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Early Anisian (Middle Triassic) ammonoid biostratigraphy of northeastern British Columbia

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Key words: Ammonoids, Early Amisian, Middle Triassic, British Columbia

ABSTRACT

The Early Anisian ammonoid sequence of the Toad Formation in northeastern British Columbia has been subdivided into the Mulleri Zone and Caurus Zone by Tozer (1994a), with further distinction of Subzones 1 and 2 within the Caurus Zone. *Gymnites procerus* TOZER, *Caucasites orchardi* n. sp., *Stenopopanoceras* sp. indet., and *Ussurites muskwa* MCLEARN are here reported for the first time from Caurus Subzone 1. Another distinct fauna characterized by *Paracrochordiceras americanum* (MCLEARN) was thought to be of Early Anisan age but its stratigraphic position in relation to other Anisian faunas was so far unkown. Two new localities yielding this distinctive fauna have now been found. It appears that the fauna occurs in beds near the Early-Middle Anisian boundary, above Subzone 1 of the Early Anisian Caurus Zone and below the early Middle Anisian Hagei Zone. Besides *Paracrochordiceras americanum* (MCLEARN), diagnostic species for this fauna include *Bradyia cameronense* n. gen. n. sp., *Columboceras inflatum* n. gen. n. sp., *Stenopopanoceras normale* (MCLEARN), and *Columbisculites maclearni* TOZER. *Paracrochordiceras* is exclusively Early Anisian. Also, the associated species *Grambergia tetsaensis* MCLEARN, *Stenophyllites kindlei* (MCLEARN), and *Ussurites muskwa* MCLEARN range up from the Caurus Subzone 1 into the *P. americanum* Beds. Among the genera of the *P. americanum* fauna, only *Bradyia, Stenopopanoceras* and *Ussurites* range up into the Middle Anisian. The newly documented superpositional relationships and the faunal content indicate a latest Early Anisian allocation of this fauna. Similarities between the *P. americanum* Beds and Caurus Subzone 2 are not great, and their mutual superpositional relationships remain unknown. However, the *P. americanum* Beds of British Columbia provide a distinct assemblage which shows strong affinities with another newly discovered latest Early Anisian fauna in the Favret Formation of northwestern Nevada (Bucher, unpubl. data). This suggests that a higher resolution in the correlations between the mid- and low-paleolatitude plate-bound records of the North American Cordillera can be achieved for ammonoid faunas of Early Anisian age.

ZUSAMMENFASSUNG

Die Abfolge der Ammonitenfaunen in der Toad Formation (Frühes Anis) von NE British Columbia wurde von Tozer (1994a) in die Mulleri-Zone und die Caurus-Zone unterteilt, wobei die Caurus-Zone noch in eine Subzone 1 und eine Subzone 2 unterteilt wurde. Hier wurden nun *Gymnites procerus* TOZER, *Caucasites orchardi* n. sp., *Stenopopanocerassp. indet.*, und *Ussurites muskwa* MCLEARN zum ersten Mal in der Caurus Subzone 1 gefunden. Eine andersartige Fauna, charakterisiert durch *Parachordiceras americanum* (MCLEARN) wurde früher ins Frühe Anis gestellt, allerdings war ihre stratigraphische Position im Verhältnis zu anderen anisischen Faunen bisher unbekannt. Zwei neue Lokalitäten mit dieser charakteristischen Fauna wurden jetzt gefunden. Es zeigt sich, dass diese Fauna in Schichten nahe der Grenze Frühes/Mittleres Anis vorkommt, oberhalb der Subzone 1 der frühanisischen Caurus-Zone und unterhalb der Hagei-Zone des frühen Mittelanis. Neben *Parachordiceras americanum* (MCLEARN) sind diagnostische Arten dieser Fauna *Bradyia cameronense* n. gen. n. sp., *Columboceras inflatum* n. gen. n. sp., *Stephanopoanoceras normale* (MCLEARN) und *Columbisulcites maclearni* TOZER. *Parachordiceras* ist auf das Frühe Anis beschränkt. Die begleitenden Arten *Grambergia tetsaensis* MCLEARN, *Stenophyllites kindlei* (MCLEARN) und *Ussurites muskwa* MCLEARN reichen von der Caurus-Subzone 1 hinauf in die *P. americanum*-Schichten. Von den Gattungen der *P. americanum*-Fauna reichen nur *Bradyia, Stenopopanoceras* und *Ussurites* hinauf bis ins Mittlere Anis. Die neu dokumentierten Lagerungsbeziehungen und der Fauneninhalt dieser Fauna zeigen ein spätestes Frühes Anis an. Die Ähnlichkeiten der *P. americanum*-Schichten mit der Caurus-Subzone 2 sind nicht gross, und ihre stratigraphischen Beziehungen sind nach wie vor unbekannt. Dagegen entsprechen die *P. americanum*-Schichten von British Columbia einer distinkten Artengesellschaft, die grosse Verwandtschaft mit einer anderen Fauna des spätesten Unteranis, die kürzlich in der Favret Formation NW Nevadas entdeckt wurde (Bucher, unveröff.). Das spricht dafür, dass eine höhere Auflösung erreicht werden kann bei Korrelationen zwischen Ammonitenfaunen des Frühen Anis aus mittleren und höheren Paläolatituden der Platte der nordamerikanischen Kordillere.

1. Introduction

The Toad Formation in the Rocky Mountain Foothills of northeastern British Columbia has yielded a wealth of Middle Triassic ammonoids, on which Silberling & Tozer (1968) and Tozer (1967, 1982) based the North American mid-paleolatitude, plate-bound standard succession. Anisian ammonoid faunas from the Tetsa River Valley (northeastern British Columbia) were first made known by McLearn (1946a, 1946b, 1948, 1969) and McLearn & Kindle (1950). The geology of the Tetsa

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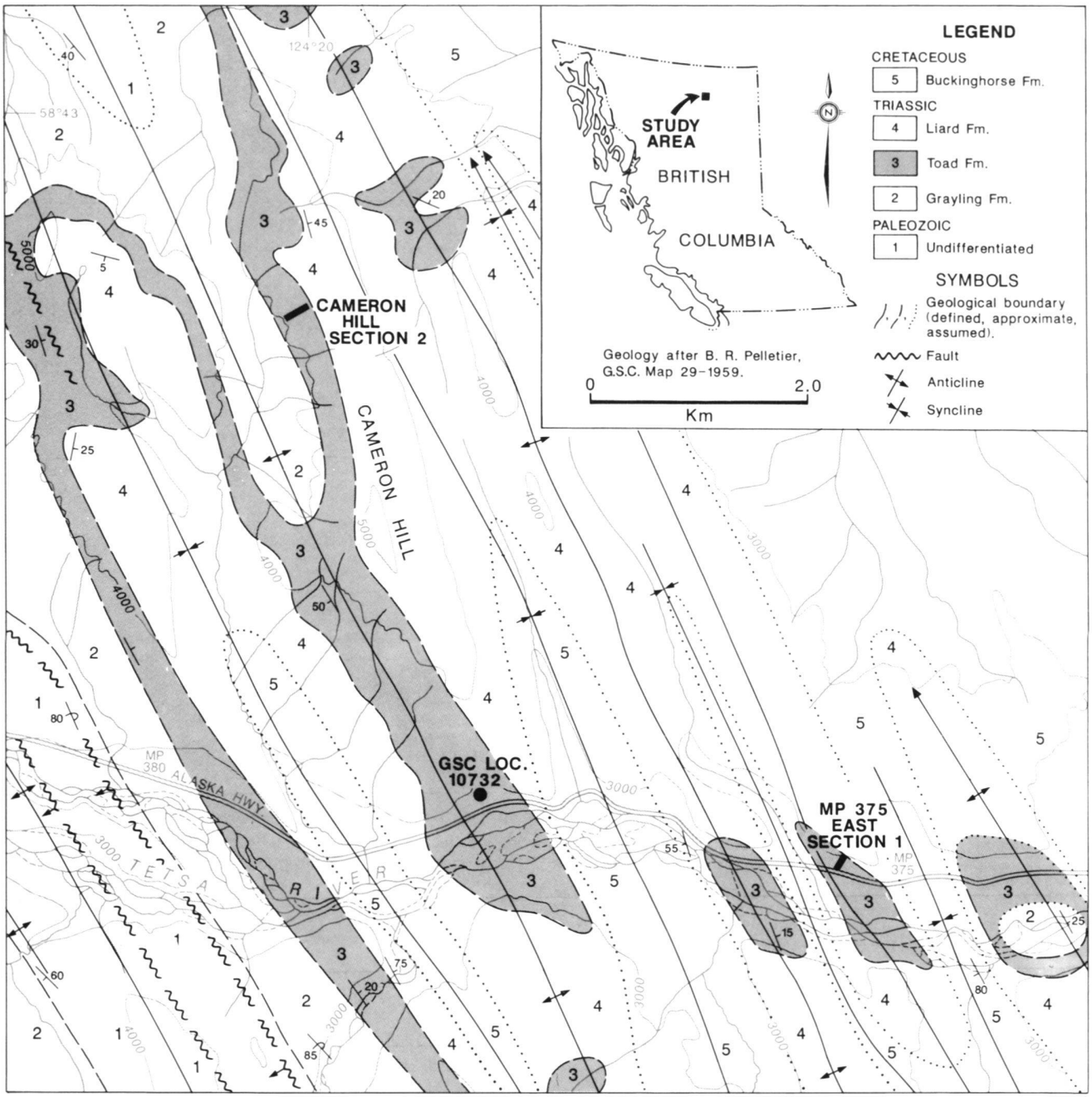

Fig. 1. Geological map (after Pelletier, 1959) and localities belonging to the *Paracrochordiceras americanum* Beds in the Tetsa River Valley, Rocky Mountains Foothills, northeastern British Columbia. Shaded geological unit (3) indicates the Toad Formation of Early and Middle Triassic age.

River Valley and adjoining areas has been mapped by Pelletier (1959). Later reports on the Triassic geology and biostratigraphy of the area are in Pelletier (1960, 1961, 1963), Tozer (1967), and Taylor & Stott (1973). This standard has been revised recently and updated by Tozer (1994a) in a comprehensive biostratigraphic and taxonomic treatment of the Triassic ammonoids from Canada. New Early, Middle, and Late Anisian collections and biostratigraphic data were obtained by the writer from the Toad Formation of the Tetsa River Valley (Figure 1). This paper deals only with the Early Anisian material. The Middle and Late Anisian will be treated separately.

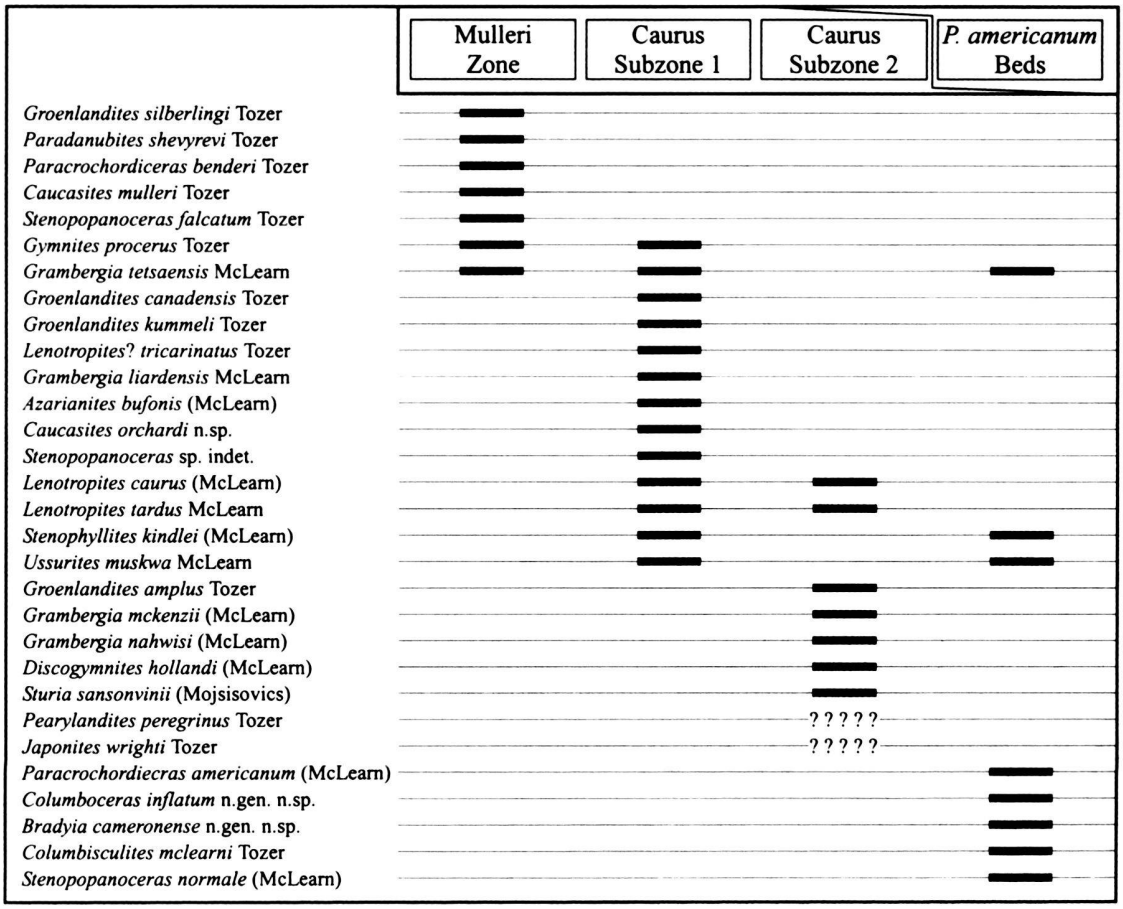

Fig. 2. Biostratigraphic distribution of Lower Anisian ammonoids from the Toad Formation, northeastern British Columbia. Based on both present work and Tozer (1994a).

2. Early Anisian biostratigraphy

Following the biostratigraphic zonation established by Bucher (1989) for the low-paleolatitude Early Anisian record in Nevada, the biostratigraphic subdivions of this substage in northeastern British Columbia have been subsequently updated by Tozer (1994a). Tozer recognizes two zones: Mulleri and Caurus, the latter being subdivided into Caurus Subzone 1 and Caurus Subzone 2 (see Figure 2). However, McLearn (1946, 1948, 1969) described another distinct, but stratigraphically isolated fauna characterized by *Paracrochordiceras americanum* (McLearn) at GSC loc. 10732 (southern tip of Cameron Hill, see Figure 1). Since McLearn's discovery, this unique fauna has never been duplicated, and its stratigraphic position with respect to other Anisian ammonoid assemblages has remained unknown. Our new field investigations have now further documented McLearn's fauna in two sections: Cameron Hill 2 and Mile Post 375 East (see Figure 1). At Cameron Hill 2, the *P. americanum* fauna (loc. C-209951) occurs 3.9 m below the base of the Middle Anisian Hagei Zone (loc. C-209953). At Mile Post 375 East, the *P. americanum* fauna (loc. C-209952) is found 4.6 m below the Hagei Zone (loc. C-209954) and about 12 m above the type locality of Subzone 1 of the Caurus Zone (GSC loc. 68203). The section at Mile Post 375 East is the most complete Early Anisian succession known from northeastern British Columbia. There, the Mulleri Zone (GSC loc, 68226), Caurus Subzone 1 (GSC loc. 68203), and the *P. americanum* fauna (loc. C-209952) are documented in sequence. Unfortunately, the Caurus Subzone 2 fauna is not known from this section.

The *P. americanum* fauna at Cameron Hill 2 (loc. C-209951) also comprises *Bradyia cameronense* n. gen. n. sp., *Grambergia tetsaensis* McLearn, *Columbisculites maclearni* Tozer, *Stenophyllites kindlei* (McLearn), and *Ussurites muskwa* McLearn. The *P. americanum* fauna at Mile Post 375 East (loc. C-209952) also includes *Bradyia cameronense* n. gen. n. sp., *Columboceras inflatum* n. gen. n. sp., *Grambergia tetsaensis* McLearn, *Stenophyllites kindlei* (McLearn), and *Ussurites muskwa* McLearn. The fauna at McLearn's original locality (GSC loc. 10732, McLearn 1969, p. 8), as revised by Tozer (1994a), includes *Paracrochordiceras americanum* (McLearn), *Gramgergia tetsaensis* McLearn, *Columbisculites maclearni* Tozer, *Stenopopanoceras normale* (McLearn), *Stenophyllites kindlei* (McLearn), and *Ussurites muskwa* McLearn.

The diagnostic ammonoid association for this fauna includes: *Paracrochordiceras americanum, Stenopopanoceras normale, Columbisculites maclearni, Bradyia cameronense*, and *Columboceras inflatum*. Representatives of *Groenlandites* KUMMEL, *Lenotropites* POPOV, *Pearylandites* KUMMEL, and *Caucasites* SHEVYREV, which are well represented in the Mulleri and Caurus zones from both Nevada and northeastern British Columbia, are not known from this fauna. *Columbisculites* is apparently restricted to this fauna, whereas *Bradyia* ranges into younger beds, being in the Middle Anisian of Nevada ("*Acrochordiceras*" *coyotense* BUCHER from Constrictus Subzone of the Hyatti Zone, see Bucher 1992).

In the Toad Formation, *Caucasites* (*C. mulleri* TOZER) and *Gymnites procerus* TOZER were previously only known from the Mulleri Zone. *Caucasites orchardi* n. sp., *Gymnites procerus* TOZER, and *Ussurites muskwa* MCLEARN are recorded for the first time from the Caurus Zone (Subzone 1) at GSC loc. 68203. Figure 2 provides a summary of the biostratigraphic distribution of Early Anisian ammonoids from northeastern British Columbia as presently known.

Superpositional relationships documented from the sections at Cameron Hill 2 and Mile Post 375 East as well as faunal content confer a latest Early Anisian age to the *P. americanum* Beds. However, McLearn (1969, p.12) described one specimen of *P. americanum* from Liard River (GSC loc. 10660). Occurrences at this locality were described by Tozer (1994a), with a succession from Caurus Subzone 1 to Subzone 2, followed by the Middle Anisian Hagei Zone. Unfortunately, the position of *P. americanum* in relation to the Caurus subzones remains unknown. In Tetsa River Valley (Cameron Hill 2 and Mile Post 375 East), Caurus Subzone 2 is so far not documented. The stratigraphic relationship of the *P. americanum* Beds with respect to Caurus Subzone 2 thus remains uncertain, as suggested in Figure 2.

In the Tetsa River Valley, a tectonic culmination consisting of Paleozoic rocks (see SW corner of Figure 1) apparently separates two groups of facies within Anisian strata of the Toad Formation. West of the culmination, Anisian strata are predominantly shaly and contain pavements of phosphatic ammonoids. East of the tectonic culmination, correlative rocks consist of interbedded sandstone, siltstone, silty limestone, occasional limestone concretions, and shale. There, ammonoid occurrences do not show any sign of condensation. Furthermore, the detailed lithostratigraphic sequence appears to be laterally consistent in the eastern facies belt, with abundant marker beds. For instance, the horizon yielding the *P. americanum* fauna provides a conspicuous marker which consists of widely spaced (up to 15 m apart), black silty limestone nodules attaining a maximum diameter of about 90 cm. In the studied area, the apparently rapid transition between the eastern facies belt and the deeper-water western facies belt suggests that a west-facing paleotopographic break existed along the future emplacement of the tectonic culmination.

The *P. americanum* Beds have no exact counterpart in the low-paleolatitude sequence of Nevada as established by Bucher (1989, Table 2), nor do they correlate well with the Siberian Tardus Zone (Dagys, 1988) whose *Lenotropites-Czekanowskites-Arctohungarites* association suggests a post-Caurus and pre-Middle Anisian age (see further discussion in Bucher, 1989: 960). However, another newly discovered latest Early Anisian fauna in the Favret Formation of Nevada (loc. HB 544 & 545, McCoy– Wildhorse mines area, Pershing County) resembles the Canadian *P. americanum* fauna, including *Bradyia, Grambergia*, and *Columbisculites* associated with typical low-paleolatitude taxa such as *Silberlingites* and earliest representatives of *Balatonitidae* (Bucher, unpubl. data). The stratigraphic position of this assemblage is unfortunately not known with respect to the Early Anisian sequence as established from the Prida Formation in northern Humboldt Range. Nevertheless, the new occurrence from Nevada suggests that the faunal assemblage provisionally referred to as *P. americanum* Beds in northeastern British Columbia has a significant potential for correlation between the mid- and low-paleolatitude records of the North American Cordillera.

All the taxa known from the *P. americanum* Beds are illustrated in Plate 1 with the exception of *Stenopopanoceras normale* (MCLEARN) whose unique occurrence is at locality GSC 10732 (see Tozer, 1994a). Systematic descriptions include new taxa as well as emended descriptions for some others.

3. Systematic descriptions

Conventions. Locality numbers with GSC prefix, e.g., GSC 10732, are in the Catalogue of the Geological Survey in Ottawa. Numbers prefixed C-, e.g., C-209951, are in the Catalogue of the Institute of Sedimentary and Petroleum Geology in Calgary. Occurrences of taxa described hereafter include the number of specimens obtained from each locality. For example, C-209951 (2) means that two specimens were identified from loc. C-209951. Whorl height (H), whorl width (W), and umbilical diameter (U) are expressed as percentages of the shell diameter. The systematic descriptions follow the classification of Tozer (1981). The definition and classification of the outer shell features termed megastriae are in Bucher & Guex (1990).

Order *Ceratitida* HYATT, 1884
Superfamily *Megaphyllitaceae* MOJSISOVICS, 1896
Family *Parapopanoceratidae* TOZER, 1971
Genus *Stenopopanoceras* POPOV, 1961
Type species: *Stenopopanoceras mirabile* POPOV, 1961

Stenopopanoceras sp. indet.
Pl. 1, Fig. 25–26

Description. A single small immature specimen was obtained from the Caurus Zone. Outline of last volution initially semicircular, venter becomes blunt and angular on end of last, volution. Coiling egressive.

Fig. 3. Suture line of *Gramberigia tetsaensis* McLEARN. Plesiotype, GSC 101809, loc. C-209951, *Paracrochordiceras americanum* Beds, × 2.

Discussion. This specimen can be assigned to *Stenopopanoceras* with some confidence on account of its early egressive coiling and angular venter, but it is too incomplete for identification at the species level.

Occurrence. GSC loc. 68203 (1), Mile Post 375 East, Caurus Zone (Subzone 1), Toad Formation, northeastern British Columbia.

Superfamily *Ceratitaceae* MOJSISOVICS, 1879
Family *Longobarditidae* SPATH, 1951
Subfamily *Longobarditinae* SPATH, 1951
Genus Grambergia POPOV, 1961
Type species: *Grambergia taimyrensis* POPOV, 1961

Grambergia tetsaensis McLEARN, 1969
Pl. 1, Fig. 27–34; Text-fig. 3

Grambergia tetsaensis McLearn, 1969, p. 36, Pl. 7, figs. 1–5; Tozer, 1994a, p. 101, Pl. 43, figs. 3–4, Pl. 44, figs. 3–4, 10.

Description. Innermost whorls evolute, venter smooth and rounded, lateral folds of variable strength. Venter gradually becomes blunt and angular at about 7 mm in diameter. Faint, wavy rursiradiate folds on lower two thirds of flanks gradually fade away. Umbilicus very small or nearly occluded. Venter raises into a true keel at about 14 mm in diameter, and becomes acute at a size of 30–40 mm. Whorl section becomes lanceolate with very small but open umbilicus. On outer shell only, up to 5 barely visible spiral lines occasionally occur on outermost fourth of flanks. Growth lines typically biconvex, with a first broad shallow sinus on lower flanks and a second, much shorter sinus on outer flanks. Largest, complete and mature specimen 88mm in diameter. Mature body chamber about two thirds of a whorl. At D = 57 mm, H = 59%, W = 21%, and U = 3%. Suture line with lateral lobe deeper than first umbilical lobe.

Occurrence. Loc. C-209951 (5), GSC loc. 10732 (6), Cameron Hill; C-209952 (5), Mile Post 375 East; *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia. Occurrences from the Mulleri and Caurus zones listed in Tozer (1994a).

Family *Acrochordiceratidae* ARTHABER, 1911
Genus *Paracrochordiceras* SPATH, 1934
Type species: *Acrochordiceras anodosum* WELTER, 1915

Paracrochordiceras americanum (McLEARN), 1946
Pl. 1, Fig. 1–4

Acrochordiceras (Paracrochordiceras) americanum McLearn, 1946a, p. 16; McLearn, 1946b, p. 3, Pl. 5, fig. 1; McLearn, 1948, p. 25, Pl. 5, fig. 1; McLearn, 1969, p. 12, Pl. 1, figs. 1–3; Tozer, 1967, p. 23, 77 (only); Tozer, 1994a, p. 111, Pl. 42, figs. 1–3.
Non *Paracrochordiceras americanum* McLearn. Silberling & Nichols, 1982, p. 21, Pl. 29, figs. 1–9 (= *P. plicatum* Bucher, 1989, p. 974).
Non *Paracrochordiceras americanum* McLearn. Tozer, 1967, p. 69, (= *P. benderi*, Tozer, 1994a).

Description. Inner whorls rounded, slightly depressed, with coarse and rursiradiate plicate ribbing on flanks but fading on the low arched venter. Ribs typically single when between two consecutive megastriae. Paired ribs associated with megastriae and conspicuous lateral parabolic on inner whorls. Umbilical shoulder indistinct, with flanks grading into the gently rounded umbilical wall. On outer whorls, loss of parabolic nodes concomitant with migration of branching point on lower flanks. Paired ribs gradually become predominant and progressively change into sinuous trajectory. While at early ontogenetic stage costation is more prominent on lower flanks, it becomes comparatively stronger on the upper flanks and venter at larger shell diameters. The whorl section also acquires a subquadrate outline, with development of rounded umbilical and ventral shoulders. Mature body chamber imperfectly known, but apparently characterized by a decreasing number of branching ribs. At D = 38 mm (plesiotype GSC 101812), H = 33%, W = 33%, and U = 46%. Largest size estimated at about 5cm in diameter. Suture line incompletely known but ceratitic, for plesiotype GSC 101813 shows smooth saddles.

Discussion. Among the localities from which McLearn (1969) reported *P. americanum*, GSC loc. 10660 on the Liard River poses a problem. With the exception of *P. americanum*, this lot of ammonoids collected by E. D. Kindle typically represents a Caurus Zone assemblage. A first alternative is that this locality encompasses more than one bed, because *P. americanum* has never been recorded from any other Caurus Zone assemblage. Although less likely, another alternative is that this locality would indicate the earliest stratigraphic occurrence of *P. americanum*. Because Caurus Subzone 2 and *P. americanum* Beds have never been documented in stratigraphic succession, a formal separation of these two faunas is still uncertain as shown in Figure 2.

"*Paracrochordiceras americanum*" was also originally recorded from GSC loc. 68226 (Mulleri Zone, Mile Post 375 East) by Tozer (1967, p. 69), but based on distinctive morphological grounds, this occurrence is now separated from *P. americanum* by Tozer (1994a) and has been renamed as *P. benderi.*

Occurrence. Loc. C-209951 (3), GSC loc. 10732 (2), Cameron Hill, *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia.

Genus *Columboceras* n. gen.
Type species: *Columboceras inflatum* n. sp.

Diagnosis. Depressed, somewhat inflated, moderately evolute, and finely ribbed acrochordiceratid without tuberculation.

Description. Venter broad, with semi-circular outline, indistinct flanks limited by high and convex umbilical wall. Up to about 1cm in diameter, the holotype shows parabolic megastriae, but without elevation at the emplacement of the parabolic segment. Plicate ribbing dense and fine, straight or slightly prorsiradiate, with only a few ribs branching below mid-line of flanks. No elevation occurs at branching point. Ribs gradually attain their greater strength on venter. At D = 21 mm (holotype of type species), H = 40%, W = 63%, and U = 26%. Suture line not known.

Etymology. Genus name derived from the Province of British Columbia.

Discussion. Conch shape of *Columboceras* invites comparison with *Pseudacrochordiceras*, a genus name introduced by Tozer (1994b) for the late Spathian *Acrochordiceras inyoense* SMITH (1914). However, the distinction at the genus level is based on the absence of any suggestion of tuberculation. *Columboceras* also differs from *Paracrochordiceras* and *Acrochordiceras* by its depressed shape and absence of tuberculation.

Columboceras inflatum n. sp.
Pl. 1, Fig. 5–6

Diagnosis and Description. As for the genus.
Etymology. Refers to the inflated whorl shape.
Occurrence. Loc. C-209952 (1), Mile Post 375 East, *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia.

Genus *Bradyia* n. gen.
Type species: *Braydia cameronense* n. sp.

Diagnosis. Small to medium-sized, non-tuberculated acrochordiceratid with constrictions and subdued plicate ribbing. Conch evolute, with either rounded or somewhat depressed whorl section. Length of body chamber at least of three forths of a whorl. Suture line subammonitic, with deeply indented and broad lateral lobe.

Etymology. Genus named for David Brady, Unionville (Nevada).

Composition of the genus. Braydia cameronense n. sp., *Bradyia coyotense* (Bucher).

Discussion. Distinction from both *Paracrochordiceras* (Early Anisian) and *Acrochordiceras* (Middle Anisian) is based on the combined absence of tubercles and presence of constrictions. The new genus is the only known acrochordiceratid that possesses constrictions. The subammonitic suture line of *Bradyia* is closely similar to that of *Acrochordiceras* and differs only in having a broader first umbilical saddle. Phylogenetically, *Bradyia* is interpreted as a separate offshoot of the earlier Early Anisian paracrochordiceratid stock, from which *Acrochordiceras* also evolved around the Early-Middle Anisian boundary.

Fig. 4. Suture line of *Bradyia cameronense* n. gen. n. sp. Holotype, GSC 101815, loc. C-209951, *Paracrochordiceras americanum* Beds, × 6.

Remarks. From the Middle Anisian sequence of Nevada, *"Acrochordiceras" coyotense* was described by Bucher (1992, p. 152, Pl. 6, figs. 1721) from the Constrictus Subzone of the Hyatti Zone. This species is here assigned to *Bradyia.* Plicate ribbing and constrictions are characters commonly shared by at least some Anisian representatives of *Balatonitidae* (e.g. *Ginsburgites*, see Bucher, 1992, p. 154, Pl., figs. 611) and *Acrochordiceratidae* (e.g. *Bradyia* n. gen.), suggesting close phylogenetic relationships at the family level. Biostratigraphic constraints suggest that *Acrochordiceratidae* may have branched off from *Balatonitidae* during the Spathian (Bucher, unpubl. data).

Occurrence. Latest Early Anisian (*P. americanum* Beds), Toad Formation, northeastern British Columbia; earliest Middle Anisian (Hyatti Zone, Constrictus Subzone), Fossil Hill Member of the Prida Formation, Nevada.

Bradyia cameronense n. sp.
Pl. 1, Fig. 35; Text-fig. 4

Diagnosis. Small-sized, evolute *Bradyia* with rounded whorl section and subdued ribbing.

Description. Shell shape evolute with rounded whorl section. The holotype has 12 shallow constrictions on the ultimate volution. Plicate ribs bordering the prorsiradiate constrictions invariably have a greater strenght than intervening ribs. Umbilical margin well defined and first rounded, then becoming higher and convex. At D = 26.5mm (holotype), H = 31%, W = 39%, and U = 45%.

Etymology. Species named derived from Cameron Hill.

Discussion. Distinguished from *B. coyotense* (BUCHER) by its more serpenticone shape, weaker ribbing, and more numerous constrictions.

Occurrence. Loc. C-209951 (1), Cameron Hill 2; C-209952 (2), Mile Post 375 East, *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia.

Superfamily *Ptychitaceae* MOJSISOVICS, 1882
Family *Isculitidae* SPATH, 1951
Genus *Columbisculites* TOZER, 1994a
Type species: *Columbisculites maclearni* TOZER, 1994a

Columbisculites maclearni TOZER, 1994a
Pl. 1, Fig. 19–24

Columbisculites maclearni TOZER, 1994a, p. 133, Pl. 45, fig. 11.

Emended description. Medium-sized isculitid with permanently occluded umbilicus and smooth outer shell. Intraspecific variation expressed by about 50% variation of the shell width. Growth lines straight on inner flanks, gently rursiradiate on upper flanks, and sinus-shaped on venter. Occurrence of constrictions highly variable, from none to up to five per half-whorl. On phragmocone, constrictions visible on both inner mold and outer shell. On mature body chamber, constrictions only visible on inner mold, not on outer shell. Outer shell of mature body chamber with occasional crinkled megastriae and wrinkle layer on dorsal side. Spiral lines occur on inner mold of mature body chamber. Broad peristomal collar on final aperture. Length of mature body chamber about four-thirds of a whorl. Suture line ammonitic with finely frilled and elongated elements (see Tozer, 1994a, fig. 32f).

Discussion. As a monospecific genus, *Columbisculites* is distinguished from all representatives of *Isculites* MOJSISOVICS (Early and Middle Anisian age) and *Nevadisculites* BUCHER (Middle Anisian age) by having a permanently occluded umbilicus and rursiradiate growth lines. Although the presence of constrictions very variable in *Columbisculites*, this character is shared with *Isculites,* but not with *Nevadisculites* (see Bucher, 1988, p. 744). On the other hand, the suture line of *Columbisculites* compares more closely with that of *Nevadisculites* (see Bucher 1988, fig. 16) than with that of *Isculites* (see Silberling & Nichols, 1982, fig. 26).

Occurrence. Loc. C-209951 (6), GSC 10732 (2), Cameron Hill 2 *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia.

Superfamily *Pinacocerataceae* MOJSISOVICS, 1879
Family *Gymnitidae* WAAGEN, 1895
Subfamily *Japonitidae* TOZER, 1971
Genus *Caucasites* SHEVYREV, 1968
Type species: *Caucasites evolutus* SHEVYREV, 1968

Caucasites orchardi n. sp.
Pl. 1, Fig. 17, 18; Text-fig. 5

Diagnosis. Cadicone, somewhat compressed *Caucasites* with megastriae on outer shell.

Description. Flanks slightly convex and converging, venter narrowly rounded. Whorl section becomes subfastigate as whorl height increases. Umbilical shoulder narrowly rounded, with progressively higher and slightly convex umbilical wall. Shell surface smooth, with prorsiradiate striae. Last whorl of phragmocone bears four megastriae showing deep U or V-shaped ventral sinuses imparting an irregular lateral outline to the siphonal line. Some bundling of growth striae results from intersection by megastriae. Remains of the flattened body chamber which were removed during preparation indicate a length of at least seven eighths of a whorl. At D = 36 mm (end of phragmocone), H = 37%, W = 42%, and U = 35%. Suture line ammonitic, conforming to that of the genus. Lateral saddle massive and less elongated than the first external saddle. Lateral saddles forming a somewhat retracted suspensive lobe.

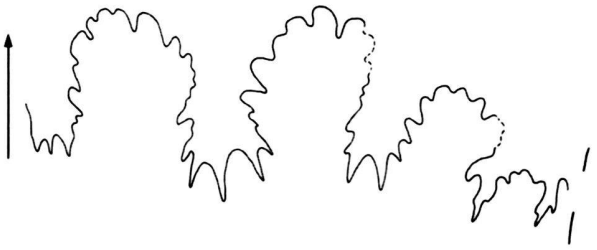

Fig. 5. Suture line of *Caucasites orchardi* n. sp. Holotype, GSC 101820, loc. GSC 68203, Caurus Zone, Subzone 1, × 6.

Etymology. Species named for Michael J. Orchard, Geological Survey of Canada (Vancouver).

Discussion. Among all of the representatives of *Caucasites*, presence of megastriae and the slightly retracted outline of the suspensive lobe are distinctive characters of *C. orchardi* n. sp. Tighter coiling is an additional difference with *C. mulleri* TOZER (Mullleri Zone of northeastern British Columbia), *C. evolutus* SHEVYREV, and *C. inflatus* SHEVYREV. A more compressed whorl section allied with a more subfastigate venter also permit distinction from *C. nicholsi* BUCHER. Although intraspecific variation of *C. orchardi* n. sp. cannot be assessed, its general shell shape more closely resembles that of compressed variants of *C. nicholsi* from the Mulleri Zone of Nevada (Bucher, 1989, p. 980).

Occurrence. GSC loc. 68203 (1), Caurus Zone, Subzone 1, Mile Post 375 East, Toad Formation, northeastern British Columbia.

Fig. 6. Suture line of *Stenophyllites kindlei* (McLEARN). Plesiotype, GSC 101810, loc. C-209951, Caurus Zone, Subzone 1, × 6.

Fig. 7. Suture line of *Ussurites muskwa* McLEARN. Plesiotype, GSC 101811, loc. C-209951, Caurus Zone, Subzone1, × 3.

Order *Phylloceratida* ZITTEL, 1884
Superfamily *Ussuritaceae* (HYATT, 1900)
Family *Palaeophyllitidae* POPOV, 1958
Genus *Stenophyllites* TOZER, 1994a
Type species: *Leiophyllites? kindlei* McLEARN, 1946.

Stenophyllites kindlei (McLEARN, 1946)
Pl. 1, Fig. 1316; Text-fig. 6

Leiophyllites? kindlei McLearn, 1946a, p. 10; Appendix II, p. 1, Pl. 2, fig. 4; McLearn, 1948, p. 12, Pl.2, fig. 4.
Leiophyllites kindlei McLEARN. Tozer, 1967, p. 23, 71; McLearn, 1969, p. 55, Pl. 1, fig.9.
Stenophyllites kindlei (McLEARN). Tozer, 1994a, p. 269, Pl. 46, figs. 46.

Description. Evolute, extremely platycone, and smooth *Stenophyllites.* Venter rounded and umbilical margin very low but steep. At D = 34 mm, H = 41%, W = 15%, and U = 32%. Suture line with finely indented lobes, and flanks of saddles crenulated. Ventral lobe wide, first umbilical lobe deeper than lateral lobe.

Discussion. Comparison of the specimens from the *P. americanum* Beds does not show any significant difference with older representatives from the Caurus Zone.

Occurrence. Loc. C-209951 (3), Cameron Hill 2; GSC 10732 (12), Cameron Hill; loc. C-209952 (6), Mile Post 375 East; *Paracrochordiceras americanum* Beds, Toad Formation, northeastern British Columbia. Occurrences from the Caurus Zone in the Toad Formation listed in Tozer (1994a).

Family *Ussuritidae* HYATT, 1900
Genus *Ussurites* HYATT, 1900
Type species. *Monophyllites sichoticus* DIENER, 1895

Ussurites muskwa McLEARN, 1946
Pl. 1, Fig. 11–12, Text-fig 7

Ussurites muskwa McLearn, 1946a, p. 10; Appendix II, p. 1, Pl. 3, figs. 34; McLearn, 1948, p. 13, Pl. 3, figs. 34; Tozer, 1967, p. 23, 69, 71; McLearn, 1969, p. 53, Pl. 13, figs. 12; Tozer, 1994a, p. 269, Pl. 46, figs.13.
Ussurites sp. cf. U. muskwa McLearn. Tozer, 1967, p. 71.

Description. Ussurites with megastriae associated with spirally elongated marginal auriculoids occurring up to a shell diameter of about 3 cm. Striation slightly prorsiradiate, with some bundling on the flanks resulting from their intersection with megastriae. Megastriae also impart a polygonal outline to the umbilicus on innermost whorls. Transition to outer whorls enhanced by gradual transformation from a subquadrangular, somewhat rounded whorl section to a much higher, subrectangular shape with concomitant accentuation of umbilical shoulders. Irregularly distributed wavy ribs still persist and are superimposed on the striation on flanks but do not cross the uniformly arched venter. The largest known specimen is about 9 cm in diameter (see McLearn, 1969, Pl. 13, fig. 2). At D = 54 mm, H = 39%, W = 26%, and U = 35%. Suture line conforms with original illustration of McLearn (1969, fig. 28).

Discussion. Distinguished from *U. cameroni* McLEARN of Upper Anisian age (Deleeni Zone from northeastern British Columbia) by a less complexly subdivided first lateral lobe, presence of wavy folds, an ontogenetically more extended marginal tuberculation, and an apparently smaller size; from *U. detwilleri* BUCHER (Caurus Zone from Nevada) by absence of well-defined ribbing on inner whorls. The range of *U. cameroni* is also here newly extended to the Caurus Zone (Subzone 1).

Occurrence. GSC loc. 68203 (1), Caurus Subzone 1, Mile Post 375 East. Loc. C-209951 (3), Cameron Hill 2; loc. C-209952 (2), Mile Post 375 East; *Paracrochordiceras americanum* Beds; Early Anisian, Toad Formation, northeastern British Colubia.

Acknowledgments

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PLATE 1

(All figures natural size)

Fig. 1–4. *Paracrochordiceras americanum* McLEARN, *Paracrochordiceras americanum* Beds, loc. C-209951; 1–2, plesiotype, GSC 101812; 3–4, plesiotype, GSC 101813.

Fig. 5–6. *Columboceras inflatum* n. gen. n. sp., *Paracrochordiceras americanum* Beds, holotype, GSC 101814, loc. C-209952.

Fig. 7–10. *Bradyia cameronense* n. gen. n. sp., *Paracrochordiceras americanum* Beds; 7–8, plesiotype, GSC 1011815, loc. C-209952; 9–10, holotype, GSC 101816, loc. C-209951.

Fig. 11–12. *Ussurites muskwa* McLEARN, *Paracrochordiceras americanum* Beds, loc. C-209951, plesiotype, GSC 101817.

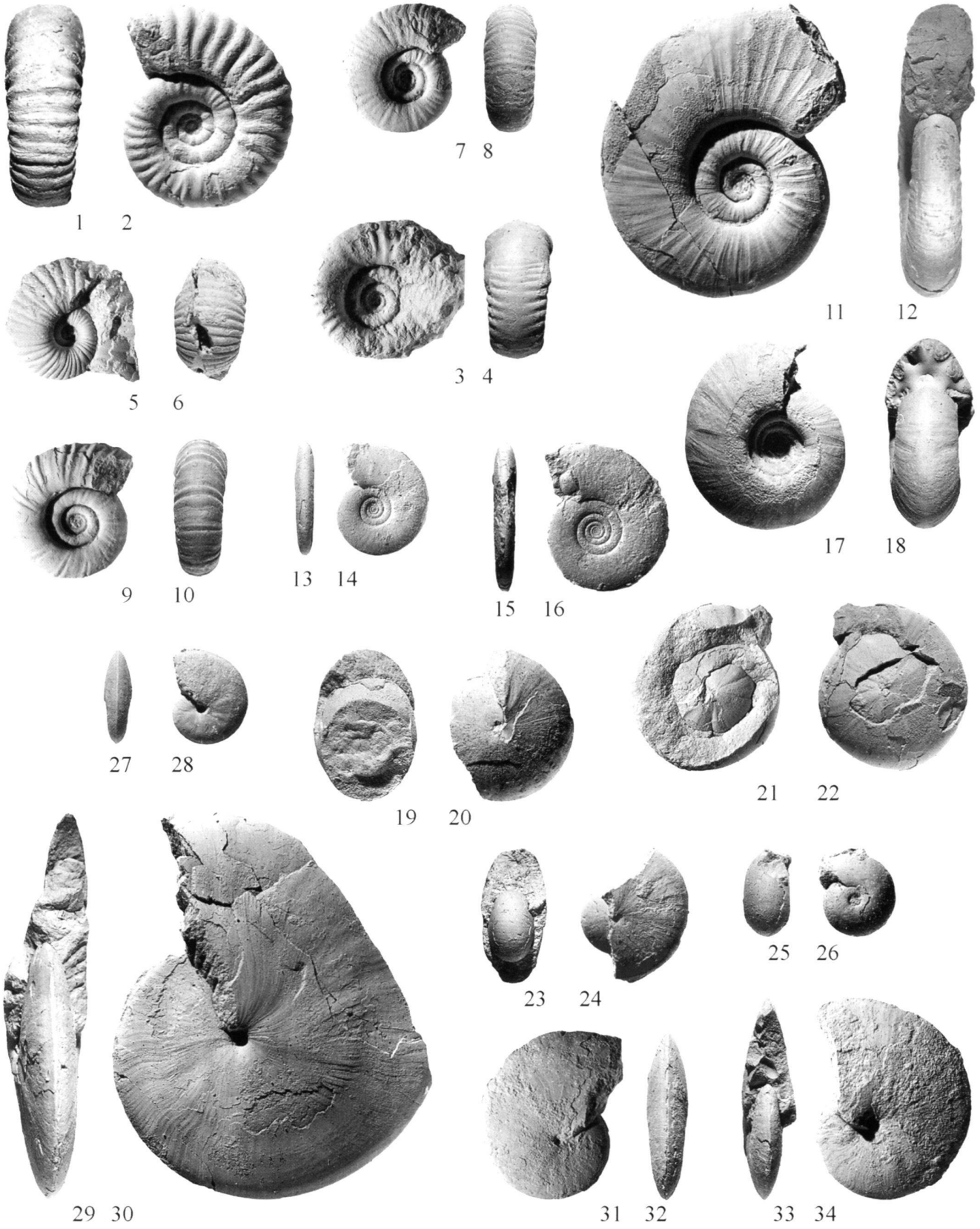
Fig. 13–16. *Stenophyllites kindlei* (McLEARN), *Paracrochordiceras americanum* Beds; 13–14, plesiotype, GSC 101818, loc. C-209951; 15–16, plesiotype, GSC 101819, loc. C-209952.

Fig. 17–18. *Caucasites orchardi* n. sp., Caurus Zone, Subzone 1, GSC loc. 68203, holotype, GSC 101820. Flattened body chamber removed.

Fig. 19–24. *Columbisculites maclearni* TOZER, *Paracrochordiceras americanum* Beds, loc. C-209951; 19–20, plesiotype, GSC 101821; 21–22, plesiotype, GSC 101822; 23–24, plesiotype, GSC 101823.

Fig. 25–26. *Stenopopanoceras* sp. indet., Caurus Zone, Subzone 1, GSC loc. 68203, plesiotype, GSC 101824.

Fig. 27–34. *Grambergia tetsaensis* McLEARN, *Paracrochordiceras americanum* Beds; 27–28, plesiotype, GSC 101825, loc. C-209951; 29-30, plesiotype, GSC 101826, loc. C-209952; 31–32, plesiotype, GSC 101827, loc. C-209951; 33–34, plesiotype, GSC 101828, loc. C-209951.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