Middle and late Hettangian (Early Jurassic) ammonites from the Queen Charlotte Islands, British Columbia, Canada

Louise M. LONGRIDGE¹, József PÁLFY², Paul L. SMITH¹ & Howard W. TIPPER†

Abstract
The Queen Charlotte Islands (QCI) yield the most diverse middle and late Hettangian ammonite assemblage in British Columbia. In total, 53 ammonite taxa are described of which *Paradasyceras carteri*, *Franziceras kennecottense*, *Pleuroacanthites charlottensis*, *Ectocentrites pacificus* and *Curviceras haidae* are new. All the middle and upper Hettangian is present but current collections do not permit the division of the Mulleri and Occidentalis zones or the Mineralense and Rursicostatum zones. New occurrences of ammonite taxa are indicated for each zone. The QCI fauna permits correlations with Hettangian and early Sinemurian faunas in other areas of North America, South America, New Zealand, western and eastern Tethys, and northwest Europe. The QCI fauna supports the location of Wrangellia in the northern Hemisphere and the eastern Pacific during the Hettangian and suggests significant northward displacement for the terrane since that time.

Keywords
Ammonites, Canada, Hettangian, zonation, Queen Charlotte Islands, eastern Pacific.

I. INTRODUCTION

The Queen Charlotte Islands (QCI) (Fig. 1) contain the most complete record of Hettangian ammonite faunas in Canada. Preliminary lists of the main taxa present were given by TIPPER & CARTER (1990), TIPPER & GUEX (1994), TIPPER et al. (1994) and CARTER et al. (1998). More detailed taxonomic studies were completed by LONGRIDGE et al. (2007) on the early Hettangian faunas and by PÁLFY (1991) on the uppermost Hettangian faunas of the Rursicostatum Zone [Fig. 2; Rursicostatum Subzone of TAYLOR et al. (2001); LONGRIDGE et al. (2006)]. The latter study was part of PÁLFY’s unpublished Master’s thesis and only a biostratigraphic summary is in print (PÁLFY et al., 1994). This study is the first detailed account of the middle and late Hettangian faunas from the QCI.

In general, North American Early Jurassic ammonites are of Tethyan affinity or endemic to the eastern Pacific, and for this reason a separate zonation for the Hettangian and Sinemurian of the Western Cordillera of North America has been established by TAYLOR et al. (2001). However, little Canadian information was included when the zonation was erected. Since then, LONGRIDGE et al. (2006) made significant changes to the upper Hettangian and lower Sinemurian zones based on a detailed study of the *Badouxia* fauna from Taseko Lakes (Fig. 2). Further updating of the zonation was done by LONGRIDGE et al. (2008a) based on additional taxonomic studies of the latest Hettangian faunas from Taseko Lakes (LONGRIDGE et al., 2008a, b). Details of the diverse ammonite fauna described here will further increase the precision of the North American Zonation for the middle and upper Hettangian (Fig. 2).

In the QCI, sections often contain volcanic tuffs interbedded with fossiliferous rock, providing the opportunity to calibrate radiometric dates with the ammonite succession at the zonal level. A tuff bed from the latest Triassic at Kunga Island has already provided a U-Pb date of 199.6±0.3 Ma (PÁLFY et al., 2000) which is currently used to approximate the age of the base of the Jurassic (e.g. GRADSTEIN et al., 2004). Work is underway by PÁLFY and others to date several middle Hettangian tuffs taken from some of the sections discussed below. Consequently, a detailed knowledge of the ammonite successions from the QCI has added importance in order to improve the correlation potential of these dates with sections in other areas.

Finally, the QCI fauna can improve Hettangian correlations within North America as well as between North America and other areas of the world.
America and the rest of the world. Ammonite endemism and provincialism are widespread in the Hettangian making correlation difficult. The QCI fauna helps to address these problems because it contains many taxa with affinities to other areas. This paper highlights correlations between the middle and late Hettangian fauna in the QCI and contemporaneous faunas in other areas of North America, South America, New Zealand, western and eastern Tethys, and northwest Europe.

II. GEOLOGICAL SETTING

The QCI are located on the western margin of the Canadian Cordillera (Fig. 1). The fauna described herein is found within the Sandilands Formation of the Kunga Group. The Sandilands Formation, established by CAMERON & TIPPER (1985) [black limestone member of the Kunga Formation of SUTHERLAND BROWN (1968)], is several hundred meters thick and ranges in age from early Rhaetian to mostly the latest Sinemurian, although its upper contact is diachronous and locally the unit is as young as earliest Pliensbachian (TIPPER & CARTER, 1990; TIPPER et al., 1991, 1994; SMITH & TIPPER, 1996). It is typically composed of thinly bedded dark shale and dark grey or blue siltstone. Fine to medium grained sandstone, tuffaceous beds and limestone beds, lenses and concretions are common. CAMERON & TIPPER (1985) suggested that much of the Sandilands Formation was deposited in a relatively deep back-arc basin somewhat distant from a source of fine volcanic detritus which is present in distal turbidites and less common air-fall tuffs (PÁLFY et al., 1990; TIPPER & GUEX, 1994). However, the precise pa-
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The geologic setting of the Late Triassic-Early Jurassic strata of the Wrangellia terrane is poorly constrained at present and more recent work suggests that the Rhaetian-Hettangian parts of the Sandilands Formation were deposited in an outer shelf to upper slope setting (Haggart et al., 2001, 2002). In situ ammonite specimens from the Mulleri to Rursicostatum zones were collected from the nine sections described below.

**Stratigraphic sections**

Stratigraphic sections exist in two principal areas (Fig. 1): Kennecott Point includes sections A to G, yielding middle and late Hettangian ammonites. All sections are exposed at low tide on a wave-cut platform. Section A and the lower portion of section B contain material from the Mulleri and Occidentalis zones. The upper portion of section B contains material from the Coronoides to Sunrisensis zones whereas section C contains material from the Sunrisensis Zone. Section D contains material from the Sunrisensis and Morganense zones and section G contains material from the Sunrisensis and Mineralense zones. Finally, sections E and F contain material from the Mineralense and Rursicostatum zones. Figures 3-7 show details of the stratigraphy and collection localities for

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<tr>
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<th>SOUTH AMERICA</th>
<th>NORTHWEST EUROPE</th>
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Fig. 2: Zonation for Hettangian and lower Sinemurian showing correlation of North American zones with South America, northwest Europe, western Tethys (circum-Mediterranean), eastern Tethys and New Zealand. Only approximate correlations are implied.

geographic setting of the Late Triassic-Early Jurassic strata of the Wrangellia terrane is poorly constrained at present and more recent work suggests that the Rhaetian-Hettangian parts of the Sandilands Formation were deposi-
Fig. 3: Lithostratigraphy and fossil localities of Section A at Kennecott Point, Queen Charlotte Islands.

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<td>Sandstone</td>
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<td>Limestone</td>
<td>A14</td>
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**Formation**
- Kammerkarites (?) n. sp.
- Nevadaphyllites psilomorphus
- Fergusonites striatus
- Euphyllites occidentalis
- Paradasycecarteri n. sp.
- Discamphiceras silberlingi
- Pleuroacanthites cf. biformis
- Phylloceras asperaense
- Nevadaphyllites aff. compressus
- Pleuroacanthites charlottensis n. sp.
- Kammerkarites cf. praecoronoides
- Discamphiceras aff. pleuronotum
- Kammerkarites cf. frigga
- Discamphiceras aff. antiquum
- Kammerkarites cf. haploptychus
- Kammerkarites aff. chinchillaensis
- Nevadaphyllites sp.
- Togaticeras togatum

**Zone**
- Mulleri and Occidentalis
Fig. 4: Lithostratigraphy and fossil localities of Section B at Kennecott Point, Queen Charlotte Islands; for key, see Figure 3.
Fig. 5: Lithostratigraphy and fossil localities of Section C at Kennecott Point, Queen Charlotte Islands; for key, see Figure 3.
Fig. 6: Lithostratigraphy and fossil localities of Sections D-F at Kennecott Point, Queen Charlotte Islands; for key, see Figure 3.
Fig. 7: Lithostratigraphy and fossil localities of Sections G-I. Section G at Kennecott Point, Sections H-I at Kunga Island, Queen Charlotte Islands; for key, see Figure 3.
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The lower portion of section KPB described by CARTER et al. (1998) is a composite section including sections A, B, D and E. The lower portion of section D of PÁLFY et al. (1994) is equivalent to section E of the current paper. The lower part of section F and all of section G of PÁLFY et al. (1994) are equivalent to our sections F and G, respectively.

Sections H and I are exposed in the supratidal region on the southern side of Kunga Island where beds are steeply dipping to nearly vertical. Both sections contain material from the Mulleri and Occidentalis to Coronoides zones. Figure 7 shows details of the stratigraphy and collection localities for each section. Section H begins near the top of section III of LONGRIDGE et al. (2007) (ammonite level A7 of section III is equivalent to H* in section H) and is equivalent to the upper portion of section SKUD described by TIPPER et al. (1994) and CARTER et al. (1998). Section I is equivalent to the upper portion of section SKUE (TIPPER et al., 1994; CARTER et al., 1998). Another section on the north side of Kunga Island contains very poorly preserved late Hettangian material (lower portion of KUD in CARTER et al., 1998). Collections from this section are not included herein as the poor preservation does not permit identification.

Figure 8 shows approximate correlations between sections A-I. Detailed data for sections A-I, including a brief geographical description of each site, latitude and longitude as well as Geological Survey of Canada (GSC) numbers for each location is shown in Appendix A.

III. SYSTEMATICS

Although a few beds yield some better preserved, three-dimensional material, the common mode of preservation of ammonites in the Sandilands Formation is flattened internal moulds resulting in significant information loss, especially for ventral features and whorl section. The extensive use of open nomenclature is therefore inevitable. Open nomenclature follows BENGTSON (1988). Figure 9 shows the ranges of ammonite taxa found within the Mulleri and Occidentalis to Mineralense and Rursicostatum zones in the QCI.

Abbreviations and measurements follow SMITH (1986) and include maximum shell diameter (DMAX), shell diameter (D), umbilical diameter (UD), whorl width (WW), whorl height (WH), umbilical diameter as a ratio of shell diameter (U), ratio of the whorl width to the whorl height (WWWH) and primary ribs per half whorl (PRHW). Graphical plots of several of these parameters are shown below and include all measurable specimens of each species collected. A record of the exact measurements of each specimen is shown in Appendix B. All measured and figured specimens are deposited in the type collection of the Geological Survey of Canada in Ottawa.

**Suborder Phylloceratina ARKELL, 1950**

**Superfamily Phylloceratoidea ZITTEL, 1884**

**Family Phylloceratidae ZITTEL, 1884**

**Genus Phylloceras SUESS, 1865**

**Type species:** *Ammonites heterophyllus* SOWERBY, 1820.

**Phylloceras asperaense** HILLEBRANDT, 2000a

Pl. I, figs 2-3, 10-11; Fig. 10A

2000a. *Phylloceras asperaense* HILLEBRANDT, p. 140, pl. 1, figs 4-7; text-fig. 27-c-e.

cf. 2008a. *Phylloceras cf. asperaense* HILLEBRANDT - LONGRIDGE et al., pl. 1, figs 26-27; text-figs 9B, 10B.

**Material and measurements:** Two well preserved, three-dimensional measured specimens (GSC 129066-129067) and one incomplete specimen. Measurements of volvation are presented in Figure 11A.

**Description:** Compressed form, evolve for genus. Whorl cross-section high oval. Umbilical wall one short arch. Flanks weakly convex with greatest width midflank. Venter broad and smooth. Flanks smooth aside from weak, prorsiradiate growth lines. Septal suture line with triphyllic first and second lateral saddles and spatular folioles (Fig. 10A).

**Discussion:** *Phylloceras asperaense* from the QCI is...
<table>
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<tr>
<th>Fauna</th>
<th>Mulleri/Occidentalis zones</th>
<th>Coronoides Zone</th>
<th>Sunrisensis Zone</th>
<th>Morganense Zone</th>
<th>Mineralense/Rursicostatum zones</th>
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<td>Fergusononites striatus</td>
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<td>Angulaticeras (?) cf. cuchiniensis</td>
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<td>Sunrisites cf. semilevis</td>
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Fig. 9: Ranges of ammonites from the Mulleri/Occidentalis zones to the Mineralense/Rursicostatum zones in the Queen Charlotte Islands. Taxa indicated in bold are new records for the Coronoides through Morganense zones of the North American Zonation. In the Mulleri/Occidentalis as well as Mineralense/Rursicostatum zones, taxa are also indicated in bold if they are not previously recognized from either zone. In cases where the zonal range is not entirely new but is extended from what was previously recognized, the new portion of the range is indicated with a thicker line.
very similar to the South American material in volution and whorl shape. In addition, the suture line of the two forms is nearly identical at similar whorl height.

**Stratigraphic position:** Sections A and B, Mulleri/Occidentalis zones.

**Family Juraphyllitidae ARKELL, 1950**

**Genus Paradasyceras SPATH, 1923**

**Paradasyceras carteri** n. sp.

**Pl. I, figs 4-5, 15, 20, 25-26; Fig. 10D**

**Material and measurements:** Eleven measured specimens (GSC 129070-129080) and many incomplete or distorted specimens or fragments (GSC 129068-129069, 129102). Preservation varies from moderate to very good with many three-dimensional specimens. Measurements of volution are presented in Figure 11A. Holotype GSC 129068 (Pl. I, fig. 20) from the Mulleri or Occidentalis Zone, Kennecott Point, section A, level 04, QCI. Paratypes GSC 129069-129080, 129102 from the Mulleri/Occidentalis zones, Kennecott Point sections A and B, QCI.

**Derivation of name:** Named for ELIZABETH CARTER for her extensive contribution to our understanding of Triassic and Jurassic radiolarian faunas in the QCI.

**Diagnosis:** Involute form. Whorl cross-section elliptical. Flanks parallel. Prorsiradiate growth lines on inner whorls. Body chamber with strong, concave to prorsiradiate flank ribs that continue across venter in forward-directed chevron.

**Description:** Compressed form, involute for genus. On inner whorls, umbilical wall upright, umbilical shoulder distinct but rounded. Whorl cross-section subelliptical. Flanks parallel to weakly trapezoidal. Widest point of whorl upper flank. Venter broad and rounded. Flanks smooth except straight to weakly sigmoid prorsiradiate growth lines visible on best-preserved material. Body chamber whorl cross-section compressed. Strong rectiradiate to prorsiradiate flank ribs weakest on lower flank, strongest on upper flank. Strong ribs continue across venter forming forward-directed chevron. Suture line not preserved.

**Discussion:** Paradasyceras carteri has significantly more involute inner whors than other species of Paradasyceras and lacks the sharp umbilical angle that helps characterize the type species. It is referred to Paradasyceras principally because of similarities in body chamber ornament to *P. bonifacii* (WÄHNER) and *P. bonfaciformis* GUEX and also resembles established species of the genus in whorl cross-section.

The inner whors of *P. carteri* resemble some species of *Phylloceras* at similar shell diameters but differ in having parallel flanks and a more upright umbilical wall. The inner whors of *P. carteri* are difficult to distinguish from poorly preserved *Fergusonites striatus* that lack ornament. The former usually have flatter flanks, lack constrictions and are more involute by 30 mm shell diameter.

**Stratigraphic position:** Sections A and B, Mulleri/Occidentalis zones.

**Genus Fergusonites GUEX, 1980**

**Type species:** *Fergusonites striatus* GUEX, 1980.

**Fergusonites striatus** GUEX, 1980

*Pl. I, figs 6-8, 21; Fig. 10C*


**Material and measurements:** Twelve measured (GSC 129081-129092) and eight incomplete specimens and fragments. Preservation varies from moderate to very good with many three-dimensional specimens. Measurements of volution are presented in Figure 11A.

**Description:** Moderately involute. Compressed with suboval whorl cross-section. Umbilical wall and shoulder rounded. Flanks weakly convex with widest point of whorl mid to upper flank. Venter broad and rounded. Fine, regularly spaced ribs prorsiradiate on flanks becoming rectiradiate on upper flank and across venter. Ribs weakest on lower flank, strongest on upper flank and across venter. Ribs regular in strength except in two specimens (GSC 129082, Pl. I, figs 6-8; GSC 129091, not figured) where rib strength varies somewhat. Fine ribs visible on internal mould but usually stronger on shell (e.g. GSC 129081, Pl. I, fig. 21). Three specimens bear
constrictions at adoral end (GSC 129082, Pl. I, figs 6-8, D = 30.5 mm; GSC 129084 and 129092, not figured, D = c. 25 mm). Constrictions hook back on umbilical shoulder then follow trajectory of ribbing. Suture line not available.

**Discussion**: As discussed by **Hillebrandt** (2000a), confident assignment of the South American examples at the species level is precluded because the constriction that marks the aperture of *F. striatus* cannot be verified.

**Stratigraphic position**: Sections A and B, Mulleri/Occidentalis zones.

**Genus Nevadaphyllites** **Guex**, 1980

**Type species**: *Nevadaphyllites compressus* **Guex**, 1980.

*Nevadaphyllites psilomorphus* (**Neumayr**, 1879)

**Plate I, figures 17-18, 27; Figure 10B**

1952. *Phylloceras psilomorphum* **Neumayr**.- **Lange**, p. 82, pl. 1, fig. 1; text-fig. 1.
1999. *Phylloceras psilomorphum* **Neumayr**.- **Böhm et al.**, p. 185, pl. 24, fig. 4; text-fig. 36.

**cf. 2007. Nevadaphyllites cf. psilomorphus** (**Neumayr**).- **Yin et al.**, p. 11, pl. 1, figs 31-32; table 2.
2008a. *Nevadaphyllites psilomorphus* (**Neumayr**).- **Longridge et al.**, pl. 1, figs 1-2, 5-6.

**Material and measurements**: Six measured specimens (GSC 129093-129098) and many flattened specimens or fragments. Preservation varies from moderate to very good with several three-dimensional specimens. Measurements of volution are presented in Figure 11B.

**Description**: Midvolute and compressed for genus. Umbilical wall one short arch. Widest point of whorl near umbilicus, flanks subparallel, sloping gently toward narrow but rounded venter. Best preserved specimen shows weak, prorsiradiate, sigmoid striae on flanks (Pl. I, figs 17-18). Suture line not preserved.

**Discussion**: *Nevadaphyllites psilomorphus* from the QCI has very similar volution to the specimens figured by **Neumayr** (1879) and **Lange** (1952). **Rakús** (1993a) differentiates *N. glaberrimus* (**Neumayr**) from *N. psilomorphus* principally based on a difference in the shape of the umbilical wall. He claims that the former species has an umbilical wall that is one short arch whereas the latter species has an umbilical wall that is straighter with a more distinct umbilical shoulder (as illustrated in **Lange**, 1952, text-fig. 1.1). The QCI material has a short, convex umbilical wall. Nevertheless, we have placed the QCI material in *N. psilomorphus* because we feel the lectotype of the species (**Neumayr**, 1879, pl. 2, fig. 4) also has a

![Fig. 11: Plots of measurements of Phylloceratina and Psiloceratina from the Queen Charlotte Islands. A-C, E, umbilical diameter (UD) versus shell diameter (D). D, primary ribs per half whorl (PRHW) versus shell diameter (D).](image-url)
convex umbilical wall. *Nevadaphyllites psilomorphus* from the QCI is slightly more evolute than the Taseko Lakes material (LONGRIDGE et al., 2008a) and the more depressed material from Salzburg (BÖHM et al., 1999) and Nevada (GUEX, 1995). Due to poor preservation, the specimens of DOMMERGUES et al. (1995) and STEVENS (2004) are attributed with uncertainty to *N. psilomorphus*. The QCI form is significantly more compressed than the more evolute *Phylloceras asperaense* HILLENBRANDT and the more involute *P. chilense* HILLENBRANDT.

**Stratigraphic position:** Section A, Mulleri/Occidentalis zones; section B, Mulleri/Occidentalis to Sunrisensis zones.

*Nevadaphyllites aff. compressus* GUEX, 1980

Pl. I, figs 12-14

v? 1967. Ammonite gen. et sp. indet. 3., FREIBOLD, p. 29, pl. 5, fig. 8.
aff. 1980. *Nevadaphyllites compressus* GUEX, p. 135, pl. 1, fig. 7.
aff. 1995. *Nevadaphyllites compressus* GUEX, p. 12, pl. 2, figs 7-12; text-fig. 8.

**Material and measurements:** One measured specimen (GSC 129099) and one fragment (GSC 129100). Measurement of volution is presented in Figure 11B.

**Description:** Compressed and midvolute for genus. Umbilical wall upright with rounded umbilical shoulder. Flanks subparallel, tapering slightly toward relatively narrow but rounded venter. Upper flank and venter with weak undulations in well preserved areas of body chamber. At adoral end of specimen, a sigmoid constriction occurs on internal mould that has its greatest inflection on flanks and projects forward across venter. Constriction absent on external shell.

**Discussion:** *Nevadaphyllites aff. compressus* is most similar to *N. compressus* GUEX but differs in having a lower, gently arched umbilical wall. It differs from *N. aff. compressus* from Taseko Lakes in bearing ventral undulations on the body chamber (LONGRIDGE et al., 2008a). Due to poor preservation, it is not possible to identify this form with confidence. *Nevadaphyllites aff. compressus* may represent a new species but our limited, poorly preserved material does not warrant a new species designation at this time.

*Nevadaphyllites aff. compressus* has similar volution to *Nevadaphyllites (?)* sp. from the lower Hettangian beds in the QCI (LONGRIDGE et al., 2007). Poor preservation hinders confident comparison; however, the early Hettangian form can attain much larger shell diameters.

**Stratigraphic position:** Section A, Mulleri/Occidentalis zones.

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*Nevadaphyllites sp.*

Pl. I, fig. 16

**Material and measurements:** One flattened, measured specimen (GSC 129101). Preservation poor. Measurement of volution is presented in Figure 11B.

**Description:** Midvolute form for genus. Flanks with fine striae strongest on upper flank. Adoral end of specimen with sigmoid constriction.

**Discussion:** The volution of *Nevadaphyllites* sp. is similar to *N. psilomorphus*. It differs in having striae on the flanks, a constriction at the adoral end of the specimen and in reaching maturity at much smaller shell diameters.

**Stratigraphic position:** Section A, Mulleri/Occidentalis zones.

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**Genus Togaticeras** RAKUS, 1989

**Type species:** *Phylloceras togatum* (NEUMAYR, 1879).

*Togaticeras togatum* NEUMAYR, 1879

Pl. I, figs 1, 9, 23-24

1879. *Phylloceras togatum* NEUMAYR, p. 21, pl. 1, figs 16-17.
1993a. *Togaticeras togatum* (NEUMAYR).- RAKUS, p. 946, pl. 3, figs 6-7 (specimens of NEUMAYR refigured); text-fig. 15.
2000. *Togaticeras togatum* (NEUMAYR).- KMENT, p. 190, pl. 1, fig. 8.
2008a. *Togaticeras togatum* (NEUMAYR).- LONGRIDGE et al., pl. 1, figs 21-22.

**Material and measurements:** Eleven measured specimens (GSC 129104-129114) and many poorly preserved or incomplete specimens and fragments (GSC 129103). All three-dimensional specimens have a shell diameter under 20 mm; larger specimens flattened. Measurements of volution are presented in Figure 11B.

**Description:** Compressed, midvolute to involute form. Subovol whorl cross-section. Umbilical wall one short arch. Umbilical shoulder distinct but rounded. Flanks weakly convex. Venter broad and rounded. Flanks and venter smooth aside from distinct, strongly prorsiradiate constrictions present on internal mould. Constrictions sigmoid on flanks, projecting forward across venter. Six to seven constrictions per whorl at shell diameters of 20 mm. At shell diameters c. 30 mm up to 11 constrictions on outer whorl. A partial suture line is preserved on one outer whorl. A partial suture line is preserved on one specimen (GSC 129108). The second lateral saddle is diphyllic and moderately strongly incised.

**Discussion:** *Togaticeras togatum* from the QCI includes specimens that are more strongly involute than previously recognized (Pl. I, fig. 1). It is possible that these
forms are a new species; however, as there is no difference in the stratigraphic range of the more evolute and involute specimens, we feel this difference is most likely due to variation within *T. togatum*. The portion of suture line preserved on GSC 129108 is very similar to the equivalent part of the suture of the lectotype figured by Rakús (1999a, text-fig. 15).

**Stratigraphic position**: Sections A and B, Mulleri/Occidentalis zones; sections B and H, Coronoides Zone; section B, Pleuroacanthites and Sunrisensis zones.

**Suborder Psiloceratina Houša, 1965**

**Superfamily Lytoceratoidea Neumayr, 1875**

**Family Pleuroacanthitidae Hyatt, 1900**

**Genus Ectocentrites Canavari, 1888**

**Type species**: *Ammonites petersi* HAUER, 1856.

**Ectocentrites pacificus** n. sp.

Pl. II, figs 2, 7, 14

**Material and measurements**: Nine measured specimens (GSC 129117, 129119-129126) and many incomplete specimens and fragments (GSC 129116, 129118). All material flattened. Measurements of volution and ribbing density are presented in Figure 11C-D. Holotype GSC 129117 (Pl. II, fig. 2) from the Sunrisensis Zone, Kennecott Point, section D, level 01, QCI. Paratypes GSC 129116, 129118, 129119-129126 from the Coronoides to Sunrisensis zones, Kennecott Point, sections B-D, QCI.

**Derivation of name**: Named for the location in the eastern Pacific.

**Diagnosis**: Involute form. No constrictions. Sigmoid flank ribs project forward on upper flank. Ribs bear ventrolateral tubercles. Ribs irregularly spaced. Ribs on outer whorls may continue strongly across venter.

**Description**: Involute form for genus. No constrictions. Sigmoid flank ribs rursiradiate to weakly prorsiradiate, projecting forward on upper flank. Ribs begin on lower flank, coarsen upflank and bear ventrolateral tubercles. Ribs on innermost whorls somewhat variable in strength. Ribs on intermediate and outer whorls irregularly spaced. Preservation limited but ribs on intermediate whorls may weaken on venter while on outer whorls ribs continue strongly across venter (Pl. II, fig. 14).

**Discussion**: *Ectocentrites pacificus* differs from the majority of the type material of *E. petersi* (HAUER) in lacking constrictions on the inner whorls and is more involute at equivalent shell diameters. Meister et al. (2000, p. 85) discuss differences between *E. cf. petersi* from South America and *E. petersi*. These include the early appearance of ribs on the inner whorls and the presence of a ventral depression caused by weak ribbing between ventrolateral tubercles. As far as preservation permits analysis, these differences are also present in *E. pacificus* from the QCI. *Ectocentrites pacificus* is very similar in volution and ornament to *E. cf. petersi* from South America (Hillebrandt 1981, pl. 1, fig. 6; 2000d, pl. 12, fig. 9). Hillebrandt (2000d, p. 86) mentions that the depth of rib interspaces on the innermost whorls are different on the South American specimen and this gives the impression of constrictions. Although some discrepancy in rib interspace depth is also visible in some of the QCI specimens, the specimens do not have constrictions. The quality of preservation in the QCI material as well as the limited quantity of South American material means it is not possible to be certain if this is a significant difference.

**Stratigraphic position**: Section B, Coronoides to Sunrisensis zones; sections C and D, Sunrisensis Zone.

**Genus Pleuroacanthites Canavari, 1888**

**Type species**: *Ammonites biformis* SOWERBY, 1831.

**Pleuroacanthites cf. biformis** (SOWERBY, 1831)

Pl. II, figs 11-12, 17


cf. 1888. *Pleuroacanthites biformis* (SOWERBY).- CANAVARI, p. 121, pl. 3, figs 8-12, 18.

cf. 1894. *Pleuroacanthites biformis* (SOWERBY).- WAHNER, p. 34, pl. 3, fig. 2, pl. 4, figs 1-3, pl. 5, figs 1-7, pl. 9, figs 3-4.

cf. 1995. *Pleuroacanthites biformis* (SOWERBY).- GUEx, p. 42, pl. 23, figs 5-6 ; text-fig. 17.


aff. 1999. *Psilophyllites* sp. YIN et al., fig. 3.8.

aff. 2007. *Pleuroacanthites aff. biformis* (SOWERBY).- YIN et al., p. 11, text-fig. 5E-G, 6 ; table 4.

**Material and measurements**: One measured specimen (GSC 129137), two measured external moulds (GSC 129138-129139) and ten incomplete specimens and fragments (GSC 129136, 129141). Material is partially to completely flattened. Measurements of volution are presented in Figure 11E.

**Description**: Inner whorls moderately evolve to moderately involute. Midvolute at larger shell diameters. Cross-section in better preserved fragment has convex flanks with flattened ventral area that projects into a slight median protuberance at midline. Parabolic ribs strongly rursiradiate on lower and middle flanks, projecting sharply forward on ventrolateral shoulder. Rib strength and spacing variable in some specimens, more regular in others. Ribs weakest on lower flanks developing greater strength upflank where they can be very strong. Ribs often asymmetric with steep adapical and gentler adoral slopes. Weaker ribs continue toward midline of venter. On largest specimen (Pl. II, fig. 17) ribs on last whorl weaken on upper flank. Suture line not preserved.

**Discussion**: Similar to *P. biformis* from the Austrian Alps and Italy. *P. cf. biformis* from the QCI varies considerably in volution on the inner whorls. *Paracaloceras*
Eolytoceras cf. biformis is comparable to P. biformis from Nevada (GUEX 1995, pl. 23, figs 5-6) but differs from P. aff. biformis (GUEX 1995, pl. 24, figs 13-14) in having more widely spaced ribs that are less coarse at similar shell diameters. The small size of P. aff. biformis from Tibet (YIN et al., 2007, text-figs 5E-G, 6) precludes close comparison with the QCI form although the general ribbing style is similar.

**Stratigraphic position**: Section A, Mulleri/Occidentalis zones; section B, Coronoides to Pleuroacanthitoides zones.

**Pleuroacanthites charlottensis n. sp.**

**Pl. II, figs 3, 6**

**Material and measurements**: Five measured specimens (GSC 129143-129147) and two incomplete specimens (GSC 129142). Smaller material partially three-dimensional; larger material flattened. Measurements of volutions are presented in Figure 11E. Holotype GSC 129142 (Pl. II, fig. 3) from the Coronoides Zone, Kennecott Point, section B, level 10, QCI. Paratypes GSC 129143-129147 from the Mulleri/Occidentalis to Coronoides, Kennecott Point, sections A and B, QCI.

**Derivation of name**: Named for the Queen Charlotte Islands where the type material was collected.


**Description**: Evolute on inner whorls; midvolute on outer whorls. Whorl cross-section compressed by 25 mm shell diameter. Inner whorls with asymmetric, moderate to strongly rursiradiate parabolic ribs with steep adapical and gentler adoral slopes. Rib strength variable, often having greatest strength at top of flanks. Beyond shell diameters of 20-25 mm, very weak rectiradiate ribs are more closely spaced. Occasional strong, rursiradiate ribs still present on flanks (Pl. II, fig. 3). Outer whorl of largest specimen smooth (Pl. II, fig. 3). Suture line not preserved.

**Discussion**: *Pleuroacanthites charlottensis* is most similar to *P. biformis evolutus* LANGE (1952, pl. 11, fig. 4). However, the QCI form is more evolute at similar shell diameters and also lacks a keel. Unfortunately, it is not possible to compare the two forms at larger size as the Alpine form of LANGE (1952, p. 93) is a microconch. The ornament is too regular in spacing and orientation in the specimens figured by WÄHNER (1894, pl. 5, figs 3, 8) that LANGE also attributes to his new subspecies. Additionally, figure 3 is too depressed. Volution and cross-section of the inner and intermediate whorls of *P. charlottensis* are similar to *P. polycyclus* WÄHNER. The QCI form differs in having more crowded, irregularly orientated ornament on the inner whorls and in being considerably more involute at large shell diameters. *Pleuroacanthites charlottensis* is more evolute and compressed on the inner whorls than *P. polycyclus* WÄHNER.

**Stratigraphic position**: Section A, Mulleri/Occidentalis zones; section B, Coronoides Zone.

**Pleuroacanthites sp.**

**Pl. II, fig. 10**

**Material and measurements**: One partially flattened specimen (GSC 129148). Measurement of volution is presented in Figure 11E.

**Description**: Midvolute for genus. Inner whorls not preserved. On inner half of outer whorl, evenly spaced, swollen ribs resemble nodes on flanks. On outer half of outer whorl, broad, weakly prorsiradiate to concave ribs on flanks. Growth lines or weaker ribs following same trajectory visible between some ribs. Suture line not available.

**Discussion**: The poor preservation of this specimen does not permit confident identification. However, this specimen probably represents a new species because it differs from all other currently recognized *Pleuroacanthites* in ribbing style.

**Stratigraphic position**: Section B, Mulleri/Occidentalis zones.

**Genus Eolytoceras** FREBOLD, 1967

**Type species**: *Eolytoceras tasekoi* FREBOLD, 1967.

**Eolytoceras cf. praeceptor** GUEX, 1995

**Pl. II, figs 1, 4, 8, 15-16; Fig. 11C**

**Material and measurements**: Nine measured specimens (GSC 129127-129129, 129130-129135) and many incomplete specimens (GSC 129140). Some uncompressed material. Measurements of volution are presented in Figure 11C.

**Description**: Inner whorls evolve for genus. Depressed on inner whorls (Pl. II, figs 15-16) becoming weakly compressed at medium shell diameters. Nucleus nodose (Pl. II, figs 4, 8). After this, moderately to strongly swollen ribs irregular in spacing and strength, often beginning midflank with greatest strength on upper flank. Beyond shell diameters of 25-30 mm, prorsiradiate to concave ribbing weak and closely spaced. Some specimens maintain this flank ribbing to end of preserved shell. Others become smooth. In some specimens, periodic undulations occur on flanks (Pl. II, fig. 1). At shell diameters of c. 50 mm, specimens diverge into two groups. One group evolute to end of preserved shell (Pl. II, figs 1, 4). Other group becomes more involute (Pl. II, fig. 8). Last 1/3 whorl of GSC 129127 (Pl. II, fig. 1) not chambered. Suture line too incomplete to illustrate. Saddles with spatulate folioli, umbilical lobes retracted.

**Discussion**: Some specimens of *Eolytoceras* cf. *praeceptor* are very similar to *E. praeceptor* from Nevada (e.g., Pl. II, fig. 1). However, this species is represented only by
the holotype and it is currently not possible to ascertain the variability of the species. Some of the QCI specimens become more involute at larger shell diameters and have swollen ribs that continue to larger shell diameters than the holotype. Therefore the QCI material is placed with uncertainty to *E. praecursor*.

It is possible that *E. cf. praecursor* is a sexually dimorphic species. The inner whorls are very similar yet differences in volution beyond shell diameters of c. 50 mm make it possible to divide the material into two groups. One group is consistently evolute (Pl. II, figs 1, 4) whereas the other is involute (Pl. II, fig. 8). One specimen may be a microconch as approximately the last one third of the outer whorl is body chamber (Pl. II, fig. 1). Unfortunately, the suture lines are mostly obscured and are not preserved in the rest of the larger material, so it is not possible to see approximation. Due to poor preservation, other signs of maturity such as the presence of a rostrum and egression cannot be confirmed. Potential microconch or macroconch status is indicated in the plate caption where possible.

As discussed by Guex (1995) for the Nevada specimen, the juvenile whorls of *Eolytoceras* cf. *praecursor* resemble *Pleuroacanthites mulleri*. Some of this material closely resembles the holotype of *Transcisiloceras transiens* Guex (1980, pl. 2, fig. 3; 1995, pl. 5, fig. 3-4) from the early Hettangian, but differs in being consistently more evolute on the inner and intermediate whorls (e.g. Pl. II, fig. 1).

**Stratigraphic position**: Section B, Coronoides to Pleuroacanthitoides zones; Section H, Coronoides Zone.

### Eolytoceras cf. tasekoi Frebold, 1967

*Pl. I, figs 19, 22*


- PALFY et al., p. 1543, fig. 5H.  
- TAYLOR, pl. 1, figs 1-10.  
- MEISTER et al., p. 445, figs 3, 7.  
- STEVENS, p. 17, pl. 1, figs 1-5 only (non figs 7-8).  
- cf. 2008a. *Eolytoceras cf. tasekoi* Frebold, AFF. 2008a, *Eolytoceras constrictum* LONGRIDGE et al., pl. 1, figs 3-4, 24-25; text-figs 9N, 10D.  

#### Material and measurements

Two measured specimens (GSC 107373-107374). Material partially compressed. Measurements of volution are presented in Figure 11C.

**Description**: Evolute form. Flanks convex. Innermost whorls smooth. Adorally, slightly convex flares develop from an early stage (6-7 flares/half whorl at D > 25 mm). At later growth stages, ventrolateral nodes develop on flares. Flares may be accompanied by a flanking constriction. Some specimens with fine growth lines.

**Discussion**: *Eolytoceras aff. constrictum* is very similar on the inner whorls to *E. constrictum* from Taseko Lakes although it attains much larger shell diameters. Additionally, in the Taseko Lakes material the flares are always preceded by a constriction (LONGRIDGE et al., 2008a). It is unclear whether these represent species level differences or simply variations within a single species. *Eolytoceras aff. constrictum* differs from other species of *Eolytoceras* in having prominent flares. It is similar to several specimens of *Analytoceras articulatum* (SOWERBY) figured by WÄHNER (1894, pl. 54, fig. 3; pl. 58, figs 1-3) in having flares and nodes on the outer whorls but differs in lacking articulated inner whorls.

**Stratigraphic position**: Sections E and F, Mineralense/Rursicosatum zones. Also occurs in the Columbae Zone in the QCI.

### Eolytoceras aff. constrictum Longridge, Smith & Tipper, 2008a

*Pl. III, figs 1, 9*

aff. 2008a. *Eolytoceras constrictum* LONGRIDGE et al., pl. 1, figs 3-4, 24-25; text-figs 9N, 10D.

#### Material and measurements

Two measured specimens (GSC 107373-107374). Material partially compressed. Measurements of volution are presented in Figure 11C.

**Description**: Evolute form. Flanks convex. Innermost whorls smooth. Adorally, slightly convex flares develop from an early stage (6-7 flares/half whorl at D > 25 mm). At later growth stages, ventrolateral nodes develop on flares. Flares may be accompanied by a flanking constriction. Some specimens with fine growth lines.

**Discussion**: *Eolytoceras aff. constrictum* is very similar on the inner whorls to *E. constrictum* from Taseko Lakes although it attains much larger shell diameters. Additionally, in the Taseko Lakes material the flares are always preceded by a constriction (LONGRIDGE et al., 2008a). It is unclear whether these represent species level differences or simply variations within a single species. *Eolytoceras aff. constrictum* differs from other species of *Eolytoceras* in having prominent flares. It is similar to several specimens of *Analytoceras articulatum* (SOWERBY) figured by WÄHNER (1894, pl. 54, fig. 3; pl. 58, figs 1-3) in having flares and nodes on the outer whorls but differs in lacking articulated inner whorls.

**Stratigraphic position**: Sections E and F, Mineralense/Rursicosatum zones. Also occurs in the Columbae Zone in the QCI.

### Pleuroacanthitidae gen. indet. n. sp.

*Pl. II, fig. 5*

#### Material

One somewhat distorted and flattened, moderately preserved specimen (GSC 129115).

**Description**: Evolute form for genus (UD/D = c. 48%). No constrictions visible. Flank ribs rursiraditate, projecting forward on upper flank. Inner whorls with weakly swollen, regularly spaced ribs. Some ribs show weak tubercles. Beyond shell diameter of c. 20 mm, flank ribs more crowded and irregular in spacing and strength. Small ventrolateral swellings visible on some ribs. Ribs
continue onto venter.

**Discussion**: Pleuroacanthitidae gen. indet. n. sp. shares many similarities in ornament to the Pleuroacanthitidae and may be an intermediate form between the Pleuroacanthitidae with its rursiradial and swollen ribs on the inner whorls and Ectocentrites with its finer, tuberculate ribs. The QCI form differs from species of *Taylorites* GUEx in lacking constrictions and ventrolateral nodes on the inner whorls. It is similar in volving and ribbing density to *E. dommerguesi* MEISTER et al., but differs in having much weaker ribbing that is rursiradial rather than prorsiradial. It is similar in ribbing density and strength to *E. italicus* MENEGHINI but is more evolute, lacks constrictions and has ribs that are rursiradial rather than weakly prorsiradial.

**Stratigraphic position**: Section I, Mulleri/Occidentalis zones.

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**Superfamily Psiloceratoidea HYATT, 1867**

**Family Psiloceratidae HYATT, 1867**

**Genus Euphyllites WÄHNER, 1898**

**Type species**: *Aegoceras struckmanni* NEUMAYR, 1879.

*Euphyllites occidentalis* GUEx, 1980

Pl. III, figs 2-4, 10-11; Fig. 10G

1980. *Euphyllites occidentalis* GUEx, p. 132, pl. 1, fig. 9.

1995. *Euphyllites occidentalis* GUEx, p. 30, pl. 21, figs 1-2, pl. 22, figs 1-4, 7-12.

**Material and measurements**: Eight measured specimens (GSC 129154-129161) and several incomplete specimens or fragments. Most specimens three-dimensional; preservation moderate to good. Measurements of volution are presented in Figure 11E.

**Description**: Evolute form. Nucleus poorly preserved. Inner whorls depressed with weak, prorsiradial flank ribs to c. 20 mm shell diameter (Pl. III, fig. 2). At shell diameters over 20 mm, whorls become compressed (Pl. III, figs 3-4) with weakly convex flanks and a broad, smooth venter. Beyond shell diameters of 20 mm, flanks vary from smooth to bearing irregular ribs of variable strength and orientation (Pl. III, figs 10-11). Two specimens show faint, straight to weakly concave growth lines on the flanks that project forward on venter (GSC 129159). Suture line not preserved.

**Discussion**: As discussed by GUEx (1995), it is not possible to see the ornament on the type material of *E. occidentalis* at shell diameters of less than 15 mm. The material from the QCI confirms that this species does not bear constrictions on the innermost whorls. Differences between *E. occidentalis* and other species of *Euphyllites* are given in GUEx (1995).

*Euphyllites occidentalis* from the QCI differ from species of Discamphiceras in being consistently more depressed.

**Stratigraphic position**: Sections A and B, Mulleri/Occidentalis zones.

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**Genus Caloceras HYATT, 1871**

**Type species**: *Ammonites torus* D’ORBIGNY, 1844.

*Caloceras aff. bloomfieldense* DONOVAN, 1956

Pl. IV, fig. 1

aff. 1952. *Psiloceras* (Caloceras) *multicostatum* DONOVAN, p. 638, pl. 22, fig. 4; text-figs 2-3.

aff. 1986. *Caloceras bloomfieldense* DONOVAN.- HODGES, p. 241, fig. 3.2-3.3.

**Material and measurements**: One flattened measured specimen (GSC 129162). Measurements of volution and ribbing density are presented in Figure 12A-B.

**Description**: Evolute form. Nucleus poorly preserved. Straight, sharp, crowded flank ribs weakly to moderately rursiradial. Ribs fade on upper flank.

**Discussion**: *Caloceras aff. bloomfieldense* differs from *C. bloomfieldense* in having a slightly lower number of ribs on the innermost whorls and a higher number of ribs on the intermediate whorls. It also has flank ribs that are rursiradial throughout ontogeny. *Caloceras bloomfieldense* was originally described by DONOVAN (1952) under the name *C. multicostatum*. The QCI form is similar to some specimens of *C. pirondi* (REYNES) (e.g. GUERIN-FRANIATTE, 1990, pl. 2, fig. 3) but differs in having flank ribs that are rursiradial rather than rectiradial to prorsiradial.

**Stratigraphic position**: Section B, Coronoides Zone.

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**Genus Discamphiceras SPATH, 1923a**

**Type species**: *Aegoceras kammerkarense* GÜMBEL, 1861.

As discussed in DONOVAN (1958), the first written description of the holotype of *A. kammerkarense* was given by GÜMBEL (1861) whereas a suture line of the specimen was first figured in WÄHNER (1884, pl. 25, fig. 2).

*Discamphiceras silberlingi* GUEx, 1980

Pl. IV, figs 6, 10

1980. *Discamphiceras silberlingi* GUEx, p. 132, pl. 2, fig. 2.


1995. *Discamphiceras silberlingi* GUEx, p. 28, pl. 6, figs 4-5, 8-9; pl. 11, figs 1-2, 5-6, 9-12; pl. 12, figs 4, 7-8; pl. 14, figs 1-2, 7-14; pl. 15, figs 5-6; text-fig. 15.

1999. *Discamphiceras* silberlingi GUEx.- PALFY et al., fig. 4A, 4D.


**Material and measurements:** Twenty-four measured specimens (GSC 129163-129180, 130669-130674) and many incomplete specimens and fragments. Material reasonably well preserved; some three-dimensional specimens. Measurements of volution and ribbing density are presented in Figure 12C, E.

**Description:** Strongly compressed, moderately evolute to moderately involute form with subelliptical whorl cross-section. Inner whorls with low yet upright umbilical wall. Umbilical shoulder rounded. Nearly flat flanks taper gently toward broad venter. Specimens where nucleus well preserved ornamented with nodes to shell diameters of 3.5 to 5 mm. Beyond this, ribs rectiradiate to weakly prorsiradiate. By shell diameters of 15 mm, gently flexuous, prorsiradiate ribs vary considerably in strength. Narrow ribs begin on lowest flank, widening and having greatest strength midflank before fading on upper flank. In well-preserved material, ribs project forward, sometimes dividing into two ribs, before crossing venter in a forward-directed chevron. Suture line not preserved.

**Discussion:** Some of the material from Alaska (IMLAY, 1981; PÁLFY et al., 1999) is marked with a question mark in the synonymy list due to poor preservation which hampers certainty of identification. The material identified by YIN & ENAY (2000) as *D. cf. silberlingi* was recently re-classified as *D. pleuronotum* (YIN et al., 2007). Some New Zealand specimens figured as *Waehneroceras otapiriense* STEVENS (2004, pl. 2, figs 4-9, 11-13) are very similar in volution and ribbing style to *D. silberlingi*; however, this species differs in being much less compressed (STEVENS, 2004, text-fig. 13).

*Discamphiceras silberlingi* is closely related to the South American forms *D. reissi* (TILMANN) and *D. cf. calci-montanum* (WÄHNER) of HILLEBRANDT (2000c).

**Stratigraphic position:** Sections A and H, Mulleri/Oc-cidentalis zones; section B, Mulleri/Occidentalis to Sunrisensis zones; section C, Sunrisensis Zone.

**Discamphiceras aff. pleuronotum (CANAVERI, 1882)**

Pl. IV, figs 2, 5

aff. 1882. *Aegoceras pleuronotum* CANAVARI, p. 169, pl. 19 figs 2, 4-5, non 3.

aff. 1884. *Aegoceras pleuronotum* CANAVARI.- WÄHNER, p. 110, pl. 25, fig. 3.

aff. 1888. *Psiloceras pleuronotum* CANAVARI, p. 149, pl. 5, figs 2, 4-5.


aff. 1999. *Kammerkarites haploptychus* (WÄHNER).- YIN et al., fig. 3.10-3.12.


Fig. 12: Plots of measurements of Psiloceratina from the Queen Charlotte Islands. A, C-D, umbilical diameter (UD) versus shell diameter (D). B, E, primary ribs per half whorl (PRHW) versus shell diameter (D).
Material and measurements: Three measured specimens (GSC 130677-130679), one measured external cast (GSC 130680), two incomplete specimens and two external casts (GSC 130676). Preservation moderate. Measurements of whorl cross-section and lack of a suture line hinders confident comparison, the QCI form is very similar to some specimens of Discamphiceras cf. pleuronotum of Hillebrandt (2000c, pl. 2, figs 6, 9, 12). The eastern Pacific form closely resembles Discamphiceras cf. pleuronotum (Canavari) in whorl cross-section and rib number but differs in having flank ribs that are rectiradiate to weakly prorsiradiate rather than weakly rursiradiate. Furthermore, as discussed by Hillebrandt (2000c, p. 8), Discamphiceras has a much more strongly incised suture line with deeper lateral and umbilical lobes (Canavari, 1882, pl. 19, fig. 2c) than Discamphiceras from South America.

Stratigraphic position: Section A, Mulleri/Occidentalis zones; section B, Coronooides Zone.

Discamphiceras cf. submesogenos Guex, 1995

Pl. IV, fig. 8

cf. 1995. Discamphiceras submesogenos Guex, p. 29, pl. 11, figs 3-4, 7-8, pl. 13, figs 5-12, pl. 14, figs 3-4.

Material and measurements: Fourteen measured (GSC 130681-130694) and many incomplete specimens. All material flattened. Measurements of whorl cross-section and lack of a suture line hinders confident comparison. The QCI form is very similar to three measured specimens (GSC 130695) and three external casts. All material at least partially flattened. Measurements of whorl cross-section and lack of a suture line hinders confident comparison.

Description: Noval for genus. Nucleus nodose. Following this, weak, prorsiradiate growth lines project forward on lower flank, rectiradiate on upper flank (GSC 130690, not figured). Intermittent weak ribs that follow trajectory of growth lines present in some specimens. On two specimens, ribs project forward onto venter in a forwardly directed chevron (Pl. IV, fig. 8). Suture line not preserved.

Discussion: Although the QCI material can be slightly more involute and two specimens bear ventral ribbing that is more pronounced than the type material of Discamphiceras cf. submesogenos, it is very similar in other respects. Discamphiceras cf. submesogenos is most similar to Discamphiceras cf. submesogenos (Wähner) but differs in being more involute and in having intermittent ribbing on the flanks and venter.

Stratigraphic position: Section B, Pleuroacanthitoides to Sunrisensis zones.

Discamphiceras aff. antiquum Guex, 1980

Pl. IV, figs 4, 7


Material and measurements: Three measured specimens (GSC 130696-130698), seven incomplete specimens (GSC 130695) and three external casts. All material at least partially flattened. Measurements of whorl cross-section and lack of a suture line hinders confident comparison.

Description: Noval for genus. Preserved internal casts (GSC 130695) and three external casts. All material at least partially flattened. Measurements of whorl cross-section and lack of a suture line hinders confident comparison.

Discussion: Discamphiceras aff. antiquum from the QCI is very similar to D. cf. antiquum from South America (Hillebrandt, 2000a, c) and Discamphiceras aff. reissi from Nevada (Guex, 1995) in whorl cross-section and rib number. Incomplete preservation of whorl cross-section and lack of a suture line hinders confident assignment. Discamphiceras aff. antiquum from the QCI is very similar to D. cf. antiquum from Nevada (Guex, 1980, 1995) in possessing more distinct ribs on the flanks, especially at small shell diameters.

Stratigraphic position: Section A, Mulleri/Occidentalis zones; section B, Mulleri/Occidentalis to Coronooides zones.

Genus Alsatites Haug, 1894

Type species: Ammonites liasicus D’Orbigny, 1844; by subsequent designation of Haug, 1894.

Discussion: Guex (1987, 1995) places Laqueoceras in synonymy with Alsatites while Hillebrandt (2000d)
maintains *Laqueoceras* as a separate genus based on the absence of a keel. The former approach is adopted here.

**Alsatites cf. liasicus** (D’Orbigny, 1844)

Pl. VII, fig. 7

cf. 1879. *Ammonites liasicus* D’Orbigny.- REYNÉS, pl. VI, figs 9-12.
cf. 1879. *Aegoceras laqueolus* SCHLOEBNACH.- WRIGHT, p. 315, pl. XV, fig. 1-2, 10-12, pl. 16, figs 1-2.
cf. 1941. *Porvarietes* (*Alsatites*) *laqueolus* (SCHLOEBNACH).- LANGE, p. 163, pl. 20, figs 1-3, 5.
cf. 1961. *Alsatites liasicus* (D’Orbigny).- DEAN et al., pl. 63, fig. 3.
cf. 1976. *Alsatites liasicus* (D’Orbigny).- SCHLEGELMILCH, p. 40, pl. 10, fig. 4.
cf. 1990. *Alsatites liasicus* (D’Orbigny).- GUERIN-FRANIATTE, p. 58, pl. 5, fig. 1, pl. 6, figs 1-2, pl. 7, fig. 1.
non 1993b. *Alsatites liasicus* (D’Orbigny).- RAKUS, p. 28, pl. 1, figs 3-4, 7, pl. 7, figs 1-3-5, pl. 8, fig. 7; text-figs 21-26.
cf. 1994. *Alsatites* sp. HILLEBRANDT, pl. 1, fig. 1a-b.
2000d. *Alsatites cf. liasicus* (D’Orbigny).- HILLEBRANDT, p. 75, pl. 6, figs 2a-b.
cf. 2004. *Alsatites liasicus* (D’Orbigny).- HALL & PITARU, p. 4, pl. 1, fig. 5.

**Material and measurements**: Two measured specimens (GSC 130699, 130701), one measured external cast (GSC 130700) and two incomplete specimens. Material partially flattened. Measurements of volution and rib density are presented in Figure 12A-B.

**Description**: Evolute form. Nodose nucleus. Beyond this, moderately strong flank ribs weakly rursiradiate to recticradiate. Weakened ribs project forward on uppermost flank onto venter. One specimen has ribs that bend forward midflank becoming prorsiradiate. Venter poorly preserved. However, one fragment is smooth at whorl height of 4 mm while in another specimen, a keel is suggested at a whorl height of 6 mm (PI. VII, fig. 7). Suture line and cross-section not preserved.

**Discussion**: The similarity of *A. liasicus* to *Gyrophioceras morganense* was discussed by TAYLOR (1998, p. 491) when he erected the new species and again by HILLEBRANDT (2000d, p. 76) with specific reference to the South American specimen of *A. cf. liasicus*. The QCI material is especially similar to the paratype of *G. morganense* (TAYLOR, 1998, fig. 21.11-21.12) but differs from the slightly more involute species in having less strongly rursiradiate ribs at the base of the flanks. As discussed by RAKUS (1993b), the material from the West Carpathians has much sparser flank ribbing than other *A. liasicus*.

**Stratigraphic position**: Section B, Coronoides Zone.

**Alsatites cf. proaries** (Neumayr, 1879)

Plate VII, figures 8, 10

cf. 1879. *Arietites proaries* NEUMAYR, p. 37, pl. 7, figs 1-2.
cf. 1882. *Aegoceras helicoideum* (MENGINI).- CANAVARI, p. 38, pl. 5, fig. 7.
cf. 1882. *Aegoceras tortuosum* CANAVARI, p. 39, pl. 5, fig. 8.
cf. 1886. *Arietites proaries* NEUMAYR.- WAHNER, p. 217, pl. 28, figs 1-2, pl. 29, figs 1-4, pl. 30, figs 5-11.
cf. 1963. *Arietites (Alsatites) proaries* NEUMAYR.- BLIND, p. 100, pl. 3, fig. 6.

**Material and measurements**: Eight measured (GSC 130703-130710) and many incomplete specimens (GSC 156959). All material flattened. Measurements of volution and rib density are presented in Figure 12A-B.

**Description**: Evolute form. Ribs on innermost whorls weakly rursiradiate to recticradiate. At shell diameters greater than 10 mm, ribs regularly spaced, more or less concave and crowded. Beyond shell diameters of 40-60 mm, concave ribbing becomes less crowded and can be irregular in spacing and strength (PI. VII, fig. 8). At large shell diameters ribbing strongly concave (PI. VII, fig. 10). Suture line and cross-section not preserved.

**Discussion**: *Alsatites cf. proaries* is very similar in volution and ribbing style to *A. proaries* although the QCI form can also have ribs that are less crowded and more irregularly spaced at larger shell diameters (PI. VII, fig. 8). *Alsatites cf. proaries* is somewhat similar in ribbing style to *Laqueoceras cf. sublaqueus* (WAHNER) from South America (HILLEBRANDT, 2000d, pl. 3, figs 8-9) but is more evolute at large shell diameters and has ribs that are more consistently concave on the flanks. *Alsatites cf. proaries* is similar in volution and ribbing style to *Para-caloceras haueri* (GUMBEL) but lacks evidence of a keel.

**Alsatites ex gr. proaries** (Neumayr, 1879)

Pl. VII, figs 5-6

ex gr. 1879. *Arietites proaries* NEUMAYR, p. 37, pl. 7, figs 1-2.
ex gr. 1882. *Aegoceras helicoideum* (MENGINI).- CANAVARI, p. 38, pl. 5, fig. 7.
ex gr. 1882. *Aegoceras tortuosum* CANAVARI, p. 39, pl. 5, fig. 8.
ex gr. 1886. *Arietites proaries* NEUMAYR.- WAHNER, p. 217, pl. 28, figs 1-2, pl. 29, figs 1-4, pl. 30, figs 5-11.
ex gr. 1963 *Arietites (Alsatites) proaries* NEUMAYR.- BLIND, p. 100, pl. 3, fig. 6.
Material and measurements: Six measured specimens (GSC 130712-130717) and several incomplete specimens and fragments (GSC 130711). All material partially or completely flattened. Measurements of volution and rib density are presented in Figure 12A-B.

Description: Midvolute form for genus. Ribbing on inner whorls variable in strength and spacing. Specimens divide into two groups beyond shell diameters of 30 mm. In one group, weak, crowded flank ribs are prorsiradiate to weakly concave (Pl. VII, fig. 5). In other group, concave flank ribs remain stronger and more widely spaced (Pl. VII, fig. 6). Suture line and cross-section not available although preserved relief suggests venter was smooth to maximum preserved shell diameter (D = c. 48 mm).

Discussion: Alsattites ex gr. proaries from the QCI is moderately to strongly more involute and has stronger ribs on the inner whorls than most A. proaries. Alsattites ex gr. proaries from the QCI has similar morphological variability as A. ex gr. proaries in Nevada (GUEx, 1995). The ribbing style is similar to some specimens of A. bipartitus (Laqueoceras bipartitum of Hillebrandt 2000d, pl. 1).

Stratigraphic position: Section B, Coronoides to Pleuroacanthitoides zones; section H, Coronoides Zone.

Genus Sunrisites GUEx, 1980

Type species: Sunrisites sunrisensis GUEx, 1980.

Discussion: Mullerites cf. pleuroacanthitoides may be slightly more evolute on the inner whors than M. pleuroacanthitoides from Nevada. Some specimens of the QCI form resemble A. nigromontanus (GUMBEL). They differ on the inner whors in having ribs that are less strongly prorsiradiate and on the outer whors in being more evolute and in having ribs that are less crowded.

Stratigraphic position: Section B, Pleuroacanthitoides to Sunrisensis zones; section C, Sunrisensis Zone.

Genus Mullerites GUEx, 1980

Type species: Mullerites pleuroacanthitoides GUEx, 1980.

Discussion: Mullerites may be a synonym of Alsattites as M. pleuroacanthitoides shares many characteristics with species of Alsattites.

Mullerites cf. pleuroacanthitoides GUEx, 1980

Pl. III, figs 6, 8

cf. 1995. Mullerites pleuroacanthitoides GUEx, p. 46, pl. 25, figs 1-2, pl. 28, figs 3-4, 7-11, pl. 30, figs 1-2, 13-14; text-fig. 19.

1999. Mullerites cf. pleuroacanthitoides GUEx. - PáLFy et al., fig. 4N-O.

Material and measurements: Eight measured specimens (GSC 130727-130734) and many incomplete specimens and fragments (GSC 130725-130726). Preservation varies from moderate to poor with one partial three-dimensional specimen. Measurements of volution and number of ribs are presented in Figure 13A-B.

Description: Evolute on inner whors, moderately involute on outer whors. Preserved relief suggests cross-section of intermediate whors rounded; cross-section of outer whors high oval with rounded venter. Widest point of whor low midflank. Umbilical wall upright, umbilical shoulder rounded. In some specimens ribbing on innermost whors irregularly spaced. In others ribs regularly spaced from nucleus. Beyond shell diameters of c. 15 mm, strong, rectiradiate to weakly concave flank ribs regularly spaced in all specimens. Above shell diameters of c. 75 mm, ribbing becomes weakly prorsiradiate and irregular in spacing and strength. In one specimen, ribs bifurcate on upper flank projecting forward onto venter as weak, forwardly inclined striae. One specimen showing complex, strongly retracted umbilical lobes (Pl. VI, fig. 16). At large shell diameters bullae are present on the lower flank (Pl. VI, fig. 15).

Discussion: Volution and ribbing on the inner whors of S. cf. chilensis are very similar to S. hadroptychus (WÄHNER). The QCI form differs in having ribs that are irregular and much weaker at large shell diameters. Some S. cf. chilensis resemble Alsattites nigromontanus of GUEx (1995) on the inner whors but differ in lacking ribs on the umbilical wall and in having ribs that are less concave at similar shell diameters. Sunrisites cf. chilensis is more involute than S. brimblecombei at large shell diameters and differs from S. chilcotinensis in having a lower number of ribs that are never nodal on the inner whors.

Stratigraphic position: Section B, C, and G, Sunrisensis Zone; section D, Sunrisensis and Morganense zones.
Sunrisites cf. senililevis Longridge, Smith, Pálfy & Tipper, 2008a

Pl. VI, fig. 11
cf. 2008b. Sunrisites senililevis Longridge et al., figs 7.1-7.2, 7.7-7.8, 8.3.

Material and measurements: One poorly preserved external mould (GSC 107385). Measurements of volution and ribbing density are presented in Figure 13A-B.

Description: Moderately involute for genus. Rectiradiate ribs blunt, coarse, and widely spaced (8-9 ribs per half whorl) with high rounded profile. Ribs show greatest height midflank.

Discussion: The inner and intermediate whorls of this species differ from all other Sunrisites species in having much coarser and more widely spaced ribs.

Stratigraphic position: Section F, Mineralense/Rursicostatum zones.

Genus Badouxia Guex & Taylor, 1976

Type species: Psiloceras canadense Frebold, 1951.

Badouxia canadensis (Frebold, 1951)
Pl. IV, figs 3, 9

1951. Psiloceras canadense Frebold, p. 3, pl. 1, figs 2, 4-5.
1967. Psiloceras occidentale Frebold, p. 19, pl. 1, figs 4-5, text-fig. 4.
1967. Eolytoceras sp. indet. 2. Frebold, p. 16, pl. 6, fig. 2.
1987. Badouxia cf. canadensis (Frebold).- Quinzio, pl. 1, fig. 11.
1994. Badouxia canadensis (Frebold).- Pálfy et al., pl. 1, fig. 3.
1994. Badouxia canadensis (Frebold).- Hillebrandt pl. 1, fig. 4.
1998. Badouxia oregonensis Taylor, p. 494, fig. 23 (11-14).
1999. Badouxia? sp. Pálfy et al., fig. 5F.
1999. Badouxia canadensis (Frebold).- Pálfy et al., fig. 5I.
2000b. Badouxia cf. canadensis (Frebold).- Hillebrandt pl. 2, fig. 5.
2000c. Badouxia canadensis (Frebold).- Hillebrandt p. 46, pl. 14, figs 4, 7, 11, pl. 15, fig. 10.
? 2000c. Badouxia canadensis (Frebold).- Hillebrandt p. 46, pl. 14, figs 6, 8, pl. 15, figs 11, 17, pl. 16, figs 2, 3, 5-6.
2006. Badouxia canadensis (Frebold).- Longridge et al., p. 802, pl. 1; text-figs 10A-C, 11A-B.

Material and measurements: Three flattened measured specimens (GSC 107392-107393, 107397) and one incomplete specimen (GSC 107399). Some specimens with preserved relief. Measurements of volution and ribbing density are presented in Figure 13A-B.

Description: Moderately evolute to moderately involute form. Whorl cross-section rounded to ellipsoidal. On inner whorls, simple flank ribs of moderate strength vary in density and orientation from weakly to strongly prorsiradiate. Ribs arise at flank base, show greatest height midflank before fading on upper flank. At large shell diameters (D > 6 cm), flanks become smooth.

Discussion: In 1991, Pálfy completed a study of the Badouxia fauna from the QCI as part of his unpublished Master’s thesis. Since this time, several detailed taxo-
nomic studies of Badouxia assemblages from other areas of North America have occurred. A study by Longridge et al. (2006) resulted in the elimination of two previously recognized species, Badouxia occidentalis (Frebold) and B. oregonensis Taylor, which were placed in synonymy with B. canadensis (Frebold). Only the latter taxonomic changes are reflected herein.

Stratigraphic position: Section G, Mineralense Zone; sections E and F, Mineralense/Rursicostatum zones. Also occurs in the Columbias Zone in the QCI.

Genus Pseudaetomoceras Spath, 1923b
Type species: Arietites abnormilobatus Wänher, 1886.

Pseudaetomoceras cf. castagnolai (Cochi in Canavari, 1882)
Pl. III, figs 5, 7

cf. 1886. Arietites Castagnolai Cocchi.- Wänher, p. 58, pl. 21, fig. 2; pl. 23, figs 2-3.
cf. 1888. Arietites Castagnolai Cocchi.- Canavari, p. 136, pl. 6, figs 18-19; Text-fig. 6b.
cf. 1995. Pseudaetomoceras castagnolai (Cocchi).- GueX, p. 52, pl. 27, fig. 25.
cf. 2000. Pseudaetomoceras cf. castagnolai (Cocchi).- Kment, p. 206, pl. 3, fig. 2.
2000. Pseudaetomoceras cf. castagnolai (Cocchi).- Kment, p. 206, pl. 3, fig. 3.
2008a. Pseudaetomoceras cf. castagnolai (Cocchi).- Longridge et al., pl. 3, figs 22-23; text-fig. 9G.

Material: Twelve flattened specimens and fragments (GSC 130735-130736).
Description: Involute form for genus. Crowded flank ribs strongly concave on flanks. Keel suggested by c. 18 mm shell diameter. Suture line and cross-section not preserved.
Discussion: Measurements were not taken on the QCI material due to inconsistent preservation of the keel that would produce inaccurate measurements of shell diameter.
Stratigraphic position: Section B, Pleurocoanithoides to Sunrisensis zones; section C, Sunrisensis Zone; section D, Sunrisensis to Morganense zones.

Pseudaetomoceras cf. doetzkirchneri (GümBEl, 1861)
Pl. II, figs 9, 13

cf. 1879. Ammonites Doetzkirchneri GümBEl.- Reynès, pl. 33, figs 7-8.
cf. 1879. Arietites Doetzkirchneri (GümBEl).- Neumayr, p. 40, pl. 5, fig. 1.
cf. 1886. Arietites Doetzkirchneri (GümBEl).- Wänher, p. 56, pl. 22, figs 1-2.
? 2004. Pseudaetomoceras cf. doetzkirchneri (GümBEl).- Hall & Pitaru, p. 4, pl. 2, fig. 2.

Material and measurements: Three measured specimens (GSC 130738-130740) and two external moulds (GSC 130737). All material flattened. Measurements of volution and number of ribs are presented in Figure 13A-B.
Description: Moderately evolute for genus. Moderately crowded flank ribs concave on flanks. No definitive keel by shell diameters of c. 27 mm. Suture line and cross-section not preserved.
Discussion: Pseudaetomoceras cf. doetzkirchneri may have a slightly lower number of ribs on the inner whorls than P. doetzkirchneri. The specimen of Hall & Pitaru (2004, pl. 2, fig. 2) is marked with a question mark in the synonym list as it has sigmoid flank ribs. This character is not as apparent in other P. doetzkirchneri.

Stratigraphic position: Sections B and C, Sunrisensis Zone.

Family Schlotheimiidae Spath, 1923b

Genus Storthoceras Lange, 1941
Type species: Aegoceras extracosatum Wänher, 1882.
The Storthoceras from the QCI are assigned to this genus based on the small shell diameter and lack of interruption of ribs on the venter of the internal whorls.

Storthoceras aff. garfieldense (Taylor, 1998)
Pl. VIII, figs 20, 25


Material and measurements: Fourteen measured specimens (GSC 130741-130754) and many incomplete specimens and fragments. All material flattened except one specimen with partial, poorly preserved venter (Pl. VIII, fig. 25). Measurements of volution and ribbing density are presented in Figure 13C-D.
Description: Involute form for genus. Fine, moderately crowded sigmoid ribs on flanks. Ribs project forward on uppermost flank onto venter. On largest specimen (Pl. VIII, fig. 25), some ribs concave on flanks of outer whorl. Preservation poor but ribbing fades somewhat on venter. Suture line and whorl cross-section not preserved.
Discussion: Storthoceras aff. garfieldense is most similar in ribbing number and style to the holotype of S. garfieldense (Taylor, 1998, fig. 14.3-14.4) although it may be slightly more involute than S. garfieldense at small shell diameters and is somewhat more evolute at large shell diameters. Storthoceras aff. garfieldense is similar to the slightly more evolute Schlotheimia (?) sp. A of Hill-Lebrandt (2000c, pl. 8, figs 26-29). The small shell diameter of the South American material precludes confident comparison with the QCI form. Aegoceras n. f. indet. of Wänher (1884, pl. 23, fig. 5) is similar to the QCI form in volution and rib trajectory but has a higher num-
ber of ribs at comparable shell diameters. The flank rib trajectory resembles that of *Storhocras cf. circacos- tatum* (WÄHNER) in HILLEBRANDT (2000c, pl. 6, figs 26-27) but the South American form is more involute. Flank ribs on *S. aff. garfieldense* are more sigmoid than in Alpine *Storhocras circacos- tatum*.

**Stratigraphic position:** Section B, Coronoides to Sunrisensis zones; sections H and I, Coronoides Zone.

**Storhocras cf. australe** HILLEBRANDT, 2000c

*Pl. VIII, figs 14, 19*


cf. 2000c. *Storhocras australe* HILLEBRANDT, p. 23, pl. 6, fig. 12-24, text-fig. 3e-h.

**Material and measurements:** Eight measured specimens (GSC 130755-130762) and many incomplete specimens and fragments. All material flattened. Measurements of volution and ribbing density are presented in Figure 13C-D.

**Description:** Evolute form for genus. Moderately crowded rursiradiate ribs. Most ribs straight to weakly concave on flanks. Occasional flank ribs weakly sigmoid. Ribs project strongly forward on upper flank. Whorl cross-section and suture line not preserved.

**Discussion:** *Storhocras cf. australe* is very similar to *S. australe* from South America in volution as well as rib number and orientation. *Storhocras cf. australe* differs from the more involute *S. aff. garfieldense* from the QCI in having much less common sigmoid flank ribs. The QCI form is more involute than *Schlotheimia phobetica* LANG.

**Stratigraphic position:** Section B, Pleuroacanthitoides to Sunrisensis zones.

**Storhocras sp.**

*Pl. VIII, figs 9-10*

**Material:** One partially preserved whorl fragment (GSC 130764).

**Description:** Evolute form for genus. Whorl cross-section high suboval. Irregularly spaced flank ribs concave to sigmoid. Ribs project strongly forward on upper flank. Much weakened ribs continue across venter in forward-directed chevron. Suture line not preserved.

**Discussion:** This fragment is assigned to *Storhocras* based on the sigmoidal ribs that are clearly projected forward on the venter. More complete material is required in order for this form to be identified at the species level. This fragment is more evolute and less densely ribbed than *Storhocras aff. garfieldense* from the QCI and is much more evolute than the type material of *S. garfieldense* from Nevada. It is less densely ribbed and has ribs that are more consistently sigmoid than *S. australe* from South America, *S. cf. australe* from the QCI and *K. frigga* (WÄHNER). This fragment resembles *C. haploptychum* (HOLLAND) and *Curviceras cf. haploptychum* of HILLEBRANDT (2000c) but differs in having ribs that are more strongly sigmoid, project more strongly forward on the venter and are more irregularly spaced.

**Stratigraphic position:** Section B, Coronoides Zone.

**Genus Curviceras BLIND, 1963**

**Type species:** *Ammonites subangularis* OPPEL, 1862.

**Curviceras haidae** n. sp.

*Pl. VIII, figs 12-13*

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Waehneroceras - on the inner whorls in having flank ribs that are much stronger across the venter. Curviceras haidae differs from the slightly more involute S. aff. portlocki in having more dense ribbing on the inner whorls and in having ribbing that continues uninterrupted across the venter. The QCI form is more evolute than Saxoceras? ex gr. portlocki of Palfy et al. (1999, fig. 4I) and has finer more closely spaced ribs than the inner whorls of Kammerkarites cf. frigga (Palfy et al., 1999, fig. 4E). Curviceras haidae somewhat resembles the Alpine species S. curviornatum (Waehner) and S. circacostatum (Waehner) but differs in being more evolute, and in having ribs that are much stronger across the venter. In addition, the ribs in S. curviornatum are sigmoid rather than concave.

Stratigraphic position: Section B, Coronoides Zone.

Genus Saxoceras Lange, 1924
Type species: Saxoceras costatum Lange, 1924.

Saxoceras aff. portlocki (Wright, 1881)
Pl. VIII, figs 2-5, 11, 15

aff. 1881. Aegoceras Portlockii Wright, p. 372, pl. 48, figs 4-5.
aff. 1952. Schlotheimia (Waehneroceras) portlocki (Wright). - Donovan, p. 646, pl. 12, fig. 5.
aff. 1961. Schlotheimia (Waehneroceras) portlocki (Wright). - Dean et al., pl. 63, fig. 4.
aff. 1965. Waehneroceras (Waehneroceras) portlocki (Wright). - Elmi & Mouterde, p. 224, pl. 6, figs 2, 5.
aff. 1986. Waehneroceras portlocki (Wright). - Guerin-Franjiatte & Muller, p. 418, pl. 3, fig. 3.
aff. 1990. Waehneroceras portlocki (Wright). - Guerin-Franjiatte, p. 89, pl. 10, fig. 14, pl. 11, fig. 3.
1999. Saxoceras? sp. Palfy et al., fig. 4G, J.

Material and measurements: Seven measured specimens (GSC 130766-130772) and many distorted specimens and fragments (GSC 130765). Some specimens with partial three-dimensional preservation. Measurements of volute and ribbing density are presented in Figure 13C-D.

Description: Midvolute form. Whorl cross-section high suboval with widest point of whorl low flank if ribs not considered (Pl. VIII, figs 4-5). Flank ribs on inner whorls crowded, sharp and usually concave. Beyond shell diameters of 30 mm, more coarse flank ribs can be concave, straight or sigmoid and rectiradiate to weakly prorsiradiate. Spacing between ribs variable with ribs more or less crowded. Ribs have greatest strength on uppermost flank where they project forward onto venter. Most ribs sharply interrupted on venter forming a smooth band down the midline. In some specimens, occasional ribs weaken but continue across venter in forward-directed chevron. Surface not preserved.

Discussion: Saxoceras aff. portlocki differs from S. portlocki on the inner whorls in having flank ribs that are more commonly concave rather than sigmoid and weakly prorsiradiate on the flanks. It includes specimens with ribs that are less strongly projected forward on the uppermost flank and other specimens with more widely spaced ribbing on the flanks at larger shell diameters. Saxoceras aff. portlocki is probably a new species but it cannot be established until better preserved large material is found.

As discussed at length by Guex (1995, p. 35), S. portlocki and S. extracostatum may belong to the same species. They differ only with respect to the ventral ornament of the internal whorls. Saxoceras portlocki has ribs that are consistently interrupted on the venter whereas S. extracostatum has ribs that continue across the venter. The ventral ornament of the QCI form is intermediate between these two ‘species’. Although most ribs are interrupted on the venter, occasional ribs weaken but continue across the venter.

Saxoceras aff. portlocki differs from Schlotheimia cuvetensis in having flank ribs that are commonly concave rather than primarily sigmoid and weakly prorsiradiate on the flanks. It differs from W. subangulare (Oppel) in being more consistently involute and in having ribs that are much less commonly sigmoid on the flanks at similar shell diameters. Ribs also continue less commonly across the venter. The QCI form resembles a specimen described under Schlotheimia angulata in Hall & Pitaru (2004, pl. 2, fig. 4). It differs in being more involute and in having ribs that are much less commonly prorsiradiate on the inner whorls. As discussed above, the distance between the flank ribs of S. aff. portlocki is variable. The division of the specimens into different species based on this difference would be arbitrary as there is a continuum of variation within the material. The specimens with wider spaced ribs are similar on the outer whorl to S. Schroederi Lange (e.g. Pl. VIII, fig. 15).

Several occurrences in other areas of North America are tentatively included in the synonymy list because they differ somewhat from the QCI form. A specimen figured by Hall & Pitaru (2004, pl. 1, fig. 4) has ribs that are more commonly sigmoid on the flanks and are not interrupted on the venter (Hall & Pitaru, 2004, p. 4). The fragments figured by Guex (1995, pl. 16, figs 3-4, 8-9) differ in being more depressed and in having flank ribs that are less strongly concave. Imlay (1981, p. 30) describes the venter in his Alaska material as smooth along its midline, but does not mention the occurrence of occasional ribs continuing across the venter. Unfortunately, no ventral view is figured.

Stratigraphic position: Sections B and I, Coronoides Zone.
Genus Kammerkarites SPATH, 1924
Type species: Aegoceras diploptychum WÄHNER, 1882.

Kammerkarites aff. chinchillaensis
HILLEBRANDT, 2000c
Pl. V, figs 2, 5
aff. 2000c. Kammerkarites chinchillaensis HILLEBRANDT, p. 15, pl. 5, figs 4-14; text-fig. 2h-m.

Material and measurements: One measured (GSC 130776) and one incomplete specimen (GSC 130775). Both specimens flattened and poorly preserved. Measurement of volution is presented in Figure 14A.

Description: One involute (Pl. V, fig. 2) and one midvolute specimen (Pl. V, fig. 5). Innermost whorls with strong, rectiradiate ribs that have greatest strength on upper flank. By shell diameters of c. 25 mm, ribs weaken. Very faint prorsiradiate ribs occur on outer whorl. Suture line and whorl cross-section not preserved.

Discussion: Although the volution of the two specimens of K. aff. chinchillaensis differs, the style of ornament is very similar. Due to small sample size, a clear understanding of the variation in the volution of this form is not possible. Thus, the two specimens are not separated here.

Ribbing style of the QCI form is very similar to K. chinchillaensis from South America. However, GSC 130776 (Pl. V, fig. 2) is considerably more involute than K. chinchillaensis and the QCI form may represent a new species.

Stratigraphic position: Sections A and B, Mulleri/Occidentalis zones.

Kammerkarites cf. frigga (WÄHNER, 1884)
Pl. VIII, figs 6-8

Material and measurements: Thirteen measured specimens (GSC 130777-130789) and several distorted specimens and fragments. All material flattened except one three-dimensional specimen. Measurements of volution and ribbing density are presented in Figure 14A-B.

Description: Evolute form, compressed on inner whorls. Nucleus nodose. Flank ribs rursiradiate, projecting strongly forward on uppermost flank. On three-dimen-
Kammerkarites (include slightly more evolute forms than the alpine variety of K. haploptychus. One specimen of K. haploptychus from the QCI (Pl. V, fig. 6) and one specimen of GUEx (1995, pl. 19, figs 5-6) are very similar to Storthoceras (Megastomoceras) silberlingi (Lange) (Lange, 1941, pl. 3, fig. 10).

Stratigraphic position: Sections A, H and I, Mulleri/Occidentalis zones; section B, Mulleri/Occidentalis to Coronoides zones.

Kammerkarites cf. rectiradiatus GUEx, 1995
Pl. IV, fig. 11


Material and measurements: One flattened measured specimen (GSC 130675). Measurements of volution and ribbing density are presented in Figure 14A-B.

Description: Involute for genus. Strong prorsiradiate ribs with greatest strength mid to upper flank on inner whorls. Beyond c. 25 mm shell diameter, strong ribs rectiradiate with greatest strength midflank. Uppermost flank smooth.

Discussion: Hillebrandt (2000c, p. 8) commented on the similarity of K. rectiradiatus and Discamphiceras pleuronotum. However, the large size and lack of suture line on the former form do not permit a thorough comparison. Unfortunately, the poorly preserved QCI specimen is also large and lacks a suture line. Kammerkarites cf. rectiradiatus is similar to some specimens of D. silberlingi. The former form probably differs in having ribs that are weaker on the upper flank although more and better-preserved material is required to fully assess the differences between the two forms. Kammerkarites cf. rectiradiatus has ribs that continue much less frequently onto the venter than the more evolute K. diploptychoides GUEx.

Stratigraphic position: Section B, Coronoides Zone.

Kammerkarites ex. gr. megastoma (GÜMBEL, 1861)
Pl. V, fig. 4

ex gr. 1882. Aegoceras megastoma GÜMBEL.- WÄHNER, p. 76, pl. 17, figs 1-5.

ex gr. 1963. Psiloceras (Discamphiceras) megastoma (GÜMBEL).- BLIND, p. 56, pl. 1, fig. 7.

ex gr. 1976. Psiloceras (Discamphiceras) megastoma (GÜMBEL).- SCHLEGELMILCH, p. 34, pl. 5, fig. 9.

ex gr. 1990. Waehneroceras (Kammerkarites) megastoma (GÜMBEL).- GUERIN-FRANIAETTE, p. 95, pl. 12, fig. 4.

ex gr. 1993b. Kammerkarites megastoma (GÜMBEL).- RAKUS, p. 21, pl. 4, fig. 1; text-fig. 12.

1999. Kammerkarites ex gr. megastoma (GÜMBEL).- PÁLFY et al., fig. 4R.

non 2004. Kammerkarites megastoma (GÜMBEL).- STEVENS, p. 31, pl. 6, figs 1-2; text-fig. 18.

Material and measurements: One flattened measured specimen (GSC 130794). Measurements of volution and
ribbing density are presented in Figure 14A-B.

**Description**: Midvolute form for genus. Flank ribs on innermost whorls closely spaced and weakly rursiradiate. Ribbing style between shell diameters of 40 – 65 mm obscured. Beyond this, flank ribs evenly spaced and rectiradiate. Ribs begin on lowest flank, have greatest strength midflank and fade on upper flank. Ribs on last part of outer whorl weaker.

**Discussion**: The ribbing style of K. ex gr. megastoma is similar to K. megastoma but the two forms differ in several respects. The inner whorls of K. ex gr. megastoma are poorly preserved but suggest it is somewhat more involute at small shell diameters. In addition, it is slightly more evolute at large shell diameters and has a higher number of ribs on the outer whorls. It is not possible to recognize the cross-section or ventral features on the QCI specimen as it is flattened. Also, the single specimen does not permit an understanding of the variability within the species. More and better material is required before a new species can be established.

**Material and measurements**: One flattened slightly distorted specimen (GSC 130793).

**Description**: Midvolute specimen. Nodose nucleus. Irregularly spaced, rectiradiate flank ribs. Ribs have greatest strength on upper flank projecting weakly forward on uppermost flank.

**Discussion**: This specimen falls within the variation in rib number and volution of K. praecoronoides.

**Stratigraphic position**: Section A, Mulleri/Occidentalis zones.

**Genus Franziceras BUCKMAN, 1923**

**Type species**: Franziceras ruidum BUCKMAN, 1923.

**Franziceras cf. coronoides** (GUEX, 1980)

**Pl. VI, figs 1-2, 4-6, 12-13**

**Material and measurements**: Eight measured (GSC 130795, 130796-130803) and many incomplete specimens (GSC 130702, 130796). In part good preservation; some small three-dimensional specimens, large specimens partially to completely flattened. Measurements of volution and ribbing density are presented in Figure 14C-D.

**Description**: Midvolute form. Nodose nucleus. Cross-section of inner whorls suboval if ribs not considered; weakly trapezoidal if ribs considered (Pl. VI, figs 5-6). Inner whorls with rectiradiate to weakly prorsiradiate flank ribs with ventrolateral nodes. Weakened ribs project forward on venter. In adult stage, preserved relief suggests whorl cross-section weakly trapezoidal if ribs not considered; strongly trapezoidal if ribs considered. Ribs
powerful and strongly rursiradiate. Ventrolateral nodes persist in some specimens (Pl. VI, fig. 2). Keel variable. In one specimen, keel visible beyond shell diameter of 8 mm. In other specimen, slight median protrusion but no defined keel at whorl height of 10 mm. Weakened ribs project forward on venter (Pl. VI, fig. 1). In well preserved fragment, ribs bifurcate into two or three coarse folds that project forward across venter (Pl. VI, fig. 6). Suture line not preserved.

**Discussion:** *Franziceras* cf. *coronoides* may have a slightly lower number of ribs on the inner whorls than the type material of *F. coronoides*. Similar to what we see in the Nevada material, the QCI form shows considerable variation in volution. One specimen from Nevada (GUEx, 1995, pl. 20, figs 3-4) is similar to the more evolute forms from the QCI (Pl. VI, fig. 4) whereas the other specimens from Nevada (GUEx, 1995, pl. 20, figs 1-2, 5-6) are similar to the more involute forms in the QCI (Pl. VI, fig. 2). However, in the QCI material, the more evolute variety of the species occurs slightly lower in section (section B, locality 12) than the more involute variety (section B, localities 18-21). More collections are required to ascertain whether this difference in stratigraphic level is due to collection failure or a true difference at the species level. As discussed by GUEx (1995, p. 34), the juvenile stage of *F. coronoides* GUEx and Kammerkarites praecoronoides GUEx from Nevada (GUEx, 1995, p. 34) are nearly identical. In addition, the inner whorls of *F. kennecottense* and *F. coronoides* from the QCI are virtually indistinguishable from these two species. *Franziceras kennecottense* differs from *K. praecoronoides* at larger shell diameters as the ventrolateral nodes and keel persist and the flank ribs are much less sigmoid. It differs from *F. coronoides* in being more evolute and in having much weaker flank ribs that are much less rursiradiate at large shell diameters. The inner and intermediate whorls of *F. kennecottense* are similar to *F. sebanum* but the QCI form differs at large shell diameters as the ribs are less crowded and more rectiradiate. The QCI form has flank ribs that are much weaker than *F. ruidum*.

**Stratigraphic position:** Section B, Coronoides to Sunrisensis zones.

**Schlotheimia** BAYLE, 1878

**Type species:** Ammonites angulatus SCHLOTHEIM, 1820; lectotype in Lange, 1951, p. 31, pl. 1, fig. 2.

Material and measurements: Five measured specimens (GSC 131668-131672) and nine incomplete specimens and fragments. Some partially preserved three-dimensional material; maximum shell diameter of c. 30 mm. Measurements of volution and ribbing density are presented in Figure 15A-B.

**Description:** Evolute form for genus. Whorl cross-section high suboval. On one specimen where nucleus visible, three strong ribs occur (Pl. VIII, fig. 16). Beyond
shell diameters of 3 mm, narrow, sharp ribbing is concave to weakly prorsiradiate on flanks. Ribs have greatest strength on uppermost flank, projecting strongly forward onto venter. Ribs form a chevron on venter with an angle of c. 90°. Ribbing is abruptly interrupted on midline of venter producing a smooth channel. Suture line not preserved.

**Discussion:** *Schlotheimia* sp. differs from *S. angulata* in being slightly more evolute and in having flank ribs that can be more strongly concave at similar shell diameters. The QCI form is similar to *S. phobetica* Lange in volution and in having some ribs that are weakly prorsiradiate. However, it differs in having a lower number of ribs per whorl, in having some ribs that are concave on the flanks and in having ribs that are completely interrupted on the venter. It is slightly more evolute than a similar specimen from the Alpine Megastoma Zone (*Aegoceras angulatum Schloth* var. ind. of Währner, 1886, pl. 20, fig. 6). Larger material is needed before this form can be identified at the species level.

**Stratigraphic position:** Section B, Coronoides Zone.

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**Genus Angulaticeras Quenstedt, 1883**

**Type species:** *Ammonites lacunatus* J. BucKman, 1844; designated by Lange, 1924.

**Discussion:** The generic assignments of the species *dumitricai* and *cachinensis* are uncertain as they share several of the characteristics of Bloos (1988a) which are commonly used to separate the genera *Angulaticeras* and *Schlotheimia*. This problem is discussed by Hillebrandt (2000c, p. 31). He suggests that the two American species may represent a branch of limited development within the Schlotheimiidae. Given the poor preservation of our material, we are unable to contribute to the resolution of this problem.

**Angulaticeras (?) cf. dumitricai Guex 1995**

Pl. VIII, figs 21, 23


**Material and measurements:** One flattened measured specimen (GSC 131675) and one measured external mould with preserved relief (GSC 131673). Measurements of volution and ribbing density are presented in Figure 15A-B. Where the flank ribs bifurcate, both ribs are included.

**Description:** Midvolute form for genus. Whorl cross-section high suboval. Umbilical wall upright, umbilical shoulder distinct but rounded. On inner whorls, weakly sigmoidal to straight ribs crowded and rectiradiate to weakly prorsiradiate. Occasional ribs bifurcate low flank. Ribs project slightly forward on uppermost flank. At large shell diameter (D > c. 55 mm), widest point of whorl upper flank. Weakly sigmoidal and rectiradiate to weakly prorsiradiate ribs narrowest on lower flanks, thickening upflank with greatest width on ventral shoulder. Suture line not preserved.

**Discussion:** *Angulaticeras (?) cf. dumitricai* is very close to the type material of the species in volution, rib number and morphology. *Angulaticeras (?) dumitricai* differs from the more involute *A. (?) cachinensis* in having ribs that bifurcate much less commonly.

**Stratigraphic position:** Section C, Sunrisensis Zone.

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**Angulaticeras (?) cf. cachinensis (Hillebrandt, 2000c)**

Pl. VIII, fig. 18


1994. *Sulciferites* *marmoreus* (Oppel.- Pálfy et al., pl. 1, fig. 1.

cf. 2000c. *Schlotheimia* *cachinensis* (Hillebrandt), p. 28, pl. 7, figs 1-14, cf. 15; text-fig. 4a-d.

**Material and measurements:** One poorly preserved flattened measured specimen (GSC 107376). Primary ribs = 10; secondary ribs = 18. Measurements of volution and ribbing density are presented in Figure 15A-B.

**Description:** Involute form of small size. Umbilical shoulder rounded. Sharp, crowded flank ribs slightly sig-
mold and gently prorsiradiate. Bifurcation and intercalation of ribs common but without consistent pattern. Bifurcation at various points from umbilical shoulder to lower flank. Venter and suture line not preserved.

**Discussion:** *Angulaticeras (?) cf. cachinensis* has ribs that are weaker on the lower flank, more coarse upflank and less sigmoidal than *A. ventricosum* (SOWERBY). It is distinguished from *A. trapezoidale* (Sowerby) by its narrower umbilicus and finer sigmoid tubing (SMITH & TIPPER, 2000).

**Stratigraphic position:** Section E, Mineralense/Rursicostatum zones. Also occurs in the Columbiae Zone in the QCI.

**Schlotheimiidae gen. et sp. indet.**

**Material and measurements:** Four flattened measured specimens (GSC 131674, 131676-131678) and fragments. Measurements of volution and ribbing density are presented in Figure 15A-B. In cases where the flank ribs bifurcate, both ribs are included.

**Description:** Involute form. Sharp, strong, rursiradiate to gently prorsiradiate flank ribs are slightly curved to weakly sigmoid. Occasional ribs bifurcate near umbilical shoulder. Flank ribs narrowest on lower flank, thickening upflank with greatest width on ventrolateral shoulder. Ribs project forward on ventrolateral shoulder. Venter and suture line not preserved.

**Discussion:** Schlotheimiidae gen. et sp. indet. has stronger flank ribs than *Angulaticeras (?) dumitríci* GUEx and the more involute *A. (?) cachinensis* (HilleBRANDT). It is more involute than *Schlotheimia cuévientis* HlleBRANDT which also lacks bifurcating ribs.

**Stratigraphic position:** Sections B and C, Sunrisensis Zone; sections E and F, Mineralense/Rursicostatum zones.

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**Superfamily Arietitidae HYATT, 1875**

**Family Arietitidae HYATT, 1875**

Generic assignment of late Hettangian species of the Family Arietitidae are often controversial (e.g., DONOVAN & FORSEY, 1973; DONOVAN et al., 1981; CORNA, 1987; BLOOS, 1994, 1995; TAYLOR, 1998; MEISTER et al., 2002). Sutural characteristics, nuclear ornament, whorl cross-section and ventral features are often critical yet they are missing in the QCI material. This often makes certain identification difficult at the species level and generic assignments tenuous.

**Genus Gyrophioceras SPATH, 1924**

**Type species:** *Arietites praespiratissimus* WÄHNER, 1887.

**Discussion:** The taxonomic position of Gyrophioceras is controversial. The most recent approaches have been to consider Gyrophioceras as a subgenus of Vermiceras (BLOOS, 1994, 1996; KMENT, 2000) or Paracaloceras (TAYLOR, 1998; STEVENS, 2004). TAYLOR & GUEx (2002) have recognized Gyrophioceras as a separate genus. We follow the latter approach here based principally on the shape of the suture line that is more similar to Vermiceras in some species of Gyrophioceras and more similar to Paracaloceras in others.

**Gyrophioceras cf. morganense** (TAYLOR, 1998)

Pl. VII, fig. 11


**Material:** One fragment (GSC 131680).

**Description:** Involute form for genus. Crowded flank ribs weakly concave. Ribs strongest on lower and middle flank projecting forward on upper flank. No keel visible.

**Discussion:** *Gyrophioceras cf. morganense* may be slightly more involute than other *G. morganense*. It is particularly similar to the paratype of TAYLOR (1998, fig. 21.11-21.12). The QCI form resembles a specimen of *Alsatites sublaqueus* (WÄHNER, 1886, pl. 30, fig. 4) but differs in being more involute. It is similar to Laqueoceras cf. sublaqueus of HlleBRANDT (2000a) but differs in being more evolute on the inner whors and in having ribs that are more regular in spacing and strength.

**Stratigraphic position:** Section D, Morganense Zone.

**Gyrophioceras aff. praespiratissimum**

(WÄHNER, 1887)

Pl. VII, fig. 3

aff. 1887. *Arietites praespiratissimus* n. f. WÄHNER, p. 139, pl. 36, figs 1-3.
aff. 1994. *Vermiceras (Gyrophioceras) praespiratissimum* (WÄHNER).- BLOOS, p. 10, pl. 3, figs 5-10, text-figs 6, 8.
cf. 2004. *Gyrophioceras praespiratissimum* (WÄHNER).- BERTINELLI et al., p. 91, fig. 5.

**Material:** One measured (GSC 131679) and one distorted specimen. Both specimens flattened. Measurement of volution is presented in Figure 15A.

**Description:** Evolute form for genus. Nucleus nodose. Weakly rursiradiate flank ribs straight to slightly concave. Ribs uniform in spacing and strength. Moderately strong keel present beyond shell diameters of 27 mm.

**Discussion:** *Gyrophioceras aff. praespiratissimum* is similar in volution and rib number to *G. praespiratissimum* (WÄHNER) but differs in having ribs that are more uniformly weakly rursiradiate. It differs from *A. liasicus* in having flank ribs that are less concave and has a stronger keel than *A. liasicus* and *G. morganense*. Gyrophio-
Ceras aff. praespiratissimum is more involute and has more strongly rursiradiate flank ribs than *G. supraspiratum* (WÄHNER).

**Stratigraphic position:** Section C, Sunrisensis Zone.

**Gyrophioceras cf. supraspiratum (WÄHNER, 1888)**

*Pl. VII, fig. 2*


cf. 1888. *Arietites supraspiratus* WÄHNER.- CANAVARI, p. 177, pl. 6, fig. 2.

? 1984. *Vermiceras* (*Vermiceras*) *supraspiratum* (WÄHNER).- BRAGA et al., p. 273, pl. 1, fig. 7.

cf. 1985. *Vermiceras supraspiratus* (WÄHNER).- VENTURI, fig. 1c-c2; text-fig. 6.

cf. 2004. *Gyrophioceras supraspiratum* (WÄHNER).- BERTINELLI et al., p. 91, fig. 5.

**Material and measurements:** One partially compressed measured specimen (GSC 107400). Measurements of volution and ribbing density are presented in Figure 15A-B.

**Description:** Strongly evolute form (UD/D = c. 70%). Flanks appear convex. Moderately densely ribbed with rib frequency increasing steadily. Rectiradiate flank ribs slightly concave adorally. Venter with low keel by shell diameter of c. 30 mm.

**Discussion:** *Gyrophioceras* cf. *supraspiratum* is similar in volution and ribbing style to *Paracaloceras* (?) sp. A of HILLEBRANDT (2000d, pl. 11, figs 1-2). Unfortunately, a closer comparison is impossible as preservation in the QCI material is poor and the South American material is incomplete and is principally of much larger shell diameter. The QCI form is somewhat similar to *G. morganense* and *Paracaloceras perspiratum* (WÄHNER) but differs in having more dense ribbing. It differs from *Alsattites proaries* in having more concave ribs and differs from evo-lute species of *Metophioceras* [*e.g. M. janus* SPATH, *M. caesar* (REYNES), *M. longidomus* (QUENSTEDT)] in having flattened flanks and as far as preservation permits us to observe, lack of a tricarinate-bisulcate venter. The QCI form differs from *Vermiceras scylla* (REYNES) in showing traces of a more prominent keel at similar shell diameters and in having straighter ribs.

**Stratigraphic position:** Sections E and F, Mineralense/Rursicostatum zones. Also occurs in the Columbiae Zone in the QCI.

**Genus Paracaloceras** SPATH, 1923b

**Type species:** *Ammonites coregonensis* SOWERBY, 1831. The holotype of SOWERBY is lost and that figured by CANAVARI, 1882, pl. 24, fig. 15 (and 1888, pl. 5, fig. 15) was designated as a neotype by DONOVAN & FORSEY (1973, p. 7).

**Paracaloceras cf. rursicostatum FREBOLD, 1967**

*Pl. VII, fig. 1*

cf. 1951. *Arietites* sp. indet. FREBOLD, p. 3, pl. 3, fig. 2.

cf. 1967. *Paracaloceras rursicostatum* FREBOLD, p. 26, pl. 7, figs 1-2; pl. 9, fig. 1.


1999. *Paracaloceras cf. rursicostatum* FREBOLD.- PÁLFY et al., fig. 5C.


cf. 2008a. *Paracaloceras rursicostatum* FREBOLD.- LONGRIDGE et al., pl. 2, figs 19, 21-22; text-figs 9U, 10L.

**Material and measurements:** Two measured specimens (GSC 107402, 107413) and several other incompletely preserved specimens. Measurements of volution and ribbing density are presented in Figure 15A-B.

**Description:** Evolute form. Flanks slightly convex. Dense, rectiradiate to rursiradiate, slightly concave flank ribs. When preservation allows, venter with prominent keel possibly flanked by sulci.

**Discussion:** End members of *P. rursicostatum* look very different; however, a detailed study on very well preserved material from Taseko Lakes has revealed that division of the species based on differences in volution, whorl cross-section or rib orientation, density or strength would be arbitrary (LONGRIDGE et al., 2008a).

Due to lack of information on ventral characteristics, it is difficult to identify the QCI material with certainty. It probably has a stronger keel than *P. grunowii* (HAUER) and differs from *Epanmonites cordieri* (CANAVARI) in having weaker flank ribs, particularly on the lowermost and uppermost flanks. It differs from *P. multicostatum* FREBOLD in being slightly less densely ribbed on the innermost whorls and in having flank ribs that are much less commonly prorsiradiate.

**Stratigraphic position:** Section E, Mineralense/Rursicostatum zones. Also occurs in the Columbiae Zone in the QCI.

**Paracaloceras (?) sp.**

*Pl. VII, figs 4, 9*

**Material and measurements:** Two measured specimens (GSC 131681-131682). Measurements of volution and ribbing density are presented in Figure 15A-B.

**Description:** Evolute form. Nucleus probably nodose
(Pl. VII, fig. 9). Strongly rursiradiate flank ribs moderately spaced. Venter with keel by 25 mm shell diameter.

**Discussion:** Paracaloceras (?) sp. has a lower number of flank ribs than *P. rursicostatum* beyond shell diameters of 30 mm and has flank ribs that are more strongly rursiradiate at very small shell diameters. The strongly rursiradiate character of the ribs is similar to *Schreinbachites reversicostatus* (Canavari) although the QCI form lacks irregularities in rib spacing and strength, the keel is stronger at similar whorl heights and as far as preservation permits observation, the QCI form has a nodose nucleus.

**Stratigraphic position:** Section C, Sunrisensis Zone.

### IV. NORTH AMERICAN MIDDLE AND UPPER HETTANGIAN AMMONITE ZONES

Ammonite taxa from the QCI indicate the presence of all zones currently recognized in the middle and upper Hettangian portion of the North American Zonation (Taylor et al., 2001; Longridge et al., 2006). However, the position of the boundary between the Mulleri and Occidentalis zones is uncertain. In the North American Zonation, *D. antiquum*, *K. frigga* and *K. haplopycthus* are restricted to the Mulleri Zone whereas *E. occidentalis* is restricted to the Occidentalis Zone and *D. silberlingi* does not appear until the Occidentalis Zone. In the QCI these two groups of taxa share some or all of the same range (Fig. 9). For this reason the Mulleri and Occidentalis zones are currently maintained as one stratigraphic unit in the QCI. Similarly, the boundary between the Mineralense and Rursicostatum zones is also uncertain. Several of the key taxa that are used to characterize these zones in the North American Zonation have not yet been found in the QCI (*e.g.* *P. mineralense* Taylor, *A. posttaurinum* (Wagner), *D. ornatum* Taylor, Paradiscamphiceras athabascaense Taylor in the Mineralense Zone; Paracaloceras reversicostatum (Canavari), *Pseudaetomoceras shoshonense* Taylor, *Schlotheimia* ex gr. *stenocephala* (Lange) in the Rursicostatum Zone (Taylor et al. 2001)). In addition, several species of the genus *Badouxia* are important in identifying the Mineralense and Rursicostatum zones. A new study of the *Badouxia* fauna is necessary to update which species of the genus occur in the QCI.

### V. CORRELATION WITH OTHER AREAS

The QCI are in an unusual biogeographic setting which means they contain many taxa with east-Pacific distributions as well as forms with affinities to species from New Zealand, western and eastern Tethys and, less commonly, northwest Europe. These instances permit correlations as indicated below. For the sake of simplicity, the complete record of common taxa are shown in Figure 16. Zones discussed in the text are shown in Figure 2.

### North America

**Canada**

In Canada, Hettangian ammonite collections are principally restricted to British Columbia with the exception of *Discamphiceras cf. silberlingi* that occurs in subsurface strata in northwestern Alberta. The exact level of this collection is uncertain but it is broadly placed in the middle to upper Hettangian (Hall *et al.*, 2000). At Williston Lake in British Columbia, *Nevadaphyllites psilomorphus* is found in lower Hettangian strata while *N. compressus* is found in the Polymorphum Zone. *Nevadaphyllites cf. compressus* is also recognized in the middle Hettangian where it occurs with *Togaticeras togatum*, *Alsaticites laticus*, *Saxoceras cf. portlocki* and *Kammerkarites frigga* (Hall & Pitaru, 2004). *Badouxia canadensis* (Frembald) [including *B. oreogenensis* Taylor which was placed in synonymy with *B. canadensis* by Longridge et al. (2006)] and possibly *Pseudaetomoceras doetzkirchneri* occur in beds that correlate with the Mineralense and Rursicostatum zones (Hall & Pitaru, 2004). In the Iskut River map area, *Paracaloceras cf. rursicostatum* occurs in beds that is probably either the Rursicostatum or Columbiae Zone (Jakobs & Palfy, 1994). In the Taseko Lakes area, *Phyllcoceras cf. asperenaense* and *T. togatum* are limited to the Mineralense Zone whereas *N. psilomorphus*, *N. aff. compressus*, *Eolytoceras tasekoi* and *E. constrictum* are limited to the Rursicostatum Zone (Frembald, 1967; Longridge et al., 2008a). *Discamphiceras silberlingi*, *P. rursicostatum*, *Sunrisites senililevis* and *B. canadensis* occur in the Mineralense and Rursicostatum zones while a single specimen of *Pseudaetomoceras cf. castagnolai* was collected from talus but is probably also from one of these two zones (Frembald, 1951, 1967; Longridge et al., 2006, 2008a, b).

These taxa permit correlation with the QCI succession. *Nevadaphyllites compressus*, *N. psilomorphus* and the possible occurrence of *P. doetzkirchneri* allow broad correlations between Williston Lake and the QCI in the Hettangian whereas *N. cf. compressus*, *A. laticus*, *T. togatum*, *S. cf. portlocki* and *K. frigga* permit tighter correlation with the middle Hettangian. *Badouxia canadensis* permits correlations between the Mineralense and Rursicostatum zones in Taseko Lakes, Williston Lake and the QCI, although in the latter area, the species ranges into the Columbiæ Zone. Direct correlations are possible between Taseko Lakes and the QCI in the Mineralense and Rursicostatum zones using *S. senililevis*, *E. constrictum* and *P. rursicostatum* whereas more broad correlations are possible between the two areas using *E. cf. tasekoi* whose range extends into the Morganense Zone and *D. silberlingi* that occurs in the middle Hettangian in the QCI. Finally, *P. cf. rursicostatum* in the Iskut River area permits broad correlation with the Mineralense through Columbiæ zones in the QCI.
Alaska
In Alaska, the best stratigraphic section with Hettangian faunas is in Pualé Bay where Kammerkarites cf. frigga, K. ex gr. megastoma, Mullerites cf. pleuroacanthitoioids and Saxoceras aff. portlockii occur in strata that are broadly equivalent to the Mulleri to Pleuroacanthitoioids zones whereas E. cf. tasekoi, P. cf. rursicostatum, Discamphiceras pleuroacanthitoioids and Saxoceras aff. portlockii occur in strata that are probably equivalent to the Rursicostatum Zone, although the Mineralense Zone cannot be excluded (IMLAY, 1981; PÁLFY et al., 1999; LONGRIDGE et al., 2006). Outside of Pualé Bay, Alaskan faunas are generally less well constrained stratigraphically because collections often come from isolated localities and often consist of single species (IMLAY, 1981). Saxoceras aff. portlockii possibly occurs at Alinchak Bay and Wide Bay in middle to upper Hettangian beds. Paracaloceras cf. rursicostatum occurs in the late Hettangian (probably Rursicostatum Zone) in the Kenai Peninsula and the Healy quadrangle. Kammerkarites cf. frigga, K. ex gr. megastoma, D. cf. silberlingi, M. cf. pleuroacanthitoioids and S. aff. portlockii provide broad correlations between the middle Hettangian in Alaska and the QCI. Eolytoceras cf. tasekoi, P. cf. rursicostatum and possibly B. canadensis provide correlation between the Mineralense and Rursicostatum zones in both areas although the first species is also found in the Morganense Zone while the latter two range into the Columbiae Zone in the QCI.

Oregon, Nevada and Mexico
Oregon and Nevada in the United States have many taxa that permit correlation with the QCI ammonite succession whereas taxa from the Sonora region in Mexico permit much more limited correlation. In Oregon, N. compressus is found in the Morganense and Mineralense zones (TAYLOR, 1998; TAYLOR et al., 2001; TAYLOR & GUEX, 2002). Gyrophioceras morganense, G. aff. supraspiratum and D. silberlingi occur in the Morganense Zone whereas B. canadensis occurs in the Mineralense Zone (TAYLOR, 1998; TAYLOR & GUEX, 2002). Finally,
P. aff. rursicostatum occurs in the Columbia to Trigonatum zones (TAYLOR, 1998; TAYLOR & GUEX, 2002). In Nevada, N. compressus occurs in the Pacificum and Polytophylum zones (GUEX, 1980, 1995; TAYLOR et al., 2001). Togatites cf. toigmatum was collected ex situ but is probably from lower Hettangian strata whereas Fergusonites striatus ranges throughout the middle Hettangian (GUEX, 1980, 1995; TAYLOR et al., 2001). Discamphiceras antiquum, K. frigga, K. rectiradiatus and K. haplopychus occur in the Mulleri Zone, Euphyllites occidentalis is limited to the Occidentalis Zone and K. praecoronoides, Franziceras coronoides and possible S. portlocki occur in the Coronoides Zone (GUEX, 1980, 1995; TAYLOR, 1998). Pleuroacanthites biformis is found in the Mulleri through Pleuroacanthitoidea zones whereas D. silberlingi ranges from the Occidentalis to Pleuroacanthitoidea zones (GUEX, 1980, 1995). Mullerites pleuroacanthitoidea, Eolytoceras praecursor, N. psilomorphus and Stothoceras garfieldense are limited to the Pleuroacanthitoidea Zone (GUEX, 1980, 1995; TAYLOR, 1998; TAYLOR et al., 2001). Discamphiceras submesogenos and A. ex gr. proaries occur in the Pleuroacanthitoidea and Sunrisense zones (GUEX, 1995; TAYLOR et al., 2001). Pseudactinoceras doetzkirchneri occurs in the Pleuroacanthitoidea through Mineralense zones, Angulaticeras (?) dunitricai occurs in the Sunrisense through Mineralense zones and P. castagnolai is limited to the Sunrisense Zone (GUEX, 1995; TAYLOR, 1998). Eolytoceras tasekoi is recognized from the Rursicostatum Zone whereas P. rursicostatum and B. canadensis are found in the Mineralense through Columbiae zones (GUEX, 1995; TAYLOR, 2000). In Mexico, B. canadensis permits correlation of what are probably the Rursicostatum and Co. canadensis are found in the Mineralense through Columbiae and possibly the Trigonatum Zone (GONZÁLEZ-LEÓN et al., 1996; TAYLOR et al., 2001; TAYLOR & GUEX, 2002) with the Mineralense to Columbiae zones in the QCI.

The middle and late Hettangian phylloceratids from the QCI permit broad correlations with the Hettangian in Nevada and Oregon. In Nevada, several ammonite taxa permit direct correlation with the QCI faunas. Direct correlations in the Mulleri/Occidentalis zones are possible using E. occidentalis, D. antiquum, K. haplopychus and K. frigga. The possible occurrence of S. aff. portlocki suggests a direct correlation with the Coronoides Zone whereas P. biformis permits direct correlation of the Mulleri/Occidentalis through Pleuroacanthitoidea zones. Discamphiceras cf. submesogenos permits direct correlation of the Pleuroacanthitoidea and Sunrisensico zones. Finally, B. canadensis and P. rursicostatum permit direct correlation of the Mineralense through Columbiae zones in both areas. In several cases, the ranges of the taxa from Nevada differ somewhat although they are still useful for correlation. Broad correlations are possible between in the middle Hettangian using A. ex gr. proaries, S. garfieldense and M. pleuroacanthitoidea, K. rectiradiatus, K. praecoronoides, F. coronoides and D. silberlingi. Eolytoceras praecursor is limited to the Pleuroacanthitoidea Zone whereas in the QCI it occurs in the Coronoides through Pleuroacanthitoidea zones. Pseudactinoceras castagnolai occurs only in the Sunrisense Zone whereas in the QCI it extends from the Pleuroacanthitoidea through Morganense zones. In the QCI, A. (? ) dunitricai and P. doetzkirchneri are limited to the Sunrisensico Zone whereas in Nevada they range from the middle middle to late Hettangian. In Oregon, G. morganense permits direct correlation with the Morganense Zone. It is possible to make broad correlations between the late Hettangian and early Sinemurian in the QCI and Nevada and Oregon using B. canadensis, G. supraspiratum and P. rursicostatum in Oregon and E. tasekoi in Nevada.

South Pacific

South America

South America has numerous taxa in common with the middle and late Hettangian fauna from the QCI. Nevadaphyllites compressus occurs in the Tilmanni Subzone and Phylloceras asperaense occurs in the Reissi through Peruvianus zones (HILLEBRANDT, 2000a) whereas F. cf. striatus and Kammerkertas chinchillaensis permit correlation with the Bayoensis Zone (HILLEBRANDT, 2000a, c). Discamphiceras aff. antiquum and D. aff. pleuronotum (HILLEBRANDT, 2000a, c) occur in the Reissi Zone. Storthoceras australis definitely occurs and K. frigga may occur in the Australe Horizon (HILLEBRANDT, 2000c). Alsaites cf. liasicus, Sunrisites chilensis and Angulaticeras (?) cf. cachinensis occur in the Peruvianus Zone (HILLEBRANDT, 2000c, d). Badouxia canadensis occurs throughout the Canadensis Zone (GEYER, 1979; QUINZIO SNN, 1987; HILLEBRANDT, 1990, 1994, 2000b, c). Alsaites cf. liasicus occurs in slightly younger strata in South America than in the QCI whereas A. (? ) cachinensis occurs in slightly older strata. Fergusononites cf. striatus and K. chinchillaensis can be used to correlate the Bayoensis Zone with the Mulleri and Occidentalis zones in the QCI. Discamphiceras aff. antiquum, D. aff. pleuronotum and the possible occurrence of K. frigga permit broad correlations between the Reissi Zone in South America with the Mulleri/Occidentalis through the Coronoides zones in the QCI whereas S. australis suggests a slightly younger association of the Australe Horizon with the Pleuroacanthitoidea and Sunrisensico zones. Sunrisites chilensis permits correlation of the South American Peruvianus Zone with the Sunrisensico and Morganense zones. Badouxia canadensis permits correlation of the Canadensis Zone in South America with the Mineralense through Columbiae zones in the QCI.

New Zealand

Based on the work of STEVENS (2004), approximate correlations are possible between the QCI ammonite successions and those of New Zealand although often the identifications of New Zealand material are questionable.
Possible *K. frigga* occurs in what is probably the early middle Hettangian in New Zealand and permits correlation with the Mulleri/Occidentalis through Coronooides zones in the QCI. In New Zealand, possible *N. psilomorphus* occurs in what are probably middle to lower upper Hettangian strata equivalent to the North American Mulleri to Morganensio zones and permits broad correlations with the middle Hettangian in the QCI. Finally, possible *E. tasekoi* may occur in the late Hettangian of New Zealand permitting broad correlation with the late Hettangian in the QCI.

**Europe**

**Western Tethys (circum-Mediterranean)**

Many of the middle and late Hettangian QCI taxa also occur in the Tethyan circum-Mediterranean area. These correlations have added importance as Mediterranean faunas are now quite well correlated with successions in northwest Europe, permitting indirect correlations with the primary standard succession (e.g., BLOOS, 1983; GUÉRIN-FRANJATTE, 1990; MOTERDE & CORNA, 1997; PAGE, 2003). In Austria, *N. psilomorphus* is found throughout the Hettangian (NEUMAYR, 1879; LANGE, 1952; DOMMERGUES et al., 1995; BÖHM et al., 1999; KMENT, 2000) whereas in Hungary, *N. cf. psilomorphus* is found from talus that is very likely to be from the lower to middle Hettangian (PÁLFY et al., 2001). Togaticeras *togatum* is found in lower and middle Hettangian strata in Austria (RAKUS, 1993a; KMENT, 2000). The Hettangian phylloceratids from the QCI permit broad correlations with the Hettangian of the circum-Mediterranean. *Pleuroacanthites* *biformis* is found in the Megastoma Zone in Austria and probably the late Hettangian in Italy (CANAVARI, 1888; WÄHNER, 1894; VENTURI, 1985). *Pseudaeotomoceras castagnolai* occurs in the Marmoreum Zone in Austria and probably the late Hettangian in Italy (CANAVARI, 1882; WÄHNER, 1886; CANAVARI, 1888; VENTURI, 1985; KMENT, 2000). *Eolytoceras cf. tasekoi* occurs in the Marmoreum Zone in Austria (KMENT, 2000) and can be used to indicate the presence of upper Hettangian strata. *Discamphiceras pleuronotum* and *A. proaries* occur in the Megastoma Zone in Austria and probably the upper Hettangian in Italy (WÄHNER, 1884, 1886; CANAVARI, 1888; LANGE, 1952; VENTURI, 1985). *Pseudaeotomoceras doetzkirchneri, K. haploptychus, K. frigga* and *K. megastoma* occur in the Megastoma Zone in Austria (WÄHNER, 1882, 1884, 1886; LANGE, 1952; BLIND, 1963; RAKUS, 1999). *Gyrophioceras praespiratissimum* occurs in the Megastoma and Marmoreum zones in Austria and the late Hettangian in Italy (WÄHNER, 1887; BERTINELLI et al., 2004). *Gyrophioceras superspiratum* occurs in the Megastoma and Marmoreum Zones in Austria, probably occurs in the late Hettangian in Italy and possibly occurs in the late Hettangian in Spain (WÄHNER, 1888; BRAGA et al., 1984; CANAVARI, 1888; VENTURI, 1985; BERTINELLI et al., 2004). *Kammerkarites megastoma* also occurs in the Liassicus Zone in the West Carpathians (RAKUS, 1993b).

**Eastern Tethys**

Broad correlations are possible between the middle and upper Hettangian ammonite successions in the QCI and the Hettangian and earliest Sinemurian in the eastern Tethys. *Nevadaphyllites* cf. *psilomorphus* is found in the Calliphylloceras Zone in Tibet (YIN et al., 2007) and permits broad correlation with middle Hettangian strata in the QCI. *Pleuroacanthites aff. biformis, D. pleuronotum* and *K. frigga* occur in the Pleuronotum Zone in Tibet (YIN et al., 2007) and permit correlations with the Mulleri through Pleurocanthidoides zones in the QCI. Finally, *E. tasekoi* occurs in lower Sinemurian strata that are probably equivalent to the Conybearei or Rotiforme subzones in Vietnam (MEISTER et al., 2002a) and permit broad correlations between the earliest Sinemurian in Vietnam and the late Hettangian in the QCI.

**Northwest Europe**

Several taxa from the middle and late Hettangian in the QCI permit direct correlations with the northwestern European successions. These successions (e.g., DEAN et al., 1961; MOTERDE & CORNA, 1997; PAGE, 2003) are considered the primary standard for Early Jurassic biochronology (CALLOMON, 1984). Thus, these correlations have added importance. *Kammerkarites haploptychus* is recognized from the Laqueus Subzone in England (DONOVAN, 1952) and permits correlation with the Mulleri/Occidentalis to Coronoides zones in the QCI. *Caloceras bloomfieldense* occurs in the Liassicus Zone in England and possibly the Portlocki Subzone and definitely the Laqueus Subzone in Wales (DONOVAN, 1952; DEAN et al., 1961; HODGES, 1986). *S. portlocki* occurs in the Portlocki Subzone in France and the Liassicus Zone in England (DONOVAN, 1952; DEAN et al., 1961; ELMI & MOTERDE, 1965; GUERIN-FRANJATTE, 1990) and *A. liasicus* occurs in the Laqueus Subzone in Franche-Comté and England and in the middle Hettangian in Germany (LANGE, 1941; DONOVAN, 1952; ELMI & MOTERDE, 1965; SCHLEGELMILCH, 1976; GUERIN-FRANJATTE, 1990). These taxa permit direct correlation of the Coronoides Zone in the QCI with the middle Hettangian successions in Europe. In addition *K. megastoma* occurs in strata from the Planorbis Zone in Germany, the Laqueus Subzone in England and the middle and late Hettangian in France (DONOVAN, 1952; SCHLEGELMILCH, 1976; GUERIN-FRANJATTE, 1990). These taxa allow broad correlations between the middle and late Hettangian ammonite successions in the QCI and the Hettangian and early Sinemurian in Europe.

**VI. PALEOBIOGEOGRAPHY**

The rich Hettangian ammonite fauna from the QCI is principally of east Pacific and Tethyan affinities although
some important taxa with Boreal affinity are also present. The QCI are part of the displaced terrane, Wrangellia (Jones et al., 1977). Based on faunal evidence, Wrangellia is believed to have been in the eastern Pacific and the northern Hemisphere during Permian through Early Jurassic time (e.g., Monger, 1984; Taylor et al., 1984; Smith & Tipper, 1986; Belasky, 1994; Aberhan, 1999; Smith et al., 2001; Belasky et al., 2002; Smith, 2006; Longridge et al., 2008b). The Hettangian ammonites in the QCI support this claim. They have strong affinity with contemporaneous endemic faunas from other areas of North America, particularly Nevada. Correlations with South America are also strong and suggest open communication throughout the eastern Pacific during Hettangian time.

Based on ammonite and bivalve distribution patterns, it has been proposed that Wrangellia was displaced northward between several hundred to over 1000 km since Sinemurian and Pliensbachian times (e.g., Taylor et al., 1984; Aberhan, 1999; Smith, 2006). Today, the QCI are at a similar latitude to the autochthonous Fernie Basin which contains the Williston Lake Hettangian ammonite fauna (Hall & Pitau, 2004). However, the diversity is far greater in the QCI fauna than the Williston Lake fauna where the succession lacks Paradasyceras, Fergusonitites, Ectocentrites, Eolytoceras, Pteryrocanthites, Euphyllites, Caloceras, Mullerites, Angulaticeras and Francizceras (Hall & Pitau, 2004). The succession in the QCI is more similar to the Nevada fauna in composition as well as diversity. Nevada was also part of autochthonous North America during the Hettangian. A diversity gradient is commonly recognized from north to south on the craton with increasing diversity toward the equator (Smith & Tipper, 1986; Smith, 1999 and references therein). The difference in diversity between the Williston Lake faunas and the QCI and Nevada faunas as well as the strong similarities between the QCI and Nevada faunas support the hypothesis of a significant northward displacement of Wrangellia relative to the craton since Early Jurassic time.

VII. CONCLUSIONS

The QCI contain the most diverse middle and late Hettangian ammonite fauna in Canada. In total, fifty-three taxa from the Mulleri/Occidentalis through Mineralense/Annonone zonation. In addition, it permits correlations with other areas of North America, South America, New Zealand, western and eastern Tethys, and northwest Europe in the Hettangian and early Sinemurian. The QCI fauna supports the location of Wrangellia in the northern Hemisphere and the eastern Pacific during the Hettangian and suggests the terrane has been displaced significantly northward since the Hettangian.

ACKNOWLEDGEMENTS

This study was supported by NSERC grant to TLS. Geological Survey of Canada contribution number 20070582 and MTA-MTM Paleoc contribution number 68. JP acknowledges support of the Hungarian Scientific Research Fund (T042802). Thanks to G. Bloos (Staatsliches Museum für Naturkunde, Stuttgart) for helpful discussion of Hettangian and Sinemurian ammonites. This paper has been significantly improved by a review from A. von Hillebrandt.

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Plate I

All specimens from the Sandilands Formation. All figures are × 1.

**Figs 1, 9, 23-24:** Togaticeras togatum (Neumayr).

1. GSC 129103; hypotype; Pleuroacanthitoides Zone; GSC loc. no. C-156960, Sec. B, loc. 17. 9, GSC 129104; hypotype; Pleuroacanthitoides Zone; GSC loc. no. 156308, Sec. B, loc. 16. 23-24, GSC 129105; hypotype; Coronoides Zone; GSC loc. no. 156915, Sec. B, loc. 12.

**Figs 2-3, 10-11:** Phylloceras asperaense Hillebrandt.

 Mulleri/Occidentalis zones. 2-3, GSC 129066; GSC loc. no. C-156302, Sec. A, loc. 04. 10-11, GSC 129067; GSC loc. no. C-156985, Sec. B, loc. 01.

**Figs 4-5, 15, 20, 25-26:** Paradasycceras carteri n. sp.

 Mulleri/Occidentalis zones. 4-5, GSC 129070, paratype; GSC loc. no. C-156998, Sec. A, loc. 02. 15, GSC 129071, paratype; GSC loc. no. C-156906, Sec. A, level 05. 20, GSC 129068, holotype; GSC loc. no. C-156302, Sec. A, loc. 04. 25-26, GSC 129069, paratype; GSC loc. no. C- 156906, Sec. A, loc. 05.

**Figs 6-8, 21:** Fergusonites striatus Guex.

 Mulleri/Occidentalis zones. 6-8, GSC 129082, hypotype; GSC loc. no. C-156906, Sec. A, loc. 05. 21, GSC 129081, hypotype; GSC loc. no. C-156906, Sec. A, loc. 05.

**Figs 12-14:** Nevadaphyllites aff. compressus Guex.

 Mulleri/Occidentalis zones. 12, GSC 129100; GSC loc. no. C-156906, Sec. A, loc. 05. 13-14, GSC 129099; GSC loc. no. C-156301, Sec. A, loc. 05.

**Fig. 16:** Nevadaphyllites sp.

 GSC 129101; Mulleri/Occidentalis zones; GSC loc. no. C-156908, Sec. A, loc. 08.

**Figs 17-18, 27:** Nevadaphyllites psilomorphus (Neumayr).

 Coronoides Zone. 17-18, GSC 129093; hypotype; GSC loc. no. C-156915, Sec. B, loc. 12. 27, GSC 129094; hypotype; GSC loc. no. C-156303, Sec. B, loc. 12.

**Figs 19, 22:** Eolytoceras cf. tasekoi Frebold.

 19, GSC 129149; Morganense Zone; GSC loc. no. C-156328, Sec. D, loc. 04. 22, GSC 107365; Mineralense/Rursicostatum zones, GSC loc. no. C-159289, Sec. E, loc. 03.
go de Chile, 1: 19 pp., 2 pls.


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Plate II

All specimens from the Sandilands Formation. Except for 17 all figures are × 1. Where possible microconch [m] and macroconch [M] forms are noted.

Figs 1, 4, 8, 15-16: *Eolytoceras* cf. *praecursor* GUEX.

1, [m], GSC 129127; Coronoides Zone; GSC loc. no. C-156915, Sec. B, loc. 12; arrow marks position of last septal suture. 4, [m], GSC 129128; Pleuroacanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19. 8, [M], GSC 129129; Pleuroacanthitoides Zone; GSC loc. no. C-156309, Sec. B, loc. 15. 15-16, GSC 129140; Coronoides Zone; GSC loc. no. C-156915, Sec. B, loc. 12.

Figs 2, 7, 14: *Ectocentrites pacificus* n. sp.

Sunrisensis Zone. 2, GSC 129117; holotype; GSC loc. no. C-156324, Sec. D, loc. 01. 7, GSC 129118; paratype; GSC loc. no. C-156925, Sec. B, loc. 22. 14, GSC 129116; paratype; GSC loc. no. C-156318, Sec. C, loc. 04.

Figs 3, 6: *Pleuroacanthites charlottensis* n. sp.

3, GSC 129142; holotype; Coronoides Zone; hypotype; GSC loc. no. 156995, Sec. B, loc. 10. 6, GSC 129143; paratype; Mulleri/Occidentalis zones; GSC loc. no. C-156344, Sec. A, loc. 05. Fig. 5.

Fig. 5:

Pleuroacanthitidae gen. indet. n. sp.

GSC 129115; Mulleri/Occidentalis zones, GSC loc. no. C-159363, Sec. I, loc. 01.


Sunrisensis Zone. 9, GSC 130737; GSC loc. no. C-157623, Sec. B, loc. 20. 13, GSC 130738; GSC loc. no. C-156927, Sec. B, loc. 23.

Fig. 10:

Pleuroacanthites sp.

GSC 129148; Mulleri/Occidentalis zones, GSC loc. no. C-156985, Sec. B, loc. 01.

Figs 11-12, 17: *Pleuroacanthites* cf. *biformis* (SOWERBY).

11, GSC 129136, Sec. B, loc. uncertain. 12, GSC 129141; Mulleri/Occidentalis zones; GSC loc. no. C-156906, Sec. A, loc. 05. 17, GSC 129137; Pleuroacanthitoides Zone; GSC loc. no. C-156308, Sec. B, loc. 16; latex cast of external mould, × 0.50.
All specimens from the Sandilands Formation. Except for 5 and 11 all figures are × 1.

Plate III

Figs 1, 9: *Eolytoceras* aff. *constrictum* LONGRIDGE et al.
Mineralense/Rursicostatum zones. 1, GSC 107374; GSC loc. no. C-175211, Sec. E, loc. 07; latex cast of external mould. 9, GSC 107373; GSC loc. no. C-159290, Sec. E, loc. 02.

Figs 2-4, 10-11: *Euphyllites occidentalis* GUEx.
Mulleri/Occidentalis zones; GSC loc. no. C-156906, Sec. A, loc. 05. 2, GSC 129157, hypotype. 3-4, GSC 129155, hypotype. 10, GSC 1129154, hypotype. 11, GSC 129156, hypotype; × 0.50.

5, GSC 130735; Pleuroacanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19; × 0.50. 7, GSC 130736; Sunrisensis Zone; GSC loc. no. C-156316, Sec. C, loc. 06.

Figs 6, 8: *Mullerites* cf. *pleuroacanthitoides* GUEx.
6. GSC 130719; Sunrisensis Zone; GSC loc. no. C-156313, Sec. B, loc. 22. 8, GSC 130718; Pleuroacanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19.


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**Plate IV**

All specimens from the Sandilands Formation. Except for 3 all figures are × 1.

Fig. 1: *Caloceras aff. bloomfieldense DONOVAN.*
GSC 129162; Coronoides Zone; GSC loc. no. C-157633, Sec. B, loc. 13.

Figs 2, 5: *Discamphiceras aff. pleuronotum (CANAVARI).*
Mulleri/Occidentalis zones; GSC loc. no. C-156906, Sec. A, loc. 05.
2, GSC 130677. 5, GSC 130676.

Figs 3, 9: *Badouxia canadensis (FREBOLD).*
Mineralense/Rursicostatum zones. 3, GSC 107399, hypotype; GSC loc. no. C-156406, Sec. F, loc. 04; latex cast of external mould, × 0.50. 9, GSC 107392, hypotype; GSC loc. no. C-156420, Sec. F, loc. 01.

Figs 4, 7: *Discamphiceras aff. antiquum GU EX.*
Mulleri/Occidentalis zones. 4, GSC 130695; GSC loc. no. C-156986, Sec. B, loc. 02. 7, GSC 130696; GSC loc. no. C-156908, Sec. A, loc. 08.

Figs 6, 10: *Discamphiceras silberlingi GU EX.*
6, GSC 129163; Coronoides Zone; hypotype; GSC loc. no. C-156303, Sec. B, loc. 12. 10, GSC 129164; Pleuroacanthitoides Zone; hypotype; GSC loc. no. C-156305, Sec. B, loc. 19.

Fig. 8: *Discamphiceras cf. submesogenos GU EX.*
GSC 130681; Pleuroacanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19.

Fig. 11: *Kammerkarites cf. rectiradiatus GU EX.*
GSC 130675; Coronoides Zone; GSC loc. no. C-156993, Sec. B, loc. 08.
All specimens from the Sandilands Formation. Except for 3 and 4 all figures are × 1.

Fig. 1: *Kammerkarites* (?) n. sp.
GSC 130773; Mulleri/Occidentalis zones; GSC loc. no. C-157640, Sec. A, loc. 01.

Figs 2, 5: *Kammerkarites* aff. *chinchillaensis* **HILLENBRANDT.**
Mulleri/Occidentalis zones. 2, GSC 130776; GSC loc. no. C-156304, Sec. A, loc. 06, 5, GSC 130775; GSC loc. no. C-156339, Sec. B, loc. 01.

Figs 3, 6-7: *Kammerkarites* cf. *haploptychus* (**WÄHNER**).
3, GSC 130790; Mulleri/Occidentalis zones; GSC loc. no. C-156988, Sec. A, loc. 02; × 0.40. 6, GSC 130792; Coronoides Zone; GSC loc. no. C-156332, Sec. B, loc. 10. 7, GSC 130791; Mulleri/Occidentalis zones; GSC loc. no. C-156988, Sec. B, loc. 04; latex cast of external mould.

Fig. 4: *Kammerkarites* ex gr. *megastoma* (**GÜMBEL**).
GSC 130794; Mulleri/Occidentalis zones; hypotype; GSC loc. no. C-157636, Sec. B, loc. 04; × 0.60.


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**Plate VI**

All specimens from the Sandilands Formation. All figures are × 1.

Figs 1-2, 4-6, 12-13: *Franziceras cf. coronoides* (GUEX). 1, GSC 130702; Sunrisensis Zone; GSC loc. no. C-156312, Sec. B, loc. 21. 2, GSC 130795; Sunrisensis Zone; hypotype; GSC loc. no. C-156924, Sec. B, loc. 21. 4, GSC 130797; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12. 5-6, GSC 130796; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12. 8-9, GSC 130802; Coronoides Zone; GSC loc. no. C-156915, Sec. B, loc. 12.

Figs 3, 7-9: *Franziceras kennecottense* n. sp. Coronoides Zone. 3, GSC 130806; holotype; GSC loc. no. C-156310, Sec. B, loc. 14. 7-8, GSC 130804; paratype; GSC loc. no. C-156303, Sec. B, loc. 12. 9, paratype; GSC 130805; GSC loc. no. C-156303, Sec. B, loc. 12.

Figs 10, 14-16: *Sunrisites cf. chilensis* HILLEBRANDT. Sunrisensis Zone. 10, GSC 130727; GSC loc. no. C-156317, Sec. C, loc. 05. 14, GSC 130728; GSC loc. no. C-156317, Sec. C, loc. 05. 15, GSC 130725; GSC loc. no. C-156317, Sec. C, loc. 05. 16, GSC 130726; GSC loc. no. C-157637, Sec. B, loc. 24.

Fig. 11: *Sunrisites cf. senililevis* LONGRIDGE et al. GSC 107385; Mineralense/Rursicostatum zones; GSC loc. no. C-156406, Sec. F, loc. 04; latex cast of external mould.
Plate VII

All specimens from the Sandilands Formation. Except for 10 all figures are × 1.

Fig. 1: **Paracaloceras cf. rursicostatum** FRE BOLD. GSC108505; lowermost Columbiae Zone; GSC loc. no. C-159284, Sec. E, 0.5 m above level 08.

Fig. 2: **Gyrophioceras cf. supraspiratum** WÄHNER. GSC 107400; Mineralense/Rursicostatum zones; GSC loc. no. C-159251, Sec. E, loc. 01.

Fig. 3: **Gyrophioceras aff. prae spiratissimum** WÄHNER. GSC 131679; Sunrisensis Zone; GSC loc. no. C-156317, Sec. C, loc. 05.

Figs 4-9: **Paracaloceras** (?) sp.

Sunrisensis Zone. 4, GSC 131681; GSC loc. no. C-156317, Sec. C, loc. 05. 9, GSC 131682; GSC loc. no. C-156317, Sec. C, loc. 05.

Figs 5-6: **Alsatites** ex gr. *proaries* (NEUMAYR). Coronoides Zone. 5, GSC 130712; GSC loc. no. C-156915, Sec. B, loc. 12. 6, GSC 130711; GSC loc. no. C-156303, Sec. B, loc. 12.

Fig. 7: **Alsatites cf. liasicus** (D’ORBIGNY).

GSC 130699; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12.

Figs 8-10: **Alsatites cf. proaries** (NEUMAYR).

8, GSC 130703; Pleurocanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19. 10, GSC 156959; Morganense Zone; GSC loc. no. C-175203, Sec. G, loc. 03; some shell material preserved, × 0.70.

Fig. 11: **Gyrophioceras cf. morganense** (TAYLOR).

GSC 131680; Morganense Zone; GSC loc. no. C-156326, Sec. D, loc. 02.


WÄHNER, F. (1882-98) - Beiträge zur Kenntnis der tieferen Zonen des unteren Lias der nordöstlichen Alpen. *Beiträge zur Paläontologie Österreich-Ungarns und des Orients,*

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**Plate VIII**

All specimens from the Sandilands Formation. All figures are × 1.

**Fig. 1:** *Kammerkarites cf. praecoronoides* GUEx.
GSC 130793; Mulleri/Occidentalis zones; GSC loc. no. C-156344, Sec. A, loc. 05.

**Figs 2-5, 11, 15:** *Saxoceras aff. portlocki* (WRIGHT).
Coronoides Zone. 2-3, GSC 130767; GSC loc. no. C-156303, Sec. B, loc. 12. 4-5, GSC 130768; GSC loc. no. C-156915, Sec. B, loc. 12. 11, GSC 130765; GSC loc. no. C-156303, Sec. B, loc. 12. 15, GSC 130766; GSC loc. no. C-156913, Sec. B, loc. 10.

**Figs 6-8:** *Kammerkarites cf. frigga* (WÄHNER).
Mulleri/Occidentalis zones. 6, GSC 130777; GSC loc. no. C-156988, Sec. B, loc. 04. 7-8, GSC 130778; GSC loc. no. C-156301, Sec. A, loc. 05.

**Figs 9-10:** *Storthoceras sp.*
GSC 130764; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12.

**Figs 12-13:** *Curviceras haidae* n. sp.
GSC 130763; holotype; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12.

**Figs 14, 19:** *Storthoceras cf. australe* HILLEBRANDT.
Sunrisensis Zone; GSC loc. no. C-156313, Sec. B, loc. 22. 14, GSC 130756. 19, GSC 130755.

**Figs 16-17:** *Schlotheimia* sp.
GSC 131668; Coronoides Zone; GSC loc. no. C-156303, Sec. B, loc. 12.

**Fig. 18:** *Angulaticeras (?) cf. cachinensis* HILLEBRANDT.
GSC 107376; Mineralense/Rursicostatum zones; GSC loc. no. C-159290, Sec. E, loc. 02.

**Figs 20, 25:** *Storthoceras aff. garfieldense* (TAYLOR).
20, GSC 130741; Pleuroacanthitoides Zone; GSC loc. no. C-156305, Sec. B, loc. 19. 25, GSC 130742; Sunrisensis Zone; GSC loc. no. C-156313, Sec. B, loc. 22.

**Figs 21, 23:** *Angulaticeras (?) cf. dumitricai* GUEx.
Sunrisensis Zone. 21, GSC 131675; GSC loc. no. C-156322, Sec. C, loc. 01. 23, GSC 131673; middle or late Hettangian, exact locality uncertain; latex cast of external mould.

**Fig. 22, 24:** *Schlotheimiiidae gen. et sp. indet.*
22, GSC 107379; lowermost Columbies Zone; GSC loc. no. C-159282, Sec. E, 1.3 m above level 08. 24, GSC 131674; GSC loc. no. C-156317, Sec. C, loc. 05.


*Accepté juin 2008*
APPENDIX A: LOCALITY INFORMATION FOR AMMONITE COLLECTIONS

Information given below includes locations for the middle and late Hettangian ammonite specimens from the QCI. Latitude and longitude are given in addition to a brief description of each location. Relevant GSC and other locality numbers are provided. Refer to Figure 1 for locations.

Section A
Kennecott Point. [53°54’47.0’, 133°09’9.8’; 53°54’44.7’, 133°09’10.9’]
Locality exposed on a wave cut platform consisting of A01 to A14 in a stratigraphic sequence. Section begins above large fault.
A01: GSC locality C-157640; A02: C-157641, C-156998, C-156323, 177354; A03: C-156905; A04: C-156302; A05: C-156906, C-156301, C-156346, C-156344; A06: C-156907, C-156304; A07: C-157642, C-156999; A08: C-156908; A09: C-156997; A10: C-156909; A11: C-156910; A12: C-156911; A13: C-156911, C-157000; A14: C-156912.

Section B
Kennecott Point. [53°54’44.7’, 133°09’10.9’; 53°54’43.3’, 133°09’12.2’]
Locality exposed on a wave cut platform consisting of B01 to B24 in a stratigraphic sequence. Base of section is beside a large boulder. Section begins with concretionary beds that are approximately the same level as the concretionary beds in section A.
B01: GSC locality C-156985, C-156334, C-156339; B02: C-156986; B03: C-156987; B04: C-157636, C-156988; B05: C-156989; B06: C-156990; B07: C-156991, C-156992, C-156333; B08: C-156993; B09: C-156994; B10: C-157635, C-157638, C-156965, C-156913, C-156332; B11: C-156914, C-157639; B12: C-156915, C-156303; B13: C-156916, C-156311; B14: C-156310; B15: C-156917, C-156309; B16: C-157630, C-156919, C-156308; B17: C-156960; B18: C-156959, C-156306; B19: C-156732, C-156921, C-156305; B20: C-157623, C-156734, C-156918, C-156314; B21: C-156924, C-156312; B22: C-156925, C-156926, C-156313; B23: C-157672, C-156927, C-156321; B24: C-157637, C-156928, C-156929.

Section C
Kennecott Point. [53°54’44.7’, 133°09’10.9’; 53°54’44.0’, 133°09’12.2’]
Locality exposed on a wave cut platform consisting of C01 to C06 in a stratigraphic sequence. Section is slice faulted against section B.
C01: GSC locality C-156322; C02: C-156320; C03: C-156319; C04: C-156318; C05: 156317; C06: 156316.

Section D
Kennecott Point. [53°54’44.7’, 133°09’10.9’; 53°54’42.3’, 133°09’08.2’]
Locality exposed on a wave cut platform consisting of D01 to D04 in a stratigraphic sequence.
D01: GSC locality C-156324; D02: C-156326; D03: C-156327; D04: C-156328.

Section E
Kennecott Point. [53°54’38.9’, 133°09’15.1’; 53°54’38.1’, 133°09’12.8’]
Locality exposed on a wave cut platform consisting of E01 to E08 in a stratigraphic sequence.
E01: GSC locality C-159251, C-159291; E02: C-159290; E03: C-159289; E04: C-159288; E05: C-159287; E06: C-159252; E07: C-159286, C-175211; E08: C-159285.

Section F
Kennecott Point. [53°54’40.3’, 133°09’07.3’; 53°54’39.5’, 133°09’07.2’]
Locality exposed on a wave cut platform consisting of F01 to F07 in a stratigraphic sequence. Section ends at a boulder field around a large boulder but continuation traceable by a marker bed further northwest, offset several meters by a strike-skip fault.
F01: GSC locality C-156420, C-175219; F02: C-156419; F03: C-156416, C-175218; F04: C-156406, C-156414, C-175216; F05: C-156405; F06: C-156404; F07: C-156403.

Section G
Kennecott Point. [53°54’42.3’, 133°09’08.2’; 53°54’41.1’, 133°09’07.6’]
Locality exposed on a wave cut platform consisting of G01 to G05 in a stratigraphic sequence. North of a boulder field, around a large boulder. Base of section is a bed with abundant Chondrites.
G01: GSC locality C-175208; G02: C-175204; G03: C-175203; G04: C-175202; G05: C-175201.

Section H
Kunga Island. [52°45’34.4’, 131°33’38.3’; 52°45’36.1’, 131°33’36.0’]
Locality exposed in supratidal region consisting of H01 to H06 in a stratigraphic sequence. Beds steeply dipping to overturned.
H01: GSC locality C-159352; H02: C-159354; H03: C-159355; H04: C-159356; H05: C-159357; H06: 159360.

Section I
Kunga Island. [52°45’36.3’, 131°33’38.7’; 52°45’36.9’, 131°33’37.1’]
Locality exposed in supratidal region consisting of I01 to I02 in a stratigraphic sequence. Beds steeply dipping to overturned.
I01: GSC locality C-159363; I02: C-159370.
APPENDIX B: AMMONITE MEASUREMENTS

Measurements are given below for all measured specimens from the QCI. Instances where the measurement is approximate are marked by the letter c. in front of the number. Abbreviations and measurements follow SMITH (1986) and include shell diameter (D), umbilical diameter (UD), whorl width (WW), whorl height (WH), umbilical diameter as a ratio of shell diameter (U), ratio of the whorl width to the whorl height (WWWH) and primary ribs per half whorl (PRHW).

Phylloceras asperacense
GSC # DMAX D UD U WW WH WWWH
129066 26.2 26.2 5.3 0.20 9.5 13.6 0.70
129067 36.7 6.8 0.19 17.5

Parascyllaceras carteri
GSC # DMAX D UD U WW WH WWWH
129072 42.6 42.6 7.8 0.18 21
129073 32.8 6.5 0.20 16.2
129074 29.9 5.8 0.19 14
129075 20.8 4.7 0.23 9.3
129076 20.5 4.3 0.21 c.6.8 9.2 0.74
129071 c.42 7.7 0.18 c.20.5
129077 30.5 30.5 5.6 0.18 15
129078 25.5 5.9 0.23 11.6
129079 13.7 3.7 0.22 6.4
129080 25.5 5.6 0.22 12.5
129070 21 5 0.24 9.4

Fergusinutes striatus
GSC # DMAX D UD U WW WH WWWH
129083 23.2 5.8 0.25 8.5 10.1 0.84
129081 27.2 6.0 0.22 11.6
129084 19.4 4.2 0.22 7.2 9.3 0.77
129085 24 5.6 0.23 11
129086 25 6 0.24 12.6
129087 c.24 c.24 5.5 0.23 11.4
129088 17.1 3.5 0.20 6.1 7.8 0.78
129089 13.5 2.5 0.19 6.2
129090 18.1 3.2 0.18 6.8 8.5 0.80
129091 28.8 6.8 0.24 12.6
129082 30.5 30.2 6.8 0.23 10.3 13.6 0.76
129092 20 4.5 0.23 7 9 0.78

Nevadaphyllites pisolomorphus
GSC # DMAX D UD U WW WH WWWH
129093 34.2 4.5 0.13
129094 68.2 68.2 10.9 0.16 35.8
129095 32 32 5 0.16 15.5
129096 27.4 4 0.15 10.1 14.5 0.70
129097 35.4 5.4 0.15 18.2
129098 40.2 6.8 0.17 20.6

Nevadaphyllites sp.
GSC # DMAX D UD U WW WH
129101 c.34 c.35 0.15

Nevadaphyllites aff. compressus
GSC # DMAX D UD U WW WH
129099 31.1 6.7 0.22 15.6

Togaticeras togatum
GSC # DMAX D UD U WW WH
129106 c.33 c.6.2 0.19
129104 24 c.4 0.17 12
129107 21.2 3.7 0.17 9.6
129108 c.21.3 3 0.14 10.7

129109 14.5 2.5 0.17 6.9
129110 17.6 4.3 0.24 7.5
129105 17.6 3.1 0.18 8
129111 16.7 3 0.18 7.9
129112 19.8 3.5 0.18 10.3
129113 17.2 3.2 0.19 7.8
129114 18 3.2 0.18 9

Eolytoceras cf. tanseki
GSC # DMAX D UD U WW WH
129150 53.7 20.3 0.38 19.5
129151 24 7.5 0.31 9.7
129152 56 23.5 0.42 17.7
129153 32 11 0.34 12
107365 89 36.2 0.41 30.5
107367 75.5 27 0.36 29

Eolytoceras aff. constrictum
GSC # DMAX D UD U WW WH
107374 83 30.4 0.37 28.7 7
107373 79.2 33.6 0.42 24.7 6

Eolytoceras cf. praecursor
GSC # DMAX D UD U WW WH
129127 51 25.7 0.50 15.4
129129 77 38.5 0.50 21
129130 29.3 13.7 0.47 9.5
129131 3.4
129132 46 21.9 0.48 14
129128 54.3 28 0.52 15.2
129133 49.5 c.26.2 0.53 c.12.5
129134 26.2 11.9 0.45 8.3
129135 c.24.6 11 0.45 7.2

Eoctocentrites pacificus
GSC # DMAX D UD U WW WH
129119 34.5 11 0.32 13
129120 35 11 0.31 14.5
129121 8.4 0.37 14
129122 27.5 8 0.29 9.5
129127 26.7 9 0.34 10
129123 c.35 c.12 0.34 15.4
129124 24.5 8.6 0.35 10
129125 16 5.4 0.34 6
129126 29 8.4 0.29 12

Pleurocantholithes cf. bifornis
GSC # DMAX D UD U WW WH
129138 59.2 29.5 0.50 20.5
129139 c.79.8 43 0.54 20.5
129137 203 119 0.59

Pleurocantholithes sp.
GSC # DMAX D UD U WW WH
129148 c.48 c.22.8 0.48 c.15.2

Pleurocantholithes charlottensis
GSC # DMAX D UD U WW WH
129144 44.3 25.5 0.58 11
129143 23.8 12.1 0.51 6.3
129145 27.4 13.1 0.48 7.4
129146 27.5 13.6 0.49 8
129147 26.4 13.6 0.52 7.2

Euphyllites occidentalis
GSC # DMAX D UD U WW WH WWWH
129154 80.7 35.5 0.44 26
129155 25.5 32 0.80
129158 119.6 58.5 0.49 33
129159 17.8 6.9 0.39 6.2
129160 c.71 36.5 0.51
Middle and late Hettangian (Early Jurassic) ammonites from the Queen Charlotte Islands

Discamphiceras aff. pleuronotum
GSC # DMAX D UD U WW WH PRHW
130678 24 7.5 0.31 10 12
130677 c.34 11.9 0.35 13.4
130679 c.25.6 9.3 0.36 14
130680 c.60.5 c.23 0.38 c.22.5

Discamphiceras aff. antiquum
GSC # DMAX D UD U WW WH
130696 34 8.4 0.25 15
130697 66 18.5 0.28 22
130698 25.5 7 0.27 12

Discamphiceras cf. submesogenos
GSC # DMAX D UD U WW WH
130682 37.3 37.3 c.9.3 0.25 16
130683 21.5 5.8 0.27 10
130684 37.5 c.9 0.24 18.6
130685 22 6.8 0.31 9
130686 23 6 0.26 11.4
130687 21.2 6.5 0.31 12
130688 27 7.8 0.29 11
130681 63.6 17.3 0.27 26
130689 35.2 c.8 0.23 16.5
130690 c.36.5 c.9.2 0.25 15
130691 22 5.9 0.27 9.7
130692 29 8.1 0.28 12
130693 28.2 8.3 0.29 11.2
130694 42.5 11.6 0.27 18.4

Sunrisites cf. chilensis
GSC # DMAX D UD U WW WH PRHW
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130731 41.5 21 0.51 12
130732 77 41 0.53 20
130727 91 43.5 0.48 26 14
130733 45 22 0.49 13.4 12
130734 22.2 10 0.43 7.1 9

Sunrisites cf. senillevus
GSC # DMAX D UD U WW WH PRHW
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Badaoaia canadensis
GSC # DMAX D UD U WW WH PRHW
107392 48.8 24 0.49 15.7 14
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107397 28.7 27.8 0.27 11.3

Pseudatoemoceras cf. doetzkirchneri
GSC # DMAX D UD U WW WH PRHW
130739 26.8 10.4 0.39 10.4 17
130740 17 6 0.35 6 15
130738 26.5 10.6 0.40 8.8 18

Storhotoceras cf. australe
GSC # DMAX D UD U WW WH PRHW
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130759 18.4 6 0.33 7.2 13
130760 26.2 10 0.38 9.1 c.15
130761 32 12.8 0.40 10.8
130762 21.7 7.5 0.35 8

Storhotoceras aff. parfeldense
GSC # DMAX D UD U WW WH PRHW
130743 22 7 0.32 8.3 15

Discamphiceras aff. Bloomfieldense
GSC # DMAX D UD U WW WH PRHW
129162 62 39 0.63 13 19

Alatosites ex gr. proarises
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130714 49 21.8 0.44 18.5
130716 44.5 c.20.2 0.45 13.9 11
130717 46.3 22.1 0.48 14 13
130712 48.2 25.4 0.53 11 c.22

Alatosites aff. proarises
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130705 39.8 24.8 0.62 8.5 27
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130709 41 24 0.59 9 26
130710 37 23 0.62 8 25

Alatosites cf. liscus
GSC # DMAX D UD U WW WH PRHW
130699 36.1 36.1 23.7 0.66 6.1 23
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Mullerites cf. pleurocanthoides
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Discamphiceras silberlingi
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### Angustaticeras (?) cf. cacambensis

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