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# TOARCIAN (EARLY JURASSIC) AMMONOIDS FROM WESTERN NORTH AMERICA

G.K. Jakobs



1997



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FROM WESTERN NORTH AMERICA**

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**Cover illustration**

*Yakounia frebaldi* collected by G.K. Jakobs from the Phantom Creek  
Formation along the Yakoun River, Graham Island, Queen Charlotte Islands  
(GSC loc. C-156390; GSC 99532). GSC 1995-249

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40	Suborder LYTOCERATINA
40	Superfamily LYTOCERATACEAE
40	Family LYTOCERATIDAE
40	Subfamily LYTOCERATINAE
40	Genus <i>Lytoceras</i>
41	Suborder AMMONITINA
41	Superfamily EODEROCERATACEAE
41	Family DACTYLIOCERATIDAE
41	Genus <i>Dactylioceras</i>
43	Genus <i>Peronoceras</i>
47	Genus <i>Collina</i>
48	Genus <i>Catacoeloceras</i>
49	Superfamily HILDOCERATACEAE
49	Family HILDOCERATIDAE
49	Subfamily HARPOCERATINAE
49	Genus <i>Harpoceras</i>
49	Genus <i>Cleviceras</i>
51	Genus <i>Taffertia</i>
51	Genus <i>Pseudolioceras</i>
52	Genus <i>Polyplectus</i>
53	Subfamily HILDOCERATINAE
53	Genus <i>Hildaites</i>
54	Genus <i>Mercaticeras</i>
55	Subfamily GRAMMOCERATINAE
55	Genus <i>Grammoceras</i>
56	Genus <i>Podagrosites</i>
57	Family PHYMATOCERATIDAE
57	Subfamily PHYMATOCERATINAE
57	Genus <i>Phymatoceras</i>
59	Genus <i>Rarenodia</i>
60	Genus <i>Pseudomercaticeras</i>
61	Genus <i>Merlaites</i>
62	Genus <i>Denckmannia</i>

63 References

70 Appendix – Locality data

### Figures

4	1. Index map showing localities mentioned in the text
5	2. Index map showing map areas that contain Toarcian ammonite localities in British Columbia and Yukon Territory
7	3. Zonation and relative stratigraphic ranges of important Toarcian ammonites in western North America
8	4. Extent of Toarcian occurrences in North America by zone
10	5. Correlation of the western North American zonation with other zonal schemes
12	6. Terrane map of the Canadian Cordillera
12	7. Toarcian fossil localities in the Carmacks map area, southern Yukon
13	8. Distribution of ammonite species at Toarcian localities in the Carmacks, Tulsequah, Cry Lake, Telegraph Creek, Iskut River, Spatsizi River, Toodoggone River, McConnell Creek, Hazelton, and Nechako River map areas
14	9. Toarcian fossil localities and sections in the Tulsequah map area, northwestern British Columbia

- 15 10. Lithological legend for measured stratigraphic sections
- 15 11. Lithostratigraphy and biostratigraphy of Section 1, Tulsequah map area
- 16 12. Distribution of ammonite species at Toarcian localities in sections 1-4
- 17 13. Toarcian fossil localities in the Cry Lake map area, northwestern British Columbia
- 18 14. Toarcian fossil localities in the Telegraph Creek and Iskut River map areas, northwestern British Columbia
- 19 15. Toarcian fossil localities and sections, Spatsizi River map area, northwestern British Columbia
- 20 16. Lithostratigraphy and biostratigraphy of Section 2, Spatsizi River map area
- 21 17. Lithostratigraphy and biostratigraphy of Section 3, Spatsizi River map area
- 22 18. Toarcian fossil localities in the Toodoggone River map area, west-central British Columbia
- 22 19. Toarcian fossil localities and sections in the McConnell Creek map area, west-central British Columbia
- 22 20. Lithostratigraphy and biostratigraphy of Section 4, McConnell Creek map area
- 23 21. Toarcian fossil localities in the Hazelton map area, west-central British Columbia
- 24 22. Toarcian fossil localities in the Nechako River map area, central British Columbia
- 24 23. Toarcian fossil localities in western Alberta
- 25 24. Distribution of ammonite species at Toarcian localities in the Southern Canadian Rocky Mountains, Nelson, Quesnel, Prince George, Taseko Lakes and Hope map areas, Queen Charlotte Islands, and southern Alaska.
- 26 25. Toarcian fossil localities in the Fernie map area, southeastern British Columbia
- 26 26. Toarcian fossil localities in the Manson River map area, central British Columbia
- 26 27. Toarcian fossil localities in the Prince George map area, central British Columbia
- 26 28. Toarcian fossil localities in the Quesnel map area, central British Columbia
- 27 29. Toarcian fossil localities in the Nelson map area, southeastern British Columbia
- 27 30. Toarcian fossil localities in the Hope map area, southwestern British Columbia
- 27 31. Toarcian fossil localities in the Taseko Lakes map area, southwestern British Columbia
- 28 32. Toarcian fossil localities in southern Alaska
- 28 33. Lower Jurassic stratigraphy in the Queen Charlotte Islands
- 29 34. Toarcian fossil localities in the Queen Charlotte Islands
- 30 35. Lithostratigraphic chart showing the north-south variation in the Whiteaves/Phantom Creek hiatus
- 31 36. Distribution of ammonite species at Toarcian localities in sections 5 and 6.
- 32 37. Toarcian fossil localities in central Graham Island, Queen Charlotte Islands, western British Columbia
- 32 38. Lithostratigraphy and biostratigraphy of Section 5, central Graham Island, Queen Charlotte Islands
- 33 39. Lithostratigraphy and biostratigraphy of Section 6, central Graham Island, Queen Charlotte Islands
- 34 40. Distribution of ammonite species at Toarcian localities in Section 7
- 36 41. Lithostratigraphy and biostratigraphy of Section 7, central Graham Island, Queen Charlotte Islands
- 37 42. Distribution of ammonite species at Toarcian localities in sections 8 and 9
- 38 43. Lithostratigraphy and biostratigraphy of Section 8, central Graham Island, Queen Charlotte Islands
- 38 44. Lithostratigraphy and biostratigraphy of Section 9, Whiteaves Bay, Queen Charlotte Islands



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# TOARCIAN (EARLY JURASSIC) AMMONOIDS FROM WESTERN NORTH AMERICA

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## *Abstract*

*Toarcian (Lower Jurassic) sedimentary rocks outcrop in western North America from southern Alaska to Nevada. The tectonic complexity of western North America, and of the Canadian Cordillera in particular, has, until recently, hampered biostratigraphic studies of this interval.*

*Work in the Queen Charlotte Islands has identified one of the best preserved Toarcian sequences in western North America. Toarcian strata in the Queen Charlotte Islands have yielded a well preserved and diverse ammonite fauna that provides a framework for a regional ammonite zonation for western North America. Other localities in western North America, particularly in southern Alaska and northwestern British Columbia have provided additional material which has contributed to the development of an ammonite zonation.*

*A diverse ammonite fauna has been collected from the Toarcian of western North America. Early Toarcian genera include Dactylioceras, Tiltoniceras, Taffertia, Cleviceras, and Hildaites. Middle Toarcian genera include Lytoceras, Peronoceras, Collina, Cleviceras, Harpoceras, Pseudolioceras, Polyplectus, Leukadiella, Paroniceras, Mercaticeras, Merlaites, Pseudomercaticeras, and Phymatoceras. Late Toarcian genera include Polyplectus, Grammoceras, Podagrosites, Pleydellia, Dumortieria, Phymatoceras, Yakounia, Sphaerocoeloceras, and Hammatoceras.*

## *Résumé*

*Dans l'Ouest de l'Amérique du Nord, des roches sédimentaires du Toarcien (Jurassique inférieur) affleurent du sud de l'Alaska au Nevada. La complexité tectonique de la portion occidentale de l'Amérique du Nord, et de la Cordillère canadienne en particulier, avait freiné, jusqu'à récemment l'étude biostratigraphique de cet intervalle.*

*Les travaux menés dans les îles de la Reine-Charlotte ont permis d'identifier l'une des séquences toarciennes les mieux conservées de l'Ouest de l'Amérique du Nord. Les couches toarciennes dans les îles de la Reine-Charlotte ont livré une faune diversifiée d'ammonites bien conservées qui a servi de base à l'élaboration d'un schéma régional de zonation des ammonites applicable à l'Ouest de l'Amérique du Nord. D'autres localités dans l'Ouest de l'Amérique du Nord, en particulier dans le sud de l'Alaska et le nord-ouest de la Colombie-Britannique, ont livré des fossiles additionnels qui ont contribué à établir une zonation des ammonites.*

*Dans le Toarcien de l'Ouest de l'Amérique du Nord, une faune diversifiée d'ammonites a été récoltée. Les genres du Toarcien précoce sont notamment Dactylioceras, Tiltoniceras, Taffertia, Cleviceras et Hildaites. Les genres du Toarcien moyen sont Lytoceras, Peronoceras, Collina, Cleviceras, Harpoceras, Pseudolioceras, Polyplectus, Leukadiella, Paroniceras, Mercaticeras, Merlaites, Pseudomercaticeras et Phymatoceras. Ceux du Toarcien tardif sont Polyplectus, Grammoceras, Podagrosites, Pleydellia, Dumortieria, Phymatoceras, Yakounia, Sphaerocoeloceras et Hammatoceras.*



## SUMMARY

Toarcian sedimentary rocks outcrop in western North America from southern Alaska to Nevada. The tectonically complex nature of western North America, composed of accreted allochthonous terranes, has hampered stratigraphic and biostratigraphic studies of these rocks. Toarcian sedimentary rocks on the North American craton and Quesnellia are generally composed of fine grained siltstones and mudstones. The ammonite fauna is of low diversity, generally composed of pandemic taxa, and commonly poorly preserved. Toarcian strata on Stikinia commonly contain a volcanic component represented by tuffs. Sedimentary rocks are generally represented by siltstones to coarse grained sandstones, although minor amounts of conglomerate occur in the Middle Toarcian of the McConnell Creek and Tulsequah map areas. The ammonite fauna, although generally poorly preserved, is diverse and contains Athabascan, East Pacific, Tethyan, and pandemic ammonite taxa. Southwestern British Columbia, composed of several terrane fragments, contains Toarcian strata that are generally argillaceous and contain minor sandstone intervals. Ammonites are rare and generally poorly preserved. Athabascan, Tethyan, and pandemic ammonite taxa have been identified. Toarcian strata in the Peninsular Terrane of southern Alaska are primarily composed of fine- to coarse-grained volcanoclastic sediments. The ammonite fauna is generally well preserved and contains Athabascan and pandemic taxa.

Recent work in the Queen Charlotte Islands has identified a relatively complete Toarcian sequence that contains a diverse and well preserved ammonite fauna. Athabascan, East Pacific, Tethyan, and pandemic ammonite taxa are present. The faunal succession in the Queen Charlotte Islands has provided the framework for a regional ammonite zonation for western North America. Five ammonite zones have been previously defined for the Toarcian of western North America.

The Kanense Zone contains a low diversity fauna of *Dactylioceras kanense* McLearn, *D. cf. D. alpestre* (Wiedenmayer), *D. aff. D. comptum* (Dagys), *Taffertia taffertensis* Guex, *Cleviceras cf. C. exaratum* (Young and Bird), *C. cf. C. chrysanthemum* (Yokoyama), and *Hildaites murleyi* (Moxon). The Kanense Zone is represented in the Whitehorse, Tulsequah, Spatsizi River, Iskut River, McConnell Creek, Hazelton, Nechako River, Nelson, Fernie, Taseko Lakes, and Hope map areas, as well as western Alberta and the Queen Charlotte Islands.

## SOMMAIRE

Dans l'Ouest de l'Amérique du Nord, des couches sédimentaires du Toarcien affleurent du sud de l'Alaska au Nevada. Le caractère tectonique complexe de l'Ouest de l'Amérique du Nord, une région composée de terranes allochtones accrétés, avait jusqu'à tout récemment freiné l'étude stratigraphique et biostratigraphique de ces roches. Les roches sédimentaires toarciennes reposant sur le craton nord-américain et dans la Quesnellie sont généralement composées de siltstones à grain fin et de mudstones. La faune d'ammonites est peu diversifiée, généralement composée de taxons pandémiques et représentée par des individus habituellement mal conservés. Dans la Stikinie, les couches toarciennes contiennent habituellement une composante volcanique qui se manifeste par des tufs. Les roches sédimentaires sont généralement représentées par des siltstones à des grès à grain grossier, bien que de faibles quantités de conglomerats soient présentes dans le Toarcien moyen des régions cartographiques du ruisseau McConnell et de Tulsequah. La faune d'ammonites, bien que les individus qui la composent soient généralement mal conservés, est diversifiée et contient des taxons des domaines d'Athabasca, du Pacifique-Est et de la Téthys, ainsi que des taxons pandémiques. Dans le sud-ouest de la Colombie-Britannique, une région composée de plusieurs fragments de terranes, les couches du Toarcien sont généralement composées de lithologies argileuse, mais on y retrouve des intervalles mineurs de grès. Les ammonites y sont rares et généralement mal conservées. On y a relevé la présence de taxons des domaines d'Athabasca et de la Téthys, ainsi que des taxons pandémiques. Dans le terrane Péinsulaire du sud de l'Alaska, les couches toarciennes sont principalement composées de roches sédimentaires volcanoclastiques à grain fin à grossier. Les ammonites y sont généralement bien conservées et la faune qu'elles définissent contient des taxons du domaine d'Athabasca et des taxons pandémiques.

Les travaux effectués récemment dans les îles de la Reine-Charlotte ont permis d'identifier une séquence toarcienne relativement complète qui contient une faune d'ammonites diversifiée aux individus bien conservés. Des taxons des domaines d'Athabasca, du Pacifique-Est et de la Téthys ainsi que des taxons pandémiques ont été reconnus. La succession faunique présente dans les îles de la Reine-Charlotte a fourni les bases nécessaires à l'établissement d'un schéma régional de zonation des ammonites applicable à l'Ouest de l'Amérique du Nord. Dans le Toarcien de l'Ouest de l'Amérique du Nord, cinq zones d'ammonites avaient jusqu'à ce jour été définies.

La Zone à Kanense contient une faune peu diversifiée de *Dactylioceras kanense* McLearn, *D. cf. D. alpestre* (Wiedenmayer), *D. aff. D. comptum* (Dagys), *Taffertia taffertensis* Guex, *Cleviceras cf. C. exaratum* (Young et Bird), *C. cf. C. chrysanthemum* (Yokoyama) et *Hildaites murleyi* (Moxon). La Zone à Kanense est représentée dans les régions cartographiques de Whitehorse, de Tulsequah, de la rivière Spatsizi, de la rivière Iskut, du ruisseau McConnell, de Hazelton, de la rivière Nechako, de Nelson, de Fernie, des lacs Taseko et de Hope ainsi que dans l'ouest de l'Alberta et les îles de la Reine-Charlotte.

The Planulata Zone is represented by a high diversity ammonite fauna that contains Tethyan and pandemic taxa such as *Peronoceras verticosum* (Buckman), *P. spinatum* (Frebald), *P. pacificum* Hillebrandt, *Leukadiella ionica* Renz & Renz, *L. amuratica* Renz, *L. aff. L. helenae* Renz, *Paroniceras sternale* (Buch), *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly), *Rarenodia planulata* Venturi, and *Denckmannia* cf. *D. tumefacta* (Buckman). The Planulata Zone is represented in the Whitehorse, Tulsequah, Spatsizi River, Iskut River, McConnell Creek, Hazelton, Nelson, and Taseko Lakes map areas, as well as western Alberta and the Queen Charlotte Islands.

The Crassicosta Zone contains a high diversity ammonite fauna with several Tethyan taxa and includes *Phymatoceras crassicosta* Merla, *P. cf. P. rude* (Simpson), *P. cf. P. erbaense* (Hauer), *P. cf. P. pseudoerbaense*, *Denckmannia* cf. *D. tumefacta*, *Peronoceras* cf. *P. moerickei* Hillebrandt, *P. cf. P. crassicostatum* (Guex), *Collina* cf. *C. lineae* Parisch & Viale, *Mercaticeras* cf. *M. hellenicum* (Renz), *Pseudomercaticeras* cf. *P. frantzi* (Reynès), *Merlites* cf. *M. alticarinatus* (Merla), *Polyplectus discoides* (Zieten), and *Lytoceras siemensii* (Denckmann). The Crassicosta Zone is represented in the Spatsizi River, McConnell Creek, Hazelton, Fernie, and Taseko Lakes map areas, as well as the Queen Charlotte Islands.

The Hillebrandti Zone contains a well preserved, low diversity ammonite fauna that includes *Phymatoceras hillebrandti* Jakobs, *Podagrosites latescens* (Simpson), *Grammoceras thouarsense* (d'Orbigny), and *Hammatoceras insigne* (Zieten). The Hillebrandti Zone is represented in the Tulsequah, Cry Lake, Spatsizi River, Iskut River, McConnell Creek, Hazelton, Nechako River, and Taseko Lakes map areas, as well as the Queen Charlotte Islands.

The Yakounensis Zone contains a diverse and endemic ammonite fauna that includes *Yakounia yakounensis* Jakobs and Smith, *Y. freboldi* Jakobs and Smith, *Y. pacifica* Jakobs and Smith, *Y. silvae* Jakobs and Smith, *P. aalensis* (Zieten), *Pleydellia maudensis* Jakobs and Smith, *P. crassiornata* Jakobs and Smith, *Dumortieria insignisimilis* (Brauns), *D. raricostata* Géczy, *D. exacta* Buckman, *D.?* cf. *D.?* *pusilla* Jaworski, *D.?* *phantasma* Jakobs and Smith, *Hammatoceras speciosum* Janensch, *Sphaero-coeloceras brochiiforme* Jaworski, *Pseudolioceras compactile* (Simpson), and *Holcophylloceras calypso* (d'Orbigny). The Yakounensis Zone is represented in the Whitehorse, Skagway, Spatsizi River, Toodoggone River, Iskut River, McConnell Creek, Hazelton, Nechako River, Manson River, Fernie, Taseko Lakes, and Hope map areas, as well as southern Alaska, eastern Oregon, and the Queen Charlotte Islands.

La Zone à Planulata est représentée par une faune d'ammonites très diversifiée qui contient des taxons téthysiens et pandémiques comme *Peronoceras verticosum* (Buckman), *P. spinatum* (Frebald), *P. pacificum* Hillebrandt, *Leukadiella ionica* Renz & Renz, *L. amuratica* Renz, *L. aff. L. helenae* Renz, *Paroniceras sternale* (Buch), *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly), *Rarenodia planulata* Venturi et *Denckmannia* cf. *D. tumefacta* (Buckman). La Zone à Planulata est représentée dans les régions cartographiques de Whitehorse, de Tulsequah, de la rivière Spatsizi, de la rivière Iskut, du ruisseau McConnell, de Hazelton, de Nelson et des lacs Taseko ainsi que dans l'ouest de l'Alberta et les îles de la Reine-Charlotte.

La Zone à Crassicosta contient une faune d'ammonites très diversifiée comportant plusieurs taxons téthysiens; elle inclut *Phymatoceras crassicosta* Merla, *P. cf. P. rude* (Simpson), *P. cf. P. erbaense* (Hauer), *P. cf. P. pseudoerbaense*, *Denckmannia* cf. *D. tumefacta*, *Peronoceras* cf. *P. moerickei* Hillebrandt, *P. cf. P. crassicostatum* (Guex), *Collina* cf. *C. lineae* Parisch & Viale, *Mercaticeras* cf. *M. hellenicum* (Renz), *Pseudomercaticeras* cf. *P. frantzi* (Reynès), *Merlites* cf. *M. alticarinatus* (Merla), *Polyplectus discoides* (Zieten) et *Lytoceras siemensii* (Denckmann). La Zone à Crassicosta est représentée dans les régions cartographiques de la rivière Spatsizi, du ruisseau McConnell, de Hazelton, de Fernie et des lacs Taseko ainsi que dans les îles de la Reine-Charlotte.

La Zone à Hillebrandti contient une faune d'ammonites peu diversifiée aux individus bien conservés incluant *Phymatoceras hillebrandti* Jakobs, *Podagrosites latescens* (Simpson), *Grammoceras thouarsense* (d'Orbigny) et *Hammatoceras insigne* (Zieten). La Zone à Hillebrandti est représentée dans les régions cartographiques de Tulsequah, du lac Cry, de la rivière Spatsizi, de la rivière Iskut, du ruisseau McConnell, de Hazelton, de la rivière Nechako et des lacs Taseko ainsi que dans les îles de la Reine-Charlotte.

La Zone à Yakounensis contient une faune d'ammonites endémique et diversifiée incluant *Yakounia yakounensis* Jakobs et Smith, *Y. freboldi* Jakobs et Smith, *Y. pacifica* Jakobs et Smith, *Y. silvae* Jakobs et Smith, *P. aalensis* (Zieten), *Pleydellia maudensis* Jakobs et Smith, *P. crassiornata* Jakobs et Smith, *Dumortieria insignisimilis* (Brauns), *D. raricostata* Géczy, *D. exacta* Buckman, *D.?* cf. *D.?* *pusilla* Jaworski, *D.?* *phantasma* Jakobs et Smith, *Hammatoceras speciosum* Janensch, *Sphaero-coeloceras brochiiforme* Jaworski, *Pseudolioceras compactile* (Simpson) et *Holcophylloceras calypso* (d'Orbigny). La Zone à Yakounensis est représentée dans les régions cartographiques de Whitehorse, de Skagway, de la rivière Spatsizi, de la rivière Toodoggone, de la rivière Iskut, du ruisseau McConnell, de Hazelton, de la rivière Nechako, de la rivière Manson, de Fernie, des lacs Taseko et de Hope ainsi que dans le sud de l'Alaska, l'est de l'Oregon et les îles de la Reine-Charlotte.

## INTRODUCTION

Toarcian sedimentary rocks occur in western North America from Alaska in the north, to Nevada in the south (Fig. 1). Attempts to understand the complex tectonic history of western North America, with its accreted allochthonous terranes, have demonstrated the need for accurate dating of sedimentary rocks using fossils. Some of the previous studies of Toarcian ammonites were conducted on isolated collections (see "Previous work", below) and comprehensive taxonomic and biostratigraphic syntheses were not achieved until now. Of the many areas in which Toarcian sedimentary rocks outcrop, the Queen Charlotte Islands contain the most complete stratigraphic sequence, and a diverse and well preserved ammonite fauna that has formed the basis of a Toarcian ammonite zonation for western North America (Jakobs et al., 1994; Jakobs et al., 1995). Jakobs and Smith (1996) described the uppermost Toarcian ammonite fauna of western North America and Jakobs (1995) reported on occurrences of the Subfamily Bouleiceratinae from western North America. The work herein describes Lower to lower Upper Toarcian stratigraphy, ammonite occurrences, and ammonite taxonomy of western North America. Much of the information published in the companion papers (Jakobs et al., 1994; Jakobs, 1995; Jakobs and Smith, 1996) is summarized in this paper.

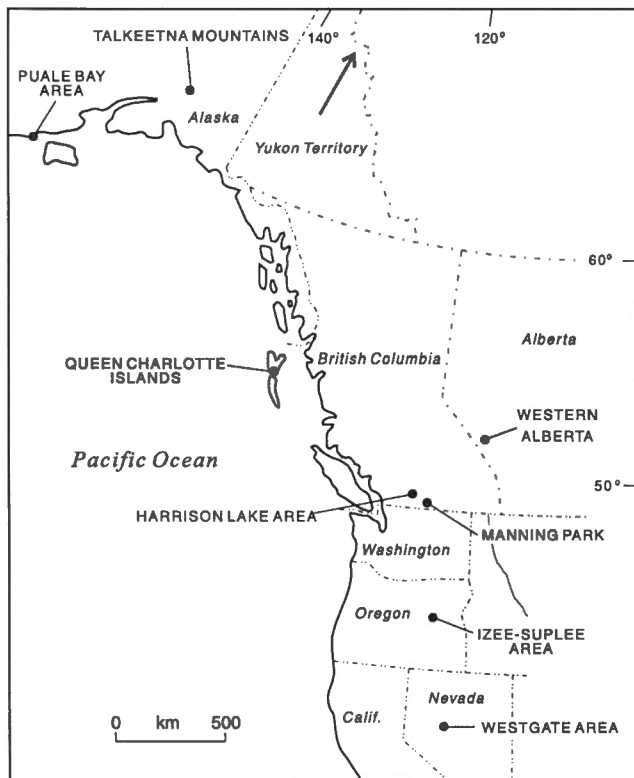


Figure 1. Index map showing localities mentioned in the text.

Toarcian strata in the Canadian Arctic and northern Alaska have yielded low diversity ammonite faunas that contain taxa identical to those of Siberia (Imlay, 1955, 1981; Frebold, 1957a, 1958, 1960, 1975; Frebold et al., 1967; Poulton, 1991). The Arctic localities are not included in this report.

### Previous work

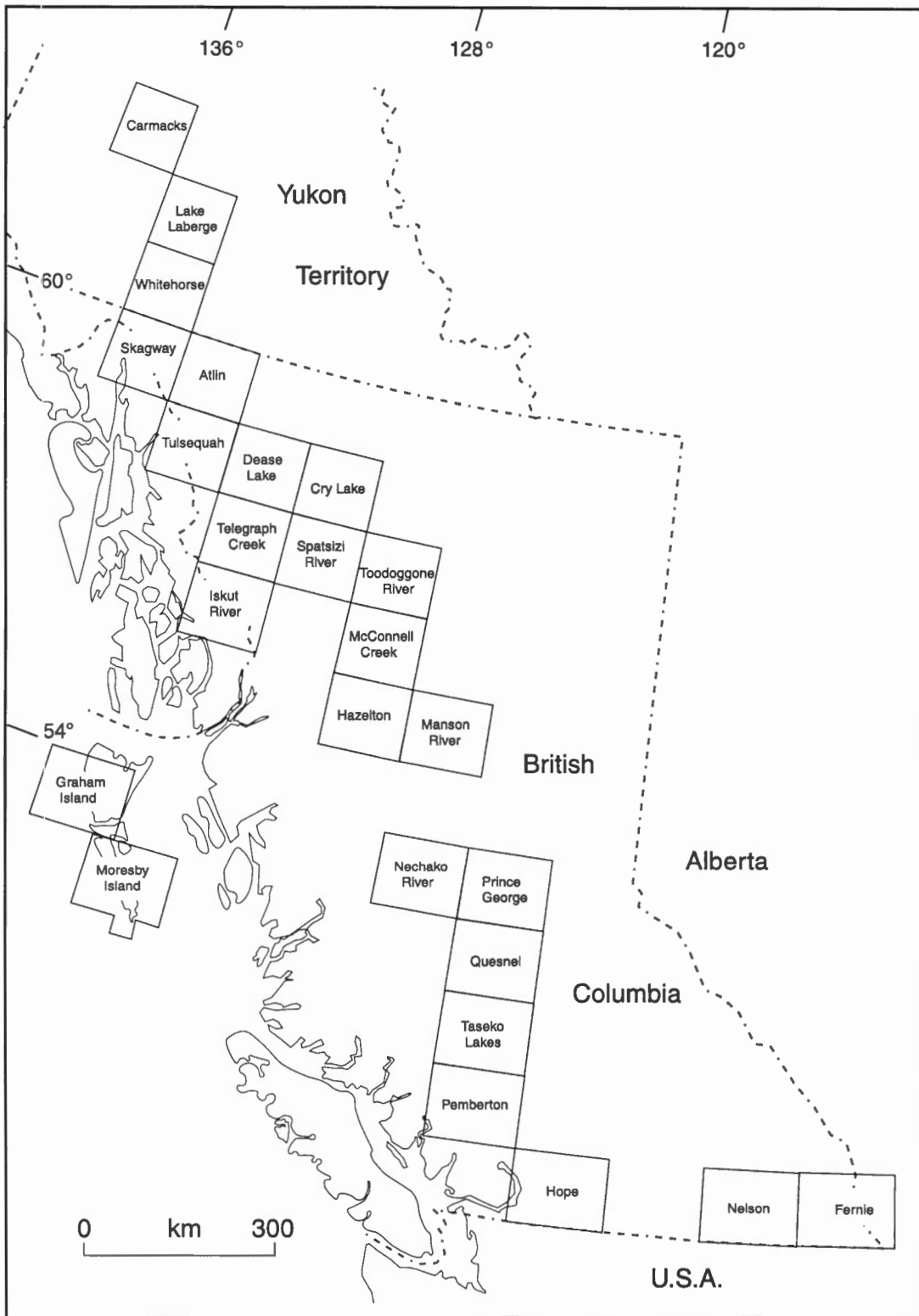
#### Canada

Frebold (1964a) documented scattered Toarcian localities from southern Yukon Territory and northern British Columbia (Fig. 2). North-central and central British Columbia have yielded numerous Toarcian ammonites, but these occurrences have generally not been published. Hans Frebold (GSC) identified many of the taxa and reported on them in GSC fossil reports, which may have been subsequently quoted by geological mappers working in the relevant map areas. Thomson et al. (1986) reported on Early Jurassic ammonite occurrences from the Spatsizi River map area and mentioned the presence of Early and Middle Toarcian genera. Arthur (1987) and Arthur et al. (1991, 1993) described a low diversity Toarcian ammonite fauna from the Harrison Lake area (Hope map area). Frebold (1959) and Frebold and Little (1962) illustrated a low diversity ammonite fauna from the Nelson map area of southeastern British Columbia. Frebold (1957b, 1969, 1976) and Frebold and Little (1962) documented the occurrence of Toarcian ammonites in the Fernie Formation, from southwestern Alberta north to the Jasper area. Hall (1984, 1987) updated the ammonite identifications and published a stratigraphic section containing three faunal intervals.

Toarcian ammonite occurrences from the Queen Charlotte Islands were documented by Whiteaves (1884) and McLearn (1927, 1929, 1930, 1932, 1949). Sutherland Brown (1968) mapped the Queen Charlotte Islands and collected Toarcian ammonites that were identified by H. Frebold (unpub. report; Sutherland Brown, 1968). Cameron and Tipper (1985) re-evaluated Jurassic strata of the Queen Charlotte Islands and recorded the occurrence of Early to Late Toarcian ammonite taxa. Recent work in the Queen Charlotte Islands has focussed on the biostratigraphy and taxonomy of the Toarcian ammonite fauna (Tipper et al., 1991; Jakobs et al., 1994; Jakobs, 1995; Jakobs et al., 1995; Jakobs and Smith, 1996).

#### United States

Imlay (1981) figured Toarcian ammonites from the Alaska Peninsula and the Talkeetna Mountains of southern Alaska. Imlay (1968) reported on Late Toarcian ammonite occurrences from the Izee-Suplee area of east-central Oregon. These were updated by Smith (1980) and Jakobs and Smith (in press), who also provided measured sections. Corvalán (1962) described a measured section from the Westgate District of central Nevada which included Toarcian strata. Smith (1981) studied Sinemurian and Pliensbachian ammonites from the same section, and also mentioned the presence of Early Toarcian *Tiloniceras* and dactylioceratids.



*Figure 2. Index map showing map areas that contain Toarcian ammonite localities in British Columbia, Alberta and Yukon Territory.*

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## BIOSTRATIGRAPHY

Jurassic ammonites have a long history of study in Europe and have proved one of the most useful index fossils. Their pelagic mode of life facilitated their geographic dispersal, and their rapid evolutionary changes allow precise chronological resolution. Previous attempts to use the standard northwest European zonation in the Lower Jurassic of North America have not been entirely successful, due to the absence of key European index species and genera in western North America, the presence of endemic western North America species and genera, and the overall affinity of western North American faunas to the Mediterranean region rather than northwest Europe.

A regional western North American ammonite zonation for the Early Jurassic is of prime importance in determining the age of sedimentary strata and the relative timing of local, regional, and global tectonic events. Toward that end, work has been progressing on producing ammonite zonations for the Early Jurassic of western North America (Smith et al., 1994). The Pliensbachian (Smith et al., 1988) and Toarcian (Jakobs et al., 1994; Fig. 3) have been completed, and the Hettangian and Sinemurian are being studied (Pálffy et al., 1995; Tipper and Guex, 1995).

Other fossils groups have also been used to identify and date Toarcian strata in western North America, with varying degrees of success. Carter et al. (1988) described radiolaria from the Lower and Middle Jurassic of the Queen Charlotte Islands and produced a radiolarian zonation for the Toarcian. A preliminary study of foraminifera from Toarcian strata of the Queen Charlotte Islands confirms their usefulness as age indicators, but points out the need for a more comprehensive study (Tipper et al., 1991). Collections of Toarcian bivalves have been described from western North America (Poulton, 1979, 1991), but a detailed biostratigraphic study has not been completed.

The co-occurrence of belemnites and the bivalve *Weyla* has been used as a Toarcian indicator in western North America. *Weyla* originated in the Early Jurassic (Hettangian) of western North America, appeared in South America in the Sinemurian, in western Tethys in the Pliensbachian, and in eastern Africa in the Toarcian; it persisted in all areas until the Toarcian (Damborenea and Manceñido, 1978). Belemnites range through the Early Jurassic to the Cretaceous (Doyle, 1987) and first appeared in Canada in the Toarcian (Jeletzky, 1966). Some workers (Friebold and Little, 1962; J. Pálffy, pers. comm., 1993) however, have documented the presence of belemnites as early as the Sinemurian of British Columbia. Belemnites can be distinguished from belemnite-like coleoids, such as aulacocerids, by the recrystallization pattern of their guards (Jeletzky, 1966). Belemnites and aulacocerids both have a concentric guard structure composed of alternating layers of calcareous and organic lamellae (Jeletzky, 1966). Belemnite guards contain calcareous lamellae that are several times thicker than the organic lamellae and the recrystallization of the calcareous lamellae into radially directed calcite crystals produces the characteristic radially prismatic structure of belemnite guards (Jeletzky, 1966). Aulacocerids guards, however, are constructed primarily of organic lamellae separated by thin layers of calcareous lamellae and generally recrystallize into an irregular and coarsely crystalline structure (Jeletzky, 1966). Aulacocerids rarely recrystallize into a radially prismatic structure (Jeletzky, 1966). Dicoelitic belemnites have radially prismatic guards bearing two longitudinal grooves and, in western North America, range from the Middle Toarcian to the Kimmeridgian (Jeletzky, 1980). Therefore, the co-occurrence of *Weyla* and belemnites in western North America is not indicative of the Toarcian, since belemnites may occur as early as the Sinemurian. It is the co-occurrence of *Weyla* and dicoelitic belemnites that can be used to identify the presence of Middle to Upper Toarcian strata in western North America.

### *Western North American Toarcian Ammonite Zones*

#### **Kanense Zone**

The base of the Kanense Zone marks the base of the Toarcian in western North America and is defined by the first appearance of *Dactylioceras* above the last occurrence of *Amaltheus* and *Fanninoceras* (Smith et al., 1988; Jakobs et al., 1994) (Fig. 3). The basal Toarcian is best exposed in the Queen Charlotte Islands and the Spatsizi River map area (Fig. 2). The lower part of the zone is characterized by *Dactylioceras kanense* McLearn, *Dactylioceras* aff. *D. comptum* (Dagys), and *Dactylioceras* cf. *D. alpestre* (Wiedenmayer). *Tiltoniceras*, recorded from the Early Toarcian of Europe (Howarth, 1992a), originated in the Late Pliensbachian of the northern Pacific (Smith et al., 1988) probably from *Liocera-toides* or *Protogrammoceras* (Howarth, 1992a). *Tiltoniceras* extends into the Kanense Zone and disappears above *D. kanense*. *Taffertia taffertensis* Guex is rare in western North America and is confined to the lower part of the Kanense Zone.

U. PLIENS	LOWER TOARCIAN	MIDDLE TOARCIAN		UPPER TOARCIAN		AALENIAN	STAGES
	KANENSE	PLANULATA	CRASSICOSTA	HILLEBRANDTI	YAKOUN.		AMMONITE ZONATION
							<i>Fanninoceras carlottense</i>
							<i>Tiltoniceras propinquum</i>
							<i>Protogrammoceras</i> spp.
							<i>Amaltheus viligaensis</i>
							<i>Protogrammoceras allifordensis</i>
							<i>Dactyloceras kanense</i>
							<i>Dactyloceras</i> aff. <i>D. comptum</i>
							<i>Dactyloceras</i> cf. <i>D. alpestre</i>
							<i>Taffertia taffertensis</i>
							<i>Cleviceras</i> cf. <i>C. exaratum</i>
							<i>Cleviceras</i> spp.
							<i>Cleviceras</i> cf. <i>C. chrysanthemum</i>
							<i>Hildaites murleyi</i>
							<i>Hildaites</i> cf. <i>H. serpentinum</i>
							<i>Harpoceras</i> cf. <i>H. subplanatum</i>
							<i>Dactyloceras</i> cf. <i>D. commune</i>
							<i>Rarenodia planulata</i>
							<i>Peronoceras</i> cf. <i>P. verticosum</i>
							<i>Leukadiella</i> aff. <i>L. ionica</i>
							<i>Leukadiella</i> aff. <i>L. helenae</i>
							<i>Peronoceras verticosum</i>
							<i>Peronoceras pacificum</i>
							<i>Peronoceras spinatum</i>
							<i>Leukadiella ionica</i>
							<i>Pseudolloceras lythense</i>
							<i>Leukadiella amuratica</i>
							<i>Phymatoceras</i> cf. <i>P. pseudoerbaense</i>
							<i>Denckmannia</i> cf. <i>D. tumefacta</i>
							<i>Paroniceras sternale</i>
							<i>Peronoceras</i> cf. <i>P. moerickel</i>
							<i>Phymatoceras crassicosta</i>
							<i>Peronoceras</i> aff. <i>P. moerickel</i>
							<i>Pseudomercaticeras</i> cf. <i>P. frantzi</i>
							<i>Peronoceras</i> cf. <i>P. crassicostatum</i>
							<i>Collina</i> cf. <i>C. ilinae</i>
							<i>Polyplectus discoides</i>
							<i>Merlites</i> cf. <i>M. alticarinata</i>
							<i>Mercaticeras</i> sp. indet.
							<i>Phymatoceras</i> cf. <i>P. rude</i>
							<i>Phymatoceras</i> cf. <i>P. erbaense</i>
							<i>Lytoceras siemensii</i>
							<i>Podagrosites</i> sp. indet.
							<i>Grammoceras</i> sp. indet.
							<i>Phymatoceras hillebrandti</i>
							<i>Podagrosites latescens</i>
							<i>Hammatoceras insigne</i>
							<i>Grammoceras thouarsense</i>
							<i>Pleydellia</i> sp. indet.
							<i>Pleydellia maudensis</i>
							<i>Yakounia silvae</i>
							<i>Hammatoceras speciosum</i>
							hammatoceratinae
							<i>Sphaerocoeloceras brochiliforme</i>
							<i>Yakounia yakounensis</i>
							<i>Pleydellia crassiorata</i>
							<i>Pleydellia aalensis</i>
							<i>Yakounia frebaldi</i>
							<i>Yakounia pacifica</i>
							<i>Dumortieria?</i> <i>phantasma</i>
							<i>Pseudolloceras compactile</i>
							<i>Hammatoceras</i> n. sp.
							<i>Dumortieria</i> cf. <i>D. pusilla</i>
							<i>Dumortieria raricostata</i>
							<i>Dumortieria</i> cf. <i>D. levesquel</i>
							<i>Dumortieria insignisimilis</i>
							<i>Dumortieria</i> cf. <i>D. exacta</i>
							<i>Dumortieria</i> cf. <i>D. dumortieri</i>
							<i>Tmetoceras scissum</i>
							<i>Bredyla manflasensis</i>
							<i>Eryctoides howellii</i>

Figure 3. Zonation and relative stratigraphic ranges of important Toarcian ammonites in western North America. U. PLIENS.— Upper Pliensbachian; YAKOUN. — Yakounensis.

The upper part of the Kanense Zone is represented by a low diversity, pandemic fauna that contains species of *Cleviceras*, *Hildaites*, and *Dactyloceras*. *Cleviceras* cf. *C. exaratum* (Young & Bird) and *Cleviceras* cf. *C. chrysanthemum* (Yokoyama) extend into the Planulata Zone. Two species of *Hildaites*, *Hildaites murleyi* (Moxon) and *H. cf. H. subserpentinus* Buckman, are confined to the upper part of the Kanense Zone. Species of *Dactyloceras* collected from the upper part of the Kanense Zone are generally too poorly preserved to identify at the species level.

The Kanense Zone is represented in the Laberge Group of the Carmacks map area, the Takwahoni Formation of the Tulsequah map area, the Spatsizi Formation of the Spatsizi River map area, the Hazelton Group of the Iskut River, McConnell Creek, Hazelton, and Nechako River map areas, the Hall Formation of the Nelson map area, the Last Creek formation of the Taseko Lakes map area, the Harrison Lake Formation of the Harrison Lake area (Hope map area), the Fernie Formation of western Alberta and southeastern British Columbia, the Sunrise Formation of the Westgate District of Nevada, and the Fannin and Whiteaves formations of the Queen Charlotte Islands (Fig. 1, 2, 4).

Kanense	Planulata	Crassicosta	Hillebrandti	Yakounensis	Zones
—	—	—	—	—	Queen Charlotte I.
				—	Puale Bay
				—	Talkeetna Mts.
—	—			—	Southern Yukon
				—	Skagway
—	—		—		Tulsequah
			—		Cry Lake
—	—		—	—	Iskut River
—	—	—	—	—	Spatsizi River
				—	Toodoggone R.
—	—	—	—	—	McConnell Cr.
—	—	—	—	—	Hazelton
—			—	—	Nechako River
				—	Manson River
—	—				Nelson
—	—	—	—	—	Taseko Lakes
—				—	Harrison Lake
				—	Manning Park
—	—				Western Alberta
	—	—		—	Fernie
				—	Izee-Suplee
— ?					Westgate

Figure 4. Extent of Toarcian occurrences in North America by zone. See Figures 1 and 2 for locality map.

### Planulata Zone

The base of the Planulata Zone is marked by the first appearance of *Rarenodia planulata* Venturi above the last occurrence of *Hildaites murleyi* (Jakobs et al., 1994) (Fig. 3). The zone contains an association of species of *Peronoceras*, *Leukadiella*, and *Paroniceras*; *Phymatoceras* and *Denckmannia* appear in the upper part of the zone. Several species of *Peronoceras* occur in the zone including *P. verticosum* (Buckman), *P. pacificum* Hillebrandt, and *P. spinatum* (Frebald). Tethyan taxa contained within the zone include *Leukadiella ionica* Renz & Renz, *Leukadiella amuratica* Renz, *Leukadiella* aff. *L. ionica*, *Leukadiella* aff. *L. helenae* Renz, and *Paroniceras sternale* (Buch) (Jakobs et al., 1994; Jakobs, 1995), some of which have been refigured in this report (Pl. 6, fig. 1-8). *Rarenodia planulata* ranges from the base to the top of the zone. *Cleviceras* cf. *C. exaratum* and *Cleviceras* cf. *C. chrysanthemum* disappear within the zone. *Denckmannia* cf. *D. tumefacta* (Buckman) and *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly) appear near the top of the zone and continue into the superjacent Crassicosta Zone. The Spatsizi River and Fernie map areas contain *Dactyloceras* cf. *D. commune* (Sowerby) and *D. athleticum* (Simpson) which appear to span the Kanense-Planulata boundary.

The Planulata Zone is represented in the Laberge Group of the Carmacks map area, the Takwahoni Formation of the Tulsequah map area, the Spatsizi Formation of the Spatsizi River map area, the Hazelton Group of the Iskut River, McConnell Creek, and Hazelton map areas, the Hall Formation of the Nelson map area, the Last Creek formation of the Taseko Lakes map area, the Fernie Formation of western Alberta and southeastern British Columbia, and the Whiteaves Formation of the Queen Charlotte Islands (Fig. 1, 2, 4).

### Crassicosta Zone

The base of the Crassicosta Zone is marked by the first appearance of *Phymatoceras crassicosta* Merla and densely ribbed *Peronoceras*, such as *Peronoceras* cf. *P. moerickei* Hillebrandt, above the last occurrence of *Rarenodia planulata* (Jakobs et al., 1994) (Fig. 3). The zone contains a diverse ammonite fauna that includes *Phymatoceras crassicosta*, *Phymatoceras* cf. *P. rude* (Simpson), and *Phymatoceras* cf. *P. erbaense* (Hauer), as well as species of *Pseudomercaticeras*, *Mercaticeras*, and *Merlaites*. *Phymatoceras* cf. *P. pseudoerbaense* and *Denckmannia* cf. *D. tumefacta* range upward from the subjacent Planulata Zone and disappear in

the Crassicosta Zone. *Peronoceras* cf. *P. moerickei* disappears in the zone. The Tethyan species *Mercaticeras* cf. *M. hellenicum* (Renz), *Pseudomercaticeras* cf. *P. frantzi* (Reynès), and *Merlites* cf. *M. alticarinatus* (Merla) occur in the middle of the zone. *Polyplectus discoides* (Zieten) appears in the zone and extends into the superjacent Hillebrandti Zone. *Phymatoceras* cf. *P. rude* and *P. cf. P. erbaense* occur near the top of the zone; *P. cf. P. erbaense* may extend into the Hillebrandti Zone. Rare specimens of *Collina* cf. *C. lineae* Parisch & Viale, *Peronoceras* cf. *P. crassicostatum* (Guex), *Peronoceras* aff. *P. moerickei*, and *Lytoceras siemensii* (Denckmann) occur in the upper part of the zone.

The Crassicosta Zone is represented in the Spatsizi Formation of the Spatsizi River map area, the Hazelton Group of the McConnell Creek and Hazelton map areas, the Last Creek formation of the Taseko Lakes map area, the Fernie Formation of southeastern British Columbia, and the Whiteaves Formation of the Queen Charlotte Islands (Fig. 1, 2, 4).

### Hillebrandti Zone

The base of the Hillebrandti Zone is marked by the appearance of *Grammoceras*, *Podagrosites latescens* (Simpson), and *Phymatoceras hillebrandti* Jakobs above the last occurrence of *Phymatoceras crassicosta* and finely ribbed species of *Peronoceras* (Jakobs et al., 1994) (Fig. 3). *Phymatoceras hillebrandti* extends through the zone and disappears near the top. *Phymatoceras hillebrandti* was described by Jakobs et al. (1994) and additional specimens are figured in this report (Pl. 14, fig. 1-6; Pl. 15, fig. 1-12; Pl. 16, fig. 7, 8). *Podagrosites latescens* and *Grammoceras thouarsense* (d'Orbigny) are common within the zone. *Hammatoceras insigne* (Zieten) appears in the zone and continues into the superjacent Yakounensis Zone.

The Hillebrandti Zone is represented in the Takwahoni Formation of the Tulsequah map area, the Laberge Group of the Cry Lake map area, the Spatsizi Formation of the Spatsizi River map area, the Hazelton Group of the Iskut River, McConnell Creek, and Hazelton map areas, the Last Creek formation of the Taseko Lakes map area, and the Whiteaves Formation of the Queen Charlotte Islands (Fig. 1, 2, 4).

### Yakounensis Zone

The base of the Yakounensis Zone is marked by the first appearance of *Yakounia silvae* Jakobs & Smith, *Pleydellia maudensis* Jakobs & Smith, *Hammatoceras speciosum* Janensch, and *Pleydellia* spp. above the last occurrence of *Phymatoceras hillebrandti* (Jakobs et al., 1994) (Fig. 3). The zone is characterized by species of *Pleydellia*, *Hammatoceras*, *Yakounia*, *Sphaerocoeloceras*, *Dumortieria*, and *Dumortieria?* *Pleydellia aalensis* (Zieten), *Pleydellia crasiornata* Jakobs & Smith, *Yakounia yakounensis* Jakobs & Smith, *Y. frebaldi* Jakobs & Smith, *Y. pacifica* Jakobs & Smith, *Sphaerocoeloceras brochiiforme* Jaworski, *Holcophylloceras calypso* (d'Orbigny), and *Dumortieria? phantasma* Jakobs & Smith appear in the middle of the zone. All these taxa disappear within, or near the top of, the zone. *Pseudolioceras compactile* (Simpson) may extend into the

Aalenian. The Yakounensis Zone ammonite fauna was described by Jakobs and Smith (1996) and a selection of specimens are refigured in this report (Pl. 9, fig. 1-15; Pl. 17, fig. 1-7).

The Yakounensis Zone is represented in the Kialagvik Formation of the Puale Bay area, the Talkeetna Formation of the Talkeetna Mountains, the Laberge Group of the Lake Laberge, Whitehorse, and Skagway map areas, the Spatsizi Formation of the Spatsizi River map area, unnamed sandstones of the Toodoggone River map area, the Hazelton Group of the Iskut River, McConnell Creek, Hazelton, and Nechako River map areas, unnamed siltstones of the Manson River map area, the Last Creek formation of the Taseko Lakes map area, the Harrison Lake Formation and Ladner Group of the Hope map area, the Fernie Formation of the Fernie map area, the Snowshoe Formation of the Izee-Suplee area of eastern Oregon, and the Phantom Creek Formation of the Queen Charlotte Islands (Fig. 1, 2, 4).

### Correlations with other areas

The Toarcian ammonite zonation for western North America has been correlated with European, Siberian, Japanese, and South American ammonite zonations (Jakobs et al., 1994). A brief comparison of the western North American zonation and other zonal schemes is given below and is summarized in Figure 5.

### Europe

Correlation of western North American and northwest European Toarcian ammonite zonations is hampered by biogeographic differences between the ammonite faunas of the two regions. Western North America lacks several key European genera that define zones in northwest Europe. These include *Haugia* and *Hildoceras*, two genera that contain zonal index species from the Middle Toarcian of northwest Europe. The following northwest European ammonite genera are also absent in western North America: *Nodicoeloceras*, *Esericeras*, *Ovaticeras*, *Hudlestonia*, *Erycites*, *Gruneria*, *Pseudoliolia*, *Phlyseogrammoceras*, and *Eleganticeras*.

The Kanense Zone of western North America correlates with the Tenuicostatum and Falciferum zones of northwest Europe based on the occurrence in both areas of species of *Cleviceras*, *Dactylioceras*, *Tiltoniceras*, and *Hildaites* (Jakobs et al., 1994) (Fig. 5). The western North American Planulata Zone probably correlates with the Bifrons Zone of northwest Europe (Jakobs et al., 1994) (Fig. 5). The Crassicosta Zone of western North America cannot be directly correlated with northwest Europe but is probably equivalent to the Variabilis Zone (Jakobs et al., 1994). The Hillebrandti Zone of western North America correlates with the Thouarsense Zone of northwest Europe based on the occurrence of *Grammoceras* in both regions (Jakobs et al., 1994). The western North American Yakounensis Zone contains a fauna with several endemic taxa, but the presence of *Dumortieria*, *Hammatoceras*, and *Pleydellia* correlates with the Levesquei Zone of northwest Europe (Jakobs et al., 1994).



	Standard NW Europe (Dean et al., 1961)	Algeria (Elmi et al., 1974)	Italy (Donovan, 1958)	Italy (Gallitelli-Wendt, 1969)	Siberia (Kalacheva, 1988)	Japan (Hirano, 1971)	South America (Hillebrandt, 1987)	Western North America (Jakobs et al., 1994)			
Upper Toarcian	Levesquei	Aalensis	Aalensis	Meneghinii	Meneghinii	Rosenkrantzi	"Pleydellia fluitans"	Yakounensis	Upper Toarcian		
		Moorei					"Pleydellia lotharingica"				
		Levesquei	Meneghinii	Tenuicostatum	Tenuicostatum						
	Dispansum	Insigne	Dispansum	Copiapense							
	Struckmanni				Thouarsense		Hillebrandti				
Thouarsense	Striatulum	Thouarsense	Erbaense	Erbaense	Toroense	Crassicosta					
Middle Toarcian	Variabilis	Gradata	Bifrons	Bifrons	Bifrons	Helianthoides	Chilensis	Moerickei	Middle Toarcian		
	Bifrons	Crassum					Mercati	Bifrons		Polare	Bolitoense
		Fibulatum	Monestieri								
		Commune	Athleticum	Pacificum							
Lower Toarcian	Falciferum	Falciferum	Serpentinus	Falciferum	Falciferum	Nipponicum	Largaense	"Hildaites"	Lower Toarcian		
		Exaratum					Tenuicostatum	Tenuicostatum		Propinquum	Hoelderi
	Tenuicostatum	Semicelatum	Tenuicostatum	Tenuicostatum	Tenuicostatum						Simplex
		Tenuicostatum									
		Clevelandicum									
Paltum	Kanense										

Figure 5. Correlation of the western North American zonation with other zonal schemes.

The Mediterranean region contains a Tethyan ammonite fauna and several zonation schemes have been developed for different parts of the region (Donovan, 1958; Gallitelli-Wendt, 1969; Elmi et al., 1974). Correlation between the Mediterranean region and western North America is hampered by the absence of key European genera in western North America (e.g., *Hildoceras*, *Bouleiceras*, *Frechiella*, and *Oxyparoniceras*).

The Kanense Zone of western North America correlates with the Tenuicostatum and Serpentinum zones of the Mediterranean region based on the occurrence of species of *Dactylioceras*, *Cleviceras*, and *Hildaites* (Jakobs et al., 1994). The western North American Planulata Zone correlates with the Mediterranean Bifrons Zone based on the occurrence of *Rarenodia planulata* and species of *Leukadiella* (Jakobs et al., 1994). The Crassicosta Zone of western North America correlates with the North African Gradata Zone (Elmi et al., 1974) and the Italian Erbaense Zone (Donovan, 1958) marked by the occurrence of species of *Merlites*, *Mercaticeras*,

*Pseudomercaticeras*, and abundant *Phymatoceras* (Jakobs et al., 1994). The Hillebrandti Zone of western North America probably correlates with the Mediterranean Thouarsense Zone based on the occurrence of species of *Grammoceras* (Jakobs et al., 1994). The Yakounensis Zone of western North America probably correlates with the Aalensis and Meneghinii zones of the Mediterranean region based on the occurrence of species of *Pleydellia*, *Dumortieria*, and *Hammatoceras* (Jakobs et al., 1994).

#### Southeast Pacific

Hillebrandt (1987) established an ammonite zonation for the Lower Jurassic of South America and subdivided the Toarcian into ten zones. Correlation between the Toarcian of South America and western North America is aided by the presence of similar taxa in both regions (Fig. 5).

The Kanense Zone of western North America correlates with the *Dactylioceras hoelderi* and *D. tenuicostatum* zones of South America (Jakobs et al., 1994) (Fig. 5). *Dactylioceras* is used in both regions to define the base of the Toarcian and *Hildaites* occurs near the top of the intervals in both regions. The western North American Planulata Zone correlates with the *Peronoceras largaense*, *Peronoceras pacificum*, and lower part of the *Collina chilensis* zones of South America (Jakobs et al., 1994). Correlation is based on the occurrence in both regions of *Peronoceras*, *Leukadiella*, *Cleviceras*, and *Harpoceras*. *Peronoceras pacificum* Hillebrandt and *Peronoceras verticosum* (Buckman) are present in both regions and provide a good correlation. *Rarenodia planulata*, a key index species in western North America, is not known from South America. The Crassicosta Zone of western North America probably correlates with the upper part of the *Collina chilensis* Zone and with the *Phymatoceras toroense* Zone of South America (Jakobs et al., 1994). Densely ribbed species of *Peronoceras* are present in both regions, but are generally rare and poorly preserved in western North America. Direct correlation of these intervals is difficult since South America contains the genera *Hildaitoides*, *Atacamoceras*, *Collina*, and *Catacoeloceras* which are rare or absent in North America. In addition, western North America contains *Merlaites*, *Pseudomercaticeras*, and *Mercaticeras*, genera that are absent in South America. The Hillebrandti Zone of western North America correlates with the *Phymatoceras copiapense* Zone of South America (Jakobs et al., 1994). *Phymatoceras copiapense* (Moericke) is very similar to *Phymatoceras hillebrandti* from western North America and provides a link between the two regions. The Yakounensis Zone of western North America probably correlates with the *Phlyseogrammoceras(?) tenuicostatum*, "*Pleydellia lotharingica*", and "*Pleydellia fluitans*" zones of South America (Jakobs et al., 1994). Both regions contain endemic species in these intervals and only *Hammatoceras insigne*, *Sphaerocoeloceras brochiiforme*, and *Dumortieria* cf. *D. pusilla* Jaworski occur in both regions and provide a correlative link.

### Northwest Pacific

Correlation between western North American and northwest Pacific faunas is hampered by the rarity of common diagnostic species or even genera.

Hirano (1971, 1973a, b) established a zonation for the Early Jurassic of Japan that included three zones. The Japanese *Fontanelliceras fontanellense* Zone correlates with the western North American Kunae Zone of the Pliensbachian (Smith et al., 1988). The lower part of the Japanese *Protogrammoceras nipponicum* Zone correlates with the Pliensbachian Carlottense Zone of western North America (Smith et al., 1988). The upper part of the Japanese *Protogrammoceras nipponicum* Zone correlates with the upper part of the Toarcian Kanense Zone of western North America (Jakobs et al., 1994). The Japanese *Dactylioceras helianthoides* Zone correlates with the upper part of the Kanense Zone and lower part of the Planulata Zone of western North America (Jakobs et al., 1994). Higher faunal levels in Japan

are poorly defined but may correlate with the Crassicosta and Hillebrandti zones of western North America (Jakobs et al., 1994).

Siberia contains a predominantly Boreal fauna that can be compared to the Arctic North American faunas rather than to those of western North America. Kalacheva (1988) summarized the Toarcian ammonite zonation for Siberia. The *Tiltoniceras propinquum* Zone of Siberia correlates with the lower part of the Kanense Zone of western North America (Jakobs et al., 1994). The Siberian *Harpoceras falciferum* Zone correlates with the upper part of the Kanense Zone of western North America (Jakobs et al., 1994). The *Dactylioceras athleticum*, *Zugodactylites monestieri*, and *Porpoceras polare* zones of Siberia probably correlate with the Planulata Zone of western North America (Jakobs et al., 1994). The undivided *Pseudolioceras rosenkrantzi* Zone of Siberia probably correlates with the Crassicosta, Hillebrandti, and Yakounensis zones of western North America (Jakobs et al., 1994).

## TOARCIAN FOSSIL OCCURRENCES AND STRATIGRAPHY

### *Tectonic setting of the western Cordillera*

The west coast of North America is tectonically complex due to the convergence of the Pacific and North American plates. Evidence for the subduction of ocean floor beneath the North American Plate goes back at least to the Late Triassic (225 Ma) (Monger, 1991). The Canadian Cordillera is made up of several terranes (Monger et al., 1991; Silberling and Jones, 1984) (Fig. 6), regions, usually fault bounded, with geological histories distinct from those of adjacent terranes. The terranes are commonly referred to as "suspect", indicating their uncertain paleogeographic affinity. Some terranes (e.g., Cache Creek) possess "exotic" faunas which indicate that the sediments of these terranes may have been deposited in lower latitudes (Monger and Ross, 1971; Carter et al., 1991). Paleomagnetic evidence from Triassic basement rocks of many of the terranes also provides evidence of significant latitudinal displacement (Irving et al., 1985). Over time the separate terranes amalgamated and accreted to the stable craton of western North America.

Toarcian strata outcrop on terranes in western North America as well as on the North American craton. Several terranes have not yielded ammonites (e.g., Bridge River Terrane) but Toarcian sedimentary rocks have been identified based on age determinations provided by microfossils such as radiolaria (Cordey, 1990). Toarcian ammonites have been collected from Stikinia, Wrangellia, Quesnellia, the Methow, Cadwallader, and Harrison Lake terranes of southwestern British Columbia; the Peninsular Terrane of southern Alaska; and the John Day Terrane of Oregon. Toarcian ammonites have also been collected from sedimentary rocks of the North American craton in the southern Canadian Rocky Mountains. In Nevada, Sonoma, an allochthonous terrane, accreted to the North American craton in the Triassic (Speed, 1979) and Lower Jurassic sediments deposited there can be considered cratonal strata (Smith and Tipper, 1986).

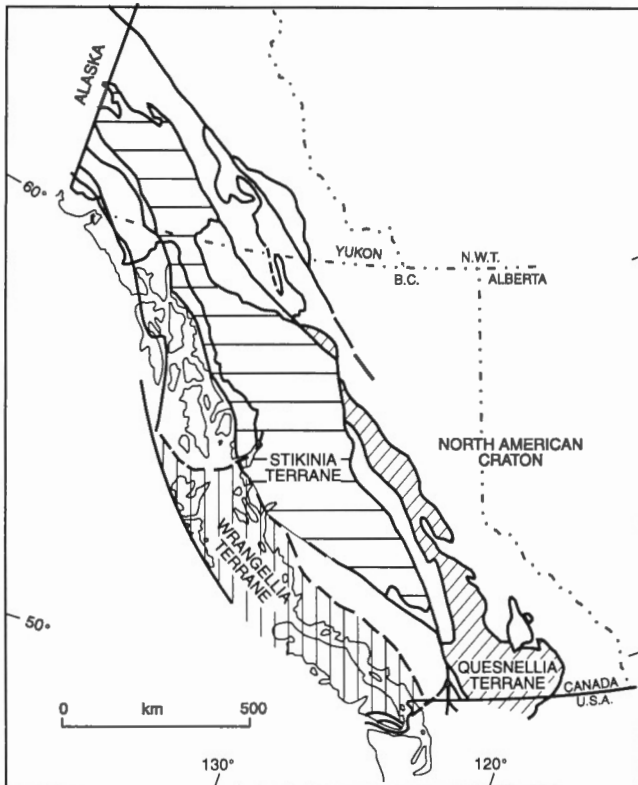


Figure 6. Simplified terrane map of the Canadian Cordillera.

### Northern Stikinia

Lower to Middle Jurassic strata of the Laberge Group outcrop in southern Yukon Territory and northwestern British Columbia (Wheeler, 1961; Souther, 1971; Monger et al., 1991) and have yielded Toarcian ammonites (Friebold, 1964a; Tipper, 1978). The Laberge Group, deposited in the Whitehorse Trough, comprises an overlap assemblage that covers parts of Stikinia, Quesnellia, and the Cache Creek Terrane (Monger et al., 1991). The Laberge Group is underlain by Upper Triassic volcanics and volcanoclastic sediments: the Lewes River Group in southern Yukon Territory (Wheeler, 1961), and the co-eval Stuhini Group and Kutcho and Sinwa formations in northwestern British Columbia (Monger et al., 1991). Toarcian strata of the Laberge Group extend from southern Yukon Territory through the Skagway, Tulsequah, and Cry Lake map areas of northwestern British Columbia (Wheeler, 1961; Friebold, 1964a; Souther, 1971; Tipper, 1978; Gabrielse, 1979; Fig. 2).

### Stratigraphy

The Laberge Group in the Whitehorse, Lake Laberge, and Carmacks map areas (Fig. 2) is Early to Middle Jurassic (Hettangian to Early Bajocian) in age (Wheeler, 1961; Tempelman-Kluit, 1984). Wheeler (1961) mapped the Laberge Group in the Whitehorse map area but did not formally subdivide it. Souther (1971) recognized two facies of the Laberge Group in the Tulsequah map area (Fig. 2): the

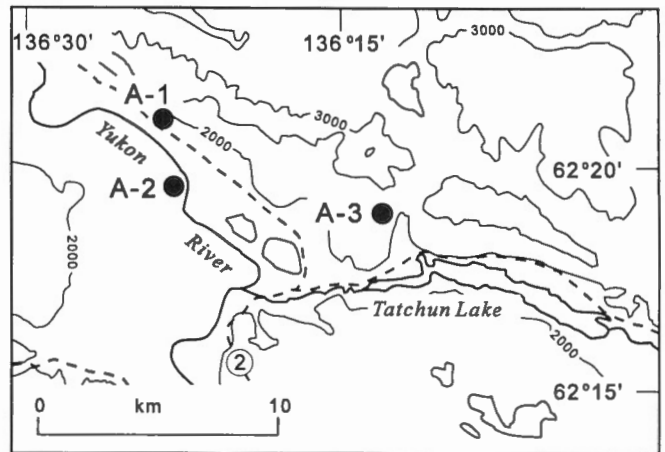


Figure 7. Toarcian fossil localities in the Carmacks map area (NTS 1151), southern Yukon (contours in feet).

coarse grained, near-shore Takwahoni Formation in the southwest and the argillaceous, basal Inklin Formation in the northeast.

The Takwahoni Formation is a thick (3350 m) assemblage of interbedded conglomerate, greywacke, siltstone, and shale (Souther, 1971). Rapid facies changes and local unconformities, due to channelling, suggest a rapidly subsiding basin near a source area of high relief (Souther, 1971). The unit was probably derived from a volcanic terrane but primary volcanic rocks are absent or restricted to the lower hundred metres of the formation (Souther, 1971). The section in the Tulsequah map area contains Lower Pliensbachian and Toarcian fossils (H.W. Tipper, pers. comm., 1994).

The Inklin Formation is a thick (3050 m) sequence of shales and siltstones containing minor greywacke and conglomerate (Souther, 1971). Convolute bedding, slump structures, and graded bedding are present (Souther, 1971). The absence of shallow-water features, such as ripple marks, and the scarcity of fossils (locally abundant in the Takwahoni Formation) suggests deposition in a fairly deep-water environment, probably by turbidity currents (Souther, 1971). The Inklin Formation is Hettangian? to Early Bajocian in age (H.W. Tipper, pers. comm., 1992).

### Biostratigraphy

Toarcian ammonites in the Whitehorse Trough are rare and generally poorly preserved. The low diversity fauna contains cosmopolitan and boreal taxa (e.g., *Dactylioceras*, *Harporoceras*, *Peronoceras*, *Pseudolioceras*) which are present in the North American Arctic (Imlay, 1955, 1981; Friebold 1960, 1975; Poulton, 1991). Tethyan taxa (e.g., *Leukadiella*, *Rarenodia*, *Denckmannia*), which are common to the south in the Spatsizi River and Hazelton map areas, are not present in the Whitehorse Trough.

Early and Middle Toarcian ammonites from the Laberge Group of southern Yukon Territory (Fig. 2, 7) include *Peronoceras* cf. *P. verticosum*, *Cleviceras* sp. indet., *Tiltoniceras*? sp.



indet., and dactylioceratids (Fig. 8; Isolated Loc. A-1 to A-3). A Late Toarcian ammonite fauna from southern Yukon Territory, identified by Frebold (1964a), has been re-evaluated and includes *Yakounia?* sp. indet., *Dumortieria?* sp. indet., and harpoceratids from the Yakounensis Zone (Jakobs and Smith, 1996).

Previous workers have indicated the presence of Toarcian strata and faunas in the Atlin map area of northwestern British Columbia (Fig. 2). Frebold and Tipper (1970) mentioned the presence of *Harpoceras?* in the area. Bultman (1979) documented the occurrence of belemnite guards in the Inklin Formation that, together with the occurrence of *Weyla* (H.W. Tipper, pers. comm., 1994), indicate a Toarcian age. Johannson (1994), in a comprehensive study of Lower Jurassic strata along Atlin Lake, found no Toarcian faunas. The *Harpoceras?* of Frebold and Tipper (1970) is probably a Late Pliensbachian *Protogrammoceras*, *Tiltoniceras*, or *Lioceratoides* which have been identified along Atlin Lake by Johannson (1994). The “belemnite” guards found by Bultman (1979) could be coleoids which were also collected by Johannson (1993, 1994) from Sinemurian and Pliensbachian strata along Atlin Lake.

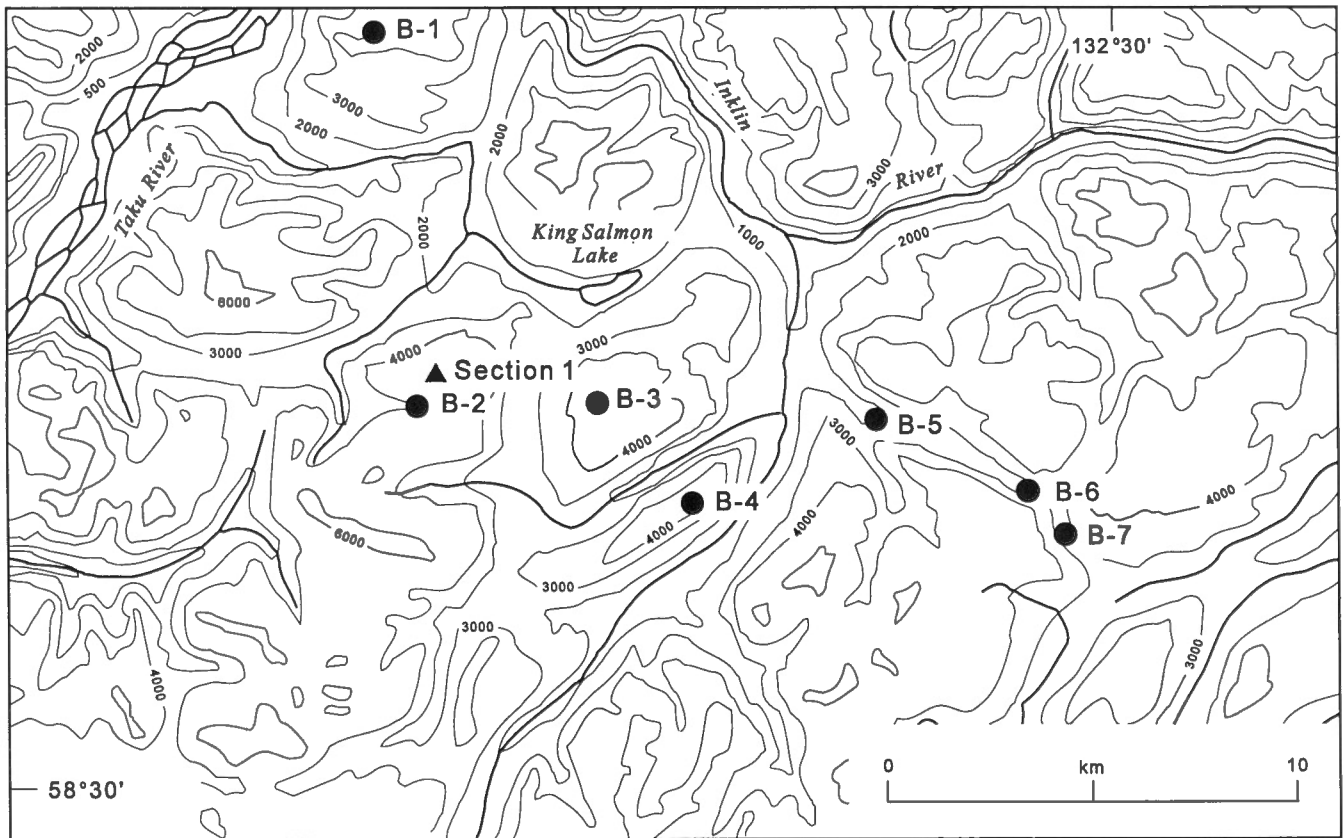
Early to Late Toarcian ammonites occur in the Takwahoni Formation of the Tulsequah map area (Fig. 2, 9) and a section was measured southwest of King Salmon Lake by H.W. Tipper (Fig. 10, 11; Section 1). The ammonoid fauna includes

*Phylloceras* sp. indet., *Cleviceras* sp. indet., *Pseudolioceras* sp. indet., *Dactylioceras* sp. indet., and *Peronoceras* sp. indet. from the Kanense and Planulata zones, and *Phymatoceras* cf. *P. hillebrandti* from the Hillebrandti Zone (Fig. 12). Ammonites from the Crassicosta Zone have not been collected, that interval apparently being represented, in part, by an unfossiliferous conglomerate. Isolated collections from the Tulsequah map area have yielded *Dactylioceras* sp. indet., *Peronoceras* sp. indet., *Harpoceras* (= *Cleviceras*) cf. *H. exaratum*, *Harpoceras* sp. indet., *Cleviceras* cf. *C. exaratum*, and *Cleviceras* sp. indet. (Fig. 8; Isolated Loc. B-1 to B-8).

Early and Middle Toarcian ammonites have been collected from the Laberge Group of the Cry Lake map area (Tipper, 1978) (Fig. 2, 13) and species present include *Cleviceras* cf. *C. chrysanthemum*, *Cleviceras* sp. indet., *Hildaites murleyi*, *Hildaites* sp. indet., *Dactylioceras* cf. *D. commune*, *Dactylioceras* sp. indet., *Peronoceras verticosum?*, *Phymatoceras?* sp. indet., and *Pseudomercaticeras?* sp. indet. from the Lower and Middle Toarcian (Fig. 8; Isolated Loc. C-1 to C-4).

### Central and southern Stikinia

Lower Jurassic strata outcrop in central Stikinia from the Stikine Arch in the north (Monger et al., 1991) to the Smithers map area in the south (H.W. Tipper, pers. comm., 1994).

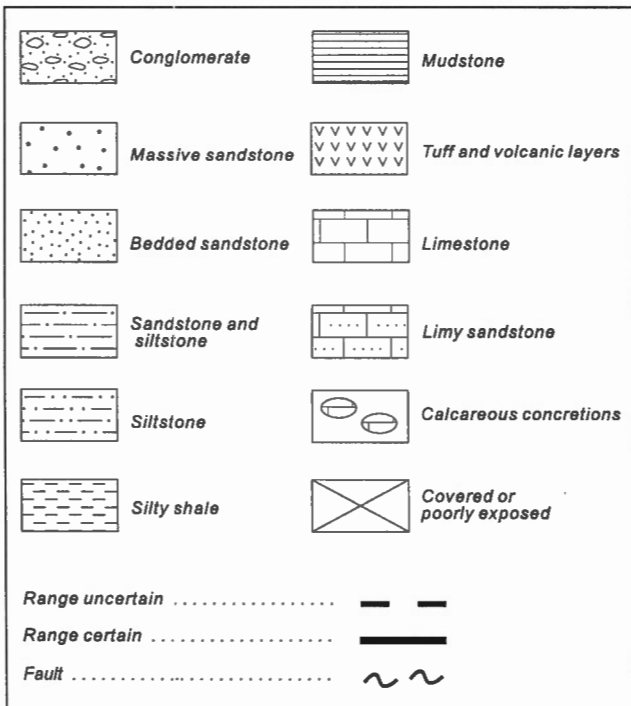


**Figure 9.** Toarcian fossil localities and sections in the Tulsequah map area (104J), northwestern British Columbia (contours in feet).

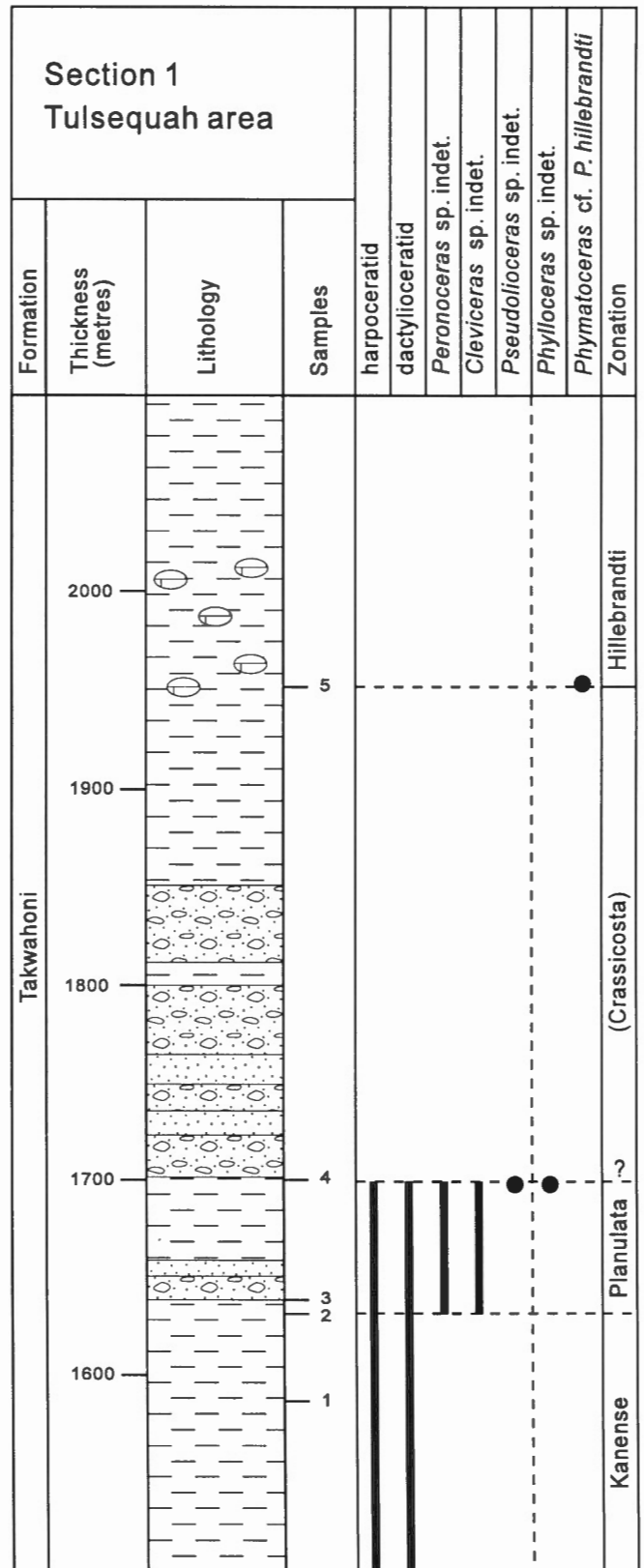
Triassic and Lower Jurassic rocks to the south of the Smithers map area are poorly exposed and their terrane affinity is unclear at present (H.W. Tipper, pers. comm., 1994) although convention has placed them within Stikinia (Gabrielse et al., 1991; Monger et al., 1991). Within Stikine Terrane, the areas of outcrop can be grouped into three broad geographic areas that may have related depositional histories: the northern area (Iskut River, Telegraph Creek, Spatsizi River, and Toodoggone River map areas), the east-central area (McConnell Creek, Hazelton, and Smithers map areas), and the southern area (Nechako River and northern part of Taseko Lakes map area).

**Northern area**

Lower Jurassic strata outcrop along the northern margin of the Bowser Basin, bounded to the north by the Stikine Arch and to the west by the Coast Plutonic Complex. Broad stratigraphic correlations can be drawn between the Iskut River, Telegraph Creek, Spatsizi River, and Toodoggone River map areas. Upper Triassic volcanics underlie all regions, capped by Lower Jurassic volcanics and Lower to Middle Jurassic sedimentary rocks and volcanoclastics of the Hazelton Group, or correlative units (Monger et al., 1991). The Middle Jurassic to Cretaceous Bowser Lake Group unconformably caps the sequence. Precise correlation of Lower and Middle Jurassic rocks between the three areas is difficult due to structural complexities and the lack of good fossil control.



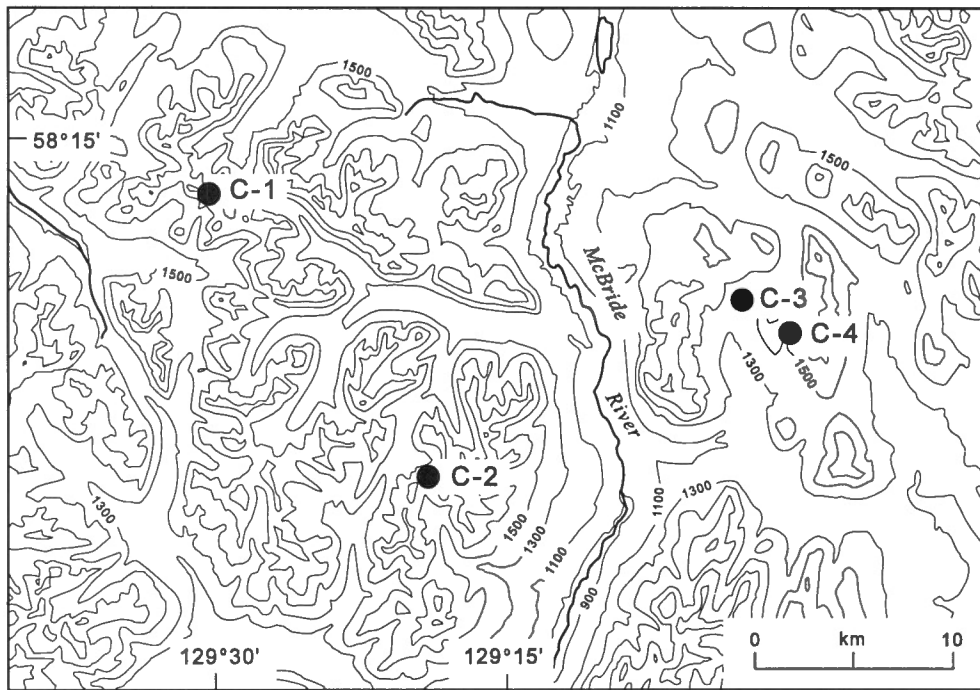
**Figure 10.** Lithological legend for measured stratigraphic sections in Figures 11, 16, 17, 20, 38, 39, 41, 43, 44.



**Figure 11.** Lithostratigraphy and biostratigraphy of Section 1, Tulsequah map area. See Figure 9 for location of section and Figure 10 for lithological legend.

Stratigraphic section	Section 1					Section 2														Section 3												Section 4				Stratigraphic section
	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	
Sample locality																																				Sample locality
Phylloceeras sp. indet.					●																															Phylloceeras sp. indet.
Reynoscoceras? sp. indet.																																				Reynoscoceras? sp. indet.
Dactyloceras cf. D. athleticum																																				Dactyloceras cf. D. athleticum
Dactyloceras sp. indet.					●																															Dactyloceras sp. indet.
Peronoceras pacificum																																				Peronoceras pacificum
Peronoceras spinatum																																				Peronoceras spinatum
Peronoceras verticosum																																				Peronoceras verticosum
Peronoceras cf. P. verticosum																																				Peronoceras cf. P. verticosum
Peronoceras cf. P. moerichkei																																				Peronoceras cf. P. moerichkei
Peronoceras aff. P. moerichkei																																				Peronoceras aff. P. moerichkei
Peronoceras aff. P. desplacai																																				Peronoceras aff. P. desplacai
Peronoceras sp. indet.																																				Peronoceras sp. indet.
Collina? sp. indet.																																				Collina? sp. indet.
dactyloceratids																																				dactyloceratids
Harpoceras sp. indet.																																				Harpoceras sp. indet.
Cleiveras cf. C. exaratum																																				Cleiveras cf. C. exaratum
Cleiveras cf. C. chrysanthemum																																				Cleiveras cf. C. chrysanthemum
Cleiveras sp. indet.																																				Cleiveras sp. indet.
Pseudoloceras lythense																																				Pseudoloceras lythense
Pseudoloceras sp. indet.																																				Pseudoloceras sp. indet.
Polyplectus discoides																																				Polyplectus discoides
Polyplectus sp. indet.																																				Polyplectus sp. indet.
harpoeratids																																				harpoeratids
Hildaites murleyi																																				Hildaites murleyi
Hildaites sp. indet.																																				Hildaites sp. indet.
Leukadiella aff. L. ionica																																				Leukadiella aff. L. ionica
Podagrosites sp. indet.																																				Podagrosites sp. indet.
Dumortiera? sp. indet.																																				Dumortiera? sp. indet.
Phymatoceras cf. P. erbaense																																				Phymatoceras cf. P. erbaense
Phymatoceras hillebrandti																																				Phymatoceras hillebrandti
Phymatoceras cf. P. hillebrandti																																				Phymatoceras cf. P. hillebrandti
Phymatoceras sp. indet.																																				Phymatoceras sp. indet.
Rarenodia planulata																																				Rarenodia planulata
Rarenodia cf. R. planulata																																				Rarenodia cf. R. planulata
Pseudomercaiceras cf. P. frantzi																																				Pseudomercaiceras cf. P. frantzi
Pseudomercaiceras sp. indet.																																				Pseudomercaiceras sp. indet.
Merlaites cf. M. altcarinatus																																				Merlaites cf. M. altcarinatus
Denckmannia cf. D. turnefacta																																				Denckmannia cf. D. turnefacta
Denckmannia sp. indet.																																				Denckmannia sp. indet.
phymatoceratids																																				phymatoceratids
Zone	K	P	P	P	H	K	P	P	H	? K	K	K	K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	? K	P	P	H	?	Zone			

Figure 12. Distribution of ammonite species at Toarcian localities in sections 1-4. Zone symbols are K – Kanense; P – Planulata; C – Crassicoستا; H – Hillebrandti. See also Figures 11, 16, 17, and 20.



**Figure 13.** Toarcian fossil localities in the Cry Lake map area (1041), northwestern British Columbia (contours in metres).

#### *Iskut River and Telegraph Creek map areas*

Recent gold and silver discoveries in Lower Jurassic rocks of the Iskut River map area (Fig. 2) have fueled an intensive geological study of the region (Alldrick and Britton, 1988; Alldrick et al., 1989; Anderson, 1989; Anderson and Thorkelson, 1990).

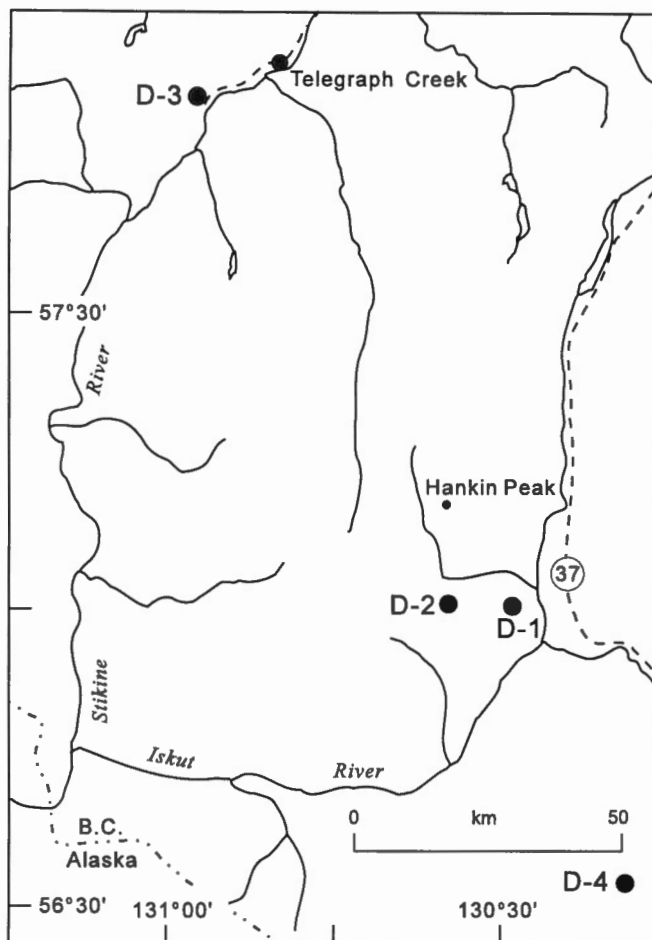
The Upper Triassic Stuhini Group is conformably to unconformably overlain by volcanic and sedimentary rocks of the Hazelton Group (Anderson, 1989). The Lower to Middle Jurassic Hazelton Group includes the volcanogenic Unuk River, Betty Creek, and Mount Dilworth formations, overlain by sedimentary rocks of the Salmon River Formation (Alldrick and Britton, 1988; Alldrick et al., 1989; Anderson and Thorkelson, 1990).

Anderson and Thorkelson (1990) restricted the Salmon River Formation to upper Lower Jurassic and lower Middle Jurassic strata and Evenchick (1991) followed the same usage in the Telegraph Creek map area. The Salmon River Formation comprises two members: a basal, thin, belemnoid-rich, upper Lower Jurassic calcareous sandstone and an overlying Lower to Middle Jurassic member containing three facies (Anderson and Thorkelson, 1990). The basal member is a rusty brown or green, fossiliferous greywacke, usually 60 to 100 cm thick. It is the only consistently fossiliferous Jurassic unit in the map area and is probably Toarcian (Anderson, 1989; Anderson and Thorkelson, 1990; Nadaraju and Smith, 1992; Nadaraju, 1993; Jakobs and Pálffy, 1994). The upper member of the Salmon River Formation contains three facies that form north-trending belts: Troy Ridge facies, Eskay

Creek facies, and Snippaker Mountain facies (Anderson and Thorkelson, 1990). The Troy Ridge facies is the easternmost unit and is a black, siliceous, radiolarian-bearing shale with white, reworked tuff turbidites and is commonly referred to informally as “pajama beds” (Anderson and Thorkelson, 1990). It is similar to the Lower Bajocian Quock Formation in the Spatsizi River map area (Thomson et al., 1986; Thomson and Smith, 1992) and the Yuen Member of the Smithers Formation in the Smithers, Hazelton, and McConnell Creek map areas (Tipper and Richards, 1976). The medial Eskay Creek facies is comprised of pillow lava and limy to siliceous shale and siltstone (Anderson and Thorkelson, 1990); similar clastics and pillow lavas occur in the Telegraph Creek map area (Evenchick, 1991). The Eskay Creek facies is Late Pliensbachian to Early Bajocian (Anderson and Thorkelson, 1990). The western Snippaker Mountain facies is composed of Toarcian sandy limestone and conglomerate overlain by andesitic volcanics and volcanoclastics (Anderson and Thorkelson, 1990) and may correlate with equivalent strata in the Telegraph Creek map area (Evenchick, 1991).

Several poorly preserved *Dactylioceras* sp. indet. (Early or Middle Toarcian) were reported by Grove (1986) from the Iskut River map area (Fig. 2), possibly from the Salmon River Formation (Fig. 8, 14; Isolated Loc. D-4). Latest Toarcian ammonites have been identified from the Salmon River Formation of the Iskut River map area and include *Pleydellia* cf. *P. maudensis* and *Pleydellia?* sp. indet. from the Yakounensis Zone (Nadaraju and Smith, 1992; Nadaraju, 1993; Jakobs and Smith, 1996).





**Figure 14.** Toarcian fossil localities in the Telegraph Creek (104G) and Iskut River (104A) map areas, northwestern British Columbia.

Frebold (1964a, p. 2) reported the presence of *Peronoceras* cf. *P. fibulatum* (Sowerby) in the Telegraph Creek map area (Fig. 2, 8, 14; Isolated Loc. D-3). Collections from the southeastern corner of the Telegraph Creek map area have yielded *Phymatoceras hillebrandti* from the Hillebrandti Zone (Fig. 8, 14; Isolated Loc. D-1 and D-2).

#### Spatsizi River map area

Rocks of the Triassic Stuhini Group and Hotailuh Intrusions are unconformably overlain by the Lower Pliensbachian Cold Fish Volcanics (Evenchick and Thorkelson, 1993). The volcanics are unconformably overlain by Lower Pliensbachian to Lower Bajocian sedimentary rocks of the Spatsizi Formation (Thomson, 1985; Evenchick and Thorkelson, 1993). The Cold Fish Volcanics and the Spatsizi Formation are part of the Hazelton Group (Evenchick and Thorkelson, 1993).

The Spatsizi Formation can be divided into five members: Joan, Wolf Den, Melisson, Abou, and Quock (Thomson et al., 1986; Evenchick and Thorkelson, 1993). The Upper Pliensbachian to Upper Toarcian Wolf Den Member attains a

thickness of 280 m and is composed of dark grey to black, fissile to blocky-weathering shale that contains concretionary beds and minor tuffaceous beds or lenses (Thomson et al., 1986).

The Melisson Member attains a maximum thickness of about 130 m and is well exposed in the Joan Lake area where its resistant beds underlie prominent ridges (Thomson et al., 1986). The Melisson Member consists of medium bedded, siliceous to calcareous siltstones and fine grained sandstones, and conformably overlies shales of the Wolf Den Member (Thomson et al., 1986). The age of the Melisson Member is not well constrained due to the absence of ammonites. The presence of late Middle and early Late Toarcian ammonites (*Denckmannia* and *Phymatoceras hillebrandti*) in the underlying Wolf Den Member and Aalenian ammonites in the overlying Abou Member indicate a probable Late Toarcian age for the Melisson Member (Thomson et al., 1986).

At the Joan Lake section (Fig. 12, 15, 16; Section 2), the oldest Toarcian fauna contains *Hildaites murleyi* and *Cleviceras* sp. indet. from the upper part of the Kanense Zone. This interval is overlain by a concretion bed that contains *Peronoceras pacificum*, *Peronoceras spinatum*, *Peronoceras verticosum*, *Leukadiella* aff. *L. ionica* (Pl. 6, fig. 4), *Phymatoceras* sp. indet., and *Pseudolioceras* sp. indet. (Pl. 4, fig. 8, 9) from the Planulata Zone. The superjacent interval, up to a tuffaceous unit at 330 m, has yielded *Rarenodia planulata*, *Denckmannia* sp. indet., *Pseudolioceras lythense*, *Polyplectus discoides*, and *Peronoceras* cf. *P. moerickei* from the Planulata and Crassicosta zones. The upper part of the Wolf Den Member, above the tuffaceous unit, has yielded *Peronoceras* aff. *P. moerickei*, *Denckmannia* cf. *D. tumefacta*, *Polyplectus* sp. indet., *Podagrosites* sp. indet., and *Phymatoceras hillebrandti* from the Crassicosta and Hillebrandti zones.

The section southwest of Nation Peak (Section 3; Fig. 12, 15, 17) does not contain a clear biostratigraphic succession and many of the ammonites were collected as talus. The fauna contains *Dactylioceras* sp. indet., *Cleviceras* cf. *C. exaratum*, *Cleviceras* cf. *C. chrysanthemum*, *Cleviceras* sp. indet., *Hildaites murleyi*, *Hildaites* sp. indet., *Dactylioceras* cf. *D. athleticum*, *Peronoceras verticosum*, *Peronoceras* sp. indet., *Merlites* cf. *M. alticarinatus*, *Pseudomercaticeras* cf. *P. frantzi*, and *Polyplectus discoides* (Fig. 12).

Isolated localities from the Spatsizi River map area (Fig. 8, 15; Isolated Loc. E-1 to E-9) have yielded *Dactylioceras* cf. *D. commune*, *Dactylioceras* cf. *D. kanense*, *Dactylioceras* cf. *D. simplex*, *Dactylioceras* sp. indet., *Peronoceras* cf. *P. moerickei*, *Peronoceras* sp. indet., *Cleviceras* cf. *C. exaratum*, *Harpoceras* sp. indet., *Polyplectus* sp. indet., *Rarenodia* cf. *R. planulata*, *Denckmannia* cf. *D. tumefacta*, *Phymatoceras* cf. *P. crassicosta*, and *Phymatoceras* sp. indet. and hammatoceratids.

#### Toodoggone River map area

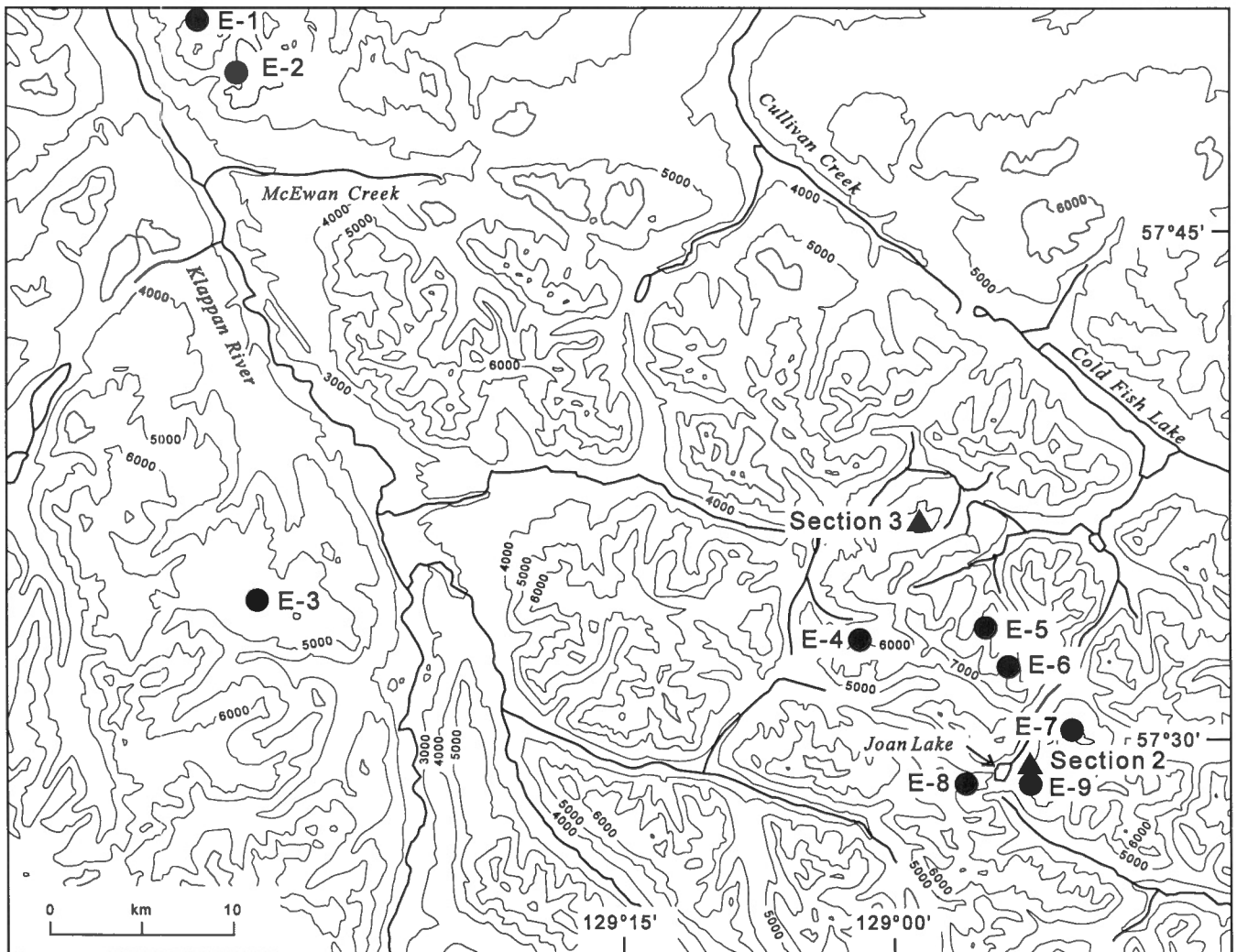
A single collection from unnamed sandstones near Claw Mountain (Fig. 8, 18; Isolated Loc. E-10) contains a mixed Late Toarcian fauna of *Podagrosites*? sp. indet. (Hillebrandti Zone) and *Pleydellia* sp. indet. (Yakounensis Zone).

**East-central area**

Lower Jurassic strata along the eastern margin of the Bowser Basin, the McConnell Creek, Hazelton, and Smithers map areas (Fig. 2), are represented by the Hazelton Group (Tipper and Richards, 1976), but their facies relationships to strata in the Spatsizi River and Toodoggone River map areas is poorly understood.

The Hazelton Group is a thick assemblage of basaltic to rhyolitic volcanics, sedimentary rocks, their tuffaceous equivalents, and minor limestone (Tipper and Richards, 1976). It is Sinemurian to Early Bajocian in age (H.W. Tipper, pers. comm., 1992). The Hazelton Group in the east-central area of central Stikinia was divided into three formations by Tipper and Richards (1976): Telkwa, Nilkitkwa, and Smithers. Recent work in the Hazelton and Smithers map areas (Richards, 1991) has demonstrated the validity of these units, with the addition of a volcanic unit between the Nilkitkwa and Smithers formations.

The Telkwa Formation is a predominantly volcanic unit of Sinemurian to Early Pliensbachian age (Tipper and Richards, 1976). It is overlain by the Nilkitkwa Formation, an Upper Sinemurian to Bajocian sequence of clastics, ash and lapilli tuff, and minor limestone (Tipper and Richards, 1976). The Nilkitkwa Formation contains a Toarcian volcanic unit, the Ankwell Member (Tipper and Richards, 1976). The Nilkitkwa Formation is overlain by Aalenian to Bajocian? volcanics and volcanoclastics of the Saddle Hill volcanics in the Hazelton map area and the Eagle Peak volcanics in the Smithers map area (Richards, 1991). These are overlain by the Smithers Formation, an Aalenian to Lower Bajocian unit of interbedded, shallow marine volcanoclastic, tuffaceous sandstone, siltstone, and greywacke, containing minor conglomerate (Tipper and Richards, 1976). In the McConnell Creek map area, the Smithers Formation extends into the Toarcian (Tipper, 1976; Tipper and Richards, 1976; Jakobs, 1993).



**Figure 15.** Toarcian fossil localities and sections, Spatsizi River map area (104H), northwestern British Columbia (contours in feet).

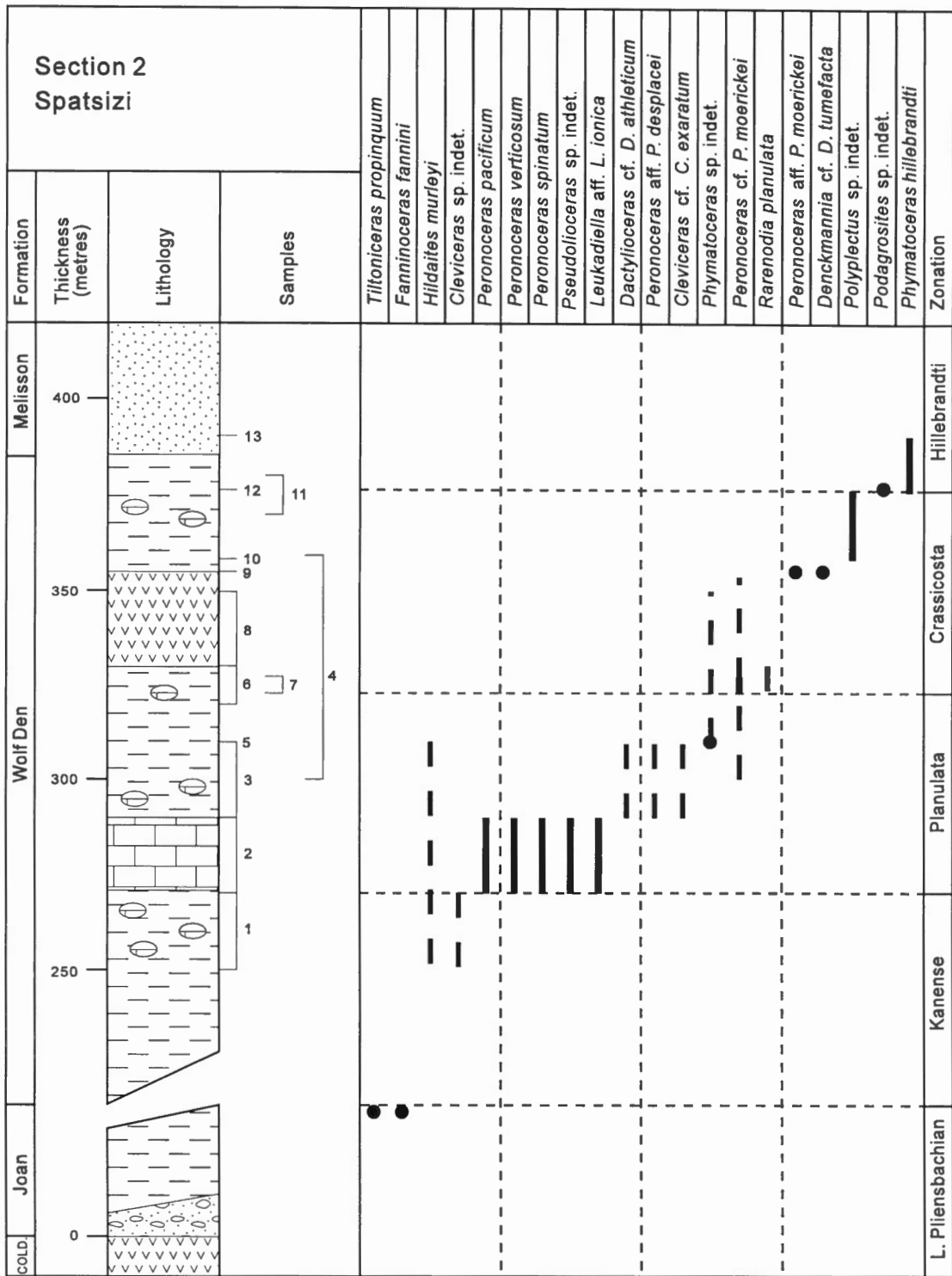
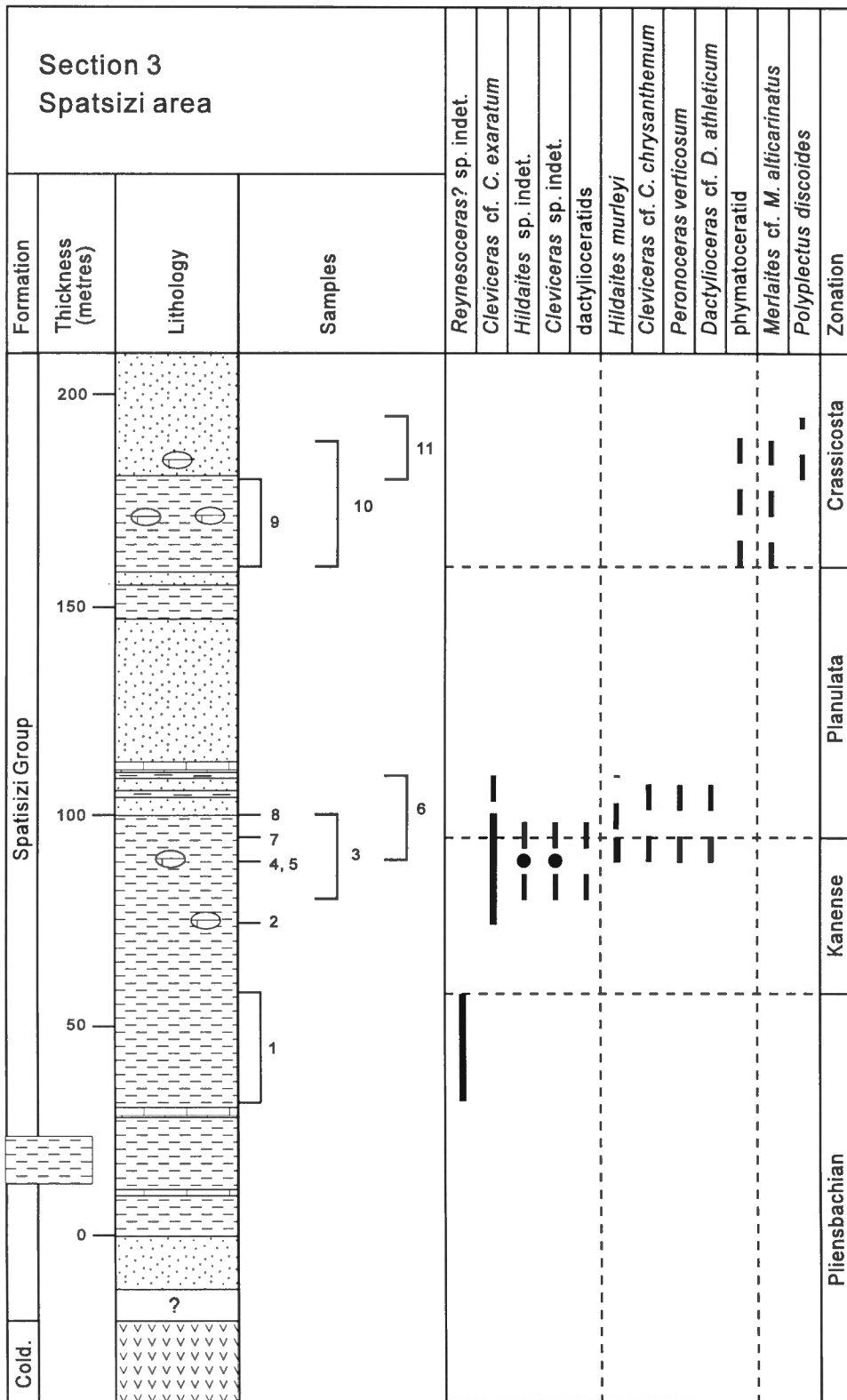


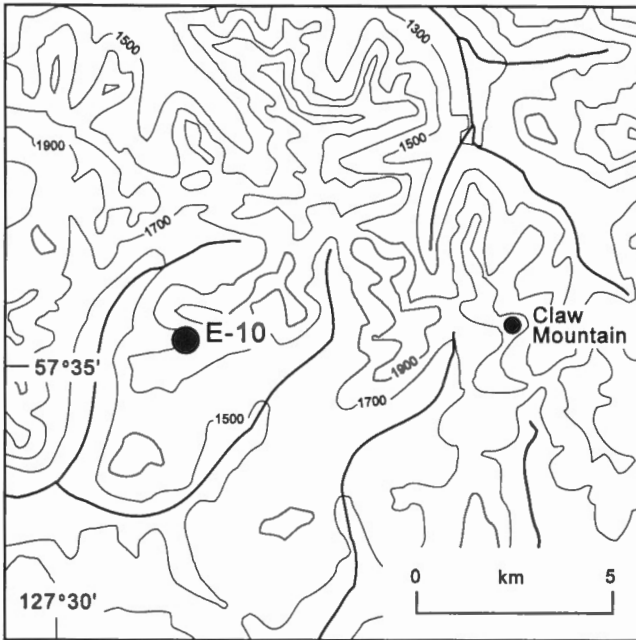
Figure 16. Lithostratigraphy and biostratigraphy of Section 2, Spatsizi River map area. See Figure 15 for location of section and Figure 10 for lithological legend. COLD. – Cold Fish Volcanics; L. Pliensbachian – Late Pliensbachian.



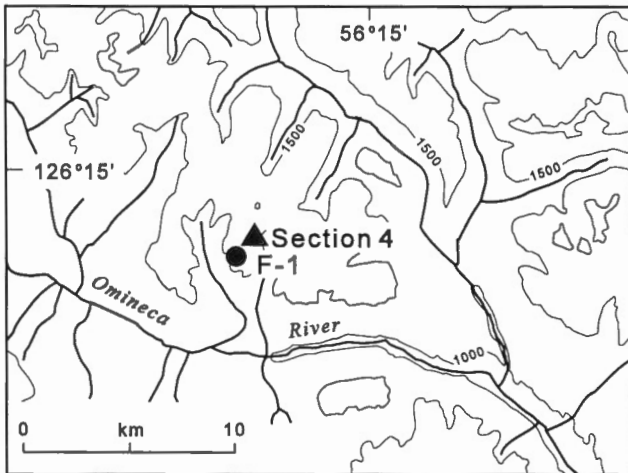
**Figure 17.** Lithostratigraphy and biostratigraphy of Section 3, Spatsizi River map area. See Figure 15 for location of section and Figure 10 for lithological legend. COLD. – Cold Fish Volcanics.

*McConnell Creek map area*

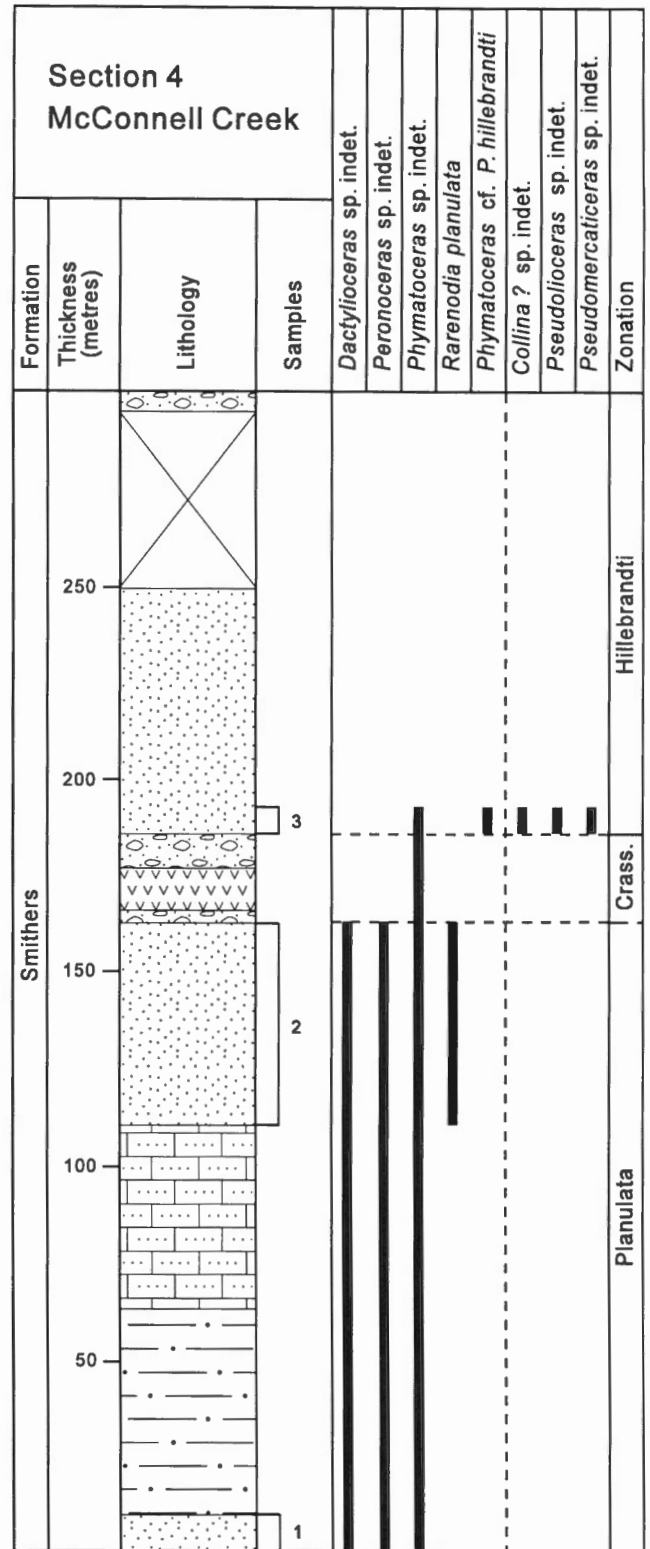
In the McConnell Creek map area (Fig. 2, 19), a section north of the Omineca River (Tipper and Richards, 1976) (Fig. 12, 20; Section 4) has yielded Early to Late Toarcian ammonites: *Dactyloceras* sp. indet., *Cleviceras* sp. indet., and *Hildaites* sp. indet. from the Kanense Zone, *Rarenodia planulata*, *Peronoceras* cf. *P. moerickei*, *Peronoceras* sp. indet., and *Pseudomercaticeras* sp. indet. from the Planulata and Crassicosta zones, and *Phymatoceras hillebrandti* from the Hillebrandti Zone.



**Figure 18.** Toarcian fossil locality in the Toadogone River map area (94E), west-central British Columbia (contours in metres).



**Figure 19.** Toarcian fossil locality and section in the McConnell Creek map area (94D), west-central British Columbia (contours in feet).



**Figure 20.** Lithostratigraphy and biostratigraphy of Section 4, McConnell Creek map area. See Figure 19 for location of section and Figure 10 for lithological legend. Crass. – Crassicosta Zone.

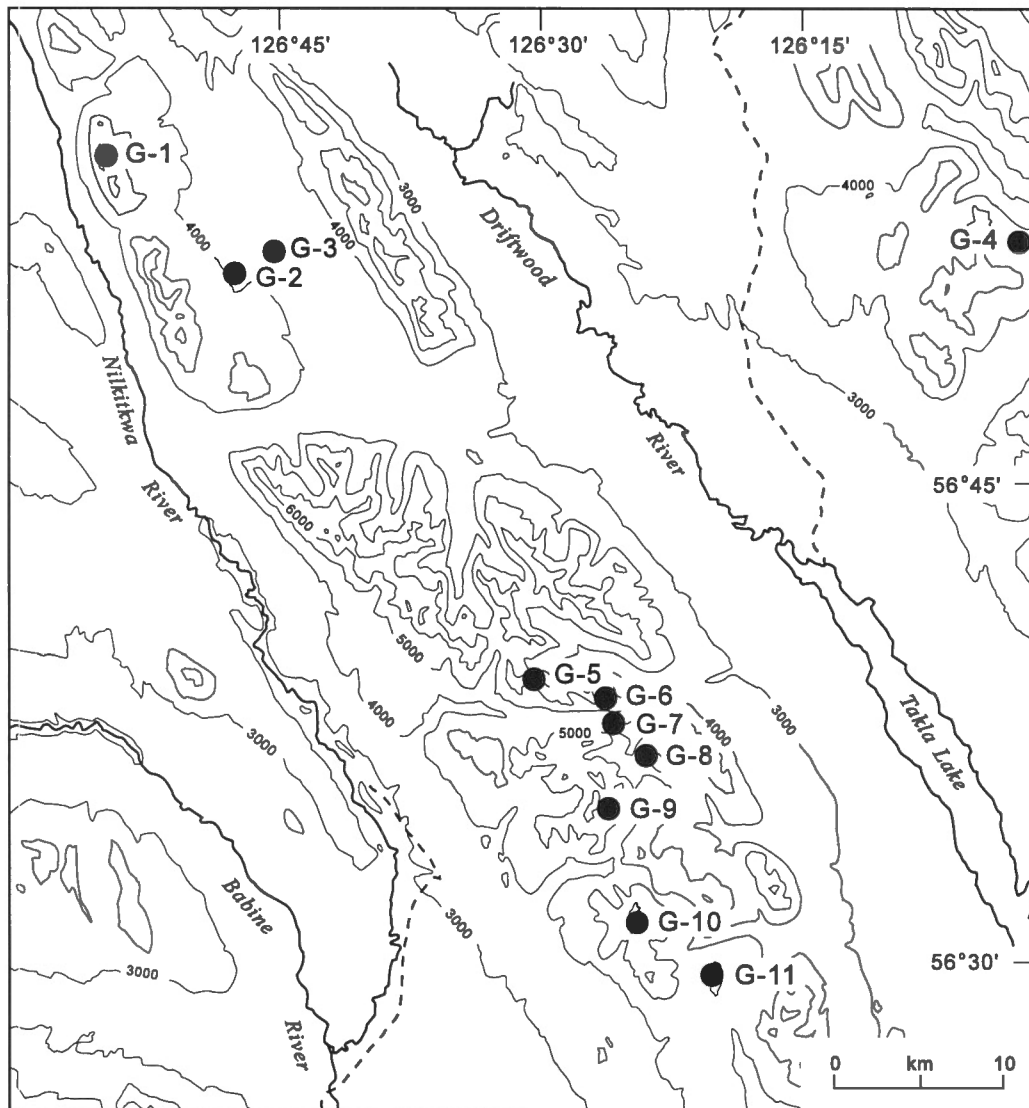


Figure 21. Toarcian fossil localities in the Hazelton map area (93M), west-central British Columbia (contours in feet).

Isolated collections from the map area have yielded *Dactyloceras* sp. indet., *Hildaites* sp. indet., *Peronoceras?* sp. indet., *Rarenodia?* sp. indet., and *Pseudolioceras* sp. indet. (Fig. 8, 19; Isolated Loc. F-1). Collections from the west half of the map area (Jakobs, 1993), have yielded *Yakounia yakounensis*, *Yakounia* cf. *Y. silvae*, and *Hammatoceras* cf. *H. speciosum* from the Yakounensis Zone (Jakobs and Smith, 1996).

#### Hazelton map area

Toarcian ammonites occur at scattered localities in the north-eastern part of the Hazelton map area (Fig. 2, 8, 21; Isolated Loc. G-1 to G-11). The fauna is diverse and includes *Dactyloceras kanense*, *Dactyloceras* sp. indet., *Hildaites* sp. indet., *Cleviceras* cf. *C. exaratum*, *Harpoceras* cf. *H. exaratum*, and *Eleganticeras?* sp. indet., probably from the

Kanense Zone; *Rarenodia planulata*, *Peronoceras* cf. *P. moerickei*, and *Leukadiella* sp. indet. (Pl. 6, fig. 3), probably from the Planulata Zone; *Denckmannia?* sp. indet., *Phymatoceras crassicosta*, *Phymatoceras* cf. *P. rude*, and *Catacoeloceras* cf. *C. crassum* (Young & Bird), probably from the Crassicosta Zone; *Phymatoceras hillebrandti*, and *Phymatoceras* sp. indet. from the Hillebrandti Zone and *Pseudolioceras* sp. indet. and *Pleydellia* cf. *P. maudensis* from the Yakounensis Zone.

#### Southern area

In the Nechako River map area (Fig. 2), a specimen of *Phymatoceras hillebrandti* was collected from the northwest quadrant of the map area, but its exact location is not known. Recent collections from the Nechako River map area have

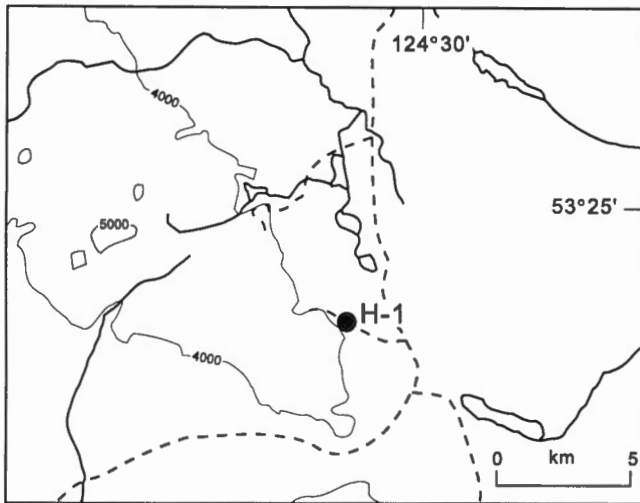


Figure 22. Toarcian fossil locality in the Nechako River map area (93F), central British Columbia (contours in feet).

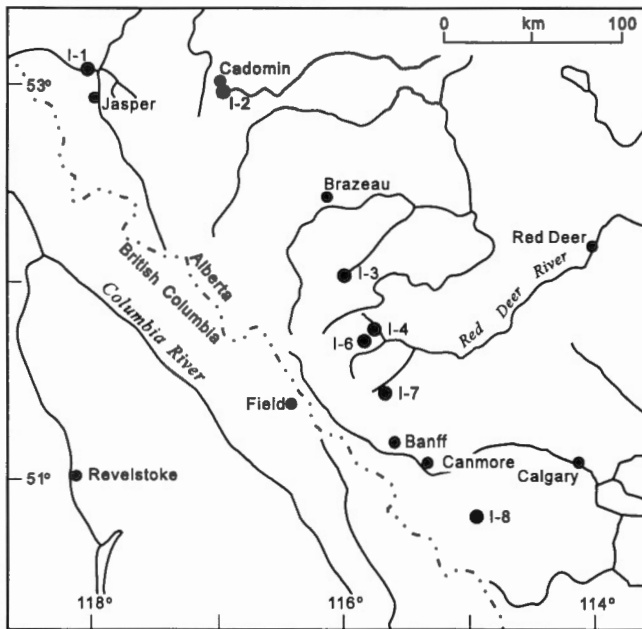


Figure 23. Toarcian fossil localities in western Alberta.

yielded an Early Toarcian fauna that includes *Dactylioceras kanense*, *Dactylioceras* cf. *D. tenuicostatum*, *Tiltoniceras antiquum* (Wright), and *Tiltoniceras propinquum* (Whiteaves) from the lower part of the Kanense Zone (Fig. 8, 22; Isolated Loc. H-1). The terrane affinities of Toarcian strata in the Nechako River map area are unclear.

The northern part of the Taseko Lakes map area (Fig. 2) has yielded poorly preserved specimens of *Pleydellia* sp. and *Dumortieria? phantasma* from Upper Toarcian siltstones (Jakobs and Smith, 1996). Hickson (1990) suggested that this argillaceous unit may correlate with Cadwallader Terrane strata farther to the south.

### Southern Canadian Rocky Mountains

The Jurassic Fernie Formation outcrops from southwestern Alberta to northeastern British Columbia (Poulton et al., 1990). The Poker Chip Shale member is an extensive unit of dark green to black, fissile to papery shale approximately 10 to 35 m thick (Hall, 1984; Poulton et al., 1990). The Poker Chip Shale is Toarcian to Aalenian and unconformably overlain by sandstones and siltstones of the Aalenian to Lower Bajocian Rock Creek sandstone member (Hall, 1984; Poulton et al., 1990), or by sandstones and shales of the upper part of the Fernie Formation (Poulton et al., 1990). The Poker Chip Shale member was probably deposited under anaerobic conditions based on the presence of nektonic faunas, the absence of ichnofossils and bioturbation, and the relatively high organic carbon content (Hall, 1984; Stronach, 1984).

### Biostratigraphy

In western Alberta (Fig. 1, 23), Lower and Middle Toarcian strata have yielded species of *Dactylioceras*, *Peronoceras*, *Hildaites*, and *Harpoceras* (Frebold, 1976; Hall, 1987) (Fig. 24; Isolated Loc. I-1 to I-8). Collet (1931, p. 17) mentioned the presence of *Hammatoceras*, *Dumortieria* or *Catullocceras*, and *Pleydellia* from western Alberta near Jasper, but this has not been confirmed.

In the Fernie map area (Fig. 2, 25), Frebold (1976) and Hall (1987) made collections at Fording River and assigned them to the Middle and Late Toarcian. The fauna was re-evaluated by Jakobs and Smith (1996) who identified *Pleydellia* sp. indet., *Pleydellia maudensis*, *Sphaerocoeloceras* sp. indet., *Dumortieria? phantasma*, *Yakounia silvae*, and *Yakounia yakounensis* from the Yakounensis Zone. Early and Middle Toarcian taxa are represented by *Peronoceras* sp. indet., *Phymatoceras* cf. *P. pseudoerbaense*, *Dactylioceras* (*Orthodactylites*) sp. indet., and *Hildaites? sp. indet.* (Fig. 24; Isolated Loc. I-9, I-10).

### Quesnellia

Poorly preserved and low diversity Toarcian ammonite faunas have been collected from four areas in Quesnellia. In the Manson River, Prince George, and Quesnel map areas (Fig. 2, 26, 27, 28), scattered collections were made from unnamed siltstones and shales. In the Nelson map area (Fig. 2, 29), Early to Middle Toarcian ammonites have been collected from the Hall Formation.

A comprehensive stratigraphic study was conducted in the Nelson map area by Mulligan (1952), McAllister (1951), and Little (1950, 1960, 1963, 1982). The Lower Jurassic in the Nelson map area is represented by the Rossland Group, divisible into three formations: the Archibald, Elise, and Hall (Frebold and Little, 1962; Little, 1982). The argillaceous Archibald Formation is Hettangian? to Sinemurian and is abruptly overlain by, or grades laterally into, the Sinemurian Elise Formation, a predominantly volcanic unit with massive lavas and pyroclastics (Little, 1982).





The Lower Pliensbachian to Lower Toarcian Hall Formation conformably overlies the Elise Formation and is composed of fissile, black, carbonaceous shales and buff to brown, argillaceous sandstone (Little, 1982). Siltstone and minor greywacke intervals are present and conglomerates are common in the type area (Little, 1982).

**Biostratigraphy**

Late Toarcian ammonites have been collected from unnamed siltstones and shales of the Manson River map area (Fig. 2, 24, 26; Isolated Loc. J-10). They include *Lytoceras* sp. indet.,

*Polyplectus discoides*, *Yakounia silvae*, *Pleydellia maudensis*, and *Dumortiera? phantasma* (Nelson et al., 1993; Jakobs and Smith, 1996).

Two collections of *Grammoceras?* sp. indet. from unnamed strata of the Prince George and Quesnel map areas (Fig. 2, 24, 27, 28; Isolated Loc. J-8, J-9) are too poorly preserved to identify with certainty, but are probably not Toarcian and may be Early Bajocian sonniids.

A poorly preserved Early to Middle Toarcian fauna of *Dactyloceras* sp. indet., *Peronoceras* sp. indet., and *Cleviceras* cf. *C. exaratum* occurs in the Nelson map area (Fig. 2, 24, 29; Isolated Loc. J-1 to J-7).

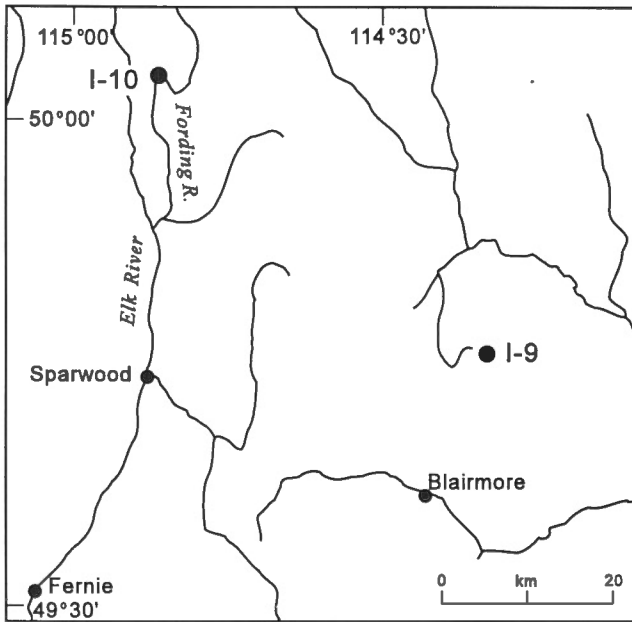


Figure 25. Toarcian fossil localities in the Fernie map area (82G), southeastern British Columbia.

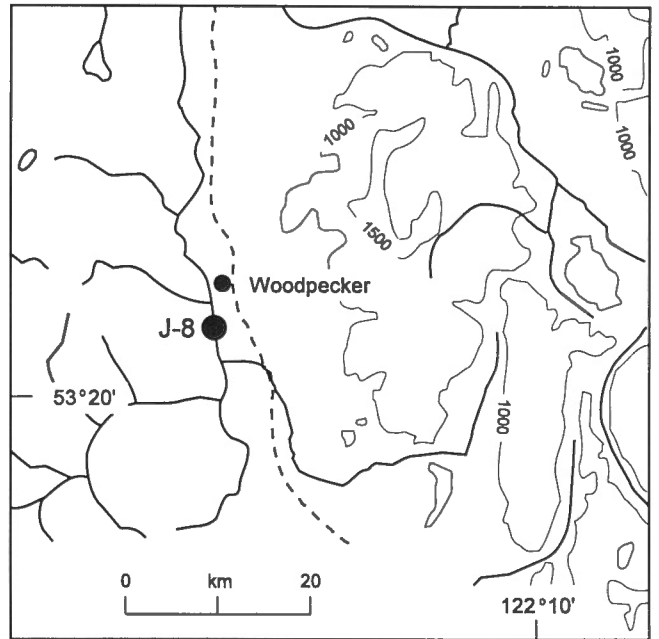


Figure 27. Toarcian fossil locality in the Prince George map area (93G), central British Columbia (contours in feet).

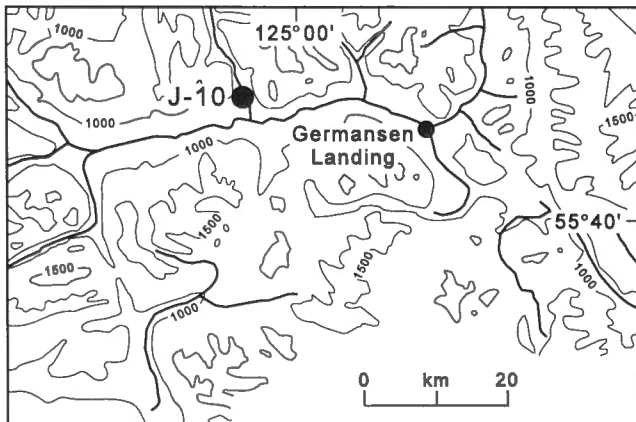


Figure 26. Toarcian fossil locality in the Manson River map area (93N), central British Columbia (contours in feet).

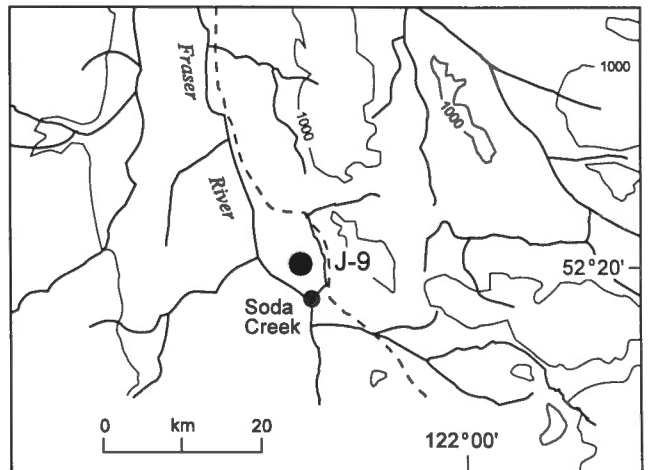


Figure 28. Toarcian fossil locality in the Quesnel map area (93B), central British Columbia (contours in feet).

## Southwestern British Columbia

Southwestern British Columbia is tectonically complex composed of numerous terrane fragments separated by faults (Monger et al., 1991). Toarcian ammonites have been collected from the Hope and Taseko Lakes map areas (Fig. 2, 30, 31), as well as the Pemberton map area (Fig. 2).

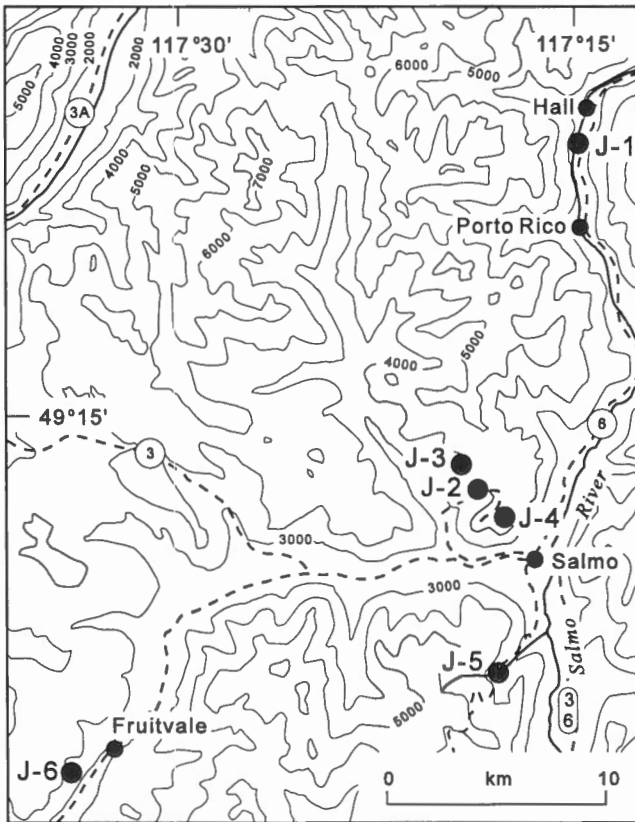
### Hope map area

The Lower to Middle Jurassic Ladner Group outcrops in the eastern part of the Hope map area (Fig. 2). It is composed of argillite, siltstone, greywacke, and conglomerate, and contains a minor volcanic component in some areas (Ray, 1986). Late Toarcian (Yakounensis Zone) ammonites, represented by *Yakounia silvae* have been collected from the Manning Park area (Fig. 1) (Frebold et al., 1969; Jakobs and Smith, 1996).

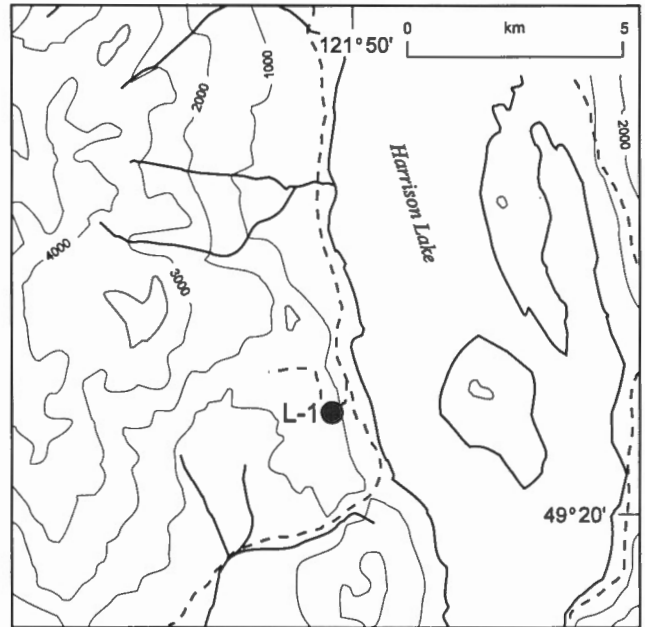
Arthur (1987; Arthur et al., 1993) recently studied the Jurassic rocks of the Harrison Lake area (Fig. 1) and collected a low diversity Toarcian ammonite fauna. The Middle Triassic Camp Cove Formation is unconformably overlain by the Lower to Middle Jurassic Harrison Lake Formation which can be subdivided into four members: Celia Cove, Francis Lake, Weaver Lake, and Echo Island (Arthur et al., 1993). The Francis Lake Member comprises a calcareous siltstone and shale containing local sandstone interbeds and is approximately

200 m thick (Arthur et al., 1993). It is Early Toarcian to middle Aalenian and appears to conformably overlie the Celia Cove Member (Arthur et al., 1993).

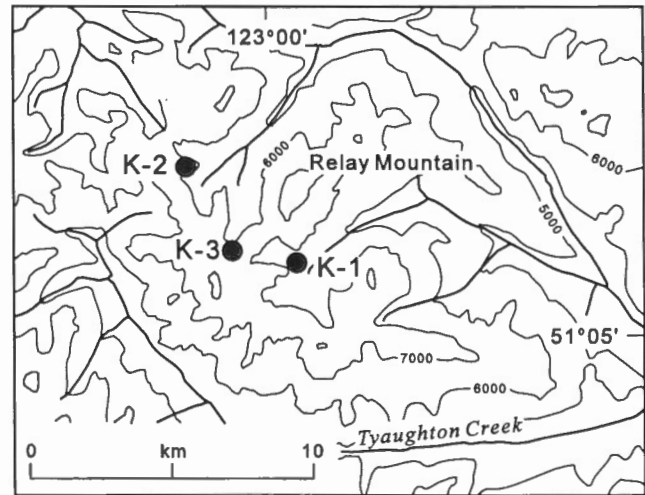
Early and Late Toarcian ammonites have been collected from the Francis Lake Member (Arthur et al., 1993). The Early Toarcian fauna contains *Dactyloceras* sp. indet., *Cleviceras* sp. indet. and *Hildaites* (Fig. 24, 30; Isolated Loc. L-1). The poorly preserved specimen identified as *Phymatoceras?* (Arthur et al., 1993; Pl. 3, fig. 1) is probably *Hildaites* cf. *H. propeserpentinum* Buckman. The Late Toarcian fauna contains *Dumortieria* cf. *D. levesquei* (d'Orbigny) and *D.* cf. *D. insiginisimilis* (Brauns) (Arthur et al., 1993).



**Figure 29.** Toarcian fossil localities in the Nelson map area (82F), southeastern British Columbia (contours in feet).



**Figure 30.** Toarcian fossil locality in the Hope map area (92H), southwestern British Columbia (contours in feet)



**Figure 31.** Toarcian fossil localities in the Taseko Lakes map area (92O), southwestern British Columbia (contours in feet).

*Pemberton map area*

A poorly preserved specimen of *Leukadiella* sp. has been collected from the Cayoosh Assemblage of the Pemberton map area (Fig. 2) (Journeay and Mahoney, 1994) and indicates a Middle Toarcian (Planulata Zone) age.

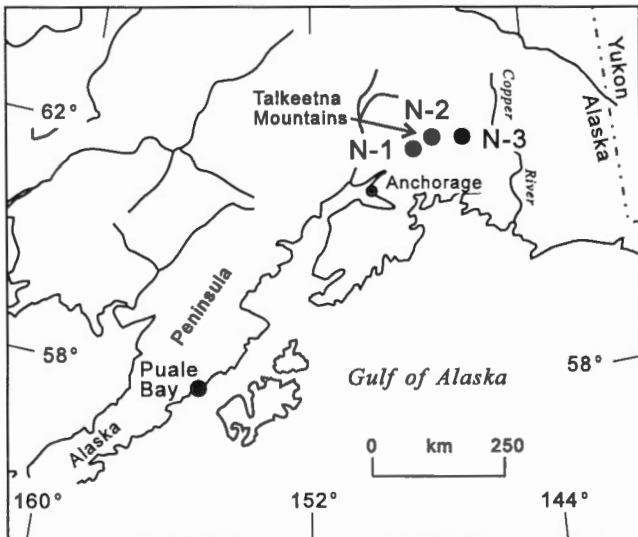
*Taseko Lakes map area*

The Cadwallader Group, defined by Rusmore (1987), is composed of Upper Triassic volcanics and clastics overlain by Upper Triassic clastics and carbonates of the Tyaughton Group (Cairnes, 1943; Schiarizza et al., 1989; Umhoefer, 1989; H.W. Tipper, pers. comm., 1991). The Lower to Middle Jurassic Last Creek formation unconformably overlies the Tyaughton Group and is a transgressive sequence with Hettangian to Sinemurian shallow marine, coarse clastics grading into Upper Sinemurian to Bajocian marine shales (Umhoefer, 1989; H.W. Tipper, pers. comm., 1991).

Toarcian ammonites have been collected from shales of the Last Creek formation and represent the Kanense to Yakounensis zones (Fig. 24, 31; Isolated Loc. K-1 to K-3). Isolated collections have yielded *Cleviceras* cf. *C. chrysanthemum*, *Dactyloceras* cf. *D. commune*, *Phymatoceras* cf. *P. rude*, *Lytoceras siemensi*, *Phylloceras* sp. indet., *Phymatoceras* cf. *P. hillebrandti*, *Dumortieria?* *phantasma*, and *Hammatoceras* sp.

**East-central Oregon**

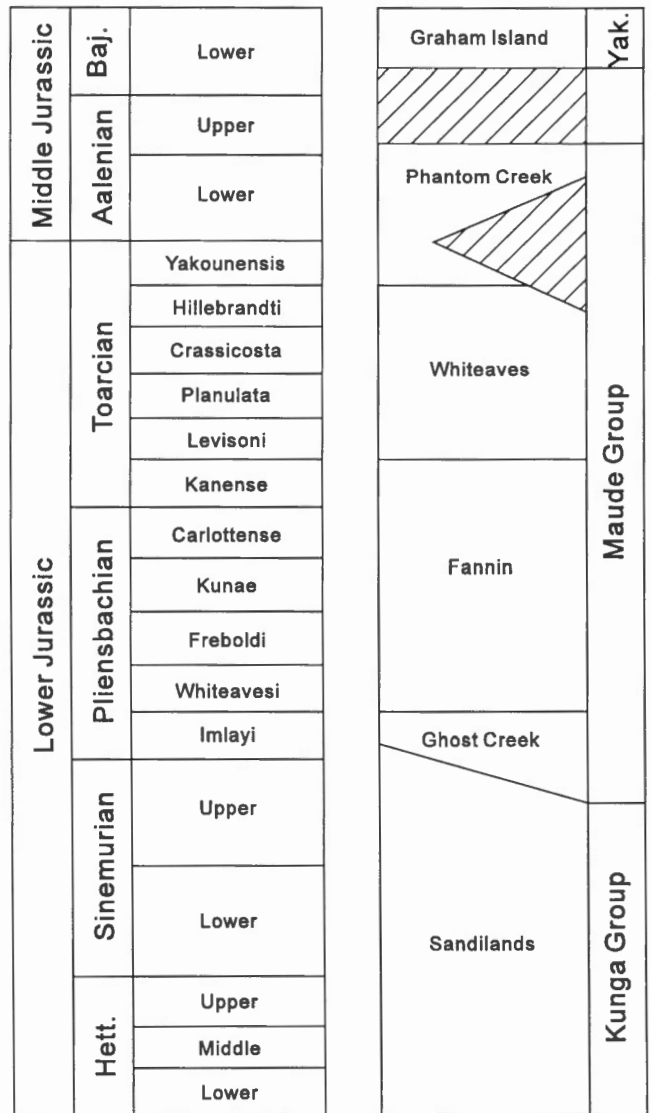
Toarcian strata are represented in east-central Oregon (Fig. 1) by the volcanoclastic Hyde Formation and the lower part of the Snowshoe Formation. The stratigraphy was described by Lupper (1941), Dickinson (1962), Dickinson and Vigrass (1964), Imlay (1968) and Smith (1980).



**Figure 32.** Toarcian fossil localities in southern Alaska.

Smith (1980) mentioned the presence of Middle and Late Toarcian *Phymatoceras* and *Dumortieria?* from the Hyde Formation, probably the same fauna that was originally placed in the stephanoceratids and sonniniids by Lupper (1941).

Ammonites, and small pectinid bivalves similar to *Bositra*, are common in the Snowshoe Formation. The lower 40 m of the Snowshoe Formation have yielded a Late Toarcian ammonite fauna that includes *Pleydellia* cf. *P. fluitans?* (Dumortier), *Hammatoceras speciosum*, *Dumortieria* cf. *D. pusilla*, *D. raricostata* Géczy (Pl. 9, fig. 3), *D. cf. D. exacta* Buckman, *D. cf. D. dumortieri* (Thiolliere), and *Polyplectus* sp. from the Yakounensis Zone (Smith, 1980; Jakobs and Smith, 1966).



**Figure 33.** Lower Jurassic stratigraphy in the Queen Charlotte Islands. Baj. – Bajocian; Hett. – Hettangian; Yak – Yakoun Group; Hatched pattern – hiatus. Modified from Jakobs and Smith, 1996).

## Nevada

The Clan Alpine Mountains in the Westgate District of Nevada (Fig. 1) have exposures of the Sinemurian to Toarcian Sunrise Formation. The stratigraphy and ammonite fauna of the Sunrise Formation was described by Muller and Ferguson (1936), Corvalán (1962), Hallam (1965), and Smith (1980). The Early Toarcian is represented by *Tiltoniceras propinquum* and rapidly expanding, depressed dactylioceratids that may belong to *Dactylioceras*, but are too poorly preserved to identify with certainty. Imlay (1968) identified a *Grammoceras* and a *Pseudolioceras* from higher in the formation, but they are poorly preserved and could be interpreted as coming from any part of the Toarcian or Aalenian.

## Peninsular Terrane

Southern Alaska is tectonically complex, composed of numerous accreted terrane fragments (Silberling and Jones, 1984) and stratigraphic sections are rare. The Peninsular Terrane includes most of the Alaskan Peninsula and extends

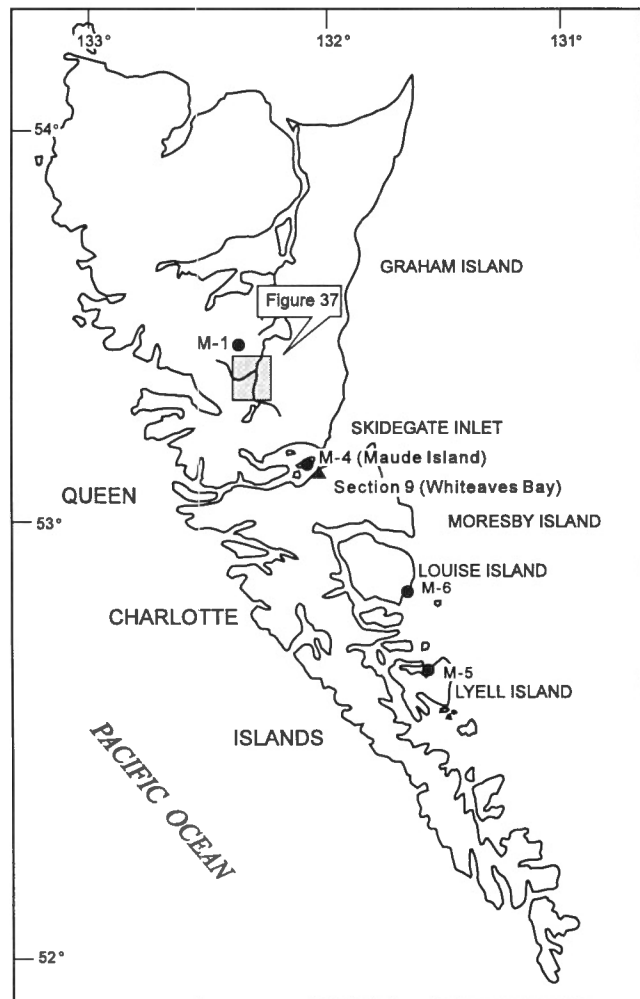


Figure 34. Toarcian fossil localities in the Queen Charlotte Islands.

northeast past Anchorage to include the Talkeetna Mountains (Silberling and Jones, 1984). Toarcian strata outcrop in the Talkeetna Mountains and in the Puale Bay area (Fig. 1, 32).

## Stratigraphy

The Upper Sinemurian to Upper Toarcian Talkeetna Formation is a thick (4600 to 5800 m) unit of volcanic and volcaniclastic rocks deposited predominantly in a marine environment (Imlay, 1981).

The Kialagvik Formation, exposed at Puale Bay, is a dark grey to black, sandy siltstone containing rare beds of hard, buff sandstone (Imlay, 1981). The Kialagvik Formation coarsens upwards and contains numerous limy concretions in the upper two thirds (Imlay, 1981). It is latest Toarcian to Aalenian and is in fault contact with underlying Hettangian to Sinemurian strata (Imlay, 1981).

## Biostratigraphy

The ammonite fauna from the Talkeetna Mountains (Fig. 1, 24, 32), identified by Imlay (1981) as Middle Toarcian, is identical to that from the Upper Toarcian Phantom Creek Formation of the Queen Charlotte Islands (Fig. 33). The fauna from the Talkeetna Mountains has been re-identified and includes *Hammatoceras* sp. indet., *Yakounia yakounensis*, *Pleydellia maudensis*, *Pleydellia* sp. indet., and *Pseudolioceras* sp. indet. from the Yakounensis Zone (Jakobs and Smith, 1996).

Specimens identified by Imlay (1981) as *Harpoceras* (= *Cleviceras*) cf. *H. exaratum*, *Dactylioceras kanense*, and *Dactylioceras* cf. *D. commune* (Fig. 24; Isolated Loc. N-1 and N-2) have been collected from the Lower Toarcian strata of the Talkeetna Mountains.

A poorly preserved ammonite, identified as *Grammoceras*, was collected from the Copper River area (Imlay, 1981), and is similar to Late Pliensbachian and Early Toarcian taxa such as *Hildaites* or *Fuciniceras* (Fig. 24; Isolated Loc. N-3).

*Pleydellia maudensis* (Yakounensis Zone) and *Pseudolioceras* sp. indet. have been collected from the base of the Kialagvik Formation at Puale Bay (Imlay, 1981; Jakobs and Smith, 1996).

## Queen Charlotte Islands

Upper Triassic to Lower Jurassic strata in the Queen Charlotte Islands (Fig. 1) represent a continuous depositional sequence (Thompson et al., 1991; Tipper et al., 1991) (Fig. 33). Toarcian strata outcrop on central Graham Island, in the Skidegate Inlet area and as far south as Louise Island (Fig. 34). A possible Toarcian locality on Lyell Island (Fig. 34; Isolated Loc. M-5) has not been confirmed.

The basal volcanics of the Triassic Karmutsen Formation were probably formed in a rifting back-arc environment (Andrew and Godwin, 1989). The overlying shales and limestones of the Triassic to Sinemurian Kunga Group represent a fairly deep water environment. They are in turn overlain by

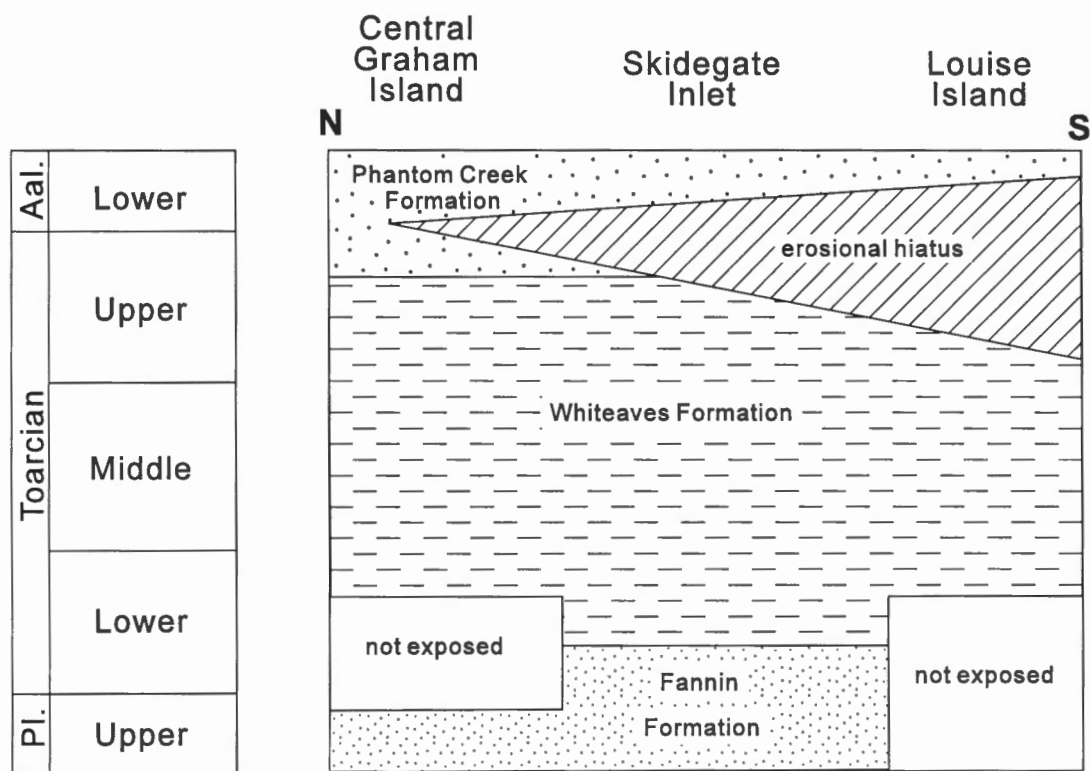


Figure 35. Lithostratigraphic chart showing the north-south variation in the Whiteaves/Phantom Creek hiatus. Pl. – Pliensbachian; Aal. – Aalenian

shales and siltstones of the Sandilands and Ghost Creek formations (Fig. 33). The Fannin Formation (Lower Pliensbachian to Lower Toarcian) represents a coarser interval and is overlain by siltstones of the Whiteaves Formation (Lower to Upper Toarcian). The Phantom Creek Formation (Upper Toarcian to Aalenian) represents a second coarser interval and is disconformably overlain by volcanics and sedimentary rocks of the Middle Jurassic Yakoun Group. The Jurassic stratigraphy was revised by Sutherland Brown (1968), Cameron and Tipper (1985), and Woodsworth (1991).

### Stratigraphy

The Lower Pliensbachian to Lower Toarcian Fannin Formation is a tuffaceous, calcareous sandstone containing minor siltstone, shale, and thin limestone interbeds and attains a thickness of 64 m on Maude Island (Cameron and Tipper, 1985). Lower Toarcian strata of the unit are exposed at Whiteaves Bay on the north shore of Moresby Island.

The Fannin Formation is conformably overlain by the Lower to Upper Toarcian Whiteaves Formation, a recessive, poorly exposed unit. Isolated sections of the Whiteaves Formation occur on Graham Island, Maude Island, northern Moresby Island, and Louise Island. An unconfirmed locality may occur on Lyell Island. The Whiteaves Formation is not exposed in its entirety but is probably 60 to 70 m thick.

The Whiteaves Formation is composed of grey-green siltstones that weather brown-grey and are commonly rich in pyrite. Bedding or lamination was not observed in the siltstones but sandy layers are present. The lower half of the formation is dominated by subspherical to discoidal septarian concretions that rarely contain ammonites and may reach 50 cm in diameter. Non-septarian concretions are predominant in the upper part of the formation and commonly contain well preserved fossils. The concretions commonly contain bitumen or bitumen-stained crystalline calcite, and non-septarian concretions may also be rich in pyrite. The concretions weather a buff colour and the outer layer is commonly friable and soft due to weathering. In some cases the calcite cement may be entirely removed and only clay pockets or layers remain. These layers were originally thought to be paleosols (Cameron and Tipper, 1985) that represented a hiatus during deposition of the Phantom Creek Formation. Ash layers are common throughout the Whiteaves Formation.

The Whiteaves Formation has yielded a diverse and abundant ammonite fauna, generally poorly preserved as flattened lateral impressions and as infilled body chamber fragments. Excellent specimens occur within the non-septarian concretions, especially in the upper half of the formation. Nautiloids, belemnites, bivalves, and rare brachiopods are also present.

The Whiteaves Formation is conformably overlain by the Phantom Creek Formation on Graham Island. On Maude Island and Louise Island the contact between the two formations is disconformable.

The Upper Toarcian to Aalenian Phantom Creek Formation is a resistant unit exposed in stream and road cuts. It can be subdivided into two units based on lithological and paleontological criteria (Cameron and Tipper, 1985). The lower unit, the coquinoid sandstone member (Cameron and Tipper, 1985), is a thin (3 to 4 m), fossiliferous, well bedded, grey to greenish-brown sandstone containing buff-weathering, fossiliferous concretions. The upper unit, the belemnite sandstone member (Cameron and Tipper, 1985), is a greenish-grey, massive sandstone containing large, unfossiliferous buff-weathering concretions. The belemnite sandstone member may reach 20 m in thickness. It contains belemnites, bivalves, gastropods, nautiloids, and rare ammonites.

The contact between the two members of the Phantom Creek Formation is an erosional hiatus (Cameron and Tipper, 1985; Jakobs, 1990), that increases in duration toward the south (Fig. 35). In the Skidegate Inlet area the belemnite sandstone member lies directly on the Whiteaves Formation.

The contact between the Phantom Creek Formation and overlying strata of the Yakoun Group is an angular unconformity in central Graham Island (Cameron and Tipper, 1985). A faunal gap is seen between the Early Aalenian ammonite fauna of the Phantom Creek Formation and the Early Bajocian ammonite fauna of the Yakoun Group (Cameron and Tipper, 1985).

### Biostratigraphy

Toarcian strata of the Queen Charlotte Islands contain a diverse ammonite fauna as well as numerous bivalves, belemnites, and gastropods. Rare brachiopods and plant fragments are also present. About 20 specimens of the nautiloid *Cenoceras* have been collected from the Whiteaves and Phantom Creek formations. Elsewhere in the Lower Jurassic of western North America, *Cenoceras* has been figured from the Lower Pliensbachian Joan Member (Spatsizi Formation)

of the Spatsizi River map area (Thomson and Smith, 1992; Smith et al., 1994) and has been mentioned from the upper part of the Fannin Formation in the Queen Charlotte Islands (Cameron and Tipper, 1985). Poulton (1991) figured a specimen of *Cenoceras* sp. aff. *C. intermedius* from the Sinemurian Scho Creek Member (Murray Ridge Formation) of northern Yukon Territory.

### Section 5 - Central Graham Island, Yakoun River

This section in Central Graham Island, originally measured and figured by Cameron and Tipper (1985, Section 15), was re-measured (Fig. 36, 37, 38). The lower part of the Whiteaves Formation is exposed in a section along the river bank and is cut by several small-scale fractures and faults. The base and top of the section are not exposed. The lowest collections have yielded *Cleviceras* sp. indet. and *Dactylioceras* sp. indet. from the Kanense Zone. The rest of the section is dominated by *Rarenodia planulata*, together with dactylioceratidae gen. et sp. indet., *Phymatoceras* sp. indet., and *Cleviceras* sp. indet., from the Planulata Zone.

### Section 6 - Central Graham Island, Yakoun River

The lower part of the Whiteaves Formation is exposed in a section along the river bank and is cut by numerous small-scale fractures and faults, leading to repetition of strata (Fig. 39). The base and top of the section are not exposed. The lowest collections have yielded *Cleviceras* cf. *C. exaratum*, *Cleviceras* cf. *C. chrysanthemum*, *Cleviceras* sp. indet., *Harpoceras* cf. *H. subplanatum* (Oppel), *Hildaites murleyi*, and *Hildaites* cf. *H. subserpentinus* from the top of the Kanense Zone and the base of the Planulata Zone. The upper part of the section is faulted and contains a mixed fauna of *Rarenodia planulata*, *Cleviceras* cf. *C. exaratum*, *Polyplectus discoides*, and *Harpoceras* cf. *H. subplanatum* representing the

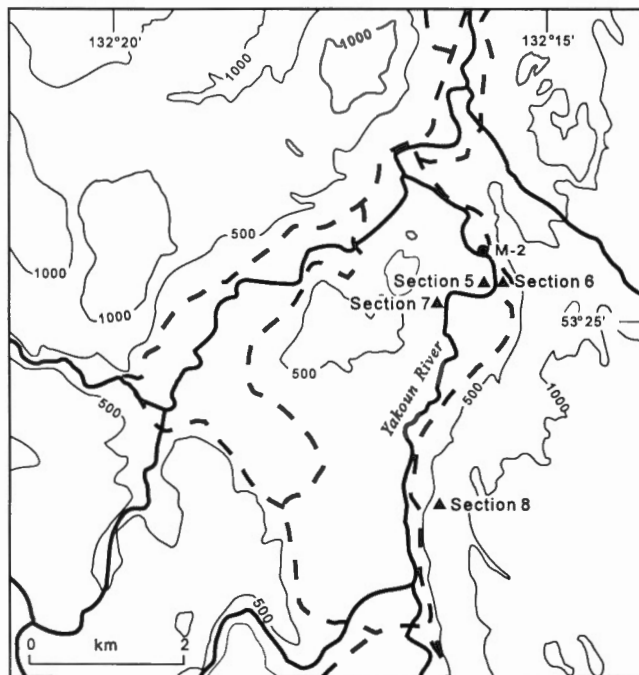
Stratigraphic section	Section 5													Section 6													Stratigraphic section												
	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13		14	15	16	17	18	19	20	21	22			
Sample locality																																					Sample locality		
<i>Phylloceras</i> sp. indet.																																					<i>Phylloceras</i> sp. indet.		
<i>Dactylioceras</i> sp. indet.	●																																				<i>Dactylioceras</i> sp. indet.		
<i>Collina</i> cf. <i>C. linnae</i>																																					<i>Collina</i> cf. <i>C. linnae</i>		
dactylioceratids					●	●						●																									dactylioceratids		
<i>Harpoceras</i> cf. <i>H. subplanatum</i>																																					<i>Harpoceras</i> cf. <i>H. subplanatum</i>		
<i>Cleviceras</i> cf. <i>C. exaratum</i>															●	●	●	●																				<i>Cleviceras</i> cf. <i>C. exaratum</i>	
<i>Cleviceras</i> cf. <i>C. chrysanthemum</i>																																						<i>Cleviceras</i> cf. <i>C. chrysanthemum</i>	
<i>Cleviceras</i> sp. indet.	●														●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	<i>Cleviceras</i> sp. indet.	
<i>Polyplectus discoides</i>																																						<i>Polyplectus discoides</i>	
harpoceratids																																						harpoceratids	
<i>Hildaites murleyi</i>																																						<i>Hildaites murleyi</i>	
<i>Hildaites</i> cf. <i>H. subserpentinus</i>																																							<i>Hildaites</i> cf. <i>H. subserpentinus</i>
<i>Hildaites</i> sp. indet.																																							<i>Hildaites</i> sp. indet.
<i>Leukadiella</i> aff. <i>L. helense</i>																																							<i>Leukadiella</i> aff. <i>L. helense</i>
<i>Phymatoceras hillebrandti</i>																																							<i>Phymatoceras hillebrandti</i>
<i>Phymatoceras</i> sp. indet.																																							<i>Phymatoceras</i> sp. indet.
<i>Rarenodia planulata</i>																																							<i>Rarenodia planulata</i>
Zone																																						Zone	
	K	K	P	P	P	P	P	P	P	P	P	P	?	K	K	K	K	K	K	K	K	K	K	K	K	K	K	P	?	?	?	?	C	?	?	?			

Figure 36. Distribution of ammonite species at Toarcian localities in sections 5 and 6. Zone symbols are K – Kanense; P – Planulata; C – Crassicoستا. See also Figures 38 and 39.

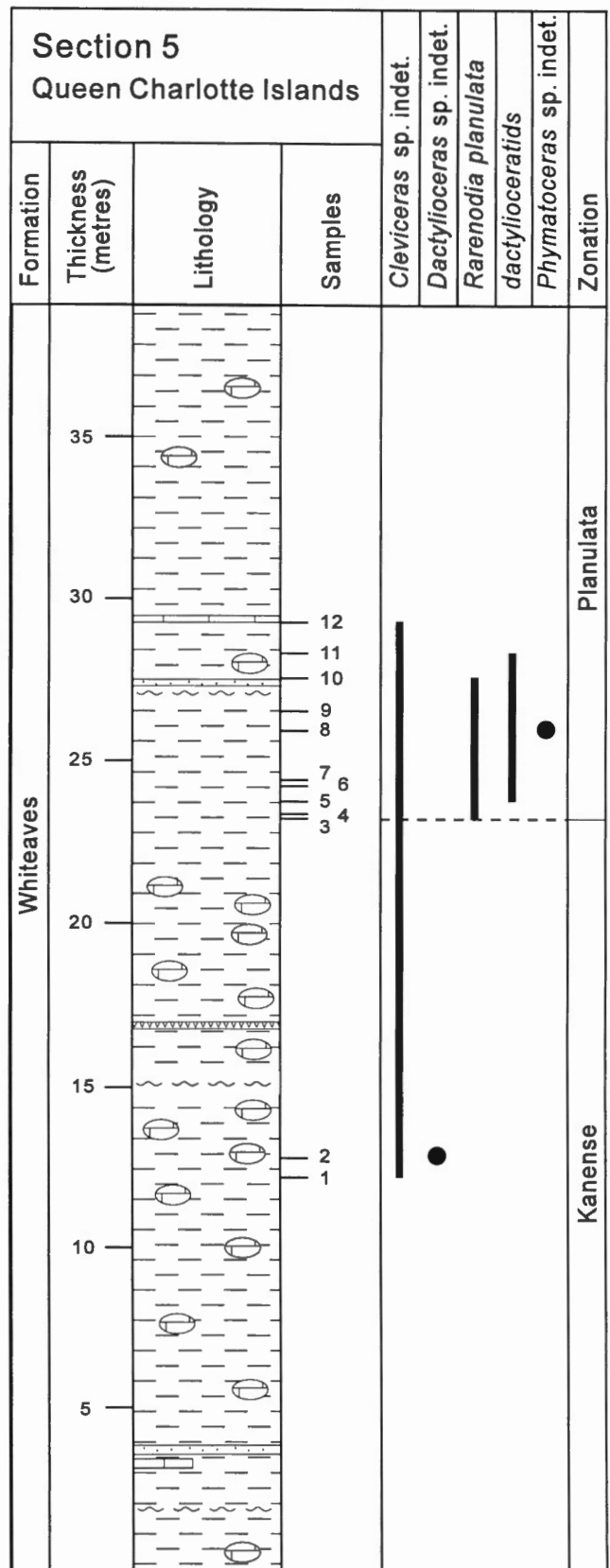
Planulata Zone. Thin slices of strata containing younger (Crassicosta Zone) or older (Kanense Zone) taxa may also be present. Talus collections from along the section have also yielded *Phylloceras* sp. indet., *Leukadiella* aff. *L. helenae*, and the nautiloid *Cenoceras* cf. *C. intermedius* (Sowerby) (Pl. 18, fig. 1, 2).

*Section 7 - Central Graham Island, Yakoun River*

This section in Central Graham Island, originally measured and figured by Cameron and Tipper (1985, Section 11), was re-measured (Fig. 37, 40, 41). This is the most complete section of Toarcian in the Queen Charlotte Islands, extending from the lower part of the Whiteaves Formation through the Phantom Creek Formation and into the Graham Island Formation of the Middle Jurassic Yakoun Group. The base of the section is faulted and the contact between the Fannin Formation and the Whiteaves Formation is not exposed. The Whiteaves Formation contains taxa from the Kanense, Planulata, Crassicosta, and Hillebrandti zones. The upper part of the Kanense Zone is represented by *Cleviceras* cf. *C. exaratum*, *Cleviceras* cf. *C. chrysanthemum*, and *Hildaites murleyi*. The Planulata Zone is represented by *Rarenodia planulata*, *Harpoceras* cf. *H. subplanatum*, *Cleviceras* cf. *C. chrysanthemum*, *Peronoceras* cf. *P. verticosum*, *Leukadiella ionica*, *Paroniceras sternale*, *Phymatoceras* cf. *P. pseudoerbaense*, and *Denckmannia* cf. *D. tumefacta*. Poorly preserved specimens of *Peronoceras* sp. indet. have been collected from this interval (Pl. 2, fig. 7, 8). The Crassicosta Zone is represented by *Phymatoceras crassicosta*,



**Figure 37.** Toarcian fossil localities in central Graham Island (103 F/8), Queen Charlotte Islands, western British Columbia (contours in feet). (Dashed line – logging roads). (Modified from Jakobs and Smith, 1996)



**Figure 38.** Lithostratigraphy and biostratigraphy of Section 5, central Graham Island, Queen Charlotte Islands. See Figure 37 for location of section and Figure 10 for lithological legend.

*Phymatoceras* cf. *P. pseudoerbaense*, *Phymatoceras* cf. *P. rude*, *Phymatoceras* cf. *P. erbaense*, *Denckmannia* cf. *D. tumefacta*, *Pseudomercaticeras* cf. *P. frantzi*, *Merlaites* cf. *M. alticarinatus*, *Mercaticeras* sp. indet. (Pl. 5, fig. 10, 11), *Peronoceras* cf. *P. moerickei*, *Polyplectus discoides*, and *Lytoceras siemensii*. Rare specimens of the nautiloid *Cenoceras* cf. *C. intermedius* have also been collected from this interval (Pl. 18, fig. 3, 4). The Hillebrandti Zone is represented by *Phymatoceras hillebrandti* (Pl. 14, fig. 1-6; Pl. 15, fig. 1, 2, 5-12; Pl. 16, fig. 7, 8), *Grammoceras thouarsense*, and *Podagrosites latescens*. The Phantom Creek Formation contains taxa from the Yakounensis Zone as well as the

Aalenian Stage. The Yakounensis Zone is represented by *Yakounia yakounensis*, *Y. silvae*, *Y. freboldi*, *Pleydellia maudensis*, *P. aalensis*, *P. crassiornata*, *Dumortieria* cf. *D. pusilla*, *Pseudolioceras compactile*, *Hammatoceras speciosum*, *H. insigne*, and *Sphaerocoeloceras brochiiforme* (see Pl. 9 and Pl. 17 for examples).

#### Section 8 - Central Graham Island

This section in Central Graham Island, originally measured and figured by Cameron and Tipper (1985, Section 14), was re-measured (Fig. 37, 42, 43). The upper part of the Whiteaves Formation is exposed in a section along a creek bank. The base of the section is not exposed but the top is overlain by the Phantom Creek Formation. The lowest collections have yielded *Merlaites* cf. *M. alticarinatus* and *Phymatoceras crassicoستا* from the Crassicoستا Zone. The upper part of the Whiteaves Formation contains *Phymatoceras hillebrandti* from the Hillebrandti Zone. Talus collections from the section have yielded *Podagrosites* sp. indet., *Polyplectus discoides*, and *Phymatoceras* cf. *P. pseudoerbaense* from the Crassicoستا and Hillebrandti zones.

#### Section 9 - Whiteaves Bay, Moresby Island

This section along Whiteaves Bay on Moresby Island, originally measured and figured by Cameron and Tipper (1985, Section 7), was remeasured (Fig. 37, 42, 44). The Fannin Formation and lower part of the Whiteaves Formation are exposed along the shore. The Fannin Formation is conformably underlain by the Ghost Creek Formation and the Whiteaves Formation is in fault contact with the Middle Jurassic Yakoun Group. The upper part of the Fannin Formation has yielded *Protogrammoceras?* sp. indet., *Tiltoniceras propinquum* (e.g., Pl. 4, fig. 12, 13), *Dactylioceras kanense*, *D. cf. D. alpestre*, *D. aff. D. comptum*, and *Taffertia taffertensis*. These taxa represent the lower part of the Kanense Zone. The Fannin Formation is conformably overlain by the Whiteaves Formation, the lower part of which is poorly exposed and has only yielded rare fossils. The upper part of the Whiteaves Formation exposed along the section has yielded *Dactylioceras* sp. indet., *Peronoceras* sp. indet., *Cleviceras* sp. indet., *Rarenodia planulata*, *Leukadiella* aff. *L. helenae*, and *Leukadiella ionica* (Pl. 6, fig. 1, 2, 7, 8) from the Planulata Zone. Talus collections from the Whiteaves Formation have also yielded *Leukadiella amuratica* (Pl. 6, fig. 5, 6) and *Phylloceras* cf. *P. heterophyllum* (Sowerby).

#### Isolated localities - Queen Charlotte Islands

In addition to the measured sections (described above), numerous ammonites have been collected from isolated localities throughout the Queen Charlotte Islands (Fig. 24; Isolated Loc. M-1 to M-6). Most of the taxa from these localities are represented in the measured sections and include *Dactylioceras* sp. indet. (Pl. 1, fig. 17, 18), *Cleviceras* cf. *C. exaratum*, *Cleviceras* sp. indet., *Harpoceras* cf. *H. subplanatum*, *Harpoceras* sp. indet., *Polyplectus discoides*, *Rarenodia planulata*, *Phymatoceras* cf. *P. pseudoerbaense*, *Denckmannia* cf. *D. tumefacta*, *Phymatoceras crassicoستا*, *Phymatoceras*

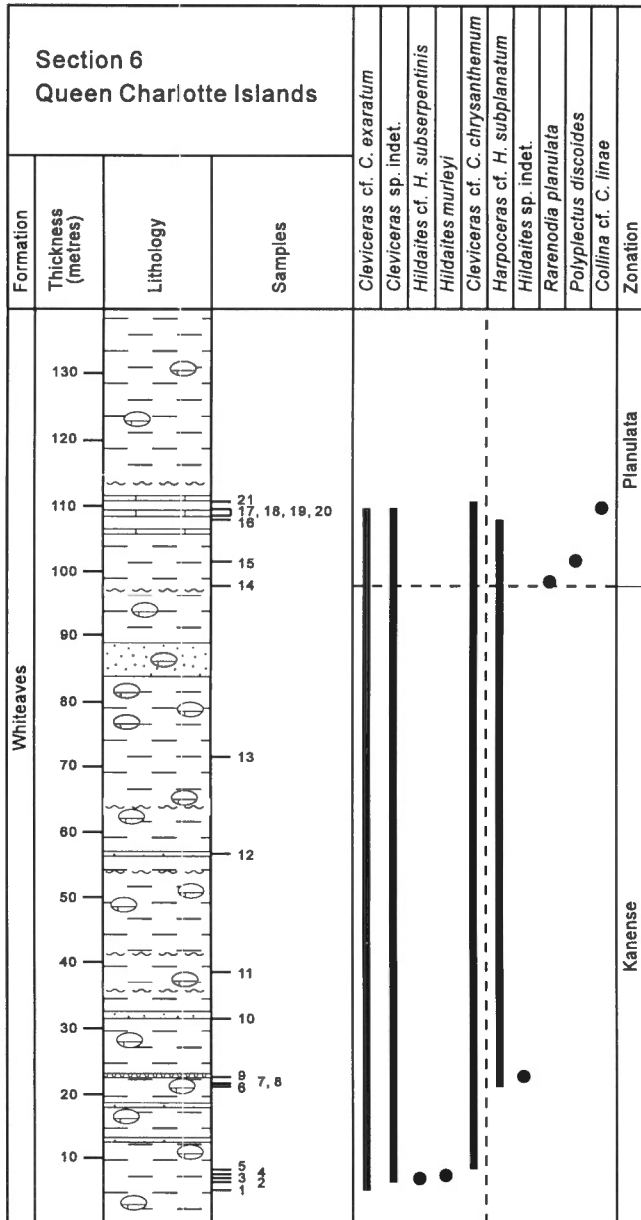


Figure 39. Lithostratigraphy and biostratigraphy of Section 6, central Graham Island, Queen Charlotte Islands. See Figure 37 for location of section and Figure 10 for lithological legend.







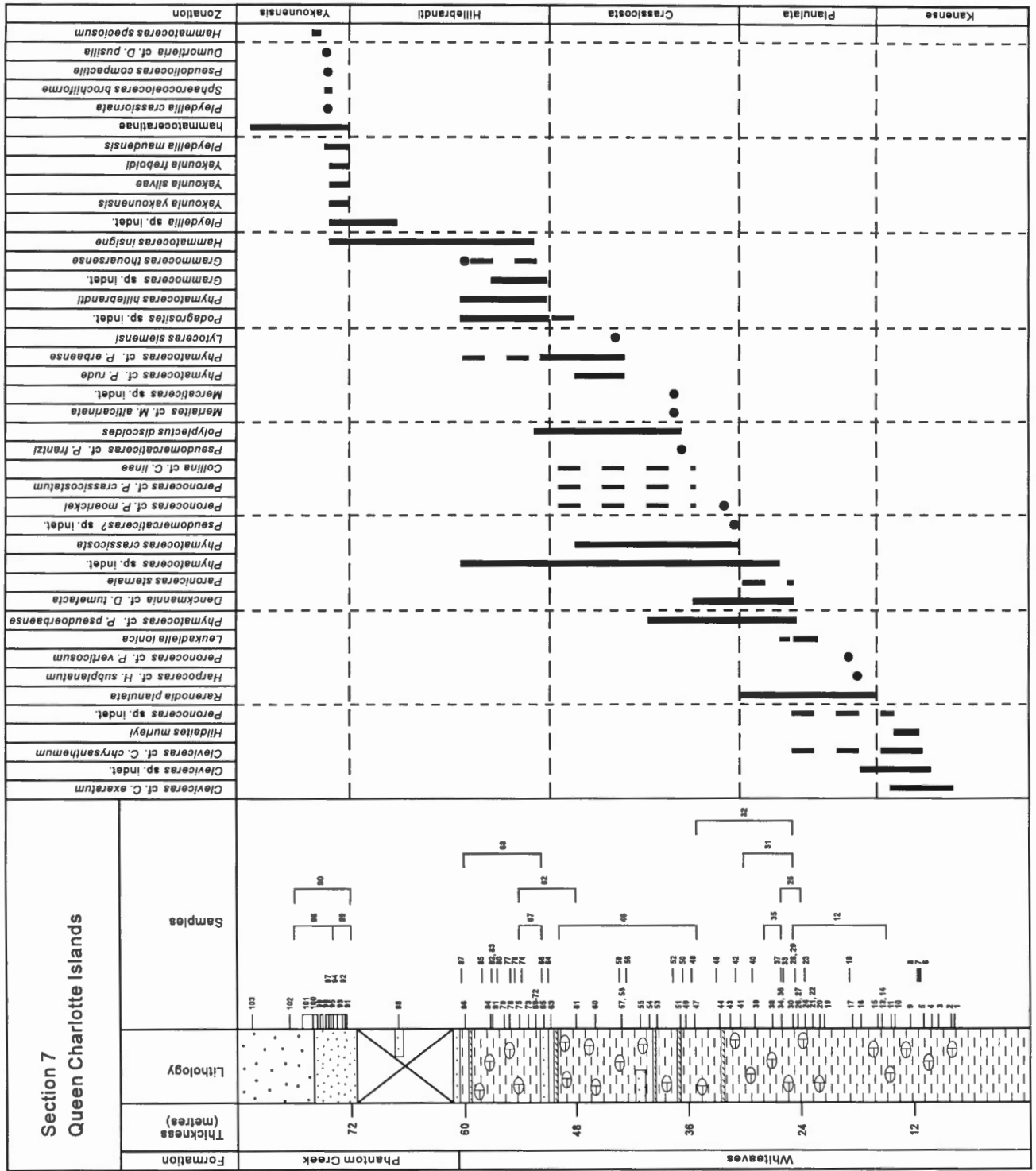


Figure 41. Lithostratigraphy and biostratigraphy of Section 7, central Graham Island, Queen Charlotte Islands. See Figure 37 for location of section and Figure 10 for lithological legend.

Stratigraphic section	Section 8														Section 9														Stratigraphic section				
Sample locality	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Sample locality	
<i>Phylloceras</i> cf. <i>P. heterophyllum</i>																																<i>Phylloceras</i> cf. <i>P. heterophyllum</i>	
<i>Dactylioceras kanense</i>																		●													●	<i>Dactylioceras kanense</i>	
<i>Dactylioceras</i> cf. <i>D. alpestre</i>																				●												<i>Dactylioceras</i> cf. <i>D. alpestre</i>	
<i>Dactylioceras</i> aff. <i>D. comptum</i>																		●	●													<i>Dactylioceras</i> aff. <i>D. comptum</i>	
<i>Dactylioceras</i> sp. indet.																								●								<i>Dactylioceras</i> sp. indet.	
<i>Peronoceras</i> sp. indet.																											●					<i>Peronoceras</i> sp. indet.	
dactyloceratids																																dactyloceratids	
<i>Protogrammoceras</i> sp. indet.															●	●	●	●	●											●	●	<i>Protogrammoceras</i> sp. indet.	
<i>Taffertia taffertensis</i>																															●	<i>Taffertia taffertensis</i>	
<i>Taffertia</i> sp. indet.																							●								●	<i>Taffertia</i> sp. indet.	
<i>Cleviceras</i> sp. indet.																												●			●	<i>Cleviceras</i> sp. indet.	
<i>Polyplectus discoides</i>														●																		<i>Polyplectus discoides</i>	
harpoceratids																		●				●	●								●	harpoceratids	
<i>Hildaites</i> sp. indet.														●																		<i>Hildaites</i> sp. indet.	
<i>Leukadiella ionica</i>																											●					●	<i>Leukadiella ionica</i>
<i>Leukadiella amuratica</i>																																●	<i>Leukadiella amuratica</i>
<i>Leukadiella</i> aff. <i>L. helena</i>																															●	<i>Leukadiella</i> aff. <i>L. helena</i>	
<i>Podagrosites</i> sp. indet.														●																		<i>Podagrosites</i> sp. indet.	
<i>Phymatoceras</i> cf. <i>P. pseudoerbaense</i>														●																		<i>Phymatoceras</i> cf. <i>P. pseudoerbaense</i>	
<i>Phymatoceras crassicoستا</i>				●																													<i>Phymatoceras crassicoستا</i>
<i>Phymatoceras hillebrandti</i>								●	●		●	●	●	●																			<i>Phymatoceras hillebrandti</i>
<i>Phymatoceras</i> sp. indet.					●	●				●		●																			●	●	<i>Phymatoceras</i> sp. indet.
<i>Rarenodia planulata</i>																										●	●					●	<i>Rarenodia planulata</i>
<i>Merlites</i> cf. <i>M. alticarinatus</i>	●	●	●																														<i>Merlites</i> cf. <i>M. alticarinatus</i>
phymatoceratids																																●	phymatoceratids
Zone	C	C	C	C	C	C	H	H	H	H	H	H	H	?	?	?	?	K	K	K	K	K	P	P	P	P	P	P	?	?	Zone		

Figure 42. Distribution of ammonite species at Toarcian localities in sections 8 and 9. Zone symbols are K – Kanense; P – Planulata; C – Crassicoستا; H – Hillebrandti. See also Figures 43 and 44.

cf. *P. rude*, *Phymatoceras* cf. *P. erbaense*, *Pseudomercaticeras* cf. *P. frantzi*, *Pseudomercaticeras* sp. indet. (Pl. 12, fig. 9, 10), *Mercaticeras* cf. *M. hellenicum*, *Mercaticeras* sp. indet., *Podagrosites latescens*, *Podagrosites* sp. indet., *Phymatoceras hillebrandti* (Pl. 15, fig. 3, 4), and *Phymatoceras* sp. indet.

## PALEOBIOGEOGRAPHIC AFFINITIES

The Toarcian ammonite fauna of western North America contains cosmopolitan, Tethyan, East Pacific, and Athabaskan (North American) taxa. The western North American fauna has affinities with those of South America and the Mediterranean region.

The Lower Toarcian of western North America contains an almost exclusively cosmopolitan fauna. Species of *Dactylioceras*, *Harpoceras*, *Cleviceras*, and *Hildaites* are most abundant, although rare specimens of the Tethyan genus *Taffertia* occur in the Queen Charlotte Islands. The Middle Toarcian fauna of western North America contains a significant number of Tethyan genera and is similar to that of the Mediterranean region (Italy, Greece, northern Africa). Species of the Tethyan genera *Leukadiella*, *Paroniceras*, *Rarenodia*, *Mercaticeras*, *Merlites*, and *Pseudomercaticeras* provide links between the two regions. Common northwest European genera such as *Hildoceras* and *Haugia* are not known from North America. The genus *Peronoceras* provides a link between the Middle Toarcian faunas of South America and western North America. The presence of numerous Tethyan taxa in western North America during the Middle Toarcian may represent a period of increased faunal exchange

between the Mediterranean and East Pacific regions. The Upper Toarcian of western North America contains several European genera such as *Phymatoceras*, *Grammoceras*, *Podagrosites*, *Hammatoceras*, *Pleydellia*, and *Dumortieria* but several of the species are endemic to western North America. In addition, western North America contains the East Pacific genus *Sphaerocoeloceras* and the Athabaskan genus *Yakounia*. This increase in endemism during the Late Toarcian may reflect decreased faunal interaction between the eastern Pacific and the Mediterranean region.

The fluctuations in abundance of Tethyan taxa in western North America during the Toarcian suggests the presence of a filter or a corridor between the two regions. Migration via an epicontinental seaway across what is now Central America, the Hispanic Corridor (Smith and Tipper, 1986), may have been governed by changes in sea level. Sea level rise during the Middle Toarcian (Hallam, 1988; Haq et al., 1988) may have facilitated the migration of taxa through the Hispanic Corridor whereas a drop in sea level during the Late Toarcian limited the migration of taxa. Cosmopolitan taxa such as *Harpoceras*, *Dactylioceras*, *Phymatoceras*, *Peronoceras*, *Dumortieria*, and *Pleydellia* may have been able to take advantage of other migration routes (Arctic or Trans-Pacific).

The low diversity Toarcian ammonite fauna of northern Alaska and the Canadian Arctic is composed almost exclusively of Boreal or cosmopolitan taxa. The fauna from these areas is very different from western North America but almost identical to that of Siberia and northeastern Asia. These faunal differences illustrate the presence of biogeographic distinctions in the Toarcian of western North America.

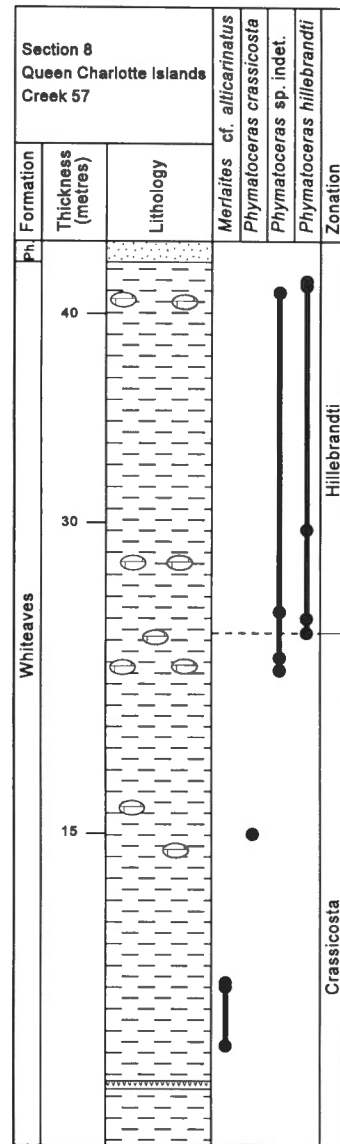
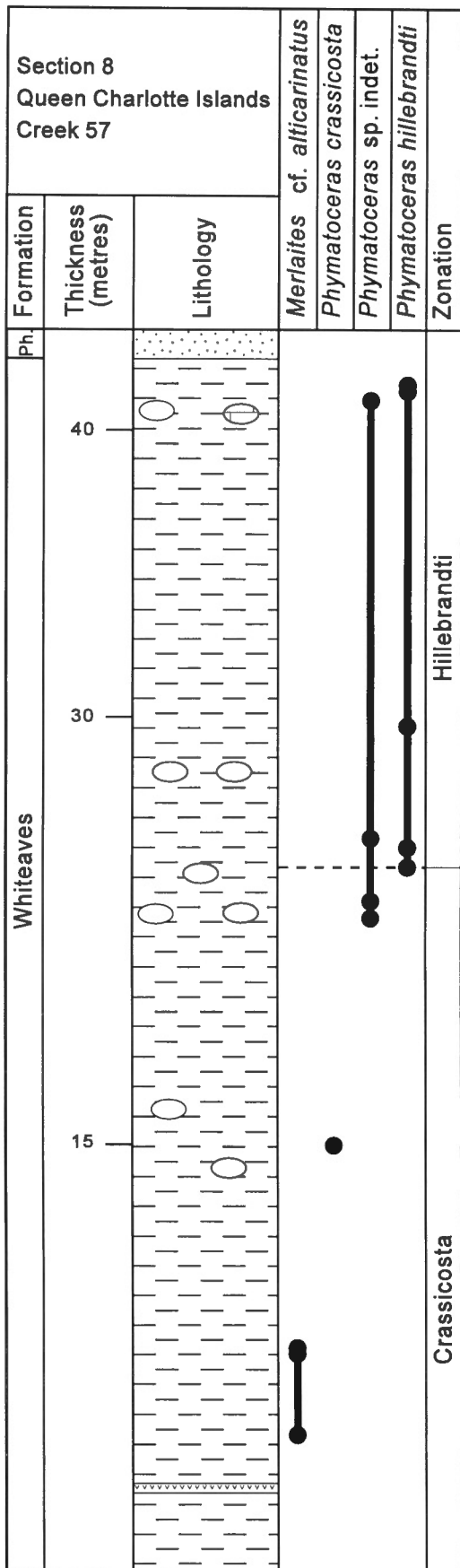


Figure 44. Lithostratigraphy and biostratigraphy of Section 9, Whiteaves Bay, Queen Charlotte Islands. See Figure 34 for location of section and Figure 10 for lithological legend. Pliens., Pliensbachian.

←  
Figure 43. Lithostratigraphy and biostratigraphy of Section 8, central Graham Island, Queen Charlotte Islands. See Figure 37 for location of section and Figure 10 for lithological legend. Ph – Phantom Creek Formation

# SYSTEMATIC PALEONTOLOGY

## Introduction

Ammonoids collected from the Queen Charlotte Islands during the course of this study were supplemented by existing GSC collections from other areas in British Columbia, Alberta, and Yukon Territory.

The classification of the Phylloceratina and Lytoceratina follows that of Arkell et al. (1957). The classification of the Ammonitina generally follows that of Donovan et al. (1981). The separation of *Denckmannia* and *Rarenodia* from *Phymatoceras* follows the usage of Gabilly (1976) and Venturi (1975a)

The mode of preservation of ammonite specimens is variable. In the Queen Charlotte Islands, some specimens are complete and well preserved in calcareous concretions, whereas other specimens are only preserved as body chamber fragments. In general, the preservation in the Queen Charlotte Islands is either three-dimensional or only slightly deformed. Specimens from the Spatsizi River map area are preserved as flattened impressions, body chamber fragments or, rarely, as complete, three-dimensional shells. Other areas in British Columbia such as the McConnell Creek, Hazelton, Taseko Lakes, Fernie, and Nelson map areas have poorly preserved, flattened specimens. In many cases specimens are too poorly or too incompletely preserved to identify to species level. The recommendations of Bengston (1988) are followed regarding the use of open nomenclature.

The morphological terminology used in the systematic descriptions follows that of Smith (1986). All morphological measurements are in millimetres. Sets of measurements made at different stages of ontogeny of the same specimen can be identified in the tables of measurements by having identical type numbers. Abbreviations used are as follows:

- \* = type material
- ~ = about
- D = shell diameter at which the following measurements were made
- UD = umbilical diameter
- U = UD/D x 100
- WH = whorl height
- WW = whorl width
- WWWH = WW/WH
- PRHW = primary ribs per half whorl

Sutures were drawn for several species (Jakobs et al., 1994; Jakobs and Smith, 1996), but complete sutures are not available, nor are ontogenetic series. Attempts to distinguish between sexual dimorphs were not successful despite the good preservation in some species. No apertural processes were seen, although some specimens do have approximated sutures.

## Systematic descriptions

Order AMMONOIDEA Zittel, 1884

Suborder PHYLLOCERATINA Arkell, 1950

Superfamily PHYLLOCERATACEAE Zittel, 1884

Family PHYLLOCERATIDAE Zittel, 1884

Subfamily PHYLLOCERATINAE Zittel, 1884

**Genus *Phylloceras* Suess, 1865**

*Synonyms.* See Arkell et al., 1957, p. L187; Schlegelmilch, 1976, p. 25.

*Type species.* *Ammonites heterophyllus* J. Sowerby, 1820, p. 119, Pl. 266, by original designation.

*Remarks.* Involute, compressed shell; high-oval whorl section. Umbilical wall gentle. Ornamentation composed of dense, fine, radial growth lines that are absent on internal mould. Septal sutures are tri- and commonly di-phyllic. *Zetoceras*, which Schlegelmilch (1976) considered a sub-genus of *Phylloceras*, has tetraphyllic sutures, but is otherwise similar to *Phylloceras* (*s.s.*).

*Age and distribution.* *Phylloceras* is found worldwide from the Lower Jurassic (Sinemurian) to the Lower Cretaceous (Valanginian) (Arkell et al., 1957).

*Phylloceras* cf. *P. heterophyllum* (Sowerby, 1820)

- \* cf. 1820 *Ammonites heterophyllus* J. SOWERBY, p. 119, Pl. 266.
- cf. 1885 *Ammonites heterophyllus posidoniae* QUENSTEDT, Pl. 45, fig. 1-7.
- cf. 1968 *Phylloceras heterophyllum* (Sowerby). LEHMANN, p. 44, 45, Pl. 20, fig. 3.
- cf. 1976 *Phylloceras (Phylloceras) heterophyllum* (Sowerby). SCHLEGELMILCH, p. 25, Pl. 1, fig. 1, 2.

*Description.* Involute shell; high-oval whorl section. Umbilical wall gentle; venter rounded. Ornamentation consists of fine radial growth lines. Septal sutures appear to be tri-phyllic.

*Discussion.* The complex septal sutures on the Queen Charlotte Islands specimen are typical of *Phylloceras* (*s.s.*). *Phylloceras supraliasicum* (Pompeckj) has flat constrictions and a slightly different whorl section than the Queen Charlotte Islands specimen.

*Occurrence.* *Phylloceras* cf. *P. heterophyllum* is represented in British Columbia by one talus specimen from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 9, Loc. 17). Its age is probably Middle Toarcian.

*Phylloceras heterophyllum* is commonly found in Europe from the Lower and Middle Toarcian: the Falciferum and Bifrons zones of southern Germany (Schlegelmilch, 1976), the Tenuicostatum Zone of northern Germany (Lehmann, 1968), the Falciferum Zone (Falciferum Subzone) of Austria (Fischer, 1966), and the Falciferum, Bifrons, and Variabilis zones of Great Britain (Howarth, 1962a, b).

*Phylloceras* sp. indet.

**Description.** Involute shell; shell smooth except for fine, radial growth lines. Septal sutures not visible.

**Discussion.** The ornamentation and evolution of the British Columbia specimens are typical of *Phylloceras*. Some of the specimens have faint undulations on the shell, probably due to secondary deformation during lithification. A specific identification is not possible due to the poor preservation.

**Occurrence.** *Phylloceras* sp. indet. is represented in British Columbia by poorly preserved whorl fragments from the Takwahoni Formation of the Tulsequah map area (Section 1, Loc. 4), from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 22), and from shales of the Last Creek formation in the Taseko Lakes map area (Isolated Loc. K-2 and K-3).

Suborder LYTOCERATINA Hyatt, 1889

Superfamily LYTOCERATAEAE Neumayr, 1875

Family LYTOCERATIDAE Neumayr, 1875

Subfamily LYTOCERATINAE Neumayr, 1875

**Genus** *Lytoceras* Suess, 1865

**Synonyms.** See Arkell et al., 1957, p. L194; Schlegelmilch, 1976, p. 28.

**Type species.** *Ammonites fimbriatus* J. Sowerby, 1817, p. 145, Pl. 164, subsequent designation in ICZN Opinion 130.

**Remarks.** Evolute to advolute shell; rounded to oval whorl section. Shell covered with fine ribs or irregular growth lines; some species have periodic constrictions or lamellar flares.

**Age and distribution.** *Lytoceras* is found worldwide from the Lower Jurassic (Sinemurian) to the Upper Cretaceous (Arkell et al., 1957).

*Lytoceras siemensii* (Denckmann, 1887)

Plate 1, figures 1, 2, 7, 8

- \* 1887 *Ammonites siemensii* DENCKMANN, Pl. 1, fig. 5, 8, 8a.
- 1968 *Lobolytoceras siemensii* (Denckmann). LEHMANN, p. 45, Pl. 19, fig. 1, 3.
- 1976 *Lytoceras siemensii* (Denckmann). SCHLEGELMILCH, p. 29, Pl. 3, fig. 4, Pl. 4, fig. 1.
- 1985 *Lytoceras siemensii* (Denckmann). RIEGRAF, Pl. 15, fig. 1.
- 1994 *Lytoceras siemensii* (Denckmann). JAKOBS et al., Pl. 3, fig. 18, 19.

Measurements.

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 107330	77.4	20.0	25.8	41.3	26.7	0.65	N82
GSC 107330	50.0	12.7	25.4	24.5	18.1	0.74	—
GSC 107330	36.9	10.2	27.6	17.6	N14.0	N0.80	—
GSC 108379	—	—	—	65.4	48.0	0.73	—
GSC 108428	—	—	—	97.1	68.1	0.70	—

**Description.** Evolute shell with minimal whorl overlap. High-oval whorl section; rounded venter. Ornamentation consists of fine ribs or growth lines, slightly rursiradiate near umbilical seam, and trending reticiradiately across flanks and venter. Constrictions may be present.

**Discussion.** The high-oval whorl section and minimal whorl overlap on the British Columbia specimens are characteristic of *Lytoceras siemensii*. Arkell et al. (1957) stated that *Ammonites siemensii* was the type species of *Lobolytoceras*, a genus now synonymized with *Lytoceras* (Schlegelmilch, 1976).

**Occurrence.** *Lytoceras siemensii* is best represented in North America by one well-preserved specimen and two whorl fragments from shales of the Last Creek formation in the Taseko Lakes map area (Isolated Loc. K-2). Two whorl fragments have also been collected from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 57 and 58). *Lytoceras siemensii* is associated with *Phymatoceras crassica* Merla and *P. cf. P. rude* (Simpson) from the Crassica Zone of the Middle Toarcian. Poorly preserved specimens of *Lytoceras* sp. indet. have been collected from the Manson River (Isolated Loc. J-10) and the Taseko Lakes (Isolated Loc. K-2) map areas.

*Lytoceras siemensii* is known from the Lower Toarcian of Europe. Lehmann (1968), Schlegelmilch (1976), and Riegraf (1985) mention its presence from the Lower Toarcian (Tenuicostatum Zone) of Germany.

Suborder AMMONITINA Hyatt, 1889

Superfamily EODEROCERATAE Spath, 1929

Family DACTYLIOCERATIDAE Hyatt, 1867

**Genus *Dactylioceras* Hyatt, 1867**

*Synonyms.* See Donovan et al., 1981, p. 139.

*Type species.* *Ammonites communis* J. Sowerby, 1815, p. 10, Pl. 107, fig. 2, 3, subsequent designation in ICZN Opinion 576, 1959.

*Remarks.* Evolute, planulate shell; compressed to depressed whorl section. Ribs commonly bifurcate at ventrolateral shoulder, but single ribs may also be present. Ribs may be annular or pass over the venter with a slight adoral arch. Small tubercles may be present at furcation points.

*Age and distribution.* *Dactylioceras* is found worldwide from the Lower and Middle Toarcian (Arkel et al., 1957).

*Dactylioceras* cf. *D. alpestre* Wiedenmayer, 1980

Plate 1, figures 3, 4

1980 *Dactylioceras* cf. *alpestre*  
WIEDENMAYER, p. 78, Pl. 27, fig. 8-11.

1994 *Dactylioceras* cf. *D. alpestre*  
Wiedenmayer. JAKOBS et al., Pl. 1,  
fig. 5, 6.

*Measurements.*

SPECIMEN	WH	WW	WWWH
GSC 107307	15.2	22.0	1.45

*Description.* Depressed whorl section. Umbilical wall short and gently inclined; convex flanks converge toward broad, rounded venter.

Ornamentation distant, composed of strong primary ribs that bifurcate at ventrolateral shoulder. Secondary ribs cross venter transversely; ribs are denser on inner whorls than on outer whorls.

*Discussion.* *Dactylioceras* cf. *D. alpestre*, figured by Wiedenmayer (1980), has a slightly higher whorl section (WWWH N1.18) than the North American specimen. Poor preservation of the Queen Charlotte Islands specimen prevents a more confident identification. The depressed whorl section of the Queen Charlotte Islands specimen distinguishes it from co-occurring species such as *D. kanense* McLearn.

*Occurrence.* *Dactylioceras* cf. *D. alpestre* is represented in North America by a single specimen from sandstones of the Fannin Formation in the Queen Charlotte Islands

(Section 9, Loc. 6). It is associated with *Dactylioceras kanense* and *D. aff. D. comptum* from the Kanense Zone of the Lower Toarcian.

*Dactylioceras alpestre* is known from the Lower Toarcian (Tenuicostatum Zone) of Italy (Wiedenmayer, 1980).

*Dactylioceras* aff. *D. comptum* (Dagys, 1968)

Plate 1, figures 5, 6

- \*aff. 1968 *Kedonoceras comptum* DAGYS, p. 59,  
Pl. 11, fig. 4.  
1994 *Dactylioceras* aff. *D. comptum* (Dagys).  
JAKOBS et al., Pl. 1, fig. 7, 8.

*Measurements.*

SPECIMEN	WH	WW	WWWH
GSC 107308	10.7	21.5	2.01
GSC 107308	11.3	22.8	2.02

*Description.* Evolute shell; depressed whorl section. Convex flanks converge toward umbilicus; venter plain and rounded.

Primary ribs begin at umbilical shoulder and trend recti-radiately up flanks. Primary ribs commonly bifurcate at subdued ventrolateral tubercles. Approximately every third or fourth primary rib remains single. Secondary ribs trend transversely across venter. On innermost whorls, primary ribs divide into two or three, slightly prorsiradiate secondary ribs separated by rare single ribs.

*Discussion.* *Dactylioceras* aff. *D. comptum* occurs with the compressed *Dactylioceras kanense* in the Queen Charlotte Islands. Howarth (1973, 1978) suggested that compressed and depressed specimens of *Dactylioceras*, collected from the same beds in England, could be more closely related to each other than to other compressed or depressed taxa from different beds. Such a comparison is not possible for the North American specimens of *Dactylioceras*, as they are rare and generally poorly preserved. *Dactylioceras compactum* (Dagys) from Siberia has a more depressed whorl section than the North American specimens and a different furcation pattern (Dagys, 1968). *Dactylioceras asperum* (Dagys) has prorsiradiate primary ribs (Dagys, 1968). Specimens of *Dactylioceras comptum* from Siberia (Dagys, 1968) are similar but generally have more strongly prorsiradiate secondary ribs than the North American specimens.

*Occurrence.* *Dactylioceras* aff. *D. comptum* is represented in North America by four fragments from sandstones of the Fannin Formation in the Queen Charlotte Islands (Section 9, Loc. 4 and 5). It is associated with *Dactylioceras kanense* and *Protogrammoceras* sp. indet. from the Kanense Zone of the Lower Toarcian.



*Dactylioceras comptum* is known from the Lower Toarcian (Propinquum Zone) of Siberia (Dagys, 1968; Kalacheva, 1988).

*Dactylioceras kanense* McLearn, 1930

Plate 1, figures 9-12, 19, 20

- \* 1930 *Dactylioceras kanense* MCLEARN, p. 4, Pl. 1, fig. 2.
- 1932 *Dactylioceras kanense* McLearn. MCLEARN, p. 59-62, Pl. 3, fig. 5, Pl. 4, fig. 1-7, 9, Pl. 5, fig. 6-9 [holotype figured].
- 1932 *Dactylioceras* cf. *D. kanense* McLearn. MCLEARN, p. 62, Pl. 5, fig. 11.
- 1955 *Dactylioceras* cf. *D. kanense* (McLearn). IMLAY, p. 88, Pl. 10, fig. 14.
- 1968 *Dactylioceras kanense* McLearn. DAGYS, p. 33, Pl. 4, fig. 7, 8.
- 1968 *Dactylioceras (Orthodactylites) kanense* McLearn. IMLAY, Pl. 3, fig. 12 [holotype refigured].
- non 1968 *Dactylioceras (Orthodactylites) cf. D. (O.) kanense* McLearn. IMLAY, p. C30, Pl. 3, fig. 11.
- 1991 *Dactylioceras kanense* McLearn. TIPPER et al., Pl. 5, fig. 4 [holotype refigured].
- 1992 *Dactylioceras kanense* McLearn. HILLEBRANDT and SMITH, Pl. 4, fig. 3 [holotype refigured].
- 1994 *Dactylioceras kanense* McLearn. JAKOBS et al., Pl. 1, fig. 9-14 [McLearn's types refigured].
- 1995 *Dactylioceras kanense* McLearn. JAKOBS et al., Pl. 1, fig. 1 [McLearn's types refigured].

Measurements.

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 6484	18.9	9.2	48.7	6.2	5.4	0.87	23
GSC 6485	15.8	8.8	55.7	4.6	4.2	0.91	23
GSC 6486	12.0	6.4	53.3	3.3	2.6	0.79	17
GSC 6487	10.5	5.5	52.4	3.0	2.8	0.93	-
GSC 6488	-	-	-	12.0	9.0	0.75	-
GSC 9051	26.8	13.2	49.3	7.9	-	-	39
GSC 108429	22.1	10.7	48.4	7.0	-	-	-

*Description.* Evolute shell; ovigal to high-ellipsoidal whorl section. Umbilical and ventrolateral shoulders gently rounded. Venter high, convex, and sharp.

Ribbing regular. Ribs strongly prorsiradiate and projected along venter. On inner whorls, primary ribs bifurcate on upper flank, whereas on outer whorls ribs bifurcate on upper or middle flank. Some ribs remain single.

*Discussion.* The bifurcation of ribs at different levels along the flanks distinguishes *Dactylioceras kanense* from other species of *Dactylioceras* that have a similar whorl section, such as *Dactylioceras helianthoides* Yokoyama from Japan (Hirano, 1971).

*Occurrence.* *Dactylioceras kanense* is best represented in British Columbia by thirty moderately well-preserved specimens from calcareous sandstones of the Fannin Formation in the Queen Charlotte Islands (Section 9, Loc. 4 and 16). It has been collected in the Hazelton map area (Isolated Loc. G-8), the Nechako map area (Isolated Loc. H-1), and southern Alaska (Isolated Loc. N-1). It is associated with *Dactylioceras* aff. *D. comptum*, *Tiltoniceras* sp. indet. and *Protogrammoceras* sp. indet. from the Kanense Zone of the Lower Toarcian. *Dactylioceras* cf. *D. kanense* has been collected from the Spatsizi River map area (Isolated Loc. E-1 and E-2).

In northeastern Asia *Dactylioceras kanense* is known from the Athleticum Zone of the Middle Toarcian (Dagys, 1968). In western North American, the co-occurrence of *Dactylioceras kanense* and *Tiltoniceras* sp. indet., and their stratigraphic position below *Cleviceras*, *Hildaites*, and *Peronoceras*, is evidence of its older age.

*Dactylioceras* cf. *D. commune* (Sowerby, 1815)

Plate 1, figures 13, 14, 21, 22

- \* cf. 1815 *Ammonites communis* J. SOWERBY, p. 10, Pl. 107, fig. 2, 3.
- 1955 *Dactylioceras* cf. *D. crassiusculosum* (Simpson). IMLAY, p. 88, Pl. 10, fig. 9, Pl. 11, fig. 16-18.
- 1955 *Dactylioceras* cf. *D. commune* (Sowerby). IMLAY, p. 88, Pl. 10, fig. 10-12, Pl. 11, fig. 4-6.
- 1955 *Dactylioceras* cf. *D. directum* (Buckman). IMLAY, p. 88, Pl. 11, fig. 7-11, 14.
- 1955 *Dactylioceras* cf. *D. delicatum* (Bean-Simpson). IMLAY, p. 88, Pl. 10, fig. 15, 16.
- 1957a *Dactylioceras commune* (Sowerby). FREBOLD, p. 2, 3, Pl. 1, fig. 1-7.
- cf. 1966 *Dactylioceras commune* (Sowerby). FISCHER, p. 30, 31, Pl. 3, fig. 10.
- cf. 1968 *Dactylioceras commune* (Sowerby). DAGYS, p. 26-30, Pl. 2, fig. 1-7.
- cf. 1976 *Dactylioceras commune* (Sowerby). SCHLEGELMILCH, p. 77, Pl. 38, fig. 7.
- 1994 *Dactylioceras* cf. *D. commune* (Sowerby). JAKOBS et al., Pl. 2, fig. 11, 12, 15, 16.

*Description.* Evolute shell; oval to rounded whorl section. Umbilical wall moderately steep; rounded umbilical shoulder. Flanks flattened to slightly convex. Venter convex and rounded.

Primary ribs strong and distant, rectiradiate to gently prorsiradiate. Ribs commonly bifurcate at ventrolateral shoulder into weaker secondary ribs that cross venter with gentle to moderately strong adoral arch. Slight swellings may be present at bifurcation points. Single ribs rare.

*Discussion.* *Dactylioceras amplum* Dagys from Siberia is generally more involute and has a more depressed whorl section than the Spatsizi specimens. *Dactylioceras circumactum* Dagys from Siberia has a higher proportion of single ribs, although its whorl section is similar to that of the Spatsizi specimens. *Dactylioceras commune* and *D. athleticum* (Simpson), common in Europe and the Arctic, are both similar to the Spatsizi specimens. In general, *D. commune* has more quadrate whorls and sparser, more rectiradiate ribbing than the Spatsizi specimens. Arctic specimens referred to *D. commune* (Friebold, 1957a; Dagys, 1968) differ from the Spatsizi specimens by having prorsiradiate primary ribs and adorally arched secondary ribs. The specimens from the Spatsizi River map area have a high whorl section, similar to *D. athleticum*, but are too incompletely and poorly preserved to be confidently identified. The Spatsizi specimens may be transitional between *D. commune* and *D. athleticum*. Howarth (in Lehmann, 1968, p. 50) felt that *D. athleticum* could be a subspecies of *D. commune*, even though *D. athleticum* occurs stratigraphically above *D. commune* in Yorkshire. The Spatsizi specimens combine characteristics from both these species and this may be a result of intra-specific variability. Similar specimens from the southern Canadian Rocky Mountains (Hall, 1987) have denser ribbing on the outer whorls than the Spatsizi specimens and are probably more closely related to *D. athleticum*, as suggested by Hall (1987).

*Occurrence.* *Dactylioceras* cf. *D. commune* is best represented in British Columbia by forty poorly preserved whorl fragments from arenaceous limestone of the Spatsizi Formation in the Spatsizi River map area (Isolated Loc. E-1). The exact stratigraphic position of the collection is unknown, but it is probably upper Lower or lower Middle Toarcian. *Dactylioceras* cf. *D. commune* has also been collected from the Cry Lake map area (Isolated Loc. C-3), the Taseko Lakes map area (Isolated Loc. K-2), western Alberta (Isolated Loc. I-8), and southern Alaska (Isolated Loc. N-1 and N-2). Similar forms are known from the Lower and Middle Toarcian of the Canadian Arctic (Friebold, 1957a, 1960, 1964b, 1975), northern Alaska (Imlay, 1955) and the southern Canadian Rocky Mountains (Hall, 1987).

*Dactylioceras commune* is known from the Middle Toarcian (Bifrons Zone -Commune Subzone) of northwestern Europe (Howarth, 1962b) and from the Middle Toarcian (Athleticum Zone) of Siberia (Dagys, 1968; Kalacheva, 1988).

## Genus *Peronoceras* Hyatt, 1867

*Synonyms.* See Arkell et al., 1957, p. 253.

*Type species.* *Ammonites fibulatus* J. de C. Sowerby, 1823, p. 147, Pl. 407, fig. 2, subsequent designation by Buckman, 1911.

*Remarks.* Evolute, discoidal shell. Whorl section weakly to strongly rounded, rectangular to roughly quadrate; flanks generally flat. Ornamentation strong. Ribbing generally fibulate but single ribs also present. Two to three secondary ribs arise from tubercles at ventrolateral shoulder.

*Age and distribution.* *Peronoceras* is found worldwide from the Middle Toarcian. In England and Germany *Peronoceras* is confined to the Fibulatum and Braunianus subzones of the Bifrons Zone (Middle Toarcian) (Schlegelmilch, 1976; Howarth, 1978, 1992a). In southern France, Spain, Italy, and Hungary it is known from the Bifrons Zone (Donovan, 1958; Mouterde et al., 1965; Guex, 1972; Géczy, 1984; Goy and Martínez, 1990; Elmi and Rulleau, 1991). In Austria it has been collected from the Bifrons and Variabilis zones (Fischer, 1966). In the Canadian Arctic and northeastern Asia, *Peronoceras* is restricted to the Polare Zone of the Middle Toarcian (Friebold, 1957a, 1960, 1964b, 1975; Dagys, 1968; Kalacheva, 1988). In South America *Peronoceras* is known from the the Largaense, Pacificum, and Chilensis zones of the Middle Toarcian (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

### *Peronoceras verticosum* (Buckman, 1914)

Plate 2, figures 5, 6, 9, 10

- |   |      |  |
|---|------|--|
| * | 1914 | <i>Porpoceras verticosum</i> BUCKMAN, Pl. 91.  |
|   | 1966 | <i>Peronoceras verticosum</i> (Buckman). FISCHER, p. 42, Pl. 2, fig. 1, Pl. 6, fig. 4.                               |
|   | 1972 | <i>Porpoceras verticosum</i> Buckman. GUEX, Pl. 8, fig. 15.  |
|   | 1981 | <i>Peronoceras</i> cf. <i>P. verticosum</i> (Buckman). HILLEBRANDT and SCHMIDT-EFFING, p. 53, 54, Pl. 5, fig. 5.     |
|   | 1981 | <i>Peronoceras</i> sp. cf. <i>P. cf. verticosum</i> (Buckman). HILLEBRANDT and SCHMIDT-EFFING, p. 54, Pl. 5, fig. 6. |
|   | 1981 | <i>Peronoceras</i> sp. ex. gr. <i>P. cf. verticosum</i> (Buckman). HILLEBRANDT and SCHMIDT-EFFING, Pl. 5, fig. 3.    |
| ? | 1987 | <i>Peronoceras</i> cf. <i>verticosum</i> (Buckman). HILLEBRANDT, Pl. 6, fig. 2, 3.                                   |
|   | 1994 | <i>Peronoceras verticosum</i> (Buckman). JAKOBS et al., Pl. 2, fig. 1, 2.  |

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 107313	54.0	30.4	56.3	12.8	—	—	35
GSC 107313	49.0	27.4	55.9	12.2	14.5	1.19	28
GSC 108384	—	—	—	14.4	13.5	0.94	—
GSC 108430	35.2	16.7	47.4	10.6	—	—	—
GSC 108430	30.4	15.4	50.7	—	—	—	—
GSC 108431	—	—	—	8.2	11.0	1.34	—

*Description.* Evolute shell; rounded-quadrate to subquadrate whorl section. Umbilical wall moderately steep. Flanks flattened to slightly convex; venter slightly convex. Whorl section more depressed and flanks more convex on inner whorls.

Primary ribs trend rectiradiately up flanks; ribs generally fibulate on outer whorls, less commonly on inner whorls. Fibulate pairs terminate in ventrolateral tubercles, separated by two or three single ribs. Single ribs may remain undivided or may bifurcate at ventrolateral shoulder. Ventrolateral tubercles give rise to two to four secondary ribs which cross venter with a slight adoral arch. Occasionally three primary ribs may join at a tubercle, giving rise to four secondary ribs. Ribs sharp and dense on inner whorls, becoming more distant on outer whorls.

*Discussion.* The western North American specimens show some variability in whorl section and ribbing pattern and are part of the *vorticellum-verticosum-vortex* group. *P. vorticellum* (Simpson) generally has denser, weaker ribs and weaker tubercles than the North American specimens whereas *Peronoceras vortex* (Simpson) has more depressed whorls. Howarth (1978) suggested that sufficiently large collections of *Peronoceras* might show that the differences between *P. vorticellum*, *P. verticosum*, and *P. vortex* are simply intra-specific variability.

*Occurrence.* *Peronoceras verticosum* is best represented in North America by thirty fragments from calcareous concretions of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 2, 14; Section 3, Loc. 6). Poorly preserved fragments of *Peronoceras* cf. *P. verticosum* have been collected in the Queen Charlotte Islands (Section 7, Loc. 17, 18), the Carmacks map area (Isolated Loc. A-3), the Cry Lake map area (Isolated Loc. C-2), the Spatsizi map area (Section 2, Loc. 14), and the southern Canadian Rocky Mountains (Isolated Loc. I-3). *Peronoceras verticosum* and *Peronoceras* cf. *P. verticosum* are associated with *Peronoceras pacificum* Hillebrandt, *Leukadiella* aff. *L. ionica* Renz & Renz, *Denckmannia* cf. *D. tumefacta* (Buckman), and *Rarenodia planulata* Venturi from the Planulata Zone of the Middle Toarcian.

*Peronoceras verticosum* is known from the Middle Toarcian (Bifrons Zone) of Europe: the Fibulatum and Braunianus subzones of Great Britain (Howarth, 1962b, 1992a), the Bifrons Subzone of France (Guex, 1972), and the Braunianus

Subzone of Austria (Fischer, 1966). In South America it is known from the Middle Toarcian (Pacificum Zone) (Hillebrandt, 1987).

*Peronoceras spinatum* (Friebold, 1957a)

Plate 2, figures 12, 13

- \* 1957a *Coeloceras spinatum* FRIEBOLD, p. 3, 4, Pl. 2, fig. 1-4.
- 1964b *Catacoeloceras spinatum* (Friebold). FRIEBOLD, Pl. 7, fig. 8.
- 1968 *Porpoceras polare* (Friebold). DAGYS, p. 66-68, Pl. 12, fig. 3-6 [non Pl. 12, fig. 1, 2, 7].
- 1968 *Peronoceras spinatum* (Friebold). EFIMOVA et al., p. 113, Pl. 50, fig. 1, 2.
- 1975 *Peronoceras spinatum* (Friebold). FRIEBOLD, p. 13, 14, Pl. 5, fig. 1.
- 1987 *Peronoceras spinatum* (Friebold). HILLEBRANDT, Pl. 6, fig. 7, 8.
- 1994 *Peronoceras spinatum* (Friebold). JAKOBS et al., Pl. 2, fig. 3, 4.

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 107314	18.4	9.1	49.5	5.4	9.5	1.76	18

*Description.* Evolute, depressed shell; wide-oval whorl section. Moderately steep umbilical wall; convex flanks converge toward umbilicus. Venter gently rounded; prominent ventrolateral shoulder.

Ornamentation consists of distant primary ribs and dense, fine, secondary ribs. No fibulation visible, probably due to small size of specimens. Approximately every third primary rib has a tubercle from which three to four secondary ribs cross venter with a slight adoral arch. Single ribs occur between tuberculate ribs and commonly bifurcate, but may cross venter singly.

*Discussion.* The Spatsizi specimens are most similar to *Peronoceras spinatum* described from the Canadian Arctic (Friebold, 1957a, 1964b, 1975). The depressed whorl section and trifurcate primary ribs distinguish the Spatsizi specimens from other *Peronoceras*. Dagys (1968) synonymized *P. spinatum* with *P. polare* (Friebold), but Friebold (1975) maintained that they were separate species. *Peronoceras spinatum* differs from *P. polare* by having more numerous fibulate ribs and finer secondary ribs that cross the venter transversely rather than with an adoral arch.

*Occurrence.* *Peronoceras spinatum* is represented in British Columbia by six specimens from calcareous concretions of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 2). It is associated with

*Leukadiella* aff. *L. ionica*, *Peronoceras verticosum* and *Peronoceras pacificum* from the Planulata Zone of the Middle Toarcian.

*Peronoceras spinatum* is known from the Middle Toarcian (Chilensis Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987), the Middle Toarcian (Polare Zone) of Siberia (Dagys, 1968; Kalacheva, 1988), and the Middle Toarcian of the Canadian Arctic (Friebold, 1957a, 1964b, 1975).

*Peronoceras pacificum* Hillebrandt, 1981

Plate 2, figures 14, 15

- \* 1981 *Peronoceras pacificum* HILLEBRANDT and SCHMIDT-EFFING, p. 51-53, Pl. 4, fig. 9, 11-16, Pl. 5, fig. 1, 2.  
 1987 *Peronoceras pacificum* Hillebrandt. HILLEBRANDT, Pl. 6, fig. 4.  
 1994 *Peronoceras pacificum* Hillebrandt. JAKOBS et al., Pl. 2, fig. 5, 6.

Measurements.

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 107315	29.0	16.3	56.2	7.1	N6.7	N0.94	N32
GSC 107315	27.0	15.0	55.6	6.8	6.8	1.0	c27
GSC 108432	32.1	17.2	53.6	8.3	8.4	1.01	c28
GSC 108433	28.5	15.0	52.6	7.4	8.2	1.11	c28

**Description.** Evolute, discoidal shell; quadrate to subquadrate whorl section. Rounded umbilical shoulder; umbilical wall moderately steep. Flanks flattened to gently convex. Ventrolateral shoulder rounded; venter narrow and slightly convex.

Primary ribs rectiradiate to slightly prorsiradiate. Approximately every second primary rib terminates in a ventrolateral spine on inner whorls. Two to three secondary ribs arise from each tubercle and cross venter with gentle adoral arch. Single ribs occur between tuberculate ribs and generally cross venter undivided. Secondary ribs may form zigzag pattern on venter. Single ribs generally more common on outer whorl.

**Discussion.** *Peronoceras pacificum* belongs to the *vorticellum-verticosum-vortex* group (Hillebrandt and Schmidt-Effing, 1981). *Peronoceras vorticellum* has a similar zigzag ribbing pattern across the venter but has a more depressed whorl section ( $WWWH \approx 1.28$ ) than *P. pacificum*. The Spatsizi specimens are similar to *Peronoceras pacificum* but tend to have denser ribs and a more pervasive zigzag pattern on the venter.

**Occurrence.** *Peronoceras pacificum* is represented in North America by a dozen specimens from calcareous concretions of the Wolf Den Member (Spatsizi Formation) in the Spatsizi

River map area (Section 2, Loc. 2, 14). *Peronoceras pacificum* is associated with *P. verticosum*, *P. spinatum*, *Denckmannia* cf. *D. tumefacta*, and *Leukadiella* aff. *L. ionica* from the Planulata Zone of the Middle Toarcian.

*Peronoceras pacificum* is known from the Middle Toarcian (Pacificum Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

*Peronoceras* cf. *P. crassicostratum* (Guex, 1972)

Plate 2, figures 3, 4

- cf. 1931 *Coeloceras* (*Peronoceras*) *millavense* var. *acanthopsis* (d'Orbigny). MONESTIER, p. 40, Pl. 1, fig. 28.  
 cf. 1931 *Coeloceras* (*Porpoceras*) *desplacei* (d'Orbigny). MONESTIER, p. 47, 48, Pl. 3, fig. 5.  
 \*cf. 1972 *Porpoceras crassicostratum* GUEX, p. 633, Pl. 8, fig. 11, 17, Pl. 12, fig. 9.  
 cf. 1981 *Peronoceras* cf. *crassicostratum* (Guex). HILLEBRANDT and SCHMIDT-EFFING, p. 61, 62, Pl. 8, fig. 2.  
 1994 *Peronoceras* cf. *crassicostratum* (Guex). JAKOBS et al., Pl. 3, fig. 10, 11.

Measurements.

SPECIMEN	WH	WW	WWWH
GSC 107324	16.0	25.6	1.6

**Description.** Moderately evolute shell; depressed whorl section. Umbilical wall steep; umbilical shoulder rounded but abrupt. Gently convex flanks converge toward umbilicus. Ventrolateral shoulder rounded; venter wide and convex.

Ribbing prominent and rectiradiate. Fibulate ribs spaced irregularly but are most common at adapical end of body chamber. Fibulate ribs terminate in prominent ventrolateral tubercles that give rise to three or four secondary ribs. Single ribs present between fibulate pairs and may cross the venter undivided or, more commonly, terminate at ventrolateral tubercles that give rise to two or three secondary ribs. Secondary ribs cross venter transversely or with slight adoral arch.

**Discussion.** The incomplete nature of the single specimen available makes identification difficult, even at the generic level. *Nodicoeloceras* is distinguished from *Peronoceras* by ontogenetic changes in ornamentation (Guex, 1972). *Nodicoeloceras crateriforme* (Monestier) is similar to the Queen Charlotte Islands specimen but Guex (1972) states that tuberculation is absent on the body chamber of *N. crateriforme* thus distinguishing it from the Queen Charlotte Islands specimen. *Peronoceras desplacei* (d'Orbigny) has a more inflated whorl section and is less compressed than the Queen Charlotte Islands specimen whereas *Peronoceras pseudodesplacei* (Guex) has

a more quadrate whorl section. *Peronoceras acanthopsis* (d'Orbigny), as described by Fischer (1966), has a similar ornamentation and whorl section to the Queen Charlotte Islands specimen, however its outer whorls tend to have flatter flanks that approach the venter at more or less right angles. The Queen Charlotte Islands specimen, which is larger than Fischer's specimens, has flanks that converge toward the umbilicus. *Peronoceras choffati* (Renz) is similar but is Early Toarcian in age whereas the Queen Charlotte Islands specimen appears in the late Middle Toarcian. *Peronoceras crassicostatum* is most similar to the Queen Charlotte Islands specimen but is slightly more compressed and more regularly fibulate.

**Occurrence.** *Peronoceras* cf. *P. crassicostatum* is represented in North America by a single, deformed body chamber fragment collected as talus from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 46). It is associated with *Collina* cf. *C. linae* Parisch & Viale and *Peronoceras* cf. *P. moerickei* Hillebrandt, probably from the Middle Toarcian (Crassicosta Zone).

*Peronoceras crassicostatum* is known from the Middle Toarcian (Bifrons Zone) of France (Guex, 1972) and *Peronoceras* cf. *crassicostatum* is known from the Middle Toarcian (Chilensis Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

*Peronoceras* aff. *P. desplacei* (d'Orbigny, 1844)

Plate 3, figures 3, 4

- \*aff. 1844 *Ammonites desplacei* D'ORBIGNY, p. 334, Pl. 107, fig. 1-4.
- aff. 1874 *Ammonites desplacei* d'Orbigny. DUMORTIER, p. 102, Pl. 27, fig. 4.

**Measurements.**

SPECIMEN	WH	WW	WWWH
GSC 108385	20.2	22.2	1.10

**Description.** Subquadrate whorl section; rounded umbilical shoulder. Convex flanks converge toward rounded venter; no prominent ventrolateral shoulder.

Ornamentation strong and distant. Three primary ribs join at coarse ventrolateral tubercles. Three secondary ribs arise from tubercles and cross venter transversely. Two to three single ribs separate fibulate pairs and may bifurcate at ventrolateral shoulder or remain single.

**Discussion.** The Spatsizi specimens are similar to the densely ribbed *P. moerickei* and *P. bolitoense* Hillebrandt of South America. *Peronoceras bolitoense* has denser ribbing than the Spatsizi specimens and both *P. moerickei* and *P. bolitoense* lack the strong tubercles of the Spatsizi specimens and only have two ribs joining at ventrolateral tubercles. The Spatsizi

specimens are similar to *P. desplacei* in terms of ribbing density and strength, but *P. desplacei* generally has a more depressed whorl section (WWWH = 1.52) and swollen flanks. *Peronoceras desplacei* is characterized by pairs of ribs that join at ventrolateral tubercles and give rise to three secondary ribs. A single rib between fibulate pairs bifurcates at the ventrolateral shoulder. The Spatsizi specimens have three primary ribs that join at strong tubercles separated by two to three single ribs. The incomplete nature of the two Spatsizi specimens does not allow a new species designation.

**Occurrence.** *Peronoceras* aff. *P. desplacei* is represented in North America by two whorl fragments collected as talus from siltstones and calcareous concretions of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 3). It is probably Middle Toarcian (Planulata Zone).

*Peronoceras desplacei* is common from the Middle Toarcian of Europe: the Bifrons Zone (Bifrons Subzone) of Spain (Goy and Martínez, 1990), the Bifrons Zone of southern Germany (Schlegelmilch, 1976), and the Bifrons Zone (Fibulatum Subzone) of Austria (Fischer, 1966). *Peronoceras* cf. *desplacei* is known from the Middle Toarcian (Largaense Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

*Peronoceras* cf. *P. moerickei* Hillebrandt, 1981

Plate 2, figures 1, 2

- \*cf. 1981 *Peronoceras moerickei* HILLEBRANDT and SCHMIDT-EFFING, p. 59-61, Pl. 7, fig. 1, 2.

**Measurements.**

SPECIMEN	WH	WW	WWWH
GSC 108382	30.5	33.2	1.09
GSC 108382	26.7	29.2	1.09
GSC 108434	24.0	29.5	1.23

**Description.** Evolute shell; subquadrate to rounded whorl section. Umbilical wall vertical; umbilical shoulder rounded and abrupt. Flanks flattened to slightly convex. Ventrolateral shoulder rounded; venter plain and rounded.

Rectiradiate primary ribs join in pairs at ventrolateral tubercles. Two to four secondary ribs arise from tubercles and cross venter transversely. Three to four single ribs separate fibulate pairs and cross venter undivided. A zigzag pattern is present on venter where fibulate rib pairs are not symmetrical.

**Discussion.** *Peronoceras bolitoense* has denser ribs than the North American specimens whereas *Peronoceras vortex* and *P. verticosum* have more depressed whorl sections. *Peronoceras moerickei* has fibulate ribs on the body chamber only

and one Queen Charlotte Islands specimen appears to have fibulate ribbing on the phragmocone. The North American specimens are most similar to *P. moerickei* but the incomplete specimens prevent a confident identification.

**Occurrence.** *Peronoceras* cf. *P. moerickei* is best represented in North America by three moderately well-preserved body chamber fragments from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 43 and 46). Poorly preserved specimens have been collected in the Spatsizi River map area (Section 2, Loc. 4, 7, 14; Isolated Loc. E-9), the McConnell Creek map area (Section 4, Loc. 4) and the Hazelton map area (Isolated Loc. G-2, G-10). Its age is not well constrained except at Section 7 in the Queen Charlotte Islands where it is associated with *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly) from the base of the Crassicosta Zone (Middle Toarcian). In the other areas it has been collected as talus with *Polyplectus discoides* (Zieten), *Rarenodia planulata*, *Denckmannia* cf. *D. tumefacta*, and *Catacoeloceras* cf. *C. crassum* (Young & Bird) from the Middle Toarcian.

*Peronoceras moerickei* is known from the Middle Toarcian (Chilensis Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

*Peronoceras* aff. *P. moerickei* Hillebrandt, 1981

Plate 2, figure 16

- \*aff. 1981 *Peronoceras moerickei* HILLEBRANDT and SCHMIDT-EFFING, p. 59-61, Pl. 7, fig. 1, 2.  
1994 *Peronoceras* aff. *P. moerickei* Hillebrandt and Schmidt-Effing. JAKOBS et al., Pl. 3, fig. 22.

**Description.** Evolute shell; rounded, subquadrate whorl section. Flanks slightly convex. Venter broad and slightly convex.

Ornamentation fine and dense. Two or three primary ribs join at prominent ventrolateral tubercles from which two to four secondary ribs arise. Three to four single ribs are present between tuberculate pairs and remain single or bifurcate at ventrolateral shoulder.

**Discussion.** The fibulate ribbing of the Spatsizi specimens, characterized by three primary ribs joining at a tubercle, is similar to *Dactylioceras* (*Orthodactylites*) *tenuicostatum chilense* Schmidt-Effing from South America (Hillebrandt and Schmidt-Effing, 1981). That species however, has a compressed whorl section and is older than the Spatsizi specimens, occurring in the basal Toarcian of South America. The whorl section and dense, fine ribbing of the Spatsizi specimens is similar to *P. bolitoense* and *P. moerickei*, collected from the Middle Toarcian of South America, but the ribbing pattern is different and the point of tuberculation lies farther down the flank in *Peronoceras* aff. *P. moerickei*. The

Spatsizi specimens are probably a new species but the poor preservation and lack of specimens prevents a formal designation.

**Occurrence.** *Peronoceras* aff. *P. moerickei* is represented in North America by four whorl fragments from siltstones of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 9, 14). *Peronoceras* aff. *P. moerickei* is associated with *Peronoceras verticosum*, *Peronoceras pacificum* and *Denckmannia* cf. *D. tumefacta*, probably from the Planulata Zone of the Middle Toarcian.

*Peronoceras moerickei* is known from the Middle Toarcian (Chilensis Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

**Genus** *Collina* Bonarelli, 1893

**Synonyms.** See Donovan et al., 1981, p. 139.

**Type species.** *Collina gemma* Bonarelli, 1893, p. 205, subsequent designation by Buckman, 1927.

**Remarks.** Evolute shell; subquadrate whorl section. Flanks flattened. Ribs retriradiate or slightly prorsiradiate and commonly divide into as many as three secondary ribs at high ventrolateral spines. Ribs generally have a zigzag pattern as they cross venter. Adult body chamber commonly has a keel-like feature along venter.

**Age and distribution.** *Collina* is common in the upper Middle Toarcian of southern Europe (Parisich and Viale, 1906; Fischer, 1966; Guex, 1972). In Siberia it is known from the Middle Toarcian Polare Zone (Dagys, 1968; Kalacheva, 1988) and in South America from the Middle Toarcian Chilensis Zone (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

Poulton (1991) compared Early Toarcian dactylioceratids in northern Yukon Territory to *Collina*(?) sp. aff. *C.*(?) *simplex* Fucini. They are similar to material collected by Imlay (1955) from northern Alaska. Their stratigraphic presence above *Amaltheus* in Alaska (Imlay, 1955) and their association with *Ovatoceras* sp. cf. *O. ovatum* (Young & Bird) (= *Tiltoniceras*) in northern Yukon Territory (Poulton, 1991) suggests that they should be placed within *Dactylioceras*. *Dactylioceras* (*Eodactylites*) *simplex* Fucini is known from the Lower Toarcian (Tenuicostatum Zone) of Europe (Wiedenmayer, 1980; Schlatter, 1980; Goy and Martínez, 1990).

*Collina* cf. *C. lineae* Parisich & Viale, 1906

Plate 3, figure 5

- \* cf. 1906 *Collina lineae* PARISICH and VIALE, p. 166, Pl. 10, fig. 9, 10, Pl. 11, fig. 3.  
cf. 1966 *Collina lineae* Parisich & Viale. FISCHER, p. 45, 46, Pl. 2, fig. 8, 9, Pl. 5, fig. 5.  
1994 *Collina* cf. *C. lineae* Parisich & Viale. JAKOBS et al., Pl. 3, fig. 12.

### Measurements.

SPECIMEN	D	UD	U	WH	WW	WWW
GSC 107328	41.3	23.2	56.2	10.1	—	—
GSC 107328	—	—	—	8.4	9.5	1.13
GSC 108435	—	—	—	10.1	10.5	1.04

**Description.** Evolute shell; rounded to subquadrate whorl section. Umbilical wall steep to almost vertical; umbilical shoulder rounded. Flanks slightly convex; ventrolateral shoulders rounded. Venter slightly rounded possessing a faint median ridge that is more prominent on outer part of body chamber.

Ribs begin at umbilical shoulder and have a slight concave bend on the flanks. Ventrolateral spines present on every second to third rib. Two secondary ribs arise from spines and cross venter with slight adoral arch. Rib lacking spines pass singly across venter or bifurcate at ventrolateral shoulder. Distinct zigzag pattern present on venter. Rib generally sharp and one pair of fibulate ribs present on one specimen (GSC 108435).

**Discussion.** *Collina chilensis* Hillebrandt lacks a ventral ridge and commonly has fibulate ribs (Hillebrandt and Schmidt-Effing, 1981). *Mucrodactylites clapiensis* Guex has an angular ventrolateral shoulder (Guex, 1972). *Collina pseudoyoungi* Guex has a similar whorl section but the secondary ribs appear to be much denser than on the Queen Charlotte Islands specimens (Guex, 1972). *Collina orientalis* Dagys has an angular ventrolateral shoulder, flattened venter, and most ribs bifurcate and terminate in ventrolateral spines. *Collina mucronata* (d'Orbigny), as figured by Dagys (1968), has more irregular tuberculation than the Queen Charlotte Islands specimens whereas *Collina gemma* Bonarelli has a slightly higher whorl section (Fischer, 1966; Guex, 1972). The Queen Charlotte Islands specimens are most similar to *Collina lineae*, both in whorl section and ornamentation.

**Occurrence.** *Collina* cf. *C. lineae* is represented in North America by two whorl fragments collected as talus from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 19; Section 7, Loc. 46). It is associated with *Peronoceras* cf. *P. crassicutatum* and *Peronoceras* cf. *P. moerickei*, probably from the Crassicutata Zone of the Middle Toarcian.

*Collina lineae* is known from the Middle Toarcian of Southern Europe: the Variabilis Zone (Variabilis Subzone) of the Causses in France (Guex, 1972) and the Variabilis Zone of Austria (Fischer, 1966).

### Genus *Catacoeloceras* Buckman, 1923

**Synonyms.** See Donovan et al., 1981, p. 139.

**Type species.** *Catacoeloceras confectum* Buckman, 1923, Pl. 413, by original designation.

**Remarks.** Evolute shell; wide-oval, commonly coronate whorl section. Umbilical shoulder rounded; flanks flattened. Ventrolateral shoulder rounded; venter plain and wide. Distant primary ribs generally bifurcate on upper flanks but may cross venter undivided. Tubercles common at bifurcation points.

**Age and distribution.** *Catacoeloceras* is common in Europe from the Bifrons and Variabilis zones of the Middle Toarcian (Buckman, 1918; Howarth, 1962a; Schlegelmilch, 1976; Jiménez and Carrera, 1991). *Catacoeloceras* is known from the Middle Toarcian (Chilensis Zone) of South America (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

*Catacoeloceras* cf. *C. crassum* (Young & Bird, 1828)

Plate 2, figure 11

- \* cf. 1828 *Ammonites crassus* YOUNG and BIRD, p. 253.  
 1918 *Coeloceras crassum* (Young & Bird). BUCKMAN, Pl. 119.  
 1930 *Coeloceras crassum* (Young & Bird). MITZOPOULOS, p. 83, 84, Pl. 8, fig. 1.  
 1976 *Catacoeloceras crassum* (Young & Bird). SCHLEGELMILCH, p. 80, Pl. 40, fig. 4, 5.  
 1987 *Catacoeloceras* cf. *crassum* (Young & Bird). HILLEBRANDT, Pl. 6, fig. 5, 6.  
 1991 *Catacoeloceras crassum* (Young & Bird). JIMÉNEZ and CARRERA, Pl. 7, fig. 8-11.  
 1994 *Catacoeloceras* cf. *C. crassum* (Young & Bird). JAKOBS et al., Pl. 3, fig. 7.

**Description.** Quadrate whorl section; rounded flanks. Distant primary ribs trend rectiradiately up flanks and generally bifurcate, rarely trifurcate, at ventrolateral tubercles. Some primary ribs cross venter undivided.

**Discussion.** The rounded, quadrate whorl section and presence of ventrolateral tubercles on the Hazelton specimen are characteristic of *Catacoeloceras*. *Catacoeloceras crassum* is similar to the Hazelton specimen but has slightly coarser ribs.

**Occurrence.** *Catacoeloceras* cf. *C. crassum* is represented in North America by a single external mould from sandstones of the Hazelton Group in the Hazelton map area (Isolated Loc. G-10). It is associated with *Rarenodia planulata* and *Peronoceras* cf. *P. moerickei* from the upper part of the Planulata Zone (Middle Toarcian).

*Catacoeloceras crassum* is known from the Middle Toarcian of Europe: the Bifrons and Variabilis zones of southern Germany (Schlegelmilch, 1976), and the Bifrons Zone (Braunianus Subzone) of England (Howarth, 1962a). In South America it is known from the Middle Toarcian (Chilensis Zone) (Hillebrandt and Schmidt-Effing, 1981; Hillebrandt, 1987).

Superfamily HILDOCERATAEAE Hyatt, 1867

Family HILDOCERATIDAE Hyatt, 1867

Subfamily HARPOCERATINAE Neumayr, 1875

Genus *Harpoceras* Waagen, 1869

*Synonyms.* See Howarth, 1992b, p. 107.

*Type species.* *Ammonites falcifer* J. Sowerby, 1820, p. 99, Pl. 254, fig. 2, subsequent designation in ICZN Opinion 303, 1954.

*Remarks.* Involute to evolute shell; subogival to subquadrate whorl section. Umbilical shoulder sharp; umbilical wall commonly vertical to undercut. Flanks flat; venter carinate. Falcoid to falcate ribs stronger and broader on upper flank than on lower flank.

Gabilly (1976) recognized that *Harpoceras exaratum* (Young & Bird) and *H. elegans* (Sowerby) were phylogenetically distinct from *Harpoceras falciferum* (Sowerby) and more closely related to *Eleganticeras*, to which he referred them. Howarth (1992a) has confirmed that these species are part of a separate phylogenetic line, but are more appropriately placed in a separate genus, which he named *Cleviceras*. *Cleviceras exaratum* and *C. elegans* are descendants of the *Tiltoniceras-Eleganticeras* line and ancestors of *Polyplectus* (Howarth, 1992a). Species of *Harpoceras* such as *Harpoceras serpentinum* (Schlotheim), *H. falciferum* and *H. subplanatum* (Oppel) are descendants of *Protogrammoceras*, and probably gave rise to *Oesperlioceras* (Howarth, 1992b).

All species of *Cleviceras* have falcoid ribs whereas the ribs of species of *Harpoceras* are commonly falcate and sharply angled (Howarth, 1992a). In addition, early species of *Harpoceras* generally have a spiral groove or a series of undulations at the falcate bend in the ribs (Howarth, 1992a).

The taxonomy of the harpoceratids is complex and difficult to interpret, even with numerous and well-preserved specimens (Howarth, 1992a). The North American specimens are poorly preserved, usually as flattened impressions or incomplete whorl fragments; septal sutures are generally not preserved.

*Age and distribution.* *Harpoceras* is found worldwide from the Lower and Middle Toarcian (Arkell et al., 1957; Howarth, 1992b).

*Harpoceras* cf. *H. subplanatum* (Oppel, 1856)

Plate 3, figure 15

- \* cf. 1856 *Ammonites subplanatus* OPPEL, p. 244.
- cf. 1874 *Ammonites subplanatus* Oppel. DUMORTIER, p. 51, Pl. 10.
- cf. 1879 *Ammonites elegans* Sowerby. REYNÈS, Pl. 4, fig. 3-6.

- cf. 1885 *Ammonites complanatus* Bruguière. QUENSTEDT, p. 420, Pl. 53, fig. 11.
- cf. 1976 *Harpoceras (Harpoceras) subplanatum* (Oppel). GABILLY, p. 104-108, Pl. 18, fig. 1, 2.
- 1992b *Harpoceras subplanatum* (Oppel). HOWARTH, p. 136-141, Pl. 22, fig. 4-7, Pl. 23, fig. 1-3 [see synonymy].

*Description.* Large, involute shell; tall whorls. Umbilical wall vertical; umbilical shoulder abrupt but rounded. Flanks converge toward carinate venter.

Sinuuous ribs trend prorsiradiately to approximately mid-flank and then curve gently backward. Ribs trend prorsiradiately on upper part of flank and project forward along venter. Ribs widen slightly on upper flank.

*Discussion.* The tall whorls, sinuous ribs, and involute shell of the Queen Charlotte Islands specimens are similar to *H. subplanatum* (see Dumortier, 1874, Pl. 10). Other species of *Harpoceras* are more evolute than the Queen Charlotte Islands specimens and have falcate ribs. North American specimens of *Cleviceras* cf. *C. exaratum* differ from *Harpoceras* cf. *H. subplanatum* by having falcoid ribs and a pronounced ventrolateral shoulder. North American specimens of *Cleviceras* cf. *C. chrysanthemum* (Yokoyama) are more evolute and have wider ribs than *Harpoceras* cf. *H. subplanatum*.

*Occurrence.* *Harpoceras* cf. *H. subplanatum* is represented in British Columbia by six specimens from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 6, 16, 20, 22; Section 7, Loc. 16; Isolated Loc. M-3). It is associated with *Cleviceras* cf. *C. exaratum* and *Rarenodia planulata* from the Lower and Middle Toarcian.

*Harpoceras subplanatum* is common in the Middle Toarcian (Bifrons Zone) of France, Britain, Germany, Switzerland, Austria, and the Caucasus (Howarth, 1992b). Goy and Martínez (1990) mentioned its presence in the Bifrons Zone (Bifrons Subzone) of Spain. In South America it is known from the Middle Toarcian (Pacificum Zone) (Hillebrandt, 1987).

Genus *Cleviceras* Howarth, 1992a

*Type species.* *Ammonites exaratus* Young & Bird, 1828, p. 266, by original designation.

*Remarks.* Moderately involute shell; subogival to subquadrate whorl section. Umbilical shoulder sharp; umbilical wall commonly vertical to undercut. Flanks flat; venter carinate. Falcoid ribs stronger and broader on upper flank than on lower flank. Ribs may bifurcate on small specimens.

*Age and distribution.* *Cleviceras* is known from the Lower Toarcian of England, France, Germany, Switzerland, and Siberia (Howarth, 1992a). In North America *Cleviceras* is known from the Lower and Middle Toarcian.



*Cleviceras* cf. *C. chrysanthemum* (Yokoyama, 1904)

Plate 4, figures 1, 2, 5

- \* cf. 1904 *Hildoceras chrysanthemum* YOKOYAMA, p. 11, 12, Pl. 2, fig. 1-4.  
 cf. 1973a *Harpoceras (Harpoceras) chrysanthemum* (Yokoyama). HIRANO, p. 1-4, Pl. 1, fig. 1-3.  
 1974 *Hildoceratoides chrysanthemum* (Yokoyama). DAGYS, p. 56-58, Pl. 10, figs. 1-4, Pl. 11, fig. 1, 2, Pl. 12, fig. 1.  
 1987 *Harpoceras* cf. *chrysanthemum* (Yokoyama). HILLEBRANDT, Pl. 7, fig. 1, 2, Pl. 8, fig. 1.  
 1994 *Cleviceras* cf. *C. chrysanthemum* (Yokoyama). JAKOBS et al., Pl. 1, fig. 19, 20.

Measurements.

SPECIMEN	WH	WW	WWWH
GSC 107312	30.1	20.7	0.69
GSC 108436	24.6	16.6	0.68

*Description.* Midvolute shell; rectangular to ellipsoidal whorl section. Umbilical wall vertical; umbilical shoulder abrupt but rounded. Flanks slightly convex. Ventrolateral shoulder abrupt but rounded. Venter moderately wide, carinate-sulcate.

Ribs strong and sinuous, separated by inter-rib spaces as wide as ribs. Ribs trend prorsiradiately to approximately mid-flank, then curve gently backward. Ribs trend prorsiradiately on upper flank and project forward along ventrolateral shoulder.

*Discussion.* The western North American specimens are similar to Japanese specimens of *Hildoceras chrysanthemum*, figured by Yokoyama (1904), in terms of ribbing pattern and ventral features. Other workers in Japan (Hirano, 1973b), northeastern Asia (Dagys, 1974; Repin, 1977; Kalacheva, 1988), and South America (Hillebrandt, 1987) assigned the species to *Harpohildoceras*, *Hildoceratoides*, and *Harpoceras*. The genus *Cleviceras* is favoured based on the shell volution and the steep to undercut umbilical wall. *Cleviceras chrysanthemum* may be transitional to *Hildaites*.

*Occurrence.* *Cleviceras* cf. *C. chrysanthemum* is best represented in western North America by six specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 5, 7, 12, 13, 21; Section 7, Loc. 5, 12, 13). It has been collected in the Spatsizi River (Section 3, Loc. 6), Cry Lake (Isolated Loc. C-3), and Taseko Lakes (Isolated Loc. K-2) map areas. It is associated with *Cleviceras* cf. *C. exaratum* and *Hildaites murleyi* (Moxon) from the Kanense Zone of the Lower Toarcian and extends into the Planulata Zone of the Middle Toarcian.

*Cleviceras chrysanthemum* is known from the Middle Toarcian (Athleticum Zone) of Siberia (Dagys, 1974), the lower Toarcian Nipponicum and Helianthoides zones of Japan (Yokoyama, 1904; Hirano, 1973b), and the Middle Toarcian (Largaense Zone) of South America (Hillebrandt, 1987).

*Cleviceras* cf. *C. exaratum* (Young & Bird, 1828)

Plate 3, figures 6, 7, 12, 13, Plate 4, figures 3, 4

- \* 1828 *Ammonites exaratus* YOUNG and BIRD, p. 266.  
 1909 *Harpoceras exaratum* (Young & Bird). BUCKMAN, Pl. 5, fig. 1, 2.  
 1961 *Harpoceras exaratum* (Young & Bird). DEAN et al., p. 478, Pl. 72, fig. 2.  
 1962 *Harpoceras* cf. *exaratum* (Young & Bird). FREBOLD and LITTLE, p. 17, Pl. 2, fig. 1-9, Pl. 3, fig. 5.  
 1968 *Harpoceras exaratum* (Young & Bird). REPIN, p. 117, 118, Pl. 47, fig. 3.  
 1973a *Harpoceras (Harpoceras)* sp. cf. *H. (H.) exaratum* (Young & Bird). HIRANO, p. 7, Pl. 2, fig. 4, Pl. 3, fig. 1.  
 1974 *Harpoceras exaratum* (Young & Bird). DAGYS, p. 36-38, Pl. 8, fig. 1-7.  
 1976 *Harpoceras exaratum* (Young & Bird). SCHLEGELMILCH, p. 86, Pl. 45, fig. 5.  
 1976 *Harpoceras exaratum* (Young & Bird). FREBOLD, p. 12, Pl. 5, fig. 1.  
 1985 *Harpoceras (Harpoceras) exaratum* (Young & Bird). RIEGRAF, p. 259, 260, Pl. 17, fig. 1-3.  
 1991 *Harpoceras* cf. *chrysanthemum* (Yokoyama). TIPPER et al., Pl. 6, fig. 4.  
 1991 *Harpoceras* cf. *exaratum* (Young & Bird). TIPPER et al., Pl. 6, fig. 5.  
 1992 *Harpoceras* cf. *chrysanthemum* (Yokoyama). HILLEBRANDT and SMITH, Pl. 4, fig. 5.  
 1992b *Cleviceras exaratum* (Young & Bird). HOWARTH, p. 90-99, Pl. 9, fig. 2-6, Pl. 10, fig. 1-8, Pl. 11, fig. 1-17, Pl. 12, fig. 1-5, Pl. 13, fig. 1, 2 [see synonymy].  
 1994 *Cleviceras* cf. *C. exaratum* (Young & Bird). JAKOBS et al., Pl. 1, fig. 21, 22.  
 1995 *Harpoceras* cf. *exaratum* (Young & Bird). JAKOBS et al., Pl. 1, fig. 2.

*Description.* Midvolute shell; high, ellipsoidal whorl section. Umbilical wall almost vertical; umbilical shoulder abrupt but rounded. Gently convex flanks converge toward venter. Venter carinate bearing a high keel.

Ribbing changes occur during ontogeny. On smaller specimens, hafts of ribs trend prorsiradiately until approximately mid-flank and then bend sharply backward. Ribs on upper flanks are gently crescentic. On larger specimens,

mid-flank bend is less pronounced and more sinuous. Ribs on all specimens are dense and narrow, but may widen on upper flanks. Ribs approach keel at moderately acute angle.

*Discussion.* The dense ribs and ontogenetic ribbing changes of the western North American specimens are similar to *Cleviceras exaratum*. The western North American specimens resemble the holotype refigured by Schlegelmilch (1976, Pl. 45, fig. 5). The poor preservation and fragmentary nature of the western North American specimens prevents a more confident identification. The western North American specimens lack the strong, mid-flank flexure of the ribs that characterizes *Harpoceras falciferum*, and are more evolute than *Harpoceras subplanatum*.

*Occurrence.* *Cleviceras* cf. *C. exaratum* is best represented in western North America by twenty whorl fragments collected from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 1, 2, 3, 4, 12, 17, 20, 22; Section 7, Loc. 1, 2, 3, 7, 11; Isolated Loc. M-4, M-6). Moderately well-preserved specimens have been collected from siltstones of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 3, 14; Section 3, Loc. 2, 5, 6, 7, 8; Isolated Loc. E-5). Poorly preserved specimens of *Cleviceras* (= *Harpoceras*) cf. *exaratum* have been collected in the Tulsequah map area (Isolated Loc. B-1, B-2, B-4, B-5, B-7, B-8), the Hazelton map area (Isolated Loc. G-1, G-7), the southern Canadian Rocky Mountains (Isolated Loc. I-8), the Nelson map area (Isolated Loc. J-2, J-3, J-4, J-7), and southern Alaska (Isolated Loc. N-1). *Cleviceras* cf. *C. exaratum* is associated with *Hildaites murley*, *Cleviceras* cf. *C. chrysanthemum*, and possibly *Peronoceras* spp. from the Kanense Zone (Lower Toarcian) and the Planulata Zone (Middle Toarcian).

*Cleviceras exaratum* is known from the Lower Toarcian of northwestern Europe (Riegraf et al., 1984; Howarth, 1992a), Siberia (Dagys, 1974), and Japan (Hirano, 1973a, b).

### Genus *Taffertia* Guex, 1973a

*Type species.* *Taffertia taffertensis* Guex, 1973a, p. 503, Pl. 2, fig. 6, by original designation.

*Remarks.* Moderately evolute shell; subogival whorl section; carinate venter. Ribs strong, gently falcate and bifurcate at regular intervals. The bifurcation of the ribs distinguishes *Taffertia* from other Harpoceratinae. Phymatoceratinae generally have coarser, less falcoid ribbing and are tuberculate.

*Age and distribution.* *Taffertia* is known from the Lower Toarcian (Levisoni Zone) of Morocco (Guex, 1973a).

### *Taffertia taffertensis* Guex, 1973a

Plate 3, figures 8, 9

- \* 1973a *Taffertia taffertensis* GUEX, p. 503, Pl. 2, fig. 6, Pl. 10, fig. 7, Pl. 14, fig. 7, Pl. 15, fig. 13.
- 1994 *Taffertia taffertensis* Guex. JAKOBS et al., Pl. 1, fig. 3, 4.

#### Measurements.

SPECIMEN	WH	WW	WWW
GSC 108466	38.6	18.2	0.47

*Description.* Moderately evolute to involute shell; narrow, ogival whorl section. Umbilical wall gently concave and steep; umbilical shoulder rounded but abrupt. Gently convex flanks converge toward the venter; ventrolateral shoulder rounded. Venter relatively narrow and carinate-sulcate.

Ribs rounded, wide, distant, and gently falcate. Ribs bifurcate at slight swellings, just below mid-flank.

*Discussion.* The poor preservation of the North American specimens makes a confident identification difficult. Bifurcate ribbing in the Harpoceratinae is restricted to *Taffertia* and although bifurcation is not seen on some specimens, the distant, coarse ribbing is unlike other Harpoceratinae of the same age. Specimens of *Harpoceras serpentinum* may have bundled ribs on the lower flank, but also have denser, finer ribs that join in threes or fours (Howarth, 1992b).

*Occurrence.* *Taffertia taffertensis* is represented in North America by five specimens from calcareous sandstones of the Fannin Formation in the Queen Charlotte Islands (Section 9, Loc. 16). It is Early Toarcian (Kanense Zone) in age. Poorly preserved specimens of *Taffertia* sp. indet. have been collected from the Queen Charlotte Islands (Section 9, Loc. 7, 16).

*Taffertia taffertensis* is known from the Lower Toarcian (Levisoni Zone) of Morocco (Guex, 1973a).

### Genus *Pseudolioceras* Buckman, 1889

*Synonyms.* See Howarth, 1992b, p. 144.

*Type species.* *Ammonites compactilis* Simpson, 1855, p. 74, by original designation (holotype figured by Buckman, 1911; Pl. 41A).

*Remarks.* Moderately involute shell; discoidal and compressed triangular whorl section. Umbilical wall vertical; umbilicus small and deep. Venter bears sharp, hollow keel bordered by narrow spaces on either side. Subfalciform ribs clearly visible on upper flank, where they are broad and rounded. Ribs faint or absent on lower flank.

*Age and distribution.* *Pseudolioceras* is a Boreal genus, commonly found in Arctic North America, Siberia, Japan, and Great Britain (Arkell et al., 1957; Howarth, 1992b). It is Middle Toarcian to Early Bajocian in age (Howarth, 1992b).

*Pseudolioceras lythense* (Young & Bird, 1828)

Plate 4, figures 6, 7, 10, 11

- \* 1828 *Ammonites lythensis* YOUNG and BIRD, p. 267.
- 1910 *Pseudolioceras lythense* (Young & Bird). BUCKMAN, Pl. 13, fig. 1, 2.
- 1957a *Pseudolioceras* aff. *compactile* (Young & Bird). FREBOLD, p. 5, Pl. 3, fig. 3-6.
- 1960 *Grammoceras?* sp. indet., FREBOLD, p. 23, Pl. 12, fig. 5-7.
- 1975 *Pseudolioceras* cf. *compactile* (Simpson). FREBOLD, p. 13, Pl. 4, fig. 5.
- 1976 *Pseudolioceras lythense* (Young & Bird). SCHLEGELMILCH, p. 89, Pl. 48, fig. 1 [holotype refigured].
- 1992b *Pseudolioceras lythense* (Young & Bird). HOWARTH, p. 145-149, Pl. 25, fig. 3-5, Pl. 26, fig. 1-5, Pl. 27, fig. 1-4. [see synonymy].
- 1994 *Pseudolioceras lythense* (Young & Bird). JAKOBS et al., Pl. 3, fig. 14, 15.

*Description.* Moderately involute shell; high-oval whorl section. Steep umbilical shoulder; moderately abrupt umbilical wall. Flanks slightly rounded. Ventrolateral shoulder moderately gentle; venter sharp, carinate.

Ornamentation comprised of coarse, distant, slightly sinuous ribs. Ribs faint on lower flanks becoming prominent on upper flanks and terminating at ventrolateral shoulder.

*Discussion.* *Pseudolioceras lythense* is similar to the Spatsizi specimens but generally has more strongly projected ribs on the upper flanks than do the Spatsizi specimens. The ribs of *Pseudolioceras spitsbergense* Frebold are more prominent and flexuous than those of the Spatsizi specimens.

*Occurrence.* *Pseudolioceras lythense* is represented in British Columbia by eight specimens from calcareous concretions and siltstones of the Wolf Den Member (Spatsizi Formation) in the Spatsizi River map area (Section 2, Loc. 14). It is associated with *Peronoceras pacificum*, *Peronoceras verticosum*, and *Denckmannia* cf. *D. tumefacta* from the Middle Toarcian (Planulata and Crassicosta zones).

*Pseudolioceras lythense* is known from the Middle Toarcian (Bifrons Zone) of northwestern Europe: the Sublevisoni Subzone of France (Guex, 1972), the Bifrons Zone of southern Germany (Schlegelmilch, 1976), the Fibulatum Subzone of Austria (Fischer, 1966), and the Braunianus, Fibulatum, and Commune subzones of England (Howarth, 1962b, 1992b). It is

also known from the Middle Toarcian (Monestieri Zone) of Siberia (Dagys, 1974; Kalacheva, 1988) and from the Middle Toarcian of Arctic Canada (Frebold, 1957a, 1960, 1975).

**Genus *Polyplectus* Buckman, 1890**

*Synonyms.* See Howarth, 1992b, p. 152.

*Type species.* *Ammonites discoides* Zieten, 1831, p. 21, Pl. 16, fig. 1, by monotypy.

*Remarks.* Involute shell; triangular whorl section. Umbilical shoulder abrupt; umbilical wall steep. Oxycone shell has knife-edge venter and hollow keel. Some species have carinate-sulcate venter. Ribs sigmoidal and strongly projected on upper flank.

*Age and distribution.* *Polyplectus* is found almost worldwide, including Europe, South America, and North America (Howarth, 1992b). It ranges in age from the Falciferum Zone (Early Toarcian) to the Levesquei Zone (Late Toarcian) (Howarth, 1992b).

*Polyplectus discoides* (Zieten, 1831)

Plate 3, figures 10, 11; Plate 4, figures 14, 15

- \* 1831 *Ammonites discoides* ZIETEN, p. 21, Pl. 16, fig. 1.
- 1845 *Ammonites discoides* (Zieten). D'ORBIGNY, p. 356, Pl. 115, fig. 1-4.
- 1884 *Harpoceras discoides* (Zieten). WRIGHT, p. 467, Pl. 82, fig. 12, 13.
- 1885 *Ammonites capellinus jurensis*, QUENSTEDT, p. 418, Pl. 53, fig. 1, 3-5.
- 1885 *Ammonites discoides* (Zieten). QUENSTEDT, p. 420, Pl. 53, fig. 9.
- 1890 *Polyplectus discoides* (Zieten). BUCKMAN, p. 215, Pl. 37, fig. 1-5.
- 1975 *Polyplectus discoides* (Zieten). GUEX, p. 115, Pl. 7, fig. 8.
- 1976 *Polyplectus discoides* (Zieten). SCHLEGELMILCH, p. 90, Pl. 47, fig. 8.
- 1987 *Polyplectus* cf. *discoides* (Zieten). HILLEBRANDT, Pl. 8, fig. 2-4.
- 1992b *Polyplectus discoides* (Zieten). HOWARTH, p. 153, 154, Pl. 28, fig. 6-8.
- 1994 *Polyplectus discoides* (Zieten). JAKOBS et al., Pl. 3, fig. 20, 21.

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWWH
GSC 108437	55.7	24.4	43.8	18.9	18.1	0.96

*Description.* Involute shell; tall, lanceolate whorl section. Umbilical wall steep; umbilical shoulder abrupt but rounded. Venter sharp.

Ribs begin on umbilical wall and trend prorsiradiately to about mid-flank, then curve gently backward and form a sickle shape on upper flank and project along venter. Ribs are fine and dense on lower flank, widening slightly on upper flank.

*Discussion.* The ribbing of the British Columbia specimens is not as dense as *Polyplectus epioticus* (Renz), figured by Kottek (1966). *Polyplectus pleuricostata* (Haas), as figured by Kottek (1966), has denser ribbing, a blunter venter and is more evolute than the British Columbia specimens. *Polyplectus bicarinatum* (Zieten) has a carinate-sulcate venter.

*Occurrence.* *Polyplectus discooides* is best represented in North America by ten specimens from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 15; Section 7, Loc. 50, 71; Section 8, Loc. 14; Isolated Loc. M-4). It has been collected in the Spatsizi River (Section 2, Loc. 4; Section 3, Loc. 11) and Manson River (Isolated Loc. J-10) map areas. It is associated with *Phymatoceras* cf. *P. pseudo-erbaense*, *Phymatoceras crassicosta* Merla, *Phymatoceras hillebrandti* Jakobs, *Hammatoceras insigne* (Zieten), and *Podagrosites* sp. from the Middle and Upper Toarcian (Crassicosta and Hillebrandti zones). Poorly preserved specimens of *Polyplectus* sp. indet. have been collected from the Spatsizi River (Section 2, Loc. 10, 12; Isolated Loc. E-2, E-9) and McConnell Creek (Section 4, Loc. 4) map areas.

Several large fragments of *Polyplectus* figured by Imlay (1968) from the Yakounensis Zone (Upper Toarcian) of eastern Oregon are too poorly preserved to be specifically assigned. The specimens figured by Hall (1987) as *Polyplectus* cf. *subplanatus* (Oppel) were assigned to *P. pleuricostata* by Howarth (1992b).

*Polyplectus discooides* is known from the Middle and Upper Toarcian of Europe: the Thouarsense and Insigne zones of France (Guex, 1975), the Bifrons Zone (Fibulatum Subzone) of Austria (Fischer, 1966), and the Thouarsense and Levesquei zones of England (Howarth, 1992b).

#### Subfamily HILDOCERATINAE Hyatt, 1867

#### Genus *Hildaites* Buckman, 1921

*Synonyms.* See Howarth, 1992b, p. 166.

*Type species.* *Hildaites subserpentinus* Buckman, 1921, Pl. 217, by original designation.

*Remarks.* Evolute to midvolute shell; rectangular to ellipsoidal whorl section. Flanks slightly convex. Venter carinate-sulcate. Ribs have short, prorsiradiate haft and crescentic curvature on the upper flank. *Hildaites* lacks the lateral groove of *Hildoceras* and has shallower ventral sulci.

*Age and distribution.* *Hildaites* has a worldwide distribution and is Early Toarcian in age (Howarth, 1992b).

#### *Hildaites murleyi* (Moxon, 1841)

#### Plate 5, figures 1-9

- \* 1841 *Ammonites murleyi* MOXON, Pl. 24, fig. 6.
- 1843 *Ammonites levisoni* SIMPSON, p. 54.
- 1883 *Harpoceras levisoni* (Simpson). WRIGHT, p. 438, Pl. 61, fig. 5, 6.
- 1910 *Hildoceras levisoni* (Simpson). BUCKMAN, Pl. 12.
- 1921 *Murleyiceras murleyi* (Moxon). BUCKMAN, Pl. 216, fig. 1-3.
- 1969 *Hildaites levisoni* (Simpson). GALLITELLI-WENDT, p. 35, Pl. 3, fig. 1.
- 1973a *Hildoceras* sp. aff. *H. bifrons* (Bruguière). HIRANO, p. 10, Pl. 4, fig. 4, 5.
- 1973b *Hildoceras* sp. HIRANO, Pl. 9, fig. 10.
- 1976 *Hildaites (Hildaites) levisoni* (Simpson). SCHLEGELMILCH, p. 85, Pl. 44, fig. 2 [non Pl. 44, fig. 3].
- 1985 *Hildoceras (Hildaites) levisoni levisoni* (Simpson). RIEGRAF, p. 258, Pl. 16, fig. 1, 3.
- 1985 *Hildoceras (Hildaites) levisoni gyrale* (Buckman). RIEGRAF, p. 258, 259, Pl. 16, fig. 2.
- 1987 *Hildoceras* cf. *levisoni* (Simpson). HILLEBRANDT, Pl. 5, fig. 3.
- 1992b *Hildaites murleyi* (Moxon). HOWARTH, p. 168-171, Pl. 30, fig. 9, 10, Pl. 31, fig. 1-8, Pl. 32, fig. 4.
- 1994 *Hildaites murleyi* (Moxon). JAKOBS et al., Pl. 1, fig. 15-18.

*Description.* Moderately evolute shell; rectangular whorl section. Umbilical wall moderately steep; umbilical shoulder gentle and rounded. Flanks slightly convex; ventrolateral shoulder abrupt but rounded. Venter moderately broad, carinate-sulcate.

Ornamentation coarse and strong. Ribs begin high on umbilical wall, are strongly prorsiradiate to lower flank, where they make a bend and become rectiradiate to gently rursiradiate. Ribs become prorsiradiate near ventrolateral shoulder. Some ribs may bundle on umbilical wall. Ribs on inner whorls have a less pronounced curvature than those on outer whorls. Fine growth lines that parallel ribs are present on outer whorls. Ribs fade on lower part of flanks.

*Discussion.* The North American specimens are similar to the holotype of *H. murleyi* (as refigured by Buckman, 1921 and Howarth, 1992b) in ribbing pattern, whorl section and venter. *Hildaites murleyi* can be distinguished from other *Hildaites* by its strong and distant ribbing.

*Occurrence.* *Hildaites murleyi* is best represented in North America by ten specimens from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 4, 22; Section 7, Loc. 6, 8, 10). It has been collected in the Spatsizi River (Section 2, Loc. 1, 3, 14; Section 3, Loc. 4, 6, 7) and Cry Lake (Isolated Loc. C-1, C-2) map areas. It is

associated with *Cleviceras* cf. *C. exaratum* and *C. cf. C. chrysanthemum* from the upper part of the Kanense Zone of the Lower Toarcian.

*Hildaites murleyi* is known from the Lower Toarcian (Falciferum Zone) of southern Germany (Schlegelmilch, 1976; Riegraf, 1985), Austria (Fischer, 1966), and England (Howarth, 1992b). It is also known from the Lower Toarcian of Morocco (Guex, 1973a), Spain (Goy and Martínez, 1990), Siberia (Dagys, 1974), and South America (Hillebrandt, 1987).

*Hildaites* cf. *H. subserpentinus* Buckman, 1921

Plate 3, figure 14

- cf. 1919 *Hildoceras serpentinum* (Reinecke). BUCKMAN, Pl. 138B.
- cf. 1921 *Hildaites subserpentinus* BUCKMAN, Pl. 217.
- cf. 1923 *Hildaites serpentiniformis*, BUCKMAN, Pl. 267B.
- cf. 1976 *Hildoceras (Hildaites) subserpentinum* (Buckman). SCHLEGELMILCH, p. 85, Pl. 45, fig. 1 [non Pl. 45, fig. 2].

**Description.** Venter carinate. Ribs fine and sinuous. Growth lines, parallel to ribs, may be present. Ribs trend prorsiradiately on lower flank then bend smoothly backward just below mid-flank. Ribs curve smoothly forward on upper flank. Ribs approach venter obliquely and weaken as they approach the keel.

**Discussion.** The Queen Charlotte Islands specimen has a similar ribbing pattern to the holotype figured by Buckman (1921), although the Queen Charlotte Islands specimen lacks the characteristic lateral, sulcus-like feature, but this may be due to secondary deformation. The specimen figured by Schlegelmilch (1976) is similar to the Queen Charlotte Islands specimen.

**Occurrence.** *Hildaites* cf. *H. subserpentinus* is represented in North America by a single, poorly preserved fragment from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 6, Loc. 2). It is Early Toarcian (Kanense Zone) in age.

*Hildaites subserpentinus* is known from the Lower Toarcian (Falciferum Zone) of southern Germany (Schlegelmilch, 1976) and England (Howarth, 1992b) and from the Lower Toarcian (Serpentinum Zone) of Algeria (Elmi et al., 1974).

@FAMILY#1 = **Genus** *Mercaticeras* Buckman, 1913

**Type species.** *Ammonites mercati* Hauer, 1856, Pl. 23, fig. 6, 7, by original designation.

**Remarks.** Midvolute shell; more or less quadrate whorl section. Umbilical wall prominent. Venter tricarinate on inner whorls, becoming carinate-sulcate on outer whorls. Ribs strong, simple, and slightly sigmoidal, thickening as they approach venter.

*Mercaticeras* is similar to *Pseudomercaticeras* but has deeper ventral sulci, thicker and less sigmoidal ribs, and a more quadrate whorl section. Some species of *Mercaticeras* resemble *Phymatoceras* and others show an affinity to *Hildaites* (Kottek, 1966).

**Age and distribution.** *Mercaticeras* is common in southern Europe from the Middle Toarcian (Bifrons Zone) (Merla, 1933; Donovan, 1958; Kottek, 1966; Géczy, 1967; Pinna, 1968; Gallitelli-Wendt, 1969). Hillebrandt and Schmidt-Effing (1981) mentioned the presence of *Mercaticeras* sp. from the Middle Toarcian (Largaense Zone) of South America.

*Mercaticeras* cf. *M. hellenicum* (Renz, 1906)

Plate 5, figures 12, 13

- \* cf. 1906 *Hildoceras mercati* (Hauer) var. *hellenica* RENZ, p. 264, Pl. 10, fig. 2.
- cf. 1933 *Mercaticeras hellenicum* (Renz). MERLA, p. 47, Pl. 6, fig. 10.
- cf. 1966 *Mercaticeras (MERCATICERAS) hellenicum* (Renz). KOTTEK, p. 83, 84, Pl. 6, fig. 6, text-fig. 33.
- cf. 1968 *Mercaticeras hellenicum* (Renz). PINNA, p. 79, Pl. 10, fig. 13, 15, 16, 18-21.
- cf. 1969 *Mercaticeras hellenicum* (Renz). GALLITELLI-WENDT, p. 29, 30, text-fig. 7.
- 1994 *Mercaticeras* cf. *M. hellenicum* (Renz). JAKOBS et al., Pl. 3, fig. 3, 4.

**Measurements.**

SPECIMEN	WH	WW	WWW
GSC 107322	16.9	20.7	1.22

**Description.** Subquadrate whorl section. Umbilical wall steep to almost vertical; umbilical shoulder rounded but abrupt. Flanks convex. Ventrolateral shoulder rounded; venter carinate-sulcate. Ventral keel only slightly higher than ventrolateral shoulder; ventral sulci moderately deep.

Ornamentation strong. Ribs approximately rectiradiate from umbilical shoulder and trend slightly prorsiradiately on upper flank as they approach ventrolateral shoulders. Ribs widen as they approach venter.

**Discussion.** The carinate-sulcate venter, swollen flanks and subquadrate whorl section are typical of *Mercaticeras*. *Mercaticeras umbilicatum* Buckman has a narrower venter, flatter flanks, more sinuous ribs and a more quadrate whorl section than the Queen Charlotte Islands specimens. *Mercaticeras mercati* (Hauer) has more sinuous ribs and a more quadrate whorl section than the Queen Charlotte Islands specimens, and *Mercaticeras rursicostatum* Merla has more sinuous ribs.

*Mercaticeras dilatatum* (Meneghini) has a more quadrate whorl section than the Queen Charlotte Islands specimens, whereas *Mercaticeras skuphoi* (Mitzopoulos) has a more rectangular whorl section. *Mercaticeras hellenicum* has relatively straight ribs and a similar whorl section to the Queen Charlotte Islands specimens.

**Occurrence.** *Mercaticeras* cf. *M. hellenicum* is represented in North America by three specimens from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Isolated Loc. M-6). Poorly preserved, indeterminate specimens of *Mercaticeras* are also found in the Queen Charlotte Islands (Section 7, Loc. 51, 62; Isolated Loc. M-4, M-6). *Mercaticeras* cf. *M. hellenicum* has been collected from the Middle Toarcian, probably from the lower part of the Crassicosta Zone.

*Mercaticeras hellenicum* is known from the the Middle Toarcian of southern Europe: the Graecum Zone of Greece (Kottek, 1966), the Bifrons Zone of Austria (Fischer, 1966), and the Bifrons Zone of Italy (Pinna, 1968). *Mercaticeras* sp. is known from the Middle Toarcian (Largaense Zone) of South America (Hillebrandt and Schmidt-Effing, 1981).

Subfamily GRAMMOCERATINAE Buckman, 1904

### Genus *Grammoceras* Hyatt, 1867

**Synonyms.** See Donovan et al., 1981, p. 140, 141.

**Type species.** *Ammonites striatulus* J. de C. Sowerby, 1823, p. 23, Pl. 421, fig. 1, subsequent designation by Buckman, 1890.

**Remarks.** Evolute to midvolute shell; lanceolate to oval whorl section. Gently inclined umbilical wall. Venter carinate, shallow sulci present. Ribs sinuous, commonly single but paired on some species.

Arkell et al. (1957) synonymized *Pseudogrammoceras* with *Grammoceras*, but Donovan et al. (1981) gave it generic status. *Pseudogrammoceras* has a more quadrate whorl section than *Grammoceras* and Donovan (1958) stated that *Grammoceras* had sharper ribs with concave interspaces whereas *Pseudogrammoceras* had flat, rounded ribs with angular interspaces.

**Age and distribution.** *Grammoceras* is almost worldwide in distribution, occurring in the lower Upper Toarcian (Arkell et al., 1957). It has not been recorded from South America (Hillebrandt, 1987) or Siberia (Kalacheva, 1988).

### *Grammoceras thouarsense* (d'Orbigny, 1843)

Plate 7, figures 5, 6; Plate 8, figures 3-7

- \* 1843 *Ammonites thouarsensis* D'ORBIGNY, p. 222, Pl. 57, fig. 1-3.
- 1890 *Grammoceras toarcense* (d'Orbigny). BUCKMAN, p. 169, Pl. 28, fig. 9, 10.
- 1975 *Grammoceras thouarsense* (d'Orbigny). GUEX, p. 103, Pl. 4, fig. 13, 14, 16.
- 1976 *Grammoceras thouarsense* (d'Orbigny). SCHLEGELMILCH, p. 83, Pl. 42, fig. 7.
- 1991 *Grammoceras thouarsense* (d'Orbigny). TIPPER et al., Pl. 6, fig. 3.
- 1994 *Grammoceras thouarsense* (d'Orbigny). JAKOBS et al., Pl. 4, fig. 7-12.

### Measurements.

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 95580	49.8	18.1	36.3	17.4	N10.0	N0.58	N26
GSC 95580	39.0	11.6	29.7	16.0	N7.7	N0.48	19
GSC 107336	21.5	11.2	52.1	8.5		0.72	c23
GSC 107336	-	-	-	7.5	5.4	0.72	-
GSC 108438	21.2	8.7	41.0	7.4	5.7	0.77	15
GSC 108438	16.6	6.7	40.4	6.1	4.9	0.80	25
GSC 108439	20.6	7.8	37.9	6.7	-	-	18

**Description.** Evolute shell; high-oval to ogival whorl section. Umbilical wall gently inclined; flanks convex to flat, converging toward venter. Venter carinate; shallow ventral sulci may be present.

Simple, sinuous ribs trend prorsiradiately on umbilical wall and lowermost flanks, almost rectiradiate at mid-flank and curve forward as they approach the venter. Tubercles absent and ribs do not join at umbilical shoulder. Ribbing density varies between specimens.

**Discussion.** *Grammoceras striatulum* (Sowerby) has finer, denser ribs than the Queen Charlotte Islands specimens, whereas *Grammoceras penestriatulum* Buckman has coarser ribs and *Grammoceras comptum* (Haug) has bifurcating ribs. *Grammoceras thouarsense* has ontogenetic variations in ribbing density but most of the Queen Charlotte Islands specimens are small (D<2 cm) and ontogenetic changes are not visible.

**Occurrence.** *Grammoceras thouarsense* is represented in North America by 20 specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 68, 87, 104). *Grammoceras thouarsense* is associated with *Podagrosites latescens* (Simpson) and *Phymatoceras hillebrandti* from the Upper Toarcian Hillebrandti Zone.

*Grammoceras thouarsense* is known from the Upper Toarcian (Thourarsense Zone) of northwestern Europe (Fischer, 1966; Schlegelmilch, 1976).

**Genus *Podagrosites* Guex, 1973b**

*Type species. Pseudogrammoceras podagrosum* Monestier, 1921, neotype figured by Guex, 1973b, Pl. 1, fig. 9.

*Remarks.* Evolute shell; subquadrate whorl section. Venter carinate-sulcate. Ornamentation consists of coarse, sharp, slightly sinuous ribs that commonly bifurcate at umbilical shoulder.

*Podagrosites* was proposed by Guex (1973b) to include those *Pseudogrammoceras* of the Upper Toarcian that have subquadrate whorls and a carinate-bisulcate venter.

*Age and distribution.* *Podagrosites* is known from France (Guex, 1973b; Gabilly, 1975) and Spain (Goy and Martínez, 1990). It ranges in age from the Variabilis Zone (Middle Toarcian) to the Insigne Zone (Late Toarcian).

*Podagrosites latescens* (Simpson, 1843)

Plate 7, figures 1-4, 7, 8; Plate 8, figures 1, 2, 8-15

- \* 1843 *Ammonites latescens* SIMPSON, p. 54, 55.
- 1874 *Ammonites grunowi* Hauer. DUMORTIER, p. 67, Pl. 15, fig. 1, 2 [non Pl. 14, fig. 6, 7].
- 1913 *Pseudogrammoceras latescens* (Simpson). BUCKMAN, Pl. 79 [holotype refigured].
- 1975 *Podagrosites latescens pseudogrunowi*, GUEX, p. 105, 106, Pl. 3, fig. 7, 8, 12, Pl. 4, fig. 1, 3.
- 1975 *Pseudogrammoceras latescens* (Simpson). GABILLY, p. 132-135, Pl. 22, fig. 2, 3, Pl. 23, fig. 9, 10.
- 1975 *Pseudogrammoceras aratum* (Buckman). GABILLY, p. 122-126, Pl. 29, fig. 1, 2.
- cf. 1983 *Grammoceras aratum* (Buckman). KNITTER and OHMERT, Pl. 1, fig. 5.
- 1983 *Pseudogrammoceras quadratum* (Quenstedt). KNITTER and OHMERT, Pl. 1, fig. 11.
- 1994 *Podagrosites latescens* (Simpson). JAKOBS et al., Pl. 4, fig. 1-6, 15, 16.
- 1995 *Podagrosites* aff. *latescens* (Simpson). JAKOBS et al., Pl. 1, fig. 5.

Measurements.

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 99488	40.8	15.5	38.0	14.0	11.9	0.85	13
GSC 99488	—	11.2	—	10.0	9.5	0.95	—
GSC 107334	63.0	25.7	40.8	22.3	16.9	0.76	17
GSC 107335	27.8	11.2	40.3	9.8	8.6	0.88	14
GSC 108398	128.3	51.7	40.3	44.5	N27.6	N0.62	13
GSC 108399	94.5	42.0	44.4	29.1	—	—	18
GSC 108400	122.9	51.3	41.7	42.3	31.3	0.74	18
GSC 108402	57.1	25.3	44.3	19.6	14.7	0.75	18
GSC 108419	—	—	—	46.8	36.4	0.78	—
GSC 108440	>130	74.3	—	—	—	—	15
GSC108441	118.9	53.9	45.3	37.2	28.4	0.76	19
GSC 108442	43.5	17.3	39.8	16.5	—	—	16
GSC 108443	N126.0	N56.0	N45	—	—	—	N19
GSC 108444	—	—	—	40.2	31.8	0.79	—

*Description.* Evolute shell; rectangular whorl section. Umbilical wall flat and moderately inclined; umbilical shoulder rounded but distinct. Flanks flat to gently convex. Venter carinate-sulcate, ventral sulci fade during ontogeny.

Ornamentation coarse. Ribs almost rectiradiate on inner whorls projecting forward as they approach the venter. Ribs sinuous on outer whorls and trend prorsiradiately on lower flank. Ribs moderately distant and sharp on inner whorls, becoming more rounded on outer whorls. Inter-rib spaces concave and wider than ribs, which tend to thicken as they approach the venter. Some ribs on outer whorls may bifurcate at or near umbilical shoulder.

*Discussion.* Gabilly (1975) included in *Pseudogrammoceras latescens* several forms that Guex (1975) separated out as distinct species, including *Podagrosites bodei* (Denckmann) and *Podagrosites latescens pseudogrunowi* Guex. These species have sinuous ribbing, distinguishing them from *Podagrosites latescens* which has more rectiradiate ribbing. The North American specimens have variations in ribbing density, a common characteristic of similar taxa (e.g., *Podagrosites latescens pseudogrunowi*). Many of the North American specimens are preserved as incomplete whorl fragments and ontogenetic variation patterns are not visible.

*Occurrence.* *Podagrosites latescens* is represented in North America by 21 specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 62, 68, 87, 104; Isolated

Loc. M-2). It is associated with *Phymatoceras hillebrandti* and *Grammoceras thouarsense* from the Upper Toarcian Hillebrandti Zone.

*Podagrosites latescens* is known from the Upper Toarcian of France, England, and Germany from the Thouarsense Zone to the Insigne Zone (Buckman, 1913; Gabilly, 1975; Guex, 1975; Elmi and Rulleau, 1991).

Family PHYMATOCERATIDAE Hyatt, 1867

Subfamily PHYMATOCERATINAE Hyatt, 1900

Genus *Phymatoceras* Hyatt, 1867

*Synonyms.* See Donovan et al., 1981, p. 141.

*Type species.* *Phymatoceras robustum* Hyatt, 1867, p. 88, (= *Ammonites tirolensis* Dumortier, 1874, Pl. 24, fig. 1, 2, non Hauer), subsequent designation by Hyatt, 1900.

*Remarks.* Evolute planulate; subquadrate to subrectangular whorl section. Venter carinate-sulcate; sulci fade during ontogeny. Ribs more or less sigmoidal and mostly twinned or triploid from umbilical tubercles.

*Age and distribution.* *Phymatoceras* is found almost worldwide from the Middle and Upper Toarcian (Arkell et al., 1957).

*Phymatoceras* cf. *P. erbaense* (Hauer, 1856)

Plate 13, figures 10, 11

- \* cf. 1856 *Ammonites erbaensis* HAUER, Pl. 11, fig. 10-14.
- cf. 1976 *Phymatoceras erbaense* (Hauer). SCHLEGELMILCH, p. 86, Pl. 44, fig. 6.

*Measurements.*

SPECIMEN	WH	WW	WWW
GSC 108416	37.2	34.2	0.92
GSC 108416	41.8	38.4	0.92
GSC 108445	39.2	31.4	0.80
GSC 108446	55.7	45.3	0.81
GSC 108447	56.1	46.0	0.82

*Description.* Evolute shell; subquadrate whorl section. Umbilical wall steep; umbilical shoulder rounded but abrupt. Flanks gently convex. Ventrolateral shoulder rounded but abrupt; venter moderately broad, carinate-sulcate; ventral sulci fade during ontogeny.

Ornamentation coarse and prominent. Ribs begin at umbilical shoulder, are rectiradiate or slightly rursiradiate on flank and curve forward near ventrolateral shoulder. Ribs rounded and narrower than inter-ribs spaces.

*Discussion.* The North American specimens are body chamber fragments and show similarities to *Phymatoceras lilli* (Hauer) and *P. erbaense*, which have similar ribbing patterns and whorl sections. *Phymatoceras lilli* is distinguished from *P. erbaense* by more regular ornamentation, a smaller umbilicus and no ventral sulci. The North American specimens are larger than the holotypes of either *P. lilli* or *P. erbaense* and the absence of complete specimens makes identification difficult.

*Occurrence.* *Phymatoceras* cf. *P. erbaense* is best represented in North America by six whorl fragments from siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 56, 66, 68, 104, Isolated Loc. M-6). It has been collected in the Spatsizi River map area (Section 2, Loc. 14). It is associated with *Phymatoceras* cf. *P. rude* (Simpson), *Phymatoceras crassicosta*, *Phymatoceras hillebrandti*, *Grammoceras* sp., and *Podagrosites* sp. from the Middle and Upper Toarcian (Crassicosta and Hillebrandti zones).

*Phymatoceras erbaense* is known from the Variabilis Zone (Middle Toarcian) and Thouarsense Zone (Upper Toarcian) of southern Germany (Schlegelmilch, 1976) and Austria (Fischer, 1966).

*Phymatoceras crassicosta* Merla, 1933

Plate 12, figures 3, 4; 11-14, Plate 13, figures 2, 3

- 1867-81 *Ammonites comensis* Buch. MENEGHINI, p. 26, Pl. 7, fig. 3.
- \* 1933 *Phymatoceras crassicosta* MERLA, p. 31, 32, Pl. 3, fig. 11.
- 1933 *Denckmannia cornucopia* MERLA, p. 22, 23, Pl. 2, fig. 4, 6-8, Pl. 8, fig. 6.
- 1994 *Phymatoceras crassicosta* (Merla). JAKOBS et al., Pl. 3, fig. 5, 6.
- 1995 *Phymatoceras crassicosta* (Merla). JAKOBS et al., Pl. 1, fig. 7.



Measurements.

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 107323	39.4	16.0	40.6	13.6	12.1	0.89	15
GSC 108411	-	-	-	18.1	15.4	0.85	-
GSC 108412	56.4	20.6	36.5	21.8	17.9	0.82	8
GSC 108412	-	9.4	-	-	-	-	10
GSC 108421	-	-	-	20.7	14.7	0.71	-
GSC 108448	-	-	-	15.3	12.4	0.81	-
GSC 108449	-	-	-	9.0	9.4	1.04	-
GSC 108450	-	-	-	35.6	27.6	0.78	-
GSC 108451	-	-	-	21.0	15.5	0.74	-
GSC 108452	28.0	10.0	35.7	10.2	10.1	0.99	9
GSC 108453	40.6	16.4	40.4	15.0	12.7	0.85	-
GSC 108453	-	-	-	9.0	9.5	1.06	-

*Description.* Moderately evolute shell; quadrate whorl section on inner whorls, rectangular on outer whorls. Umbilical wall steep, almost vertical in larger specimens. Flanks gently convex to flat; ventrolateral shoulder rounded. Venter carinate-sulcate; ventral sulci fade on outer whorls.

Prominent, moderately dense ribs arise in pairs from umbilical tubercles. Ribs trend almost rectiradiately up flanks and curve forward slightly as they approach venter. Single ribs may appear between paired ribs, but are less common on inner whorls.

*Discussion.* Merla (1933) described several species of *Phymatoceras* that have similar ribbing patterns and whorl sections as the North American specimens. *Phymatoceras pulcher* Merla and *P. anomalum* Merla generally have more densely spaced ribs than the North American specimens.

*Occurrence.* *Phymatoceras crassicosta* is best represented in North America by 27 specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 41, 47, 54, 55, 59, 61, 104; Section 8, Loc. 4; Isolated Loc. M-4, M-6). It has also been collected in the Hazelton map area (Isolated Loc. G-10). It is associated with *Phymatoceras* cf. *P. pseudoerbaense*, *Phymatoceras* cf. *P. rude*, *Phymatoceras* cf. *P. erbaense*, *Denckmannia* cf. *D. tumefacta*, *Pseudomercaticeras* cf. *P. frantzi* (Reynès), *Merlites* cf. *M. alticarinatus* (Merla), *Polyplectus discoides*, and *Peronoceras* cf. *P. moerickei* from the Crassicosta Zone of the Middle Toarcian. Poorly preserved specimens of *Phymatoceras* cf. *P. crassicosta* are known from the Queen Charlotte Islands (Section 7, Loc. 62, 68, 104; Isolated Loc. M-4, M-6) and the Spatsizi River map area (Isolated Loc. E-5).

*Phymatoceras crassicosta* is known from the Middle Toarcian (Erbaense Zone) of Italy (Merla, 1933; Donovan, 1958; Pinna, 1973).

*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly, 1975)

Plate 13, figures 1, 8, 9

- \*cf. 1975 *Denckmannia pseudoerbaensis* GABILLY, p. 54, 55, Pl. 4, fig. 1, 2.  
 1987 *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly). HILLEBRANDT, Pl. 10, fig. 4, Pl. 11, fig. 1, 2.  
 1994 *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly). JAKOBS et al., Pl. 3, fig. 16, 17.

Measurements.

SPECIMEN	D	UD	WH	WW	WWWH	PRHW
GSC 107332	-	-	12.0	13.8	1.15	-
GSC 108413	-	37.4	-	-	-	N10
GSC 108413	-	34.0	-	-	-	N9
GSC 108413	-	29.4	-	-	-	N9
GSC 108413	-	26.5	-	-	-	N9
GSC 108454	-	-	37.0	33.7	0.91	-
GSC 108455	-	-	25.0	26.1	1.04	-
GSC 108456	-	-	67.0	54.4	0.81	-
GSC 108456	-	39.3	-	-	-	-
GSC 108457	-	-	37.1	35.0	0.94	-
GSC 108458	-	-	23.0	26.9	1.17	-
GSC 108459	36.0	-	10.0	12.0	1.20	-

*Description.* Evolute shell; whorl section subquadrate on inner whorls, becoming quadrate to subrectangular on outer whorls. Umbilical wall steep; umbilical shoulder rounded. Flanks convex; ventrolateral shoulder rounded. Venter carinate-sulcate; ventral sulci fade on outer whorls.

Ornamentation coarse and strong. Prominent umbilical tubercles present at irregular intervals on inner whorls; tubercles fade on outer whorls. Two to three secondary ribs arise from tubercles and are slightly sinuous, projecting forward at ventrolateral shoulder. Pairs of ribs and single ribs may arise at umbilical shoulder without tubercles. On inner whorls, a constriction is often observed before tuberculate ribs.

*Discussion.* *Phymatoceras* cf. *P. pseudoerbaense* belongs to a group of *Phymatoceras* that differ from each other only in the coarseness and regularity of their ornamentation. The inadequate number and condition of the North American specimens makes a confident identification difficult. *Phymatoceras erbaense* generally has fewer tubercles than the North American specimens and the tubercles are separated by five or six single ribs. *Phymatoceras iserense* (Buckman) possesses strong rursiradiate ribbing. *Phymatoceras rude* is similar to the North American specimens in terms of the coarseness of ornamentation and the whorl section, but tends to have more regular ornamentation. *Phymatoceras robustum* Hyatt has flatter flanks and fewer tubercles on the outer whorls.

*Occurrence.* *Phymatoceras* cf. *P. pseudoerbaense* is best represented in North America by 18 specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 27, 29, 34, 37, 43, 44, 52, 54, 104; Section 8, Loc. 14; Isolated Loc. M-4). It has been collected in the southern Canadian Rocky Mountains (Isolated Loc. I-10). It is associated with *Phymatoceras crassicosta*, *Rarenodia planulata*, *Denckmannia* cf. *D. tumefacta*, *Pseudomercaticeras* cf. *P. frantzi*, *Merlaites* cf. *M. alticarinatus*, *Leukadiella ionica*, *Polyplectus discoides*, and *Peronoceras* cf. *P. moerickei* from the Middle Toarcian (Planulata Zone to Crassicosta Zone).

*Phymatoceras pseudoerbaense* is known from the Middle Toarcian (Variabilis Zone) of France (Gabilly, 1975). *Phymatoceras* cf. *P. pseudoerbaense* is known from the Middle Toarcian (Toroense Zone) of South America (Hillebrandt, 1987).

*Phymatoceras* cf. *P. rude* (Simpson, 1843)

Plate 10, figures 3-7

- \*cf. 1843 *Ammonites rudis* SIMPSON, p. 44.
- cf. 1910 *Denckmannia rudis* (Simpson).  
BUCKMAN, Pl. 14 [holotype refigured].
- cf. 1966 *Phymatoceras* (*Phymatoceras*) *rude*  
(Simpson). KOTTEK, p. 43, 44, Pl. 1, fig. 3.
- cf. 1975 *Denckmannia rudis* (Simpson). GABILLY,  
p. 57-59, Pl. 6, fig. 1, 2, Pl. 9, fig. 1, 2.
- 1994 *Phymatoceras* cf. *P. rude* (Simpson).  
JAKOBS et al., Pl. 3, fig. 13.

*Measurements.*

SPECIMEN	WH	WW	WWWH
GSC 108404	17.1	19.3	1.13
GSC 108404	14.9	15.6	1.05
GSC 108405	16.8	18.7	1.11
GSC 108405	16.3	17.3	1.06
GSC 108460	15.9	N15.2	N0.96

*Description.* Evolute shell; umbilical wall steep to moderately gentle. Flanks gently convex; venter carinate with shallow ventral sulci.

Coarse ribs trend rectiradiately or rursiradiately on flanks and curve forward slightly as they approach venter. Primary ribs begin on umbilical wall and coarsen, on lower third and half of flank, into elongate bullae that give rise to two secondary ribs. Single rib may occur between bifurcate pairs. Ribs distant; inter-rib spaces as wide as ribs.

*Discussion.* The North American specimens are similar to coarsely ribbed species of *Phymatoceras* such as *Phymatoceras robustum* (Denckmann) and *Phymatoceras rude*. Gabilly (1975, p. 59) noted that differences between *P. robustum* and *P. rude* do not become readily apparent until the shell reaches 60 mm in diameter. The whorl section of *P. rude* remains subquadrate (WW>WH) to a diameter of 70 to 80 mm, but in *P. robustum*, the subquadrate whorl section persists to a diameter of 110 to 120 mm. *Phymatoceras robustum* differs from *P. rude* by being more evolute, more strongly and irregularly ribbed, and by having deeper ventral sulci.

*Occurrence.* *Phymatoceras* cf. *P. rude* is best represented in North America by 20 specimens from shales of the Last Creek formation in the Taseko Lakes map area (Isolated Loc. K-1, K-2). It has been collected in the Queen Charlotte Islands (Section 7, Loc. 56, 61; Isolated Loc. M-6) and the Hazelton map area (Isolated Loc. G-10). It is associated with *Phymatoceras crassicosta* and *Phymatoceras* cf. *P. erbaense* from the Crassicosta Zone of the Middle Toarcian.

*Phymatoceras rude* is known from the Middle Toarcian of Europe: the Bayani Zone (*Phymatoceras rude* Subzone) of Greece (Kottek, 1966), and the Variabilis Zone of France (Gabilly, 1975), southern Germany (Schlegelmilch, 1976), and Austria (Fischer, 1966).

**Genus *Rarenodia* Venturi, 1975a**

*Type species.* *Rarenodia planulata* Venturi, 1975a, p. 13, Pl. 1, fig. 7, by original designation.

*Remarks.* Evolute planulate; subquadrate to subrectangular whorl section. Venter carinate-sulcate; ventral sulci fade on outer whorls. Ribs more or less sigmoidal and generally bifurcate or trifurcate from umbilical tubercles.

*Rarenodia* is *Hammatoceras*-like possessing straight ribs, tubercles low on the flanks, and a carinate venter with no ventral sulci or well-defined ventrolateral shoulders (Venturi, 1975a). *Phymatoceras narbonense* is somewhat similar but its secondary ribs have a distinct rursiradiate arch. *Denckmannia obliquata* (Young & Bird), as figured by Gabilly (1975), is similar but has prorsiradiate bullae that give rise to only two ribs. The type specimen of *D. obliquata* figured by Buckman (Buckman, 1921) is more evolute and compressed and has a more gently inclined umbilical wall than *Rarenodia*. Venturi (1975a) erected two new species within *Rarenodia* and noted their similarity to *Hammatoceras*.

*Age and distribution.* *Rarenodia* is known from the Lower and Middle Toarcian (Falcifer and Mercati zones) of Italy (Venturi, 1975a).

*Rarenodia planulata* Venturi, 1975a

Plate 10, figures 1, 2; Plate 11, figures 1, 2;  
Plate 12, figures 1, 2, 5-8

- \* 1975a *Rarenodia planulata* VENTURI, p. 13-15, Pl. 1, fig. 3, 6-9, text-fig. 3-5.
- 1994 *Rarenodia planulata* Venturi. JAKOBS et al., Pl. 2, fig. 21, 22.
- 1995 *Rarenodia planulata* Venturi. JAKOBS et al., Pl. 1, fig. 4.

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 99486	50.2	20.9	41.6	17.3	13.8	0.80	N8
GSC 99486	—	11.6	—	10.9	—	—	8
GSC 108403	—	—	—	33.7	24.2	0.72	—
GSC 108407	70.5	27.0	38.3	15.3	—	—	13
GSC 108407	—	—	—	35.0	24.6	0.70	—

*Description.* Evolute, discoidal shell; oval to ellipsoidal whorl section. Umbilical wall steep to vertical; umbilical shoulder rounded but moderately abrupt. Convex to flattish flanks converge toward carinate venter.

Broad, faint, primary ribs arise on umbilical wall. Umbilical tubercles faint on innermost and outermost whorls. Two or three rectiradiate secondary ribs arise from tubercles and trend rectiradiately up the flanks to the keel. Secondary ribs may be slightly sinuous on lower part of flanks. Ribs blunt and approximately as wide as inter-rib spaces.

*Discussion.* *Rarenodia latecostata* has a gentler umbilical wall and fainter ribs on the lower part of the flank than *Rarenodia planulata*. *Rarenodia planulata* is identical to the North American specimens although the specimens figured by Venturi (1975a) are slightly smaller.

*Occurrence.* *Rarenodia planulata* is best represented in North America by 105 specimens from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 5, Loc. 3, 4, 7, 9, 10, 13; Section 6, Loc. 14, 22; Section 7, Loc. 14, 18, 19, 21, 22, 24, 25, 26, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 41, 104; Section 9, Loc. 10, 11, 17; Isolated Loc. M-3, M-4). It has been collected in the Spatsizi River (Section 2, Loc. 6), McConnell Creek (Section 4, Loc. 2), and Hazelton (Isolated Loc. G-3, G-9, G-10, G-11)

map areas. It is associated with *Phymatoceras* cf. *P. pseudo-erbaense*, *Denckmannia* cf. *D. tumefacta*, *Peronoceras* cf. *P. verticosum*, and *Leukadiella ionica* from the Planulata Zone of the Middle Toarcian. Poorly preserved specimens of *Rarenodia* cf. *R. planulata* are also known from the Spatsizi River map area (Section 2, Loc. 14; Isolated Loc. E-7).

*Rarenodia planulata* is known from the Middle Toarcian (Mercati Zone) of Italy (Venturi, 1975a).

**Genus** *Pseudomercaticeras* Merla, 1933

*Synonyms.* See Donovan et al., 1981, p. 141.

*Type species.* *Pseudomercaticeras parvilibum* Merla, 1933, p. 41, Pl. 5, fig. 13, subsequent designation by Arkell et al., 1957.

*Remarks.* Evolute shell; subquadrate to rectangular whorl section. Venter carinate-sulcate. Umbilical tubercles present on inner whorls and give rise to two or more ribs. Ribs fade on lower flanks of outer whorls.

*Pseudomercaticeras* is similar to some *Phymatoceras*, but has ribs that fade on the outer whorls. *Pseudomercaticeras* has been included as a subgenus of *Mercaticeras* (Venturi, 1975b; Kottek, 1966) but Donovan et al. (1981) considered it to be a separate genus. *Mercaticeras* generally has a subquadrate to quadrate whorl section and thicker ribs that rarely reach the umbilical shoulder in pairs. *Pseudomercaticeras* has a rectangular whorl section, bifurcate ribs, and umbilical swellings. *Merlites* is more involute than *Pseudomercaticeras* and has shallower ventral sulci and more common and prominent umbilical tubercles.

*Age and distribution.* *Pseudomercaticeras* is known from the Middle Toarcian (Variabilis Zone) of Italy, Greece, Hungary, southern France, and Spain (Merla, 1933; Géczy, 1966; Kottek, 1966; Pinna, 1968; Guex, 1972; Venturi, 1975b; Goy and Martínez, 1990; Elmi and Rulleau, 1991).

*Pseudomercaticeras* cf. *P. frantzi* (Reynès, 1868)

Plate 13, figures 4-7

- \* cf. 1868 *Ammonites frantzi* REYNÈS, p. 108, Pl. 5, fig. 6.
- 1926 *Hildoceras (Brodiceras) comense* (Buch.) JAWORSKI, p. 239-242, Pl. 1, fig. 9a-e.
- cf. 1933 *Pseudomercaticeras* cf. *frantzi* (Reynès). MERLA, p. 39, 40, Pl. 5, fig. 12.
- cf. 1968 *Pseudomercaticeras frantzi* (Reynès). PINNA, p. 84, Pl. 11, fig. 8, 10, 11, 13.
- cf. 1975b *Pseudomercaticeras venzoi* Pinna. VENTURI, Pl. 29, fig. 4, 8, 9.

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 108414	–	–	–	20.0	17.4	0.87	–
GSC 108461	82.0	34.4	42.0	N29.3	–	–	14
GSC 108461	–	–	–	21.4	18.8	0.88	–

*Description.* Moderately evolute shell; subrectangular whorl section. Umbilical wall steep; umbilical shoulder rounded but abrupt. Flanks gently convex becoming flatter on outer whorls. Ventrolateral shoulder rounded; venter carinate-sulcate.

Ribs begin on umbilical wall and are slightly prorsiradiate on lower fifth of flank, then trend rectiradiately to approximately four-fifths the flank height and curve forward to the venter. Approximately every second rib bifurcates at one-fifth the flank height. Furcation points may have tubercles or swellings on inner whorls. Ribs fainter on lower flanks, becoming more prominent on upper flanks; ribs narrower than inter-rib spaces.

*Discussion.* The North American specimens are similar to *Pseudomercaticeras venzoi* Pinna and *P. frantzi*. *Pseudomercaticeras venzoi* tends to have shallower ventral sulci and denser ribbing than *P. frantzi*.

*Occurrence.* *Pseudomercaticeras* cf. *P. frantzi* is best represented in North America by four fragments from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 49, 104; Isolated Loc. M-4). It has been collected in the Spatsizi River map area (Section 3, Loc. 12). It is associated with *Phymatoceras crassicosta* and *Phymatoceras* cf. *P. pseuderbaense* from the Crassicosta Zone of the Middle Toarcian.

*Pseudomercaticeras frantzi* is known from the Middle Toarcian of southern Europe: the Variabilis Zone of Spain (Goy and Martínez, 1990) and France (Guex, 1972; Elmi and Rulleau, 1991), the Bayani Zone of Greece (Kottek, 1966), and the Erbaense Zone of Italy (Pinna, 1968).

**Genus *Merlaites* Gabilly, 1974**

*Type species.* *Brodiceras alticarinum* Merla, 1933, p. 37, Pl. 4, fig. 11, by original designation.

*Remarks.* Involute shell; ogival whorl section. Venter bears non-septate keel; ventral sulci present. Sigmoidal ribs fade on the lower part of the flanks.

*Merlaites* was erected by Gabilly (1974) to include Mediterranean forms, previously included within *Brodieia*, that could be distinguished by their carinate-sulcate venter and non-tuberculate ribs that fade on the lower flanks. The “alticarinata” group of *Brodieia*, now included within *Merlaites*, are thought to have evolved from *Pseudomercaticeras*, and *Pseudomercaticeras* from *Mercaticeras* (Gabilly, 1974). *Merlaites* and *Pseudomercaticeras* share many common

features and a confident identification of the four incomplete specimens from the Queen Charlotte Islands is difficult. Generally *Pseudomercaticeras* is more evolute and has a more quadrate whorl section than *Merlaites*.

*Age and distribution.* *Merlaites* is known from the Middle Toarcian of Europe (Merla, 1933; Géczy, 1966; Kottek, 1966; Venturi, 1972; Gabilly, 1974), northern Africa (Elmi et al., 1974), and South America (Hillebrandt, 1979).

*Merlaites* cf. *M. alticarinum* (Merla, 1933)

Plate 16, figures 3, 4

- \* cf. 1933 *Brodiceras alticarinum* MERLA, p. 37, 38, Pl. 4, fig. 11, Pl. 5, fig. 1-3, Pl. 7, fig. 8.
- cf. 1966 *Brodieia alticarinata horvathae* GÉCZY, p. 25, 26, Pl. 2, fig. 4.
- cf. 1972 *Brodieia alticarinata* (Merla). VENTURI, p. 222-224, Pl. 42, fig. 12, 14-16.
- cf. 1974 *Merlaites* (“*Brodieia*”) *alticarinum* (Merla). ELMI et al., Pl. 6, fig. 5, *non*. Pl. 6, fig. 2.
- cf. 1974 *Merlaites alticarinum* (Merla). GABILLY, fig. 1-3.
- 1994 *Merlaites* cf. *M. alticarinum* (Merla). JAKOBS et al., Pl. 3, fig. 1, 2.

*Measurements.*

SPECIMEN	D	UD	U	WH	WW	WWWH	PRHW
GSC 107321	–	–	–	27.0	19.5	0.72	–
GSC 107321	–	–	–	32.0	21.4	0.67	–
GSC 108462	57.4	13.6	23.7	27.0	21.5	0.80	–
GSC 108462	–	–	–	25.5	19.8	0.78	–
GSC 108462	–	–	–	18.0	16.5	0.92	–
GSC 108463	–	–	–	20.5	16.7	0.81	–
GSC 108463	–	–	–	23.0	19.0	0.83	–
GSC 108464	93.6	32.4	34.6	–	–	–	20

*Description.* Moderately involute shell; subrectangular whorl section, quadrate inner whorls. Umbilical wall moderately steep; umbilical shoulder rounded but distinct. Flanks gently convex on inner whorls becoming flatter on outer whorls. Ventrolateral shoulder rounded and abrupt. Venter carinate-sulcate bearing prominent non-septate keel; ventral sulci fade on outer whorls.

Gently sigmoidal ribs commonly join in pairs at umbilical swellings. Ribs strong on upper flank and faint, or absent, on lower flank, especially on body chamber.

*Discussion.* The absence of complete specimens in North America prevents a confident specific identification. The North American specimens are similar to *M. alticarinatus*, possessing a subrectangular whorl section and ribs that fade on the lower flank. Species of *Brodieia* generally have more prominent umbilical tubercles and stronger ribs on the lower flanks. A ventral view of *Merlites alticarinatus* was not given by Merla (1933) or Kottek (1966), although the latter states that the species has weak depressions along the venter instead of actual sulci.

*Occurrence.* *Merlites* cf. *M. alticarinatus* is best represented in North America by four fragments from calcareous concretions and siltstones of the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 51; Section 8, Loc. 1, 2, 3). It has been collected in the Spatsizi River map area (Section 3, Loc. 10, 12). It is associated with *Phymatoceras crassica* and *Phymatoceras* cf. *P. pseudoerbaense* from the Crassica Zone of the Middle Toarcian.

*Merlites alticarinatus* is known from the Middle and Upper Toarcian of Europe: the Bayani Zone (*Phymatoceras rude* Subzone) of Greece (Kottek, 1966), the Thouarsense Zone of Austria (Fischer, 1966), and the Rudis Zone of Italy (Pinna, 1968). It is also known from the Middle Toarcian (Gradata Zone - *Alticarinata* Subzone) of Algeria (Elmi et al., 1974).

#### Genus *Denckmannia* Buckman, 1898

*Type species.* *Denckmannia tumefacta* Buckman, 1898, p. xvii-xix, Pl. 1, fig. 7-10, by original designation.

*Remarks.* Moderately evolute shell; quadrate to subrectangular whorl section. Venter carinate. Ornamentation strong, characterized by more or less regular umbilical tubercles or bullae.

*Denckmannia* was established as a genus by Buckman (1898, p. xvii) and was distinguished from *Lillia* by being less compressed, more involute, and with more pronounced ornamentation. Donovan (1954, p. 18) synonymized *Denckmannia* with *Chartronia* Buckman, 1898, a genus which has page precedence over *Denckmannia*. Arkell et al. (1957) synonymized *Denckmannia* and *Chartronia* with *Phymatoceras*. Donovan (1958, p. 54) reduced *Chartronia* to a subgenus of *Phymatoceras* and restricted *Phymatoceras* s.s. to species in which the inner whorls "have periodic constrictions which are preceded by paired ribs meeting in an umbilical tubercle, these ribs often being more prominent than others". *Chartronia* was defined as having a continuous row of umbilical tubercles and no constrictions (Donovan, 1958, p. 54). Gabilly (1975) and Guex (1975) maintained that *Denckmannia* was distinct from *Phymatoceras*. Gabilly (1975, p. 46-48) stated that *Denckmannia* could be distinguished by its more involute shell shape, its well-developed tubercles and its higher stratigraphic position (Variabilis Zone). Donovan et al.

(1981) discounted this and included it under *Phymatoceras*. The type species of *Denckmannia* as illustrated by Buckman (1898, Pl. 1, fig. 7-10) lacks the strong umbilical tubercles on the inner whorls that characterizes *Chartronia*. Gabilly (1975) also separated *Chartronia* from both *Phymatoceras* and *Denckmannia* based on its ornamentation and suture line.

The North American specimens differ from *Phymatoceras* s.s. in ribbing, whorl section, and venter, yet also differ from species which have previously been included in *Denckmannia* (*D. rudis*, *D. robusta*). The definition of *Denckmannia* used here includes forms that lack ventral sulci and possess a tall keel.

*Age and distribution.* *Denckmannia* is common in the Middle Toarcian (Variabilis Zone) of Europe (Gabilly, 1975).

#### *Denckmannia* cf. *D. tumefacta* Buckman, 1898

Plate 16, figures 1, 2, 5, 6, 9-14

- \* cf. 1898 *Denckmannia tumefacta* BUCKMAN, Pl. 1, fig. 7-10.
- 1966 *Phymatoceras erbaense* (Hauer). BEHMEL and GEYER, p. 25, Pl. 2, fig. 6, Pl. 4, fig. 1, Pl. 6, fig. 22.
- cf. 1972 *Denckmannia* cf. *tumefacta* Buckman. GUEX, Pl. 4, fig. 2.
- cf. 1975 *Denckmannia* cf. *tumefacta* Buckman. GUEX, p. 110, Pl. 7, fig. 11.
- 1994 *Denckmannia* cf. *D. tumefacta* Buckman. JAKOBS et al., Pl. 2, fig. 17, 18, Pl. 3, fig. 8, 9.

#### Measurements.

SPECIMEN	D	UD	U	WH	WW	WWW	PRHW
GSC 107320	-	-	-	29.6	21.0	0.71	-
GSC 107326	43.9	20.0	45.6	14.4	13.3	0.92	N10
GSC 107326	35.8	14.8	41.3	11.4	10.5	0.92	N13
GSC 108386	-	-	-	10.7	9.7	0.91	-
GSC 108408	-	-	-	10.6	9.5	0.90	-
GSC 108423	22.6	7.9	35.0	8.2	9.6	1.17	14
GSC 108423	17.1	5.7	33.3	7.8	8.2	1.05	11
GSC 108424	23.4	8.6	36.8	8.8	8.8	1.00	13
GSC 108424	17.1	6.2	36.2	6.6	7.1	1.08	-
GSC 108425	70.0	31.1	44.4	22.0	16.2	0.74	-
GSC 108465	-	-	-	12.2	9.6	0.79	-

*Description.* Moderately involute, robust shell; subquadrate inner whorls becoming oval to rectangular on outer whorls. Umbilical wall steep on inner whorls, becoming gentler on outer whorls. Flanks gently swollen; venter carinate bearing a high, hollow keel.

Ornamentation coarse and changes during ontogeny. Ribs on inner whorls single and slightly sigmoidal, arching forward toward venter. On outer whorls some ribs bifurcate near umbilical shoulder and are slightly projected along ventrolateral shoulder and fade just before the venter. Bifurcation points irregular and subdued. Tubercles and bifurcate ribs more common on outer whorls, with only occasional single ribs. Tubercles fade on outermost whorls.

*Discussion.* The high keel, non-sulcate venter, and coarse ribbing are characteristic of *Denckmannia*. Its ornamentation shows some similarities to the "lower" *Haugia* such as *Haugia navis* (Dumortier), which possess irregular tuberculation and more quadrate whorl sections (Gabilly, 1975). The North American specimens have weaker and more irregular tuberculation, which does not appear until about the fourth or fifth whorl, much later than in *Haugia navis*. Some of the larger North American specimens show the tuberculation better and are similar to specimens figured by Behmel and Geyer (1966). The Spatsizi specimens are similar to Buckman's type, but those figured by Guex (1972, 1975) and Gabilly (1975) have tubercles present at a much earlier growth stage.

*Occurrence.* *Denckmannia* cf. *D. tumefacta* is best represented in North America by a dozen specimens from calcareous concretions of the Spatsizi Formation in the Spatsizi River map area (Section 2, Loc. 9, 14; Isolated Loc. E-9). About a dozen fragments have been collected from the Whiteaves Formation in the Queen Charlotte Islands (Section 7, Loc. 29, 31, 35, 40, 45, 47, 104; Isolated Loc. M-4, M-6). *Denckmannia* cf. *D. tumefacta* is associated with *Phymatoceras* cf. *P. pseudoerbaense*, *Phymatoceras crassicosta*, *Rarenodia planulata*, *Peronoceras verticosum*, *Peronoceras pacificum*, *Peronoceras* aff. *P. moerickei*, *Peronoceras* cf. *P. moerickei*, and *Pseudolioceras lythense* from the Middle Toarcian (Planulata Zone to Crassicosta Zone).

*Denckmannia tumefacta* is known from the Middle Toarcian of Europe: the Variabilis Zone (Illustris and Vitiosa subzones) of Spain (Goy and Martínez, 1990) and the Variabilis Zone of France (Guex, 1972, 1975; Elmi and Rulleau, 1991).

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# APPENDIX

## Locality Data

### Repositories

Geological Survey of Canada collections are housed at the Geological Survey of Canada office in Calgary, Alberta.

### Identifications

Most of the collections listed below have been examined and re-identified by the author. Where the material has been previously identified in either publications or GSC Internal Fossil Reports, mention is made of that reference and whether the material was examined and re-identified. Material that was not available for re-examination retains the original identification from publications or fossil reports.

### Measured sections

Collections within each section are assigned locality numbers from the base to the top of the section. Measurements for each locality are from the base of the section.

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**Section 1** – Tulsequah map area, southwest of King Salmon Lake, north limb of Bug Mountain anticline. Latitude 58°39'N, longitude 133°05'W. Section measured and collected by H.W. Tipper, 1979. The ammonite taxa collected from each locality are summarized in Figure 12.

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- |   |   |   |   |
|---|---|---|---|
| 1 | <b>GSC loc. C-86505.</b> Takwahoni Formation; 1586 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>harpoceratinae</i> gen. et. sp. indet.<br><i>dactylioceratidae</i> gen. et sp. indet.<br>Early to Middle Toarcian – probably Kanense Zone | 4 | <b>GSC loc. C-86503.</b> Takwahoni Formation; 1697 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>Peronoceras</i> sp. indet.<br><i>Dactylioceras</i> sp. indet.<br><i>Cleviceras</i> sp. indet.<br><i>Pseudolioceras</i> sp. indet<br><i>Phylloceras</i> sp. indet.<br>bivalves<br>Middle Toarcian – Planulata Zone             |
| 2 | <b>GSC loc. C-86502.</b> Takwahoni Formation; 1632 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>Peronoceras</i> sp. indet.<br><i>Cleviceras</i> sp. indet.<br>Middle Toarcian – Planulata Zone  | 5 | <b>GSC loc. C-86504.</b> Takwahoni Formation; 1697 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>Cleviceras</i> sp. indet.<br><i>Pseudolioceras</i> sp. indet.<br><i>Peronoceras</i> sp. indet.<br><i>dactylioceratidae</i> gen. et sp. indet.<br><i>harpoceratinae</i> gen. et sp. indet.<br>Middle Toarcian – Planulata Zone |
| 3 | <b>GSC loc. C-86501.</b> Takwahoni Formation; 1638 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>Peronoceras</i> sp. indet.<br><i>Cleviceras</i> sp. indet.<br>Middle Toarcian – Planulata Zone  |   | <b>GSC loc. C-86529.</b> Takwahoni Formation; 1954.5 m above base of section.<br>Report J-3-1980-HWT – re-identified by Jakobs, 1992.<br><i>Phymatoceras</i> cf. <i>P. hillebrandti</i> Jakobs<br>Late Toarcian – Hillebrandti Zone   |

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**Section 2** – Spatsizi River map area, 0.8 miles (1.28 km) east of south end of Joan Lake. Latitude 57°29'24"N, longitude 128°52'18"W. Section measured by R.C. Thomson, 1983. The ammonite taxa collected from each locality are summarized in Figure 12.

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- 1 **GSC loc. C-90826.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member; 250 to 270 m above base of section – talus collection.  
*Hildaites murleyi* (Moxon)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone
- 2 **GSC loc. C-90741.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 270 to 290 m above base of section.  
*Leukadiella* aff. *L. ionica* Renz & Renz  
*Peronoceras verticosum* (Buckman)  
*Pseudolioceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-90742.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 270 to 290 m above base of section.  
*Leukadiella* aff. *L. ionica* Renz & Renz  
*Peronoceras pacificum* Hillebrandt  
Middle Toarcian – Planulata Zone
- GSC loc. C-90743.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 270 to 290 m above base of section.  
*Leukadiella* aff. *L. ionica* Renz & Renz  
*Peronoceras pacificum* Hillebrandt  
*Peronoceras spinatum* (Frebold)  
*Pseudolioceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-90744.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 270 to 290 m above base of section.  
*Peronoceras verticosum* (Buckman)  
Middle Toarcian – Planulata Zone
- GSC loc. C-90805.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member; 270 to 290 m above base of section  
*Peronoceras pacificum* Hillebrandt  
*Peronoceras verticosum* (Buckman)  
*Phymatoceras* sp. indet.  
bivalves  
Middle Toarcian – Planulata Zone
- 3 **GSC loc. C-90806.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member; 290 to 310 m above base of section – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Hildaites murleyi* (Moxon)  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
*Peronoceras* aff. *P. desplacei* (d'Orbigny)  
Early to Middle Toarcian
- 4 **GSC loc. C-90512.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 300 to 360 m above base of section – talus collection.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Polyplectus discoides* (Zieten)  
Middle Toarcian – probably Crassicosta Zone
- GSC loc. C-90513.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 300 to 360 m above base of section – talus collection.  
*Polyplectus discoides* (Zieten)  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian
- GSC loc. C-90514.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 300 to 360 m above base of section – talus collection.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian – probably Crassicosta Zone
- GSC loc. C-90540.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member; 300 to 360 m above base of section – talus collection.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Denckmannia* sp. indet.  
Middle Toarcian – probably Crassicosta Zone
- 5 **GSC loc. C-90809.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member; 310 m above base of section – talus collection.  
*Podagrosites* sp. indet.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 6 **GSC loc. C-90813.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 320 to 330 m above base of section – talus collection.  
*Phymatoceras* sp. indet.  
Middle to Late Toarcian
- GSC loc. C-90819.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 320 to 330 m above base of section – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata
- 7 **GSC loc. C-90808.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 323 to 327 m above base of section.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Phymatoceras* sp. indet.  
Middle Toarcian – probably Crassicosta Zone
- 8 **GSC loc. C-90816.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 330 to 350 m above base of section.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- 9 **GSC loc. C-90814.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 355 m above base of section  
*Peronoceras* aff. *P. moerickei* Hillebrandt  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Crassicosta Zone

- 10 **GSC loc. C-90815.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 359 m above base of section.  
*Polyplectus* sp. indet.  
Middle Toarcian – probably Crassicosta Zone
- 11 **GSC loc. C-103112.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 370 to 380 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 12 **GSC loc. C-90817.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 376.4 m above base of section.  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
*Podagrosites* sp. indet.  
*Polyplectus* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 13 **GSC loc. C-90818.** R.C. Thomson, 1981. Spatsizi Formation, Wolf Den Member; 391.2 m above base of section.  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 14 **GSC loc. C-90801.** H.W. Tipper, 1981. Spatsizi Formation, Wolf Den Member – talus collections.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Hildaites* sp. indet.  
*Phymatoceras* sp. indet.  
bivalves  
belemnites  
Early to Middle Toarcian
- GSC loc. C-90810.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
Middle Toarcian – Crassicosta Zone
- GSC loc. C-90811.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle to Late Toarcian
- GSC loc. C-90812.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-90822.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Peronoceras pacificum* Hillebrandt  
*Peronoceras verticosum* (Buckman)  
*Peronoceras* aff. *P. moerickei* Hillebrandt  
*Pseudolioceras lythense* (Young & Bird)  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Planulata Zone
- GSC loc. C-90846.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
*Rarenodia* cf. *R. planulata* Venturi  
*Denckmannia* sp. indet.  
Middle to Late Toarcian
- GSC loc. C-103125.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Phymatoceras* sp. indet  
Middle Toarcian – probably Crassicosta Zone
- GSC loc. C-103126.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
*Dumortieria?* sp. indet.  
Late Toarcian
- GSC loc. C-103334.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Peronoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-103339.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Hildaites* sp. indet.  
Early Toarcian – Kanense Zone
- GSC loc. C-103348.** R.C. Thomson, 1983. Spatsizi Formation, Wolf Den Member – talus collections.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone

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**Section 3** – Spatsizi River map area, 4.25 km southwest of Nation Peak. Latitude 57°37'N, longitude 128°58'W. Section measured and collected by R.C. Thomson, 1983. The ammonite taxa collected from each locality are summarized in Figure 12.

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- 1 **GSC loc. C-103144.** Spatsizi Formation; 35 to 60 m above base of section.  
*Reynesoceras?* sp. indet.  
Late Pliensbachian
- 2 **GSC loc. C-103139.** Spatsizi Formation; 75 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone

- 3 **GSC loc. C-103146.** Spatsizi Formation; 80 to 100 m above base of section.  
*Hildaites* sp. indet.  
bivalves  
Early Toarcian – Kanense Zone
- GSC loc. C-103201.** Spatsizi Formation; 80 to 100 m above base of section.  
*Cleviceras* sp. indet.  
dactylioceratidae gen. et sp. indet.  
Early Toarcian – Kanense Zone
- 4 **GSC loc. C-103137.** Spatsizi Formation; 90 m above base of section.  
*Hildaites murleyi* (Moxon)  
*Cleviceras* sp. indet.  
dactylioceratidae gen. et sp. indet.  
bivalves  
Early Toarcian – Kanense Zone
- 5 **GSC loc. C-103138.** Spatsizi Formation; 90 m above base of section – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Peronoceras* sp. indet.  
gastropods  
Middle Toarcian – probably Planulata Zone
- 6 **GSC loc. C-103143.** Spatsizi Formation; 90 to 110 m above base of section – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Hildaites murleyi* (Moxon)  
*Peronoceras verticosum* (Buckman)  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
Early to Middle Toarcian
- GSC loc. C-103202.** Spatsizi Formation; 90 to 110 m above base of section – talus collection.  
*Hildaites murleyi* (Moxon)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
*Peronoceras verticosum* (Buckman)  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- 7 **GSC loc. C-103140.** Spatsizi Formation; 95 m above base of section.  
*Hildaites murleyi* (Moxon)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
bivalves  
Early Toarcian – Kanense Zone
- 8 **GSC loc. C-103141.** Spatsizi Formation; 100 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
bivalves  
Early to Middle Toarcian
- 9 **GSC loc. C-103148.** Spatsizi Formation; 160 to 180 m above base of section – talus collection.  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian
- 10 **GSC loc. C-103150.** Spatsizi Formation; 160 to 190 m above base of section – talus collection.  
*Merlites* cf. *M. alticarinatus* (Merla)  
trigonal bivalves  
bivalves  
belemnites  
Middle Toarcian – Crassicosta Zone
- 11 **GSC loc. C-103130.** Spatsizi Formation; 180 to 195 m above base of section – talus collection.  
*Polyplectus discoides* (Zieten)  
trigonal bivalves  
Middle to Late Toarcian
- GSC loc. C-103135.** Spatsizi Formation; 180 to 195 m above base of section – talus collection.  
phymatoceratinae gen. et sp. indet.  
trigonal bivalves  
Middle Toarcian
- 12 **GSC loc. C-103134.** Spatsizi Formation – talus collection.  
*Merlites* cf. *M. alticarinatus* (Merla)  
*Pseudomercaticeras* cf. *P. frantzi* (Reynès)  
bivalves  
Middle Toarcian – Crassicosta Zone

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**Section 4** – McConnell Creek map area, ridge 178° from Mount Carruthers. Latitude 56°12'30"N, longitude 126°21'00"W. Section measured and collected by H.W. Tipper, 1975. The ammonite taxa collected from each locality are summarized in Figure 12.

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- 1 **GSC loc. 93235.** Smithers Formation; 0 to 10.5 m above base of section.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Peronoceras* sp. indet.  
*Dactylioceras* sp. indet.  
Middle Toarcian – probably Planulata Zone
- GSC loc. 93236.** Smithers Formation; 0 to 10.5 m above base of section.  
Report J-11-1976-HF – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- 2 **GSC loc. 93132.** Smithers Formation; 111.0 to 163.5 m above base of section.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Phymatoceras* sp. indet.  
*Dactylioceras* sp. indet.  
Middle Toarcian
- GSC loc. 93147.** Smithers Formation; 111.0 to 163.5 m above base of section.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Rarenodia planulata* Venturi  
*Peronoceras* sp. indet.  
Middle Toarcian – Planulata Zone



- 3 **GSC loc. 93131.** Smithers Formation; 186.0 to 193.5 m above base of section.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Collina?* sp. indet.  
*Pseudolioceras* sp. indet.  
*Phymatoceras* sp. indet.  
*Pseudomercaticeras* sp. indet.  
Middle Toarcian – Crassicosta Zone
- GSC loc. 93142.** Smithers Formation; 186.0 to 193.5 m above base of section.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 4 **GSC loc. 93133.** Smithers Formation – talus collections.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Hildaites* sp. indet.  
Early Toarcian – Kanense Zone
- GSC loc. 93149.** Smithers Formation – talus collections.  
Report J-13-1976-HF  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 93161.** Smithers Formation – talus collections.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Hildaites* sp. indet.  
Early Toarcian – Kanense Zone
- GSC loc. 93220.** Smithers Formation – talus collections.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
Middle Toarcian – Crassicosta Zone
- GSC loc. 93268.** Smithers Formation – talus collections.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. 93269.** Smithers Formation – talus collections.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
*Polyplectus* sp. indet.  
Middle Toarcian
- GSC loc. 93270.** Smithers Formation – talus collections.  
Report J-8-1976-HF – re-identified by Jakobs, 1992.  
*Hildaites* sp. indet.  
harpoceratinae  
Early Toarcian – Kanense Zone

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**Section 5** – Queen Charlotte Islands, Central Graham Island, Yakoun River. Latitude 53°25'02"N, longitude 132°15'30"W. Section measured by G.K. Jakobs, 1987. The ammonite taxa collected from each locality are summarized in Figure 36.

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|---|---|----|--|
| 1 | <b>GSC loc. C-149673.</b> G.K. Jakobs, 1987. Whiteaves Formation; 12.40 m above base of section.<br><i>Cleviceras</i> sp. indet.<br>Early Toarcian – probably Kanense Zone                                | 7  | <b>GSC loc. C-149685.</b> G.K. Jakobs, 1987. Whiteaves Formation; 24.60 m above base of section.<br><i>Rarenodia planulata</i> Venturi<br>Middle Toarcian – Planulata Zone |
| 2 | <b>GSC loc. C-149674.</b> G.K. Jakobs, 1987. Whiteaves Formation; 12.90 m above base of section.<br><i>Dactylioceras</i> sp. indet.<br>Early Toarcian – probably Kanense Zone                             | 8  | <b>GSC loc. C-149684.</b> G.K. Jakobs, 1987. Whiteaves Formation; 26.00 m above base of section.<br><i>Phymatoceras</i> sp. indet.<br>Middle Toarcian – Planulata Zone     |
| 3 | <b>GSC loc. C-149676.</b> G.K. Jakobs, 1987. Whiteaves Formation; 23.30 m above base of section.<br><i>Rarenodia planulata</i> Venturi<br><i>Cenoceras</i> sp. indet.<br>Middle Toarcian – Planulata Zone | 9  | <b>GSC loc. C-149680.</b> G.K. Jakobs, 1987. Whiteaves Formation; 26.60 m above base of section.<br><i>Rarenodia planulata</i> Venturi<br>Middle Toarcian – Planulata Zone |
| 4 | <b>GSC loc. C-149677.</b> G.K. Jakobs, 1987. Whiteaves Formation; 23.40 m above base of section.<br><i>Rarenodia planulata</i> Venturi<br>Middle Toarcian – Planulata Zone                                | 10 | <b>GSC loc. C-149681.</b> G.K. Jakobs, 1987. Whiteaves Formation; 27.60 m above base of section.<br><i>Rarenodia planulata</i> Venturi<br>Middle Toarcian – Planulata Zone |
| 5 | <b>GSC loc. C-156882.</b> G.K. Jakobs, 1988. Whiteaves Formation; 24.00 m above base of section.<br>dactylioceratidae gen. et sp. indet.<br>Middle Toarcian   | 11 | <b>GSC loc. C-149682.</b> G.K. Jakobs, 1987. Whiteaves Formation; 28.50 m above base of section.<br>dactylioceratidae gen. et sp. indet.<br>Middle Toarcian                |
| 6 | <b>GSC loc. C-149679.</b> G.K. Jakobs, 1987. Whiteaves Formation; 24.40 m above base of section.<br>dactylioceratidae gen. et sp. indet.<br>Middle Toarcian   | 12 | <b>GSC loc. C-149683.</b> G.K. Jakobs, 1987. Whiteaves Formation; 29.30 m above base of section.<br><i>Cleviceras</i> sp. indet.<br>Middle Toarcian – Planulata Zone       |

13 **GSC loc. C-90607.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

**GSC loc. C-159785.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

**GSC loc. C-159786.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone

**GSC loc. C-159796.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Phymatoceras* sp. indet.  
Middle to Late Toarcian

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**Section 6** – Queen Charlotte Islands, Central Graham Island, Yakoun River. Latitude 53°25'02"N, longitude 132°15'30"W. Section measured by G.K. Jakobs, 1987. The ammonite taxa collected from each locality are summarized in Figure 36.

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1 **GSC loc. C-158003.** G.K. Jakobs, 1987. Whiteaves Formation; 5.41 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone

2 **GSC loc. C-158004.** G.K. Jakobs, 1987. Whiteaves Formation; 6.33 m above base of section.  
*Hildaites* cf. *H. subserpentinus* Buckman  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

3 **GSC loc. C-158005.** G.K. Jakobs, 1987. Whiteaves Formation; 6.90 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

4 **GSC loc. C-158006.** G.K. Jakobs, 1987. Whiteaves Formation; 7.78 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone

5 **GSC loc. C-158007.** G.K. Jakobs, 1987. Whiteaves Formation; 8.31 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early Toarcian – Kanense Zone

6 **GSC loc. C-158011.** G.K. Jakobs, 1987. Whiteaves Formation; 21.04 m above base of section.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

7 **GSC loc. C-158013.** G.K. Jakobs, 1987. Whiteaves Formation; 21.86 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early Toarcian – Kanense Zone

8 **GSC loc. C-158014.** G.K. Jakobs, 1987. Whiteaves Formation; 21.99 m above base of section.  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

9 **GSC loc. C-158010.** G.K. Jakobs, 1987. Whiteaves Formation; 22.68 m above base of section.  
*Hildaites* sp. indet.  
Early Toarcian – Kanense Zone

10 **GSC loc. C-158015.** G.K. Jakobs, 1987. Whiteaves Formation; 31.79 m above base of section.  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

11 **GSC loc. C-158017.** G.K. Jakobs, 1987. Whiteaves Formation; 38.28 to 38.50 m above base of section.  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

12 **GSC loc. C-158021.** G.K. Jakobs, 1987. Whiteaves Formation; 56.53 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

13 **GSC loc. C-158026.** G.K. Jakobs, 1987. Whiteaves Formation; 71.80 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone

14 **GSC loc. C-158034.** G.K. Jakobs, 1987. Whiteaves Formation; 97.80 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

15 **GSC loc. C-158032.** G.K. Jakobs, 1987. Whiteaves Formation; 101.90 m above base of section.  
*Polyplectus discoides* (Zieten)  
Middle Toarcian

16 **GSC loc. C-158036.** G.K. Jakobs, 1987. Whiteaves Formation; 108.00 m above base of section.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cenoceras* cf. *C. intermedius* (Sowerby)  
bivalves  
Early to Middle Toarcian

- 17 **GSC loc. C-158037.** G.K. Jakobs, 1987. Whiteaves Formation; 108.60 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- 18 **GSC loc. C-158039.** G.K. Jakobs, 1987. Whiteaves Formation; 108.90 m above base of section.  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- 19 **GSC loc. C-158040.** G.K. Jakobs, 1987. Whiteaves Formation; 109.00 m above base of section.  
*Collina* cf. *C. linae* Parisch & Viale  
bivalves  
Middle Toarcian – probably Crassicosta Zone
- 20 **GSC loc. C-158043.** G.K. Jakobs, 1987. Whiteaves Formation; 109.60 m above base of section.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
bivalves  
Early to Middle Toarcian
- 21 **GSC loc. C-158038.** G.K. Jakobs, 1987. Whiteaves Formation; 110.80 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early to Middle Toarcian
- 22 **GSC loc. C-87203.** B.E.B. Cameron, 1980. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* sp. indet.  
Middle Toarcian
- GSC loc. C-90620.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-90625.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
*Cleviceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-90626.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collections.  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-90627.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-158008.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. C-158012.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
Early to Middle Toarcian
- GSC loc. C-158016.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Hildaites* sp. indet.  
Early Toarcian
- GSC loc. C-158027.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* sp. indet.  
harpoceratinae gen. et sp. indet.  
*Hildaites murleyi* (Moxon)  
*Phylloceras* sp. indet.  
bivalves  
Early to Middle Toarcian
- GSC loc. C-158033.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-158035.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Cleviceras* sp. indet.  
*Rarenodia planulata* Venturi  
*Hildaites* sp. indet.  
*Leukadiella* aff. *L. helenae* Renz  
*Cenoceras* cf. *C. intermedius* (Sowerby)  
bivalves  
Early to Middle Toarcian
- GSC loc. C-159778.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Hildaites* sp. indet.  
Early Toarcian
- GSC loc. C-159783.** H.W. Tipper, 1980. Whiteaves Formation – talus collections.  
*Cleviceras* sp. indet.  
Early to Middle Toarcian

**Section 7** – Queen Charlotte Islands, Central Graham Island, Yakoun River. Latitude 53°25'00"N, longitude 132°16'05"W. Section measured by G.K. Jakobs, 1987. The ammonite taxa collected from each locality are summarized in Figure 40.

- 1 **GSC loc. C-158053.** G.K. Jakobs, 1987. Whiteaves Formation; 7.90 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- GSC loc. C-159387.** G.K. Jakobs, 1989. Whiteaves Formation; 7.90 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- 2 **GSC loc. C-158054.** G.K. Jakobs, 1987. Whiteaves Formation; 8.20 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- 3 **GSC loc. C-158055.** G.K. Jakobs, 1987. Whiteaves Formation; 9.60 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- 4 **GSC loc. C-158056.** G.K. Jakobs, 1987. Whiteaves Formation; 10.30 m above base of section.  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone
- 5 **GSC loc. C-159897.** G.K. Jakobs, 1990. Whiteaves Formation; 11.00 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early Toarcian – Kanense Zone
- 6 **GSC loc. C-159388.** G.K. Jakobs, 1989. Whiteaves Formation; 11.50 m above base of section.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone
- 7 **GSC loc. C-159898.** G.K. Jakobs, 1990. Whiteaves Formation; 11.60 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- 8 **GSC loc. C-156899.** G.K. Jakobs, 1990. Whiteaves Formation; 11.70 m above base of section.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone
- GSC loc. C-176582.** G.K. Jakobs, 1990. Whiteaves Formation; 11.70 m above base of section.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone
- 9 **GSC loc. C-158057.** G.K. Jakobs, 1987. Whiteaves Formation; 12.60 m above base of section.  
*Cleviceras* sp. indet.  
Early Toarcian – Kanense Zone
- 10 **GSC loc. C-158058.** G.K. Jakobs, 1987. Whiteaves Formation; 14.20 m above base of section.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone
- 11 **GSC loc. C-156898.** G.K. Jakobs, 1990. Whiteaves Formation; 14.70 m above base of section.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early Toarcian – Kanense Zone
- 12 **GSC loc. C-87101.** H.W. Tipper, 1980. Whiteaves Formation; 15.00 to 20.00 m – interval collection.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early to Middle Toarcian – Kanense Zone to Planulata Zone
- GSC loc. C-87146.** H.W. Tipper, 1980. Whiteaves Formation; 15.00 to 20.00 m – interval collection.  
*Peronoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 13 **GSC loc. C-176575.** G.K. Jakobs, 1990. Whiteaves Formation; 15.40 m above base of section.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early Toarcian – Kanense Zone
- 14 **GSC loc. C-158059.** G.K. Jakobs, 1987. Whiteaves Formation; 15.50 m above base of section.  
*Rarenodia planulata* Venturi  
bivalves  
Middle Toarcian – Planulata Zone
- 15 **GSC loc. C-158060.** G.K. Jakobs, 1987. Whiteaves Formation; 16.00 m above base of section.  
*Cleviceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 16 **GSC loc. C-158061.** G.K. Jakobs, 1987. Whiteaves Formation; 17.70 m above base of section.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
Middle Toarcian – Planulata Zone
- GSC loc. C-159394.** G.K. Jakobs, 1989. Whiteaves Formation; 17.70 m above base of section.  
*Cleviceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 17 **GSC loc. C-159896.** G.K. Jakobs, 1990. Whiteaves Formation; 18.50 m above base of section.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
Middle Toarcian – Planulata Zone
- 18 **GSC loc. C-156379.** G.K. Jakobs, 1989. Whiteaves Formation; 19.00 m above base of section.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 19 **GSC loc. C-159389.** G.K. Jakobs, 1989. Whiteaves Formation; 21.60 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

- 20 **GSC loc. C-159890.** G.K. Jakobs, 1990. Whiteaves Formation; 22.00 m above base of section.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- GSC loc. C-159895.** G.K. Jakobs, 1990. Whiteaves Formation; 22.00 m above base of section.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- 21 **GSC loc. C-159390.** G.K. Jakobs, 1989. Whiteaves Formation; 23.00 m above base of section.  
*Rarenodia planulata* Venturi  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- 22 **GSC loc. C-158064.** G.K. Jakobs, 1987. Whiteaves Formation; 23.10 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 23 **GSC loc. C-156380.** G.K. Jakobs, 1989. Whiteaves Formation; 23.50 m above base of section.  
*Leukadiella ionica* Renz & Renz  
*Cenoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 24 **GSC loc. C-158065.** G.K. Jakobs, 1987. Whiteaves Formation 23.70 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 25 **GSC loc. C-87103.** H.W. Tipper, 1980. Whiteaves Formation; 24.00 to 26.00 m above base of section – talus collection.  
*Leukadiella ionica* Renz & Renz  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-156382.** G.K. Jakobs, 1989. Whiteaves Formation; 24.00 to 26.00 m above base of section – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 26 **GSC loc. C-158066.** G.K. Jakobs, 1987. Whiteaves Formation; 24.30 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 27 **GSC loc. C-158067.** G.K. Jakobs, 1987. Whiteaves Formation; 24.50 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Planulata Zone
- 28 **GSC loc. C-176566.** G.K. Jakobs, 1990. Whiteaves Formation; 24.70 m above base of section.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- 29 **GSC loc. C-159392.** G.K. Jakobs, 1989. Whiteaves Formation; 24.80 m above base of section.  
*Rarenodia planulata* Venturi  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Planulata Zone
- 30 **GSC loc. C-158068.** G.K. Jakobs, 1987. Whiteaves Formation; 25.00 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 31 **GSC loc. C-87104.** H.W. Tipper, 1980. Whiteaves Formation; 25.00 to 27.00 m above base of section – interval collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-87105.** H.W. Tipper, 1980. Whiteaves Formation; 25.00 to 27.00 m above base of section – interval collection.  
*Paroniceras sternale* (Buch)  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Planulata Zone
- 32 **GSC loc. C-87140.** H.W. Tipper, 1980. Whiteaves Formation; 25.00 to 35.00 m above base of section – interval collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-87141.** H.W. Tipper, 1980. Whiteaves Formation; 25.00 to 35.00 m above base of section – interval collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 33 **GSC loc. C-158069.** G.K. Jakobs, 1987. Whiteaves Formation; 25.80 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 34 **GSC loc. C-156381.** G.K. Jakobs, 1989. Whiteaves Formation; 26.00 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Planulata Zone
- 35 **GSC loc. C-90982.** H.W. Tipper, 1981. Whiteaves Formation; 26.00 to 28.00 m above base of section – interval collection.  
*Rarenodia planulata* Venturi  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Planulata Zone
- 36 **GSC loc. C-158070.** G.K. Jakobs, 1987. Whiteaves Formation; 26.20 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 37 **GSC loc. C-159393.** G.K. Jakobs, 1989. Whiteaves Formation; 26.40 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
*Phymatoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-159891.** G.K. Jakobs, 1990. Whiteaves Formation; 26.40 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 38 **GSC loc. C-176567.** G.K. Jakobs, 1990. Whiteaves Formation; 27.00 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

- 39 **GSC loc. C-159893.** G.K. Jakobs, 1990. Whiteaves Formation; 29.00 m above base of section.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- 40 **GSC loc. C-158072.** G.K. Jakobs, 1987. Whiteaves Formation; 29.30 m above base of section.  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Planulata Zone
- 41 **GSC loc. C-158073.** G.K. Jakobs, 1987. Whiteaves Formation; 30.50 m above base of section.  
*Rarenodia planulata* Venturi  
*Phymatoceras crassicoستا* Merla  
Middle Toarcian – Planulata Zone to Crassicoستا Zone
- GSC loc. C-159892.** G.K. Jakobs, 1990. Whiteaves Formation; 30.50 m above base of section.  
*Pseudomercaticeras*? sp. indet.  
Middle Toarcian – Planulata Zone to Crassicoستا Zone
- 42 **GSC loc. C-176573.** G.K. Jakobs, 1990. Whiteaves Formation; 31.00 m above base of section.  
*Phymatoceras* sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 43 **GSC loc. C-159886.** G.K. Jakobs, 1990. Whiteaves Formation; 31.50 m above base of section.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Crassicoستا Zone
- 44 **GSC loc. C-159888.** G.K. Jakobs, 1990. Whiteaves Formation; 32.50 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Crassicoستا Zone
- 45 **GSC loc. C-159400.** G.K. Jakobs, 1989. Whiteaves Formation; 33.00 m above base of section.  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Crassicoستا Zone
- 46 **GSC loc. C-81710.** H.W. Tipper, 1980. Whiteaves Formation; 35.00 to 50.00 m above base of section – interval collection.  
*Peronoceras* cf. *P. crassicoستatum* (Guex)  
*Collina* cf. *C. linae* Parisch & Viale  
*Peronoceras* cf. *P. moericki* Hillebrandt  
Middle Toarcian – Crassicoستا Zone
- GSC loc. C-87139.** H.W. Tipper, 1980. Whiteaves Formation; 35.00 to 50.00 m above base of section – interval collection.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Peronoceras* sp. indet.  
*Phymatoceras* sp. indet.  
*Cenoceras* cf. *C. intermedius* (Sowerby)  
Middle Toarcian – Crassicoستا Zone
- 47 **GSC loc. C-176568.** G.K. Jakobs, 1990. Whiteaves Formation; 35.50 m above base of section.  
*Phymatoceras crassicoستا* Merla  
Middle Toarcian – Crassicoستا Zone
- GSC loc. C-176583.** G.K. Jakobs, 1990. Whiteaves Formation; 35.50 m above base of section.  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian – Crassicoستا Zone
- 48 **GSC loc. C-157721.** G.K. Jakobs, 1987. Whiteaves Formation; 35.80 m above base of section.  
harpoceratinae gen. et sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 49 **GSC loc. C-157713.** G.K. Jakobs, 1987. Whiteaves Formation; 36.20 m above base of section.  
*Pseudomercaticeras* cf. *P. frantzi* (Reynès)  
*Phymatoceras* sp. indet.  
Middle Toarcian – Crassicoستا Zone
- GSC loc. C-159885.** G.K. Jakobs, 1990. Whiteaves Formation; 36.20 m above base of section.  
*Pseudomercaticeras* cf. *P. frantzi* (Reynès)  
Middle Toarcian – Crassicoستا Zone
- 50 **GSC loc. C-176569.** G.K. Jakobs, 1990. Whiteaves Formation; 36.50 m above base of section.  
*Phymatoceras* sp. indet.  
*Polyplectus discoides* (Zieten)  
Middle Toarcian – Crassicoستا Zone
- 51 **GSC loc. C-159887.** G.K. Jakobs, 1990. Whiteaves Formation; 37.00 m above base of section – talus collection.  
*Mercaticeras* sp. indet.  
Middle Toarcian – Crassicoستا Zone
- GSC loc. C-159889.** G.K. Jakobs, 1990. Whiteaves Formation; 37.00 m above base of section – talus collection.  
*Merlites* cf. *M. alticarinatus* (Merla)  
Middle Toarcian – Crassicoستا Zone
- 52 **GSC loc. C-159884.** G.K. Jakobs, 1990. Whiteaves Formation; 37.50 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Crassicoستا Zone
- GSC loc. C-176570.** G.K. Jakobs, 1990. Whiteaves Formation; 37.50 m above base of section.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian – Crassicoستا Zone
- 53 **GSC loc. C-157717.** G.K. Jakobs, 1987. Whiteaves Formation; 39.40 m above base of section.  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 54 **GSC loc. C-176571.** G.K. Jakobs, 1990. Whiteaves Formation; 40.00 m above base of section – talus collection.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
*Phymatoceras crassicoستا* Merla  
Middle Toarcian – Crassicoستا Zone
- 55 **GSC loc. C-176574.** G.K. Jakobs, 1990. Whiteaves Formation; 41.00 m above base of section.  
*Phymatoceras crassicoستا* Merla  
grammocerotinae gen. et sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 56 **GSC loc. C-157714.** G.K. Jakobs, 1987. Whiteaves Formation; 42.70 m above base of section.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
Middle Toarcian – Crassicoستا Zone

- 57 **GSC loc. C-159883.** G.K. Jakobs, 1990. Whiteaves Formation; 43.00 m above base of section.  
*Lytoceras siemensi* (Denckmann)  
Middle Toarcian – Crassicoستا Zone
- 58 **GSC loc. C-157715.** G.K. Jakobs, 1987. Whiteaves Formation; 43.30 m above base of section.  
*Lytoceras siemensi* (Denckmann)  
Middle Toarcian – Crassicoستا Zone
- 59 **GSC loc. C-157718.** G.K. Jakobs, 1987. Whiteaves Formation; 43.50 m above base of section.  
*Phymatoceras crassicoستا* Merla  
Middle Toarcian – Crassicoستا Zone
- 60 **GSC loc. C-159881.** G.K. Jakobs, 1990. Whiteaves Formation; 46.00 m above base of section.  
*Phymatoceras* sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 61 **GSC loc. C-159880.** G.K. Jakobs, 1990. Whiteaves Formation; 48.00 m above base of section.  
*Phymatoceras crassicoستا* Merla  
*Phymatoceras* cf. *P. rude* (Simpson)  
Middle Toarcian – Crassicoستا Zone
- 62 **GSC loc. C-87135.** H.W. Tipper, 1980. Whiteaves Formation; 48.00 to 54.00 m above base of section – interval collection.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87136.** H.W. Tipper, 1980. Whiteaves Formation; 48.00 to 54.00 m above base of section – interval collection.  
*Podagrosites latescens* (Simpson)  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87137.** H.W. Tipper, 1980. Whiteaves Formation; 48.00 to 54.00 m above base of section – interval collection.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87138.** H.W. Tipper, 1980. Whiteaves Formation; 48.00 to 54.00 m above base of section – interval collection.  
*Podagrosites latescens* (Simpson)  
*Phymatoceras* cf. *P. crassicoستا* Merla  
*Grammoceras* sp. indet.  
*Cenoceras* cf. *C. intermedius* (Sowerby)  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-176584.** G.K. Jakobs, 1990. Whiteaves Formation; 48.00 to 54.00 m above base of section – interval collection.  
*Mercaticeras* sp. indet.  
Middle Toarcian – Crassicoستا Zone
- 63 **GSC loc. C-157722.** G.K. Jakobs, 1987. Whiteaves Formation; 50.90 m above base of section.  
*Podagrosites* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 64 **GSC loc. C-157723.** G.K. Jakobs, 1987. Whiteaves Formation; 51.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
*Grammoceras* sp. indet.  
bivalves  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-159879.** G.K. Jakobs, 1990. Whiteaves Formation; 51.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 65 **GSC loc. C-157724.** G.K. Jakobs, 1987. Whiteaves Formation; 51.60 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 66 **GSC loc. C-156900.** G.K. Jakobs, 1990. Whiteaves Formation; 52.00 m above base of section.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-159395.** G.K. Jakobs, 1989. Whiteaves Formation; 52.00 m above base of section.  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 67 **GSC loc. C-87134.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 54.00 m above base of section – interval collection.  
*Phymatoceras hillebrandti* Jakobs  
*Podagrosites* sp. indet.  
*Grammoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 68 **GSC loc. C-87122.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collection.  
*Grammoceras thouarsense* (d’Orbigny)  
grammoceratinae gen. et sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87125.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collection.  
*Podagrosites latescens* (Simpson)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87130.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collection.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87132.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collection.  
*Podagrosites latescens* (Simpson)  
*Grammoceras thouarsense* (d’Orbigny)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-87133.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collection.  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone

- GSC loc. C-90635.** H.W. Tipper, 1980. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149693.** G.K. Jakobs, 1989. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-159894.** G.K. Jakobs, 1990. Whiteaves Formation; 52.00 to 60.00 m above base of section – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* cf. *P. crassica* Merla  
*Phymatoceras* sp. indet.  
*Grammoceras* sp. indet.  
*Podagrosites latescens* (Simpson)  
Late Toarcian – Crassica Zone to Hillebrandti Zone
- 69 **GSC loc. C-159397.** G.K. Jakobs, 1989. Whiteaves Formation; 52.20 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 70 **GSC loc. C-159882.** G.K. Jakobs, 1990. Whiteaves Formation; 52.50 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 71 **GSC loc. C-159396.** G.K. Jakobs, 1989. Whiteaves Formation; 52.70 m above base of section.  
*Polyplectus discoides* (Zieten)  
*Hammatoceras insigne* (Zieten)  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 72 **GSC loc. C-156376.** G.K. Jakobs, 1989. Whiteaves Formation; 52.80 m above base of section.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 73 **GSC loc. C-156375.** G.K. Jakobs, 1989. Whiteaves Formation; 53.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-159398.** G.K. Jakobs, 1989. Whiteaves Formation; 53.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 74 **GSC loc. C-156374.** G.K. Jakobs, 1989. Whiteaves Formation; 53.80 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 75 **GSC loc. C-156895.** G.K. Jakobs, 1990. Whiteaves Formation; 54.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 76 **GSC loc. C-157729.** G.K. Jakobs, 1987. Whiteaves Formation; 54.50 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 77 **GSC loc. C-157730.** G.K. Jakobs, 1987. Whiteaves Formation; 54.74 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 78 **GSC loc. C-156373.** G.K. Jakobs, 1989. Whiteaves Formation; 55.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-156896.** G.K. Jakobs, 1990. Whiteaves Formation; 55.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 79 **GSC loc. C-157731.** G.K. Jakobs, 1987. Whiteaves Formation; 55.40 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 80 **GSC loc. C-157732.** G.K. Jakobs, 1987. Whiteaves Formation; 56.60 m above base of section.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 81 **GSC loc. C-156897.** G.K. Jakobs, 1990. Whiteaves Formation; 57.00 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
*Grammoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 82 **GSC loc. C-157733.** G.K. Jakobs, 1987. Whiteaves Formation; 57.10 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 83 **GSC loc. C-157734.** G.K. Jakobs, 1987. Whiteaves Formation; 57.20 m above base of section.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 84 **GSC loc. C-156372.** G.K. Jakobs, 1989. Whiteaves Formation; 57.50 m above base of section.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- 85 **GSC loc. C-156371.** G.K. Jakobs, 1989. Whiteaves Formation; 58.20 m above base of section.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 86 **GSC loc. C-157736.** G.K. Jakobs, 1987. Phantom Creek Formation. 60.10 m above base of section – talus collection.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- 87 **GSC loc. C-156370.** G.K. Jakobs, 1989. Whiteaves Formation; 60.50 m above base of section.  
*Grammoceras thouarsense* (d'Orbigny)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
*Podagrosites latescens* (Simpson)  
*Podagrosites* sp. indet.  
Late Toarcian – Hillebrandti Zone



- 88 **GSC loc. C-156369.** G.K. Jakobs, 1989. Phantom Creek Formation. 67.20 m above base of section.  
*Pleydellia* sp. indet.  
Late Toarcian – Yakounensis Zone
- 89 **GSC loc. C-87109.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 74.00 m above base of section.  
*Yakounia yakounensis* Jakobs & Smith  
*Yakounia silvae* Jakobs & Smith  
grammoceratinae gen. et sp. indet.  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87111.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 74.00 m above base of section.  
*Yakounia yakounensis* Jakobs & Smith  
*Yakounia silvae* Jakobs & Smith  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia aalensis* (Zieten)  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87116.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 74.00 m above base of section.  
*Yakounia silvae* Jakobs & Smith  
*Yakounia yakounensis* Jakobs & Smith  
*Yakounia freboldi* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- 90 **GSC loc. C-87110.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Hammatoceras speciosum* Janensch  
hammatoceratinae gen. et sp. indet.  
*Pleydellia maudensis* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87114.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia crassiornata* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87115.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Pleydellia* sp. indet.  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87117.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Pleydellia maudensis* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87119.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
hammatoceratinae gen. et sp. indet.  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87120.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia crassiornata* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87127.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Yakounia silvae* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87131.** H.W. Tipper, 1980. Phantom Creek Formation. 72.00 to 78.00 m above base of section – interval collection.  
*Pleydellia* sp. indet.  
Late Toarcian – Yakounensis Zone
- 91 **GSC loc. C-157746.** G.K. Jakobs, 1987. Phantom Creek Formation. 72.60 to 72.80 m above base of section.  
*Yakounia silvae* Jakobs & Smith  
*Pleydellia maudensis* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- 92 **GSC loc. C-157745.** G.K. Jakobs, 1987. Phantom Creek Formation. 72.80 to 73.10 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Yakounia silvae* Jakobs & Smith  
Late Toarcian – Yakounensis Zone
- 93 **GSC loc. C-157744.** G.K. Jakobs, 1987. Phantom Creek Formation. 73.10 to 73.60 m above base of section.  
hammatoceratinae gen. et sp. indet.  
bivalves  
gastropods  
Late Toarcian – Yakounensis Zone
- 94 **GSC loc. C-157741.** G.K. Jakobs, 1987. Phantom Creek Formation. 73.60 to 74.00 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia* sp. indet.  
Late Toarcian – Yakounensis Zone
- 95 **GSC loc. C-87107.** H.W. Tipper, 1980. Phantom Creek Formation. 74.00 to 74.20 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia crassiornata* Jakobs & Smith  
*Pleydellia aalensis* (Zieten)  
Late Toarcian – Yakounensis Zone
- GSC loc. C-87118.** H.W. Tipper, 1980. Phantom Creek Formation. 74.00 to 74.20 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia crassiornata* Jakobs & Smith  
*Pleydellia aalensis* (Zieten)  
*Pleydellia* sp. indet.  
*Sphaerocoeloceras brochiiforme* Jaworski  
*Hammatoceras insigne* (Zieten)  
Late Toarcian – Yakounensis Zone
- GSC loc. C-157742.** G.K. Jakobs, 1987. Phantom Creek Formation. 74.00 to 74.20 m above base of section.  
*Pseudolioceras compactile* (Simpson)  
*Pleydellia maudensis* Jakobs & Smith  
*Pleydellia crassiornata* Jakobs & Smith  
*Pleydellia* sp. indet.  
bivalves  
Late Toarcian – Yakounensis Zone

- 96 **GSC loc. C-87108.** H.W. Tipper, 1980. Phantom Creek Formation. 74.00 to 78.00 m above base of section.  
hammatoceratinae gen. et sp. indet.  
Late Toarcian – Yakounensis Zone
- 97 **GSC loc. C-157740.** G.K. Jakobs, 1987. Phantom Creek Formation. 74.20 to 74.50 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Sphaerocoeloceras brochiiforme* Jaworski  
*Dumortieria* cf. *D. pusilla* Jaworski  
hammatoceratinae gen. et sp. indet.  
gastropods  
bivalves  
Late Toarcian – Yakounensis Zone
- 98 **GSC loc. C-157743.** G.K. Jakobs, 1987. Phantom Creek Formation. 74.50 to 74.80 m above base of section.  
*Pleydellia maudensis* Jakobs & Smith  
*Sphaerocoeloceras brochiiforme* Jaworski  
hammatoceratinae gen. et sp. indet.  
bivalves  
Late Toarcian – Yakounensis Zone
- 99 **GSC loc. C-157748.** G.K. Jakobs, 1987. Phantom Creek Formation. 75.20 to 75.40 m above base of section.  
*Hammatoceras speciosum* Janensch  
bivalves  
Late Toarcian – Yakounensis Zone
- 100 **GSC loc. C-157749.** G.K. Jakobs, 1987. Phantom Creek Formation. 75.60 to 76.20 m above base of section.  
*Hammatoceras speciosum* Janensch  
hammatoceratinae gen. et sp. indet.  
gastropods  
bivalves  
Late Toarcian – Yakounensis Zone
- 101 **GSC loc. C-157750.** G.K. Jakobs, 1987. Phantom Creek Formation. 76.20 to 77.30 m above base of section.  
hammatoceratinae gen. et sp. indet.  
bivalves  
belemnites  
Late Toarcian to Early Aalenian
- 102 **GSC loc. C-158001.** G.K. Jakobs, 1987. Phantom Creek Formation; 78.70 m above base of section.  
hammatoceratinae gen. et sp. indet.  
Late Toarcian to Early Aalenian
- 103 **GSC loc. C-158002.** G.K. Jakobs, 1987. Phantom Creek Formation; 82.60 m above base of section.  
hammatoceratinae gen. et sp. indet.  
Late Toarcian to Early Aalenian
- 104 **GSC loc. C-87129.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian
- GSC loc. C-90621.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Podagrosites* sp. indet.  
*Phymatoceras* sp. indet.  
Late Toarcian
- GSC loc. C-90630.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian
- GSC loc. C-90631.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian
- GSC loc. C-90632.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian
- GSC loc. C-90633.** B.E.B. Cameron, 1982. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian
- GSC loc. C-90800.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras crassica* Merla  
*Phymatoceras* sp. indet.  
*Podagrosites latescens* (Simpson)  
Late Toarcian
- GSC loc. C-156378.** G.K. Jakobs, 1989. Whiteaves Formation – talus collection.  
*Podagrosites latescens* (Simpson)  
*Podagrosites* sp. indet.  
*Grammoceras thouarsense* (d’Orbigny)  
*Grammoceras* sp. indet.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* cf. *P. crassica* Merla  
*Phymatoceras* sp. indet.  
*Pseudomercaticeras* cf. *P. frantzi* (Reynès)  
bivalves  
Middle to Late Toarcian
- GSC loc. C-157716.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
*Podagrosites latescens* (Simpson)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle to Late Toarcian
- GSC loc. C-157727.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
*Phymatoceras* sp. indet.  
gastropods  
Middle Toarcian
- GSC loc. C-157728.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
*Podagrosites latescens* (Simpson)  
*Grammoceras thouarsense* (d’Orbigny)  
hammatoceratinae gen. et sp. indet.  
bivalves  
Late Toarcian

**GSC loc. C-157737.** G.K. Jakobs, 1987. Whiteaves Formation – talus collection.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian

**GSC loc. C-159391.** G.K. Jakobs, 1989. Whiteaves Formation – talus collection.

*Rarenodia planulata* Venturi

*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)

Middle Toarcian

**GSC loc. C-159399.** G.K. Jakobs, 1989. Whiteaves Formation – talus collection.

*Grammoceras thouarsense* (d'Orbigny)

*Phymatoceras hillebrandti* Jakobs

*Phymatoceras* sp. indet.

*Podagrosites* sp. indet.

Late Toarcian

**GSC loc. C-159781.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.

*Phymatoceras* cf. *P. erbaense* (Hauer)

Middle Toarcian

**GSC loc. C-159878.** G.K. Jakobs, 1989. Whiteaves Formation – talus collection.

*Cenoceras* sp. indet.

Middle Toarcian

**GSC loc. C-176562.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian

105 **GSC loc. C-90634.** H.W. Tipper, 1982. Phantom Creek Formation – talus collection.

*Yakounia yakounensis* Jakobs & Smith

*Yakounia silvae* Jakobs & Smith

Late Toarcian

**GSC loc. C-90981.** H.W. Tipper, 1981. Phantom Creek Formation – talus collection.

*Yakounia silvae* Jakobs & Smith

Late Toarcian

**GSC loc. C-157739.** G.K. Jakobs, 1987. Phantom Creek Formation – talus collection.

*Hammatoceras speciosum* Janensch

hammatoceratinae gen. et sp. indet.

Late Toarcian

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**Section 8** – Queen Charlotte Islands, Central Graham Island, Creek 57. Latitude 53°23'35"N, longitude 132°15'30"W. Section measured by G.K. Jakobs, 1987. The ammonite taxa collected from each locality are summarized in Figure 42.

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1 **GSC loc. C-157707.** G.K. Jakobs, 1987. Whiteaves Formation; 4.77 m above base of section.

*Merlaites* cf. *M. alticarinatus* (Merla)

Middle Toarcian – Crassicosta Zone

2 **GSC loc. C-157708.** G.K. Jakobs, 1987. Whiteaves Formation; 7.65 m above base of section.

*Merlaites* cf. *M. alticarinatus* (Merla)

Middle Toarcian – Crassicosta Zone

3 **GSC loc. C-157709.** G.K. Jakobs, 1987. Whiteaves Formation; 7.76 m above base of section.

*Merlaites* cf. *M. alticarinatus* (Merla)

Middle Toarcian – Crassicosta Zone

4 **GSC loc. C-156362.** G.K. Jakobs, 1989. Whiteaves Formation; 15.00 m above base of section.

*Phymatoceras crassicosta* Merla

Middle Toarcian – Crassicosta Zone

5 **GSC loc. C-156363.** G.K. Jakobs, 1989. Whiteaves Formation; 23.00 m above base of section.

*Phymatoceras* sp. indet.

Middle Toarcian

6 **GSC loc. C-157710.** G.K. Jakobs, 1987. Whiteaves Formation; 23.61 m above base of section.

*Phymatoceras* sp. indet.

bivalves

Middle Toarcian

7 **GSC loc. C-157711.** G.K. Jakobs, 1987. Whiteaves Formation; 24.82 m above base of section.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian – Hillebrandti Zone

8 **GSC loc. C-156364.** G.K. Jakobs, 1989. Whiteaves Formation; 25.40 m above base of section.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian – Hillebrandti Zone

9 **GSC loc. C-156365.** G.K. Jakobs, 1989. Whiteaves Formation; 25.70 m above base of section.

*Phymatoceras* sp. indet.

Late Toarcian – Hillebrandti Zone

10 **GSC loc. C-156366.** G.K. Jakobs, 1989. Whiteaves Formation; 29.70 m above base of section.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian – Hillebrandti Zone

11 **GSC loc. C-157712.** G.K. Jakobs, 1987. Whiteaves Formation; 40.78 to 41.47 m above base of section.

*Phymatoceras hillebrandti* Jakobs

*Phymatoceras* sp. indet.

Late Toarcian – Hillebrandti Zone

12 **GSC loc. C-156883.** G.K. Jakobs, 1988. Whiteaves Formation; 41.50 m above base of section.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian – Hillebrandti Zone

13 **GSC loc. C-156367.** G.K. Jakobs, 1989. Whiteaves

Formation; 41.60 m above base of section.

*Phymatoceras hillebrandti* Jakobs

Late Toarcian – Hillebrandti Zone

- 14 **GSC loc. C-90585.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.

*Hildaites* sp. indet.

Early Toarcian

**GSC loc. C-90608.** H.W. Tipper, 1980. Whiteaves

Formation – talus collection.

*Phymatoceras hillebrandti* Jakobs

*Podagrosites* sp. indet.

*Polyplectus discoides* (Zieten)

Late Toarcian

**GSC loc. C-176551.** B.E.B. Cameron, 1984.

Whiteaves Formation – talus collection.

*Phymatoceras hillebrandti* Jakobs

*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)

Middle to Late Toarcian

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**Section 9** – Queen Charlotte Islands, Moresby Island, Whiteaves Bay. Latitude 53°11'20"N, longitude 132°01'10"W. Section measured by G.K. Jakobs, 1987. The ammonite taxa collected from each locality are summarized in Figure 42.

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|---|--|
| <p>1 <b>GSC loc. C-156384.</b> G.K. Jakobs, 1989. Fannin Formation; 1.30 to 1.65 m above base of section.<br/><i>Protogrammoceras</i> sp. indet.<br/>Late Pliensbachian to Early Toarcian</p> <p><b>GSC loc. C-156385.</b> G.K. Jakobs, 1989. Fannin Formation; 1.30 to 1.65 m above base of section.<br/><i>Protogrammoceras</i> sp. indet.<br/>Late Pliensbachian to Early Toarcian</p> <p>2 <b>GSC loc. C-156386.</b> G.K. Jakobs, 1989. Fannin Formation; 2.20 to 2.45 m above base of section.<br/><i>Protogrammoceras</i> sp. indet.<br/>Late Pliensbachian to Early Toarcian</p> <p>3 <b>GSC loc. C-156389.</b> G.K. Jakobs, 1989. Fannin Formation; 2.45 to 2.85 m above base of section.<br/><i>Protogrammoceras</i> sp. indet.<br/>Late Pliensbachian to Early Toarcian</p> <p>4 <b>GSC loc. C-156383.</b> G.K. Jakobs, 1989. Fannin Formation; 3.65 to 4.05 m above base of section.<br/><i>Dactylioceras</i> aff. <i>D. comptum</i> (Dagys)<br/><i>Dactylioceras kanense</i> McLearn<br/><i>Protogrammoceras</i> sp. indet.<br/>Early Toarcian – Kanense Zone</p> <p><b>GSC loc. C-157560.</b> H.W. Tipper, 1987. Fannin Formation; 3.65 to 4.05 m above base of section.<br/><i>Dactylioceras kanense</i> McLearn<br/>harpoceratinae gen. et sp. indet.<br/>Early Toarcian – Kanense Zone</p> <p>5 <b>GSC loc. C-156387.</b> G.K. Jakobs, 1989. Fannin Formation; 4.25 to 4.35 m above base of section.<br/><i>Dactylioceras</i> aff. <i>D. comptum</i> (Dagys)<br/><i>Protogrammoceras</i> sp. indet.<br/>Early Toarcian – Kanense Zone</p> | <p>6 <b>GSC loc. C-149698.</b> G.K. Jakobs, 1990. Fannin Formation; 4.80 m above base of section.<br/><i>Dactylioceras</i> cf. <i>D. alpestre</i> Wiedenmayer<br/>Early Toarcian – Kanense Zone</p> <p>7 <b>GSC loc. C-157562.</b> H.W. Tipper, 1987. Fannin Formation; 5.00 to 7.00 m above base of section.<br/><i>Taffertia</i> sp. indet.<br/>harpoceratinae gen. et sp. indet.<br/>Early Toarcian – Kanense Zone</p> <p>8 <b>GSC loc. C-149697.</b> G.K. Jakobs, 1990. Fannin Formation; 5.80 m above base of section.<br/>harpoceratinae gen. et sp. indet.<br/>Early Toarcian – Kanense Zone</p> <p>9 <b>GSC loc. C-149695.</b> G.K. Jakobs, 1990. Whiteaves Formation; 21.10 m above base of section.<br/>phymatoceratinae gen. et sp. indet.<br/>trigonid bivalves<br/>Middle Toarcian – Planulata Zone</p> <p>10 <b>GSC loc. C-156875.</b> G.K. Jakobs, 1988. Whiteaves Formation; 28.10 m above base of section.<br/><i>Dactylioceras</i> sp. indet.<br/><i>Rarenodia planulata</i> Venturi<br/>Middle Toarcian – Planulata Zone</p> <p>11 <b>GSC loc. C-156876.</b> G.K. Jakobs, 1988. Whiteaves Formation; 28.60 m above base of section.<br/><i>Rarenodia planulata</i> Venturi<br/>Middle Toarcian – Planulata Zone</p> <p>12 <b>GSC loc. C-156878.</b> G.K. Jakobs, 1988. Whiteaves Formation; 29.20 m above base of section.<br/><i>Leukadiella ionica</i> Renz &amp; Renz<br/>Middle Toarcian – Planulata Zone</p> |
|---|--|

- 13 **GSC loc. C-156879.** G.K. Jakobs, 1988. Whiteaves Formation; 30.00 to 32.00 m above base of section - talus collection.  
*Peronoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 14 **GSC loc. C-156881.** G.K. Jakobs, 1988. Whiteaves Formation; 30.70 m above base of section.  
*Cleviceras* sp. indet.  
Middle Toarcian – Planulata Zone
- 15 **GSC loc. C-156880.** G.K. Jakobs, 1988. Whiteaves Formation; 30.80 m above base of section.  
*Leukadiella* aff. *L. helenae* Renz  
Middle Toarcian – Planulata Zone
- 16 **GSC loc. 13630.** McLearn, 1921. Fannin Formation – talus collection.  
*Dactylioceras kanense* McLearn  
Early Toarcian – Kanense Zone
- GSC loc. C-80774.** B.E.B. Cameron, 1978. Fannin Formation – talus collection.  
harpoceratinae gen. et sp. indet.  
Late Pliensbachian to Early Toarcian
- GSC loc. C-80777.** B.E.B. Cameron, 1978. Fannin Formation – talus collection.  
harpoceratinae gen. et sp. indet.  
Late Pliensbachian to Early Toarcian
- GSC loc. C-80778.** B.E.B. Cameron, 1978. Fannin and Whiteaves formations – talus collection.  
*Dactylioceras kanense* McLearn  
*Phymatoceras* sp. indet.  
*Taffertia taffertensis* Guex  
*Taffertia* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-80779.** B.E.B. Cameron, 1978. Fannin Formation – talus collection.  
harpoceratinae gen. et sp. indet.  
Late Pliensbachian to Early Toarcian
- GSC loc. C-156388.** G.K. Jakobs, 1989. Fannin Formation – talus collection.  
*Dactylioceras kanense* McLearn  
*Protogrammoceras* sp. indet.  
harpoceratinae gen. et sp. indet.  
bivalves  
Early Toarcian – Kanense Zone
- 17 **GSC loc. C-80780.** B.E.B. Cameron, 1978. Whiteaves Formation – talus collection.  
*Leukadiella amuratica* Renz & Renz  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-80781.** B.E.B. Cameron, 1978. Whiteaves Formation – talus collection.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- GSC loc. C-80782.** B.E.B. Cameron, 1978. Whiteaves Formation – talus collection.  
*Leukadiella ionica* Renz & Renz  
*Rarenodia planulata* Venturi  
*Phylloceras* cf. *P. heterophyllum* (Sowerby)  
Middle Toarcian – Planulata Zone
- GSC loc. C-81914.** H.W. Tipper, 1979. Fannin and Whiteaves formations – talus collection.  
*Rarenodia planulata* Venturi  
*Protogrammoceras* sp. indet.  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-81915.** H.W. Tipper, 1979. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-86359.** T.P. Poulton, 1979. Whiteaves Formation – talus collection.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- GSC loc. C-87202.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Leukadiella ionica* Renz & Renz  
Middle Toarcian – Planulata Zone
- GSC loc. C-90613.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Leukadiella ionica* Renz & Renz  
*Leukadiella amuratica* Renz & Renz  
*Rarenodia planulata* Venturi  
*Phymatoceras* sp. indet.  
gastropods  
Middle Toarcian – Planulata Zone
- GSC loc. C-93572.** H.W. Tipper, 1980. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-176559.** B.E.B. Cameron, 1984. Whiteaves Formation, – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian – Planulata Zone
- GSC loc. C-156877.** G.K. Jakobs, 1988. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
*Cenoceras* sp. indet.  
Middle Toarcian – Planulata Zone

### *Isolated localities*

Specimens collected as isolated samples have a two part locality number. Collections are generally grouped together under regional geographic areas, usually NTS map areas, and are assigned a letter (A, B, C, etc). Groups of collections from a particular locality are assigned a locality number. The ammonite taxa collected from each area and locality are summarized in Figures 8 and 24.

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#### A. Carmacks map area (NTS 115I)

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- A-1 **GSC loc. 91783.** D.J. Tempelman-Kluit, 1974. Carmacks map area – beside Mayo Road, close to gravel pit; lat. 62°21'N, long. 136°24'W. Laberge Group.  
Report J-1-1970-HF – re-identified by Jakobs, 1992.  
*Tiloniceras* ? sp. indet.  
dactylioceratidae gen. et sp. indet.  
harpoceratinae gen. et sp. indet.  
*Weyla* sp. indet.  
Early Toarcian – Kanense Zone
- A-2 **GSC loc. 91782.** D.J. Tempelman-Kluit, 1974. Carmacks map area – west bank of Yukon River at Rink Rapids; lat. 62°19'30"N, long. 136°22'30"W. Laberge Group.  
Report J-1-1970-HF – re-identified by Jakobs, 1992.  
*Tiloniceras*? sp. indet.  
Late Pliensbachian to Early Toarcian
- A-3 **GSC loc. 91784.** D.J. Tempelman-Kluit, 1974. Carmacks map area – 1.5 miles (2.5 km) north of west end of Tatchun Lake; lat. 62°18'30"N, long. 136°13'W. Laberge Group – talus collections.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Cleviceras* sp. indet.  
dactylioceratidae gen. et sp. indet.  
Middle Toarcian – Planulata Zone

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#### B. Tulsequah map area (NTS 104J)

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- B-1 **GSC loc. 40431.** J.F. Souther, 1959. Tulsequah map area – 0.5 miles (0.8 km) southwest of Tangle Lake; lat. 58°48'12"N, long. 133°06'32"W. Takwahoni Formation.  
Frebold, 1964 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- B-2 **GSC loc. 40427.** J.F. Souther, 1959. Tulsequah map area – 0.5 miles (0.8 km) northeast of Frozen Lake. Takwahoni Formation.  
Report J-10-60/61-HF  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 40428.** J.F. Souther, 1959. Tulsequah map area – 0.5 miles (0.8 km) northeast of Frozen Lake. Takwahoni Formation.  
Report J-10-60/61-HF  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 40475.** J.F. Souther, 1959. Tulsequah map area – 0.25 miles (0.4 km) southwest of Frozen Lake; lat. 58°40'06"N, long. 133°03'18"W. Takwahoni Formation.  
Frebold, 1964 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
*Peronoceras* sp. indet.  
Middle Toarcian
- GSC loc. 43651.** J.F. Souther, 1960. Tulsequah map area – 5.5 miles (8.8 km) southeast of Mount Lester Jones; lat. 58°40'45"N, long. 133°06'44"W. Takwahoni Formation.  
Frebold, 1964 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 43669.** J.F. Souther, 1969. Tulsequah map area – Kowatua Creek, 4 miles (6 km) east of Wade Lake; lat. 58°40'58"N, long. 133°05'40"W. Takwahoni Formation.  
Frebold, 1964 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- B-3 **GSC loc. 40465.** J.F. Souther, 1959. Tulsequah map area – on west slope south of west end of King Salmon Lake, 5050' (1540 m) elevation; lat. 58°39'N, long. 132°56'W. Takwahoni Formation.  
Report J-10-60/61-HF  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 40470.** J.F. Souther, 1959. Tulsequah map area – south above west end of King Salmon Lake, 5240' (1600 m) elevation; lat. 58°40'N, long. 132°55'W. Takwahoni Formation.  
Report J-10-60/61-HF  
*Harpoceras* sp. indet.  
Early to Middle Toarcian

- B-4 **GSC loc. 43650.** J.F. Souther, 1960. Tulsequah map area – west of Sutlahine River, 9 miles (14.4 km) above its junction with the Inklin River; lat. 58°37'35"N, long. 132°50'50"W. Takwahoni Formation. Frebold, 1964 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- B-5 **GSC loc. 40447.** J.F. Souther, 1959. Tulsequah map area – south side of creek bottom flowing out of One-Way Lake; lat. 58°39'38"N, long. 132°40'50"W. Takwahoni Formation. Frebold, 1964 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
belemnoids  
Early to Middle Toarcian
- GSC loc. 40449.** J.F. Souther, 1959. Tulsequah map area – south side of creek bottom flowing out of One-Way Lake; lat. 58°39'38"N, long. 132°40'50"W. Takwahoni Formation. Frebold, 1964 – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 40474.** J.F. Souther, 1959. Tulsequah map area – south side of creek bottom flowing out of One-Way Lake; lat. 58°39'38"N, long. 132°40'50"W. Takwahoni Formation. Report J-10-60/61-HF1  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- B-6 **GSC loc. 40469.** J.F. Souther, 1959. Tulsequah map area – north shore of One-Way Lake; lat. 58°37'N, long. 132°31'W. Takwahoni Formation. Report J-10-60/61-HF  
*Harpoceras* sp. indet.  
belemnoids  
Early to Middle Toarcian
- B-7 **GSC loc. 40440.** J.F. Souther, 1959. Tulsequah map area – canyon 0.5 miles (0.8 km) south of One-Way Lake; lat. 58°36'N, long. 132°31'W. Takwahoni Formation. Report J-10-60/61-HF  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- B-8 **GSC loc. 40441.** J.F. Souther, 1959. Tulsequah map area – 1 mile (1.6 km) east of Skinny Lake. Takwahoni Formation. Report J-10-60/61-HF 1961  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
belemnoids  
Early to Middle Toarcian

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### C. Cry Lake map area (NTS 104I)

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- C-1 **GSC loc. C-81903.** H. Gabrielse, 1979. Cry Lake map area – 3.2 km south-southeast of Horn Mountain; lat. 58°13'19"N, long. 129°31'03"W. Laberge Group. Report J-8-1980-HF – re-identified by Jakobs, 1992.  
*Pseudomercaticeras*? sp. indet.  
*Hildaites murleyi* (Moxon)  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- C-2 **GSC loc. 95026.** J.W.H. Monger, 1977. Cry Lake map area – west of McBride River; lat. 58°06'N, long. 129°19'W. Laberge Group?. Report J-14-1977-HF – re-identified by Jakobs, 1992.  
*Hildaites murleyi* (Moxon)  
Early Toarcian – Kanense Zone
- GSC loc. 95093.** H.W. Tipper, 1977. Cry Lake map area – west of McBride River; lat. 58°07'N, long. 129°19'W. Laberge Group?. Report J-14-1977-HF – re-identified by Jakobs, 1992.  
*Cleviceras*? sp. indet.  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Phymatoceras*? sp. indet.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- C-3 **GSC loc. 95263.** H.W. Tipper, 1977. Cry Lake map area – 17.2 km at 200° from Mount Shea; lat. 58°10'N, long. 129°02'W. Laberge Group?. Report J-17-1977-HF – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
*Cleviceras* sp. indet.  
*Hildaites* sp. indet.  
*Dactylioceras* cf. *D. commune* (Sowerby)  
Early to Middle Toarcian
- GSC loc. 95266.** H.W. Tipper, 1977. Cry Lake map area – 17.2 km at 200° from Mount Shea; lat. 58°10'N, long. 129°02'W. Laberge Group?. Report J-17-1977-HF  
*Cleviceras*? sp. indet.  
dactylioceratidae gen. et sp. indet.  
Early to Middle Toarcian
- C-4 **GSC loc. 95101.** H.W. Tipper, 1977. Cry Lake map area – 12.4 miles (19.8 km) at 190° from Mount Shea; lat. 58°09'N, long. 129°00'W. Laberge Group?.  
*Hildaites*? sp. indet.  
dactylioceratidae gen. et sp. indet.  
Early Toarcian – Kanense Zone

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D. *Telegraph Creek (NTS 104G) and Iskut River (NTS 104B) map areas*

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- D-1 **GSC loc. C-116289.** P. Read, 1983. Telegraph Creek map area – 5.3 km at 209° from I.P. 2213 M at 5450' (1660 m) elevation; lat. 57°00'31"N, long. 130°27'03"W. Hazelton Group.  
Report J-1983-HWT – re-identified by Jakobs, 1992.  
*Phymatoceras hillebrandti* Jakobs  
*Myophorella* sp. indet.  
*Pinna* sp. indet.  
*Trigonia* sp. indet.  
bivalves  
Late Toarcian – Hillebrandti Zone
- D-2 **GSC loc. C-116290.** P. Read, 1983. Telegraph Creek map area – 2.9 km at 60° from Thenatlope Mountain; lat. 57°01'00"N, long. 130°37'05"W. Hazelton Group.  
Report J-1983-HWT – re-identified by Jakobs, 1992.  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
*Weyla* sp. indet.  
*Myophorella?* sp. indet.  
*Trigonia* sp. indet.  
Late Toarcian – Hillebrandti Zone
- D-3 **GSC loc. 48624.** F.A. Kerr, 1926. Telegraph Creek map area – east bank of Glenora Creek; lat. 57°50'20"N, long. 131°23'00"W. Hazelton Group.  
Frebald, 1964 – re-identified by Jakobs, 1992.  
*Peronoceras* cf. *P. fibulatum* (Sowerby)  
Middle Toarcian
- D-4 **GSC loc. 87061.** E.W. Grove, 1970. Iskut River map area – east side of small unnamed glacier 7.2 km south of Treaty Creek (1450 m elevation); lat. 56°32'00"N, long. 130°02'00"W. Salmon River Formation?.  
Report J-15-1971-HF – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian

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E. *Spatsizi River (NTS 104H) and Toodoggone River (NTS 94E) map areas*

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- E-1 **GSC loc. C-117208.** H.W. Tipper, 1985. Spatsizi River map area – 5500' Elbow Mountain northwest corner; lat. 57°52'10"N, long. 128°34'05"W. Spatsizi Formation.  
*Dactylioceras* cf. *D. commune* (Sowerby)  
Early to Middle Toarcian
- GSC loc. C-87250.** P. Read, 1981. Spatsizi River map area – 5375' (1640 m) elevation at 339° from peak 6407 at 1.04 km distance; lat. 57°52'18"N, long. 129°34'26"W. Spatsizi Formation.  
Report J-2-1982-HWT – re-identified by Jakobs, 1992.  
*Dactylioceras* cf. *D. kanense* McLearn  
*Dactylioceras* sp. indet.  
harpoceratinae gen. et sp. indet.  
Early to Middle Toarcian
- GSC loc. C-90698.** P. Read, 1981. Spatsizi River map area – 5675' (1730 m) elevation at 343.5° from peak 6407 at 0.9 km distance; lat. 57°52'12"N, long. 129°34'18"W. Spatsizi Formation.  
Report J-2-1982-HWT – re-identified by Jakobs, 1992.  
*Dactylioceras* cf. *D. kanense* McLearn  
*Dactylioceras* cf. *D. commune* (Sowerby)  
harpoceratinae gen. et sp. indet.  
*Weyla alata* (Buch)  
*Weyla* cf. *W. bodenbenderi* (Behrendsen)  
pectinid bivalves  
bivalves  
rhynchonellid brachiopods  
terebratulid brachiopods  
Early to Middle Toarcian
- E-2 **GSC loc. C-103152.** P.L. Smith, 1983. Spatsizi River map area – Elbow Mountain; lat. 57°51'29"N, long. 129°34'15"W. Spatsizi Formation – talus collections.  
*Dactylioceras* cf. *D. kanense* McLearn  
Early Toarcian – Kanense Zone
- GSC loc. C-103154.** P.L. Smith, 1983. Spatsizi River map area – Elbow Mountain; lat. 57°51'29"N, long. 129°34'15"W. Spatsizi Formation – talus collections.  
*Dactylioceras* cf. *D. kanense* McLearn  
harpoceratinae gen. et sp. indet.  
Early Toarcian – Kanense Zone
- GSC loc. C-103153.** P.L. Smith, 1983. Spatsizi River map area – Elbow Mountain; lat. 57°51'29"N, long. 129°34'15"W. Spatsizi Formation – talus collections.  
*Dactylioceras* cf. *D. simplex* Fucini  
*Dactylioceras* cf. *D. kanense* McLearn  
Early Toarcian – Kanense Zone
- GSC loc. C-103188.** P.L. Smith, 1983. Spatsizi River map area – Elbow Mountain; lat. 57°51'29"N, long. 129°34'15"W. Spatsizi Formation – talus collections.  
*Dactylioceras* cf. *D. kanense* McLearn  
Early Toarcian – Kanense Zone



- GSC loc. C-103428.** H.W. Tipper, 1983. Spatsizi River map area – Elbow Mountain; lat. 57°51'29"N, long. 129°34'15"W. Spatsizi Formation – talus collection.  
*Polyplectus* sp. indet.  
trigonid bivalves  
bivalves  
Middle to Late Toarcian
- E-3 **GSC loc. C-101220.** H.W. Tipper, 1983. Spatsizi River map area – ridge east of Eaglenest Range; lat. 57°35'38"N, long. 129°36'24"W. Spatsizi Formation?  
*Phymatoceras* sp. indet.  
Middle to Late Toarcian
- E-4 **GSC loc. C-103192.** P.L. Smith, 1983. Spatsizi River map area – ridge east of Eaglenest Range; lat. 57°33'04"N, long. 129°01'30"W. Spatsizi Formation.  
*Phymatoceras?* sp. indet.  
Middle to Late Toarcian
- E-5 **GSC loc. C-88217.** H.W. Tipper, 1983. Spatsizi River map area – 4.2 miles (6.7 km) west-northwest of Mount Will; lat. 57°33'47"N, long. 128°54'13"W. Spatsizi Formation – talus collections.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Peronoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-88218.** H.W. Tipper, 1983. Spatsizi River map area – 4.2 miles (6.7 km) west-northwest of Mount Will; lat. 57°33'47"N, long. 128°54'13"W. Spatsizi Formation – talus collections.  
*Phymatoceras* sp. indet.  
nautiloid  
Middle Toarcian
- GSC loc. C-88219.** H.W. Tipper, 1983. Spatsizi River map area – 4.2 miles (6.7 km) west-northwest of Mount Will; lat. 57°33'47"N, long. 128°54'13"W. Spatsizi Formation – talus collections.  
*Phymatoceras* cf. *P. crassicosta* Merla  
Middle Toarcian – Crassicosta Zone
- E-6 **GSC loc. C-90730.** P. Peller, 1981. Spatsizi River map area – ridge 3.5 miles (5.6 km) west of Mount Will; lat. 57°32'24"N, long. 128°53'30"W. Spatsizi Formation. Report J-6-88-HWT  
*Peronoceras* sp. indet.  
bivalves  
Middle Toarcian
- E-7 **GSC loc. C-103439.** H.W. Tipper, 1983. Spatsizi River map area – 2.23 miles (3.56 km) southwest of Mount Will; lat. 57°31'24"N, long. 128°50'18"W. Spatsizi Formation.  
*Peronoceras?* sp. indet.  
*Rarenodia* cf. *R. planulata* Venturi  
bivalves  
Middle Toarcian – Planulata Zone
- GSC loc. C-103438.** H.W. Tipper, 1983. Spatsizi River map area – 2.23 miles (3.56 km) southwest of Mount Will; lat. 57°31'24"N, long. 128°50'18"W. Spatsizi Formation.  
*Peronoceras?* sp. indet.  
trigonid bivalves  
Middle Toarcian
- GSC loc. C-103440.** H.W. Tipper, 1983. Spatsizi River map area – 2.23 miles (3.56 km) southwest of Mount Will; lat. 57°31'24"N, long. 128°50'18"W. Spatsizi Formation.  
*Peronoceras?* sp. indet.  
Middle Toarcian
- GSC loc. C-116875.** C.A. Evenchick, 1986. Spatsizi River map area – 3.5 km south-southwest of Mount Will; lat. 57°31'02"N, long. 128°49'25"W. Spatsizi Formation. Report J-5-88-HWT  
*Dactylioceras* sp. indet.  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-90666.** J. Read, 1981. Spatsizi River map area – 2.6 miles (4.2 km) southwest of Mount Will; lat. 57°32'00"N, long. 128°51'50"W. Spatsizi Formation. Report J-6-88-HWT  
*Peronoceras?* sp. indet.  
hammatoceratinae gen. et sp. indet.?  
Middle to Late Toarcian
- GSC loc. C-103434.** H.W. Tipper, 1983. Spatsizi River map area – 2.46 miles (3.9 km) south-southwest of Mount Will; lat. 57°30'54"N, long. 128°49'36"W. Spatsizi Formation.  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-103435.** H.W. Tipper, 1983. Spatsizi River map area – 2.46 miles (3.9 km) south-southwest of Mount Will; lat. 57°30'54"N, long. 128°49'36"W. Spatsizi Formation.  
*Phymatoceras* sp. indet.  
trigonid bivalves  
Middle Toarcian
- E-8 **GSC loc. C-103123.** R.C. Thomson, 1983. Spatsizi River map area – Joan Lake area; lat. 57°29'N, long. 128°57'W. Spatsizi Formation.  
*Peronoceras* sp. indet.  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian
- GSC loc. C-103124.** R.C. Thomson, 1983. Spatsizi River map area – Joan Lake area; lat. 57°29'N, long. 128°57'W. Spatsizi Formation.  
*Peronoceras* sp. indet.  
phymatoceratinae gen. et sp. indet.  
Middle Toarcian
- E-9 **GSC loc. C-90660.** J. Read, 1981. Spatsizi River map area – 7.7 miles (12.3 km) north-northeast of headwaters of Conglomerate Creek; lat. 57°29'10"N, long. 128°52'10"W. Spatsizi Formation. Report J-16-1988-HWT – re-identified by Jakobs, 1992.  
*Denckmannia* cf. *D. tunefacta* Buckman  
*Phymatoceras* sp. indet.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
Middle Toarcian – Crassicosta Zone

**GSC loc. C-90661.** J. Read, 1981. Spatsizi River map area – 7.8 miles (12.5 km) north-northeast of headwaters of Conglomerate Creek; lat. 57°29'25"N, long. 28°52'00"W. Spatsizi Formation.  
Report J-6-88-HWT  
*Polyplectus* sp. indet.  
Middle to Late Toarcian

**E-10 GSC loc. 93261.** H.W. Tipper, 1975. Toodoggone River map area – 5.4 miles (8.6 km) west of Claw Mountain; lat. 57°34'24"N, long. 127°25'W. Unnamed sandstones.  
*Pleydellia* sp. indet.  
*Podagrosites?* sp. indet.  
Late Toarcian

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*F. McConnell Creek map area (NTS 94D)*

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**F-1 GSC loc. 93274.** H.W. Tipper, 1975. McConnell Creek map area – ridge 2 miles (3.2 km) at 180° from Mount Carruthers; lat. 56°13'N, long. 126°21'W. Smithers Formation?.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Hildaites* sp. indet.  
harpoceratinae  
Early Toarcian – Kanense Zone

**GSC loc. 93275.** H.W. Tipper, 1975. McConnell Creek map area – ridge 2 miles (3.2 km) at 180° from Mount Carruthers; lat. 56°13'N, long. 126°21'W. Smithers Formation?.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Peronoceras?* sp. indet.  
*Rarenodia?* sp. indet.

Middle Toarcian – Planulata Zone  
**GSC loc. 93137.** H.W. Tipper, 1975. McConnell Creek map area – ridge 2 miles (3.2 km) at 180° from Mount Carruthers; lat. 56°13'N, long. 126°21'W. Smithers Formation?.  
Report J-13-1976-HF – re-identified by Jakobs, 1992.  
*Pseudolioceras* sp. indet.  
*Dactylioceras* sp. indet.  
Middle Toarcian

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*G. Hazelton map area (NTS 93M)*

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**G-1 GSC loc. 90979.** T. Richards, 1973. Hazelton map area – north end of Nilkitkwa Range; lat. 55°55'39"N, long. 126°54'18"W. Hazelton Group.  
Report J-8-1974-HF  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
*Eleganticeras?* sp. indet.  
aptychi  
Early to Middle Toarcian

**G-2 GSC loc. 90952.** T. Richards, 1973. Hazelton map area – east of Nilkitkwa Range – headwaters of Driftwood River; lat. 55°51'09"N, long. 126°47'27"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
bivalves  
Middle Toarcian – Planulata Zone

**GSC loc. 90953.** T. Richards, 1973. Hazelton map area – east of Nilkitkwa Range – headwaters of Driftwood River; lat. 55°51'36"N, long. 126°47'30"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
*Phymatoceras* sp. indet.  
bivalves  
Middle Toarcian

**G-3 GSC loc. 90958.** T. Richards, 1973. Hazelton map area – east of Nilkitkwa Range – headwaters of Driftwood River; lat. 55°51'58"N, long. 126°44'48"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone

**G-4 GSC loc. 91077.** T.P. Poulton, 1973. Hazelton map area – Hogen Range – ridge 2 miles (3.2 km) southwest of Ominicetla Creek; lat. 55°52'42"N, long. 126°02'54"W. Hazelton Group – mixed collection.  
Report J-11-1974-HF – re-identified by Jakobs, 1992.  
*Pleydellia* cf. *P. maudensis* Jakobs & Smith  
*Phymatoceras hillebrandti* Jakobs  
*Amaltheus* sp. indet.  
Late Pliensbachian to Late Toarcian

**G-5 GSC loc. 90977.** T. Richards, 1973. Hazelton map area – north-central Bait Range – 6550' ridge north of Charleston Creek; lat. 55°38'42"N, long. 126°31'24"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
*Hildaites* sp. indet.  
dactylioceratidae gen. et sp. indet.  
harpoceratinae gen. et sp. indet.  
Early Toarcian – Kanense Zone

**G-6 GSC loc. 91148.** T. Richards, 1973. Hazelton map area – Bait Range – northeast Charleston-Ankwill divide on ridge; lat. 55°38'12"N, long. 126°25'48"W. Hazelton Group.  
Report J-9-1974-HF  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian

- G-7 **GSC loc. 89044.** H.W. Tipper, 1972. Hazelton map area – 4 miles (6.4 km) south of Centre Peak, north of head of Ankwil Creek. Hazelton Group.  
Report J-6-1972-HF  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- G-8 **GSC loc. 90974.** T. Richards, 1973. Hazelton map area – north-central Bait Range – south of head of Ankwil Creek; lat. 55°36'20"N, long. 126°23'24"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
*Dactylioceras kanense* McLearn  
*Dactylioceras* sp. indet.  
Early Toarcian – Kanense Zone
- G-9 **GSC loc. 89594.** T. Richards, 1972. Hazelton map area – Bait Range – central part; lat. 55°34'24"N, long. 126°26'48"W. Hazelton Group.  
Report J-11-1974-HF – re-identified by Jakobs, 1992.  
*Rarenodia planulata* Venturi  
dactylioceratidae gen. et sp. indet.  
Middle Toarcian – Planulata Zone
- G-10 **GSC loc. 89595.** T. Richards, 1972. Hazelton map area – Bait Range – Frypan Creek area; lat. 55°31'30"N, long. 126°23'48"W. Hazelton Group.  
*Rarenodia planulata* Venturi  
*Peronoceras* cf. *P. moerickei* Hillebrandt  
*Catacoeloceras* cf. *C. crassum* (Young & Bird)  
Middle Toarcian
- GSC loc. 91131.** T.P. Poulton, 1973. Hazelton map area – Bait Range – north of head of Frypan Creek; lat. 55°30'54"N, long. 126°24'24"W. Hazelton Group.  
Report J-9-1974-HF – re-identified by Jakobs, 1992.  
*Denckmannia?* sp. indet.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Phymatoceras crassicosta* Merla  
dactylioceratidae gen. et sp. indet.  
gastropods  
Middle Toarcian – Crassicosta Zone
- GSC loc. 91138.** T.P. Poulton, 1973. Hazelton map area – Bait Range – north of head of Frypan Creek; lat. 55°30'40"N, long. 126°23'42"W. Hazelton Group.  
Report J-11-1974-HF – re-identified by Jakobs, 1992.  
*Phymatoceras* cf. *P. hillebrandti* Jakobs  
star-shaped crinoid columnals  
Late Toarcian – Hillebrandti Zone
- G-11 **GSC loc. 90949.** T. Richards, 1973. Hazelton map area – south Bait Range – small ridge northwest of Frypan Peak; lat. 55°29'18"N, long. 126°19'36"W. Hazelton Group.  
Report J-8-1974-HF – re-identified by Jakobs, 1992.  
dactylioceratidae gen. et sp. indet.  
*Leukadiella* sp. indet.  
*Rarenodia planulata* Venturi  
*Pseudolioceras* sp. indet.  
bivalves  
belemnites  
Middle Toarcian – Planulata Zone

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### H. Nechako River map area (93F)

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- H-1 **GSC loc. C-177436.** T. Richards, 1993. Nechako River map area – road cut at causeway outcrop on northeast side of Nechako Ranges; lat. 53°22'50"N, long. 124°32'29"W. Hazelton Group.  
*Dactylioceras kanense* McLearn  
*Dactylioceras* cf. *D. tenuicostatum* (Young & Bird)  
*Tiltoniceras propinquum* (Whiteaves)  
*Tiltoniceras antiquum* (Wright)  
Early Toarcian – Kanense Zone

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### I. Southern Canadian Rocky Mountains

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- I-1 **GSC loc. 79915.** H. Frebold, 1969. Western Alberta – Snake Indian River; lat. 53°15'N, long. 118°05'W. Fernie Formation. Frebold, 1976 – re-identified by Jakobs, 1992.  
*Peronoceras* sp. indet.  
*Hildaïtes?* sp. indet.  
Early to Middle Toarcian
- GSC loc. 88015.** H. Frebold, 1969. Western Alberta – Snake Indian River; lat. 53°15'N, long. 118°05'W. Fernie Formation. Frebold, 1976 (not figured)  
*Hildaïtes* sp. indet.  
*Dactylioceras (Orthodactylites)* sp. indet.  
Early Toarcian
- GSC loc. 91923.** H. Frebold, 1969. Western Alberta – Snake Indian River; lat. 53°15'N, long. 118°05'W. Fernie Formation. Frebold, 1976 (not figured)  
*Dactylioceras (Orthodactylites)* sp. indet.  
*Hildaïtes* sp. indet.  
Early Toarcian
- I-2 **GSC loc. 31413.** H. Frebold, 1969. Western Alberta – Cadomin Railway section; lat. 52°55'N, long. 117°05'W. Fernie Formation. Frebold, 1976 – re-identified by Jakobs, 1992.  
*Peronoceras* sp. indet.  
Middle Toarcian

- I-3 **GSC loc. 19557.** H. Frebold, 1969. Western Alberta – opposite George Creek valley; lat. 52°05'N, long. 115°55'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992  
*Peronoceras* cf. *P. verticosum* (Buckman)  
*Hildaites* sp. indet.  
Early to Middle Toarcian
- I-4 **TMP 86 139.** R.L. Hall, 1986. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Hall, 1987  
*Polyplectus* cf. *P. subplanatus* (Oppel)  
*Harpoceratoides* sp. indet.  
*Hildaites* cf. *H. serpentiniformis* Buckman  
*Harpoceras* cf. *H. falciferum* (Sowerby)  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
Early to Middle Toarcian
- TMP 86 140.** R.L. Hall, 1986. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Hall, 1987  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
Early to Middle Toarcian
- GSC loc. 78841.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 (not figured)  
*Dactylioceras* sp. indet.  
*Brodieia?* sp. indet. (not seen, but based on similar identifications from other collections, it may be an *Harpoceras*).  
Early to Middle Toarcian
- GSC loc. 78843.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
Early to Middle Toarcian
- GSC loc. 78844.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Polyplectus* cf. *P. subplanatus* (Oppel)  
Early to Middle Toarcian
- GSC loc. 78852.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 (not figured)  
*Dactylioceras* sp. indet.  
*Brodieia?* sp. (not seen, but based on similar identifications from other collections, it may be an *Harpoceras*).  
Early to Middle Toarcian
- GSC loc. 78853.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Cleviceras?* sp. indet.  
Early to Middle Toarcian
- GSC loc. 91936.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Hildaites* cf. *H. serpentiniformis* Buckman  
*Harpoceras* cf. *H. falciferum* (Sowerby)  
Early Toarcian
- GSC loc. 91943.** H. Frebold, 1969. Western Alberta – Bighorn Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Hildaites* cf. *H. serpentiniformis* Buckman  
*Harpoceras* cf. *H. falciferum* (Sowerby)  
*Cleviceras?* sp. indet.  
dactylioceratidae gen. et sp. indet.  
Early Toarcian
- I-5 **GSC loc. unknown.** H. Frebold, 1969. Western Alberta – Red Deer River. Fernie Formation.  
Frebold, 1976 – re-identified by Jakobs, 1992.  
*Peronoceras* sp. indet.  
Middle Toarcian
- I-6 **TMP 86 234.** R.L. Hall, 1986. Western Alberta – Scalp Creek; lat. 51°45'N, long. 115°32'W. Fernie Formation.  
Hall, 1987  
*Dactylioceras* cf. *D. athleticum* (Simpson)  
*Harpoceras* cf. *H. falciferum* (Sowerby)  
Early to Middle Toarcian
- I-7 **GSC loc. 88027.** H. Frebold, 1969. Western Alberta – Sheep Creek, Panther River area; lat. 51°33'N, long. 115°27'W. Fernie Formation.  
Frebold, 1976 (not figured)  
*Hildaites* sp. nov?  
Early Toarcian
- I-8 **GSC loc. 12877.** H. Frebold, 1950. Western Alberta – Moose Mountain area, Canyon Creek; lat. 50°55'N, long. 115°00'W. Fernie Formation.  
Frebold, 1957a – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 12879.** H. Frebold, 1950. Western Alberta – Moose Mountain area, Canyon Creek; lat. 50°55'N, long. 115°00'W. Fernie Formation.  
Frebold, 1957a – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Dactylioceras* (*Orthodactylites*) sp. indet.  
Early to Middle Toarcian
- GSC loc. 12880.** H. Frebold, 1950. Western Alberta – Moose Mountain area, Canyon Creek; lat. 50°55'N, long. 115°00'W. Fernie Formation.  
Frebold, 1957a – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Dactylioceras* (*Orthodactylites*) sp. indet.  
Early to Middle Toarcian

- GSC loc. 12881.** H. Frebold, 1950. Western Alberta – Moose Mountain area, Canyon Creek; lat. 50°55'N, long. 115°00'W. Fernie Formation.  
Frebold, 1957a – re-identified by Jakobs, 1992.  
*Dactylioceras* aff. *D. commune* (Sowerby)  
Early to Middle Toarcian
- I-9 **GSC loc. 19095.** H. Frebold, 1969. Southern area – Daisy Creek Summit; lat. 49°45'N, long. 113°25'W. Fernie Formation.  
Frebold, 1976 (not figured)  
*Peronoceras* sp. indet.  
Middle Toarcian
- I-10 **GSC loc. 31430.** H. Frebold, 1968. Fernie map area – Fording River; lat. 49°55'N, long. 114°52'W. Fernie Formation.  
Frebold, 1969 – re-identified by Jakobs, 1992.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian
- GSC loc. 78594.** H. Frebold, 1968. Fernie map area – Fording River; lat. 49°55'N, long. 114°52'W. Fernie Formation.  
Frebold, 1969 – re-identified by Jakobs, 1992.  
*Hildaites?* sp. indet.  
Early Toarcian
- GSC loc. 91942.** H. Frebold, 1968. Fernie map area – Fording River; lat. 49°55'N, long. 114°52'W. Fernie Formation.  
Frebold, 1969 (not figured)  
*Dactylioceras* (*Orthodactylites*) sp. indet.  
Early to Middle Toarcian

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**J. Nelson (NTS 82F), Quesnel (NTS 93B), and Prince George (NTS 93G) map areas**

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- J-1 **GSC loc. unknown.** H. Frebold, 1958. Nelson map area – highway between Hall and Porto Rico; lat. 49°22'N, long. 117°15'W. Elise Formation.  
Frebold, 1959 – re-identified by Jakobs, 1992.  
*Cleviceras* sp. indet.  
*Protogrammoceras argutum* (Buckman)  
Early Toarcian
- J-2 **GSC loc. 38909.** H. Frebold and H.W. Little, 1959. Nelson map area – junction of a road from the north with Keystone Road; lat. 49°14'N, long. 117°18'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 38919.** H. Frebold and H.W. Little, 1959. Nelson map area – junction of a road from the north with Keystone Road; lat. 49°14'N, long. 117°18'W. Hall Formation.  
Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 38920.** H. Frebold and H.W. Little, 1959. Nelson map area – junction of a road from the north with Keystone Road; lat. 49°14'N, long. 117°18'W. Hall Formation.  
Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 38921.** H. Frebold and H.W. Little, 1959. Nelson map area – junction of a road from the north with Keystone Road; lat. 49°14'N, long. 117°18'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38923.** H. Frebold and H.W. Little, 1959. Nelson map area – junction of a road from the north with Keystone Road; lat. 49°14'N, long. 117°18'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- J-3 **GSC loc. 38910.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation.  
Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
*Peronoceras* sp. indet.  
*Pseudolioceras?* sp. indet.  
Middle Toarcian
- GSC loc. 38911.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
Hildoceraceae  
Toarcian
- GSC loc. 38912.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38914.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation.  
Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian

- GSC loc. 38915.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38916.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38917.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Dactylioceras* sp. indet.  
*Pseudolioceras?* sp. indet.  
Early to Middle Toarcian
- GSC loc. 38918.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38924.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 (not figured)  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- GSC loc. 38932.** H. Frebold and H.W. Little, 1959. Nelson map area – Arlington Mine; lat. 49°14'N, long. 117°20'W. Hall Formation. Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- J-4 **GSC loc. 39282.** H. Frebold and H.W. Little, 1959. Nelson map area – Second Chance Mine; lat. 49°13'N, long. 117°17'W. Hall Formation. Frebold & Little, 1962 (not figured)  
*Harpoceras* cf. *H. exaratum* (Young & Bird)  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- J-5 **GSC loc. 38941.** H. Frebold and H.W. Little, 1959. Nelson map area – Hell Roaring Creek Road, 0.1 miles (0.16 km) before a tributary from the west; lat. 49°14'N, long. 117°17'W. Hall Formation. Report J-5-59/60-HF  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- J-6 **GSC loc. 45111.** H.W. Little, 1961. Nelson map area – Bath Creek Road from Fruitvale; lat. 49°06'20"N, long. 117°33'30"W. Hall Formation. Little, 1982 (not figured)  
*Dactylioceras* sp. indet.  
bivalves  
Early to Middle Toarcian
- J-7 **GSC loc. 36219.** H. Frebold and H.W. Little, 1959. Nelson map area – exact location unknown. Hall Formation. Frebold & Little, 1962 – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
Early to Middle Toarcian
- J-8 **GSC loc. 90770.** H.W. Tipper, 1973. Prince George map area – south of Woodpecker on the Fraser River; lat. 53°30'N, long. 122°40'W. Unnamed strata. Report J-1-1974-HF  
*Grammoceras?* sp. indet.  
Late Toarcian?
- J-9 **GSC loc. 91745.** H.W. Tipper, 1974. Quesnel map area – Soda Creek; lat. 52°20'N, long. 122°15'W. Unnamed strata. Report J-16-1974-HF  
*Grammoceras?* sp. indet.  
Late Toarcian?
- J-10 **GSC loc. 93186.** H.W. Tipper, 1975. Manson River map area – Discovery Creek, northwest of GERMansen Landing; lat. 55°49'N, long. 125°08'W. Unnamed strata.  
*Polyplectus discoides* (Zieten)  
*Dumortieria? phantasma* Jakobs and Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. 93341.** H.W. Tipper, 1975. Manson River map area – Discovery Creek, northwest of GERMansen Landing; lat. 55°49'N, long. 125°08'W. Unnamed strata.  
*Dumortieria? phantasma* Jakobs and Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-189664.** J. Nelson, 1992. Manson River map area – Discovery Creek, northwest of GERMansen Landing. lat. 55°49'18"N, long. 125°06'52"W. Unnamed strata.  
*Dumortieria? phantasma* Jakobs and Smith  
*Yakounia silvae* Jakobs and Smith  
Late Toarcian – Yakounensis Zone
- GSC loc. C-189742.** J. Nelson, 1992. Manson River map area – Discovery Creek, northwest of GERMansen Landing. lat. 55°48'45"N, long. 125°05'48"W. Unnamed strata.  
*Pleydellia maudensis* Jakobs and Smith  
*Yakounia silvae* Jakobs and Smith  
*Lytoceras* sp. indet.  
Late Toarcian – Yakounensis Zone

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**K. Taseko Lakes map area (NTS 920)**

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- K-1 GSC loc. 94767.** H.W. Tipper, 1976. Taseko Lakes map area – 2.75 miles (4.4 km) west of Cardtable Mountain; lat. 53°06'10"N, long. 123°00'25"W. Last Creek formation.  
*Phymatoceras* cf. *P. rude* (Simpson)  
Middle Toarcian – Crassicosta Zone
- K-2 GSC loc. 94772.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 94778.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
harpoceratinae gen. et sp. indet.  
Toarcian
- GSC loc. 94781.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phylloceras* sp. indet.  
belemnites  
Toarcian
- GSC loc. 94784.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 94789.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Lytoceras siemensii* (Denckmann)  
Early to Middle Toarcian
- GSC loc. 94792.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Dactylioceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 94793.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Lytoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 94795.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras?* sp. indet.  
Middle to Late Toarcian
- GSC loc. 94805.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Lytoceras siemensii* (Denckmann)  
Early to Middle Toarcian
- GSC loc. 94810.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras* cf. *P. hillebrandtii* (Jakobs)  
Late Toarcian – Hillebrandti Zone
- GSC loc. 94813.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early to Middle Toarcian
- GSC loc. 94823.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Lytoceras siemensii* (Denckmann)  
*Dactylioceras* cf. *D. commune* (Sowerby)  
Early to Middle Toarcian
- GSC loc. 94824.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 94826.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Lytoceras* sp. indet.  
dicoelitid belemnites  
Middle Toarcian
- GSC loc. 94837.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras* cf. *P. rude* (Simpson)  
Middle Toarcian – Crassicosta Zone
- GSC loc. 94851.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras* cf. *P. hillebrandtii* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. 94866.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Cleviceras* cf. *C. chrysanthemum* (Yokoyama)  
Early to Middle Toarcian
- GSC loc. 94870.** H.W. Tipper, 1976. Taseko Lakes map area – head of south branch of Relay Creek; lat. 51°06'45"N, long. 123°01'45"W. Last Creek formation.  
*Phymatoceras* sp. indet.  
Middle to Late Toarcian
- K-3 GSC loc. 94814.** H.W. Tipper, 1976. Taseko Lakes map area – near volcanic neck at head of Relay Creek; lat. 51°06'28"N, long. 123°01'27"W. Last Creek formation.  
*Phylloceras* sp. indet.  
Toarcia

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L. Hope map area (NTS 92H)

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- L-1 **GSC loc. C-118595.** A.J. Arthur, 1985. Harrison Lake area – on road north-northwest from Celia Cove; lat. 49°20'34"N, long. 121°49'52"W. Harrison Lake Formation – Francis Lake Member.  
Arthur et al., 1993 – re-identified by Jakobs, 1992.  
*Cleviceras* sp. indet.  
*Dactyloceras* sp. indet.  
*Hildaites* cf. *H. propeserpentinum* (Buckman)  
Early Toarcian – Kanense Zone

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M. Queen Charlotte Islands (NTS 103F)

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- M-1 **GSC loc. C-156887.** G.K. Jakobs, 1988. Central Graham Island – Marie Lake; lat. 53°29'30"N, long. 132°19'45"W. Whiteaves Formation.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
*Podagrosites* sp. indet.  
Late Toarcian – Hillebrandti Zone
- M-2 **GSC loc. C-87240.** H.W. Tipper, 1980. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149660.** G.K. Jakobs, 1987. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149661.** G.K. Jakobs, 1987. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149663.** G.K. Jakobs, 1987. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149665.** G.K. Jakobs, 1987. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-149666.** G.K. Jakobs, 1987. Central Graham Island – Yakoun River; lat. 53°25'05"N, long. 132°15'30"W. Whiteaves Formation.  
*Podagrosites latescens* (Simpson)  
*Phymatoceras hillebrandti* Jakobs  
*Phymatoceras* sp. indet.  
Late Toarcian – Hillebrandti Zone
- M-3 **GSC loc. 52335.** A. Sutherland-Brown, 1962. Central Graham Island. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. 52336.** A. Sutherland-Brown, 1962. Central Graham Island. Whiteaves Formation – talus collection.  
*Harpoceras* cf. *H. subplanatum* (Oppel)  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. 52339.** A. Sutherland-Brown, 1962. Central Graham Island. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- M-4 **GSC loc. C-80788.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Polyplectus discoides* (Zieten)  
*Phymatoceras* cf. *P. crassicosta* Merla  
Middle Toarcian – Crassicosta Zone
- GSC loc. C-80811.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Harpoceras* sp. indet.  
Early to Middle Toarcian



- GSC loc. C-80812.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collections.  
*Phymatoceras hillebrandti* Jakobs  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Harpoceras* sp. indet.  
Early to Late Toarcian
- GSC loc. C-80813.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collections.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-80819.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collections.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-80820.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Pseudomercaticeras* cf. *P. frantzi* (Reynès)  
Middle Toarcian – Crassicosta Zone
- GSC loc. C-80821.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras hillebrandti* Jakobs  
Late Toarcian – Hillebrandti Zone
- GSC loc. C-80826.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-80847.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Rarenodia planulata* Venturi  
Middle Toarcian – Planulata Zone
- GSC loc. C-80848.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Harpoceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-80849.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Mercaticeras* sp. indet.  
Middle Toarcian – Crassicosta Zone
- GSC loc. C-80850.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-80853.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-80854.** B.E.B. Cameron, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Harpoceras* sp. indet.  
*Cenoceras* sp. indet.  
trigonal bivalves  
Early to Middle Toarcian
- GSC loc. C-81722.** H.W. Tipper, 1982. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Harpoceras* sp. indet.  
belemnoid  
Early to Middle Toarcian
- GSC loc. C-81726.** H.W. Tipper, 1982. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Polyplectus discoides* (Zieten)  
Middle Toarcian
- GSC loc. C-81912.** H.W. Tipper, 1979. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
Middle Toarcian
- GSC loc. C-81913.** H.W. Tipper, 1979. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras* cf. *P. pseudoerbaense* (Gabilly)  
Middle Toarcian
- GSC loc. C-86358.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassicosta* Merla  
Middle Toarcian – Crassicosta Zone
- GSC loc. C-86360.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Denckmannia* cf. *D. tumefacta* Buckman  
Middle Toarcian
- GSC loc. C-86365.** H.W. Tipper, 1978. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Mercaticeras* sp. indet.  
Middle Toarcian – Crassicosta Zone

- GSC loc. C-156893.** G.K. Jakobs, 1988. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
*Phymatoceras hillebrandti* Jakobs  
Middle to Late Toarcian
- GSC loc. C-159386.** G.K. Jakobs, 1989. Skidegate Inlet – Maude Island; lat. 53°12'00"N, long. 132°03'00"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
Middle Toarcian – Crassica Zone
- M-5 **GSC loc. 36986.** A. Sutherland-Brown, 1961. Lyell Island – Atli Inlet; lat. 52°42'N, long. 131°33'W. Whiteaves Formation.  
*Phymatoceras?* sp. indet.  
Middle Toarcian?
- M-6 **GSC loc. C-159865.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Dactylioceras* sp. indet.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Phymatoceras* cf. *P. crassica* Merla  
*Phymatoceras* sp. indet.  
*Pseudomercaticeras* sp. indet.  
bivalves  
Middle Toarcian
- GSC loc. C-159866.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Phymatoceras* cf. *P. crassica* Merla  
*Phymatoceras* sp. indet.  
bivalves  
Middle Toarcian – probably Crassica Zone
- GSC loc. C-159867.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Denckmannia* cf. *D. tumefacta* Buckman  
*Phymatoceras* cf. *P. crassica* Merla  
*Phymatoceras* sp. indet.  
*Mercaticeras* cf. *M. hellenicum* (Renz)  
*Mercaticeras* sp. indet.  
bivalves  
Middle Toarcian – probably Crassica Zone
- GSC loc. C-159868.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
*Phymatoceras* sp. indet.  
Middle Toarcian – Crassica Zone
- GSC loc. C-159869.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
*Phymatoceras* sp. indet.  
Middle Toarcian – Crassica Zone
- GSC loc. C-159870.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Cleviceras* sp. indet.  
Early to Middle Toarcian
- GSC loc. C-159871.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
Middle Toarcian – Crassica Zone
- GSC loc. C-159872.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras* sp. indet.  
bivalves  
Middle Toarcian
- GSC loc. C-159873.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras* cf. *P. rude* (Simpson)  
*Phymatoceras* sp. indet.  
bivalves  
Middle Toarcian
- GSC loc. C-159874.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
*Phymatoceras* sp. indet.  
*Cenoceras* sp. indet.  
trigonid bivalves  
Middle Toarcian – Crassica Zone
- GSC loc. C-159875.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
Middle Toarcian – Crassica Zone
- GSC loc. C-159876.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
Middle Toarcian – Crassica Zone
- GSC loc. C-159877.** G.K. Jakobs, 1988. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras* cf. *P. erbaense* (Hauer)  
Middle Toarcian
- GSC loc. 48591.** A. Sutherland-Brown, 1961. Louise Island – south of Skedans village; lat. 52°57'20"N, long. 131°36'45"W. Whiteaves Formation – talus collection.  
*Phymatoceras crassica* Merla  
Middle Toarcian – Crassica Zone

- N-1 **USGS Mesozoic loc. 29198.** British Petroleum, 1962.  
Chugach Mountains – from saddle on south side  
of Kings Mountain; lat. 61°44'N, long. 148°30'00"W.  
Talkeetna Formation.  
Imlay, 1981 – re-identified by Jakobs, 1992.  
*Cleviceras* cf. *C. exaratum* (Young & Bird)  
*Dactylioceras kanense* McLearn  
*Dactylioceras* cf. *D. commune* (Sowerby)  
Early to Middle Toarcian
- N-2 **USGS Mesozoic loc. 24787.** A. Grantz, 1953.  
Talkeetna Mountains – 1km northwest of where Camp  
Creek crosses the Glenn Highway; lat. 61°50'53"N,  
long. 147°24'43"W. Talkeetna Formation.  
Imlay, 1981  
*Dactylioceras* cf. *D. commune* (Sowerby)  
Early to Middle Toarcian
- N-3 **USGS Mesozoic loc. 25939.** A. Grantz, 1955.  
Copper River Basin – south side of western Copper  
River Basin; lat. 61°54'02"N, long. 146°52'00"W.  
Talkeetna Formation.  
Imlay, 1981– re-identified by Jakobs, 1992.  
*Hildaites?* sp. indet.  
Late Pliensbachian to Early Toarcian

## **PLATES 1 to 18**

All figured specimens are actual size unless otherwise stated.

All the type specimens, with prefix "GSC", are stored in the Type Collection, Geological Survey of Canada, Ottawa, Ontario.

The fossil localities from which the specimens come are described in the Appendix and are prefixed by "GSC locality" or "GSC loc.". These collections, with the exception of the type specimens, are housed at the Geological Survey of Canada, Calgary, Alberta.

## PLATE 1

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 7, 8. *Lytoceras siemensii* (Denckmann, 1887)

- 1, 2. Figured specimen GSC 108379 from GSC loc. C-157715, Section 7, Loc. 58, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
- 7, 8. Figured specimen GSC 107330 from GSC loc. 94789, Isolated Loc. K-2, Taseko Lakes map area, Last Creek formation, Lower to Middle Toarcian.

Figures 3, 4. *Dactylioceras* cf. *D. alpestre* Wiedenmayer, 1980

Figured specimen GSC 107307 from GSC loc. C-149698, Section 9, Loc. 6, Queen Charlotte Islands, Fannin Formation, Kanense Zone.

Figures 5, 6. *Dactylioceras* aff. *D. comptum* (Dagys, 1968)

Figured specimen GSC 107308 from GSC loc. C-156383, Section 9, Loc. 4, Queen Charlotte Islands, Fannin Formation, Kanense Zone.

Figures 9-12, 19, 20. *Dactylioceras kanense* McLearn, 1930

- 9, 10. Figured specimen GSC 6485 (plesiotype) from GSC loc. 13630, Queen Charlotte Islands, Fannin Formation, Kanense Zone.
- 11, 12. Figured specimen GSC 6484 (plesiotype) from GSC loc. 13630, Queen Charlotte Islands, Fannin Formation, Kanense Zone.
- 19, 20. Figured specimen GSC 9051 (holotype) from GSC loc. 13630, Queen Charlotte Islands, Fannin Formation, Kanense Zone.

Figures 13, 14, 21, 22. *Dactylioceras* cf. *D. commune* (Sowerby, 1815)

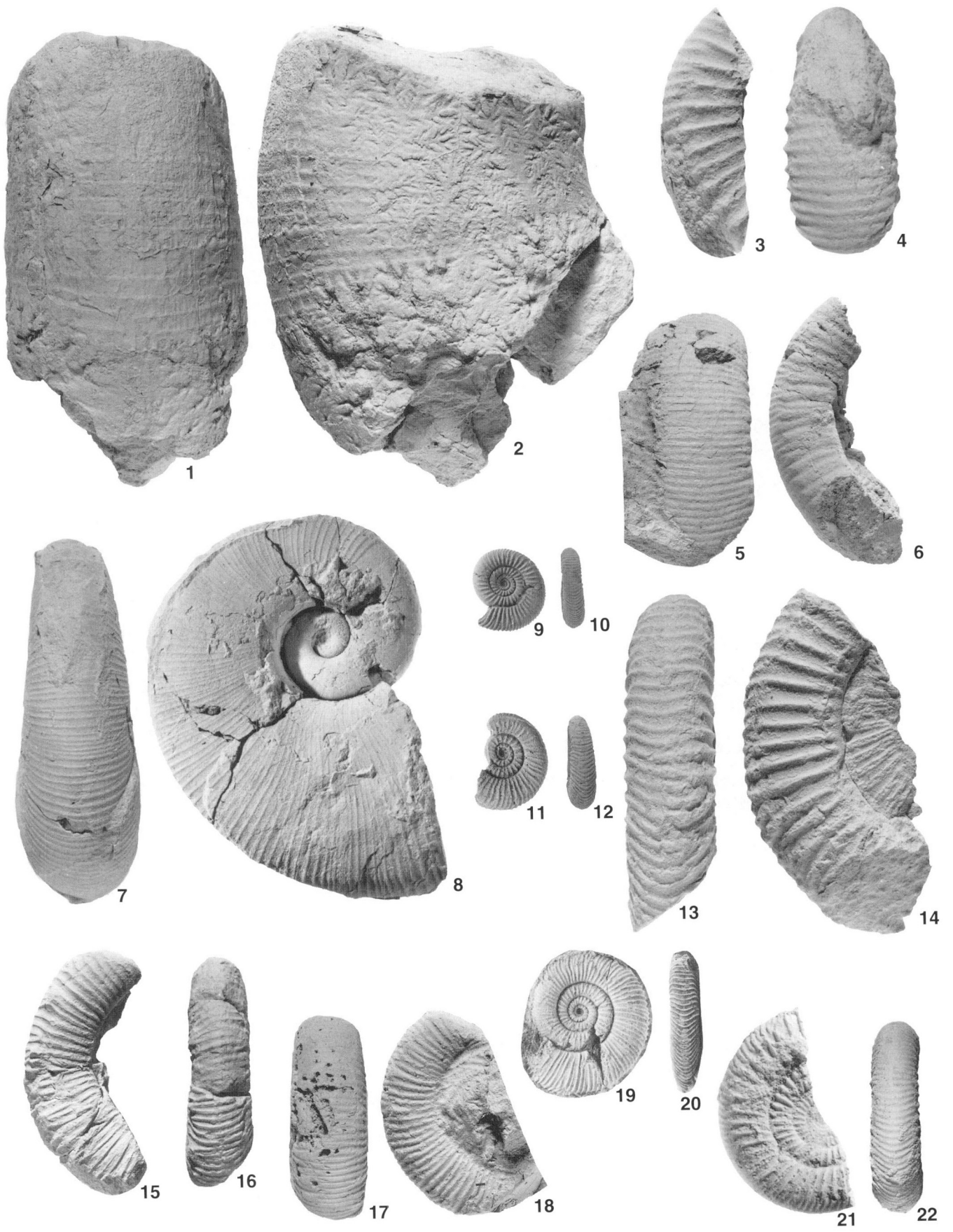
- 13, 14. Figured specimen GSC 107319 from GSC loc. C-90698, Isolated Loc. E-1, Spatsizi River map area, Spatsizi Formation, Lower to Middle Toarcian.
- 21, 22. Figured specimen GSC 107317 from GSC loc. C-90698, Isolated Loc. E-1, Spatsizi River map area, Spatsizi Formation, Lower to Middle Toarcian.

Figures 15, 16. *Peronoceras* cf. *P. verticosum* (Buckman, 1914)

Figured specimen GSC 108380 from GSC loc. C-159896, Section 7, Loc. 17, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.

Figures 17, 18. *Dactylioceras* sp. indet.

Figured specimen GSC 108381 from GSC loc. C-159865, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone/Planulata Zone.



## PLATE 2

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Peronoceras* cf. *P. moerickei* Hillebrandt, 1981

Figured specimen GSC 108382 from GSC loc. C-87139, Section 7, Loc. 46, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

Figures 3, 4. *Peronoceras* cf. *P. crassicostatum* (Guex, 1972)

Figured specimen GSC 107324 from GSC loc. C-81710, Section 7, Loc. 46, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone (ventral view x 0.93).

Figures 5, 6, 9, 10. *Peronoceras verticosum* (Buckman, 1914)

5, 6. Figured specimen GSC 107313 from GSC loc. C-90743, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

9, 10 Figured specimen GSC 108384 from GSC loc. C-90744, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

Figures 7, 8. *Peronoceras* sp. indet.

Figured specimen GSC 108383 from GSC loc. C-87139, Section 7, Loc. 46, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.

Figure 11. *Catacoeloceras* cf. *C. crassum* (Young & Bird, 1828)

Latex cast of figured specimen GSC 107331 from GSC loc. 89595, Isolated Loc. G-10, Hazelton map area, Hazelton Group, Middle Toarcian.

Figures 12, 13. *Peronoceras spinatum* (Frebald, 1957a)

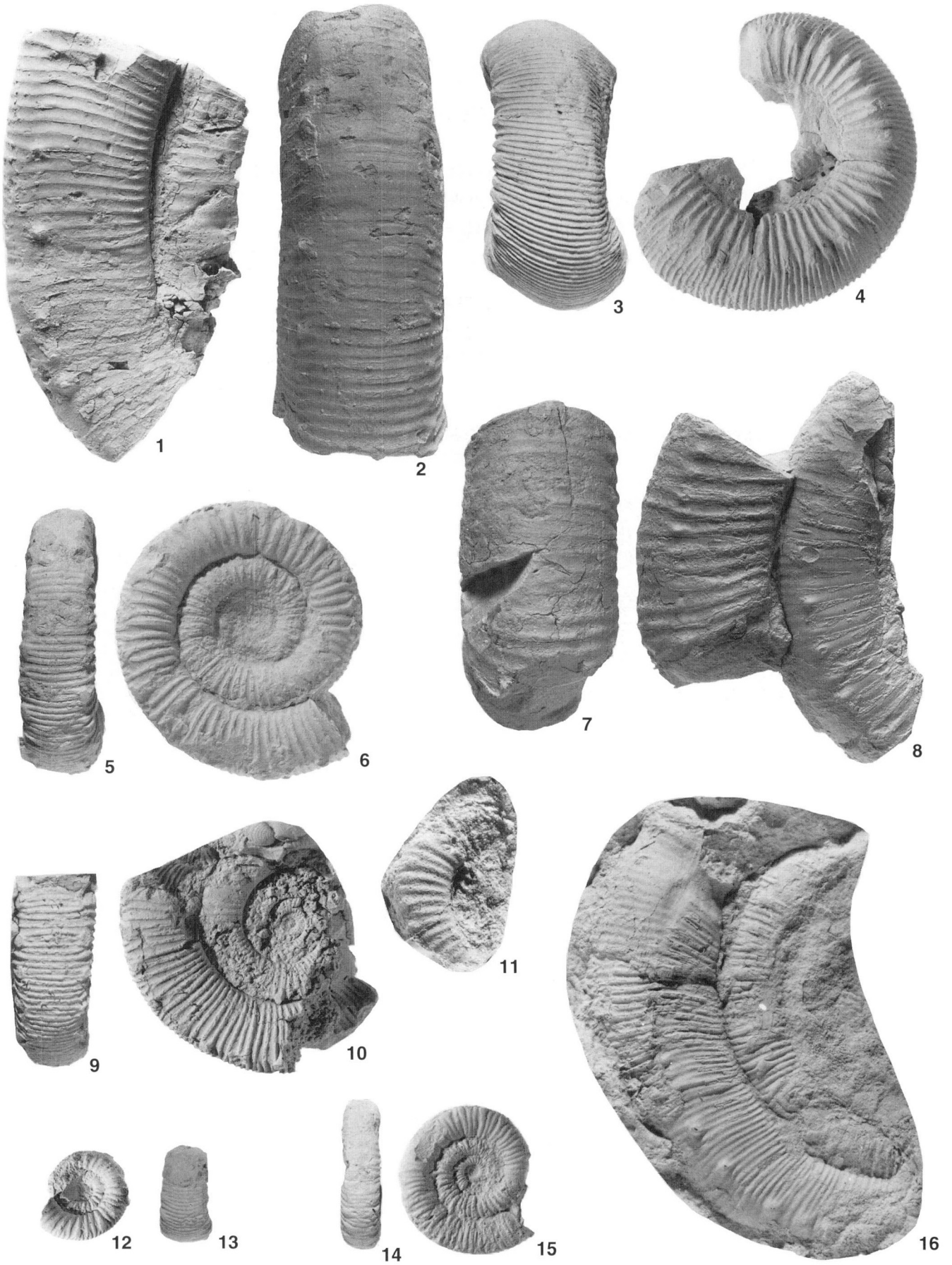
Figured specimen GSC 107314 from GSC loc. C-90743, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

Figures 14, 15. *Peronoceras pacificum* Hillebrandt, 1981

Figured specimen GSC 107315 from GSC loc. C-90743, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

Figure 16. *Peronoceras* aff. *P. moerickei* Hillebrandt, 1981

Figured specimen GSC 107333 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Middle Toarcian.





### PLATE 3

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Peronoceras* cf. *P. verticosum* (Buckman, 1914)

Figured specimen GSC 107318 from GSC loc. C-156379, Section 7, Loc. 18, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.

Figures 3, 4. *Peronoceras* aff. *P. desplacei* (d'Orbigny, 1844)

Figured specimen GSC 108385 from GSC loc. C-90806, Section 2, Loc. 3, Spatsizi River map area, Spatsizi Formation, Planulata Zone?

Figure 5. *Collina* cf. *C. linae* Parisch & Viale, 1906

Figured specimen GSC 107328 from GSC loc. C-81710, Section 7, Loc. 46, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

Figures 6, 7, 12, 13. *Cleviceras* cf. *C. exaratum* (Young & Bird, 1828).

6, 7. Figured specimen GSC 95581 from GSC loc. C-158008, Section 6, Loc. 22, Queen Charlotte Islands, Whiteaves Formation, Lower to Middle Toarcian.

12, 13. Figured specimen GSC 108387 from GSC loc. C-158043, Section 6, Loc. 20, Queen Charlotte Islands, Whiteaves Formation, Lower to Middle Toarcian (ventral view x 0.97).

Figures 8, 9. *Taffertia taffertensis* Guex, 1973a

Figured specimen GSC 107306 from GSC loc. C-80778, Section 9, Loc. 16, Queen Charlotte Islands, Fannin Formation, Kanense Zone.

Figures 10, 11. *Polyplectus discoides* (Zieten, 1830)

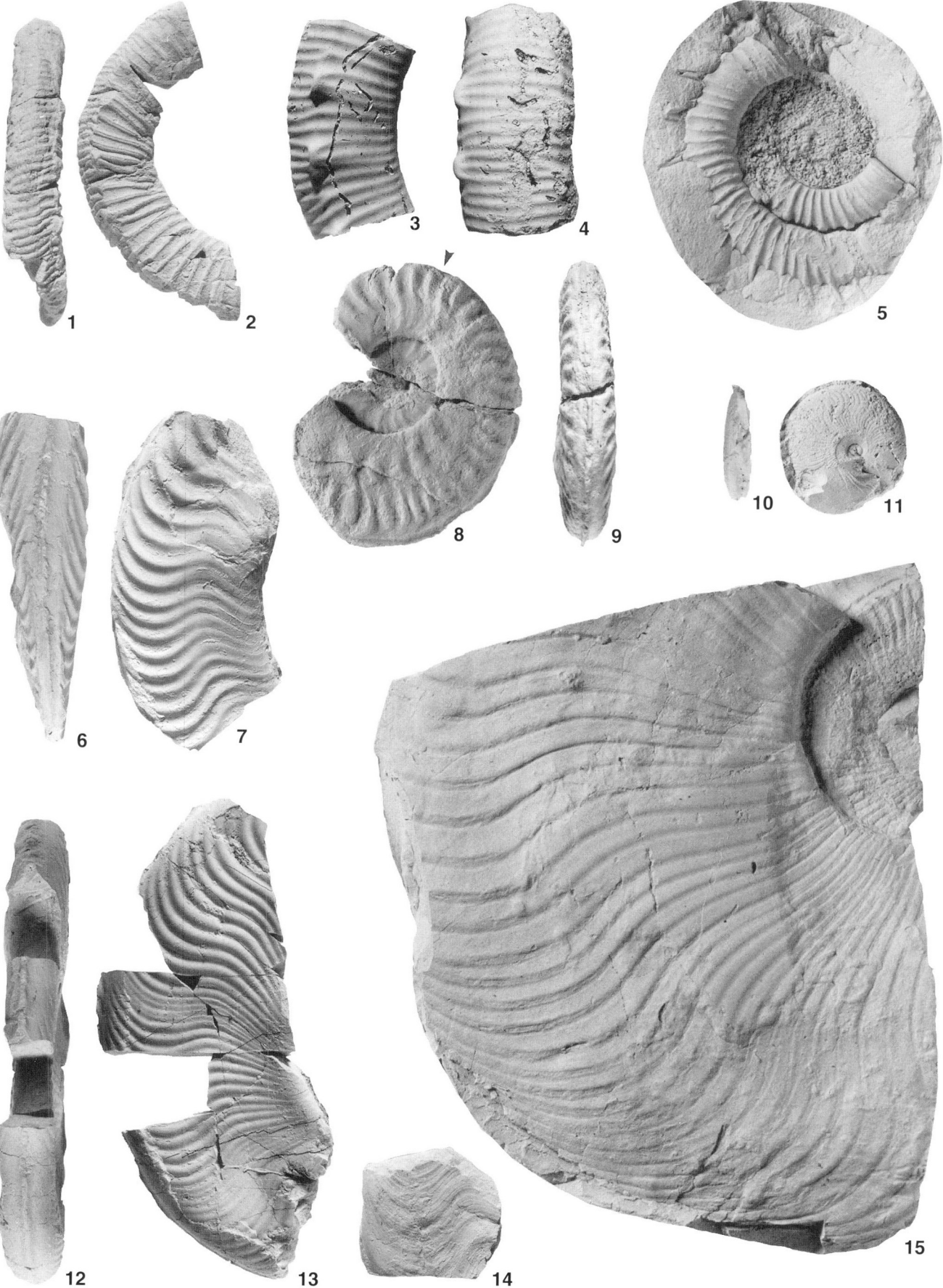
Figured specimen GSC 107327 from GSC loc. C-159396, Section 7, Loc. 71, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.

Figure 14. *Hildaites* cf. *H. subserpentinus* Buckman, 1921

Figured specimen GSC 108388 from GSC loc. C-158004, Section 6, Loc. 2, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone.

Figure 15. *Harpoceras* cf. *H. subplanatum* (Oppel, 1856)

Figured specimen GSC 108389 from GSC loc. 52336, Isolated Loc. M-3, Queen Charlotte Islands, Whiteaves Formation, Lower to Middle Toarcian.



## PLATE 4

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 5. *Cleviceras* cf. *C. chrysanthemum* (Yokoyama, 1904)

- 1, 2. Figured specimen GSC 107312 from GSC loc. C-87101, Section 7, Loc. 12, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone to Planulata Zone.
5. Latex cast of figured specimen GSC 108390 from GSC loc. C-158013, Section 6, Loc. 7, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone.

Figures 3, 4. *Cleviceras* cf. *C. exaratum* (Young & Bird, 1828)

Figured specimen GSC 95582 from GSC loc. C-158027, Section 6, Loc. 22, Queen Charlotte Islands, Whiteaves Formation, Lower to Middle Toarcian (ventral view x 0.85).

Figures 6, 7, 10, 11. *Pseudolioceras lythense* (Young & Bird, 1828)

- 6, 7. Figured specimen GSC 107325 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Crassicosta Zone.
- 10, 11. Figured specimen GSC 108391 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Crassicosta Zone.

Figures 8, 9. *Pseudolioceras* sp. indet.

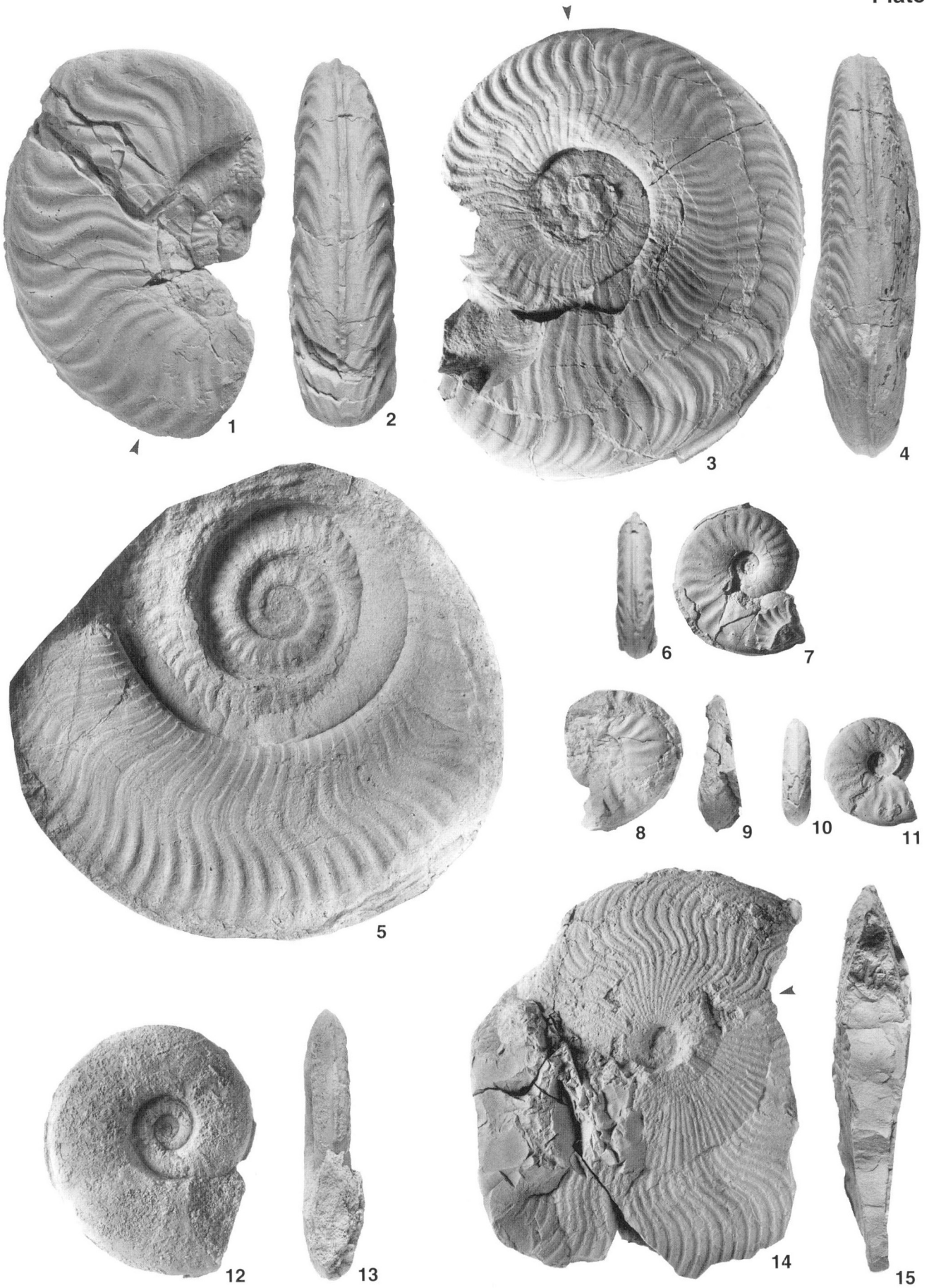
Figured specimen GSC 107316 from GSC loc. C-90742, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

Figures 12, 13. *Tiltoniceras propinquum* (Whiteaves, 1884)

Figured specimen GSC 4877 (holotype) from GSC loc. C-117033, (Jakobs et. al., 1994; Loc. 25) Queen Charlotte Islands, Maude Island, Fannin Formation, Pliensbachian Carlottense Zone.

Figures 14, 15. *Polyplectus discoides* (Zieten, 1830)

Figured specimen GSC 108392 from GSC loc. C-90608, Section 8, Loc. 14, Queen Charlotte Islands, Whiteaves Formation, Middle Toarcian (ventral view x 0.94).



## PLATE 5

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1-9. *Hildaites murleyi* (Moxon, 1841)

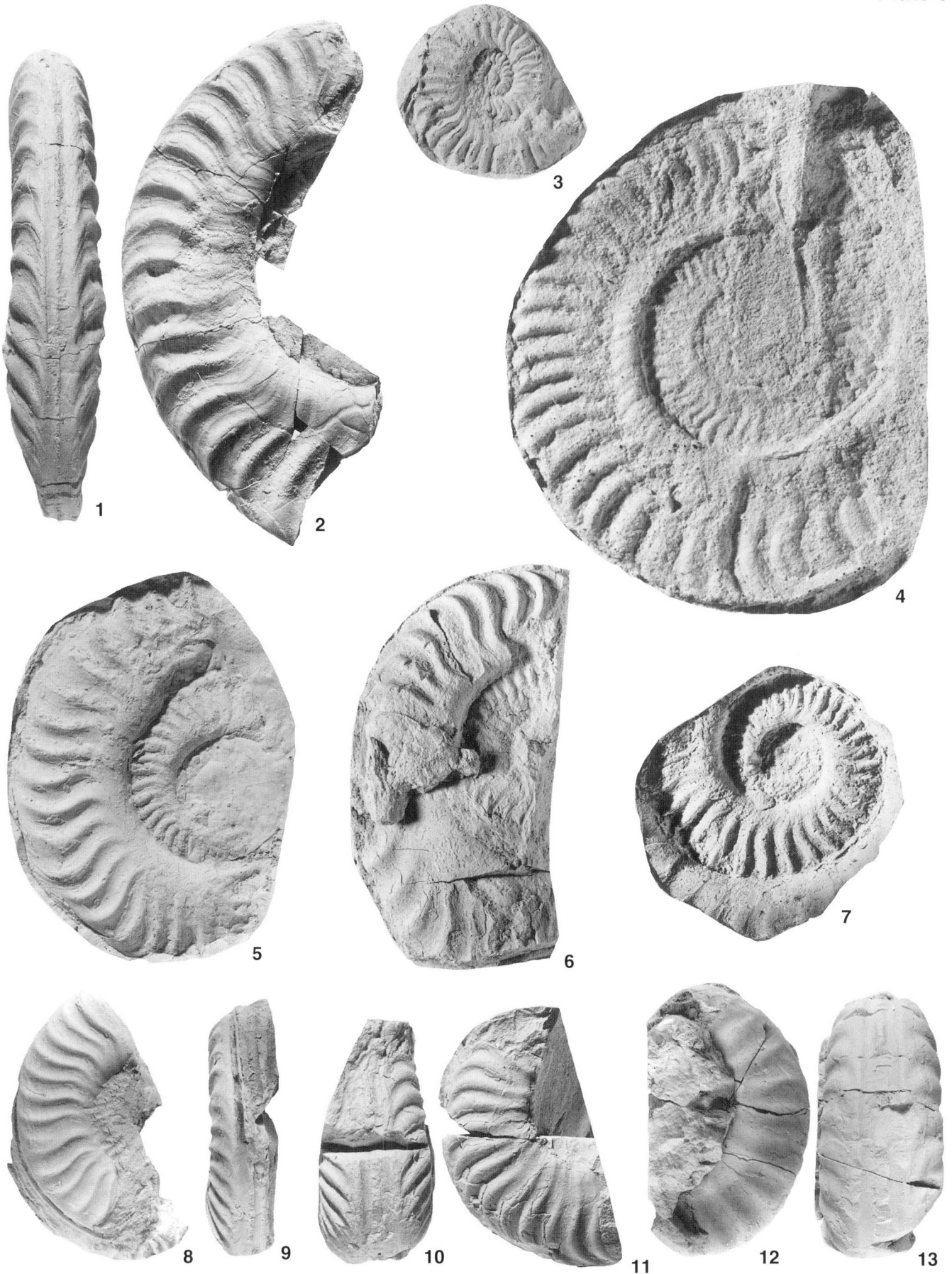
- 1, 2 Figured specimen GSC 108393 from GSC loc. C-156899, Section 7, Loc. 8, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone.
3. Latex cast of figured specimen GSC 107309 from GSC loc. C-103137, Section 3, Loc. 4, Spatsizi River map area, Spatsizi Formation, Kanense Zone.
4. Latex cast of figured specimen GSC 108394 from GSC loc. 95026, Isolated Loc. C-2, Cry Lake map area, Laberge Group, Kanense Zone.
5. Latex cast of figured specimen GSC 107311 from GSC loc. C-90826, Section 2, Loc. 1, Spatsizi River map area, Spatsizi Formation, Kanense Zone.
6. Figured specimen GSC 108395 from GSC loc. C-158058, Section 7, Loc. 10, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone.
7. Latex cast of figured specimen GSC 108396 from GSC loc. C-103143, Section 3, Loc. 6, Spatsizi River map area, Spatsizi Formation, probably Kanense Zone.
- 8, 9. Figured specimen GSC 107310 from GSC loc. C-159388, Section 7, Loc. 6, Queen Charlotte Islands, Whiteaves Formation, Kanense Zone.

Figures 10, 11. *Mercaticeras* sp. indet.

Figured specimen GSC 108397 from GSC loc. C-159887, Section 7, Loc. 51, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

Figures 12, 13. *Mercaticeras* cf. *M. hellenicum* (Renz, 1906)

Figured specimen GSC 107322 from GSC loc. C-159867, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.



## PLATE 6

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 7, 8. *Leukadiella ionica* Renz & Renz, 1947

- 1, 2. Figured specimen GSC 99496 from GSC loc. C-87202, Section 9, Loc. 17, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.93).
- 7, 8. Latex cast of figured specimen GSC 99501 from GSC loc. C-90613, Section 9, Loc. 17, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.

Figure 3. *Leukadiella* sp. indet.

Figured specimen GSC 99508 from GSC loc. 90949, Isolated Loc. G-11, Hazelton map area, Hazelton Group, Planulata Zone.

Figure 4. *Leukadiella* aff. *L. ionica* Renz & Renz, 1947

Latex cast of figured specimen GSC 99505 from GSC loc. C-90741, Section 2, Loc. 2, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Planulata Zone.

Figures 5, 6. *Leukadiella amuratica* Renz & Renz, 1947

Figured specimen GSC 99504 from GSC loc. C-80780, Section 9, Loc. 17, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.





## PLATE 7

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

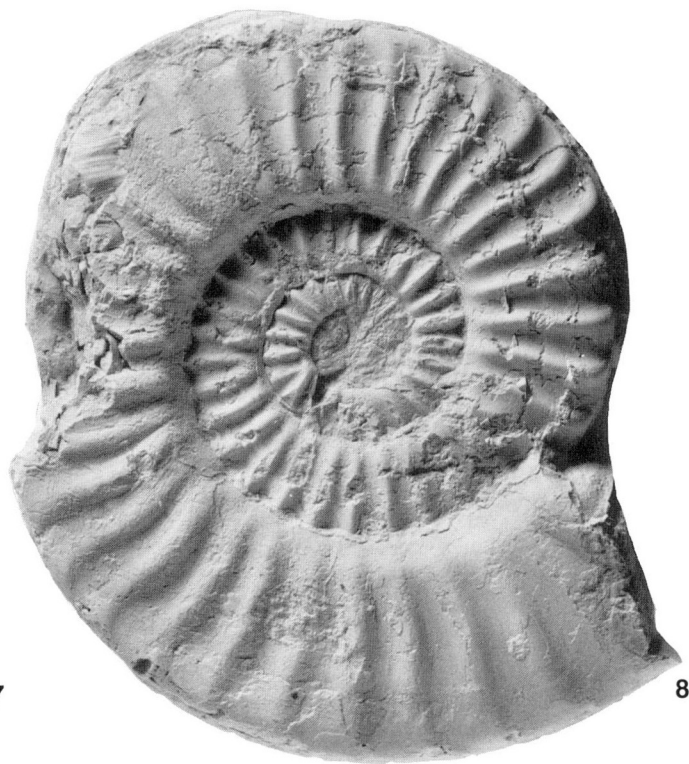
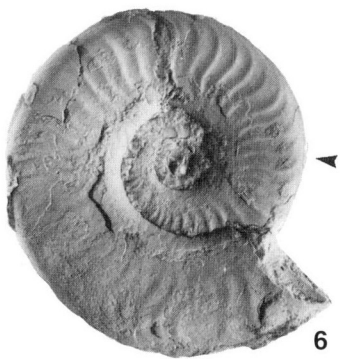
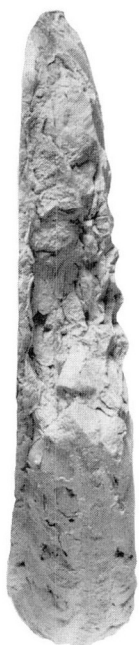
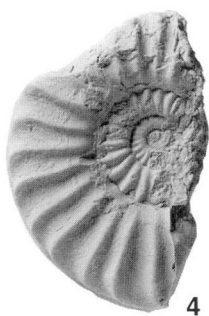
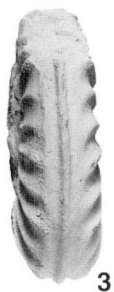
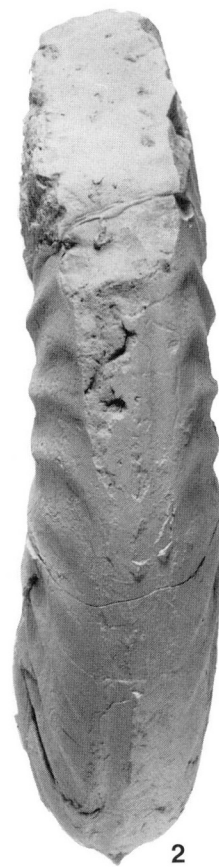
End of phragmocone indicated with an arrowhead.

Figures 1-4, 7, 8. *Podagrosites latescens* (Simpson, 1843)

- 1, 2. Figured specimen GSC 108398 from GSC loc. C-90800, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.85).
- 3, 4. Figured specimen GSC 99488 from GSC loc. C-156378, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.93).
- 7, 8. Figured specimen GSC 108399 from GSC loc. C-157728, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.86).

Figures 5, 6. *Grammoceras thouarsense* (d'Orbigny, 1843)

Figured specimen GSC 95580 from GSC loc. C-87122, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.96).



## PLATE 8

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

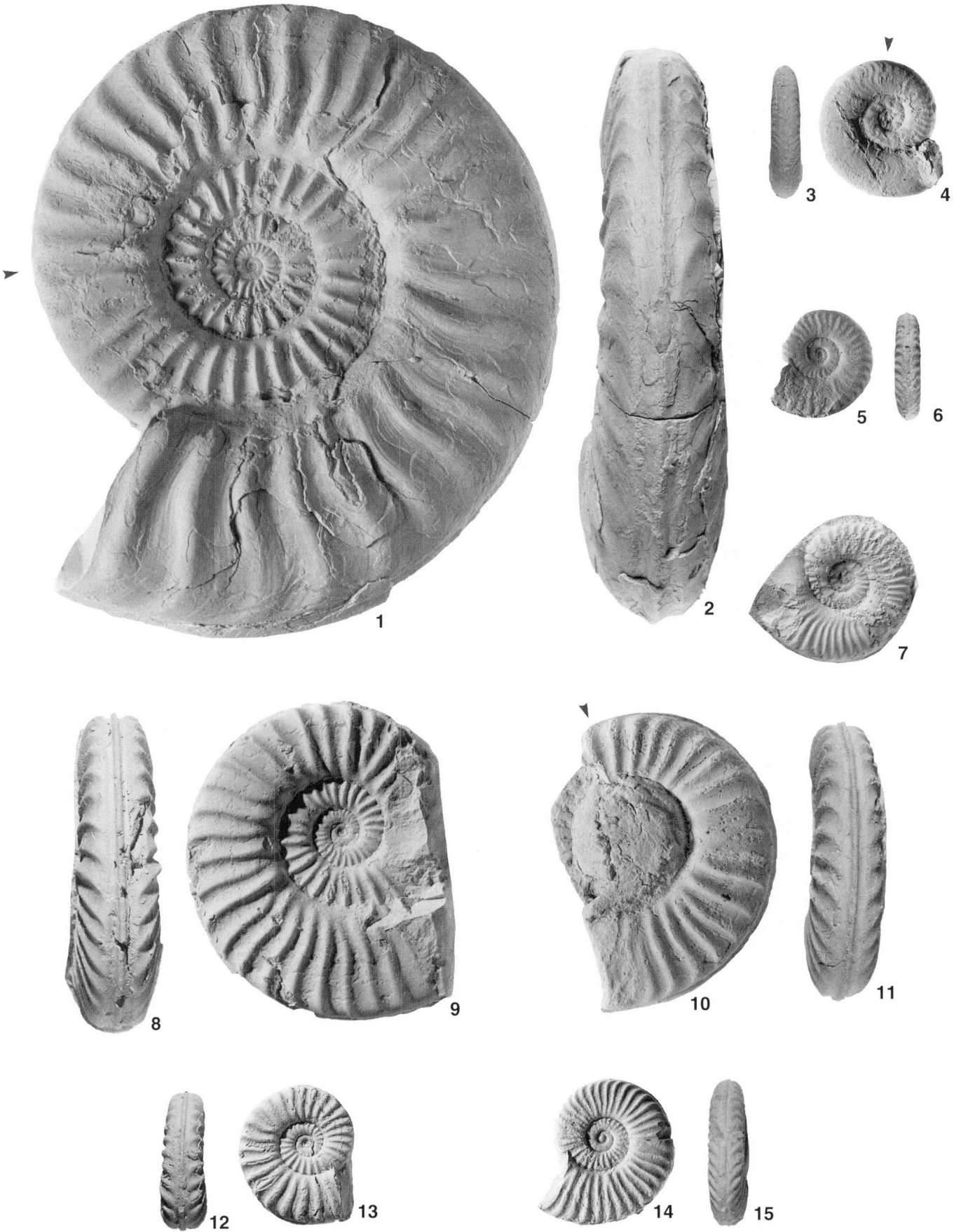
End of phragmocone indicated with an arrowhead.

Figures 1, 2, 8-15. *Podagrosites latescens* (Simpson, 1843)

- 1, 2. Figured specimen GSC 108400 from GSC loc. C-157728, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.92).
- 8, 9. Figured specimen GSC 107334 from GSC loc. C-159894, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.
- 10, 11. Figured specimen GSC 108402 from GSC loc. C-157728, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.96).
- 12, 13. Figured specimen GSC 107335 from GSC loc. C-159894, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.
- 14, 15. Figured specimen GSC 107338 from GSC loc. C-159894, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.

Figures 3-7. *Grammoceras thouarsense* (d'Orbigny, 1843)

- 3, 4. Figured specimen GSC 107336 from GSC loc. C-156378, Section 7, Loc. 104 Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.
- 5, 6. Figured specimen GSC 107339 from GSC loc. C-156378, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.
- 7. Figured specimen GSC 108401 from GSC loc. C-87138, Section 7, Loc. 62, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.



## PLATE 9

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 14, 15 *Pleydellia maudensis* Jakobs & Smith, 1996

Figured specimen GSC 99523 from GSC loc. C-87118, Queen Charlotte Islands,  
Figured specimen GSC 107276 from GSC loc. C-158081, (Jakobs and Smith, 1996;  
Section 5, Loc. 5), Queen Charlotte Islands,  
Phantom Creek Formation, Yakounensis Zone.

Figures 3. *Dumortieria raricostata* Géczy, 1967

Figured specimen UBC 013 from UBC locality F4-3-D, (Jakobs and Smith, 1996; Section 7,  
Loc.4) Izee area, eastern Oregon,  
Warm Springs Member, Snowshoe Formation, Yakounensis Zone.

Figures 4, 5, 6, 7, 12, 13. *Pleydellia crassiornata* Jakobs & Smith, 1996

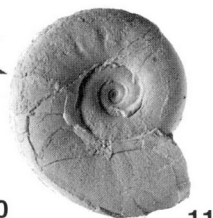
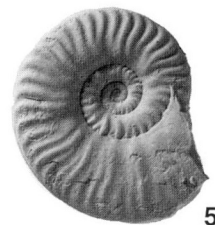
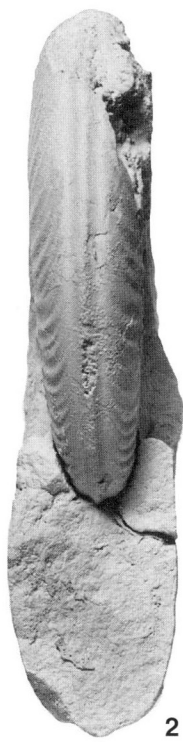
Figured specimen GSC 108547 from GSC loc. C-87118, Queen Charlotte Islands,  
Figured specimen GSC 99513 from GSC loc. C-87118, Queen Charlotte Islands,  
Figured specimen GSC 108548 from GSC loc. C-87118, Queen Charlotte Islands,  
Phantom Creek Formation, Yakounensis Zone.

Figures 8, 9. *Pleydellia aalensis* (Zieten, 1832)

Figured specimen GSC 108546 from GSC loc. C-87118, Queen Charlotte Islands,  
Phantom Creek Formation, Yakounensis Zone.

Figures 10, 11. *Dumortieria? phantasma* Jakobs & Smith, in press

Figured specimen GSC 99520 from GSC loc. C-87220, (Jakobs and Smith, 1996;  
Section 2, Loc. 4) Queen Charlotte Islands,  
Phantom Creek Formation, Yakounensis Zone.



## PLATE 10

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

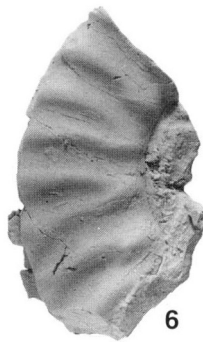
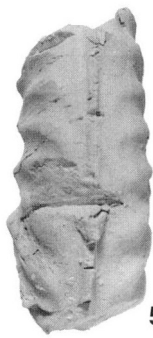
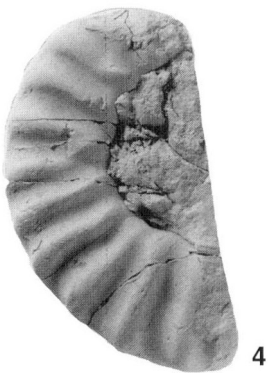
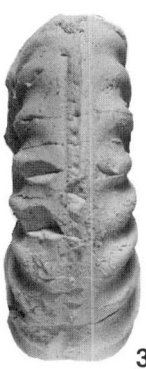
End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Rarenodia planulata* Venturi, 1975a

Figured specimen GSC 108403 from GSC loc. C-87103, Section 7, Loc. 25, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.96).

Figures 3-7. *Phymatoceras* cf. *P. rude* (Simpson, 1843)

- 3, 4. Figured specimen GSC 108404 from GSC loc. C-159866, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
- 5, 6. Figured specimen GSC 108405 from GSC loc. C-159866, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
7. Figured specimen GSC 107329 from GSC loc. 94837, Isolated Loc. K-2, Taseko Lakes map area, Last Creek Formation, Crassicosta Zone.





## PLATE 11

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Rarenodia planulata* Venturi, 1975a

Figured specimen GSC 108406 from GSC loc. C-159391, Section 7, Loc. 104,  
Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.96).



1



2

## PLATE 12

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 5-8. *Rarenodia planulata* Venturi, 1975a

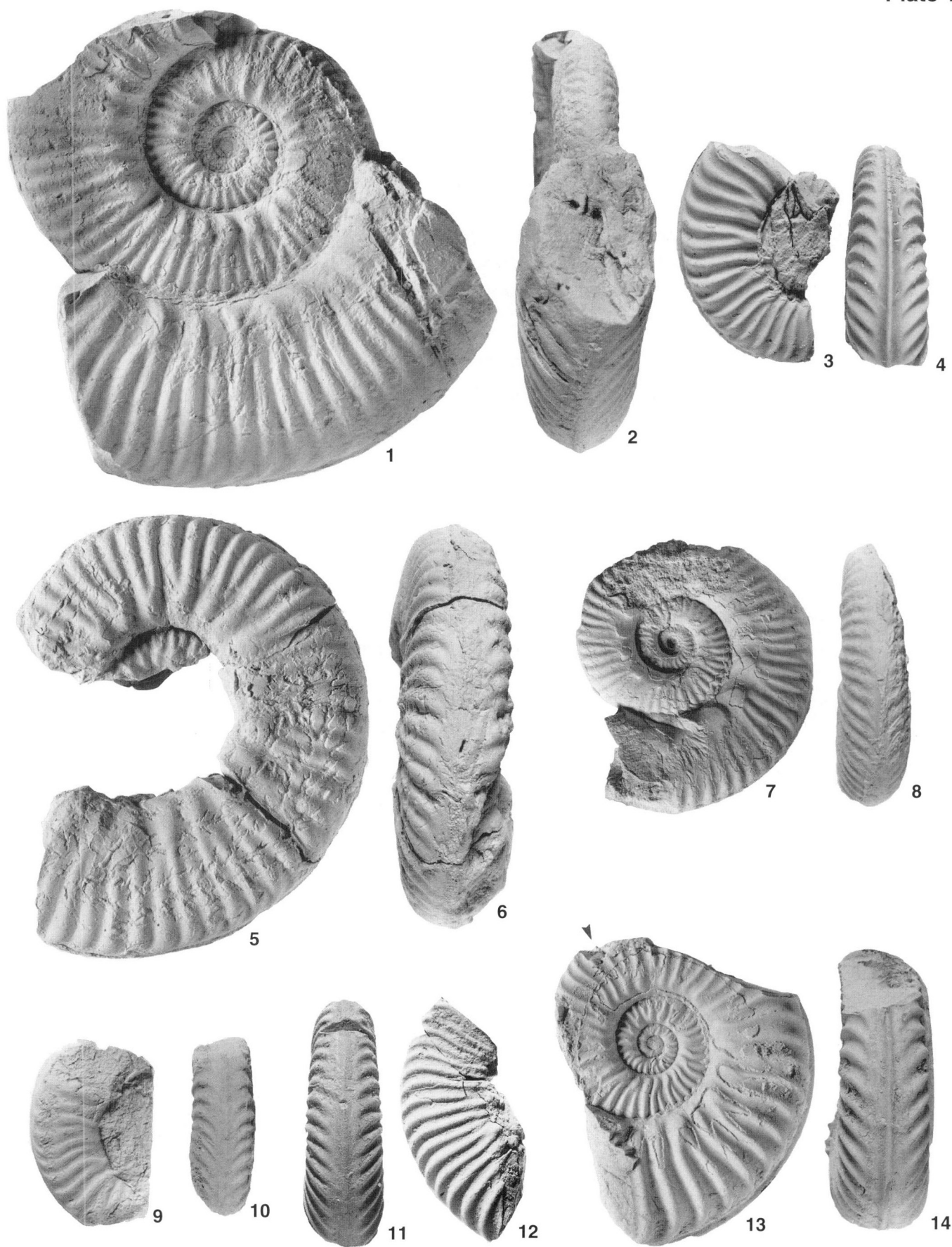
- 1, 2. Figured specimen GSC 108407 from GSC loc. C-158066, Section 7, Loc. 26, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.88).
- 5, 6. Figured specimen GSC 108409 from GSC loc. C-158073, Section 7, Loc. 41, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.92).
- 7, 8. Figured specimen GSC 99486 from GSC loc. C-93572, Section 9, Loc. 17, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone.

Figures 3, 4, 11-14. *Phymatoceras crassicosta* Merla, 1933

- 3, 4. Figured specimen GSC 99487 from GSC loc. C-159874, Isolated loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
- 11, 12. Figured specimen GSC 108411 from GSC loc. C-159386, Isolated Loc. M-4, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
- 13, 14. Figured specimen GSC 108412 from GSC loc. C-159871, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone (ventral view x 0.92).

Figures 9, 10. *Pseudomercaticeras* sp. indet.

Figured specimen GSC 108410 from GSC loc. C-159865, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.



## PLATE 13

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figure 1, 8, 9. *Phymatoceras* cf. *P. pseudoerbaense* (Gabilly, 1976)

1. Figured specimen GSC 108413 from GSC loc. C-81913, Isolated Loc. M-4, Queen Charlotte Islands, Whiteaves Formation, Middle Toarcian.
- 8, 9. Figured specimen GSC 107332 from GSC loc. C-176551, Section 8, Loc. 14, Queen Charlotte Islands, Whiteaves Formation, Middle Toarcian.

Figures 2, 3. *Phymatoceras crassicosta* Merla, 1933

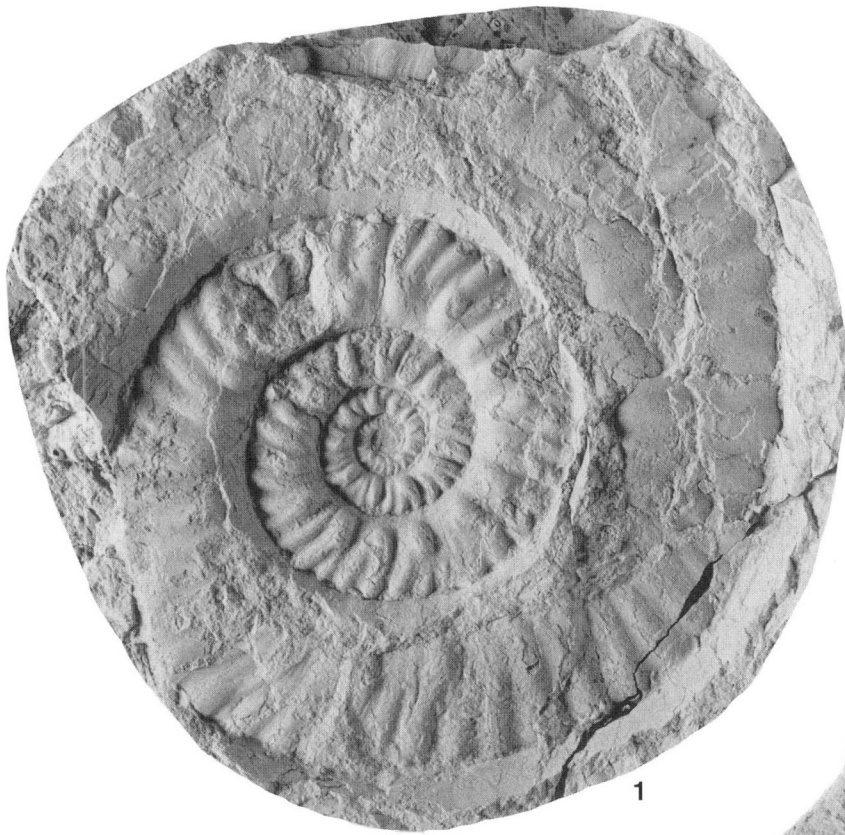
Figured specimen GSC 107323 from GSC loc. C-159876, Isolated Loc. M-6, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

Figures 4-7. *Pseudomercaticeras* cf. *P. frantzi* (Reynès, 1868)

- 4, 5. Figured specimen GSC 108414 from GSC loc. C-159885, Section 7, Loc. 49, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.
- 6, 7. Figured specimen GSC 108415 from GSC loc. C-103134, Section 3, Loc. 12, Spatsizi River map area, Spatsizi Formation, Crassicosta Zone.

Figures 10, 11. *Phymatoceras* cf. *P. erbaense* (Hauer, 1856)

Figured specimen GSC 108416 from GSC loc. C-157714, Section 7, Loc. 56, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.



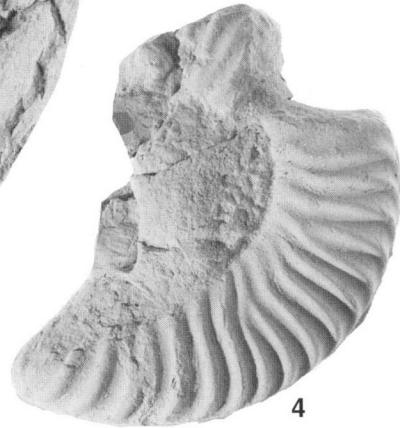
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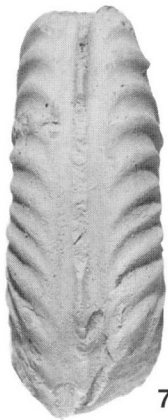
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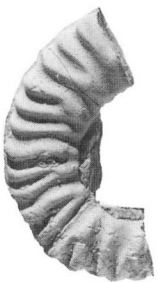
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## PLATE 14

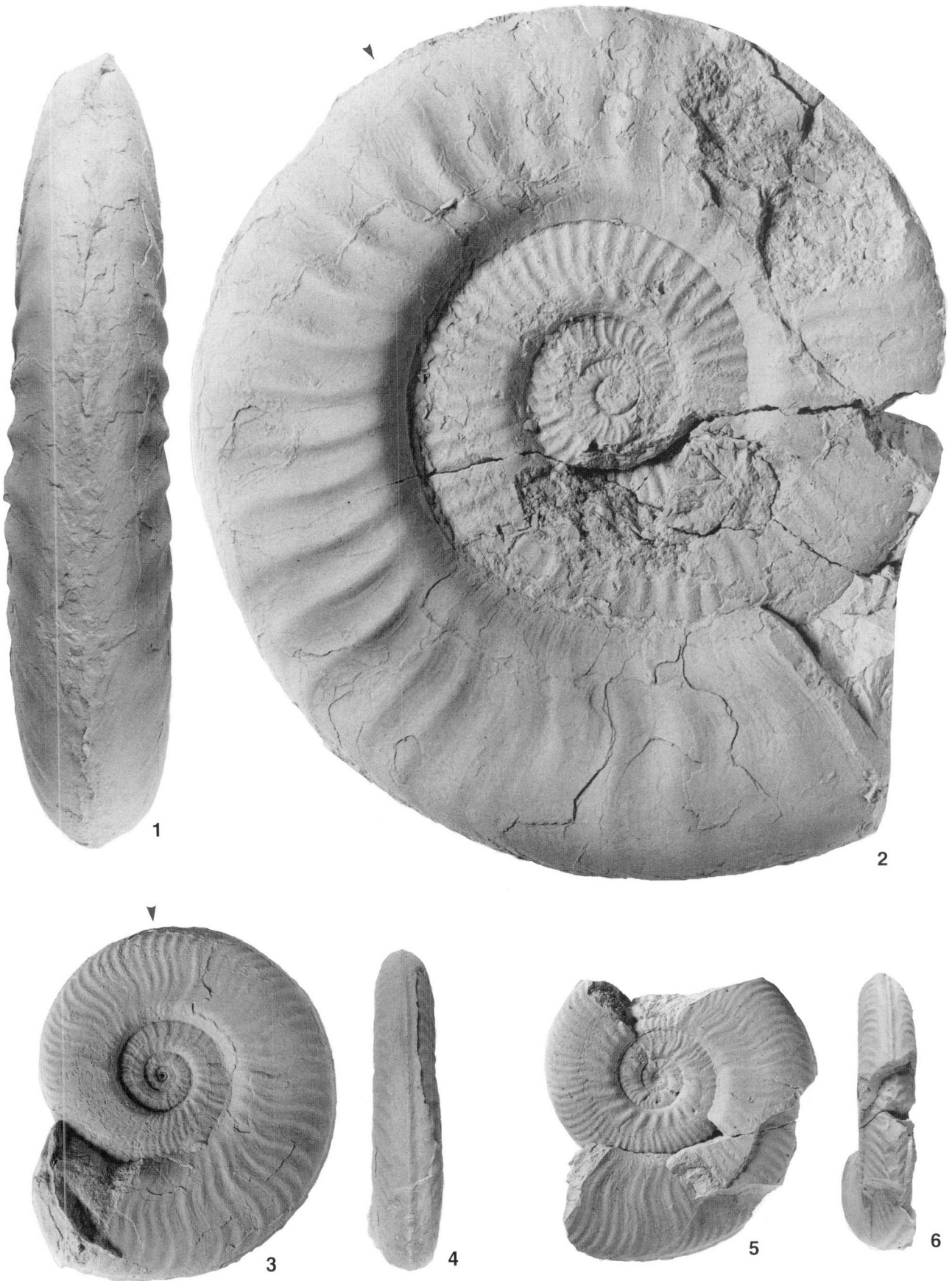
All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1-6. *Phymatoceras hillebrandti* Jakobs, 1994

- 1, 2. Figured specimen GSC 108417 from GSC loc. C-87130, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.90).
- 3, 4. Figured specimen GSC 107337 from GSC loc. C-149693, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.94).
- 5, 6. Figured specimen GSC 108418 from GSC loc. C-87132, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.





## PLATE 15

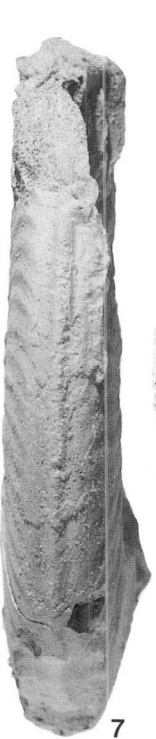
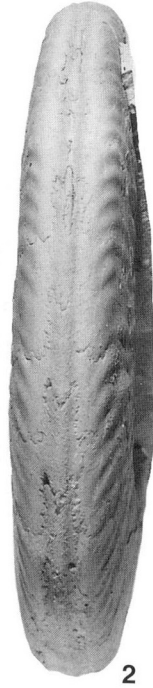
All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1-12. *Phymatoceras hillebrandti* Jakobs, 1994

- 1, 2. Figured specimen GSC 107344 from GSC loc. C-159894, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.94).
- 3, 4. Figured specimen GSC 107341 from GSC loc. C-149666, Isolated Loc. M-2, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.96).
- 5, 6. Figured specimen GSC 108420 from GSC loc. C-149693, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.
- 7, 8. Figured specimen GSC 107343 from GSC loc. C-159894, Section 7, Loc. 68, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.93).
- 9, 10. Figured specimen GSC 107340 from GSC loc. C-156378, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.94).
- 11, 12. Figured specimen GSC 108422 from GSC loc. C-157730, Section 7, Loc. 77, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone.



## PLATE 16

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2, 5, 6, 9-14. *Denckmannia* cf. *D. tumefacta* Buckman, 1898

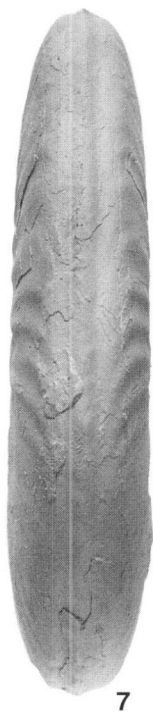
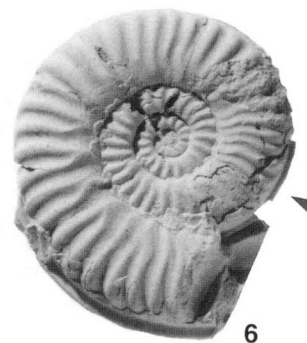
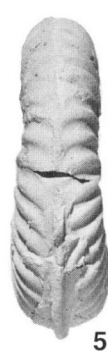
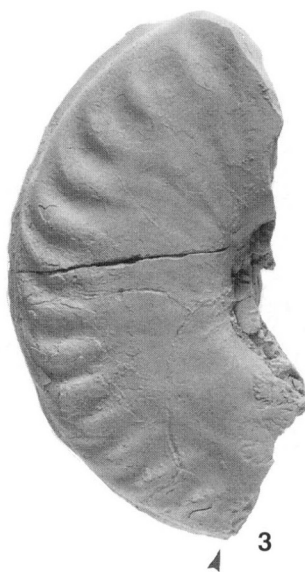
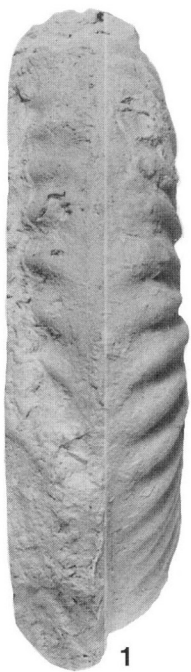
- 1, 2. Figured specimen GSC 107320 from GSC loc. C-90982, Section 7, Loc. 35, Queen Charlotte Islands, Whiteaves Formation, Planulata Zone (ventral view x 0.91).
- 5, 6. Figured specimen GSC 107326 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Middle Toarcian.
- 9, 10. Figured specimen GSC 108423 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Middle Toarcian.
- 11, 12. Figured specimen GSC 108424 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Middle Toarcian.
- 13, 14. Figured specimen GSC 108425 from GSC loc. C-90822, Section 2, Loc. 14, Spatsizi River map area, Spatsizi Formation, Wolf Den Member, Middle Toarcian.

Figures 3, 4. *Merlaites* cf. *M. alticarinatus* (Merla, 1933)

Figured specimen GSC 107321 from GSC loc. C-157707, Section 8, Loc. 1, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

Figures 7, 8. *Phymatoceras hillebrandti* Jakobs, 1994

Figured specimen GSC 95578 (holotype) from GSC loc. C-157728, Section 7, Loc. 104, Queen Charlotte Islands, Whiteaves Formation, Hillebrandti Zone (ventral view x 0.83).



## PLATE 17

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Hammatoceras speciosum* (Janensch, 1902)

Figured specimen GSC 95583 from GSC loc. C-87215, (Jakobs and Smith, 1996; Section 2, Loc. 4) Queen Charlotte Islands, Phantom Creek Formation, Yakounensis Zone.

Figures 3. *Sphaerocoeloceras brochiiforme* Jaworski, 1926

Figured specimen GSC 99485 from GSC loc. C-149652, (Jakobs and Smith, 1996; Section 2, Loc. 4) Queen Charlotte Islands, Phantom Creek Formation, Yakounensis Zone.

Figures 4, 5. *Yakounia yakounensis* Jakobs & Smith, 1966

Figured specimen GSC 99529 from GSC loc. C-149652, (Jakobs and Smith, 1996; Section 2, Loc. 4) Queen Charlotte Islands, Phantom Creek Formation, Yakounensis Zone.

Figures 6, 7. *Yakounia silvae* Jakobs & Smith, 1966

Figured specimen GSC 99525 from GSC loc. C-149652, (Jakobs and Smith, 1996; Section 2, Loc. 4) Queen Charlotte Islands, Phantom Creek Formation, Yakounensis Zone.



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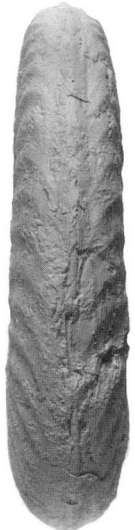
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## PLATE 18

All figures are natural size unless otherwise indicated.

Locality information is listed in Appendix.

End of phragmocone indicated with an arrowhead.

Figures 1, 2. *Cenoceras* cf. *C. intermedius* (Sowerby, 1816)

Figured specimen GSC 108426 from GSC loc. C-158036, Section 6, Loc. 16, Queen Charlotte Islands, Whiteaves Formation, Kanense/Planulata Zone.

Figures 3, 4. *Cenoceras* cf. *C. intermedius* (Sowerby, 1816)

Figured specimen GSC 108427 from GSC loc. C-87139, Section 7, Loc. 46, Queen Charlotte Islands, Whiteaves Formation, Crassicosta Zone.

