingi McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 2, Pl. VI, figs. 1, 2 (1947).

Material. The holotype, GSC 9504, is from the *Himavatites* zone at XV on river bank, Little Parle Pas Rapids (9784).

Description. The only known specimen is a distorted half whorl at an approximate diameter of 50 mm. It is compressed, involute, with fairly flat sides and venter and rounded ventral shoulders. The somewhat flattened ribs number about fifty to the half whorl. The tubercles of the inner four lateral rows are very faint, those of the fifth to eighth rows are well defined and those of the ninth and tenth rows are clavate. The shallow, ventral sulcus is bordered on either side by two rows of denticulate clavi.

Comparisons. This species resembles the inner whorls of those specimens of *Himavatites columbianus* McLearn in which in growth the appearance of large, lateral spines is long delayed. The tubercles of the inner rows are more faint, however, and the clavi of the outer rows are smaller and without well-defined pairs of small tubercles. If not a distinct species, it is a very extreme variant of *H. columbianus*.

Himavatites canadensis McLearn

Plate IV, figures 5a, b

Himavatites canadensis McLearn, Can. Field-Naturalist, vol. 54, p. 115, Pl. III, fig. 3 (1940).

Material. The holotype, GSC 8847, is from a talus block of the *Himavatites* zone on the west slope of the west spur of Brown Hill (9830). Other specimens are from another talus block from same zone and locality (9829).

Measurements. Holotype: 47.8; 59; 27.5; 8.

Description. The holotype, a well-preserved specimen of a half whorl, is compressed, very involute and has almost flat sides, rounded umbilical shoulder,

angular ventral shoulder and a very shallow, almost flat, ventral sulcus. The flat, lateral ribs number about sixty to the half whorl and bear eight rows of very small, faint tubercles, bullae and clavi. The ventral sulcus or flat band is bordered on either side by two rows of fine tubercles or denticles. The outer row, immediately bordering the ventral band, comprises mostly single denticles or tubercles, rarely two, borne on low clavi. The tubercles of the inner row are commonly borne on clavi.

The few fragmental specimens in collection 9829 differ little from the holotype. They have similar compressed form and very fine, lateral ornament, including the numerous, fine, flat ribs.

Comparisons. This species differs considerably from others of the genus, lacking the periodic strong ribs and lateral spines, and apparently no doubling of lateral tubercles on the ribs. The general plan of the venter, with two rows of tubercles and denticles on either side of the ventral "sulcus", is as in *Himavatites*.

Himavatites sp.

Material. In 9728, 9729, 9741, 9744, 9768, 10685, 10740, 10742, 10745 and 10767, from *Himavatites* zone.

Description. Some specimens, undoubtedly of the genus *Himavatites* but because of immature growth cannot be specifically identified, are designated as *Himavatites* sp. in the faunal lists. Most of them are probably of the species *Himavatites columbianus* McLearn, but have not reached the diagnostic growth stage with lateral spines.

It is interesting to note that in some of these specimens the origin of the two separate rows of external clavi can be determined. They form by splitting of the tubercles of an original single row at a diameter of less than 11 mm.

A specimen in 9741, listed as *Himavatites* sp., differs from the above and has a few small external ears or enlarged clavi.

Genus *Acanthinites* Mojsisovics

Acanthinites cf. *eusebii* Diener ?

Plate XIX, figures 1a, b

cf. *Acanthinites eusebii* Diener, Sitzb. Akad. Wiss. Wien, Abt I, 129 Band, p. 607, Pl. I, figs. 3a-c (1920).

Material. The figured specimen, GSC 13489, is from the *Cyrtopleurites* beds on the west slope of the west spur of Brown Hill (9841).

Description. The only specimen comprises nearly half a whorl of what is probably living chamber. It is compressed, involute, with well-defined umbilical shoulder, nearly flat sides, rounded ventral shoulder, wide venter and narrow, ventral sulcus. It is covered with extremely fine costae and ten or more rows of very fine tubercles. The ventral ornament is poorly preserved, but narrow keels may border the ventral sulcus.

Comparisons. This specimen resembles *Acanthinites eusebii* Diener, but whether tuberculate keels occur is unknown. It lacks the two tubercles per rib on each lateral row of tubercles of typical *Acanthinites* and the whorls are not so compressed, nor is the venter as narrow as in typical species of the genus.

Family TIBETITIDAE Hyatt
Genus *Metacarnites* Diener

Metacarnites sp.

Plate XIX, figure 4

Material. The figured specimen, GSC 13491, is from a talus block, horizon unknown, on the west slope of the west spur of Brown Hill (9838). Other specimens are in 9146, exact horizon unknown, and in 9841 from *Cyrtopleurites* beds.

Description. The figured specimen consists partly of a crushed living chamber and partly of the phragmocone. The latter is compressed, very involute, smooth and with a sharp oxynote venter. The ammonitic suture line comprises a wide EL with large ventral saddle, deeply divided ES, a longer L1 than EL, a fairly large, moderately indented S1, a smaller L2 than L1, a small S2 with small indentations and very small auxiliary lobes and saddles.

A larger but imperfect specimen in 9146 is not so compressed as the figured specimen, but is smooth and has a sharp venter and a similar suture line.

A small, crushed specimen in 9841, at a diameter of 28 mm comprises the inner whorls of a very compressed, very involute, smooth species. At this stage of growth, it has a shallow, ventral sulcus, bordered at the posterior end of the ultimate whorl by low, although not well defined, external ears, recalling the external ornament of the Tibetitidae and bordered at the anterior end by low keels. Like the figured specimen, it occurs on the west slope of the west spur of Brown Hill, although in place in the *Cyrtopleurites* beds and not in talus. Possibly both are from the same horizon and the smaller specimen may comprise the inner whorls of the same species as the figured specimen.

Genus *Pterotoceras* Welter
Pterotoceras caurinum McLearn

Plate IV, figures 3, 4; Plate V, figures 1a, b, 2

Pterotoceras caurinum McLearn, Trans. Roy. Soc. Can., 3rd ser., vol. 33, sec. 4, p. 56, Pl. I, fig. 2 (1939); Geol. Surv., Canada, Paper 53-21, p. 14 (1953).

Pterotoceras caurinum var. *elegantulum* McLearn, Trans. Roy. Soc. Can., 3rd ser., vol. 33, sec. 4, p. 56, Pl. I, fig. 4 (1939).

Pterotoceras caurinum var. *arctum* McLearn, Can. Field-Naturalist, vol. LIV, p. 115, Pl. III, fig. 2 (1940).

Material. The holotype, GSC 9412, is from the *Pterotoceras-Cyrtopleurites magnificus* beds on the west slope of the west spur of Brown Hill (9836). The

hypotype, GSC 12581, is from a miscellaneous collection from the Peace River Foothills (13522). The specimen figured as the type of *Pterotoceras caurinum* var. *elegantulum*, GSC 9413, is from the same collection as the holotype of the species (9836). The specimen figured as the type of *Pterotoceras caurinum* var. *arctum*, GSC 8846, is from the same collection as the holotype of the species (9836).

Other specimens are in 9473, 9475, 9833, 9836, 9848, 9864 and 13522, from *Pterotoceras-Cyrtopleurites magnificus* beds and talus.

Measurements. Holotype: 35; 47; —; 24.8; 32.5; 46; 24.5; 24.5. Type of var. *elegantulum*: 27.7; 50.5; —; 20; 26; 49.2; 25.7; 20.8.

Description. The holotype, of which most of the living chamber is preserved, is compressed, moderately involute, with rounded umbilical shoulder, well-defined ventral shoulder, narrow venter, and shallow, indistinct ventral sulcus. The curved, broad, low lateral ribs are strongest on the inner part of the side of the whorl, and less elevated and less well defined on the outer part. They are slightly convex forward on the sides and curve forward near the ventral shoulder. They are mostly single, but some divide on the outer part of the sides. They are produced into a bulla-like projection on the umbilical shoulder. A median and a ventro-lateral row of faint, minute tubercles can be seen in the anterior part of the ultimate whorl. The external ears, one at the end of each lateral rib, are somewhat cone-shaped and pointed, number about seventeen to the half-whorl, lie along either side of the venter and are joined across it by very low, transverse ridges.

The variant formerly described and figured as var. *elegantulum* is more compressed and more involute than the holotype of this species and has a more abruptly rounded umbilical shoulder, more and finer ribs, more and smaller external ears and finer umbilical tubercles. Very small tubercles form three rows, one on the umbilical shoulder, a median, and a ventro-lateral row. External cone-shaped or hornlike ears, number about twenty-nine per half whorl. They are joined across the venter by low, transverse ridges.

The suture line of the hypotype, GSC 12581, includes a wide, short EL with a small ventral saddle and a small adventitious saddle on either side of it, an entire ES, an L1 much longer than EL and with a few, very small indentations, an entire S1 of about the same size as ES, an L2 much shorter and smaller than L1 and with very fine indentations, an entire S2 smaller than S1 and two small auxiliary lobes and saddles. In one specimen a small lobule divides the ES.

This is a very variable species in size of umbilicus and in number of external ears or lateral ribs. In about twenty specimens the width of umbilicus varies from

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about 16 to 36 per cent of the diameter and the number of ears per half whorl from fourteen to thirty-seven. An overall relation of number of external ears to width of umbilicus occurs, specimens with fewer external ears tending to have a large umbilicus. The relation is not an exact one, however, for the number of external ears is not in exact inverse proportion to the size of the umbilicus as the following measurements show:

| Number of Specimens | Number Ears per Half Whorl | Umbilicus as percentage of Diameter |
|---------------------|----------------------------|-------------------------------------|
| several | 14-16 | 27-34 |
| 1 | 16 | 26 |
| 1 | 17 | 31.5 |
| 1 | 17 | 30 |
| 1 | 18 | 36 |
| 1 | 18 | 34.5 |
| 1 | 20 | 28 |
| 1 | 21 | 28.5 |
| 1 | 22 | 23 |
| 1 | 23 | 24.2 |
| 1 | 24 | 23 |
| 1 | 26 | 23 |
| 1 | 27 | 24 |
| several | 29 | 16.5-21.5 |
| several | 30 | 22-26 |
| 1 | 30 | 20 |
| 1 | 31 | 16 |
| 1 | 37 | 18 |

The specimen described as *Pterotoceras caurinum* var. *arctum* McLearn, is compressed, moderately involute, almost involute (20 per cent of diameter), with flattened sides and about twenty-one external ears to the half whorl. It differs chiefly from the species and its variants described above, in the more rapid increase in height of whorl with growth of the shell. Until more specimens are found, however, and the variation better known it is not thought advisable to create a new species.

Comparisons. Compared with *Pterotoceras helminae* Diener, the ribbing is more distinct, the ventral furrow is not so well defined and the external ears are more hornlike and less clavate in form. Compared with species like *Pterotoceras insigne* Diener with stronger ribbing, the lateral and ventro-lateral tubercles are finer. It differs from *Pterotoceras abnorme* Diener, which Spath has made the genotype of *Dimorphotoceras*, in the earlier appearance of ribs and in the ceratitic, not ammonitic, suture line.

Genus *Tibetites* Mojsisovics

"Tibetites" sp.

Plate V, figures 8, 9a, b

Material. The figured specimen GSC 12582 is from talus possibly from the *Styrites ireneanus* zone, south bank of Peace River at Little Parle Pas Rapids (9699). The figured specimen GSC 12583 is from talus at same locality (9161). Other material is in 9373 and 9695, from talus.

Description. Most of the shells are of the internal mould and not well enough preserved to establish the species or genus.

The figured specimen GSC 12582 at a diameter of 22 mm is compressed, moderately involute, almost moderately evolute, with somewhat flattened sides, rounded but distinct umbilical shoulders, rounded ventral shoulders and ventral sulcus, bordered by low, narrow keels. In the posterior part of the ultimate whorl, which is phragmocone, well-defined ribs divide at the umbilical or other row of tubercles, are curved a little on the sides and curved forward outside the ventro-lateral row of tubercles. In addition to umbilical there are two rows of lateral and one row of ventro-lateral tubercles. A row of small tubercles occurs on either side of the ventral sulcus and is borne on the keels. In the anterior and non-septate part of this whorl, the ribs are fairly low and wide. Here are five rows of tubercles. Those of the fifth or ventro-lateral row are clavate. Somewhat clavate tubercles border the ventral sulcus.

The figured specimen GSC 12583 consists of less than half a whorl of phragmocone most of which is internal mould only. At an approximate diameter of 40 mm, it is moderately involute, not quite moderately evolute, with whorls higher than thick, rounded, converging sides, abruptly rounded umbilical shoulders, rounded, not well defined ventral shoulders and shallow ventral sulcus. The tubercles of the umbilical row are not well preserved, those of the second are somewhat clavate, those of the third row small and narrowly clavate and those of the fourth or ventro-lateral row, large and rounded to clavate. Bordering the ventral sulcus are large, curved clavi, alternating or staggered on either side, apparently not fringed or denticulate, but only the internal mould is preserved. The ribs are greatly reduced and ill-defined.

A specimen in 9373 of about the size of GSC 12583 is mostly of the internal mould and incompletely preserved, but is similar to it in form and ornament. The lateral ornament consists of indistinct ribs, an umbilical row of tubercles, a second row of tubercles of about the same size, a third row of somewhat smaller tubercles and a fourth or ventro-lateral row of fairly large tubercles, most of which are clavate in form. The shallow ventral sulcus is bordered by a row of large, elongate, somewhat curved clavi, alternating or staggered on either side.

The ammonitic suture line of a small specimen in 9373 at a diameter of about 25 mm has a small, high, ventral saddle and two very small adventitious ? saddles on either side, an ES with shallow indentations, an L1 longer than EL with coarse indentations, S1 only a little smaller than ES and with few indentations, L2 shorter than L1 and with indentations, and a smaller coarsely denticulated S2 on the umbilical tubercles.

Other specimens are of the same or closely related species. Unfortunately they are commonly preserved as internal moulds, so that the surface ornament cannot be observed.

Comparisons. The mature ventral ornament recalls that of *Palicites*, particularly the alternating curved ventral clavi. The suture line is different, however, ammonitic not ceratitic, and there are more lateral rows of tubercles. As the surface is not well preserved it is not known whether the ventral clavi are smooth or denticulate and so whether the Tibetitidae or the Cyrtopleuritidae is indicated. The internal moulds of the clavi are smooth, however. The ventral aspect is certainly not typical of *Cyrtopleurites*. The ammonitic suture line removes it from either *Pterotoceras* or *Tibetites*. It does not exhibit the late acquired ornament of *Dimorphotoceras* Spath. The ventral or external clavi of this species suggest the Cyrtopleuritidae or Tibetitidae. The preservation does not justify generic or species recognition.

Genus *Stikinoceras* McLearn

Stikinoceras kerri McLearn

Plate III, figures 1a, b, 2a-c, 3

Stikinoceras kerri McLearn, Trans. Roy. Soc. Can., 3rd ser., vol. 24, sec. 4, p. 5, Pl. I, fig. 2 (1930); Geol. Surv., Canada, Paper 47-14, p. 13, Appendix, Pl. II, figs. 1, 2 (1947); Geol. Surv., Canada, Paper 53-21, p. 5 (1953).

Stikinoceras robustum McLearn, Can. Field-Naturalist, vol. 51, p. 98, Pl. I, fig. 4 (1937).

Material. The holotype, GSC 9048, is from a general collection taken on the west slope of the west spur of Brown Hill, presumably from the *Stikinoceras* zone (9157). The hypotype, GSC 12574, and the original holotype of *Stikinoceras robustum*, GSC 8839, are from the *Stikinoceras* zone on the west slope of the west spur of Brown Hill (9851).

Other specimens are in 9157, 9479, 9481, 9719, 9851, 9852 and 9854, from *Stikinoceras* zone and talus.

Measurements. Holotype: 35; 35.7; 24.3; 37. Holotype of *Stikinoceras robustum*: 29.6; 32.8; 28.7; 38.5.

Description. The holotype is a compressed, moderately evolute specimen, with somewhat flattened sides, rounded ventral shoulders, narrow, almost flattened venter, thread-like elevation along the venter and poorly defined, rounded

umbilical shoulders. The sides bear numerous, rather slender, gently curved ribs, about twenty-six per half whorl, alternately long and short and very rarely joining on the umbilical shoulder. The longer ribs thicken a little at their inner ends to form incipient bullae. All ribs bear two rows of tubercles ventrally, an outer row of somewhat clavate tubercles at the ends of the ribs and an inner row of somewhat smaller non-clavate tubercles. The ribs are reduced in relief between the two rows. The ornament of the penultimate is similar to that of the ultimate whorl, including nearly the same number of ribs, about twenty-four to the half whorl. There is thus no reduction in number of ribs on the ultimate whorl.

The hypotype, GSC 12574, is similar to the holotype, but has only about twenty-one ribs to the half whorl. The suture line is figured. EL is wide, L1 is long and almost as wide as EL and has a few indentations. L2 is partly on the umbilical shoulder. ES is higher than wide and entire, S1 is wide, high and entire. S2 is small and on the inner part of the umbilical shoulder.

The variant originally described as *Stikinoceras robustum* is a little smaller than the holotype of the species, has somewhat lower and thicker whorls and a somewhat larger umbilicus. On the ultimate whorl it has fewer, sixteen, ribs to the half whorl. The penultimate whorl has twenty-one to the half whorl, a marked reduction in number of ribs from penultimate to ultimate whorl. As there is fairly continuous variation between the holotypes of *Stikinoceras kerri* and *S. robustum*, they are placed in synonymy.

In about thirty-seven specimens the number of ribs per half whorl varies from about fifteen to twenty-eight and the width of the umbilicus from about 34 to 43 per cent of the diameter. It can be shown, by means of a scatter diagram, that there is little or no correlation between the number of ribs and width of umbilicus. Degree of reduction of number of ribs on ultimate whorl of mature specimens also varies.

The holotype of this species has a few more ribs than an average specimen, but has about an average sized umbilicus.

Comparisons. The systematic position of *Stikinoceras* in the arrangement of Triassic ammonoid families has not yet been established. In 1951 Spath tentatively included this genus in the Tibetitidae, but noted that it might prove advisable to incorporate *Mojsisovicsites*, *Palicites* and *Stikinoceras* into a new family. He had earlier entertained the possibility of including *Stikinoceras* in the Clionitidae. McLearn, too, as early as 1947 had suggested a possible relation to *Clionites* and in 1953 actually placed it in that family, but with reservations. Spath (1951) and Kummel (*in* Arkell, *et al.*, 1957) are followed here and *Stikinoceras* is tentatively included in the Tibetitidae.

It is probable that *Stikinoceras* is close to *Mojsisovicsites* and some palæontologists may wish to place the two genera in synonymy, that is, in a broad, inclusive

Mojsisovicsites.¹ None of the Peace River specimens shows the mature stage of greatly reduced ribbing of *Mojsisovicsites*, as figured and described by Gemmellaro from the Trias near Monreale in the province of Palermo. One of the Peace River specimens has a diameter of 42 mm and is almost as large as any of the Palermo specimens. None of the Peace River specimens shows strigate ornament. All specimens of *Stikinoceras* have a median elevation along the venter.

In 1951, Spath claimed that the lateral ornament of the variant originally described as *S. robustum* is "remarkably like that of *Palicites*". Comparison of the Peace River specimens with Gemmellaro's illustrations of *Palicites* does suggest some resemblance. Despite all the variation exhibited by specimens of *Stikinoceras*, however, all have a median ventral elevation, none has a ventral sulcus and all have small ventral tubercles, not ventral clavi.

In a discussion of this genus Spath (1951) stated that no peripheral view or sectional outline has been illustrated, overlooking the fact that such a view had already been figured (McLearn, 1947).

Family BUCHITIDAE Hyatt

Genus *Helicites* Mojsisovics

Helicites cf. *subgeniculatus* Mojsisovics

Plate V, figures 3a, b, 4a, b

- cf. *Ammonites geniculatus* Hauer, Denkschr. Akad. Wiss. Wien, IX Band, p. 153, Pl. V, figs. 21-23 (1855).
cf. *Helicites geniculatus* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 417, Pl. CXXXIX, figs. 6-8 (1893).
cf. *Helicites subgeniculatus* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 419, Pl. CXXXIX, fig. 9 (1893).

Material. The figured specimen GSC 12584 is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741). The figured specimen GSC 12585 is from talus, *Himavatites* zone, also very high on the west slope of Black Bear Ridge (9744). Other specimens are in 9729 and 9744, *Himavatites* zone and talus.

¹ An important publication (Silberling, 1959) appeared while this memoir was in press. It contains much new and valuable information concerning Upper Triassic ammonoids and their zoning. Silberling records both *Stikinoceras kerri* and *S. robustum* at about 300 feet above the base of the calcareous shale member of the Luning formation in the Union district, Nevada. At a higher horizon he records *Mojsisovicsites* cf. *crassecostatus* Gemmellaro, the specimens of which show all variations between the typical ornament of *Stikinoceras*, as exhibited by *S. kerri* and *S. robustum*, and the reduced ornament of typical *Mojsisovicsites*. On this basis he places *Stikinoceras* in synonymy with *Mojsisovicsites* and includes *S. kerri* and *S. robustum* in the latter genus. This has much to recommend it. *Stikinoceras* as used in the Peace River section, however, does define a very definite zone in the lower part of the major *Gonionotites-Malayites* zone and comparable with a zone in the Union district section 300 feet above base of the calcareous shale member and stratigraphically below the occurrence of the very variable species that records the gradation between typical *Stikinoceras* and *Mojsisovicsites*.

The *Gonionotites-Malayites* major zone has *Stikinoceras kerri* and *Guembelites clavatus* in common with Silberling's *Guembelites* zone.

Measurements. Figured specimen GSC 12584: 13; 36.5; 38; 41. Figured specimen GSC 12585: 15.5; 35.5; 30; 42.

Description. The figured specimen GSC 12584 is small, probably not mature, moderately evolute, has fairly stout whorls, a little thicker than high, flat sides and venter, and rounded, but distinct ventral shoulders. The lateral ribs are almost straight, elevated, single and about eight to the half whorl. Ribs cross the venter, are almost straight there and a little thicker than on the sides, but not so elevated. They are produced into short, thickened, bulla-like processes or flares on the ventral shoulders.

The figured specimen GSC 12585 is slightly larger than figured specimen GSC 12584; both are moderately evolute. The posterior part of the ultimate whorl is a little thicker than high, has flat sides, almost flat venter, rounded ventral shoulders, single ribs almost straight on the sides and across the venter, thickened and produced on the ventral shoulders and fine striae parallel to the ribs on the venter. The anterior part of the ultimate whorl is compressed, being higher than thick, and has a gently arched venter and rounded ventral shoulders. The ribs, numbering twelve per half whorl, are slightly curved on the sides and a little arcuate across the venter. At this stage of growth the bulla-like projections on the ventral shoulders are reduced.

The smaller specimen in 9729 is similar to figured specimen GSC 12584, but is larger, has more ribs, about twelve per half whorl, which are slightly arcuate across the venter and has less distinct bulla-like processes on the ventral shoulder. A much larger specimen in this collection has somewhat arcuate ribs on the venter.

Poorly preserved specimens in 9744 have somewhat arcuate ribs across the venter and only slightly thickened and projecting processes on the ventral shoulder.

More than one species may be represented.

Comparisons. The figured specimen GSC 12584 resembles *Helictites subgeniculatus* Mojsisovics in form and ornament, but has more slender ribs and lacks the umbilical tubercles.

Helictites decorus McLearn

Plate VI, figures 8, 9a, b, 10a, b

Helictites decorus McLearn, Can. Field-Naturalist, vol. 54, p. 49, Pl. II, figs. 4, 5 (1940).

Helictites decorus var. *transitionis* McLearn, Can. Field-Naturalist, vol. 54, p. 50, Pl. II, figs. 7, 8 (1940).

Helictites decorus var. *obesus* McLearn, Can. Field-Naturalist, vol. 54, p. 50, Pl. I, fig. 12 (1940).

Material. The holotype GSC 8824 is from talus high on the west slope of Black Bear Ridge (9744). The holotype, GSC 8823, of var. *transitionis* is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741). The holotype, GSC 8822, of var. *obesus* is from the same collection (9741).

Other specimens are in 9729, 9730, 9741, 9744 and 9745, from *Himavatites* zone and talus.

Measurements. Holotype: 25.3; 36.3; 28; 39.5. Holotype of var. *transitionis*: 22.7; 35.2; 35.2; 45. Holotype of var. *obesus*: 25.5; 38.5; 37.2; 37.2.

Description. The holotype is a compressed, moderately evolute shell with whorls higher than thick, flattened sides, almost flat venter and rounded but well-defined ventral and umbilical shoulders. The ribs, about twenty-nine per half whorl, are curved a little on the sides of the whorl, continuous and only slightly arcuate across the venter where they tend to be not much thicker than on the sides. In the posterior part of the ultimate whorl they are mostly single, but in the anterior part a few are intercalated or bifurcate. On the ventral shoulder the ribs are only slightly elevated and do not form bulla-like flares. Even striae, parallel to the ribs, occur where the surface is well preserved.

The specimen originally chosen as the type of var. *transitionis* differs from the holotype of the species, having a somewhat flatter and wider venter, larger umbilicus and a thicker whorl, which is about as thick as high. The ventral shoulders are abruptly rounded. The ribs, about twenty-two to the half whorl, are only a little curved on the sides, are straight or only slightly arcuate across the venter, are mostly single and only slightly flared on the ventral shoulders.

The specimen that was chosen as the type of var. *obesus*, has a more rounded venter, less well defined ventral shoulders and more arcuate ribs across the venter than the holotype of the species. The ribs, twenty-three per half whorl, are curved a little on the sides and lack any flaring on the ventral shoulder.

The number of ribs to the half whorl of this variable species is from about fourteen to thirty-one, about twenty is common. Few specimens have as many as the holotype, which is twenty-nine. Some have single ribs only, others have a few short, intercalated or bifurcating ribs. Gentle curvature of the ribs on the sides is common, as in the holotype, but is more pronounced in some specimens. The ribs are gently arcuate across the venter as in the holotype, but rarely is the curvature as pronounced as in the variant described as var. *obesus*. Some slight flaring of the ribs on the ventral shoulder occurs in some specimens, but not in others. Although some specimens have as flat a venter as the holotype, others have a more rounded venter. In eleven measured specimens the height of whorl varies from about 35 to 45 per cent of the diameter, the thickness from about 28 to 37 per cent, and the width of umbilicus from about 36 to 45 per cent.

The suture line is simple. Both lobes and saddles are entire. EL has a small ventral saddle, ES is rounded and large, L1 wide and a little longer than EL, S1 is rather low and wide and smaller than ES, L2 is very small and S2 is small and on the umbilical slope.

Comparisons. This species lacks the definite marginal nodes or flares on the ventral shoulder which occur at some stages of growth in *Helicites geniculatus* (Hauer) and the elevated or tubercle-like ornament on the ribs on the

middle of the venter. Specimens with more rounded whorls resemble the illustrated Timor specimen of *Helictites mojsvari* Diener, but have flatter sides and venter, and better defined ventral shoulder. This species lacks the umbilical tubercles of *Helictites sundaicus* Diener.

Helictites decorus McLearn ?

Plate V, figures 5a, b

Material. The figured specimen, GSC 12586, is from talus, very high on the west slope of Black Bear Ridge (9744).

Description. An imperfect specimen, it is much larger than any of the specimens definitely identified as *Helictites decorus* and has a diameter of 36 mm. The posterior part of the ultimate whorl is compressed, with nearly flat venter and slender ribs that cross the venter with little thickening or flaring on the ventral shoulder. The anterior part of this whorl is compressed, with flattened sides and venter and well-defined ventral shoulder. The lateral ribs are fine, numerous and little elevated. The ribs cross the venter where they are alternately strong and weak. They are a little thickened and elevated on the ventral shoulder.

If this really is a mature specimen of *H. decorus*, then it is the only one in all of the Survey collections.

Family THISBITIDAE Spath

Genus *Thisbites* Mojsisovics

Thisbites dawsoni (McLearn)

Plate VI, figures 1a, b, 2

Buchites hilaris var. *dawsoni* McLearn, Can. Field-Naturalist, vol. 54, p. 49, Pl. I, figs. 4-5 (1940).

Buchites dawsoni McLearn, Geol. Surv., Canada, Paper 47-14, p. 13 (1947).

Material. The holotype, GSC 8825, is from talus block, west side Juvavites Gully, between XI and XII, Pardonet Hill (9643) and probably from the *Styrites ireneanus* zone. The hypotype, GSC 12587, is from the same collection.

Other specimens are in 9377, 9641, 9642, 9644, 9647, 9648 and 9856, *Styrites ireneanus* zone and talus and *Thisbites* beds below *Stikinoceras* zone.

Measurements. Holotype: 23.2; 38.8; 37.5; 36.5.

Description. The holotype is a small, moderately evolute specimen with stout, rounded whorls, only a little higher than thick. The single ribs about twenty-two to the half whorl, are stiffly curved on the sides of the whorls and are curved forward a little as they approach the venter. In the posterior part of the ultimate whorl the ventral surface is slightly elevated to form a thread-like keel. There the ribs are well defined to within a short distance of this keel and are expanded

into faint tubercles. At the anterior end of this whorl the delicate keel almost disappears, the swellings or tubercles become indistinct and some ribs cross the venter. Fine striae, parallel to the ribs, cross the venter on the ultimate whorl.

The simple ceratitic suture of the hypotype is illustrated. S1 is almost as large as ES, but S2 is much smaller than S1. L1 is longer than wide and has a few indentations. L2 is small.

Some specimens are larger than the holotype. The umbilicus varies from about 34 to 43 per cent of the diameter. The whorls of some specimens are more slender than those of the holotype. Ribs number from 15 to 24 per half whorl. The faint thread-like keels or faint ventral elevations and the faint tubercles tend to decline with growth of shell and the ribs tend to cross the venter at maturity. In some specimens faint keels and faint ventral tubercles do not appear to occur. None of the faint ventral elevations can be called true keels and the tubercles are nothing more than slight swellings of the ends of the ribs.

Comparisons. The ventral ornament recalls *Ceratites waltheri* Mojsisovics, but in *T. dawsoni* the ribs cross the venter at maturity and the "keel" and "tubercles" decline or disappear. This species resembles the figured and type specimen of *Buchites hilaris* Mojsisovics and can be considered a close species.

The resemblance is in similarity of size, ribs, faint ventral tubercles, faint ventral elevation or keel and decline of these tubercles and keel adorally. The whorls are stouter, however, on the average and the ribs are more slender and lack the considerable curvature on the sides at the anterior or adoral end of the ultimate whorl of *Thisbites hilaris*.

Both *Thisbites hilaris* and *Thisbites dawsoni* are included in *Thisbites* because they show an early stage of the typical ventral ornament of this genus.

Thisbites charybdis (Gemmellaro)

Plate VI, figure 6; Plate VII, figure 6

Ceratites (Thisbites) charybdis Gemmellaro, Giorn. Sci. Nat. Econ. Palermo, vol. 24, p. 35, Pl. XXIX, figs. 10-11 (1904).

Thisbites charybdis var. *ireneanus* McLearn, (in part), Can. Field-Naturalist, vol. 54, p. 49, Pl. II, fig. 3 (1940).

Material. The hypotype GSC 8791 (paratype GSC 8791 of var. *ireneanus*) is from the *Styrites ireneanus* zone at XII, Juvavites Gully (9663). The hypotype GSC 14330 is from a talus block between X and XI, Juvavites Gully, and presumably from the same zone (9638). Other specimens are in collections 9638, 9639, and 9672, from the *Styrites ireneanus* zone and talus, Juvavites Gully.

Measurements. Hypotype, GSC 14330: 20.5; 41; 28?; 29.5. Hypotype, GSC 8791: 16; 40.5; 34.5; 31.

Description. The type specimen of this species in the Museum of Geology, University of Palermo, is a small specimen, diameter about 14 mm. It is com-

pressed, moderately involute, with somewhat flattened sides, ventral shoulder, and whorls higher than wide. The fine ribs or costae number about twenty-five to the half whorl, are mostly single, bend forward a little near the ventral shoulder and end in small swellings or tubercles. The ventral keel or carina is only a slight elevation along the venter.

Several specimens in talus from the *Styrites ireneanus* zone are close enough to this type specimen to be included in the same species. They too are compressed and have the numerous ribs and rather faint ventral ornament. The hypotype GSC 14330 is much larger than the Sicilian type specimen and of a diameter of 20.5 mm. It is compressed with somewhat flattened sides, has a ventral shoulder, is moderately involute and has about thirty ribs to the half whorl, small ventral tubercles and slight ventral elevation or "keel". This specimen, however, has been a little flattened. The hypotype GSC 8791 of a diameter of about 15 mm, is compressed, is moderately involute and has ribs and ventral ornament similar to that of the Palermo type specimen. It has about twenty-three ribs per half whorl. The ventral keel is a little more distinct than in the hypotype specimen GSC 14330. A specimen in collection 9672, at a diameter of 18.5 mm, is similar, but has a somewhat wider umbilicus and has about twenty-five ribs per half whorl. A much larger specimen is similar and has about twenty-five ribs per half whorl at a diameter of 24 mm.

Comparisons. Compared with *Thisbites dawsoni* (McLearn), the species is more compressed, is a little more involute and has on the average more ribs per half whorl. Adorally, the ventral keel persists to a later stage of growth.

Both the Peace River specimens and the Palermo type specimen have weaker keels than *Thisbites agricolae* Mojsisovics, the genotype of the genus.

Thisbites custi (McLearn)

Plate VI, figures 3a, b, 4, 5a, b

Thisbites charybdis var. *custi* McLearn, Can. Field-Naturalist, vol. 54, p. 49, Pl. I, figs. 6, 7 (1940).

Thisbites charybdis var. *ireneanus* McLearn, Can. Field-Naturalist, vol. 54, p. 49, Pl. I, figs. 9, 10 (1940).

"*Buchites*" *custi* McLearn, Geol. Surv., Canada, Paper 47-14, p. 13 (1947).

"*Buchites*" *ireneanus* McLearn, Geol. Surv., Canada, Paper 47-14, p. 13 (1947).

Material. The holotype, GSC 8801, is from the *Styrites ireneanus* zone, between XI and XII, west side of Juvavites Gully, Pardonet Hill (9672). The specimen chosen as holotype of var. *ireneanus*, GSC 8802, is from the same collection. The hypotype, GSC 12588, is from talus at XII, west side Juvavites Gully, Pardonet Hill (9662).

Other specimens are in 9661, 9663, 9671 and 9672, from *Styrites ireneanus* zone and talus.

Measurements. Holotype: 24.5; 40; 34.5; 34. Specimen originally designated holotype of var. *ireneanus*, GSC 8802: 29; 41; 28; —. Hypotype, GSC 12588: 23; 38.5; 33; 35.

Description. The holotype, GSC 8801, is a small moderately involute, almost moderately evolute, shell with compressed, somewhat flattened, although gently convex sides, rounded venter, well-rounded umbilical shoulder and well-rounded ventral shoulder. The ribs are stiffly curved, a little convex forward on the sides and only produced a very little forward on the ventral shoulder, are mostly single and number about twenty-three to the half whorl. The venter in the posterior part of the ultimate whorl is elevated into a very low and weak keel. Enlargements of the ends of the ribs have the appearance of weak, ventral tubercles. The ventral ornament at the anterior end of the ultimate whorl is poorly preserved but some ribs may cross the venter.

The specimen GSC 8802 is a small, moderately involute, almost moderately evolute, shell with compressed, more or less flattened whorls, gently convex venter and rounded, but well-defined ventral shoulder. The ribs are mostly single, stiffly curved on the sides and bent forward a little on the ventral shoulder. At the posterior end of the ultimate whorl the venter is not well preserved, but a low keel is bordered on either side by a row of poorly defined tubercles formed by a swelling of the ends of the lateral ribs. The venter at the anterior end of the whorl is poorly preserved.

The suture line of the hypotype includes an EL divided by a small, ventral saddle, an L1 somewhat narrower than, but about as long as, EL and with a few indentations, an L2 much smaller and shorter than L1, an ES wider than L1 and broadly rounded and entire, an S1 only a little smaller than ES and similarly entire, and a very low, wide S2 extending down on the umbilical wall and probably to the umbilical suture.

In several measured specimens the size of whorl varies in height from about 38 to 42 per cent, in thickness from about 28 to 34.5 per cent, in width of umbilicus from about 35 per cent, and in number of ribs to the half whorl from 20 to 25 approximately. The sides of the whorls are flatter in some specimens than in others, and the ribs are broader. The weak ventral keel is rather indefinite in some specimens.

Comparisons. This species has more compressed and flatter whorls, a flatter venter and a better defined ventral shoulder than *Thisbites dawsoni* (McLearn). It resembles *Thisbites charybdis* (Gemmellaro) very closely, but is larger, on the average somewhat more evolute, and the ribs are fewer per half whorl in large and mature specimens. All of these species belong to a variation-complex difficult to segregate into species. The ventral keel is not so distinct or so elevated as in a typical *Thisbites*, such as *Thisbites agricolae* Mojsisovics.

Thisbites cf. *pyrami* (Gemmellaro)

cf. *Ceratites* (*Thisbites*) *pyrami* Gemmellaro, Giorn. Sci. Nat. Econ. Palermo, vol. 24, p. 35, pl. XXIX, figs. 10-11 (1904).

Material. Hypotype, GSC 13481, is from the *Styrites ireneanus* zone between XI and XII in Juvavites Gully (9672).

Measurements (near anterior end): 23.2; 33.5; 29; 43.

Description. A few specimens of *Thisbites custi* (McLearn) show some approach to *Thisbites pyrami* (Gemmellaro). One specimen, however, is too close to the Palermo species to be included in *Thisbites custi* and it is listed as *Thisbites* cf. *pyrami* (Gemmellaro). The umbilicus is wider and the percentage height of whorl is less in this specimen and in the type specimen of *Thisbites pyrami* than in *Thisbites custi*. Compared with the type specimen of *Thisbites pyrami*, however, the ribs are a little coarser and fewer in number and are straighter, on the side of the whorl. The ventral keel is better defined in *Thisbites pyrami* than in *Thisbites custi*.

Genus *Parathisbites* Mojsisovics*Parathisbites oineus* McLearn

Plate VI, figures 11a, b, 12

Parathisbites oineus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. IV, fig. 1 (1947).

Material. The holotype, GSC 9495, is from talus block east of and higher than XX, west end of Pardonet Hill and from the *Parathisbites oineus* beds (9762). The hypotype, GSC 12589, is from the same collection.

Other specimens are in 9474? (talus Brown Hill), 9762 and 9764, from *P. oineus* beds and talus.

Measurements. Holotype: 35; —; —; —: 32.5; 52.5; 32.5; 12.5.

Description. The holotype comprises internal mould only, and the ultimate whorl includes about three quadrants of living chamber. It is a discoidal, involute shell, with flattened whorls, well-defined umbilical shoulder, thick, rather low keel and shallow, but distinct ventral furrows on either side of the keel. The ribs number about thirty in the last half whorl, are stiffly curved on the sides and strongly projected forward on the ventral shoulder. They are evenly spaced and somewhat elevated on the posterior part of the ultimate whorl and less evenly spaced on the anterior part of the same whorl. Some are single, some branch, and some are shorter than others and intercalated.

Other specimens are mostly smaller than the holotype and are variable in strength and number of ribs, from twenty-five to thirty-five per half whorl, and in degree of compression of whorls.

The suture line includes a rather short, narrow EL, an entire, wide ES, a wide and indented L1, much longer than EL, an entire, wide S1, a small, short L2 and a rather small S2. Some poorly preserved specimens in 9474 may be of this species.

Comparisons. This species is close to *Parathisbites meleagri* (Mojsisovics), but appears to have better defined ventral furrows and in some specimens finer and more numerous ribs.

In 1947 McLearn recommended that species like *P. meleagri*, with stout keels, hitherto placed in *Thisbites*, should be included in *Parathisbites* despite lack of corrugation of the keel. Later, in 1951, Spath also placed *P. meleagri* in *Parathisbites*.

Family DISTICHITIDAE Diener
Genus *Distichites* Mojsisovics
Distichites gethingi McLearn

Plate VI, figures 7a, b

Distichites gethingi McLearn, Can. Field-Naturalist, vol. 54, p. 116, Pl. II, fig. 4 (1940).

Material. The holotype, GSC 8849, is from talus, very high on the west slope of Black Bear Ridge (9744).

Measurements. Holotype: 67; —; —; —: 61; 39.3; 32.7; 34.5.

Description. The holotype and only specimen is about medium sized for the genus, is compressed, about moderately evolute, with flat-sided whorls, abruptly rounded umbilical shoulders, rounded but distinct ventral shoulder, narrow ventral sulcus, narrow, somewhat elevated keels and shallow ventro-lateral furrows. On the posterior part of the ultimate whorl, short stout ribs extend between the small umbilical tubercles and the larger, lateral spines, outside of which smaller but distinct and fairly wide ribs project forward on the ventral shoulder. One projected rib originates in the lateral spine and at least one is intercalated between these ribs. Near the anterior end of the ultimate whorl two slender lateral ribs are intercalated between the stronger, spine-bearing ribs. Faint tubercles replace the spines on the slender ribs.

Comparisons. This species is smaller than *Distichites megacanthus* Mojsisovics, has better defined ventral shoulders, probably shallower ventro-lateral furrows, weaker and intercalated ribs on the anterior part of the ultimate whorl. It shows some resemblance to a specimen described and figured by Welter (1914, Pl. XXVI, figs. 4, 5) as *Distichites pudens* var. *fatuensis*. It appears, however, to have a narrower and more flattened venter, more pronounced ventro-lateral furrows, better defined ventral shoulders, and wider and stouter lateral ribs. Welter's figured specimen lacks the mature ornament of *D. gethingi*, but it has not, however, attained the stage of growth of the holotype of that species.

Distichites cf. megacanthus Mojsisovics

Plate VII, figures 4a, b

cf. *Distichites megacanthus* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 598, Pl. CXLVI, figs. 4a, b (1893).

Material. The figured specimen, GSC 12590, is from talus, very high on the west slope of Black Bear Ridge (9744).

Description. Part of the ultimate whorl of a small specimen is compressed, nearly moderately evolute and with narrow ventral sulcus and narrow ventral keels. The lateral ribs are almost straight and spaced at moderate intervals. The narrow ribs outside of the lateral spines are projected forward; some originate at the lateral spines and others are intercalated between them.

Comparisons. As the specimen is small and may represent the inner whorls of a large specimen, no exact identification of it can be made. It belongs to the *megacanthi*, however, and may be close to *Distichites gethingi* McLearn. The lateral ribs, however, are more slender.

Distichites cf. mesacanthus Diener

Plate VII, figure 5

cf. *Distichites mesacanthus* Diener, Jaarb. Mij. Ned.-Oost-Ind., 1920, p. 218, Pl. VI, fig. 2, Pl. IX, figs. 3a, b (1923).

Material. The figured specimen, GSC 12591, is from the *Himavatites* zone, above XX, west end of Pardonet Hill (9781).

Description. An imperfectly preserved specimen is moderately evolute and has stout whorls that are thicker than high. The penultimate whorl has wide, straight, lateral ribs and lateral spines. The ultimate whorl is poorly preserved; lateral spines are visible but not near the anterior end. Lateral ribs are reduced and possibly disappear at the anterior end. The ribs outside the lateral spines are greatly reduced and the surface there is nearly smooth. Some small umbilical tubercles occur.

Comparisons. This shell resembles *Distichites mesacanthus* Diener, but the preservation and immature stage of growth do not permit exact comparison.

Distichites cf. celticus Mojsisovics

Plate XXI, figure 5

cf. *Distichites celticus* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 600, Pl. CXLVII, fig. 2 (1893).

Material. The figured and only specimen, GSC 13492, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741).

Description. This specimen consists of part of a penultimate and part of an ultimate whorl. The penultimate whorl, entirely phragmocone, is about as wide as high and has the narrow ventral sulcus and narrow ventral keels of this genus. The umbilical and large, lateral spines are joined by wide, low, moderately spaced ribs. Beyond the lateral spines the ribs are narrow, elevated and strongly curved forward. About two of these are intercalated between the ribs originating at the lateral spines.

The part of the ultimate whorl preserved is living chamber and is compressed, being much higher than thick. The sides are nearly smooth, although some faint, low ribs curve forward near the ventral shoulder. The small umbilical tubercles are fairly evenly spaced and are somewhat conical in shape.

Comparisons. As in *Distichites celticus* Mojsisovics, the inner whorls contain well-defined ribs and spines and the ribs and lateral spines almost disappear at maturity. Compared with the figured type of *D. celticus*, however, the umbilical tubercles at maturity, although small, are larger than in that species.

Distichites canadensis (McLearn)

Plate VII, figure 3

Distichites loidli var. *canadensis* McLearn, Can. Field-Naturalist, vol. 54, p. 50, Pl. III, fig. 6 (1940).

Distichites canadensis (McLearn), Geol. Surv., Canada, Paper 47-14, p. 14 (1947).

Material. The holotype, GSC 8816, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741). A second specimen is, possibly, in 9744.

Measurements. Holotype: 65; 46; —; 24.5; 42.5; 43.5; 34.5; 28.

Description. The holotype is imperfect; much of one side of the ultimate or last whorl is missing. The anterior part of the penultimate whorl is higher than thick, is moderately involute and has a narrow, ventral sulcus bordered by narrow, but elevated keels. The umbilicus is bordered by very small tubercles. The lateral tubercles, which first appear in the second half of the penultimate whorl, increase in size and are fairly large and were possibly elevated into short spines at the anterior end of this whorl and also in the posterior part of the ultimate whorl. The thick but somewhat low ribs are stiffly curved on the inner part of the sides, but are strongly projected forward on the ventral shoulder. They mostly divide at the lateral tubercle or spine. Short ribs may be intercalated.

On the anterior part of the ultimate whorl, the ribs are less uniform in strength and consist of both long and short ribs and are more numerous. The lateral tubercles or spines at this stage are widely spaced and few in number, and are lacking on many of the ribs.

A specimen in 9744 can be referred to this species if a sufficient range of variation is assumed. It is smaller than the holotype, but is similarly compressed, moderately involute, and has lateral spines. Some ribs are weaker than others and not all of them bear lateral spines.

Comparisons. Compared with *Distichites loidli* Mojsisovics, *D. canadensis* has only one row of lateral tubercles or spines. Compared with *Distichites tropicus* Diener, the umbilical tubercles are smaller and with decline of lateral ornament the species passes through a stage of widely spaced lateral spines, larger than any on the ultimate whorl of *D. tropicus*.

As this species retains enough of the typical *Distichites* lateral ornament for inclusion in this genus it is not assigned to *Paradistichites* Diener although it is moderately involute and compressed.

Distichites palliseri McLearn

Plate VII, figures 1a-c

Distichites palliseri McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 2, Pl. V, figs. 10, 11 (1947).

Material. The holotype, GSC 9505, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741).

Other material is in collections 9741, 9744 and 9745, from *Himavatites* zone and talus.

Measurement. Holotype: 48; 45; 35.5; 28.

Description. The holotype is a compressed, moderately involute species, with much higher than thick whorls, somewhat flattened sides, angular umbilical shoulder, rounded ventral shoulder, narrow ventral sulcus, narrow ventral keels and narrow, shallow, not very distinct ventro-lateral furrows. The fairly broad ribs are about twenty-four to the half whorl, are only a little curved on the sides but are projected forward on the ventral shoulder. The umbilical tubercles are small and number about ten to the half whorl; the lateral tubercles are small.

Specimens vary in proportions and ornament. Some have higher whorls than the holotype, some have a smaller umbilicus and some have fewer ribs to the half whorl. The lateral tubercles vary from fine to very fine and in some specimens are indistinct.

Comparisons. Compared with the type of *Distichites loidli* Mojsisovics, the specimens of this species are smaller and have one lateral row of tubercles, not two. They have thinner whorls than *Distichites gobli* Mojsisovics and a better defined lateral row of tubercles. They have fewer ribs than *Distichites kmetyi*

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Mojsisovics. They are smaller than *Distichites orteli* Mojsisovics, have smaller, finer umbilical tubercles, and have lateral tubercles. They are smaller than *Distichites tropicus* Diener and have smaller lateral tubercles at a comparable stage of growth.

Distichites cf. *hacqueti* Mojsisovics

Plate VII, figure 2

cf. *Distichites hacqueti* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, pt. 2, p. 610, Pl. CLII, fig. 2 (1893).

Material. The figured specimen, GSC 12592, is from talus, very high on the west slope of Black Bear Ridge (9744).

Description. The figured specimen comprises only part of one side of a whorl. It is compressed, moderately involute, has somewhat flattened sides, small, very narrow ventral sulcus, and small narrow ventral keels. The surface is nearly smooth with little more than varices of growth.

Comparisons. The ornament is more reduced than in *Distichites anacanthus* Diener. It is as much reduced as in *Distichites hacqueti* Mojsisovics, but the shell is more evolute.

Family CHORISTOCERATIDAE Hyatt

Genus *Hannaoceras* Tomlin

Hannaoceras sp.

Plate VIII, figure 9

Material. The figured specimen, GSC 12593, is from beds just west of south face of McLay Spur (9146).

Description. About a quadrant of a small specimen of what appears to be the living chamber is known. The whorl is about as thick as high and has elevated, rather narrow, almost straight ribs which, although continuous across the venter, are slightly notched or depressed there.

Genus *Choristoceras* Hauer

Choristoceras ? sp.

Plate XIX, figures 3a, b

Material. The figured specimen, GSC 13488, is from the *Styrites ireneanus* zone between XI and XII on west side of Juvavites Gully, Pardonet Hill (9672).

Description. The ultimate whorl of the figured specimen is higher than wide, very gently convex on the sides, and has a rounded ventral shoulder and

almost flat venter. The lateral ribs are narrow and stiffly curved to nearly straight. In the posterior part of this whorl the ribs do not cross the venter but leave a smooth band there, anteriorly they cross the venter and curve slightly forward.

Family TROPITIDAE Mojsisovics

Genus *Tropites* Mojsisovics

Tropites sp.

Plate VIII, figures 10a, b

Tropites sp., McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, Pl. III, figs. 6, 7 (1947).

Material. The figured specimen, GSC 12594, is from a bed at V, high on Cascades Creek, Pardonet Hill (9688). Other, but fragmentary, specimens are from talus, same locality (9687).

Description. The figured specimen is a moderately evolute cadicone with much thicker than high whorls. The low, narrow ventral keel is bordered by very shallow furrows. The ribs are strongly produced forward and originate in well-defined umbilical tubercles. About two branch from each tubercle, except near the anterior end where only one originates in an umbilical tubercle. The specimens in 9687 are mere fragments.

Comparisons. The available material does not justify specific identification. The strong forward projection of the ribs is an important diagnostic character.

Genus *Discotropites* Hyatt and Smith

Discotropites sandlingensis (Hauer)

Plate VIII, figure 7

Ammonites sandlingensis Hauer, Haidinger's Naturwiss., Abh., III, p. 10, Pl. III, figs. 10-12 (1849).

Eutomoceras sandlingensis Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 285, Pl. CXXX, figs. 11-13; Pl. CXXXI, figs. 1-11 (1893).

Discotropites sandlingensis Smith, U.S. Geol. Surv., Prof. Paper 141, p. 39, Pl. XXXV, figs. 1-12; Pl. XXXVI, figs. 1-26 (1927).

Material. The hypotype, GSC 12595, is from Pardonet beds on north bank Peace River, above Point Creek (9360). Additional specimens are in 9360.

Measurements. Hypotype, GSC 12595: 66.5; 52; —; 13 (very approximate).

Description. The figured hypotype is much compressed by pressure. The mostly narrow ribs are slightly convex forward on the sides and curved forward near the venter. They are crossed by numerous, spiral striae. The moderately high keel is preserved in parts of the specimen.

Other specimens in 9360 have similar ribs and spiral striae.

Discotropites cf. *acutus* (Mojsisovics)

Plate VIII, figures 8a, b

cf. *Eutomoceras acutum* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 290, Pl. CXXX, figs. 1, 2 (1893).

Material. The figured specimen, GSC 12596, is from talus of Pardonet beds, north bank Peace River, below Jewitt Spur (9144).

Measurements. Figured specimen, GSC 12596: 37.5; 53; 24; 12.

Description. The figured and only known specimen is very compressed, involute, with gently convex, almost flat sides, rounded, but fairly well-defined ventral shoulder, narrow keel and abruptly rounded umbilical shoulder. On the internal mould are rather evenly sized striae or very fine ribs, little curved on the sides; if anything a little stronger there, bent forward on the ventral shoulder and continuous on the keel. Some obscure spiral striae occur.

The complex ammonitic suture line includes a deeply indented ES, a long L1 also deeply indented, a deeply incised S1 smaller than ES, a short L2, a small S2 and about two? auxiliary lobes and saddles.

Comparisons. This specimen is very close to the type of *Discotropites acutus* (Mojsisovics), but it has a more complex and more deeply indented suture line.

Discotropites sp.

Material. In 9359, 9360, 9370, 9772 and 9871, from *D. sandlingensis* beds and talus and from other localities. Several poorly preserved specimens are assigned to this genus.

Description. A fragment of living chamber in collection 9359 from the north bank of Peace River above Point Creek resembles *Discotropites sandlingensis* (Hauer) but lacks the strigate ornament. A fragment in 9360 from the same locality has fine ribs with fine strigate ornament like *Discotropites formosus* Smith and *Discotropites lineatus* Smith. A fragment in 9360 with very fine ribs may represent the inner whorls of species like *D. formosus* or *D. lineatus*.

A specimen in 9772 from talus in Monotis Gully, unknown horizon, is compressed, involute, with apparently a ventral keel and almost angular umbilical shoulder. The surface is poorly preserved, but in the anterior half of the ultimate whorl, short almost straight ribs occur on the middle of the side.

A specimen in 9370 from west side of Schooler Hill is small, compressed involute, with small ventral keel, abruptly rounded umbilical shoulder and faint, irregular, fine ribs and ammonitic suture line. It possibly stands somewhere between *Discotropites acutus* (Mojsisovics) and *Discotropites denudatus* (Mojsisovics). Some poorly preserved specimens in 9871 from the talus south end McLay Spur, resemble the specimen in 9370, but are larger. They are smooth to unevenly striate and some exhibit a faint strigate ornament.

Genus *Styrites* Mojsisovics*Styrites ireneanus* McLearn

Plate VIII, figures 3a, b

Styrites ireneanus McLearn, Can. Field-Naturalist, vol. 54, p. 48, Pl. I, figs. 1, 2 (1940); Geol. Surv., Canada, Paper 47-14, p. 12, Appendix, Pl. III, figs. 2, 3 (1947).

Material. The holotype, GSC 8826, is from the *Styrites ireneanus* zone, west side Juvavites Gully at XII, Pardonet Hill (9663).

Other specimens are in 9659, 9663, 9664, 9671 and 9672, from *Styrites ireneanus* zone and talus.

Measurements. Holotype: 27.5; 51; 22; 16.5.

Description. The holotype, almost entirely preserved as an internal mould, is very compressed, almost moderately involute with high, flattened whorls and abruptly rounded umbilical shoulder. At the posterior end of the ultimate whorl the venter is very narrow and has a small, elevated keel. At the anterior end the venter is wider, a rounded ventral shoulder occurs, the keel is low and small, but still distinct. On the internal mould are very fine irregular folds, rare fine costae or striae and growth lines, convex forward on the sides of the whorl and produced forward near the venter.

A larger specimen, at a diameter of 31 mm, in 9663, has at the anterior end a relatively wide, somewhat flattened ventral area and a rounded ventral shoulder. On the internal mould of the sides are rather indefinite, faint folds, irregular costae or striae and growth lines convex forward. The growth lines and other ornament are somewhat bent forward on the ventral shoulder and cross the keel with a gentle forward arch. At this stage the keel is a low, narrow ridge. At the posterior end of the ultimate whorl the keel is small, but elevated and distinct.

Some specimens are almost smooth except for growth lines and very faint, irregular ornament. In some specimens are fine costae or striae, irregular in size and spacing, to somewhat evenly spaced and best defined on the middle of the side of the whorl. In a few specimens shallow furrows parallel the other ornament.

The suture line is simple and goniatitic, both saddles and lobes are entire. L1 is wide and longer than EL. L2 is much shorter than L1. ES is wide and rounded, S1 is somewhat smaller and S2 is small and close to the umbilical shoulder and apparently better defined than in illustrations of most suture lines of species of *Styrites*.

Comparisons. This species is of the *acuti* group of the genus and resembles *Styrites altus* Mojsisovics, but is larger, the ventral keel is a little less well defined and less elevated and the venter widens at maturity. It is more compressed and more involute than *Styrites collegialis* Mojsisovics and *Styrites niger* (Dittmar) and indeed more so than most species of *Styrites*. It is less involute and more compressed than *Styrites reinischi* Mojsisovics and is more compressed than *Styrites disciformis* Gemmellaro.

Family TROPICELITIDAE Spath
Genus *Tropicelites* Mojsisovics
Tropicelites columbianus (McLearn)

Plate VIII, figures 6a, b

Styrites columbianus McLearn, Can. Field-Naturalist, vol. 54, p. 48, Pl. I, fig. 3 (1940);
Geol. Surv., Canada, Paper 47-14, p. 12, Appendix, Pl. III, fig. 1 (1947).

Material. The holotype, GSC 8827, is from the *Styrites ireneanus* zone, west side Juvavites Gully, at XII, Pardonet Hill (9663).

Other specimens are in 9640, 9659, 9660, 9661, 9662, 9663, 9664, 9671, 9672 and 9719, *Styrites ireneanus* and *Stikinoceras* zones and talus.

Measurements. Holotype: 26.5; 34; 34; 40.

Description. The holotype, mostly of living chamber but lacking the anterior end, is moderately evolute with stout whorls. At the posterior end of the last whorl, thickness is about equal to height, the sides are rounded, the ventral keel is low but distinct, the ventral furrows are shallow, the stout lateral ribs extend a little more than half-way across the sides, are much reduced beyond this, and with the growth lines are curved forward. At the anterior end of the last whorl, height and thickness are about the same, the sides are gently rounded, the venter is almost flat, the ventral shoulder rounded, the keel is somewhat reduced in strength and the lateral ribs are slender and reduced ventrally. Reduced ribs, growth lines and varices of growth are strongly produced forward on the ventral shoulder.

Some specimens are larger than the holotype, up to a diameter of about 38 mm. These larger specimens at the anterior end of the last or ultimate whorl, have compressed whorls higher than thick, have flattened sides, somewhat flattened venter, distinct ventral shoulders, and narrow, slender lateral ribs and reduced ventral keel. Small specimens, for example, at a diameter of about 10 mm, have whorls thicker than high, stout, short ribs on the sides and ventral keels and shallow ventral furrows. Some can best be described as keeled cadicones (*Tropites* stage) but they vary, particularly in degree of depression of whorls.

The shells pass through several stages of development: cadicones of variable proportions; serpenticones with more or less rounded whorl and height equal thickness; serpenticones with more or less flattened venters and with ventral shoulders; and finally compressed, flat-sided whorls with height greater than thickness, with ventral shoulders and more or less flattened venter. The keel weakens in strength and in a few specimens almost entirely disappears. In the earlier stages the ribs are very short. Later they lengthen to stout ribs extending half-way across the side of the whorl and finally they become slender and thin. The stage of growth at which these changes, singly or together, take place, varies, that is, ontogenetic variation occurs. This leads to considerable variation in the specimens.

A specimen in 9663, *Styrites ireneanus* zone, diameter of 24 mm, may be an extreme variant of this species or even a different species. The slender ribs occur on all of the ultimate whorl and are not confined to the anterior end. The penultimate whorl at a diameter of about 12 mm is about as high as thick, not thicker than high; the ribs are longer than in normal specimens at this stage of growth; the sides and venter are rounded. There is no true cadicone stage, so mature characters appear at an early stage of ontogeny.

The suture line is simple and goniatitic, both saddles and lobes are entire, EL is apparently long, ES large, L1 fairly wide, but apparently shorter than EL, S1 is smaller to much smaller than ES, L2 is very shallow and close to the umbilical shoulder and S2 is small, very low, much lower than wide and about on the umbilical shoulder.

Comparisons. The early and inner whorls of this species have a more cadicone shape than those of *Tropiceltites ceciliae* Mojsisovics. It attains a larger size and greater compression at maturity. This species also resembles some of the more ornate species of the *tropitiiformes* group of *Styrites*. *Styrites haugi* Gemmellaro has much shorter ribs at maturity; *Styrites richthofeni* Gemmellaro is more compressed and has shorter ribs on the last whorl.

The Peace River species stands somewhere between the *tropitiiformes* group of *Styrites* and the genus *Tropiceltites*.

Family METASIBIRITIDAE Spath

Genus *Thetidites* Mojsisovics

Thetidites exquisitus (McLearn)

Plate VIII, figures 4a, b, 5a, b

"*Heraclites*" ? *exquisitus* McLearn, Geol. Surv., Canada, Paper 47-14, p. 13, Appendix, p. 1, Pl. V, figs. 1-4 (1947).

Material. The holotype, GSC 9496, is from talus block at XX, west end Pardonet Hill (9782). The paratype, GSC 9497, is from *Himavatites* zone, above XX, west end Pardonet Hill (9781).

Other specimens are in 9759, 9781 and 9782, from *Himavatites* zone and talus.

Measurements. Holotype: 10.2; 39; 37; 33 (very approximate). Paratype: 8.7; 41; 40; 32 (very approximate).

Description. The holotype is a small, moderately involute, almost moderately evolute specimen with stout whorls little higher than thick, almost flat sides, very gently convex almost flat venter, almost angular ventral shoulder and well-rounded umbilical shoulder. On the sides are somewhat stiffly curved ribs, about fifteen per half whorl, a few are more slender than the others, particularly near the anterior end. They project forward at the ventral shoulder. The lateral ribs are

mostly single, but at one place two ribs unite at a ventro-lateral tubercle to form a button-and-loop ornament. In the anterior part of the ultimate whorl the stronger ribs carry bulla-like tubercles on the ventral shoulder. Low ribs, originating at the ventro-lateral tubercle, as well as fine costae and growth lines, are arched forward across the venter. On the ultimate whorl a very faint ventral furrow is bordered on either side by a very low elevation or "keel", where these keels cross the ribs low clavi are formed. The suture line is simple and goniatic and includes a small, short EL, a wide, round and entire ES, a large undivided L1, longer than EL and an entire, rounded S1 on about the umbilical shoulder.

The paratype is similar in form and proportions to the holotype, but has more numerous lateral ribs, about twenty-eight per half whorl. Some ribs are coarser than others and the proportion of coarse to fine ones varies in different parts of the ultimate whorl. Most ribs are single and intercalated, but some branch near the umbilical shoulder. They are stiffly curved and a little convex forward on the sides. Some are expanded and thickened on the umbilical shoulder and a few expand to form tubercles on the ventral shoulder, particularly near the anterior end of the ultimate whorl. Numerous fine ribs or costae of variable strength cross the venter and are arched forward there, some originating in the ventro-lateral tubercles and continuous with the lateral ribs and others intercalated and independent of the lateral ribs. A shallow ventral sulcus or furrow is bordered by very low "keels", thickened where they cross the ventral ribs.

This is a variable species. The ventral furrow is very shallow or replaced by a narrow, flat band. The ventral keels vary from very low ridges to faint, indistinct and discontinuous elevations. The lateral ribs vary in number from fifteen to twenty-eight per half whorl, in proportion of weak to strong ones, in degree of curvature, but mostly stiffly curved to almost straight, and in proportion of single to branching ribs. The ventral tubercles on the ventral keels vary in size and shape, some being clavate. The button-and-loop ornament is not common.

Comparisons. In an earlier report this species was compared with *Heraclites ariciae* Mojsisovics, which it superficially resembles, but the Peace River species is not so involute. The simple suture line precludes inclusion in *Heraclites*. The Peace River species resembles *Ectolcites sidoniae* Diener in form and ornament, but is smaller and more involute and the ventro-lateral tubercles do not disappear at maturity. It cannot be included in *Ectolcites* Mojsisovics, which has a much better defined ventral sulcus and much more distinct ventral keels and a ceratitic or ammonitic suture line.

It is referred to *Thetidites* Mojsisovics, in a broad sense, because of a similar shape of whorl, similar lateral ornament, including, even if rare, button-and-loop ornament, some interruption of ornament on the venter and a simple suture line, even more reduced, however, than in typical species of the genus. It is a small species and if of this genus is a dwarf development.

Family HALORITIDAE Mojsisovics
 Subfamily HALORITINAE Mojsisovics

A great variety of ornament and shape is exhibited by genera and species of the subfamily Haloritinae in the Pardonet formation:

- | | |
|---------------------------------------------------------|----------------------------|
| Ribs continuous across venter | Genus <i>Juvavites</i> |
| <i>Juvavites biornatus</i> | |
| <i>J. magnus</i> | |
| <i>J. mclayi</i> | |
| <i>J. mertoni</i> | |
| <i>Juvavites</i> sp. | |
| Ribs interrupted on venter | Genus <i>Juvavites</i> |
| <i>Juvavites mackenzii</i> | |
| <i>J. schoolerensis</i> | |
| <i>J. cf. subinterruptus</i> | |
| <i>J. selwyni</i> | |
| <i>Juvavites</i> sp. | |
| Periodic constrictions | Subgenus <i>Anatomites</i> |
| <i>Juvavites (Anatomites) cf. brocchii</i> | |
| <i>J. (Anatomites) humi</i> | |
| <i>J. (Anatomites) cf. edithae</i> | |
| <i>J. (Anatomites) sp.</i> | |
| Smooth venter, clavi at end of ribs | Genus <i>Guembelites</i> |
| <i>Guembelites</i> sp. | |
| Eccentric umbilicus of adult whorl | Genus <i>Parajuvavites</i> |
| Reduction of ribs on venter | |
| <i>Parajuvavites cf. buddhaicus</i> | |
| Ribs continuous across venter | |
| <i>Parajuvavites</i> sp. | |
| Numerous, fine ribs form V on round venter | Genus <i>Indojuvavites</i> |
| <i>Indojuvavites cf. angulatus</i> | |
| Compressed, nearly flat venter, numerous very fine ribs | Genus <i>Dimorphites</i> |
| <i>Dimorphites pardonetiensis</i> | |
| <i>Dimorphites</i> sp. | |

Upper Triassic Ammonoids of the Peace River Foothills

Ribbed to costate inner whorls, nearly smooth outer whorls Genus *Gonionotites*

With ventro-lateral ribs

Gonionotites gethingi

G. cf. italicus

G. spiekeri

Without ventro-lateral ribs

Gonionotites belli

Gonionotites sp.

Ventro-lateral tubercles on adult living chamber

Gonionotites sp.

Clavi at ends of faint ribs

G. clavatus

Nearly smooth inner as well as outer whorls

Gonionotites rarus

G. cf. rarus

G. fuscus

Gonionotites sp.

Strigate ornament, with or without reduced ribs Genus *Malayites*

Relative coarse strigation

Malayites dawsoni

M. butleri

M. cf. antipatris

Malayites sp.

Very fine strigation

Malayites parvus

M. custi

M. bococki

Malayites sp.

Small, ribs interrupted on venter Genus *Miltites*

Miltites ? sp.

Ventral keel Genus *Waldthausenites*

Waldthausenites cf. leophanis

Among the specimens referred to *Anatomites*, those listed as *Juvavites* (*Anatomites*) cf. *edithae* have the "externiplicate" pattern of ornament. The species referred to *Dimorphites* have the discoidal, compressed whorls, the distinct ventral shoulder and numerous very fine ribs diagnostic of the genus. Compared

with the genotype, however, the ventral shoulder is more rounded and less angular and no early stage with constrictions has been observed in the specimens in the Pardonet collections.

Gonionotites gethingi, *G. cf. italicus* and *G. spiekeri*, with reduction of lateral ornament on outer whorls, a late stage of ventro-lateral ribs or costae and a narrow venter are the closest of the species in the Pardonet formation to the genotype in the Sicilian fauna. The adult stage of inflated whorl, with increase in width of venter, is not preserved in any of the specimens. The ribs on the inner whorls of *Gonionotites belli* are much coarser than those of the foregoing species and no ventro-lateral rib stage occurs. It may be explained that the stage with ventro-lateral ribs follows that of the ribbed stage by decline of ribs on the side of the whorl, and by preservation of ribs on the ventro-lateral part of the whorl, bordering the venter.

Some poorly preserved specimens among those listed as *Gonionotites* sp. have ribbed inner whorls and smooth or nearly smooth body or living chamber and ventro-lateral tubercles on the living chamber only. No tubercles occur on the phragmocone, that is on the septate inner whorls. These specimens cannot be referred to *Griesbachites* or *Molengraaffites*, if these two genera are to be restricted to comprise species with tubercles or clavi on the phragmocone as well as on the adult living chamber (see Spath, 1951; Kummel in Arkell, *et al.*, 1957). In this restricted sense neither *Griesbachites* nor *Molengraaffites* occurs in the Pardonet faunas.

The species originally described as *Juvavites clavatus* is difficult to place generically. It is here included in *Gonionotites* because the ornament is greatly reduced, the shell is compressed and the venter is narrowly rounded. Clavi, however, occur at the ventral ends of ribs as in *Guembelites*. In that genus, however, reduction in strength of ribs is confined to the anterior end of the ultimate whorl, the whorls are inflated and the venter broadly rounded. No gradation in shape or ornament is observed between the specimens of *Gonionotites clavatus* and species of *Guembelites*. In the Pardonet formation *Gonionotites clavatus* seems to occur at a lower horizon than *Guembelites*, although the two have not been found in the same section.

Gonionotites rarus and *G. fuscus* have only faint surface ornament at any stage of growth. They lack the ventro-lateral ribs or costae of typical species of *Gonionotites*, that is species close to the genotype. In one specimen *G. rarus* is somewhat inflated at the anterior end of the last whorl with increase in width of the venter.

Malayites comprises species with both coarse and fine strigate ornament. Of those with coarse strigation, *Malayites butleri* and *M. cf. antipatris* have well-developed, coarse ribs. *Malayites dawsoni*, however, has finer and more reduced ribs, somewhat as in *Heinrichites* Diener, which has been defined as a *Gonionotites*

with strigation: *M. dawsoni* is retained in *Malayites* in the broad sense. Several species are set apart from these more typical *Malayites* by their extremely fine strigation, namely, *Malayites parvus*, *M. custi* and *M. bococki*. Their reduced ornament suggests *Heinrichites*, but because of the very fine strigation they are not included in that genus. It seems best to place all of these species with strigate ornament in one broad genus *Malayites*.

It may be concluded that some characters are shared by more than one genus of this subfamily and are not exclusive features of any one. Increase in width and flattening of venter at maturity are not confined to *Gonionotites*, for both are found in *Juvavites selwyni*. Reduction of ribs and other ornament on outer whorls, resulting in smooth or nearly smooth adult body chambers, is not confined to *Gonionotites*. Both Mojsisovics (1893) and Smith (1927) include *Juvavites* subgenus *Anatomites* species like *Juvavites (Anatomites) konnincki* Mojsisovics with greatly reduced surface ornament. Similar reduction in ribbing occurs in *Heinrichites* and is marked in the peculiar species group of *Malayites parvus*, *M. custi* and *M. bococki*. Reduction in surface ornament also is found in *Gonionotites clavatus* which appears to have at least one character in common with *Guembelites*. It also occurs in the specimens with ventro-lateral tubercles on the body or living chamber, with some resemblance to *Griesbachites*.

Ventro-lateral tubercles and clavi are not exclusive features of *Griesbachites* and *Molengraaffites* for they are found on the body chamber of some species of *Juvavites*, *Anatomites* and *Gonionotites*. In 1947 McLearn noted that these tubercles appear in different stocks of *Juvavites*. The ventro-lateral tubercles or nodes of *Juvavites selwyni* and *J. (Anatomites) humi* do not require that these species be placed in *Griesbachites* and *Molengraaffites* respectively for the nodes do not appear on the phragmocone. The ventro-lateral tubercles also occur on some specimens referred to *Gonionotites* because of reduction in ribbing, as already noted. This occurrence also does not demand that all these species bearing them be placed in the same genus. It may be noted that the position on the whorl at which the ventro-lateral tubercles or clavi occur is not the same as that of the clavi in *Guembelites*. The one is found where ribs divide and the other at the end of ribs.

Numerous fine ribs are not an exclusive feature of *Indojuvavites*: *Juvavites mclayi* has them but without the chevron pattern on the venter. Even finer and more numerous ribs occur in *Dimorphites* but other characters distinguish this as a distinct genus.

Juvavites biornatus McLearn

Plate XI, figures 4a, b

Juvavites biornatus McLearn, Can. Field-Naturalist, vol. 54, p. 48, Pl. I, fig. 11 (1940); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype, GSC 8838, is from the *Pterotoceras-Cyrtopleurites magnificus* beds, west slope, west spur Brown Hill (9836). Other specimens are

in collections 9820, 9833, 9836, 9848 and 9864 and some are doubtfully identified in 9473, 9739, 9740 and 9866, from *Pterotoceras-Cyrtopleurites magnificus* beds and talus.

Measurements. Holotype: 48; —; —; —: 46; 52; 32.5; 11.5.

Description. The holotype is of moderate size, compressed and involute with gently convex, almost flattened sides, well-defined umbilical shoulder, rounded ventral shoulder and rounded venter except at the anterior end where it is almost flat. In the posterior part of the ultimate whorl are fine, even, elevated ribs, somewhat flexuous on the sides, bent forward a little on the ventral shoulder, arched across the venter and branching near the middle of the sides, a little below it and high up on the sides of the whorl. In the anterior half of the ultimate whorl branching declines and most ribs are single. Some stouter ribs, one or two of which are nearly straight, extend to the umbilical shoulder and several short intercalated ones fall short of it. The ribs number about forty-eight to the half whorl.

The stage of growth varies at which the ornament passes from the branched to single ribs. In some specimens it occurs at an earlier stage than in the holotype and in others at a later stage. The proportion of short ribs to long varies; all ribs may be of the same strength or the short ones may be more slender than the long ones. In most specimens the number of ribs varies from forty-five to fifty per half whorl, but others have finer and more numerous ribs; one specimen has sixty-five. In a few specimens the ribs are almost straight on the sides; in all specimens they are continuous across the venter.

Some specimens are doubtfully referred to this species. They are not, however, of sufficient size to include the diagnostic single rib stage.

Comparisons. The branched ornament resembles that of *Juvavites senni* Mojsisovics, but in that species a stage of single ribs is not attained. The final single rib stage resembles the rib pattern of *Juvavites (Dimorphites ?) weberi* Welter, but in *J. biornatus* this kind of ornament is confined to the anterior part of the ultimate and probably adult whorl.

This species belongs to the *continui* section of the genus in which the ribs cross the venter without interruption.

Juvavites magnus McLearn

Plate IX, figures 1a-c, 2; Plate X, figures 2a, b

Juvavites magnus McLearn, Can. Field-Naturalist, vol. 54, p. 48, Pl. I, fig. 8 (1940); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Juvavites concretus McLearn, Can. Field-Naturalist, vol. 54, p. 113, Pl. I, figs. 3, 4 (1940); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype of *Juvavites magnus*, GSC 8837, is from the *Pterotoceras-Cyrtopleurites magnificus* beds on the west slope of the west spur of Brown

Hill (1936). The holotype, GSC 8818, and the paratype, GSC 8819, of *Juvavites concretus* are from the same beds and locality. Other specimens are in collections 9475, 9836 and 9847, from *Pterotoceras-Cyrtopleurites magnificus* beds and talus.

Measurements. Holotype: 69.5; 52.5; 43; 11.5. Holotype of *J. concretus*: 60; —; —; —: 54.5; 45.8?; 51?; 17. Paratype of *J. concretus*: 70; —; —; —: 66; 48.5; 51.5; 14.5.

Description. The holotype of *Juvavites magnus* is fairly large, moderately compressed and involute, with whorls higher than thick, rounded umbilical shoulder, rounded but poorly defined ventral shoulder, narrow, rounded venter in posterior part of ultimate whorl, and broad, gently rounded venter in anterior part. The ribs are narrow and elevated, gently flexuous on the sides and arched forward a little on the venter. About thirty-six ribs occur on the posterior half of the ultimate whorl and about twenty-four on the anterior half. The ribs branch below and above the middle of the sides of the whorl in the posterior part of the ultimate whorl but are single and increasingly distantly spaced towards the anterior end. Some ribs are long and extend to the umbilical shoulder, others stop short of it.

The specimen that was taken as the holotype of *Juvavites concretus* is smaller than the holotype of *Juvavites magnus*, has stouter and thicker whorls, thicker than high, has a broader venter in the posterior part of the ultimate whorl and is a little less involute. The ribs are similar but fewer; about twenty-five per half whorl on the posterior part of the ultimate whorl, and about eighteen on the anterior part.

The specimen chosen as the paratype of *Juvavites concretus* is about equal in size to the holotype of *J. magnus*, whorls are stouter and thicker, and thicker than high. It has a broad venter and is involute. The whorls, however, are relatively a little higher than those of the holotype of *J. concretus* and are intermediate in this respect between the holotypes of *J. magnus* and *J. concretus*. The ribbing is similar to that of both, but the stage with branching ribs persists longer and is only beginning to pass to the single rib stage.

Although not enough specimens are known to trace a complete transition between the holotype of *J. magnus* and the variants figured as *J. concretus*, the few specimens in addition to the types, suggest that a transition may have existed.

Comparisons. There are two stages of ornament as in *Juvavites biornatus* McLearn. *Juvavites magnus* is much larger, however, and the single rib stage of ornament is only reached after growth to a much larger size. Although no continuous variation is recorded, the two species may be related. The more inflated forms with stouter whorls bear some resemblance to *Juvavites ehrlichi* Hauer, but second stage of ornament is better defined with the ribs much farther apart.

This species is of the *continui* section of the genus in which the ribs cross the venter.

Juvavites mclayi McLearn

Plate XI, figures 5a, b

Juvavites mclayi McLearn, Can. Field-Naturalist, vol. 54, p. 113, Pl. III, fig. 10 (1940).

Material. The holotype, GSC 8792, is from the west part of the south face of McLay Spur (9147).

Measurements. Holotype: 80; —; —; —: 61; 54.5; 44.5; 10.5.

Description. The holotype and only known specimen lacks a part of the living chamber. It is compressed, involute, almost very involute, with whorls higher than thick, somewhat flat sides, gently convex venter and rounded, but distinct umbilical shoulder. In the posterior part of the ultimate whorl, which is mostly if not entirely living chamber, are fine, numerous ribs or costae, dividing and almost straight on the sides and moderately arcuate and continuous across the venter. In the anterior part of the ultimate whorl the surface is poorly preserved, but the ribs are wider and possibly of low relief.

Comparisons. This species is larger than *Juvavites (Anatomites) laevicostatus* Mojsisovics, appears to have a better defined ventral shoulder, passes to coarser but possibly subdued ribs at maturity and lacks constrictions. The ribs are finer and form a more obtuse angle across the venter than those of *Indojuvavites angulatus* (Diener). The shell is not sufficiently compressed to be included in *Dimorphites* Mojsisovics.

As the ribs cross the venter, this species belongs to the *continui* section of the genus.

Juvavites mertoni McLearn

Plate VIII, figures 1a-c, 2

Juvavites mertoni McLearn, Can. Field-Naturalist, vol. 51, p. 130, Pl. I, figs. 14, 15 (1937).

Material. The holotype, GSC 8828, is from talus on south bank Peace River, at Little Parle Pas Rapids (9161). The paratype, GSC 8796, is probably of the same origin.

Description. The holotype is involute, fairly compressed, with gently convex, converging sides, narrow, rounded venter and rounded umbilical shoulders. The surface is covered with very fine, even ribs or costae, which curve forward across the venter and are continuous, although somewhat reduced there. The suture line is unknown.

The paratype is smaller than the holotype and of similar shape and ornament. Some costae, however, are coarser and more elevated than others.

Comparisons. It might have been better if these two, possibly immature specimens, had not been given species names. They show some resemblance to

specimens in collection 9373 doubtfully referred to *Malayites parvus* (McLearn). No strigate ornament, however, is preserved. *Juvavites mertoni* may belong to the *continui* section of the genus.

Juvavites mackenzii McLearn

Plate XI, figures 1a, b

Juvavites mackenzii McLearn, Can. Field-Naturalist, vol. 51, p. 130, Pl. I, fig. 5 (1937).

Material. The holotype, GSC 8829, is from the Peace River Foothills, exact locality unknown. Other specimens tentatively compared with this species are in collection 9373 from talus in Juvavites Gully.

Description. The holotype is a small, involute specimen with stout whorls, rather wide and almost flat venter, rounded ventral shoulders and approximately twenty-five ribs on the last half whorl, which divide on the sides, bend forward a little on the ventral shoulders and do not cross the venter, at least not on the internal mould.

The several specimens in 9373, listed as *Juvavites mackenzii* may be of this species. They are about the size of the holotype and have similar shape and ribs, but have a less flattened venter and not such stout whorls.

Comparisons. This is not a very well established species. It has thinner whorls than *Juvavites otiartis* Diener. As the ribs are interrupted on the venter it belongs to the *interrupti* section of the genus.

Juvavites schoolerensis McLearn

Plate XI, figures 3a, b

Juvavites schoolerensis McLearn, Geol. Surv., Canada, Paper 47-14, p. 11, Appendix, p. 1, Pl. II, figs. 3, 4 (1947).

Material. The holotype, GSC 9488, is from the *Stikinoceras* zone, west slope, west spur of Brown Hill (9854).

Measurements. Holotype: 49; 55; 42; 12.

Description. The holotype is moderately compressed, involute, whorls higher than thick with converging convex sides, rounded, rather narrow venter and rounded umbilical shoulder. Only the internal mould of the phragmocone is preserved. The evenly sized ribs, about thirty-five to the half whorl, mostly divide on the sides, are only gently curved there, are bent forward a little as they approach the venter, which they do not cross. The ammonitic suture line comprises high, indented saddles and long lobes.

Comparisons. This species closely resembles *Juvavites subinterruptus* Mojsisovics, having ribs slightly bent forward on the ventral shoulder, and is of about the same size. Compared with specimens of *J. subinterruptus* from California the ribs on the internal mould are somewhat more angular and less flattened and

the increase in height per whorl appears to be slightly greater. *J. schoolerensis* and *J. kellyi* are both very similar and may be mere variants of the Alpine species. *Juvavites knowltoni* Smith is different, having, for example, coarser ribs.

Juvavites cf. *subinterruptus* Mojsisovics

Plate XX, figures 4a, b

cf. *Juvavites subinterruptus* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 90, Pl. LXXXIX, fig. 13, Pl. XC, figs. 2, 3, Pl. CXXVI, fig. 16 (1893).

Material. The figured specimen, GSC 13482, is from talus at V, Cascades Creek, Pardonet Hill (9686).

Description. The imperfect figured specimen has a diameter of about 56 mm, comprising part of the living chamber, and resembles this species. It has branching ribs on the sides, which are bent forward a little near the venter and are interrupted on the internal mould of the venter.

Juvavites selwyni McLearn

Plate X, figures 1a, b

Juvavites selwyni McLearn, Can. Field-Naturalist, vol. 54, p. 113, Pl. II, fig. 3 (1940).

Material. The holotype, GSC 8820, is from the *Styrites ireneanus* zone, near X, Juvavites Gully, Pardonet Hill (9636).

Measurements. Holotype: 76.5; 55.5; —; 7.8: 62.5; 55.5; 32, 10. Very approximate.

Description. The holotype is fairly large, involute, compressed, whorls higher than thick, and has a rounded umbilical shoulder. In the posterior part of the ultimate whorl the venter is narrowly rounded and the sides gently convex. At the anterior end the venter broadens and flattens and rounded ventral shoulders appear. The ribs are nearly straight in the posterior part of the ultimate whorl and bend forward a little near the venter but do not cross it. They divide on the sides, particularly on the outer part. Ribs and furrows are somewhat uneven in size, curve very little on the sides and slightly forward near the venter in the anterior part of the ultimate whorl. At the very anterior end two or three furrows and ribs cross the venter. Also at the anterior end, some ribs carry low, rather obscure, tubercles on the ventral shoulder.

Comparisons. The inner whorls somewhat resemble those of *Juvavites subinterruptus* Mojsisovics, but they are more compressed and the flattened venter and faint tubercles on the ventral shoulder at maturity are unknown in Mojsisovics' species. At an equivalent stage of growth, the whorls of *Juvavites schoolerensis* McLearn are not so compressed and the ribs not so stiffly curved. Compared with *Juvavites chamissoi* Mojsisovics, the ribbing is not so much reduced at maturity and the ventro-lateral tubercles are not so well defined.

As the tubercles are weak and appear very late in the growth, this species is not included in *Griesbachites*. Because of the interruption of the ribs on the venter it is placed in the *interrupti* section of *Juvavites*.

Juvavites sp.

Material. In collections 9161, 9373, 9375, 9469, 9475, 9655, 9662, 9663, 9691, 9699, 9719, 9740, 9755, 9765, 9815, 9821 and 9835, from *Stikinoceras* and *Styrites ireneanus* zones and talus.

Description. Some specimens are listed as *Juvavites* sp. In some the ribs cross the venter and in others the ribs are interrupted on the venter, at least on the internal mould. They represent many different species but are too immature or too poorly preserved for specific identification.

Subgenus *Anatomites* Mojsisovics

Juvavites (Anatomites) cf. brocchii Mojsisovics

Plate XII, figures 6a, b

cf. *Juvavites (Anatomites) brocchii* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Halfte, p. 104, Pl. XC, fig. 10 (1893).

Material. The figured specimen, GSC 12597, is from the *Pterotoceras-Cyrtopleurites magnificus* beds on the west slope of the west spur of Brown Hill (9836). A second specimen is in 9739, probably from same horizon on Black Bear Ridge.

Measurements. Figured specimen: 42; 57; 44; 12.

Description. The figured specimen is of moderate size, involute, somewhat compressed with whorls higher than thick, gently convex sides, rounded ventral shoulders, arched venter and rounded umbilical shoulders. The ribs are little curved on the sides and cross the venter with hardly any forward bend. They divide near the middle or outside the middle of the sides. Some deep and wide constrictions cross the venter.

The specimen in 9739 closely resembles the figured specimen. It has similar shape, ribbing, and constrictions.

Comparisons. The two specimens are placed in *Anatomites* because of the constrictions. They are also of a species with ribs continuous across the venter. The shells are more compressed than those of *Juvavites (Anatomites) brocchii* Mojsisovics and *Juvavites (Anatomites) brocchiiformis* Welter and have even less curvature of the ribs.

Juvavites (Anatomites) humi McLearn

Plate XI, figures 2a-c; Plate XII, figures 3a, b, 4a, b

Juvavites (Anatomites) humi McLearn, Can. Field-Naturalist, vol. 51, p. 130, Pl. I, fig. 4 (1937); Geol. Surv., Canada, Paper 47-14, p. 11, Appendix, Pl. II, fig. 5 (1947).

Juvavites (Griesbachites) caurinus McLearn, Geol. Surv., Canada, Paper 47-14, p. 11, Appendix, p. 1, Pl. II, fig. 6 (1947).

Material. The holotype, GSC 8799, is from a general collection on the west slope of the west spur of Brown Hill (9157). The holotype of *J. (Griesbachites) caurinus*, GSC 9489, is from the *Stikinoceras* zone, west slope of west spur of Brown Hill (9851). The hypotype, GSC 9511, is from the *Stikinoceras* zone at III, east of Cascades Creek on Pardonet Hill (9719).

Other specimens are in 9481, 9719, 9851 and 9854, from *Stikinoceras* zone.

Measurements. Holotype: 24.5; —; —; —: 23; 56.5; 45.5; 7.8. Hypotype: 45; 56; 33; 9.3. Holotype of *J. (Griesbachites) caurinus*: 56; —; —; —: 50.5; 55.5; 35.5; 10.5.

Description. The holotype, a small, immature specimen, is a poor choice for a type. It is very involute and compressed, with convex sides, gently rounded venter and rounded umbilical shoulder. The ribs divide on inner and outer parts of the sides of the whorl, curve forward near the venter but do not cross it. Some furrows between the ribs are deeper and wider than others, cross the venter and are the constrictions typical of *Anatomites*. The ammonitic suture line includes a deep ES and long EL.

The hypotype is much larger than the holotype, is involute, almost very involute, and compressed with whorls higher than thick, rather narrow, rounded venter, very gently rounded, converging sides, poorly defined, rounded ventral shoulder and rounded umbilical shoulder. About three quadrants of the ultimate whorl are living chamber, but all of that chamber is not preserved. The narrow but rather prominent ribs are convex forward on the sides and curve forward on the ventral shoulders. They divide on both the inner and outer parts of the sides of the whorl, do not cross the venter and number about thirty per half whorl. The constrictions are wider and deeper than the ordinary furrows between the ribs, but do not cross the venter. EL is long, ES high, L1 as long as EL, S1 much smaller than ES, L2 smaller and much shorter than L1, and S2 much smaller than S1. Two auxiliary saddles occur between S2 and the umbilical shoulder. Saddles and lobes are moderately indented.

The holotype of *caurinus* is larger than the hypotype but is involute and has similar shell proportions. The whorls are much higher than thick, gently convex and with almost flattened sides, rounded ventral shoulders, rounded venter and rounded umbilical shoulders. The ornament of the posterior part of the ultimate whorl is not well preserved. In the anterior half the ribs divide near the middle of the sides of the whorl and again on the ventral shoulder. Faint tubercles appear at the outer point of division of the ribs. The ventral ribs number about thirty-five on the last half of the ultimate whorl. Some wide and deep furrows occur but they are not *Anatomites* constrictions as they do not cross the venter. No ribs cross the venter. The close resemblance of *caurinus* to *humi* was noted by McLearn in 1947.

This is a variable species, particularly in ornament. The short ventral ribs and ventro-lateral tubercles are not present in all specimens, but where they do occur it is at a late, presumably mature stage; they appear, however, at an earlier stage in some specimens than in others. The constrictions cross the venter in some small specimens. Because of the faintness of the tubercles and their occurrence at maturity only, this species is placed in *Anatomites* and not in *Griesbachites* or *Molengraaffites*.

Comparisons. This species has been compared with *Juvavites (Anatomites) herbichi* Mojsisovics. There is some similarity of the inner whorls, but they are more compressed and the ribs are more strongly curved forward on the ventral shoulders than in Mojsisovics' species.

Juvavites (Anatomites) cf. edithae Mojsisovics

Plate XIX, figures 6a, b

cf. *Juvavites (Anatomites) edithae* Mojsisovics, Abh. Geol. Reichsanst., Wien, VI Band, II Hälfte, p. 133, Pl. XCIII, figs. 6, 7 (1893).

Material. The figured specimen, GSC 13484, is from the *Styrites ireneanus* zone near XI in Juvavites Gully, Pardonet Hill (9640).

Other specimens are in 9640, 9652, 9663, 9719, 9854 and 13522, from *Stikinoceras* and *Styrites ireneanus* zones and talus.

Description. These specimens are probably not all of the same species. They resemble the more compressed, more or less flat-sided species of the *intermittens* group of *Anatomites*, like *Juvavites (Anatomites) externiplicatus* Mojsisovics, *Juvavites (Anatomites) edithae* and *Juvavites (Anatomites) loczyi* Gemmellaro. Exact identification is not justified, however, because they are all small and immature.

Juvavites (Anatomites) sp.

Material. In collections 9157, 9638, 9658, 9663, 9718, 9873 and 10762, from *Styrites ireneanus* zone, etc., and talus.

Description. Some specimens with constrictions and probably of subgenus *Anatomites* are too small and immature or too imperfectly preserved for identification of species or for description as new species.

Genus *Guembelites* Mojsisovics

Guembelites sp.

Plate XII, figures 2a, b

Material. The figured specimen, GSC 12599, is from the *Pterotoceras-Cyrtopleurites magnificus* zone, west slope of the west spur of Brown Hill (9836).

Description. The only specimen is a fragment of the living chamber of a stout-whorled species of which the whorl is about as wide as thick. The poorly preserved surface appears to be covered with low, reduced ribs. The somewhat flattened venter is bordered on either side by low, but stout clavi, about six to the quadrant, alternating on either side.

Comparisons. This fragment of a typical *Guembelites* shows considerable resemblance to *Guembelites jandianus* (Mojsisovics). The ventral clavi, however, are more widely spaced.

Genus *Parajuvavites* Mojsisovics

Parajuvavites cf. *buddhaicus* Mojsisovics

cf. *Parajuvavites buddhaicus* Mojsisovics, Pal. Indica, ser. XV, vol. III, pt. 1, p. 31, Pl. VIII, figs. 1-5 (1901).

Material. In *Himavatites* zone, Sikanni Chief River, below mouth of Chicken Creek (10739).

Description. The best specimen has a diameter of 53 mm, is crushed on one side, and the anterior end is missing. The posterior end of the ultimate whorl is a little higher than thick with rounded sides and venter and with an indistinct band on the venter. The numerous fine ribs are nearly straight on the sides, bend forward very little and finally disappear as they approach the venter. The anterior part of the same whorl is compressed, but this may be due in part to the crushing of this part of the specimen. The ribs are fine here and bend forward a little as they approach the venter. There is some umbilical enlargement at this stage.

Comparisons. There is some resemblance to *Parajuvavites buddhaicus* Mojsisovics, but the crushing of the specimens does not admit of exact comparison.

Parajuvavites sp.

Plate XII, figures 1a, b

Material. The figured specimen, GSC 12600, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741).

Measurements. Figured specimen: 33.5; 47.7; 35.8; 19.

Description. The thickness at the posterior end of the ultimate whorl is about equal to the height, and the sides and venter are rounded. The height of whorl is greater than the thickness at the anterior end, the sides are flattened, the ventral shoulder is very distinct and the venter fairly narrow and only gently convex. There is umbilical enlargement at this stage. The ribs on the internal mould are slender and bent forward on the sides and cross the venter.

Comparisons. This species resembles *Parajuvavites mercedis* (Mojsisovics) in the continuity of the ribs across the venter. It is, however, smaller and more

compressed. In typical species of the genus like *Parajuvavites blanfordi* Mojsisovics and *Parajuvavites buddhaicus* Mojsisovics, the ribs are interrupted on the venter, at least on the living chamber at maturity.

Genus *Indojuvavites* Diener

Indojuvavites cf. *angulatus* (Diener)

Plate XII, figures 5a, b

cf. *Juvavites angulatus* Diener, Pal. Indica, ser. XV, vol. V, Mem. 3, p. 115, Pl. XXI, figs. 4-8 (1908).

Material. The figured specimen, GSC 12601, is from west of a shallow gully, at south end McLay Spur (9873).

Description. The figured and only specimen comprises about half an ultimate whorl, including the anterior quadrant. Whorl is much higher than thick. The ribs are fine, numerous, almost straight on the sides, curved forward as they approach the venter, which they cross and meet at an angle of about 90 degrees.

Comparisons. This shell is more compressed and has a narrower venter than *Indojuvavites angulatus* (Diener)

Genus *Dimorphites* Mojsisovics

Dimorphites pardonetiensis (McLearn)

Plate XVI, figures 1a-c, 2a, b

Juvavites (*Dimorphites* ?) *pardonetiensis* McLearn, Can. Field-Naturalist, vol. 54, p. 48, Pl. I, fig. 13 (1940); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype, GSC 8833, is from the *Stikinoceras* zone, west slope of the west spur of Brown Hill (9481). The hypotype, GSC 12602, is from the same zone at III, east of Cascades Creek, Pardonet Hill (9719).

Other specimens are in 9147, 9157, 9477, 9719 and 9854, *Stikinoceras* zone and talus.

Description. The holotype consists of less than one-half whorl of internal mould of the living chamber. It is very compressed, the sides of the whorl only slightly convex, the ventral shoulder rounded and the venter narrow and nearly flat. The umbilicus is poorly preserved, but is small and the umbilical shoulder is round. The ribs are slender and round, in places bifurcating, slightly convex on the sides, produced forward on the ventral shoulder and interrupted on the internal mould of the venter.

The hypotype is much smaller than the holotype. Only a small part of the living chamber remains. It is very compressed, very involute, with gently rounded sides, rounded ventral shoulder and narrow, almost flat venter, very small umbilicus and rounded umbilical shoulder. The numerous, slender ribs, about sixty to the half whorl, are a little convex forward on the sides, produced forward

near the venter, in places bifurcate, and interrupted on the core of the venter. The moderately indented suture line includes a fairly large ES, a somewhat smaller S1, a much smaller S2, two small auxiliary saddles with possibly space for a third, a wide EL, a long L1 with three lobules at the base, a smaller L2 and small auxiliary lobes.

Most specimens are flattened and distorted so that variation in form cannot be determined, and some are small and immature. The ribs vary from about fifty to seventy per half whorl. The ventral shoulder appears to be fairly well defined in most specimens, but is angular in none. Too little is known of the shell to determine whether or not the ribs are interrupted on the venter on the surface of the shell.

Comparisons. This species lacks the angular ventral shoulder, the flat ribs and constricted inner whorls of *Dimorphites selectus* Mojsisovics. Apparently the ribs do not cross the venter, at least not on the internal mould. It is much more involute than *Dimorphites apertus* Mojsisovics. The ribs are narrower and more rounded and mostly greater in number than those of *Juvavites (Dimorphites) mariae* Gemmellaro, a fairly close species, however.

This species lacks the angular ventral shoulder of typical *Dimorphites* Mojsisovics. A ventral shoulder is present, however, and the shell is similarly compressed.

Dimorphites sp.

Material. In 9475 and 9477, from talus on the west slope of the west spur of Brown Hill and probably from the *Stikinoceras* zone; and in 9815 in talus on West Glacier Spur, possibly from the *Stikinoceras* zone.

Description. A few specimens are not so compressed as those of *Dimorphites pardonetiensis* (McLearn) and have fewer ribs per half whorl.

Genus *Gonionotites* Gemmellaro

Gonionotites gethingi (McLearn)

Plate XIII, figures 3, 4a, b

Juvavites (Gonionotites) gethingi McLearn, Geol. Surv., Canada, Paper 47-14, p. 12, Appendix, p. 1, Pl. III, figs. 4-5 (1947).

Material. The holotype, GSC 9490, is from the *Styrites ireneanus* zone, west side of Juvavites Gully, at about XI, Pardonet Hill (9640). The paratype, GSC 9491, is from the same zone and collection.

Other specimens are in 9636, 9640 and 9659, from *Styrites ireneanus* zone.

Measurements. Paratype: 52.5; 55.5; 26.5; 7.0.

Description. The holotype is compressed, very involute, with narrow, rounded venter, small umbilicus and rounded, umbilical shoulder. The ultimate whorl, not quite complete, is all living chamber. The posterior part of this whorl

has fine ribs, nearly straight on the sides, with some pronounced furrows between them. The ribs are more numerous on the ventral shoulder, and are curved forward. The anterior part of this whorl is nearly smooth, except for fine ribs on the ventral shoulder.

The paratype is somewhat larger than the holotype, is similarly very compressed and very involute and has a narrow, rounded venter, a small umbilicus and rounded umbilical shoulders. The ultimate whorl is entirely of living chamber. The side of the whorl carries faint, irregular ribs with, in places, shallow furrows between them, and the ventral shoulder bears more numerous fine ribs or costae, all declining at the anterior end.

Some variation occurs in strength of ornament, but all specimens have irregular ribbing, with faint furrows on the sides and more distinct fine ribbing or costae on the ventral shoulder.

Comparisons. The surface ornament is more distinct than that of *Gonionotites rarus* (McLearn). The faint constrictions and the "externiplicate" ventral ornament recall the ornament of the *intermittens* species section of *Anatomites*, but the constrictions are not so regularly spaced, do not cross the venter, and the shell passes finally to a smooth stage. The lateral ornament of the inner whorls somewhat recalls that of *Gonionotites clavatus* (McLearn), which, however, lacks the ventro-lateral ribbing and has ventral clavi. In *Gonionotites italicus* Gemmellaro, the ventro-lateral ornament extends to a much later stage of growth.

Gonionotites cf. *italicus* Gemmellaro

Plate XX, figure 3

cf. *Gonionotites italicus* Gemmellaro, Giorn. Sci. Nat. Econ. Palermo, vol. 24, p. 158, Pl. V, figs. 6, 7, Pl. IX, figs. 6, 7, Pl. XXI, figs. 4-6, Pl. XXX, fig. 8 (1904).

Material. The figured specimen, GSC 13483, is from the *Styrites ireneanus* zone, at about XI, Juvavites Gully, Pardonet Hill (9640).

Description. A specimen of a phragmocone with a diameter of about 63 mm resembles this species. It is compressed, very involute with converging sides and narrow, rounded venter. The posterior part of the ultimate whorl is poorly preserved, but apparently has a faint ribbing on the sides of the whorl. The anterior part of the ultimate whorl has smooth sides. All of the same whorl has the ventro-lateral ornament of short fine ribs or coarse costae on the outer part of the sides and bordering the venter.

Gonionotites spiekeri (McLearn)

Plate XIV, figures 1a-c

Juvavites (*Gonionotites*) *spiekeri* McLearn, Can. Field-Naturalist, vol. 51, p. 130, Pl. I, fig. 13 (1937); Geol. Surv., Canada, Paper 47-14, p. 12 (1947).

Material. The holotype, GSC 8807, is from a general collection from the west slope of the west spur of Brown Hill (9157).

Specimens from 9686, talus at V, Cascades Creek and from 9698, talus at Little Parle Pas Rapids, Pardonet Hill, are also referred to this species. These specimens are from the lower part of the Pardonet beds and probably somewhere from *Stikinoceras* to *Styrites ireneanus* zones inclusive.

Measurements. Holotype (penultimate whorl): 35; 63; 34; 8.

Description. The holotype comprises a quadrant of phragmocone enclosing about three quadrants of an inner (penultimate) whorl. The inner or penultimate whorl is very compressed, discoidal, involute, almost very involute with almost flattened sides, well-rounded ventral shoulders, rounded narrow venter and small umbilicus. Very fine costae cover the sides and are arcuate across the venter. Some lateral costae are coarser than others. The ammonitic suture line has high saddles and long lobes with rather long indentations. The large quadrant preserved of the ultimate whorl is septate, compressed, almost very involute with gently convex, rather flattened, converging sides, well-rounded ventral shoulders and narrow, rounded venter. The sides of this whorl are apparently smooth. The ventro-lateral ornament of short fine ribs or costae on the ventral shoulder apparently persists to the anterior end of this specimen.

Specimens in 9698 are similar to the discoidal, finely costate penultimate whorl of the holotype, but are more evenly costate on the sides. The specimen in 9686 is poorly preserved, but is discoidal and finely costate.

Comparisons. Compared with the genotype of *Gonionotites*, that is *Gonionotites italicus* Gemmellaro, the inner whorls are more discoidal in shape and have finer ornament. Compared with *Gonionotites discus* Gemmellaro, the inner whorls are even more discoidal in shape, the ornament is even finer and the ventro-lateral ornament persists to a later stage of growth.

Gonionotites belli (McLearn)

Plate XIV, figures 2a-c

Juvavites (*Gonionotites*) *belli* McLearn, Can. Field-Naturalist, vol. 54, p. 114, Pl. I, fig. 5 (1940).

Material. The holotype, GSC 8834, is from a general collection from the west slope of the west spur of Brown Hill (9157).

Other specimens are in the *Gonionotites belli* beds on the west slope of the west spur of Brown Hill (9845).

Measurements. Holotype: 70±; —; —; —: 32.5; 51; 50; 7.5.

Description. The holotype comprises a little more than a quadrant of an ultimate or outer whorl, entirely of living chamber and most of a penultimate whorl. The penultimate whorl is a little higher than thick, is very involute, has rounded converging sides, well-rounded ventral shoulders and rounded venter. Numerous bifurcating ribs are nearly straight on the sides, curved forward a little on the ventral shoulders and apparently weakened rather than actually interrupted on the venter. The outer quadrant is more compressed than the

penultimate whorl, being much higher than thick, has convergent sides and narrowly rounded venter and is nearly or completely smooth. The suture line of the penultimate whorl is ammonitic with moderately indented lobes and saddles, with deep ES and S1, and long L1.

Two specimens in 9845 are close enough to be included in this species. The smaller, at a diameter of about 30 mm, is much like the penultimate whorl of the holotype. It is a little more compressed and the forward curvature of the ribs on the ventral shoulder may be a little greater. A second and larger specimen is closer to the holotype in size. The posterior part of the penultimate whorl is much like the penultimate whorl of the holotype and much like the smaller specimen in 9845. In the anterior part of this whorl, however, the ribbing becomes reduced and less regular. The imperfect ultimate whorl is compressed, like that of the holotype, and is nearly smooth except for varices of growth and faint, uneven ridges.

Comparisons. The ribbed inner whorls, the reduced ornament of the outer whorl, and the narrowing of the venter of the same whorl are typical of *Gonionotites* Gemmellaro. *Gonionotites belli* does not, however, show the broadening of the venter at maturity, but the anterior end of the living chamber is obviously not preserved in the specimens collected.

Compared with *Gonionotites spiekeri* (McLearn), the inner whorls are not so compressed and have much coarser ribs, and the adult whorl lacks the ventro-lateral short, fine ribs. Compared with *Gonionotites maurolicoi* Gemmellaro, the inner whorls are more compressed, have somewhat coarser ribs and no stage of ventro-lateral ribs is known. The inner whorls somewhat resemble those of *Gonionotites* n.f. ind. ex. aff. *Gonionotites maurolicoi* Gemmellaro.

Gonionotites clavatus (McLearn)

Plate XIII, figures 1, 2a, b

Juvavites clavatus McLearn, Trans. Roy. Soc. Can., 3rd ser., sec. 4, vol. 33, p. 51, Pl. I, fig. 6 (1939); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype, GSC 9408, is from the *Styrites ireneanus* zone, near XI in Juvavites Gully, Pardonet Hill (9640). The hypotype, GSC 12598, is from the same horizon, in Juvavites Gully, Pardonet Hill between XI and XII (9661).

Other specimens are in the *Styrites ireneanus* zone in 9640, 9659 and 9672, in the *Stikinoceras* zone in 9719 and in 9725, talus probably of *Stikinoceras* zone.

Measurements. Holotype: 97.5; 56.5; 30+; 8.2.

Description. The holotype, of which only a part of the ultimate whorl and probably only part of the living chamber are preserved, is large, compressed, very involute, with moderately convex sides, very narrow, smooth venter and well-defined, rounded umbilical shoulder. In about the third quadrant of the

ultimate whorl a few, very low, indistinct ribs are nearly straight on the sides and curved forward near the venter. The anterior part of this whorl is smooth except for a few broad, low folds. The very narrow, smooth venter is bordered by large clavi which are not opposite but alternating.

The hypotype, at a diameter of about 50 mm and at an earlier stage of growth than the holotype, is compressed, very involute and with narrow venter. In the posterior part of the ultimate whorl, rather slender, evenly sized ribs of low relief are almost straight on the sides, curved forward near the venter, and some are thickened at their ventral ends. In the anterior part of the same whorl the ribs are also of low relief, reduced, nearly straight on the sides, curved forward near the venter and some end in clavi, bordering the venter.

A fragment of a large specimen in 9719 and so from the *Stikinoceras* zone is undoubtedly of this species, for it bears the typical ventral clavi.

The suture line is preserved in specimens in 9719 and 9725 from the *Stikinoceras* zone, is ammonitic with moderately indented lobes and saddles. The wide EL bears a large ventral saddle. There is a long L1, shorter L2 and about three auxiliary lobes. ES is higher than thick, S1 and S2 are smaller than ES and there are possibly three auxiliary saddles.

An examination of about eighteen specimens, none of them very well preserved, shows that finely ribbed inner whorls pass to almost smooth outer whorls. The ribs pass from a stage with little forward curvature to one with distinct forward curvature near the venter of outer whorls. Also with growth, the ribs thicken at their outer ends and finally distinct ventral clavi form. The stage at which these changes occur varies from one specimen to another, so that the variation is mainly ontogenetic. Shallow furrows appear between some ribs, but for the most part can hardly be called constrictions.

Comparisons. This species is difficult to place in any genus so far recognized. It is included in *Gonionotites* because the ribs are much reduced on outer whorls and because of the shape of the whorl. The clavi at the ends of the ribs recall the genus *Guembelites*. It differs from any known species of *Gonionotites*, none of which has ventral clavi.¹

Gonionotites rarus (McLearn)

Plate XV, figures 2a, b, 3a-c

Juvavites (*Gonionotites*) *rarus* McLearn, Can. Field-Naturalist, vol. 54, p. 114, Pl. III, fig. 5 (1940); Geol. Surv., Canada, Paper 47-14, p. 12, Appendix, Pl. II, fig. 7 (1947).

Material. The holotype, GSC 8830, is from the *Stikinoceras* zone, west slope of west spur of Brown Hill (9854). The hypotype, GSC 9512, is from the same horizon and locality.

¹ Silberling (1959) in a valuable monograph, issued while this memoir was in the press, states that in collections from the Union district of Nevada a continuous variation occurs between *Gonionotites clavatus* and *Guembelites jandianus* Mojsisovics and places *G. clavatus* in the genus *Guembelites*. This range of variation is not recorded by the Peace River specimens probably because there are too few of them.

Other specimens are in 9698, 9719, 9722 and 9849, from *Stikinoceras* and *Malayites* beds, west slope of west spur of Brown Hill and from *Stikinoceras* zone and talus, Pardonet Hill.

Measurements. Hypotype: 66; 56; 25; 4.

Description. The holotype is compressed, very involute, with converging sides, very narrow, rounded venter and very small umbilicus. A large part of the ultimate whorl is living chamber and at the very anterior end the venter widens and becomes nearly flat. The specimen is mostly internal mould, but the shell was evidently almost smooth except for nearly straight varices of growth on the sides which bend forward a little near the venter. The ammonitic suture line has squat saddles with very small indentations. ES is wide, L1 about as long as EL and L2, auxiliary lobes very small. S2, S1 and auxiliary saddles are small.

The hypotype is smaller than the holotype and comprises more than half a whorl of which about one quadrant is of the posterior part of the living chamber. It is compressed, very involute, with very narrow and rounded venter and very small umbilicus. The specimen is too small to have reached a stage of widened venter as in the holotype. The surface is smooth. The suture line closely resembles that of the holotype.

Specimens in 9719 closely resemble the type specimens in shape, suture line and lack of ornament. One is relatively thicker. Small specimens of the inner whorls show only faint costae or striae or varices of growth. Specimens in 9698 are also close in shape and suture line. The inner whorls show only faint irregular costae or striae. Specimens in 9722 have the compressed, very involute shell with very small umbilicus and almost smooth surface.

The small specimen in 9849 has the diagnostic characters of this species, but shows what appear to be faint furrows on the sides, which do not, however, cross the venter.

Comparisons. This species differs from those previously described and from typical *Gonionotites*, in having smooth or nearly smooth inner whorls as well as smooth outer whorls. It resembles *Gonionotites irmintrudis* Diener of which unfortunately only a drawing is recorded. Diener's species is similarly very involute and apparently has similar smooth, outer whorls. If his species attains a stage of widened venter, it must do so at a later stage of growth.

Gonionotites cf. *rarus* (McLearn)

Plate XX, figures 1a, b

Material. The figured specimen, GSC 13485, is from the *Stikinoceras* zone, at III, east of Cascades Creek, Pardonet Hill (9719). Other specimens are in 9719 and 9854, from *Stikinoceras* zone.

Description. These specimens are compressed, involute, with narrow, rounded venter and smooth or almost smooth surface. They resemble specimens of *Goniono-*

tites rarus (McLearn) very closely, but have a much more complex suture line, with deeply indented lobes and saddles.

Gonionotites fuscus (McLearn)

Plate XV, figures 1a, b; Plate XVI, figures 3a, b

Juvavites (*Gonionotites*) *fuscus* McLearn, Can. Field-Naturalist, vol. 54, p. 114, Pl. I, fig. 1 (1940); Geol. Surv., Canada, Paper 47-14, p. 12 (1947).

Material. The holotype, GSC 8835, is from a talus block near V, near Cascades Creek, Pardonet Hill (9722). The hypotype, GSC 12603, is from talus block on west slope, west spur of Brown Hill (9859). Another specimen is in 9722.

Measurements. Holotype: 50; 49; 31; 12; taken at beginning of last quadrant.

Description. The holotype is a compressed, involute specimen, with nearly flat sides, rounded venter, round, ventral shoulder and almost angular umbilical shoulder. The internal mould is nearly smooth, but very faint, irregular, fine ribs or costae and furrows are visible and are curved forward on the ventral shoulder.

The hypotype is smaller than the holotype and has slightly more rounded sides. It has, however, the typical, almost angular umbilical shoulder and the faint irregular costation on the internal mould. The figured suture line is incomplete, but shows rather low saddles with very short indentations, an ES much larger than S1, and L1 about as long as EL.

The second specimen in 9722 is smaller than the holotype, but similar in form and ornament.

It is probable that a specimen in 9144, from talus on the north bank of Peace River below Jewitt Spur, at a diameter of 30 mm, represents the inner whorls of this species. It is compressed, involute, has an almost angular umbilical shoulder and faint ornament on the internal mould.

Comparisons. This species can be readily separated from *Gonionotites rarus* by the flatter sides, wider umbilicus and angular umbilical shoulder. The form somewhat suggests a *Malayites*, but no strigation is preserved on the known specimens.

Gonionotites sp.

Material. In 9469, 9481, 9640, 9663, 9672 and 9719 from *Stikinoceras* and *Styrites ireneanus* zones.

Description. A specimen in 9663, from the *Styrites ireneanus* zone, at a diameter of about 45 mm, has rather fine, low ribs on the posterior part of the last whorl and greatly reduced ribbing at the anterior end. The ribbing declines at an earlier stage than in *Gonionotites belli*.

A specimen in 9719 from the *Stikinoceras* zone, at a diameter of about 50 mm has well-defined ribs and constrictions on the posterior part of the ultimate whorl. The anterior part of this whorl is crushed, but appears to have been smooth.

A large, but imperfect specimen in 9640, from the *Styrites ireneanus* zone, includes part of a penultimate whorl, with coarse ribs interrupted on the venter and part of a smooth, ultimate whorl. The penultimate whorl has coarser ribbing than *Gonionotites belli* (McLearn) and is not so compressed.

A specimen in 9469, from Stelck Ridge, has inner whorls with well-defined ribs interrupted on the venter and apparently a smooth ultimate whorl, now, however, distorted by pressure.

A very large but poorly preserved specimen in 9672, from the *Styrites ireneanus* zone, at a diameter of about 140 mm, has ventro-lateral ribs at the posterior end of the ultimate whorl and is almost smooth at the anterior end of this whorl, which is mostly living chamber.

Poorly preserved specimens in 9481 from the *Stikinoceras* zone, and in 9640 and 9663 from the *Styrites ireneanus* zone, have ribbed inner whorls without ventro-marginal nodes and smooth or almost smooth living chambers with ventro-marginal nodes. These cannot be assigned to the genus *Griesbachites* and are included in *Gonionotites*.

Genus *Malayites* Welter

Malayites dawsoni McLearn

Plate XVII, figures 7, 8a, b

Malayites dawsoni McLearn, Can. Field-Naturalist, vol. 51, p. 130, Pl. I, fig. 16 (1937); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype, GSC 8836, is from talus on river bank, north side Peace River, near Jewitt fault (9556). The hypotype, GSC 12604, is from talus at approximately the same locality (9467).

Other specimens are in 9463, 9467, 9556 and 9832, comprising talus from near the Jewitt fault on the river bank and talus from the west slope, west spur, Brown Hill.

Measurements. Holotype: 48; —; —; —: 42; 53.3; 39; 9.

Description. The greater part of the holotype is septate, that is of the phragmocone, but a short section of crushed living chamber is preserved. It is compressed, involute, almost very involute, with gently convex, converging sides, narrow, rounded venter, well-rounded ventral shoulders and rounded, but well-defined umbilical shoulder. Fine ribs of low relief are nearly straight on the sides and curve forward on the ventral shoulder. Ribs are more numerous on the venter and ventral shoulders than on the sides due to bifurcation or intercalation of ribs. In addition there are fine, numerous, strigate costae of low relief. The suture line is moderately complex with fairly deep indentations.

The hypotype is smaller but of similar shape and ornament. The saddles of the suture line are fairly long and moderately indented.

Comparisons. This species appears to be close to *Malayites brouweri* Pakuckas of which it may be only a subspecies. It is more compressed, the venter is more narrowly rounded and the suture line a little more indented. The ribs are probably more reduced. Compared with *Malayites indomalayicus* Welter, the shell is a little more compressed and the ribs are somewhat more reduced. The ribs are less reduced than in *Heinrichites paulckeii* Diener and are more bent forward near the venter. The species is retained in *Malayites* in a broad sense.

Malayites butleri (McLearn)

Plate XVII, figures 5, 6a, b

Juvavites (Malayites) butleri McLearn, Can. Field-Naturalist, vol. 54, p. 114, Pl. II, fig. 5 (1940).

Material. The holotype, GSC 8840, is from talus, west slope, west spur, Brown Hill (9832). The hypotype, GSC 12605, is from talus near V, upper part Cascades Creek, Pardonet Hill (9722). Other specimens are in 9722 and 9859, from talus.

Measurements. Holotype: 58.5; —; —; —: 50; 52; 35±; 16.

Description. The holotype, including one whorl of living chamber, is compressed, involute, almost moderately involute, with almost flat, converging sides, narrow, rounded venter, well-rounded ventral shoulder and rounded, but well-defined umbilical shoulder. The low, but well-defined, numerous ribs are nearly straight on the sides, curve forward on the ventral shoulder and are continuous across the venter. They increase in number ventrally by intercalation and bifurcation, so that they are much more numerous on the venter than on the sides. The ribs decline somewhat in strength towards the anterior end of the ultimate whorl. They are crossed by a strigate ornament of very numerous, fine costae, flatter and wider on the sides of the whorl than on the venter.

The rather simple suture line of the hypotype includes an ES higher than wide with small indentations, an S1 a little smaller than the ES with small indentations, an S2 much smaller than S1 with very small indentations, an EL longer than wide, and L1 with few indentations, and an L2 much shorter than L1 with few indentations.

Comparisons. The ribs are coarser and better defined than those of *Malayites dawsoni* McLearn, the shell is not so involute and the suture line is simpler with somewhat smaller indentations and smaller L2.

Compared with *Malayites brouweri* Pakuckas, the shell is larger, more compressed and less involute, the ribs are coarser, and the suture line is as simple, but possibly with shorter L2. Compared with *Malayites indomalayicus* Welter, the shell is more compressed and less involute.

Malayites cf. antipatris Diener

Plate XVI, figures 4a, b

cf. *Malayites antipatris* Diener, Denkschr. Akad., Wiss., Wien, 97 Band, p. 490, Taf. VI, figs. 4a, b, text fig. 10 (1921).

Material. The figured specimen, GSC 12606, is from talus a little northwest of III, Pardonet Hill (9693).

Description. The figured specimen, all phragmocone, is involute and inflated with whorls much thicker than high. The sides are rounded and convergent and pass into the broad, rounded venter. The stout ribs curve forward a little on the sides and are continuous across the venter. There is also a fine strigate ornament.

Comparisons. This specimen is close to the type of *Malayites antipatris* Diener, but the strigate ornament appears to be finer.

Malayites parvus (McLearn)

Plate XVIII, figures 1a, b, 2;

Plate XX, figures 5a, b

Juvavites (Malayites) parvus McLearn, Can. Field-Naturalist, vol. 54, p. 115, Pl. II, fig. 1 (1940).

Material. The holotype, GSC 8843, is from a talus block at XIII, west of Juvavites Gully, Pardonet Hill (9649). The hypotypes, GSC 12607 and GSC 13486, are from the same collection.

Other specimens are in 9373, 9649, 9737, 9755 and 9788, high on east side Black Bear Ridge and in talus in and near Juvavites Gully and near XIX west end Pardonet Hill.

Measurements. Holotype: 40; 54; 37.5; 11.2: 33.5; 53.5; 36.5; 10.5.

Description. The holotype is involute, compressed, with gently convex, converging sides, narrow rounded venter and rounded umbilical shoulder. The surface is covered with narrow, weak, rather irregular ribs, separated by broad, shallow furrows, all becoming reduced ventrally and replaced near and on the venter by numerous, very fine ribs or costae. The ribs bend backwards a little near the umbilicus, are nearly straight on the middle of the sides of the whorl, and curve forward near and on the venter. In addition and best developed on the venter is a strigate ornament of very fine costae or striae. The ultimate whorl of this specimen appears to be entirely living chamber.

The suture line is well preserved in hypotype GSC 12607. L1 is longer than EL and deeply indented with long lobules; L2 is much shorter than L1, but has well-defined lobules; ES is higher than wide and is deeply indented; S1 is smaller than ES, but is relatively high and has fairly deep indentations; S2 is a little smaller and is deeply indented. Two small auxiliary saddles are on the

umbilical shoulder. Shell form and ornament are much as in the holotype. The ribs are weak, irregular in strength and spacing but stronger on the inner part of the sides. Numerous fine costae occur on and near the venter and cross it, although reduced there.

Other specimens in 9649 resemble the holotype and hypotypes in general shape and ornament. The innermost whorls appear to have very fine and fairly even ribs. The peculiar irregular lateral ribs and shallow furrows, however, begin at an early stage. The very fine costate, strigate ornament is in places faintly recorded on the internal mould and shell. The suture line varies somewhat in degree of indentation and in the height and slenderness of the saddles.

Other specimens in 9373, 9737, 9755 and 9788 have a more subdued ornament, but have sufficient of the typical ribbing and costation to be included in this species. The specimen in 9788 shows the lateral furrows and irregular ribs only faintly. Two specimens in 9737 have weak lateral furrows and faint irregular ribs, but have also very fine strigate ventral ornament. A specimen in 9755 is almost smooth, but has a faint ornament typical of this species. In 9373 a nearly smooth specimen also shows faintly the typical pattern of ornament of this species.

Comparisons. The reduced ornament suggests comparison with species which have been included in *Heinrichites* Diener. None, however, has the peculiar irregular lateral ribbing of this species nor the extremely fine strigate ornament, very much finer than in any typical species of *Heinrichites* or *Malayites*. It is placed in *Malayites* in a broad sense.

Malayites custi (McLearn)

Plate XVII, figures 3a-c

Juvavites custi McLearn, Can. Field-Naturalist, vol. 54, p. 113, Pl. II, fig. 2 (1940).

Material. The holotype, GSC 8821, is from talus block above IX, east of Juvavites Gully, Pardonet Hill (9691).

Other specimens are in 9691 and 9695, talus from and near Juvavites Gully.

Measurements. Holotype: 38; 52.5; 50; 8.5±.

Description. The holotype, entirely phragmocone, is involute, almost very involute, and has stout whorls only a little higher than thick, a wide, almost flat venter, rounded ventral shoulder, slightly convex sides, small umbilicus and rounded umbilical shoulder. On the posterior part of the ultimate whorl are nearly straight, low ribs separated by furrows which die out towards the ventral shoulder. Numerous fine ribs or costae occur on the ventral shoulder, where they curve forward and are continuous across the venter. At the anterior end of the ultimate whorl the surface is nearly smooth and with only some faint radial ornament. In the suture line, EL is wide and divided by a low ventral saddle, L1 is as long as EL and is indented by about three lobules at the base, L2 is smaller

and there are two auxiliary lobes near the umbilical shoulder. ES is higher than wide and is moderately indented, S1 is high, much higher than wide and moderately indented, S2 is small with shallow indentations, and a small auxiliary saddle is near the umbilical shoulder.

The other specimens in 9691 resemble the holotype, but some variation in width of whorl and flattening of the venter occurs. Most specimens, however, show some degree of flattening of the venter or at least low convexity. Some specimens are more compressed than the holotype and have finer, almost costate ornament on the sides. One large specimen exhibits a faint and rather indefinite strigate ventral ornament. The exfoliation and poor preservation of the shell in many of the specimens are not favourable to record fine strigation.

The specimen in 9695 has a somewhat flat or at least lowly convex venter on the posterior part of the ultimate whorl and a somewhat more rounded venter at the anterior end. The surface is almost smooth, except for varices of growth and a faint strigate ornament.

Comparisons. This species is probably close to *Malayites parcus* (McLearn), but it has typically a flat venter and the ornament is mostly more reduced. Specimens with less flattened venters may lie somewhere between this species and *Malayites bococki* (McLearn).

Malayites bococki (McLearn)

Plate XVII, figures 1a, b, 2

Juvavites bococki McLearn, Can. Field-Naturalist, vol. 51, p. 98, Pl. I, fig. 14 (1937); Geol. Surv., Canada, Paper 47-14, p. 11 (1947).

Material. The holotype, GSC 8831, is from talus block south bank Peace River at Little Parle Pas Rapids (9161). The hypotype, GSC 12608, is from the same collection.

Other materials are in 9161, 9373, 9469, 9556, 9655, 9691 and 9727, on Stelck Ridge, and talus, Black Bear Ridge, in and near Juvavites Gully, Pardonet Hill and north bank Peace River near Jewitt Spur.

Measurements. Holotype 32.8; 58; 39.5; 7.

Description. The holotype consists mostly of internal mould; very little of the shell remains. The sides are rounded and converging and the venter is rather narrowly rounded. The umbilicus is small and the umbilical shoulder well rounded. The surface of the internal mould is nearly smooth, but obscure, irregular, very faint ribs and furrows are visible and curve forward a little as they approach the venter. No strigate ornament can be seen, but the shell is nowhere well preserved and indeed mostly absent.

The numerous specimens in 9161 and 9373 are mostly preserved as internal mould. They vary in degree of compression, some being more compressed and others more inflated than the holotype, and they vary also a little in degree of

involution. They all, however, have the rather narrow, rounded venter and are nearly smooth, except for very faint irregular ribs and furrows. A few have a faint very fine strigate ornament.

The single specimen in 9556 is provisionally assigned to this species. The umbilicus is somewhat wider and the ribbing more distinct in the posterior part of the ultimate whorl.

The large specimen in 9727 has the general form and obscurely ribbed to smooth surface typical of the species but the venter is wider at the anterior end.

A specimen in 9691 has stout whorls, rounded venter and faint surface ornament, including a very fine strigate striation. Specimens in 9655 appear to be compressed variants of this species; one exhibits very fine strigation. Specimens in 9469 are provisionally referred to this species. They are more compressed than shells of the typical species.

The suture line of the hypotype includes higher than wide, moderately indented saddles and two small auxiliary saddles.

Comparisons. Because of the poorly preserved surface and the absence of most of the shell itself, it is difficult to compare with other species. The very fine strigate ornament is preserved in a few specimens, a feature shared by *Malayites parvus* and *Malayites custi*. The three species may be closely related. The ornament is much more reduced than that of *M. parvus* and the involution is somewhat greater. The venter is not flattened as in *M. custi*. The strigation is much finer than in typical species of *Malayites* and *Heinrichites*.

Malayites sp.

Material. In 9373, 9463, 9467, 9655, 9695, 9723, 9849, 9850 and 9867, *Malayites* beds and talus, west slope, west spur, Brown Hill and talus from near Cascades Creek, Juvavites Gully, west of Juvavites Gully, Pardonet Hill and from north bank Peace River below Jewitt Spur.

Description. The specimens comprise shells with coarse strigation and those with very fine strigation. They are merely listed as *Malayites* sp. because of uncertain identification, immature growth or poor preservation.

Specimens in 9463, 9467 and 9723 resemble the inner whorls of *Malayites butleri* (McLearn). One of the specimens in 9723 has a very high and slender ES in the suture line. The specimen in 9467 has very numerous fine ribs. Small specimens in 9373 also have numerous ribs. A large, but partly crushed and incomplete specimen in 9867 has low broad ribs, curved forward a little towards the venter.

A fairly well-preserved specimen in 9850, *Malayites* beds, west slope, west spur, Brown Hill has low ribs in the posterior part of the ultimate whorl and is nearly smooth, except for the strigation at the anterior end of the same whorl.

A specimen in 9655 shows some resemblance to both *Malayites custi* and *Malayites bococki*. The saddles of the suture line, however, are deeply indented.

A specimen in 9695 has rather stout whorls, faint costation, very fine, not very distinct strigation and low saddles in the suture line with very shallow indentations. A specimen in 9849, *Malayites* beds, west slope, west spur, Brown Hill, is somewhat compressed, with faint radial ornament and faint, very fine strigation.

Genus *Miltites* Mojsisovics

Miltites ? sp.

Material. In 9694, talus block northwest of III, Pardonet Hill.

Description. A few specimens may belong to this genus. They comprise moderately evolute specimens with round whorls about as high as thick or a little higher than thick. On the sides are fairly thick ribs that divide near the middle of the sides into somewhat weaker straight ribs, which do not cross the venter.

Comparisons. They appear to have stronger ribs in the inner part of the sides than *Miltites christinae* Mojsisovics.

Genus *Waldthausenites* Welter

Waldthausenites cf. *leophanis* Diener

Plate XVII, figures 4a, b

cf. *Waldthausenites leophanis* Diener, Jaarb. Mijn. Ned.-Oost-Ind., 1920, p. 159, Pl. XIX, figs. 5a-c (1923).

Material. The figured specimen, GSC 12609, is from talus, west slope, west spur, Brown Hill (9860).

Description. A small, imperfect, involute shell has convex converging sides, narrow venter and ventral keel. The slender ribs number about twenty-two to the half whorl, are fairly straight on inner part and curved forward on outer part of sides. They cross the venter and keel where they expand into a tubercle-chevron-like ornament. The suture line is moderately indented.

Comparisons. This species closely resembles the figured type of *Waldthausenites leophanis* Diener, but appears to be somewhat more compressed.

Subfamily SAGENITINAE Spath

Genus *Sagenites* Mojsisovics

Sagenites sp.

Plate XIX, figures 5a, b

Material. The figured specimen, GSC 13487, is from talus Tepee Rocks Coulee (9471).

Description. The figured, moderately involute specimen at a diameter of 15 mm has rounded whorls much thicker than high. On the sides are nearly straight fine ribs or costae, ending in small tubercles. On the outer part of the

sides and outside the tubercles are more numerous and finer costae which cross the venter. In addition, there is a fine strigate ornament. Two very small specimens occur. All are too small for identification of species.

Subfamily EPISCULITINAE Spath

Genus *Episculites* Spath

Episculites browni (McLearn)

Plate XVIII, figures 3, 4a, b

Isculites browni McLearn, Trans. Roy. Soc. Can., 3rd ser., sec. 4, vol. 33, p. 52, Pl. I, fig. 3 (1939); Geol. Surv., Canada, Paper 47-14, p. 12, Appendix, Pl. IV, fig. 7 (1947).
Episculites browni (McLearn), Geol. Surv., Canada, Paper 53-21, p. 5 (1953).

Material. The holotype, GSC 9409, is from *Himavatites* zone, very high on west slope of Black Bear Ridge (9741). The hypotype, GSC 9513, is from the same horizon and locality.

Other specimens are in 9741 and 9744, including talus from same locality.

Measurements. Holotype: 15.5; 45; 45; 18; made at about posterior end of last quadrant, very approximate.

Description. The holotype is a small specimen with stout whorls about as thick as high, somewhat flat sides, rounded ventral shoulders and rounded, wide venter. The umbilicus expands on the ultimate whorl. At least three quadrants of the ultimate whorl are living chamber. The surface is covered with fine, approximate ribs, mostly of even size, curved forward on the sides and arcuate across the venter. The inner whorls are very involute.

The hypotype is of about the same size as the holotype, but the anterior end is missing. Like the holotype it has stout whorls, somewhat flat sides, rounded ventral shoulders and rounded venter. About half a whorl of living chamber is preserved and it shows umbilical enlargement. The ribs are fine and approximate and arcuate across the venter. The very simple suture line includes a large entire ES, a fairly large entire S1 not as wide as ES, a very low, wide S2 reaching to the umbilical shoulder, a longer than wide EL, a wide L1 with a few indentations and a wide, shallow L2.

In two specimens in 9741 the ribbing is not as distinct as in the holotype. In one specimen the L1 is narrower than in the hypotype.

In a specimen in 9744 the posterior part of the ultimate whorl is thicker and more rounded than the anterior part. The inner whorls of this species are apparently more rounded and more involute than the ultimate whorl.

Comparisons. Compared with *Episculites decrescens* (Hauer) there are no well-defined constrictions and the suture line is ceratitic, not goniatic. Compared with *Episculites smithi* Diener, the ribs are mostly finer, the sides flatter and the ventral shoulders are better defined.

Episculites ornatus (McLearn)

Plate XVIII, figures 7a, b

Isculites ornatus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. V, figs. 5, 6 (1947).

Material. The holotype, GSC 9492, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741). Other specimens are in 9741.

Measurements. Holotype: 15; 47.5; 49.5; 13.5.

Description. The holotype is a small but probably mature specimen as it shows umbilical enlargement on the three last quadrants of the ultimate whorl. The posterior part of the ultimate whorl is very depressed, being much thicker than high, and is very involute. The sides are rounded, the venter is very wide and of low convexity, and the ribs are fine, almost costate and only moderately arcuate across the venter. The anterior part of the same whorl is not so relatively depressed, the sides are somewhat flattened and there is marked umbilical enlargement. The coarse ribs curve forward on the sides and are strongly arcuate across the venter.

A specimen in 9741 is larger than the holotype, but is in a less mature stage of development, as the umbilical enlargement is not so advanced. It has very wide depressed whorls, rounded on sides and venter. The well-defined ribs curve forward a little on the sides and are to some degree arcuate across the venter. A smaller specimen in 9741 is incomplete, but has the ribbing typical of the species.

Comparisons. Compared with *Episculites browni* (McLearn), this species has coarser ribs and somewhat less flat sides.

Episculites teres (McLearn)

Plate XVIII, figures 6a, b

Isculites teres McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. IV, fig. 8 (1947).

Material. The holotype, GSC 9493, is from talus, very high on west slope of Black Bear Ridge (9744).

Other material in 9741, 9744 and 9745, in place and from talus of *Himavatites* zone, very high on west slope of Black Bear Ridge.

Measurements. Holotype: 23; —; —; —: 19.5; 55.5; 66.5; —.

Description. The holotype is large for this genus, and is imperfect, only a very small part of the living chamber being preserved. It is very involute and has robust but depressed whorls with converging rounded sides and rounded venter. It is covered with fine ribs or costae, curved forwards on the sides and moderately arcuate across the venter. There is a slightly flattened area on the venter bordered by faint transverse costae. EL has a small ventral saddle, ES is

wide and entire, L1 is wide with a few indentations, S1 is smaller than ES and entire, L2 is much smaller than L1, and S2 is small and on the umbilical shoulder.

A second specimen in 9744 is smaller than the holotype and incomplete; one in 9741 resembles the holotype, but is smaller and some ribs are coarser than others.

The specimen in 9745 is larger than the holotype, comprises more of the living chamber (more than half a whorl) and shows some umbilical expansion. The whorls are robust and rounded. Fine ribs are arcuate across the venter. A few fine ribs or costae are coarser than others.

Comparisons. This is a larger and more robust species than *Episculites browni* (McLearn). The ornament is finer than that of *Episculites ornatus* (McLearn).

Episculites corpulentus (McLearn)

Plate XVIII, figures 5a, b

Episculites corpulentus McLearn, Geol. Surv., Canada, Paper 47-14, Appendix, p. 1, Pl. IV, figs. 9, 10 (1947).

Material. The holotype, GSC 9494, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741).

Measurements. Holotype: 16.5; 45.5; 97; 21; very approximate.

Description. The holotype and only specimen is incomplete, as only the phragmocone is preserved. It is a moderately involute shell with greatly depressed, very thick whorls, very wide, gently convex venter, rounded ventral shoulder, narrow sides, deep umbilicus and well-defined umbilical shoulder. The surface ornament is not well preserved, but comprises very fine ribs, or costae, some of which branch on the sides and all are arcuate where they cross the venter. EL is longer than wide with a narrow ventral saddle, ES is fairly large and entire, L1 is wide with small indentations, S1 is nearly as large as ES and entire, L2 is small, and S2 is apparently small and on the umbilical shoulder.

Comparisons. Compared with other species of the genus in the *Himavatites* fauna, the whorls are much thicker and more depressed.

Genus *Hypisculites* Spath

Hypisculites stelcki (McLearn)

Plate XVIII, figures 9a, b

Daphnites (*Phormedites* ?) *stelcki* McLearn, Can. Field-Naturalist, vol. 54, p. 50, Pl. II, figs. 9, 10 (1940).

Hypisculites stelcki (McLearn), Geol. Surv., Canada, Paper 53-21, p. 6 (1953).

Material. The holotype, GSC 8832, is from the *Himavatites* zone, west slope, west spur, Brown Hill (9839). Other material is in 9839.

Measurements. Holotype: 38.5; 42.5; 31; 29.

Description. The holotype is a moderately involute, compressed specimen with flattened sides, converging to a narrow flat or almost sulcate venter. The numerous ribs bend forward a little on the sides, but are very much projected forward as they approach the venter. At about the end of the penultimate whorl the lateral ribs unite in umbilical bulges. These are replaced at the beginning of the ultimate whorl by bullae, which disappear on the anterior half of this whorl. In the posterior part of the ultimate whorl, the narrow, flat to almost sulcate venter is bordered by small clavi, formed by thickening of the ends of the lateral ribs. The clavi decline at the anterior end of this whorl and the ribs cross the venter.

One specimen in 9839 has finer ribs than the holotype and other specimens.

Comparisons. This species very closely resembles *Hypisculites dieneri* (Pakuckas) but the ribs are more strongly projected forward, the ventral calvi decline or disappear at the anterior end, and the ribs tend to cross the venter there.

Family ARCESTIDAE Mojsisovics

Genus *Arcestes* Suess

"*Arcestes*" sp.

Plate XX, figures 2a, b

Material. The figured specimen, GSC 13494, is from talus near XIX, west end Pardonet Hill (9765).

Other specimens are in 9215, 9719, 9729, 9741, 9742, 9744, 9767, 9776 and 9779, ranging throughout the Pardonet beds.

Description. Specimens listed as *Arcestes* sp. are mostly unsatisfactory for exact specific or even generic identification and may be of more than one genus of the Arcestidae. Many are small and represent only inner whorls, the shells of some specimens are exfoliated with only the internal mould remaining, and the suture line of many is unknown. Considerable differentiation occurs among the specimens listed in degree of involution and inflation, in occurrence of constrictions and possibly in the suture line.

The figured specimen at a diameter of 45 mm is involute, somewhat compressed and has constrictions. If it is an adult form, it may belong to the genus *Proarcestes*.

Some specimens in 9742 from the *Himavatites* zone are fairly large, robust and inflated and without constrictions. Some specimens in 9215 and 9776 are not so involute. A specimen in 9779 has wide, rather depressed whorls, apparently without constrictions. Other specimens are small.

Family PINACOCERATIDAE Mojsisovics

Genus *Placites* Mojsisovics*Placites* sp.

Plate XVIII, figure 8

Material. The figured specimen, GSC 12610, is from the *Himavatites* zone, very high on the west slope of Black Bear Ridge (9741).

Other specimens are in 9319, 9321, 9323, 9374, 9471, 9474, 9478, 9631, 9693, 9694, 9728, 9729, 9730, 9732, 9741, 9742, 9744, 9745, 9758, 9762, 9767, 9768, 9771, 9778, 9779, 9781, 9782, 9784, 9830, 9841, 9858, 10740, 10776 and 13522, ranging from *Cyrtopleurites* beds to above the *Monotis sub-circularis* zone and from talus.

Description. Despite the large number of specimens in the collections no attempt is made to identify the species represented. Many are below mature size. Some larger specimens are distorted.

Genus *Pinacoceras* Mojsisovics*Pinacoceras* sp.

Plate XXI, figure 1

Material. The figured specimen, GSC 13495, is from the *Himavatites* zone, above XX, west end Pardonet Hill (9781).

Other specimens are in 9632, 9633, 9756, 9757, 9758, 9760, 9781, 9782 and 10740, from *Himavatites* zone and from talus.

Description. The figured specimen is a very much compressed, involute, almost very involute, apparently smooth specimen, with angular umbilical shoulder and sharp venter.

Specimens of this genus in the collections are too fragmentary for specific identification and more than one species may be represented. All are very compressed, almost involute to very involute with angular umbilical shoulder, sharp oxynate venter and smooth surface. The suture line is highly complex with numerous, deeply indented lobes and saddles, including a convex row of numerous adventitious lobes and saddles and a sloping row of smaller auxiliary ones.

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APPENDIX

Description of Localities

Note. The numbers are GSC locality catalogue numbers. All collections are from the Pardonet beds. All made by the author unless otherwise stated.

9144. Talus, north bank Peace River below Jewitt Spur.
9146. A little west of south face, McLay Spur.
9147. West part south face, McLay Spur.
9157. Miscellaneous collection west slope, west spur, Brown Hill.
9161. Talus block, south bank Peace River at Little Parle Pas Rapids.
9215. Higher part section at Rapide-qui-ne-parle-pas. Collected by C. M. Sternberg.
9319. Sixty feet above *M. subcircularis* zone, Rapide-qui-ne-parle-pas.
9321. Fifty-four feet above *M. subcircularis* zone, Rapide-qui-ne-parle-pas.
9322. Twenty-four feet above *M. subcircularis* zone, Rapide-qui-ne-parle-pas.
9323. One hundred and thirty feet below top *M. subcircularis* zone, Rapide-qui-ne-parle-pas.
9325. One hundred and sixty-seven feet below top of *M. subcircularis* zone, Rapide-qui-ne-parle-pas.
9359, 9360. North bank Peace River, above Point Creek.
9370. West side Schooler Hill.
9373. Talus block in Juvavites Gully.
9374. *Himavatites* zone, 20 feet below *M. subcircularis* zone at XV, south bank Peace River, Little Parle Pas Rapids.
9375. Talus block, south bank Peace River, Little Parle Pas Rapids.
9377. Talus block, Little Parle Pas Rapids, just east of Juvavites Gully.
9380. Just below *Styrites ireneanus* zone, near IX, about 50 feet east of Juvavites Gully.
9463. Talus block, north bank Peace River below Jewitt Spur.
9466. *Cryptoleurites* beds, west slope, west spur, Brown Hill.
9467. Talus on ledge, north bank Peace River below Jewitt Spur.
9469. Stelck Ridge.
9471, 9473. Each from a separate talus block, Tepee Rocks Coulee.
9474. Talus block, west slope, west spur, Brown Hill.
9475. Talus, west slope, west spur, Brown Hill.
9477. Talus block, west slope, west spur, Brown Hill.
9478. *Himavatites* zone, west slope, west spur, Brown Hill.
9479. Talus block, west slope, west spur, Brown Hill.
9481. *Stikinoceras* zone, west slope, west spur, Brown Hill.
9556. Talus block, north bank Peace River near Jewitt Spur.
9631. *Himavatites* zone at XVIII, west end Pardonet Hill.
9632. Talus block at XIX, west end Pardonet Hill.
9633. Talus at XVIII and XIX, west end Pardonet Hill.
9636. *Styrites ireneanus* zone, near X, Juvavites Gully.
9638, 9639. Each from a separate talus block, between X and XI, Juvavites Gully.
9640. *Styrites ireneanus* zone at about XI, Juvavites Gully.
9641, 9642. *Styrites ireneanus* zone, between XI and XII, Juvavites Gully.
9643, 9644. Each from a separate talus block between XI and XII, Juvavites Gully.
9647. Talus block at IX, just east of Juvavites Gully.
9648. Talus at IX, just east of Juvavites Gully.

9649. Talus block at XIII, west of Juvavites Gully.
 9652. Talus block between Juvavites Gully and XIII, Pardonet Hill.
 9655. Large talus block near XIII, Juvavites Gully.
 9658. Talus block, Juvavites Gully.
 9659. *Styrites ireneanus* zone about midway between XI and XII, Juvavites Gully.
 9660. Small talus block, west side Juvavites Gully.
 9661. *Styrites ireneanus* zone about midway between XI and XII, Juvavites Gully.
 9662. Talus block at XII, Juvavites Gully.
 9663. *Styrites ireneanus* zone at XII, Juvavites Gully.
 9664. Talus block at XII, Juvavites Gully.
 9671. *Styrites ireneanus* zone at XI, Juvavites Gully.
 9672. *Styrites ireneanus* zone between XI and XII, Juvavites Gully.
 9681. Large talus block at VII, Pardonet Hill.
 9686, 9687. Talus at V, Cascades Creek.
 9688. *Tropites* bed at V, Cascades Creek, Pardonet Hill.
 9691. Talus block, above IX, just east of Juvavites Gully.
 9693. Talus, a little northwest of III, Pardonet Hill.
 9694. Talus block, northwest of III, Pardonet Hill.
 9695. Talus block, Juvavites Gully.
 9697, 9698, 9699. Each from separate talus block on south bank Peace River at Little Parle Pas Rapids.
 9718. Talus block, a little northwest of III, Pardonet Hill.
 9719. *Stikinoceras* zone, at III, Pardonet Hill, east of Cascades Creek.
 9722. Talus block near V, near Cascades Creek, Pardonet Hill.
 9723. Talus block near VI, near Cascades Creek, Pardonet Hill.
 9725. Talus at IV, Pardonet Hill.
 9727a. Talus, Black Bear Ridge, above 200-foot terrace.
 9728. *Himavatites* zone, on Black Bear Ridge.
 9729, 9730. Each from separate talus block, fairly high on Black Bear Ridge.
 9732. High on Black Bear Ridge.
 9737. High on east side Black Bear Ridge.
 9739. High on west slope Black Bear Ridge.
 9740. Talus high on west slope Black Bear Ridge.
 9741. *Himavatites* zone, very high on west slope Black Bear Ridge.
 9742. *Himavatites* zone with *Monotis alaskana*, very high on west slope Black Bear Ridge.
 9744, 9745. Talus *Himavatites* zone very high on west slope Black Bear Ridge.
 9755. Talus near XIX, west end Pardonet Hill.
 9756. Talus at XIX, west end Pardonet Hill.
 9757. Talus block below XX, west end Pardonet Hill.
 9758. *Himavatites* zone at XX, west end Pardonet Hill.
 9759. Talus below XX, west end Pardonet Hill.
 9760. *Himavatites* zone at about XXI, east side Monotis Gully, west end Pardonet Hill.
 9761. *Himavatites* zone, at about XI, west side Monotis Gully, Pardonet Hill.
 9762. Talus block, east of and higher than XX, west end Pardonet Hill.
 9764. *Parathisbites oineus* zone, at XVI, west end Pardonet Hill.
 9765. Talus block near XIX, west end Pardonet Hill.
 9767. Talus, just west of Monotis Gully, near XXII, west end Pardonet Hill.
 9768. *Himavatites* zone, in Western Gully near XXIII, Pardonet Hill.
 9770. *Himavatites* zone near XXIII, west end Pardonet Hill.
 9771. Talus at XXIII in Western Gully, Pardonet Hill.
 9772. Talus block in Monotis Gully west end Pardonet Hill.

- 9776, 9778, 9779, 9780. Above *M. subcircularis* zone, east end ledge at Rapide-qui-ne-parle-pas.
9781. *Himavatites* zone, above XX, west end Pardonet Hill.
9782. Talus block at XX, west end Pardonet Hill.
9784. *Himavatites* zone at XV, on south bank Peace River at Little Parle Pas Rapids.
9788. Talus just west of Juvavites Gully.
- 9815, 9818. Talus west slope West Glacier Spur.
- 9820, 9821. Each from separate talus block west slope West Glacier Spur.
- 9829, 9830. Talus, west slope, west spur, Brown Hill.
9832. Talus west slope, west spur, Brown Hill.
- 9833, 9835. Each from separate talus block, west slope, west spur, Brown Hill.
9836. *Pterotoceras-Cyrtopleurites magnificus* beds, west slope, west spur, Brown Hill.
9838. Talus block, west slope, west spur, Brown Hill.
9839. *Himavatites* zone, west slope, west spur, Brown Hill.
- 9840, 9841. *Cyrtopleurites* beds, west slope, west spur, Brown Hill.
9842. *Drepanites* beds, west slope, west spur, Brown Hill.
9843. Talus block, west slope, west spur, Brown Hill.
9845. *Gonionotites belli* beds, west slope, west spur, Brown Hill.
9847. Talus block, west slope, west spur, Brown Hill.
9848. *Pterotoceras-Cyrtopleurites magnificus* beds, west slope, west spur, Brown Hill.
- 9849, 9850. *Malayites* beds, west slope, west spur, Brown Hill.
9851. *Stikinoceras* zone, west slope, west spur, Brown Hill.
9852. Talus, *Stikinoceras* zone, west slope, west spur, Brown Hill.
9854. *Stikinoceras* zone, west slope, west spur, Brown Hill.
9856. *Thisbites* beds, west slope, west spur, Brown Hill.
9858. *Cyrtopleurites* beds, west slope, west spur, Brown Hill.
- 9859, 9860, 9864, 9866. Talus block, west slope, west spur, Brown Hill.
9867. Talus, west slope, west spur, Brown Hill.
9871. Talus, south end McLay Spur.
9873. West of shallow gully, south end McLay Spur.
10685. *Himavatites* zone, upper 100 feet of Pardonet beds, north bank, Sikanni Chief River, below mouth of Chicken Creek. Collected by S. S. Holland.
10739. *Himavatites* zone, just below beds with common *Monotis alaskana*, north bank Sikanni Chief River, below mouth Chicken Creek.
10740. Talus, north bank Sikanni Chief River, below mouth Chicken Creek.
10741. *Himavatites* zone, north bank Sikanni Chief River, below mouth Chicken Creek.
10742. Talus, north bank Sikanni Chief River, below mouth Chicken Creek.
10743. Beds with common *Monotis alaskana* at top exposure Pardonet beds, north bank Sikanni Chief River, below mouth Chicken Creek.
10745. Talus, north bank Sikanni Chief River, below mouth Chicken Creek.
10750. Upper 5 feet Pardonet formation, Sikanni Chief River, below mouth Chicken Creek. Collected by C. O. Hage.
10762. Nine hundred and twenty feet below flag station, Pink Mountain. Collected by W. I. Wright.
10767. *Himavatites* zone, upper 100 feet limestone, beneath massive sandstone on west side Klingzut Mountain. Collected by S. S. Holland.
10776. West Gully, Mount Wright.
13520. Miscellaneous north bank Sikanni Chief River, below mouth Chicken Creek.
13522. Miscellaneous Peace River Foothills.

PLATES I to XXI

PLATE I

Sirenites nabeschi McLearn (Page 38.)

- Figure 1. Suture line, hypotype, GSC 12562.
Figure 2. Suture line, hypotype, GSC 12563.
Figures 3a, b. Ventral and side views, hypotype, GSC 12564.
Figures 4a, b. Side and ventral views, holotype, GSC 9410.
Figure 5. Side view, hypotype, GSC 12565.

Pseudosirenites pardoneti (McLearn) (Page 40.)

- Figures 6a, b. Ventral and side views, holotype, GSC 8844.

Vredenburgites sp. (Page 42.)

- Figure 7. Side view, figured specimen, GSC 12566.



1



2



3a



4a



4b



3b



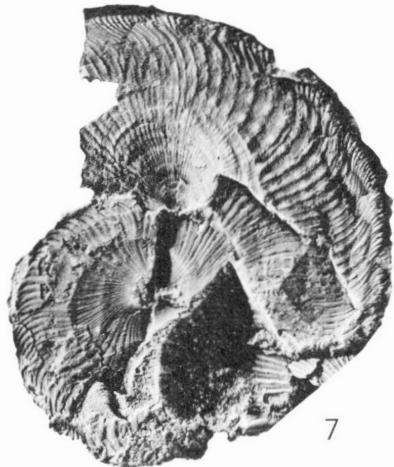
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6a



6b



7

PLATE II

Alloclionites sp. (Page 43.)

- Figures 1a, b. Ventral and side views, figured specimen, GSC 12571.
Figures 2a, b. Ventral and side views, figured specimen, GSC 12570.

Sandlingites ? sp. (Page 43.)

- Figures 3a, b. Side and ventral views, figured specimen, GSC 12569.

Sandlingites cf. *idae* Mojsisovics (Page 42.)

- Figures 4a, b. Side and ventral views, figured specimen, GSC 12568.
Figures 5a, b. Anterior and side views, figured specimen, GSC 12567.

Pseudosirenites pressus McLearn (Page 41.)

- Figures 6a, b. Ventral and side views, holotype, GSC 9501.

Pseudosirenites pardoneti (McLearn) (Page 40.)

- Figures 7a, b, c. Side, anterior and side views, paratype, GSC 8845.
Figure 8. Side view, holotype of *Sirenites inaequiornatus*, GSC 9502.

Steinmannites sp. (Page 44.)

- Figures 9a, b. Ventral and side views, figured specimen, GSC 12572.



1a



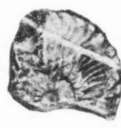
2a



3a



3b



4a



4b



5a



5b



1b



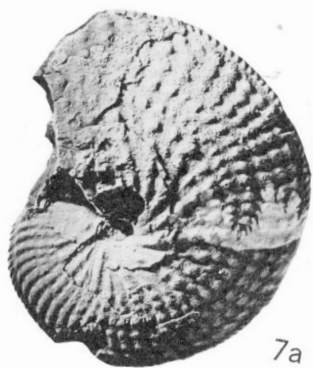
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6a



6b



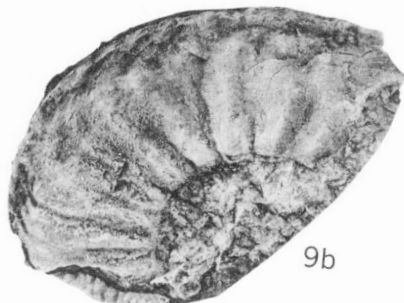
7a



7b



7c



9b



9a



8

PLATE III

Stikinoceras kerri McLearn (Page 58.)

- Figures 1a, b. Side and ventral views, holotype of *Stikinoceras robustum*, GSC 8839.
Figures 2a, b., c. Anterior, ventral and side views, holotype, GSC 9048.
Figure 3. Suture line, hypotype, GSC 12574.

Cyrtopleurites sp. (Page 47.)

- Figures 4a, b. Side and ventral views, figured specimen, GSC 12576.
Figure 5. Side view, figured specimen, GSC 12577.

Alloclionites sp. (Page 43.)

- Figure 6. Side view, figured specimen, GSC 12573.

Lecanites mundus McLearn (Page 46.)

- Figures 7a, b, c. Ventral, anterior and side views, holotype, GSC 9498.
Figure 8. Suture line, paratype, GSC 9499.

Lecanites beattii McLearn (Page 47.)

- Figures 9a, b. Apertural and side views, holotype, GSC 9500.

Drepanites hyatti subsp. *rutherfordi* (McLearn) (Page 46.)

- Figures 10a, b. Suture line and side view, hypotype, GSC 12575.
Figure 11. Side view, holotype, GSC 8817 (for ventral view see Pl. XXI, fig. 6).

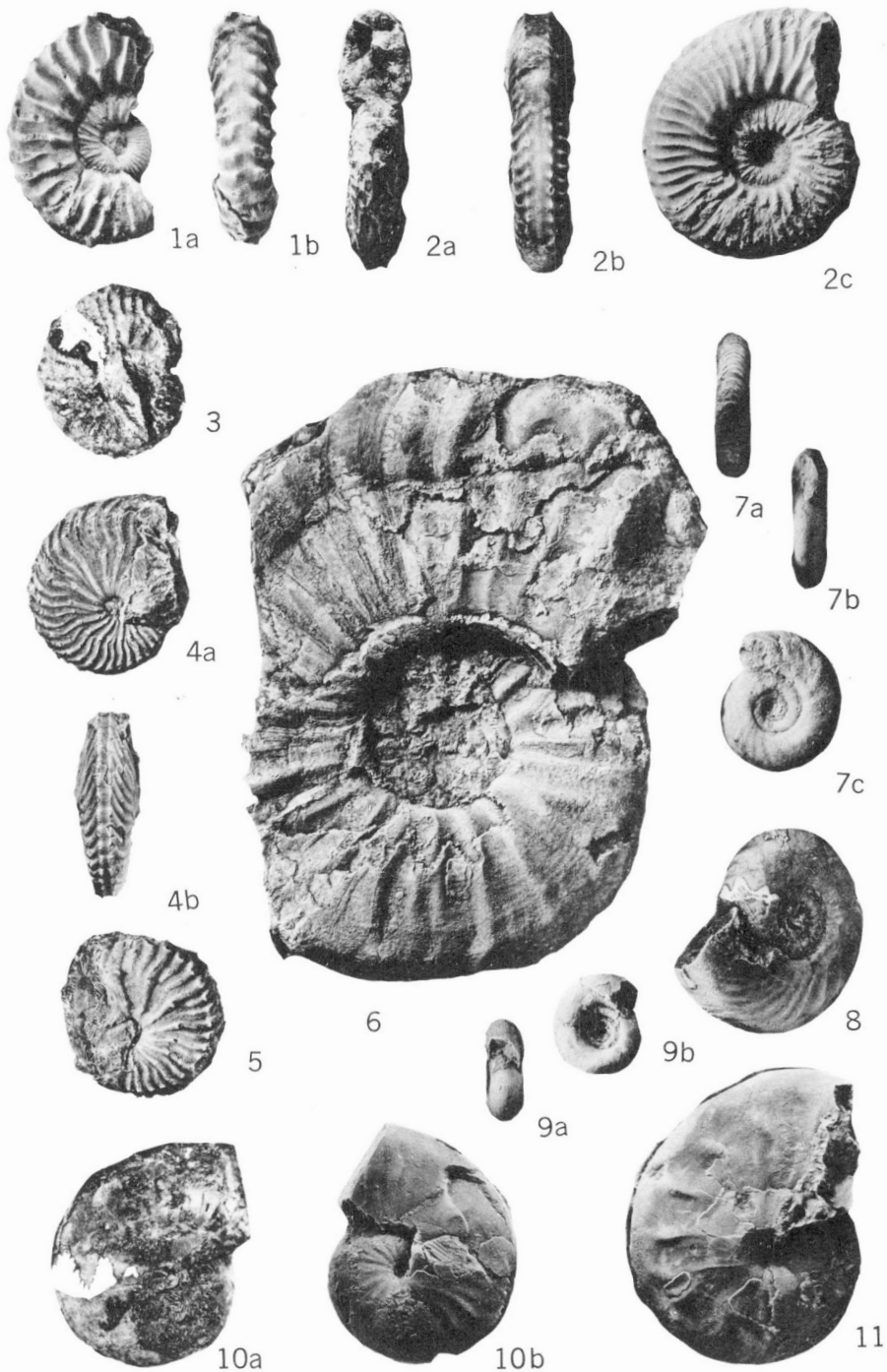


PLATE IV

Cyrtoleuroides magnificus McLearn (Page 48.)

- Figures 1a, b. Side and ventral views, holotype, GSC 9414.
Figure 2. Side view, hypotype, GSC 12578.

Pterotoceras caurinum McLearn (Page 54.)

- Figure 3. Suture line, hypotype, GSC 12581.
Figure 4. Side view, var. *arctum*, holotype, GSC 8846.

Himavatites canadensis McLearn (Page 52.)

- Figures 5a, b. Ventral and side views, holotype, GSC 8847.

Himavatites cf. watsoni Diener (Page 49.)

- Figure 6. Side view, figured specimen, GSC 12579.
Figure 7. Side view, figured specimen, GSC 12580.

Himavatites multiauritus McLearn (Page 50.)

- Figures 8a, b. Ventral and side views, holotype, GSC 9503.

Himavatites burlingi McLearn (Page 52.)

- Figures 9a, b. Anterior and side views, holotype, GSC 9504.

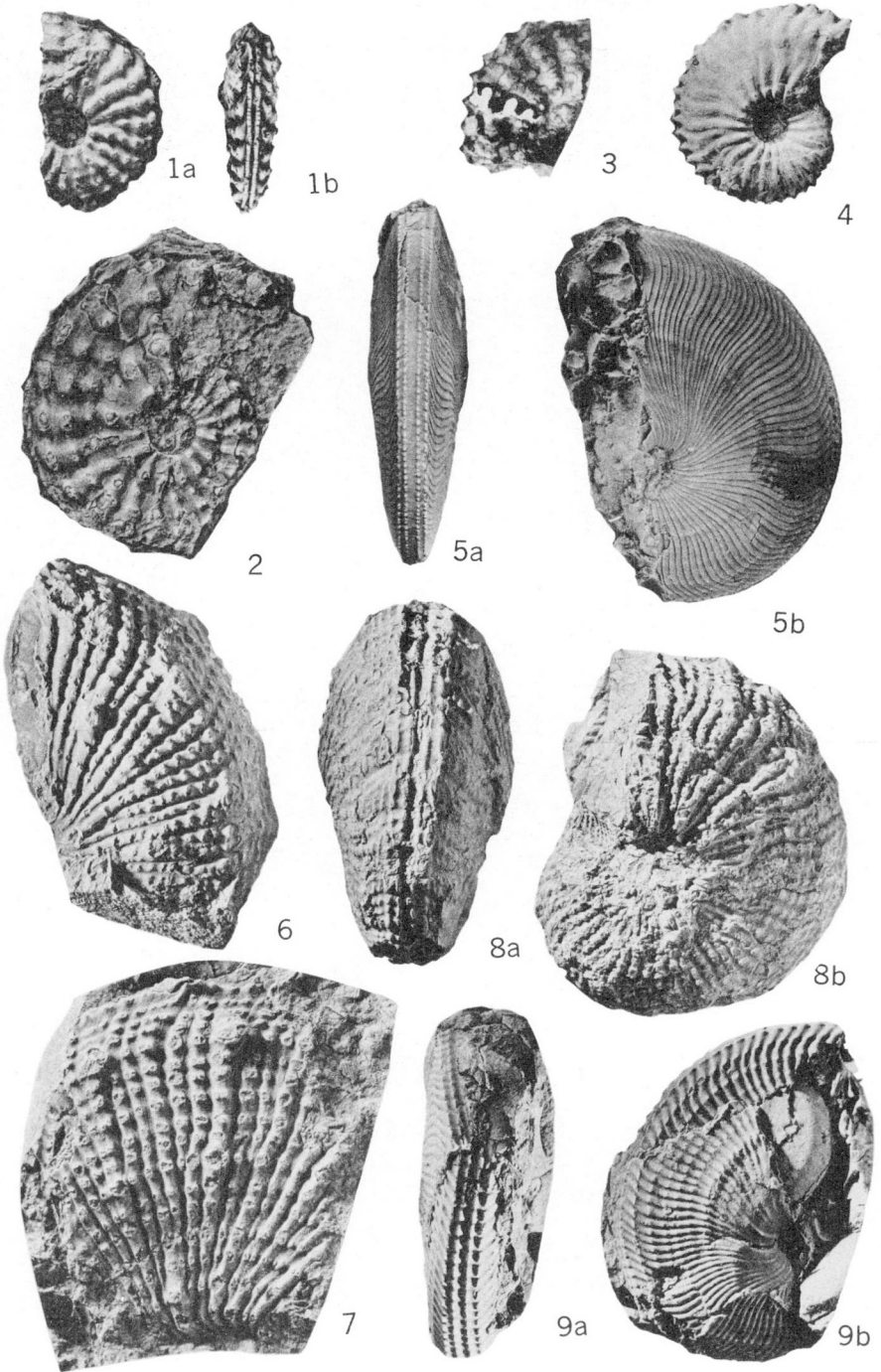


PLATE V

Pterotoceras caurinum McLearn (Page 54.)

- Figures 1a, b. Side and ventral views, holotype, GSC 9412.
Figure 2. Side view of var. *elegantulum*, holotype, GSC 9413.

Helicitites cf. *subgeniculatus* Mojsisovics (Page 60.)

- Figures 3a, b. Side and ventral views, figured specimen, GSC 12585.
Figures 4a, b. Side and ventral views, figured specimen, GSC 12584.

Helicitites decorus McLearn ? (Page 63.)

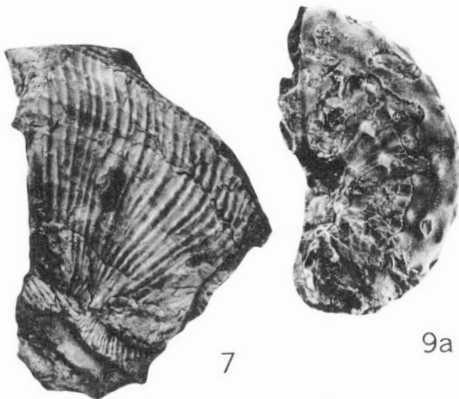
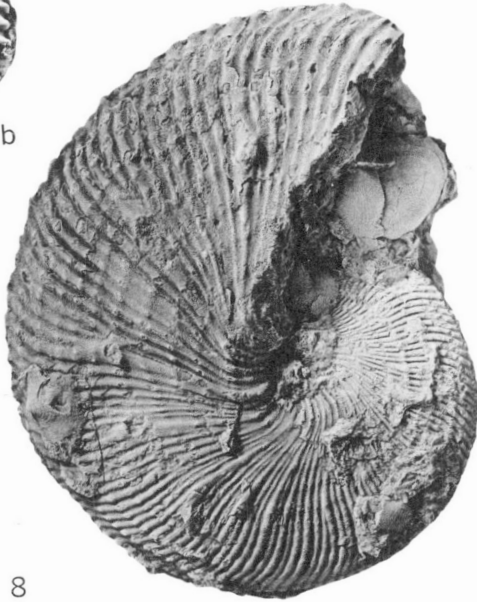
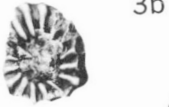
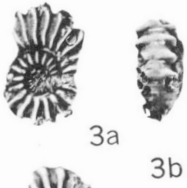
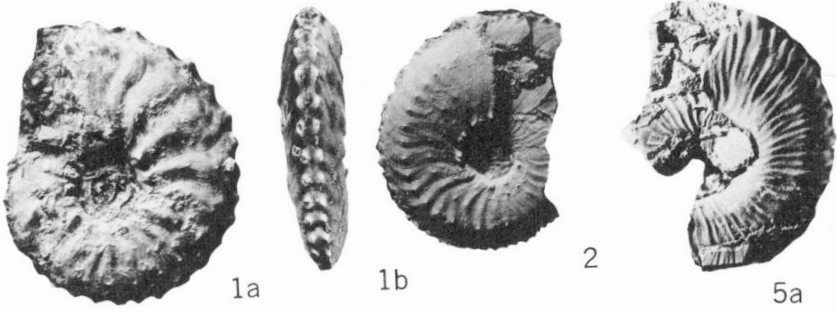
- Figures 5a, b. Side and ventral views, figured specimen, GSC 12586.

Himavatites columbianus McLearn (Page 51.)

- Figures 6a, b. Side and ventral views, hypotype, GSC 9265.
Figure 7. Side view $\times \frac{1}{2}$, holotype, GSC 9411.

"*Tibetites*" sp. (Page 57.)

- Figure 8. Side view, figured specimen, GSC 12582.
Figures 9a, b. Side and ventral views, figured specimen, GSC 12583.



x 1/2

PLATE VI

Thisbites dawsoni (McLearn) (Page 63.)

- Figures 1a, b. Side and anterior views, holotype, GSC 8825.
Figure 2. Side view and suture line, hypotype, GSC 12587.

Thisbites custi (McLearn) (Page 65.)

- Figures 3a, b. Side and anterior views, holotype of var. *ireneanus*, GSC 8802.
Figure 4. Side view and suture line, hypotype, GSC 12588.
Figures 5a, b. Side and anterior views, holotype, GSC 8801.

Thisbites charybdis (Gemmellaro) (Page 64.)

- Figure 6. Ventral view $\times 4$, hypotype, GSC 8791.

Distichites gethingi McLearn (Page 68.)

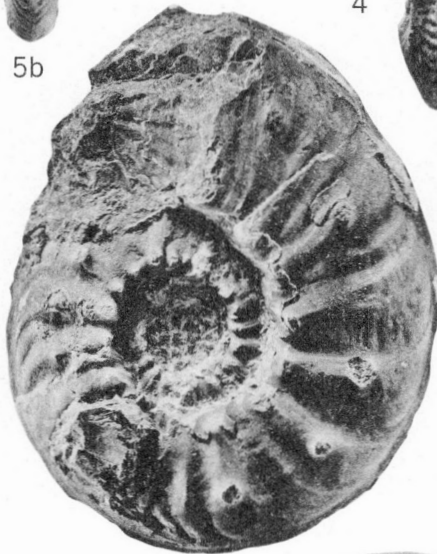
- Figures 7a, b. Side and ventral views, holotype, GSC 8849.

Helictites decorus McLearn (Page 61.)

- Figure 8. Side view, holotype of var. *obesus*, GSC 8822.
Figures 9a, b. Side and ventral views, holotype, GSC 8824.
Figures 10a, b. Ventral and side views, holotype of var. *transitionis*, GSC 8823.

Parathisbites oineus McLearn (Page 67.)

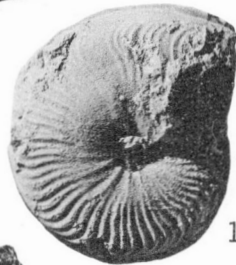
- Figures 11a, b. Side and ventral views, holotype, GSC 9495.
Figure 12. Side view and suture line, hypotype, GSC 12589.



X4



7a



11a



10a



10b



12



11b

PLATE VII

Distichites palliseri McLearn (Page 71.)

Figures 1a, b, c. Side and ventral views, holotype, GSC 9505.

Distichites cf. *hacqueti* Mojsisovics (Page 72.)

Figure 2. Side view, figured specimen, GSC 12592.

Distichites canadensis (McLearn) (Page 70.)

Figure 3. Side view, holotype, GSC 8816.

Distichites cf. *megacanthus* Mojsisovics (Page 69.)

Figures 4a, b. Ventral and side views, figured specimen, GSC 12590.

Distichites cf. *mesacanthus* Diener (Page 69.)

Figure 5. Side view, figured specimen, GSC 12591.

Thisbites charybdis (Gemmellaro) (Page 64.)

Figure 6. Side view, hypotype, GSC 14330.



1a



6



1b



2



1c



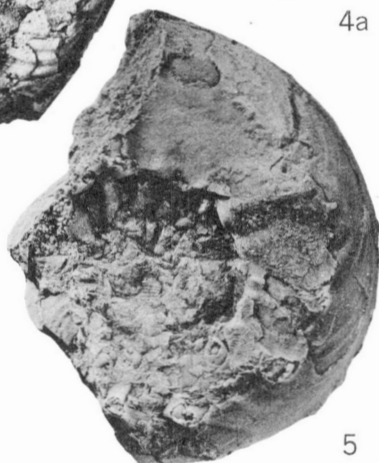
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4a



4b



5

PLATE VIII

Juvavites mertoni McLearn (Page 85.)

- Figures 1a, b, c. Ventral, anterior and side views, holotype, GSC 8828.
Figure 2. Side view, paratype, GSC 8796.

Styrites ireneanus McLearn (Page 75.)

- Figures 3a, b. Ventral and side views, holotype, GSC 8826.

Thetidites exquisitus (McLearn) (Page 77.)

- Figures 4a, b. Side and ventral views, paratype, GSC 9497.
Figures 5a, b. Side and ventral views, holotype, GSC 9496.

Tropiceltites columbianus (McLearn) (Page 76.)

- Figures 6a, b. Ventral and side views, holotype, GSC 8827.

Discotropites sandlingensis (Hauer) (Page 73.)

- Figure 7. Side view, hypotype, GSC 12595.

Discotropites cf. acutus (Mojsisovics) (Page 74.)

- Figures 8a, b. Section and side views, figured specimen, GSC 12596.

Hannaoceras sp. (Page 72.)

- Figure 9. Side view, figured specimen, GSC 12593.

Tropites sp. (Page 73.)

- Figures 10a, b. Side and anterior views, figured specimen, GSC 12594.

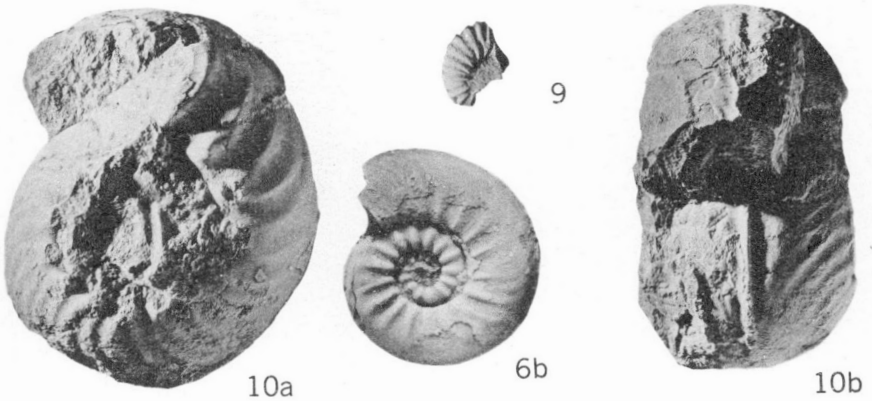
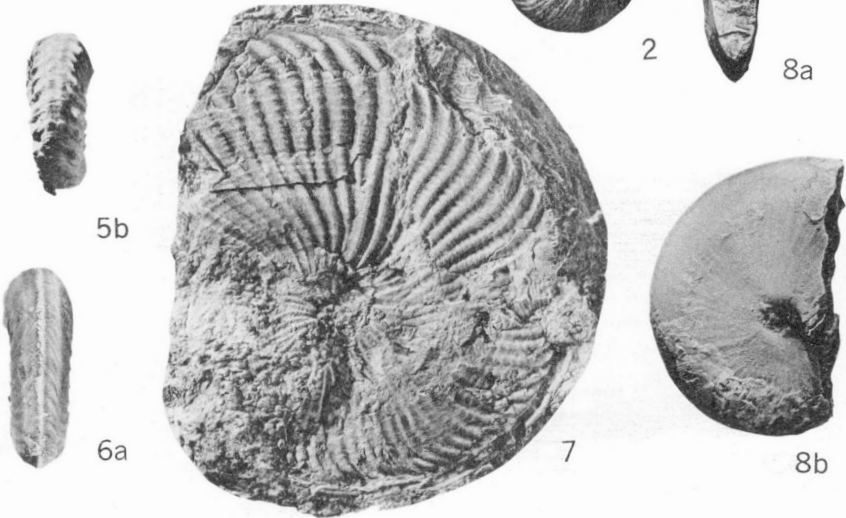
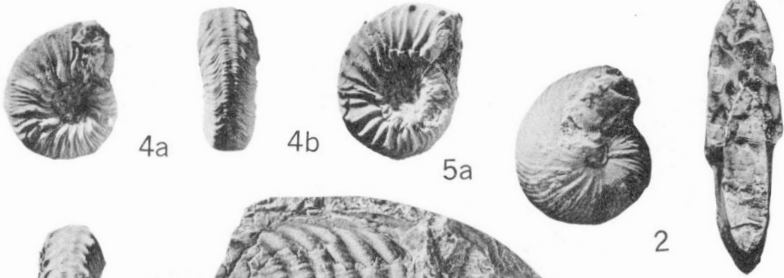


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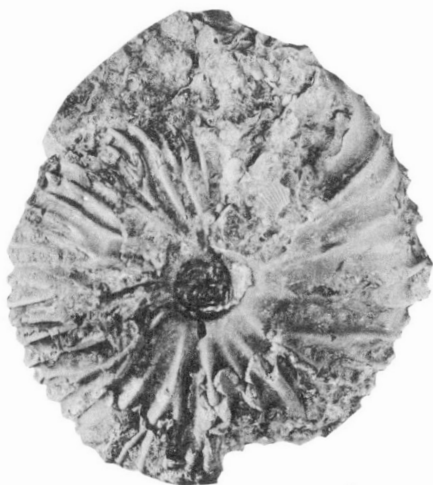
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Figures 1a, b, c. Anterior, side and ventral views, holotype, GSC 8837.

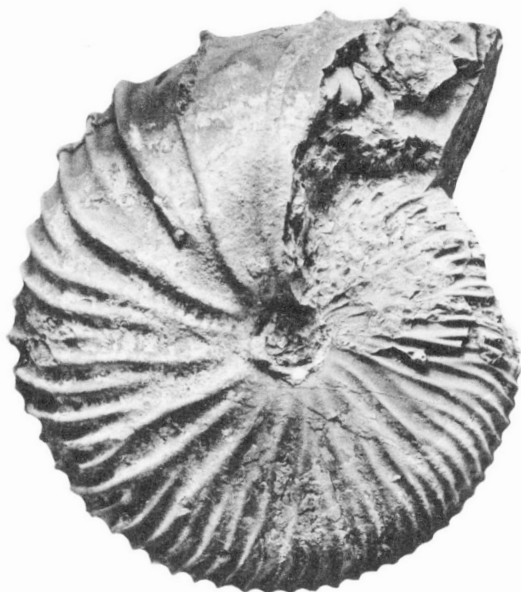
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1a



2



1b



1c

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1a



1b



2a



2b

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1a



1b



2a



3a



2b



2c



4a



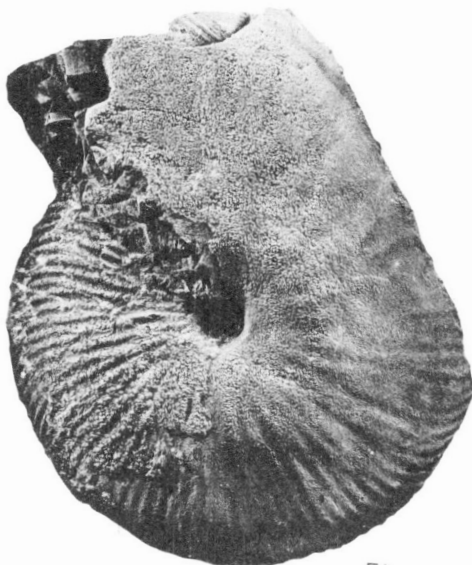
4b



3b



5a



5b

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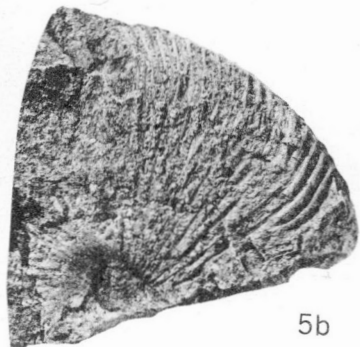


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1



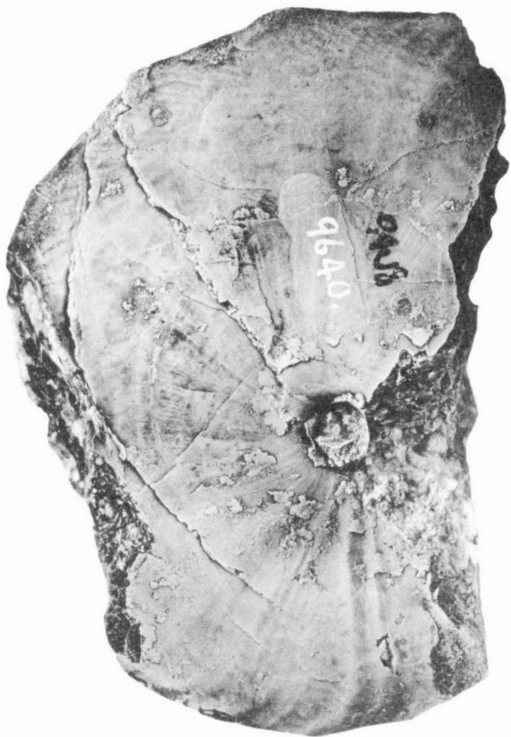
4a



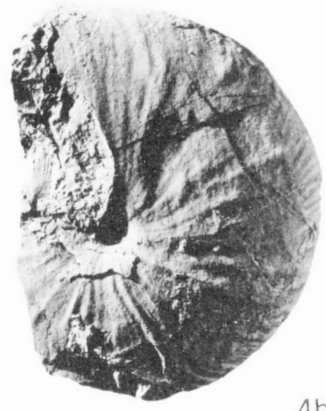
3



2b



2a



4b

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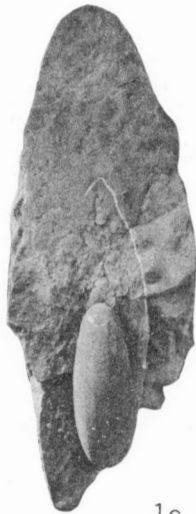
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1a



1b



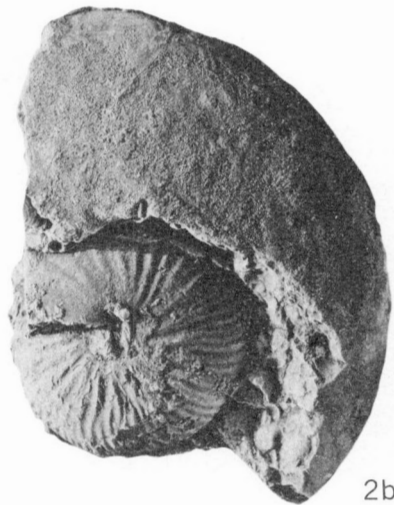
1c



2c



2a



2b

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1a



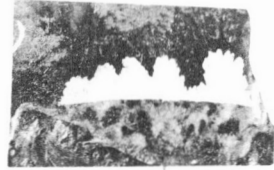
2a



2b



1b



3c



3a



3b

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1a



1c



1b



3a



2a



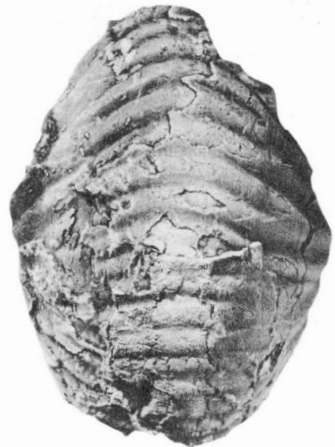
3b



2b



4a



4b

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- Figures 3a, b, c. Side, anterior and side (with suture line) views, holotype, GSC 8821.

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1a



1b



2



3a



3c



3b



4a



4b



5



7



8a



6a



6b



8b

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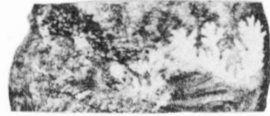
- Figures 9a, b. Anterior and side views, holotype, GSC 8832.



1a



1b



2



3



5a



5b



4a



4b



6a



6b



X2 7a



X2 7b



8



9a



9b

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1a



2a



2b



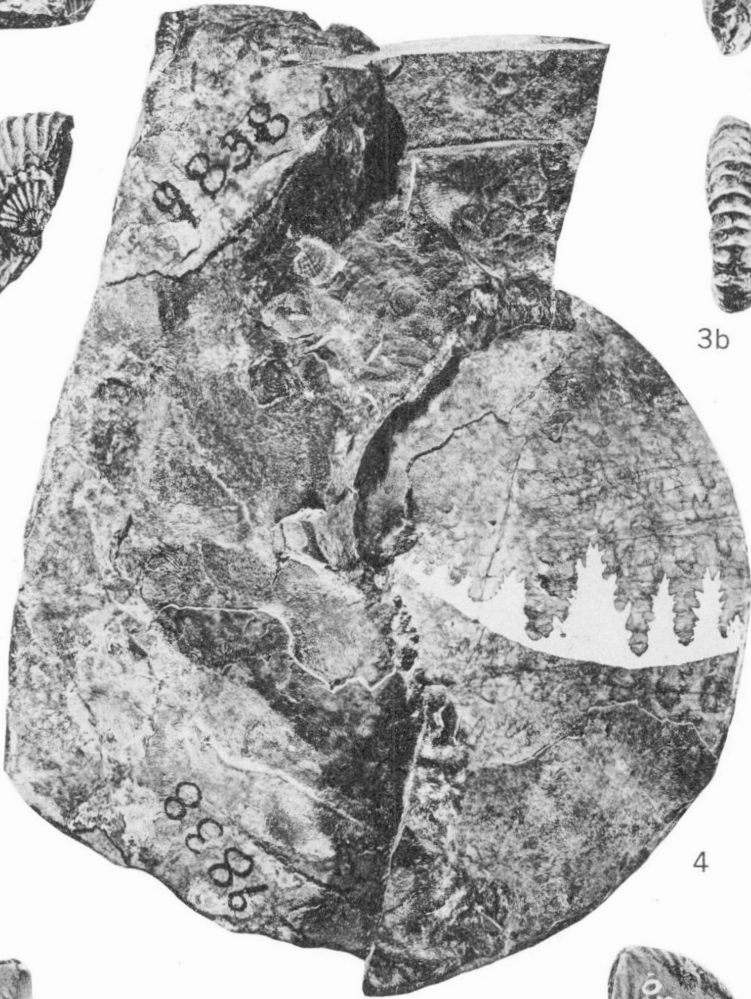
1b



3a



3b



4



6a



5a



5b



6b

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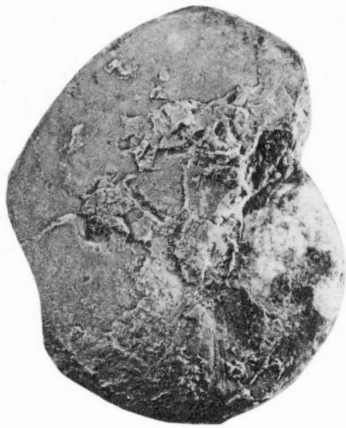
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1a



1b



2a



2b



3



5a



4a



4b



5b

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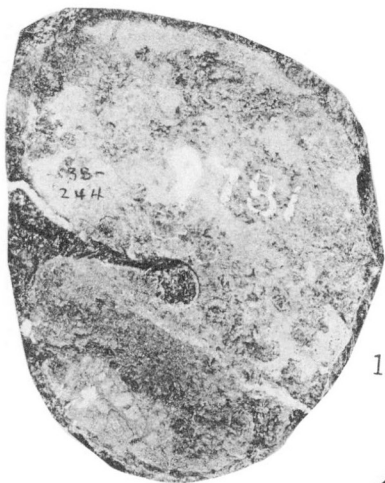
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1



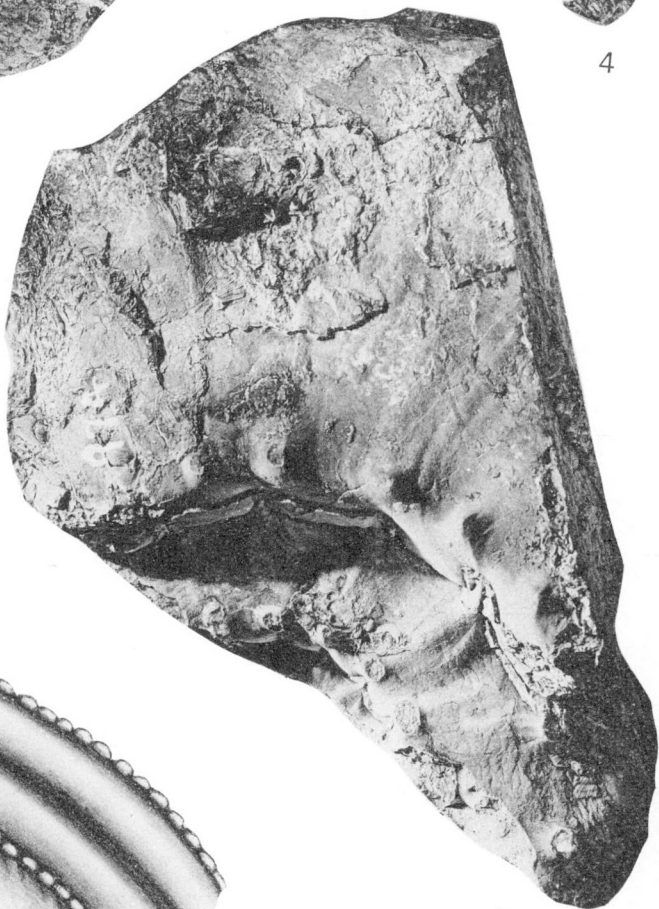
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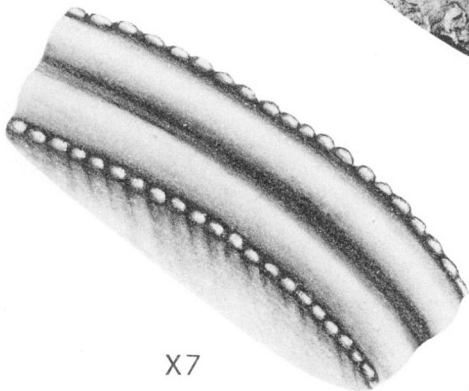
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4



5



X7

6

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