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NOTES ON TRIASSIC AMMONOIDS FROM NORTHEASTERN BRITISH COLUMBIA

By

F. H. McLearn

OTTAWA

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INTRODUCTION

In the years from 1945 to 1948, five reports on the Triassic of northeastern British Columbia were published in the Paper series of the Geological Survey of Canada. They comprise descriptions and stratigraphic relations of a Lower Triassic Wasatchites fauna, a Middle Triassic (Anisian) Beyrichites fauna, a Middle? Triassic (Ladinian?) Nathorstites fauna, and several Upper Triassic faunas (McLearn, 1945, 1946, 1947, 1947a, 1948)[1]. The text of these reports is chiefly in mimeographed form, but brief descriptions of new species are included as printed appendices or supplements, and the fossils are illustrated on half-tone plates. Later study has furnished new information, as a result of which some correction of generic assignment is required. New genera have also been made since the publication of these papers; more is known of the characters of many species; and, in particular, more is known of the families Cyrtopleuritidae and Tibetitidae. This new information is here recorded in this, probably the last, contribution by the writer in the Paper series on Triassic ammonoids of northeastern British Columbia.

In Part I of this report the emphasis is on the genus. The generic assignment of some species is carefully re-examined and the advisability of changing some of them is discussed. Some of Spath's new genera, proposed in the second part of his important work (1951) on the classification of Triassic ammonoids, are adopted, and his comments on the use and status of some ammonoid genera in the Triassic faunas of northeastern British Columbia are considered.

In Part II, the emphasis is on the family, and the scope of treatment is confined within the families Cyrtopleuritidae and Tibetitidae. These families are fairly well represented in northeastern British Columbia by the genera Cyrtopleurites, Himavatites, Metacarnites, and Pterotoceras. It is admitted, however, that no species like Cyrtopleurites transiens occur in the faunas of northeastern British Columbia, and that all comments made on this and species similar to it are based on descriptions and illustrations in the literature. It is regretted that Spath, the palaeontologist most capable of doing so, has not given a diagnosis of ammonoid families in the second part of his important work (1951) on Triassic ammonoids. An attempt is made in this paper to formulate a diagnosis of the families Cyrtopleuritidae and Tibetitidae. As these families are very similar and closely related, a diagnosis is first attempted of a combined family, comprising both the Cyrtopleuritidae and Tibetitidae. This is followed by an examination of the characters by means of which the two families can be separated, and some hypotheses are considered to account for the source of these families. In addition,

[1] Dates in parentheses are those of References at the end of the report.

in Part II, the genera Cyrtopleurites, Himavatites, and Pterotoceras, as they occur in northeastern British Columbia, are more fully described than in previous papers, and although these descriptions might have been more properly included in Part I, these genera are members of the Cyrtopleuritidae and Tibetitidae families and so are included with the discussion of these families in Part II of this report.

A few definitions are required. The term species group is used merely to designate a group of species with similar characters within a genus. It is not a standard or technical term, and in a very refined nomenclature, species groups other than the typical group, including the genotype, could be recognized as new genera or subgenera. Standard abbreviations for elements of the suture line are: EL, external lobe; L1, first lateral lobe; L2, second lateral lobe; ES, external saddle; S1, first lateral saddle; and S2, second lateral saddle. The size of the umbilicus is recorded in terms of percentage of the diameter as follows:

	Per cent
Very involute	1 to 8
Involute	8 to 17
Moderately involute	17 to 34
Moderately evolute	34 to 60
Very evolute	60+

The percentage ranges are like those of Spath for his terms "perangustumbilicate", etc.

PART I

Amendment of Genera

Family, HUNGARITIDAE Waagen

Genus, Neodalmatites Spath

It is probable that the genus Neodalmatites recently described by Spath (1951), can be used for at least some of the species of 'Longobardites' listed by McLearn (1951), under 'normal' suture line, if Dalmatites parvus Smith, the genotype of Neodalmatites, has a similar suture line. The typical Longobardites suture line and what has been called tentatively the 'normal' suture line, as they occur in oxycones in the Middle Triassic of northeastern British Columbia, have been described in earlier papers (McLearn, 1948, 1951). Among other distinguishing characters, the 'normal' suture line, as compared with the true Longobardites suture line, has mostly wider and lower - that is, less slender - saddles.

It is unfortunate that no mature suture line of Dalmatites

parvus, the genotype of Neodalmatites, but only one at an early stage of growth, has been figured. Smith (1914), however, notes that this species lacks the 'adventitious' lobes of Longobardites, and that it has one or two auxiliary lobes. Indeed, 'Longobardites' bufonis (McLearn) may be very close to D. parvus, providing that the suture lines are similar. Compared with illustrated specimens of that species, the growth lines of 'L.' bufonis have a somewhat different course, the radial furrows are not so well defined, and the ventral end of the living chamber of 'L.' bufonis widens at maturity.

Among specimens received from Washington through the courtesy of Doctor John B. Reeside, Jr., one is said by F. N. Johnston (note on label) to be the young of Longobardites nevadanus Hyatt and Smith and to be indistinguishable from Dalmatites parvus. This specimen actually consists of the inner whorls of what had previously been described (McLearn, 1948) as Longobardites internatus, but was later included in L. nevadanus when the latter was treated as a broad species (McLearn, 1951). It thus represents the inner whorls of an internatus-like variant, but not of the typical species. If the innermost whorls of the type specimen of L. nevadanus have any ornament it disappears, and the whorls become smooth, long before the stage of growth reached by this specimen from Washington and other internatus-like variants of L. nevadanus of the same size. The Washington specimen is of course distinguishable from Neodalmatites parvus.

It cannot be said that the oxycones of Longobardites and Longobardites-like shells, with smooth inner whorls, have exclusively the 'adventitious' suture line, nor that those with pleats, ribs, or carinae on the inner whorls have exclusively the normal, presumably Neodalmatites suture line. Species with both kinds of suture line can have ornate or keeled inner whorls.

Family, TRACHYCERATIDAE Haug

Genus, Paratrachyceras Arthaber

Paratrachyceras meginae (McLearn)

If Paratrachyceras can be used in a broad sense to comprise Trachyceratids without rows of lateral tubercles, and if it is considered that McLearn has exaggerated the importance of the initial Sirenites-like ventral ornament of P. meginae, no objection can be raised to placing this species in Paratrachyceras as Spath has recently proposed. In P. meginae the ratio of the number of ventral clavi to the number of lateral ribs is only about 6 to 5 or 8 to 7, whereas in the genotype of Sirenites, S. senticosus Dittmar, it is apparently much greater.

In ontogeny, the ventral ornament on either side of the

ventral sulcus in P. meginae passes from tuberculate, through clavate, to braided (McLearn, 1937). The rather stiffly curved ribs bear no lateral rows of tubercles and are curved forward a little at their ventral ends. The suture line is ceratitic, for the saddles are entire. ES is mostly higher than wide and is more slender in some specimens than in others. L1 is fairly wide, with about two well-defined notches at the base, and is longer than EL. SI is smaller than ES; L2 is shorter than L1 and irregularly and indefinitely notched; and S2 is smaller than S1 and is situated on the umbilical shoulder.

Paratrachyceras meginae was first described as a species of a new subgenus Meginoceras of the genus Steinmannites in an early paper by McLearn (1930). The statement "for Steinmannites read Paratrachyceras" was, however, stamped on most of the separates distributed at that time. McLearn was impressed by the initial Sirenites-like ventral ornament of P. meginae and later placed it under Sirenites (McLearn, 1937, 1947). It was also pointed out that this species has characters of both Sirenites and Paratrachyceras. Spath (1951) approves the early reference to Paratrachyceras and notes the close resemblance to Paratrachyceras hofmanni Boeckh, genotype of Paratrachyceras, which, he claims, differs in little more than the width of the umbilicus. No initial Sirenites-like venter, however, has been described for P. hofmanni. Spath also compares P. meginae with Paratrachyceras homfrayi (Gabb). If this species is correctly described by Smith (1914), however, it has lateral rows of tubercles and in this respect is unlike P. meginae.

Other species in the Nathorstites fauna have been placed in Paratrachyceras. P. aylardi McLearn is evolute, like an Anolcites, and has been compared with P. richthofeni Mojsisovics, a species that Spath places in Anolcites. P. aylardi, however, is best left in Paratrachyceras, used in the broad sense. The genotype of Anolcites is Trachyceras doleriticum Mojsisovics, a Ladinian species. On this continent it is natural to think of Anolcites as an Anisian genus, because of the fine specimens from the Anisian of Nevada, described and illustrated by J. P. Smith (1914).

Family, CLIONITIDAE Arabu emend. Spath

Genus, Alloclionites Spath

Spath's (1951) new genus Alloclionites can be used for the species listed as Clionites (group of C. ares) from the Himavatites fauna of Pardonet Hill and Sikanni Chief River below the mouth of Chicken Creek (McLearn, 1946, 1947). The closely related genus Steinmannites Mojsisovics has also been reported from the Himavatites fauna of northeastern British Columbia (McLearn, 1946, 1947).

? Stikinoceras McLearn

The status of this genus and its place in the classification are not yet established. McLearn (1937a) was at first impressed with the resemblance to Mojsisovicsites Gemmellaro, but later, after seeing specimens of that genus from Nevada, did not feel so confident of a close relation of these two genera. In 1947, McLearn suggested an origin of Stikinoceras "close to that of Clionites". Spath (1951) considers it to be a doubtful genus, but places it close to Mojsisovicsites, following McLearn's opinion of 1937. However, he states that he had considered placing Stikinoceras in the Clionitidae.

A peripheral view of Stikinoceras kerri was included among illustrations accompanying a mimeographed report (McLearn, 1947). The suture line is ceratitic and not unlike Clionites. ES is wide and entire; S1 is a little smaller than ES; and S2 is smaller than S1 but larger and better defined than S2 in Clionites angulosus Mojsisovics. No auxiliary saddles occur. L1 is longer than EL and coarsely indented at the base. L2 is much smaller than L1 and somewhat indented.

Family, HALORITIDAE Haug

Genus, Episculites Spath

Isculites browni McLearn and related species can be referred to the genus Episculites, recently described by Spath (1951). They have ceratitic suture lines and are intermediate between Episculites Spath, with entire suture line, and Euisculites Spath, also recently described, with weakly ammonitic suture line.

As Spath points out, Isculites was first listed by Mojsisovics in 1886 and the name followed, in parentheses, by H. hauerinus. No description was given, and the reference was almost casual. Seven years later, when Isculites was actually described (Mojsisovics, 1893), H. hauerinus was not mentioned, but the first species described was I. decrescens. Later, Diener (1915) chose this species as the genotype of Isculites. In 1934, Spath followed Diener and also cited I. decrescens as genotype. In 1937 and 1939, McLearn called attention to Mojsisovics' first mention of Isculites, and in 1939 states that if the name could not be used for I. decrescens then a new name would be required. The hope was expressed, however, that the established use of Isculites could be retained. Later, Spath evidently became aware of Mojsisovics' original reference to "Isculites (H. hauerinus)" and considered it necessary that H. hauerinus be accepted as the genotype of Isculites in spite of the brevity of the original designation. It followed that a new generic name was required for species like I. decrescens, and Episculites Spath was proposed.

It may be added that the Peace River species lack the constrictions of the genotype of Episculites and that they are modified Juvavites rather than modified Anatomites.

Genus, Hypisculites Spath

The recently described genus Hypisculites Spath (1951) allows a place in the classification for the species originally described as Daphnites (Phormedites?) stelcki McLearn (1940). It was included in Daphnites because of its resemblance to Daphnites berchtae Mojsisovics. Phormedites juvavicus Mojsisovics has similar strong projection of the ribs.

Hypisculites stelcki (McLearn) has ventral and lateral ornament much like that of H. dieneri Pakuckas, genotype of Hypisculites, and has similar umbilical 'bulges' and umbilical expansion. It shows ontogenetic variation. The mature stage, with loss of umbilical 'bulges' and with umbilical expansion, begins at different states of growth and results in both large and small variants. The holotype is large. Compared with H. dieneri Pakuckas, the ventral tubercles disappear at the anterior end of the living chamber and the ribs cross the venter. The projection of the ribs at their ventral ends is much greater and the lobes of the suture line are longer than in H. dieneri.

Family, ISCULITIDAE Spath

Genus, Thanamites Diener

If species of Thanamites Diener exhibit umbilical expansion and whorl contraction the Peace River species Isculites schooleri McLearn can be included in this genus, for the whorl shape, lack of surface ornament, and suture line are at least somewhat similar. The genotype is Thanamites bicuspidatus (Diener).

Isculites schooleri was first described by McLearn in 1930 and placed in the genus Isculites. Later, McLearn (1937) noted the resemblance of this species to Isculites ladinus Welter from Timor, with similar umbilical expansion and a similar suture line, with broad, rounded ES and S1 and narrow L1. It was also stated in the same publication (McLearn, 1937) that the suture line was similar to that of Thanamites, but that I. schooleri could not be placed in this genus because it (Thanamites) lackes umbilical expansion. Diener (1908) says of Thanamites bicuspidatus that it reminded him of a small Arcestes or Isculites "in which the umbilical suture of the last volution has not yet left the normal spiral". In 1951, Spath includes Isculites cadinus definitely in Thanamites, and observes but it may be possible to include I. schooleri there also.

Family, PINACOCERATIDAE Mojsisovics

Genus, Parapinacoceras Diener

Parapinacoceras hagi (McLearn)

Gymnites hagi from the Anisian of northeastern British Columbia is now placed in the genus Parapinacoceras Diener. This genus had been overlooked by the writer in previous papers. The species was described by McLearn in 1948 as an involute, sharp-ventered Gymnites, with a special, but simple, kind of surface ornament. In a broad sense it can be considered an involute, oxyconic development of that genus. A divided ES is known in Gymnites and other genera of the Gymnitidae, but in most of that family ES has not as broad a base.

PART II

A study of the Families Cyrtopleurididae and Tibetitidae

Diagnosis of a Combined Family

As stated in the introduction, it is first proposed in Part II to attempt a definition of a family combining the Cyrtopleuritidae and Tibetitidae. Most of the shells in this assumed family are very involute to moderately involute, have a ventral sulcus at some stage of growth, are generally ribbed, in most instances have a tuberculate ornament, rarely pass to smooth shells at maturity, and are rarely oxycones. These characters, although forming an essential part of a definition of this combined family, are shared by other families and are not peculiar to it. Other and more exclusive characters must be found and added to the definition. No single discriminating feature is universal to this combined family. One, however, comes very close to being so, namely, a row of external ears on either side of the ventral sulcus, and although it is true that the shells of some species have external keels instead, these appear to be genetically related to rows of external ears, for some, apparently, have originated by coalescence of external ears. In some species of Cyrtopleuritidae, external ears of the inner whorls pass into keels at maturity and some keels are undulatory or wavy in outline, suggesting that the keels are fused ears. In Metacarnites, the sharp venter is preceded in at least one species by stages of external keels and external ears (Welter, 1915). External ears do not occur in all species of Himavatites; instead, the ventral sulcus is bordered by rows of external clavi. In typical species of Himavatites, however, external ears as well as clavi border the ventral sulcus, and external keels occur in typical forms of Acanthinites. Another almost universal feature is the occurrence of only a few rows of lateral tubercles, arranged according to a definite plan. Basic to this plan is a ventro-lateral row on about

the ventro-lateral shoulder and a median row a little below the middle of the side of the whorl, from the tubercles of which the lateral ribs divide. An umbilical row is also common, and one or more additional rows may occur in rare instances. In typical species of Himavatites, the ventro-lateral row of large clavi and the median row of large spines may correspond to the two typical rows in other genera of this combined family. The very numerous rows of very fine tubercles, 2 or 3 on each rib per row, occurring in the genera Acanthinites and Himavatites, are considered to be a feature apart from the typical rows of coarser tubercles in the two families and are evaluated as a generic, not a family, character.

It is proposed that a brief diagnosis of the combined family be stated as follows: very involute to moderately involute shells, with, characteristically, a row of external ears, passing to external keels at maturity in some species, or, rarely, a row of external clavi on either side of a ventral sulcus; the venter rarely sharp; with, characteristically, lateral ribs and only a few lateral rows of tubercles, in some species declining in strength at maturity; with both ammonitic and ceratitic suture line, having both divided and undivided ES, and with rare formation of adventitious elements in the suture line.

Criteria for Separation of the Two Families

The Cyrtopleuritidae and Tibetitidae will probably, however, be kept separate, as Spath (1951) has proposed and Kummel (1952) accepted. If this is to be so, the criteria distinguishing the two families must be examined.

Two characters play an important part in this separation. One is fringing or notching of the external ears and keels and the other is division of ES by a lobule of variable dimensions in the suture line. If fringed or notched external ears and keels, ammonitic suture line, and undivided ES were always associated characters, and if the same were true of smooth external ears and keels, ceratitic suture line and divided ES, a short, concise definition based on co-ordinated diagnostic characters could be given for each family. Although these characters do mostly occur together, as stated above, the linkage is not complete. In the C. transiens species group of Cyrtopleurites, fringed external ears are found with ceratitic, not ammonitic, suture lines. The fringing of the ears is indeed weak, but is definitely recorded in descriptions of the species. A smooth keel or smooth external ear is associated with an ammonitic, not a ceratitic, suture line in two species of Paratibetites. It is, consequently, difficult to appraise this feature of the suture line. Division of ES by a lobule, however, is probably more important and is specially mentioned by Spath (1951). It is commonly associated with smooth keels and smooth external ears. However, it appears to accompany a notched keel in Hauerites rarestriatus var. timorensis Diener; is associated with notched or fringed ears at an

early growth stage of Metacarnites dieneri Welter; and does not occur typically with the smooth external ears of Pterotoceras. To separate the two families, somewhat qualified criteria are required. The Cyrtopleuritidae, as now established, have characteristically fringed or notched external ears and keels, rarely fringed or notched external clavi, chiefly but not exclusively ammonitic suture lines, and very rare subdivision of ES in the suture line. The Tibetitidae, on the other hand, have characteristically smooth external ears and keels, mainly but not exclusively ceratitic suture lines, and generally, but not always, a divided ES.

Source of the Two Families

Spath (1951) and Kummel (1952) derive both families (Cyrtopleuritidae and Tibetitidae) from the Trachyceratidae. It would be interesting first of all to trace the source of the Cyrtopleuritidae in that family and to infer the characters inherited from the source and those acquired since in the course of evolution. It is doubtful, however, if this can be done satisfactorily. As all of the species of the C. bicrenatus species group of Cyrtopleurites closely resemble one another, it may be inferred that all came from one common source in the Trachyceratidae. One hypothesis is that they arose from some Paratrachyceras-like species or group of species with few or no lateral rows of tubercles and a ceratitic suture line. If this is so, the ventral tubercles at the ends of the ribs have been modified to form fringed ears, and the ceratitic suture line has become ammonitic. The few lateral rows of tubercles may have been inherited from the source species or source group of species in the Trachyceratidae or acquired later. Apparently, the keels evolved later and by fusing of the external ears. Species like C. herodoti and even C. thinnfeldi and C. strabonis could have had a similar origin. It could also be proposed as one hypothesis that species like C. transiens form a transition group between the inferred trachyceratid source and the typical C. bicrenatus species group, and that they represent a stage in which fringing of the external ears is weak, lateral rows of tubercles are beginning to appear, and the suture line is as yet ceratitic. The question may be raised, however, as to whether they appear early enough to play this part. Cyrtopleurites magnificus McLearn with its exaggeration of the ornament of Cyrtopleurites may not be far removed from the typical species group of that genus. If this is so, the extra rows of tubercles have been acquired since the family developed from the source family. Another hypothesis is that the extra rows of lateral tubercles were inherited from a multi-rowed source in the Trachyceratidae and that C. magnificus had a somewhat different origin than typical Cyrtopleurites. Himavatites does not appear until Norian (mid-Upper Triassic) time, but external ears in some species suggest an affinity with other genera of the Cyrtopleuritidae and at least a somewhat similar source. The lateral division of external tubercles and clavi recall Trachyceras. It is doubtful whether, at present, a

choice can be made between these hypotheses.

In the Tibetitidae, the genera Tibetites, Anatibetites, Paratibetites, and Neotibetites are fairly close and may have had a common origin in the Trachyceratidae and, possibly, not far from the source of the Cyrtopleuritidae. They have not acquired the fringed ears, but have added a division of ES in the suture line. Pterotoceras first appeared early in the Ladinian stage of the Middle Triassic, as Spath (1951) points out. Its source in the Trachyceratidae is not, however, easy to locate, and the question could be raised whether the Upper Triassic Pterotoceras is directly descended from the typical and Middle Triassic Pterotoceras (See Spath, 1951).

Family, CYRTOPLEURITIDAE Diener

Genus, Cyrtopleurites Mojsisovics

Species of the genus Cyrtopleurites are mostly compressed, very involute to moderately involute forms. They have a more or less well-defined sulcus, bordered on either side by a row of fringed or notched external ears, which in some species pass at maturity into fringed or notched keels, and have only a few lateral rows of tubercles and fairly complex ammonitic to ceratitic suture lines. The genotype is Cyrtopleurites bicrenatus (Hauer).

Typical species of the genus, like C. bicrenatus, C. altissimus Mojsisovics, C. socius Mojsisovics, C. saussurei Mojsisovics, and C. himamalayicus Diener, of Norian Age, and C. partheniae Diener, of lower Karnian Age are very involute to involute, rarely moderately involute, and have 20 or more ribs to each half whorl. The external ears touch, or are joined at their bases, and in some species form wavy external keels. The suture line, where known, is ammonitic. This species group is represented in the Peace River faunas.

No species like C. herodoti Mojsisovics or C. jonkeri Diener are known in the Peace River faunas. They have fewer ribs, 15 or less to each half whorl, and are mostly more evolute than species of the C. bicrenatus group. The fringed external ears do not fuse to form keels, and only the ventro-lateral and median rows of tubercles are developed.

No species like C. thinnfeldi Mojsisovics or C. euphrasiae Diener, with their reduced ribbing, narrow venter, and fringed keels have yet been found in northeastern British Columbia. Nor have any like C. strabonis Mojsisovics, with strong, sigmoidal ribbing, fringed wavy keels, and ventro-lateral and median rows of long clavi or longitudinal lines, been collected.

No species resembling C. transiens Diener, C. indonesicus

Diener, C. agrippinae Mojsisovics, or C. hutteri Mojsisovics, all of Norian Age, nor any like C. hersiliae Diener from the Karnian-Norian Mischen fauna, have yet been found in the Peace River faunas. They have, as in the typical C. bicrenatus group, 20 or more ribs to each half whorl, but the ornament and suture line are simpler. The external ears appear to be smaller, are not joined at their bases, do not unite at any stage of growth to form keels, and in most instances are more weakly fringed. The rows of lateral tubercles are faint or lacking, and where they occur they generally represent the ventro-lateral and median rows. The average shell is more evolute than in the typical group of the genus. C. hutteri and C. hersiliae are very involute, and the other species moderately so. The suture line is ceratitic, and ES is undivided. Diener (1923) considers C. transiens to be a transition form between Cyrtopleurites and Tibetites and, as such, between the Cyrtopleuritidae and Tibetitidae. The merely weakly fringed ears and the ceratitic suture line might be interpreted as transitional stages, but not the weak, inconspicuous tubercles, and the poorly developed external ears. As suggested above, the species of this group of Cyrtopleurites could be transitional to the species or species group within the Trachyceratidae from which Cyrtopleurites was derived.

The typical ornament of Cyrtopleurites is exaggerated in an almost extravagant manner in the Peace River species Cyrtopleurites magnificus McLearn. The notching of the external ears is pronounced, and the bases of the external ears are united into a strong keel, above which the unfused parts of the ears project. Two well-defined lateral rows of tubercles and clavi occur, in addition to the ventro-lateral, median, and umbilical rows. The suture line is unknown.

The species groups of C. bicrenatus, C. herodoti, and C. thinnfeldi must of course be retained in the genus Cyrtopleurites, and it is doubtful whether a new genus should be made for the C. transiens group. It has been suggested, however, that a new genus be erected for C. magnificus (McLearn, 1939).

Genus, Himavatites Diener

Although in 1906 Diener described Himavatites as a subgenus of Acanthinites and used it as a subgeneric heading he also used it as though it were a genus in the heading for the description of Himavatites watsoni Diener. McLearn (1939, 1947) and Spath (1951) have treated it as a genus. The genotype is Himavatites watsoni Diener.

In the original description, Diener (1906) stressed the ribs of alternating strength, the stout, lateral spines - recalling to him the lateral ornament of Protrachyceras pollux Mojsisovics - the spiral rows of fine tubercles as in Acanthinites, and the external ears of Cyrtopleurites. McLearn (1939) has recorded the two rows

of fringed clavi on either side of the ventral sulcus and has observed that they originate, during growth of the shell, by splitting of the tubercles of a single row on either side. In 1951, Spath considered that the "peripheral aspect" of H. welteri Diener justifies the recognition of Himavatites as a distinct genus.

In a broad sense, Himavatites comprises involute species with numerous lateral ribs; numerous spiral rows of fine tubercles or spines, 1 to 3 on each rib; a more or less well-defined ventral sulcus; two rows of fringed or notched clavi on either side of the ventral sulcus; in typical species, large, fringed, or notched external ears on the inner row of external clavi; in some species, occasional stout ribs bearing a median row of large spines; a ventro-lateral row of large clavi; and, apparently, an ammonitic suture line.

The following species have been found in northeastern British Columbia:

Himavatites cf. watsoni Diener and H. multiauritus McLearn (1947) are both very close to the genotype and, when the variation of H. watsoni is better known, may prove to be only variants of it. Both have external ears as well as external clavi. In H. multiauritus the lateral spines are not very distinct, and there are no distinct, periodic strong ribs.

Himavatites columbianus McLearn has no large external ears, but does possess periodic strong ribs with large lateral spines.

Himavatites canadensis McLearn is farther removed from the genotype than any other of the species of this genus in the Peace River foothills. It has no large, external ears, no periodic strong ribs, and no large, lateral spines. It has, however, two rows of notched clavi on either side of the venter and some doubling of fine tubercles on the ribs where the lateral rows of tubercles cross them. It lacks, of course, the keels of typical Acanthinites.

Family, TIBETITIDAE Hyatt

The following genera have not yet been recognized in the faunas of northeastern British Columbia: Tibetites Mojsisovics, with smooth external ears, ceratitic suture line, and divided ES; Anatibetites Mojsisovics, with broad, low venter, well-defined ventro-lateral shoulders, smooth external ears, ceratitic suture line, and divided ES; Paratibetites Mojsisovics, with elevated venter, smooth external ears and keels, rare, sharp venter, ceratitic to ammonitic suture line, divided ES, and some adventitious elements in EL; and Neotibetites Krumbeck, with shells passing to a stage of sharp venter, and with simple ceratitic suture line.

Metacarnites Diener is placed close to Paratibetites by Spath (1951). It occurs in northeastern British Columbia, but only poor specimens have been collected. Pterotoceras Welter is discussed below. The ornament of Palicites Gemmellaro and even a small division in ES of the suture line suggest this family. The place of the genus Mojsisovicsites Gemmellaro in this family is more doubtful. Stikinoceras McLearn is referred to under Clionitidae.

Genus, Pterotoceras Welter

As a measure of caution it is considered advisable for the time being to interpret this genus in a broad sense and embrace within it species of both Middle and Upper Triassic age. The genotype is Pterotoceras arthaberi Welter from bed C. Bihati, island of Timor, said by Welter (1915) to be of Ladinian, that is, late Middle Triassic age.

The Ladinian holotype is compressed, moderately involute, and has a ventral sulcus. The inner whorls are ribbed and have three rows of tubercles, one around the umbilicus, another, median row from which the ribs bifurcate, and a third, ventro-lateral row. The ventral sulcus is bordered on either side by a row of external ears. While in the septate stage - as illustrated by the only known specimen - the ribs and the median and ventro-lateral rows of tubercles disappear, but the umbilical row of tubercles and the external rows of ears persist. The decline in lateral ornament has been noted by Spath (1951). The suture line has a fairly broad EL; broad, rounded, entire saddles, with S2 lower than S1; and what appears to be a poorly defined auxiliary saddle on the umbilical shoulder.

Spath (1951) has proposed the new generic name Dimorphotoceras for the Upper Triassic species Pterotoceras abnorme Diener. It is based on an incomplete, involute, compressed specimen with umbilical tubercles and external ears. It can be inferred from the illustration that ribs, median tubercles, and faint ventro-lateral tubercles occur only on the living chamber. So, in contrast with the Ladinian type, the lateral ornament appears to be increasing rather than decreasing with growth. Compared also with the Ladinian type, the suture line is weakly ammonitic rather than ceratitic, and adventitious saddles form in EL (See Spath, 1951). Based on this genotype, P. abnorme, the genus Dimorphotoceras Spath is distinct from typical Pterotoceras and its erection justified.

If other Upper Triassic species referred to Pterotoceras, including the Peace River P. caurinum, share the diagnostic characters of Dimophotoceras they should be placed in this genus. In P. clarissae Diener, the inner whorls have two lateral rows of tubercles and in addition an umbilical and a ventro-lateral row. With growth, the lower row of lateral tubercles disappears; the upper row becomes

weaker; and the ribs become broader and lower and finally disappear, whereas the umbilical tubercles and external ears persist and are even said to become stronger (Diener, 1923). Thus, a decrease rather than an increase in some of the lateral ornament occurs. Pterotoceras subclarissae Diener apparently does not show this decrease in lateral ornament, for it is said not to have the lateral ornament that occurs at an early stage of growth in P. clarissae. Pterotoceras insigne Diener displays a robust ornament of strong ribs, large ventro-lateral tubercles, and large external ears on the outermost whorl. The ornament of inner whorls, as seen in the umbilicus, suggests that it is strongly defined there. Tubercles of the umbilical and median rows are relatively weak. P. insigne is not so involute as D. abnorme and the suture line is subammonitic. In P. helminae Diener, the lateral ribbing is weak or missing, but large umbilical tubercles and external ears occur. So far as known, only P. clarissae of these Upper Triassic species exhibits, like the Ladinian type, any decline in lateral ornament with growth. The others, however, show no marked increase in lateral ornament and are not particularly close to D. abnorme, that is, to typical Dimorphotoceras Spath. It is preferred, tentatively at least, to group the Upper Triassic species, except D. abnorme, in Pterotoceras, used in a broad sense.

Pterotoceras caurinum McLearn

This species from the Pardonet beds of northeastern British Columbia (McLearn, 1939) is very variable, but can be retained in a broadly interpreted Pterotoceras. It is moderately involute and compressed, and has a more or less flat venter, bordered on either side by a row of triangular ears. The species has fine to coarse ribs, which tend to flatten on the outer part of the sides of the whorl; a row of umbilical nodes (or thickened ends of ribs); and, particularly in the finer ribbed variants, a median and a ventro-lateral row of very fine tubercles. The number of ribs and external ears vary. Finer and more numerous ribs are associated with smaller and more numerous external ears. Shells with smaller and more numerous external ears have, on the average, a smaller umbilicus than those with larger and fewer external ears. The suture line is ceratitic. ES is entire, except that it is divided by a small lobule in some specimens, as in Tibetites, but not in other known species of Pterotoceras; S1 is entire; S2 is smaller than S1 and is on the umbilical tubercle; L1 is longer than EL and denticulate at the base; and L2 is shorter than L1, and has about two notches. In its lack of strong ventro-lateral tubercles this species resembles P. helminae.

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