LATEST TOARCIAN AMMONOIDS FROM THE
NORTH AMERICAN CORDILLERA

by GISELLE K. JAKOBS and PAUL L. SMITH

ABSTRACT. Latest Toarcian (Early Jurassic) strata crop out in southern Alaska, southern Yukon, British Columbia, south-western Alberta, and eastern Oregon. Work in the Queen Charlotte Islands, British Columbia, has proved a relatively complete Toarcian sequence which has provided the basis for a North American Toarcian ammonite zonation. The Upper Toarcian Yakounensis Zone is characterized by a diverse ammonite fauna, previously assigned to the Middle Toarcian. Species of Hammatoceras, Dumortieria, Sphaeroceroceras, Pleyedella, Holophyloceras, and Pleuroceroceras allow correlation with the younger part of the Levesquei Zone of north-west Europe. The new genus Yakounia and seven new species (Yakounia yakounensis, Y. pacifica, Y. freboldi, Y. silvae, Pleyedella moulensis, P. erosionata and Dumortieria? phantasma) are introduced, all of which are endemic to western North America. A global regression during the Late Toarcian may have restricted migration between the eastern Pacific and western Tethys resulting in the development of endemic taxa.

Western North America is a tectonically complex area made up of numerous accreted terranes (Text-fig. 1). These are commonly fault-bounded regions and each appears to have a separate and distinct geological history. Palaeomagnetic and palaeontological evidence suggests that some terranes may have undergone significant latitudinal displacement since the Jurassic (Irving et al. 1980; Taylor et al. 1984; Smith and Tipper 1986; Irving and Yole 1987; Irving and Wynne 1991). Understanding this complex history requires correlation within and between terranes, and between the terranes and the craton. To date, Toarcian strata in western North America have been recognized from Alaska to Oregon, both on the craton (southern Canadian Rocky Mountains) and in the following terranes: Peninsular, Stikine (Stikinia), Queescn (Queenelia), Wrangell (Wrangellia), Isee (in Oregon), as well as in several small slivers in south-western British Columbia (Text-figs 1–2).

Previous ammonite workers (Frebold 1957, 1964a, 1964b, 1969, 1976; Frebold et al. 1967, 1969; Imlay 1968, 1981; Frebold and Tipper 1970) had difficulty interpreting the Toarcian succession of western North America because of the complex geology of the Cordillera and the lack of stratigraphical sections. They relied on the north-west European zonation and compared the North American fauna with common north-west European taxa. However, work on the Early Jurassic of the Americas has shown consistently that eastern Pacific faunas have closer affinities with Tethyan faunas, contain endemic Pacific species, lack certain European elements, and may have different age ranges for common taxa. For example, a re-assessment of some older collections previously assigned to the Middle Toarcian based on the supposed presence of Hammatoceras (Frebold 1976; Imlay 1981), indicates that they are in fact late Toarcian age, as had been suggested tentatively by Hall (1987). This latest Toarcian fauna includes Hammatoceras, Sphaeroceroceras, Dumortieria, Pleyedella, and a new genus of the Phymatoceperatinae; the genus Hammatoceras does not occur along the Pacific rim. Such observations clearly point to the need for a regional zonation. A significant step in this direction has been the discovery of a relatively complete Toarcian succession in the Queen Charlotte Islands, British Columbia (Text-fig. 2; Jakobs 1992; Jakobs et al. 1994, 1995). The purpose of this paper is to review the distribution of Late Toarcian rocks in North America, and to describe the latest Toarcian ammonites from successions that form the basis of a North American ammonite zonation.

TEXT-FIG. 1. Generalized terrane map of the Canadian Cordillera.

UPPER TOARCIAN ZONES OF NORTH AMERICA

The two Upper Toarcian ammonite zones detailed below were outlined by Jakobs et al. (1995), and have been formally described by Jakobs et al. (1994).
TEXT-FIG. 2. Map showing Upper Toarcian localities in western North America. The biostratigraphy of sections 1–8 is shown in Text-figures 7–14. Locality data and faunal listings for Collections 1–52 are available from the British Library as Supplementary Publication No. SUP 14044.

Hillebrandti Zone

This zone (Zone 5 of Jakobs et al. 1995) contains a prolific, albeit low diversity fauna that includes Phymatoceras hillebrandti Jakobs, 1994, Podagrosites latescens (Simpson, 1834), and Grammoceras thouarsense (d'Orbigny, 1843). The Hillebrandti Zone correlates roughly with the Thouarsense Zone of north-west Europe, based on the occurrence of Grammoceras thouarsense and Podagrosites latescens, and correlates with the Copiapense Zone of South America based on the similarity between Phymatoceras copiapense (Moriccic, 1894) and P. hillebrandti.
Text-fig. 3. Lower Jurassic stratigraphy of the Queen Charlotte Islands. Hett., Hettangian; Baj., Bajocian; Yak., Yakoum Group.

Yakounensis Zone

This zone (Zones 5a and 6 of Jakobs et al. 1995) is widespread in western North America, being recognized in southern Alaska, Stikinia, Wrangellia, Quesnellia, south-western British Columbia, Oregon, and on the craton. The interval is thin and stratigraphical relationships between the different species are sometimes difficult to establish. The diverse fauna includes Pleydella maudensis sp. nov., Pl. crassiornata sp. nov., Pl. ailenis (Zieten, 1832), Yakounia yakounensis gen. et sp. nov., Y. freboldi sp. nov., Y. pacifica sp. nov., Y. silvæ sp. nov., Sphaerococloceras brochiforme Jaworski, 1926, Hummatoceras speciosum Janesch, 1902, Dumortieria insiguisimilis (Brauns, 1865), D. raricostata Giéczy, 1967, D. exacta Backman, 1905, D. cf. dumortieri Thiollière in Dumortier, 1874. D. cf. pusilla Jaworski, 1926, D. ? phantasma sp. nov., Pseudococloceras compactale (Simpson, 1855)
and *Holoophylloceras calypso* (d’Orbigny, 1841). It contains several taxa endemic to North America and the eastern Pacific.

Both Frebold (1976) and Imlay (1981) assigned this interval to the Middle Toarcian based on the erroneous recognition of *Haugia* (in fact, specimens of *Pleydellia* and *Yakounia*, a new genus endemic to western North America. A rough correlation can be made with the *Pleydellia fluitans* and *Pleydellia lotharingica* zones of South America, based on the co-occurrence of *Sphaerocoeloceras brochiforme, Dumorteria cf. pastila*, and species of *Pleydellia*. Both *Pleydellia lotharingica* (Branco, 1879) and *Phlyseogromnoceras? temniostatum* (Jaworski, 1926) are similar to *Pleydellia maudensis* which spans the Yakouensis Zone. According to Poulton and Tipper (1991), the base of the Aalenian Stage in North America is defined by the first appearance of *Tmetoceras seissum* (Benecke, 1865). Although *T. seissum* is abundant above the Yakouensis Zone fauna in east-central Oregon, only a single specimen of *Tmetoceras* has been collected from central Graham Island in the Queen Charlotte Islands, the Aalenian there being more commonly characterized by species of *Planammatoceras*, *Bredyia*, and *Erycita*.

**OCCURRENCES OF LATE TOARCIAN STRATA IN NORTH AMERICA**

*Queen Charlotte Islands, British Columbia*

Mesozoic strata in the Queen Charlotte Islands include the most complete marine Lower Jurassic depositional sequence in North America (Sutherland Brown 1968; Cameron and Tipper 1985; Jakobs 1990; Tipper et al. 1991) (Text-fig. 3). Toarcian strata of the Maude Group are represented by the Fannin, Whiteaves and Phantom Creek formations.
The Whiteaves Formation is a grey-green siltstone, weathering brown-grey, which is recessive and commonly poorly exposed in road and stream cuts in central Graham Island, the Skidegate Inlet area and on Louise Island (Text-fig. 5). Neither bedding nor lamination were observed in the siltstones but sandy layers occur at intervals. The siltstones are rich in pyrite and glaucomite; ash layers and buff-weathering, calcareous concretions are common. The contact with the overlying Phantom Creek Formation is conformable on much of Graham Island, whereas a hiatus is probably present on Maude island (Skidegate Inlet) and Louise Island (Text-fig. 4).

TEXT-FIG. 5. Toarcian localities in the Queen Charlotte Islands.

The Phantom Creek Formation is a resistant sandstone unit exposed in stream and road cuts. It is best exposed in central Graham Island where it is 25 m thick. Thin (< 2 m) sequences crop out on Maude Island and Louise Island. The formation can be subdivided into two units, a lower
Coquinoid Sandstone Member and an upper Belemnite Sandstone Member (Cameron and Tipper 1985); these are separated by an erosional hiatus that increases in magnitude toward the south (Text-fig. 4). In central Graham Island, the two members are conformable at Sections 1–3 (Textfigs 5–6), with a cumulative thickness of over 25 m, but at Sections 5 and 6, the Coquinoid Sandstone Member is absent. At Maude Island, Skidegate Inlet, the Coquinoid Sandstone Member is also absent, and a thin (2–3 m) layer of the Belemnite Sandstone Member separates the Whiteaves Formation from the overlying Yakoun Group. The contact between the Phantom Creek Formation and the overlying Yakoun Group is an angular unconformity, best exposed in central Graham Island.

Southern Alaska

In the Talkeetna Mountains (Text-fig. 2), Early Jurassic strata are represented by the Upper Sinemurian to Upper Toarcian Talkeetna Formation, a thick (4600–5800 m) unit of volcanic and volcanioclastic rocks deposited in a marine to non-marine environment (Imlay 1981). Imlay (1981) identified a Middle Toarcian fauna from the Talkeetna Mountains which he assigned to the
north-west European Variabilis Zone. Recent work in the Queen Charlotte Islands has shown that the Alaskan fauna is identical to the Late Toarcian Yakouensis Zone assemblage from the Queen Charlotte Islands and contains *Hammatoceras* sp. indet. ( = *Phymatoceras*? sp. of Imlay (1981)). *Yakounia yakouensis* (= *Haugia* cf. variabilis (d’Orbigny, 1842) of Imlay (1981)), *Pleiodella maudensis* (= *Haugia* cf. grandis Buckman, 1898 and *Haugia* cf. compressa Buckman, 1898 of Imlay (1981)), *Pleiodella* sp. indet. (= *Brodieia* cf. *tenuecostatum* var. *nodosa* and probably *Haugia* sp. of Imlay (1981)), and *Pseudolioceras* sp. indet. (Collections 1–9).

A small section of Jurassic strata exposed at Paule Bay (Text-fig. 2) includes the Upper Toarcian to Lower Bathonian Kialagvik Formation, a dark grey to black, sandy siltstone containing some hard, buff sandstone (Imlay 1981). Imlay (1981) assigned a single collection to the Middle Toarcian, Variabilis Zone. The fauna is identical to that from the Talkeetna Mountains and Queen Charlotte Islands and contains *Pleiodella maudensis* (= *Haugia* cf. compressa of Imlay (1981)). *Pl. sp. indet.* (= *Haugia* cf. *grandis* of Imlay (1981)), and *Pseudolioceras* sp. indet. (Collection 10).

**Northern Stikine Terrane**

In the northern part of the Stikine Terrane, sediments of the Lower to Middle Jurassic Laberge Group have yielded Late Toarcian ammonites. Two facies were recognized by Souther (1971): the coarse-grained, near-shore Takawahi Formation in the south-west; and the argillaceous, basal Inkin Formation in the north-east. Toarcian fossils occur in the former and possibly in the latter (H. W. Tipper, pers. comm. 1992).

Late Toarcian ammonites identified by Frebold (1964a) from the Whitehorse area, southern Yukon (Text-fig. 2; Collections 12–15) include *Catulloceras*? (probably a *Dumortieria*), *Dumortieria*?, and *Harpoceras*? (probably a *Pseudolioceras*). A poorly preserved specimen of *Yakounia sp.* sp. indet. has also been identified (Collection 11). The reported *Grammomoceras aff. G. fallaciosum* (Bayle, 1878) and *Grammomoceras? boreale* (Whiteaves, 1889) (Frebold 1964a, p. 17, pl. 7, figs 1–4) are actually Middle Jurassic forms (Poulsen and Tipper 1991; D. G. Taylor, pers. comm. 1991). Frebold (1964a, p. 4) mentioned the presence of *Catulloceras? sp. indet.* (= *Dumortieria* cf. *dumortieri*) from the Bennett area (Text-fig. 2; Collections 16–17).
TEXT-FIG. 7. Biostratigraphy of Section 1 (Latitude 53° 25' 20" N. Longitude 132° 15' 45" W) along the Yakoun River, Queen Charlotte Islands.
Central Stikine Terrane

Along the west-central margin of the Stikine Terrane, interbedded sediments and volcanics of the Triassic to Middle Jurassic Hazeltown Group have yielded Late Toarcian ammonites. In the Iskut area, the Hazeltown Group has been divided into four formations: the volcanogenic Unuk River, Betty Creek, and Mount Dilworth formations, overlain by sediments of the Salmon River Formation (Anderson and Thorkelson 1990). The Salmon River Formation in the Iskut area (Text-fig. 2) has yielded several collections of Pleyedella cf. maudensis from the Yakounensis Zone (Collections 18-19).

In the Spatsizi area, along the northern margin of the Bowser Basin, sedimentary rocks of the Lower to Middle Jurassic Spatsizi Group have been divided into five formations of which the Melison Formation is probably Late Toarcian in age (Thomson et al. 1986). Isolated localities in the Spatsizi area (Text-fig. 2) have yielded Pleyedella maudensis, Yakounia yakounensis, Y. sp. indet., Dumortieria cf. pusilla, Dumortieria sp. indet., and Hammatoeceras sp. indet. (Collections 20-32).

A collection of Toarcian ammonites in volcaniclastic sediments from the Toodoggone area (Text-fig. 2) has yielded Pleyedella sp. indet. and Podagrosites? sp. indet. (Collection 33).

In the McConnell Creek area (Text-fig. 2), along the eastern margin of the Bowser Basin, Lower to Middle Jurassic sediments of the Hazeltown Group have yielded isolated collections of Late Toarcian ammonites (Tipper and Richards 1976) from the Smithers Formation, a unit of interbedded, shallow marine volcaniclastic sediments. Poorly preserved specimens of Dumortieria sp. indet. and Yakounia yakounensis have been collected from the Yakounensis Zone (Collections 34-35).

Toarcian ammonites occur at isolated localities in the Hazeltown area (Text-fig. 2). Two collections in the Hazeltown Group yielded Pleyedella cf. maudensis and Dumortieria sp. indet. (Collections 36-37) from the Yakounensis Zone.

Quesnel Terrane

Late Toarcian ammonites including Pleyedella maudensis, Yakounia silvae, Polyplectus, and Dumortieria? phantasma (Collection 38) have been found in the Manson River area on the Quesnel Terrane (Text-fig. 2).

South-western British Columbia

In the Taseko Lakes area (Text-fig. 2), the Lower to Middle Jurassic (Upper Hettangian to Lower Bajocian) Last Creek Formation rests unconformably on the Tyauhton Group (Umhofer 1989).

The upper part of the poorly exposed Last Creek Formation (Upper Sinemurian to Lower Bajocian) is composed of black, calcareous shales, minor sandstones, and thin ash beds. Toarcian shales of the Taseko Lakes area contain Dumortieria? sp. and Hammatoeceras sp. of the Yakounensis Zone (Collections 39-41).

On the west side of Harrison Lake in south-western British Columbia (Text-fig. 2), the Jurassic Harrison Lake Formation rests unconformably on Triassic rocks (Arthur et al. 1993). The lowest two of four members (the Celia Cove and Francis Lake members) have yielded rare ammonites of probable Toarcian age with the highest assemblage containing species of Dumortieria indicating the Yakounensis Zone (Collections 42-43).

O'Brien (1987) subdivided the Ladner Group in the Boston Bar area into the Lower Jurassic Boston Bar Formation, a sequence of argillite, siltstone, greywacke and conglomerate, and the Middle Jurassic Dewdney Creek Formation, a sequence of volcanic breccia, lava and argillaceous sediments. This sequence is similar to that found to the south in Manning Park (Text-fig. 2). Toarcian ammonites collected from the Ladner Group of Manning Park were assigned to Physoecampaniscoceras aff. P. dispanstomiforme (Wunstorf, 1907) by Frebold (Frebold et al. 1969) but are comparable with Yakounia silvae from the Yakounensis Zone (Collection 44).
TEXT-FIG. 8. Biostratigraphy of Section 2 (Latitude 53° 25' 05" N. Longitude 132° 15' 30" W) along the Yakoun River, Queen Charlotte Islands.
TEXT-FIG. 9. Biostratigraphy of Section 3 (Latitude 53° 25' 00" N, Longitude 132° 16' 05" W) along the Yakoun River, Queen Charlotte Islands.
Southern Canadian Rocky Mountains
The Jurassic Fernie Formation, deposited on the North American craton, crops out from south-western Alberta to the Peace River area of north-eastern British Columbia. It includes the Toarcian Poker Chip Shale, a laterally extensive black shale, 10–38 m thick, that appears to be overlain conformably by sandstones and siltstones of the Lower Bajocian Rock Creek Member; no Aalenian ammonites have been found (Hall 1984, 1987).

In the southern outcrop area (Text-fig. 2; Collection 45), a Late Toarcian fauna of Pleydellia maudensis (= ?Grammoceratinae gen. et sp. indet. of Hall (1987)), Yakounia silvae (= ?Grammoceratinae gen. et sp. indet. of Hall (1987)), Y. yakounensis (= ?Grammoceratinae gen. et sp. indet. of Hall (1987)), Sphaeroconoceras sp. indet. (= ?Hammatoceratidae gen. et sp. indet. of Hall (1987)), and Dumortieria phantasmatosa (= ?Hildoceratinae gen. et sp. indet. of Hall (1987)) has been collected. Frebold (1976) identified several forms as Middle Toarcian but these are actually Late Toarcian in age and include Pleydellia maudensis (= Hungia sp. indet. and Hungia aff. H. illestris (Denkman, 1887) of Frebold (1976)) and Yakounia freboldi (= Hungia aff. H. navis (Dumortier, 1874) of Frebold (1976)) (Collections 46–51).

BIOSTRATIGRAPHY OF THE MEASURED SECTIONS
Section 1: Yakoun River. This section (Text-figs 5–7) was measured and figured originally by Cameron and Tipper (1985, Section 12) who inadvertently inverted the stratigraphy as a result of misinterpreting a poorly exposed and faulted succession. The section was re-measured during the summers of 1987–90 when lower water levels had increased exposure significantly. Siltstones of the Whiteaves Formation lie conformably beneath sandstones of the Phantom Creek Formation. The boundary between the Hillebrandti and Yakounensis zones is not well documented because of poor exposure. The boundary between the Yakounensis Zone and the Aalenian Stage is similar not well constrained, although it appears to occur above the contact between the Coquinoïd Sandstone and Belemnite Sandstone members (Jakobs 1990). The presence of Bredyia and Eryctoides howelli (White, 1889) at 17 m indicates that such taxa as Tnetoceras and Troitsia could be expected below. Radiolaria identified by E. S. Carter from concretions at 11-4 m indicate a Late Toarcian age; those at 17 m are Aalenian (Carter and Jakobs 1990).

Section 2: Yakoun River. A sequence similar to Section 1 occurs a few metres upstream (Text-figs 6, 8). The Whiteaves Formation is not exposed, but the Phantom Creek Formation is better exposed. The scarcity of ammonites makes the boundary between the Yakounensis Zone and the Aalenian Stage difficult to determine, but it appears to occur below the contact between the Coquinoïd Sandstone and Belemnite Sandstone members of the Phantom Creek Formation.

Section 3: Yakoun River. This section (Text-figs 6, 9), originally measured and figured by Cameron and Tipper (1985, Section 11), was re-measured during the summers of 1987–90. The Whiteaves Formation is overlain by a sandstone unit, and a 10 m thick covered interval separates this sandstone unit from the remainder of the Phantom Creek Formation; a fault is possibly present. The top of the section is faulted.

Section 4: Central Graham Island. This section (Text-figs 6, 10), measured and figured originally by Cameron and Tipper (1985, Section 14), was re-measured during the summers of 1987–90. The Whiteaves Formation appears to be overlain conformably by the Phantom Creek Formation. No fossils were collected from the Whiteaves Formation in this section, but another section nearby yielded Phymatoceras hillebrandti just below the contact. The boundary between the Yakounensis Zone and the Aalenian Stage is not well constrained because of poor recovery of fossils.

Sections 5–6: Central Graham Island. These two sections (Text-figs 6, 11–12) were measured at Road 59 in Central Graham Island. Section 5 had been measured and figured previously by

Camerón and Tipper (1985, Section 13). The base of both sections is covered. The top of Section 5 is truncated by a fault whereas Section 6 is overlain unconformably by the Yakoun Group. The erosional hiatus between the two members of the Phantom Creek Formation has cut out the Coquina Sandstone Member in both sections. A single *Tethys poecilaspis* was collected from a faulted section of the Belemnite Sandstone Member.

Sections 7-8: Izeé Area, Oregon. South-west of the abandoned town of Izeé in east-central Oregon (Text-fig. 2), the basal Warm Springs Member of the Snowshoe Formation has yielded Late Toarcian ammonites (Dickinson and Vigrass 1964; Imlay 1968; Smith 1980). Representatives of this poorly preserved fauna were first described by Imlay (1968) but the stratigraphy at that time
TEXT-FIG. 12. Biostratigraphy of Section 6 (Latitude 53° 23′ 00″ N, Longitude 132° 15′ 30″ W) in central Graham Island, Queen Charlotte Islands.

was poorly understood. Stratigraphical sections have now been measured at Sheep Creek Divide (Section 7; Text-fig. 13) and Flat Creek (Section 8; Text-fig. 14) where the recessive siltstones and mudstones of the Warm Springs Member rest with a gradational contact on the resistant, volcanioclastic sandstones of the Hyde Formation. Some of the original identifications of the basal Snowshoe Formation ammonites (Imlay 1968) must now be revised in the light of richer collections.
and a better understanding of the biostratigraphy. Several species of *Dumortieria* occur together with *Hammatoceras speciosum*, *Hammatoceras* spp. (= *Haugia* spp. of Inlay (1968)), *Pleodella* spp. (= *Grammoceras* spp. of Inlay (1968)), and *Polypectus* sp. This association is stratigraphically
TEXT-FIG. 14. Biostratigraphy of Section 8 (Latitude 44° 00’ 58” N, Longitude 119° 28’ 23” W) at Flat Creek, Izee area, Oregon.
beneath the first occurrence of the Aalenian ammonite *Tnetoceras scissum* (see Imlay 1973) and is assigned to the Yakounensis Zone. Although the Yakounensis Zone correlates in part with the Levesquei Zone of north-west Europe, the ammonite assemblage, and particularly the common occurrence of *Polyplectus* sp., is more typical of Mediterranean successions (Donovan 1958; Gézy 1967; Goy and Martínez 1990).

Detailed locality data for Sections 1 to 8 and Collections 1 to 52 have been deposited with the British Library, Boston Spa, Yorkshire, U.K., as Supplementary Publication No. SUP 14044. The information includes geographical and stratigraphical position, locality numbers, the lithostratigraphical unit sampled, and the fauna present.

**SYSTEMATIC PALAEONTOLOGY**

Specimens described and illustrated in this paper are housed at the Geological Survey of Canada in Ottawa (GSC) and the University of British Columbia in Vancouver, Canada (UBC).

Abbreviations are as follows (after Smith 1986): CHW, constrictions per half whorl, counted on adoral half whorl; D, shell diameter at which measurements were made; PRIHW, primary ribs per half whorl, counted on the adoral half whorl; U = (UD/D) × 100; UD, umbilical diameter; WH, whorl height; WW, whorl width; WWWH = (WW/WH) × 100. Measurements are in millimetres.

Order AMMONOIDEA von Zittel, 1884

Suborder PHYLOCERATINA Arkell, 1950

Superfamily PHYLOCERATAECI von Zittel, 1884

Family PHYLOCERATIDAE von Zittel, 1884

Subfamily CALLIPHYLLOCERTINAE Spath, 1927

Genus HOLOCYPHYLLOCERAS Spath, 1927

[= Saffoldiella Spath, 1927; Telegericeras Kovács, 1939]

*Type species.* *Phylloceras mediterraneum* Neumayr, 1871.

*Diagnosis.* Involute shell with high oval whorl section and plain venter; periodic, acutely sigmoidal or angular constrictions present at all stages of ontogeny; outer half of whorl appears to be ribbed; septal sutures with diphylic saddles except for first lateral saddle which becomes triphylic in later forms.

*Distribution.* *Holocypphyloceras* is found world-wide from the Lower Jurassic (Toarcian) to the Cretaceous.

*Holocypphyloceras calypso* (d'Orbigny, 1841)

Plate 5, figures 7–8

*1841 Ammonites calypso* d'Orbigny, pl. 110, figs 1–3.

1976 *Holocypphyloceras calypso* (d'Orbigny); Schlegelmilch, p. 26, pl. 1, fig. 6.

*Material.* Three specimens collected from calcareous concretions within sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 2, loc. 17, tabu).

*Measurements.*

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Description. Involute shell with a high oval whorl section and gently sloping umbilical wall. Ornament consists of about eight sinuous constrictions per whorl. Sutures are diphylllic.

Distribution. *Pleodiellina calypzo* is found world-wide in the Toarcian.

Suborder AMMONITINA Hyatt, 1889
Superfamily HILDOCERATAE Hyatt, 1867
Family HILDOCERATIDAE Hyatt, 1867
Subfamily GRAMMOCERATINAE Buckman, 1904

*Genus Pleodiellia* Buckman, 1899

[ = *Cotteswooldia* Buckman, 1902 (= *Cotteswooldia* Théobald, 1950); *Canavaria* Buckman, 1902 (non Gemmellaro, 1886) (= *Canavaria* Buckman, 1904); *Walkeria* Buckman, 1902 (= *Walkeria* Buckman, 1913)]

Type species. *Pleodiellia comata* Buckman, 1899.

Diagnosis. Involute to evolute shell with tall, compressed whorls; whorl section lanceolate to triangular; umbilical shoulder abrupt to moderately rounded; ventricrate with weak ventro-lateral shoulders; ribbing sinuous, prostriaduate on upper flank, and terminating at ventro-lateral shoulder. Ribs may bifurcate at or near umbilical shoulder, and may fade on inner or outer half of flanks.

Distribution. *Pleodiellia* is common in the uppermost Toarcian of Europe, South America and North America.

*Pleodiellia maudensis* sp. nov.

Plate 1, figures 1–2; Plate 2, figures 1–2, 11–12; Text-figure 1A

1991 "*Physoeuroceras* (?) sp., Tipper *et al.*, pl. 7, fig. 3.
1992 "*Haugia* cf. *compressa*" Buckman; Hildebrandt and Smith, pl. 4, fig. 7.
1992 "*Haugia* sp. indet., Hildebrandt and Smith, pl. 7, fig. 5.

Derivation of name. After Maud Island in Skidegate Inlet, site of some of the first discoveries of Jurassic fossils in the Queen Charlotte Islands.

Material. About 150 specimens in sandstones and calcareous concretions of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, locs 3, 5, 17; Section 2, locs 3, 7, 9, 12, 17; Section 3, locs 89–92, 94–95, 97–98; Section 4, locs 1–3, 5–6, 8–10, 14; Section 5, locs 2–5, 5; Section 6, locs 1–2). Other specimens from the Upper Toarcian of the Talkeetna Mountains (Text-fig. 2, Collection 2), Puale Bay (Collection 10), the Iscut area (Collections 18–19), the Spatsizi area (Collections 21–22), the Hazelton area (Collection 36), the Manson River area (Collection 38), and the southern Canadian Rocky Mountains (Collections 45–46, 48).

Holotype. GSC 99523 (Pl. 2, figs 11–12) from the lower part of the Phantom Creek Formation (Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

Paratypes. GSC 99519 (Pl. 2, figs 1–2), GSC 99524 (Pl. 1, figs 1–2), GSC 99509, GSC 107267–107277.
TEXT-FIG. 15. Septal suture lines of *Playdella maradiensis*, *Playdella crassornata* and *Yakoula freboldi* from the Queen Charlotte Islands. a, GSC 99519; Section 4, loc. 14; b, GSC 107347; Section 3, loc. 95; c, GSC 107286, Section 4, loc. 4. WH, whorl height.

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Diagnosis. Moderately evolute shell; ovigal whorl section and flat flanks; umbilical wall gently sloping, becoming undercut on outer whorls; umbilical shoulder gently rounded becoming sharp on outer whorls; venter carinate-sulcate; lateral sulci fade during ontogeny; ribbing sinuous. On inner whorls, primary ribs bifurcate at about one-third flank height. On outer whorls, ribs arise singly and in pairs from small tubercles at umbilical shoulder. Ribs weaken on upper flank. Some ribs bifurcate on upper flank or intercalatory ribs may appear. Ribs terminate at ventro-lateral shoulder.

Description. The holotype, GSC 99523, is a moderately well preserved specimen, septate up to 77-4 mm shell diameter with approximately 190° of body chamber, ending in an incomplete aperture at 111-4 mm shell diameter. One side is slightly distorted. The shell is moderately evolute with an ovigal whorl section, flat flanks, and a carinate-sulcate venter. The umbilical wall is gently sloping on the inner whorls becoming steeper with age until, at approximately 52 mm shell diameter, it becomes slightly undercut. The umbilical shoulder is gently rounded on the inner whorls, becoming angular as the umbilical wall steepens. The venter possesses shallow lateral sulci which fade on the outer whorls. On the inner whorls, the primary ribs are slightly prorsiradiate. On the outer whorls, the primary ribs arise from small tubercles at the umbilical shoulder and have a more pronounced prorsiradiate trend. The primary ribs are stronger than the secondary ribs which appear at approximately mid-flank. The paratype, GSC 99519, is a moderately well preserved specimen, septate to 77-1 mm shell diameter with approximately 130° of body chamber, ending in an incomplete aperture at 100-4 mm shell diameter. The phragmocone is damaged on one side and is partially obscured by encrusting bivalves. The body chamber is partially crushed. This specimen illustrates the ribbing on the outer whorls of the phragmocone. From the umbilical tubercles, a primary rib proceeds across the flank and bifurcates at approximately one-quarter to one-third the flank height. At approximately two-thirds to three-quarters the flank height, the ribs may bifurcate again or weak intercalatory ribs may arise. The ribbing fades on the body chamber. The paratype, GSC 99524, is a larger specimen, albeit less well preserved. It is septate to 121-7 mm shell diameter with approximately 190° of body chamber ending in an incomplete aperture at 165 mm shell diameter. One side is poorly preserved and partially obscured by encrusting bivalves. The body chamber is fragmented and parts of the venter have been eroded or broken away. The phragmocone lacks fine detail because of the medium-grained sandstone that forms the matrix. This specimen, whilst having faint ribbing on the outer whorls, maintains the tubercles at the umbilical shoulder and these do not fade but remain prominent. Of the other paratypes, one specimen (GSC 107268) differs slightly in that it is slightly more evolute and has more pronounced umbilical tubercles from which three ribs commonly arise. Two other specimens (GSC 99509 and GSC 107267) are fragments of inner whorls. Both show strong primary ribs which bifurcate at mid-flank. The venter is more strongly carinate-sulcate than on the larger specimens.

Remarks. This form is similar to several Late Toarcian genera including Pseudolitilla, Gruneria, Physosearamnoceras, as well as Pleyedella. The whorl shape and rib pattern on the outer whorls are similar to species of Pseudolitilla figured by Else and Rulneau (1987) but the inner whorls are different. Ribbing on the inner whorls of Pseudolitilla is much denser and finer, and the ribs tend to bundle or remain single rather than bifurcating as markedly as in Pleyedella maudensis. In addition, Pseudolitilla lacks the small umbilical swellings characteristic of the North American species. Gruneria has a similar ribbing pattern in which the primary ribs on the inner whorls bifurcate on the lower to mid-flank; however, the whorl shape is more rounded and ellipsoidal, the ribs are finer and denser, and the outer whorls lack the small umbilical swellings that characterize Pl. maudensis. Physosearamnoceras has a similar ribbing pattern, and a steep to undercut umbilical wall on the outer whorls, but the whorl section is more compressed and the venter is sharper, lacking the ventral sulci of Pl. maudensis. Hillebrandt (1987) figured several specimens which he assigned to Physosearamnoceras (? tonatocostatum), a form similar to the North American species but with a more involute shell. Hall (1987) described specimens from the Fernie Formation (Grammoceratinae gen. et sp. indet.) which he compared with species of Pleyedella such as Pl. flattatus (Dumortier, 1874)

EXPLANATION OF PLATE I

Figs 1-2. Pleyedella maudensis sp. nov.; GSC 99524, paratype; Yakounensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-87111, Section 3, loc. 89; × 1.
and *Pl. lotharingica*. *Pl. fluitans* has coarse, distant, rectiradiate ribs and a bisulcate venter, whereas *Pl. lotharingica* has a narrow venter and an ogival whorl section (Knitter and Ohmert 1983, pl. 3, figs 12–14). Hillebrandt (1987, pl. 13, fig. 7, pl. 14, fig. 8) figured several specimens of *Pl. cf. lotharingica* which have a bisulcate venter on the inner whorls and a similar ribbing pattern, but lack the undulate umbilical shoulder and umbilical swellings on the outer whorls that characterize *Pl. maunden*is. The North American form has a strong carinate-sulcate inner whorl and subdued umbilical swellings that are significantly different from other *Pleydellia*, and a new species designation is warranted.

**Pleydellia crassiorrata** sp. nov.

Plates 3, figures 1–8; Text-figure 15b

**Derivation of name.** The name refers to the thick ornamentation (Latin *crassus*, thick; *ornatus*, ornament).

**Material.** About 24 well preserved specimens in sandstones and calcareous concretions of the Phantom Creek Formation (Section 1, locs 5, 17; Section 2, locs 4, 17; Section 3, locs 90, 95; Section 4, locs 6, 14), Queen Charlotte Islands.

**Holotype.** GSC 99513 (Pl. 3, figs 7–8) from the lower part of the Phantom Creek Formation (middle Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

**Paratypes.** GSC 99510 (Pl. 3, figs 1–2), GSC 99511 (Pl. 3, figs 3–4), GSC 99512 (Pl. 3, figs 5–6), GSC 107278–107279

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**EXPLANATION OF PLATE 2**

Figs 1–2, 11–12. *Pleydellia mauden*is sp. nov.; Yakounensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 1–2. GSC 99519, paratype; GSC Loc. No. C-176555, Section 4, loc. 14. 11–12, GSC 99523, holotype; GSC Loc. no. C-87118, Section 3, loc. 95. Figs 3–7. *Dumortieria? phantasma* sp. nov.; Yakounensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 3–4, GSC 99520, holotype; GSC Loc. No. C-87220, Section 2, loc. 4, 5–6, GSC 99521, paratype; GSC Loc. No. C-93576, Section 2, loc. 4, 7, GSC 99522, paratype; GSC Loc. No. C-87220, Section 2, loc. 4. Fig. 8–16. *Dumortieria pusilla* Jaworski; Yakounensis Zone, Warm Springs Member of the Snowshoe Formation; Ize area, eastern Oregon. 8, UBC 014; UBC Loc. No. F4-4-E, Section 7, loc. 5, 15, UBC 015; UBC Loc. No. F4-4-E, Section 7, loc. 5, 16, UBC 016; UBC Loc. No. F5-1, Collection 52. Figs 9–110, 13–14. *Dumortieria pusilla* Jaworski; Arroyo Negro Argentina, Locality 22, Section 9, Horizon 6 of Jaworski (1925). 9–10, plaster cast of the paratype. 13–14, plaster cast of the holotype. Arrows mark start of body chamber. All are ×1.
JAKOBS and SMITH, *Pleydellia* and *Dumortieria*
Diagnosis. Moderately evolute shell; ogival whorl section; umbilical wall gently sloping, becoming steeper during ontogeny; umbilical shoulder gently rounded, becoming more angular during ontogeny; flanks slightly convex; venter carinate with weak lateral sulci on inner whorls; ribs sinuous; thick, prominent primary ribs split into two or three weaker, secondary ribs at approximately one-third to one-half flank height; secondary ribs terminate at ventro-lateral shoulder; some variation in length of primary ribs.

Description. The holotype, GSC 99513, is a moderately well preserved specimen septate to 13 mm umbilical diameter with approximately 180° of body chamber ending in an incomplete aperture at 49 mm shell diameter. The body chamber is broken and slightly crushed. The shell is moderately evolute with an ogival whorl section. The umbilical wall is gently sloping and the umbilical shoulder is rounded. The flanks are gently convex and merge into the venter with only weak ventro-lateral shoulders. The venter is carinate, bounded by narrow, smooth strips. The ornament consists of sinuous ribs. The coarse primary ribs arise high on the umbilical wall. On the inner whorls, they are short and appear bullate. The primary ribs split into two or three weaker secondary ribs at approximately one-third to one-half the flank height. The secondary ribs terminate at the ventro-lateral shoulder. The paratype, GSC 99511, is a well preserved specimen septate to 43 mm shell diameter with approximately 70° of body chamber ending in an incomplete aperture at 47.5 mm shell diameter. The body chamber is slightly crushed. The shell is moderately evolute with an ogival whorl section and possesses similar shell characteristics to the holotype. The ornament differs slightly by being slightly more subdued, and the primary ribs are longer on the inner whorls and not as bullate. The paratype, GSC 99512, is a moderately well preserved shell, septate to 16.6 mm umbilical diameter with approximately 110° of body chamber ending in an incomplete aperture. Most of the venter on the outer whorl of the phragmocone has been eroded away. This specimen is similar to the previous two but has slightly longer primary ribs on the inner whorls than the holotype. The paratype, GSC 99510, is a moderately well preserved shell with approximately 180° of body chamber. The shell is fragmented and distorted with portions of the phragmocone broken away. This specimen is one of the largest, with a maximum shell diameter of approximately 66 mm. It possesses a similar ribbing pattern to the two previous paratypes. The ornament does not fade on the body chamber. The paratype, GSC 107279, is a well preserved specimen septate to 250 mm umbilical diameter and with approximately 150° of body chamber ending in an incomplete aperture. The primary ribs on the inner whorls, while not as bullate as the holotype, are shorter than in the other paratypes. The paratype, GSC 107278, is a moderately well preserved specimen with approximately 180° of body chamber ending in an incomplete aperture. Part of the venter on the body chamber is broken away. It is a smaller specimen than the others, and the whorl section is slightly more depressed. The ornament is similar to the other paratypes.

EXPLANATION OF PLATE 3

Figs 1–8. Pleyelilla erassonata sp. nov.: Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, 1–2, GSC 99510, paratype; GSC Loc. No. C-87718, Section 3, loc. 95, 3–4, GSC 99511, paratype; GSC Loc. No. C-87221, Section 2, loc. 17, 5–6, GSC 99512, paratype; GSC Loc. No. C-176555, Section 4, loc. 14, 7–8, GSC 99513, holotype; GSC Loc. No. C-87718, Section 3, loc. 95.

Figs 9–14. Pleyelilla advenita (Zietien); Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, 9–10, GSC 99514; GSC Loc. No. C-87707, Section 3, loc. 95, 11–12, GSC 99515; GSC Loc. No. C-87233, Section 1, loc. 17.

Fig. 15. Dumortieria cf. exacta Buckman; UBC 010; Yakouensis Zone, Warm Springs Member of the Snowshoe Formation; Ize area, eastern Oregon, UBC Loc. No. F4-4-E, Section 7, loc. 5.

Fig. 16. Dumortieria cf. dumortieri (Thiébaut); UBC 011; Yakouensis Zone, Warm Springs Member of the Snowshoe Formation; Ize area, eastern Oregon, UBC Loc. No. F4-4-E, Section 7, loc. 6.

Fig. 17. Dumortieria insignisimilis (Brauns); UBC 012; Yakouensis Zone, Warm Springs Member of the Snowshoe Formation; Ize area, eastern Oregon, UBC Loc. No. F4-4-E, Section 7, loc. 5.

Fig. 18. Dumortieria cf. puella Jankowski; GSC 99517; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-157740, Section 3, loc. 97.

Fig. 19. Dumortieria insignisimilis (Brauns); GSC 99518; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-81736, Section 5, loc. 3.

Fig. 20. Dumortieria rariorostata Gécz;' UBC 013; Yakouensis Zone, Warm Springs Member of the Snowshoe Formation; Ize area, eastern Oregon, UBC Loc. No. F4-3-D, Section 7, loc. 4.

Arrows mark start of body chamber. All are x 1.
JAKOBS and SMITH, *Pleydellia* and *Dumortieria*
Remarks. The shell shape and whorl section are similar to those of *Pleydella aalenensis* as figured by Schlegelmlch (1976, pl. 51, figs 8-9). *P. aalenensis* encompasses a broad variety of forms and shows wide morphological variability. In general, the style of jointed ribs distinguishes *P. aalenensis* from other species of *Pleydella* (Buckman 1890, p. 193), some of which have jointed ribs but these tend to be fine and bundled, e.g. *P. subcompta* (Banco, 1879). The specimens of *P. aalenensis* illustrated by Buckman (1890, pl. 32, figs 4-10) differ from *P. crassornata* by lacking swollen primaries, by being slightly more involute, and by having a steeper umbilical wall. Géczy (1967) figured several forms of *P. aalenensis*, creating several new subspecies that are similar to *P. crassornata* but which lack the prominent and pervasive bifurcation and swollen primaries that characterize the North American species. *Pleydella* from North America that have bifurcate and widely spaced ribbing show some differences in the coarseness of the primary ribs, but this may be intra-specific variation and is probably not sufficient to justify the recognition of two separate species.

*Pleydella crassornata* also shows similarity to the Leiocerasinae which, according to Donovan et al. (1981, p. 115), evolved from *Pleydella* during the early Aalenian. Schlegelmilch (1985) figured some species of *Leioceras* and *Staufenia* (pls 9-11) which are similar to *P. crassornata*. *Leioceras* and *Staufenia* have acute venters and simple septal sutures.

**Pleydella aalenensis** (Zieten, 1832)

Plate 3, figures 9-14

*1832* *Ammonites aalenensis* Zieten, pl. 28, fig. 3.
1890 *Grammoceras aalenense* (Zieten); Buckman, p. 192, pl. 32, figs 7-8.
1976 *Pleydella aalenensis* (Zieten); Schlegelmilch, p. 94, pl. 51, figs 8-9.
1983 *Pleydella aalenensis* (Zieten); Knitter and Ohmert, pl. 3, figs 2-3.
1990 *Pleydella aalenensis* (Zieten); Goy and Martinez, pl. 4, fig. 10.

Material. 20 specimens in the sandstones and calcareous concretions of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, loc. 17; Section 2, loc. 17; Section 3, locs 89, 95).

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<td>7.3</td>
<td>5.0</td>
<td>0.68</td>
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**Description.** The moderately evolute shell has a high oval, whorl section and shallow umbilicus. The umbilical wall and shoulder are gently sloping. Flanks are gently convex and merge into the venter with weak ventro-lateral shoulders. The venter is carinate. Ribbing density and strength vary. Primary ribs are slightly prorsiradiate to approximately one-third the flank height where, generally, they bifurcate. Secondary ribs are rectiradiate to the ventro-lateral shoulders, then become prorsiradiate and approach, but do not reach, the venter. Intercalary ribs are common.

**Remarks.** Théobald and Moine (1959) studied *P. aalenensis* in an attempt to define this variable species more clearly. They concluded that *P. aalenensis* could be defined as possessing simple ribs that commonly bifurcate near the umbilical shoulder. The ribs are flat, rounded and fade toward the venter. The whorl section is oval and the flanks are slightly flattened. The *U* value averages 31.5 but can range from 27 to 36, and WWH averages 0.58, but can range from 0.50 to 0.66. Two varieties can be distinguished by ribbing density, a coarsely ribbed *aalenensis* type and a densely ribbed *tenuicostata* type.

The North American specimens fall within the range of variability of *P. aalenensis*, although the ribs tend to bifurcate higher on the flanks than in the holotype. However, the specimen figured by Schlegelmilch (1976, pl. 51, fig. 9) has ribs that bifurcate near mid-flank. *P. flens* (Buckman, 1890) has much finer and dense ribbing. *P. subcompta* has fine, dense ribbing which bundles in threes or fives at the umbilical shoulder. *P. crassornata* has a coarser ornament and swollen primary ribs.
TEXT-FIG. 16. Septal suture lines of *Dumortieria, Dumortieria*, *Pleydellia* and *Atacamiceras*. A, GSC 107345; Section 2, loc. 4, Queen Charlotte Islands; B, GSC 107346; Section 2, loc. 4, Queen Charlotte Islands; C, Hillebrandt (1987, pl. 8, fig. 2; text-fig. 2a); D, Hillebrandt (1987, pl. 8, fig. 16; text-fig. 2b); E, Hillebrandt (1987, pl. 8, fig. 17; text-fig. 2c); F, Jaworski (1926, pl. 4, fig. 17); G, Jaworski (1926, pl. 4, fig. 22); H, Schlegelmilch (1976, p. 94); I, Schlegelmilch (1976, p. 94); J, Jaworski (1926, pl. 4, fig. 19); K, Schindewolf (1964, p. 293, text-fig. 178); L, Schindewolf (1964, p. 295, text-fig. 179). WH, whorl height.
Distribution. *Pleistoceras aalenis* is common in the Upper Toarcian Aalenis Zone of Europe (Fischer 1966; Géczy 1967; Goy and Martínez 1990).

**Genus Dumortieria** Haug, 1885

[≡ *Catullocceras* Buckman, 1925; *Dactyliogamus* Buckman, 1925; *Phenakoceras* Maubeuge, 1949 (non Frech, 1902); *Phenakocerites* Maubeuge, 1950]

*Type species.* *Ammonites levesquei* d’Orbigny, 1844 (subsequent designation by Buckman 1890).

*Diagnosis.* Moderately evolute planulates with ogival whorl sections; umbilical shoulder abrupt to moderately rounded; venter carinate; ribbing almost rectiradiate, becoming slightly prosiradiate on upper flanks, terminating at venter; ribbing sparse or dense.

*Distribution.* *Dumortieria* is found almost world-wide in the Late Toarcian correlative of the Levesquei Zone (Donovan et al. 1981).

*Dumortieria insignis* (Brauns, 1865)

Plate 3, figures 17, 19

1865 *Ammonites insignis similis* Brauns, p. 106, pl. 5, figs 5–7.
1923 *Dumortieria insignis* (Brauns); Ernst, p. 56, pl. 9, figs 1–3.
1967 *Dumortieria insignis* (Brauns); Géczy, p. 144, pl. 31, fig. 6.
1993 *Dumortieria cf. insignis* (Brauns); Arthur et al., p. 32, pl. 1, figs 11–15.

*Material.* Five specimens from eastern Oregon (Section 7, loc. 5) where the species is best represented. Poorly preserved specimens from the Queen Charlotte Islands (Section 5, loc. 5) and from Harrison Lake (Arthur et al. 1993; Text-fig. 2; Collections 42–43).

*Description.* The evolute shell bears a low rounded keel. The ribs are wiry and widely spaced, reaching a density of up to 20 per half whorl at umbilical diameters greater than 10 mm. The ribs are rectiradiate across the flanks and project onto the venter where they abut directly against the keel.

*Remarks.* This species is more evolute and less densely ribbed than *D. exca* Buckman, 1905. *D. cf. dumortieri* Thiollière in Dumortier, 1874 is more evolute and slowly expanding, and its ribs are more densely spaced and projecting. *D. rartostata* Géczy, 1967 has less rectiradiate, more projecting ribbing.

*Distribution.* In Europe, *Dumortieria insignis* is known from the Upper Toarcian of Germany (Ernst 1923), Austria (Fisher 1966), Hungary (Géczy 1967) and possibly Spain (de Villalta and Rosell 1966).

*Dumortieria cf. dumortieri* (Thiollière in Dumortier, 1874)

Plate 3, figure 16

cf. 1874 *Ammonites dumortieri* Thiollière in Dumortier; figured by Roman 1938, p. 105, pl. 9, fig. 96; and Arkell et al. 1957, p. 262, fig. 296.

cf. 1892 *Catullocceras dumortieri* (Thiollière); Buckman, p. 277, pl. 39, figs 6–9.

cf. 1964a *Catullocceras?* sp. indet.; Fribold, p. 16, pl. 7, figs 5–9.

cf. 1967 *Dumortieria dumortieri* Thiollière in Dumortier; Géczy, p. 137, pl. 30, fig. 8.

1968 *Catullocceras cf. C. dumortieri* (Thiollière); Inlay, p. 46, pl. 9, figs 2–4 only.

1968 *Dumortieria dumortieri* (Thiollière in Dumortier); Setti, p. 329, pl. 30, fig. 3; pl. 31, fig. 1.

cf. 1975 *Catullocceras dumortieri* (Thiollière); Guex, p. 115, pl. 7, fig. 1.

*Material.* Three small and poorly preserved specimens from east-central Oregon (Section 7, locs 5–6). According to Inlay (1968), it is also present in the Bennett area, northern British Columbia (Text-fig. 2; Collections 16–17).
Description. The evolute shell expands slowly and has convex flanks. The ribbing is sharp, dense, rectiradiate, and only weakly projecting onto the venter.

Remarks. These specimens cannot be identified with confidence because of their small size and poor preservation. They are evolute and finely ribbed but not as markedly as, for example, *D. evolutissima* (Prinz, 1904), and we prefer to compare them with *D. durmortieri* which Imlay (1968) has already reported from Oregon on the basis of larger specimens.

Distribution. *Durmortieria durmortieri* is widely distributed in the Upper Toarcian of Europe: in Italy from the Meneghini Zone (Donovan 1958), in Austria from the Aalenius Subzone of the Levesquei Zone (Fischer 1966), and in France from the Levesquei Subzone of the Pseudoradiosa Zone (Gues 1975; Elmi and Rulneau 1991).

*Durmortieria* cf. *exacta* Buckman, 1905

Plate 3, figure 15

cf. 1892  *Durmortieria subundulata* Buckman, pl. 45, figs 6–7 only.
cf. 1905  *Durmortieria exacta* Buckman, supplement, p. 187.

Material. A single specimen preserved in a siltstone of the Snowshoe Formation, east-central Oregon (Section 7, loc. 5).

Description. A small, moderately evolute specimen (U = 40) bearing a low keel. The ribs are sharp and slightly flexuous on early whorls. Ribbing density increases from 21 ribs per half whorl at an umbilical diameter of 6 mm to 29 at 11 mm.

Remarks. As far as the preservation permits comparison, this specimen is similar to a variant of *Durmortieria subundulata* (Buckman, 1892, pl. 45, figs 6–7) that Buckman (1905) elevated to the rank of species and named *D. exacta*. It differs from all other species of *Durmortieria* described from North America by its densely spaced, fine ribbing which is characteristic of the *pseudoradiosa* group of species, as described by Ernst (1923).

*Durmortieria raricostata* Géczy, 1967

Plate 3, figures 20–21

1967  *Durmortieria stefaninii? raricostata* n. subsp. Géczy, p. 142, pl. 31, fig. 8.
1968  *Durmortieria raricostata* Géczy; Setti, p. 332, pl. 32, fig. 3.
1968  *Cattuloceras* cf. *Durmortieria* (Thiollière); Imlay, p. 46, pl. 9, fig. 5 only.

Material. Three specimens, two of them fragments, preserved in a siltstone of the Snowshoe Formation, east-central Oregon (Section 7, loc. 4).

Description. The shell is evolute, secondarily compressed and bears a low rounded keel. The coarse ribs project onto the venter from the uppermost part of the flank; there are 26 ribs on the outer half whorl. Weak constrictions are evident and the figured specimen bears an 8 mm wide collar that shows faint growth lines and a constricted peristome.

Remarks. The figured specimen represents a mature individual, presumably a macroconch although its microconch is unknown. One specimen of *D. raricostata* is known from the Upper Toarcian of Hungary (Géczy 1967) and two from Italy (Setti 1968), but none show evidence of maturity in spite of reaching larger shell diameters than the Oregon specimen.
Dumortieria? phantasma sp. nov.
Plate 2, figures 3–7; Text-figure 16A–B

Derivation of name. After Phantom Creek in central Graham Island, Queen Charlotte Islands.

Material. 50 small casts in calcareous concretions and several flattened specimens in shales and siltstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 2, locs 3–5). Also specimens from the Mau son River area (Text-fig. 2; Collection 38) and the southern Canadian Rocky Mountains (Collection 45).

Holotype. GSC 99520 (Pl. 2, figs 3–4) from the lower part of the Phantom Creek Formation (Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

Paratypes. GSC 99521 (Pl. 2, figs 5–6), GSC 99522 (Pl. 2, fig. 7)

Measurements. \( \begin{array}{cccccc}
 & D & UD & U & WH & WW & WWH \\
GSC 99520 & 22.3 & 8.4 & 36.1 & 8.7 & 6.1 & 0.70 \\
GSC 99521 & 18.6 & 7.5 & 40.3 & 6.5 & 4.6 & 0.71 \\
GSC 99522 & 16.9 & 8.0 & 47.3 & 5.2 & 3.8 & 0.73 \\
\end{array} \)

Diagnosis. Compressed, moderately evolute shell; elliptical whorl section; umbilical wall gently sloping; umbilical shoulder gently rounded; flanks gently convex, converging toward sharp venter; ornament generally weak or absent. On outer whorls of some specimens, there are simple, distant, rectiradiate ribs which fade on outer part of flank.

Description. The holotype, GSC 99520, is a moderately well preserved specimen, septate to 23.1 mm shell diameter with approximately 130° of body chamber ending in an incomplete aperture. The body chamber is slightly crushed. The shell is moderately evolute with a compressed, elliptical whorl section. The flanks are gently convex and converge toward the venter. The venter is sharp but plain. Faint, sparse, rectiradiate ribs are present on the last whorl and fade on the upper part of the flank. The holotype is one of the largest specimens collected, and the sutures on the last part of the phragmocone are approximated. The paratype, GSC 99521, is a moderately well preserved specimen, septate to approximately 5 mm umbilical diameter with approximately 180° of body chamber ending in an incomplete aperture. The body chamber is slightly crushed. The shell has similar features to the holotype. Faint, sparse, rectiradiate ribs are present on the body chamber. The paratype, GSC 99522, is a moderately well preserved specimen, septate to 19.2 mm shell diameter with approximately 100° of body chamber ending in an incomplete aperture. The body chamber is partially crushed.

Remarks. This form shows similarities to Atacamiceras and Dumortieria. Its ornament and septal suture are similar to the South American genus Atacamiceras described by Hillebrandt (1987). Atacamiceras glabrum Hillebrandt, 1987 is smooth except for rare mid-flank ribs. A. parvicostatum Hillebrandt, 1987 has smooth inner whorls and is ribbed on the last part of the phragmocone and on the body chamber. Both Atacamiceras and the North American form have simple septal sutures.

EXPLANATION OF PLATE 4

Figs 1–6, 9–10. Yakounia silvae gen. et sp. nov.; Yakounensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 1–2, GSC 99523, holotype; GSC Loc. No. C-149652, Section 2, loc. 4. 3–4, GSC 99526, paratype; GSC Loc. No. C-149652, Section 2, loc. 4. 5–6, GSC 99527, paratype; GSC Loc. No. C-149652, Section 2, loc. 4. 7–10, GSC 99528, paratype; GSC Loc. No. C-149652, Section 2, loc. 4.

Figs 7–8, 11–14. Yakounia yakounensis gen. et sp. nov.; Yakounensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 7–8, GSC 99529, paratype; GSC Loc. No. C-149652, Section 2, loc. 4. 11–12, GSC 99530, paratype; GSC Loc. No. C-149652, Section 2, loc. 4. 13–14, GSC 99531, holotype; GSC Loc. No. C-149652, Section 2, loc. 4.

Arrows mark start of body chamber. All are \( \times 1 \).
(Text-fig. 16). Dumortieria? phantasma has a more compressed shell whereas Atacamiceras has convex flanks. In addition, Atacamiceras occurs in the Middle Toarcian of South America whereas the North American form occurs in the latest Toarcian. Dumortieria? phantasma is also similar to D. pusilla which has smooth internal whorls with distant, simple, rectiradiate ribs on the outer whorls (see below). D. pusilla, however, has prominent ribbing and achieves it at an earlier stage of development. D.? phantasma could be an offshoot of D. pusilla via neoteny. The paratype, GSC 99521, displays prominent simple ribs toward the end of the shell, and is similar to the early stage of D. pusilla. In addition, the simple septal sutures of D.? phantasma could represent the early sutures of D. pusilla.

**Dumortieria?** cf. pusilla Jaworski, 1926

Plate 2, figures 8, 15-16; Plate 3, figure 18

**Material.** 75 specimens from limestones, mudstones and siltstones of the Snowshoe Formation, east-central Oregon (Section 7, locs 4-5; Section 8, loc. 1), where the species is best represented. Rare and poorly preserved specimens from the Queen Charlotte Islands (Text-fig. 2; Section 3, loc. 97) and the Spatsizi area (Collection 28).

**Description.** The shell is moderately evolute bearing a weak keel. The ribbing is distant and simple. The ribs are rectiradiate on the flanks and project onto the venter where they fade. The inner whorls are smooth.

**Discussion.** Dumortieria pusilla was originally described from Argentina by Jaworski (1926) where it occurs in the South American “Pleydelia fluitans” Zone, a correlate of the upper Aalenian Subzone of the European Levesquei Zone, according to Hillebrandt (1987). Plaster copies of Jaworski’s (1926) type material are figured in Plate 2, figures 9-10 and 13-14. The species is characterized by its smooth inner whorls, a feature that distinguishes it from other species of Dumortieria which, at most, have only a small smooth median.

The generic assignment of Dumortieria pusilla is based on the simple, distant ribs which characterize many other Dumortieria species, such as D. levesquei (d’Orbigny, 1844), D. insignisculus and D. striatulocostata (Quenstedt, 1885). No other Dumortieria, however, possesses smooth internal whorls to such large shell diameters.

**Family PHYMATOCERATIDAE Hyatt, 1867**

**Subfamily PHYMATOCERATINAE Hyatt, 1900**

**Genus YAKOUNI GEN. NOV.**

**Derivation of name.** After the Yakoun River, central Graham Island, Queen Charlotte Islands where Toarcian outcrops are most abundant.

**Type species.** Yakouania yakouensis sp. nov.

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**EXPLANATION OF PLATE 5**

Figs 1-2. Yakouania freboldi gen. et sp. nov.; GSC 99532, holotype; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-156390, Section 1, loc. 17.

Figs 3-6. Yakouania yakouensis gen. et sp. nov.; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 3-4, GSC 107258, paratype; GSC Loc. No. C-149652, Section 2, loc. 4, 5-6, GSC 107259, paratype; GSC Loc. No. C-149652, Section 2, loc. 4.

Figs 7-8. Holocophylloceris catypos (d’Orbigny); GSC 107260, Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-87221, Section 2, loc. 17.

All are ×1.
JAKOBS and SMITH, *Yakounia* and *Holocophylloceras*
Diagnosis. Moderately evolute shell; ogival whorl section; umbilical wall gently sloping; umbilical shoulder rounded; flanks moderately flat, converging toward a carinate venter with weak ventro-lateral shoulders. Venter on inner whorls may be weakly carinate-sulcate. Ornament distinctive, consisting of gently sinuous to approximately rectiradiate ribs that arise in twos or threes from strong umbilical tubercles or prorsiradiate bullae.

Remarks. This form can be compared with several genera of the Phymatoceratinae. According to Donovan (1958), Brodiaea has sigmoidal ribs joined in groups of two or more to umbilical tubercles. Brodiaea can be differentiated from Phymatoceras and Haugia by its non-septate keel. Yakounia possesses a septate keel, is more evolute, and the umbilical tubercles are more regular and prominent than in Brodiaea. Haugia has a tall keel, and the ribs and tubercles tend to fade on the outer whorls. In addition, the ribs tend to be more rectiradiate. Yakounia’s keel is more subdued, the ornament is prominent on the outer whorls, and the ribs are generally more sinuous and project along the venter. Phymatoceras is similar, especially such species as *P. copiapense* and *P. hillebrandtii*. In general, however, Yakounia has stronger tuberculation, shallower sulci, and a more gently rounded umbilical shoulder. Yakounia, especially *Y. pacifica* which has a pronounced angular bend of the ribs low on the flanks, may have evolved into *Ludwigia* or some of the Graphoceratidae.

Distribution. The genus is Late Toarcian in age, occurring with *Hammatoxoceras*, *Dumortieria*, *Sphaerococloceras* and *Pleyellia*. It has been collected from the Queen Charlotte Islands, the Fernie area, southern Alaska, and possibly the Sputazi area.

*Yakounia yakounensis* sp. nov.

Plate 4, figures 7–8, 11–14; Plate 5, figures 3–6.

1976 *Haugia aff. H. navis* (Dumontier); Frebold, p. 14, pl. 7, fig. 3.
1981 *Haugia cf. variolis* (d’Orbigny); Inlay, p. 43, pl. 12, figs 1–2, 5.

v 1987 *Grammatoceratinae gen. et sp. indet.*, Hall, p. 1702, pl. 5, figs N–O.

Derivation of name. After the Yakoun River, central Graham Island, Queen Charlotte Islands where Toarcian outcrops are most abundant.

Material. 60 specimens from calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands where the species is best represented (Section 1, loc. 17; Section 2, locs 3–6, 17; Section 3, locs 89, 105; Section 4, locs 2, 4, 6, 14; Section 5, locs 2, 5). Also specimens from the Talkeetna Mountains (Text-fig. 2; Collections 5, 9), the Sputazi area (Collections 21, 26), and the southern Canadian Rocky Mountains (Collection 45).

Holotype. GSC 99531 (Pl. 4, figs 13–14) from the lower part of the Phantom Creek Formation (middle Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

Paratypes. GSC 99529 (Pl. 4, figs 7–8), GSC 99530 (Pl. 4, figs 11–12), GSC 107258 (Pl. 5, figs 3–4), GSC 107259 (Pl. 5, figs 5–6), GSC 107281–107283

Measurements. D UD U WH WW WWWH PRHW

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Diagnosis: Moderately evolute shell; ogival whorl section; umbilical wall gently sloping; umbilical shoulder rounded; flanks flat to gently convex; venter carinate-sulcate on inner whorls becoming carinate on outer whorls; ornament distinctive, consisting of sharp umbilical tubercles from which two to three secondary ribs proceed up the flanks with a gently sinuous trend.

Description. The holotype, GSC 99531, is a well preserved specimen, septate to 55.8 mm shell diameter with approximately 90° of body chamber ending in an incomplete aperture at 64.0 mm shell diameter. The specimen is cracked and a small part of the venter is absent. The shell is moderately evolute with a compressed ogival whorl section. The umbilical wall is gently dipping and the umbilical shoulder is rounded. The flanks are flat to slightly convex and converge toward the carinate venter. The ornament consists of sharp, prominent tubercles at the umbilical shoulder from which two to three secondary ribs proceed up the flank with a gently sinuous trend and terminate at the ventro-lateral shoulder. The tubercles are slightly prorsiradiate and are more prominent on the outer whorls. The paratype, GSC 99530, is a moderately well preserved specimen, septate to 24.6 mm umbilical diameter, with approximately 180° of body chamber ending in an incomplete aperture at approximately 52 mm shell diameter. The specimen is broken on one side. The shell is moderately evolute with a compressed, ogival whorl section. The umbilical wall is gently dipping and the umbilical shoulder is rounded. The flanks are flat to gently rounded. The venter is carinate-sulcate on the inner whorls becoming carinate on the outer whorls. The tubercles at the umbilical shoulder are slightly prorsiradiate and give rise to two or three gently sinuous ribs. The paratypes, GSC 99529 and GSC 107259, are moderately well preserved with parts of their body chambers but incomplete apertures. The body chamber of the latter is slightly crushed. The paratype, GSC 107258, is a moderately well preserved specimen with approximately 230° of body chamber ending in an incomplete aperture. The shell is cracked, slightly crushed and part of the nucleus and venter are absent. The shell is moderately evolute with an ogival whorl section. The whorl section is less compressed than in the previous forms and GSC 107282 has a similar shape. The tubercles at the umbilical shoulder are prominent, sharp and slightly prorsiradiate.

Remarks. This species is distinctive and easily recognized because of its prominent, pointed umbilical tubercles and the gently sinuous ribs. Inlay (1981) compared the southern Alaskan specimens to Haugia variabilis, but he noted that they were more evolute and more sparsely ribbed on the outer whorls. He also noted that the holotype of H. japonica (Neumayr, 1875) as figured by Kobayashi (1935, pl. 12, figs 3–4) had a much weaker ornament. He compared the southern Alaskan specimens to Haugia aff. japonica figured by Matsumoto and Ono (1947, pl. 2, fig. 5) but that specimen has much weaker tuberculation, that fades on the outer whorl, and sigmoidal ribbing; it is possibly Phymatoceras hallebrandti.

Yakouna yakounensis is distinguished from other species by its prominent umbilical tubercles. Y. freboldi sp. nov. has thick, distant ribs with prorsiradiate bullae. Y. pacifica sp. nov. has a prominent angular flexure of the ribs, and the ribs and tubercles are subduded. Y. silvae sp. nov. is an intermediate form which has characteristics of all three. It possesses tubercles similar to Y. freboldi, but the ribbing density is similar to that of Y. yakounensis.

Yakouna freboldi sp. nov.

Plate 5, figures 1–2; Text-figure 45c

Derivation of name. After Dr H. Frebold who, for many years, was the Jurassic palaeontologist of the Geological Survey of Canada.

Material. Nine specimens in calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, loc. 17; Section 2, loc. 4; Section 3, loc. 89; Section 4, locs 2, 4, 6; Section 5, locs 2, 5). Also from the southern Canadian Rocky Mountains (Text-fig. 2; Collection 47).

Holotype. GSC 99532 (Pl. 5, figs 1–2) from the lower part of the Phantom Creek Formation (Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

Paratypes. GSC 107284–107287
Measurements:  

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Diagnosis. Moderately evolute shell; ellipsoidal to rectangular whorl section; venter carinate-sulcate on inner whorls becoming carinate on outer whorls; ornament coarse, consisting of prorsiradiate bullae on lower flank from which two to three secondary ribs arise.

Description. The holotype, GSC 99532, is a well preserved specimen with more than 360° of body chamber ending in an incomplete aperture at 129-4 mm shell diameter. Part of the venter is broken away on a small segment of the body chamber. The shell is moderately evolute with a rectangular to ellipsoidal whorl section. The umbilical wall is gently sloping, and the umbilical shoulder is rounded. The flanks are flattish to gently convex. The venter is carinate with weak ventrolateral shoulders. The ornament is coarse. On the inner whorls, umbilical tubercles give rise to two or three gently sinuous ribs. During ontogeny, the tubercles lengthen into prorsiradiate bullae which give rise to two or three sinuous ribs. The ribs are strongly projecting along the ventro-lateral shoulder and occasionally may reach the venter where subdual swellings are sometimes seen on well preserved parts of the body chamber. The paratype, GSC 107286, is a moderately well preserved specimen wholly septate to a shell diameter of 87-0 mm. The shell is cracked and parts of the phragmocone have broken off. The inner whorls are not exposed. The shell is moderately evolute with a rectangular to ellipsoidal whorl section. The umbilical wall is gently sloping and the umbilical shoulder is rounded. The flanks are flattish, and the venter is carinate on rounded ventro-lateral shoulders. The ornament is coarse with prorsiradiate umbilical bullae, commonly giving rise to two sinuous ribs at approximately one-quarter the flank height. The ribs are strongly projecting along the ventro-lateral shoulder, and, where the specimen is well preserved, may reach the venter, where subdual swellings are seen. The other paratypes are not as well preserved but all have similar features to the other types.

Remarks. This species has a coarser ornament than *Yakounia yakouensis*, and the bullae are not as sharp. The inner whorls are similar to *Phymatoceras copiapense* and *Ph. hillebrandti*, which may have been ancestors. *Y. freboldi* may, in turn, be ancestral to *Ludwigia*. The inner whorls have almost straight ribs and sharp tubercles. On the outer whorls, the ribs become more sigmoidal and the tubercles more elongated. The ornament on the outer whorls is similar to that on the inner whorls of species of *Ludwigia* but, in general, that genus has coarser, more sigmoidal ribbing, elongated bullae or primary ribs, and a less sulcate venter.

*Yakounia pacifica* sp. nov.

Plate 6, figures 1–2

Derivation of name. After the Pacific Ocean, along the north-eastern shore of which the genus is found.

Material. Three specimens in calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 2, loc. 4).

Holotype. GSC 107261 (Pl. 6, figs 1–2) from the lower part of the Phantom Creek Formation (Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

Paratype. GSC 107288
**Diagnosis.** Moderately evolute shell; compressed, ogival whorl section; venter carinate-sulcate; ornament prominent, consisting of thick, prosirradiate primary ribs that split into two or three sinuous secondary ribs low on flanks.

**Description.** The holotype, GSC 107261, is a moderately well preserved specimen septate to approximately 88 mm shell diameter with approximately 180° of body chamber ending in an incomplete aperture at 113-4 mm shell diameter. The specimen is slightly worn in places. The shell is moderately evolute with an ogival whorl section. The umbilical wall is gently sloping, and the umbilical shoulder is rounded. Flanks are flat, ventrolateral shoulders weak, and the venter carinate. The ornament consists of prosirradiate primary ribs on the inner whorls that begin high on the umbilical wall. Some ribs may remain single but most bifurcate at approximately one-third the flank height. On the outer whorls, the primary ribs swell into bulbilae. The paratype, GSC 107288, is a moderately well preserved specimen ending in an incomplete aperture at 78-7 mm shell diameter. The specimen is slightly worn and one side is not exposed. Its morphology is similar to that of the holotype. Septal sutures are present.

**Remarks.** This species shows some similarity to certain Graphoceratidae such as *Ludwigia* (*Pseudographoceras*) (see Schlegelmilch 1976, pl. 12, figs 5, 7) in terms of whorl shape and ribbing style. However, the Graphoceratidae tend to have a sharp angular flexure of the ribs on the lower flank; this feature is less prominent in similar forms, such as *Phymatoceras kellebrandtii*, *Yakounia freboldi*, and *Y. yakounensis*. The Graphoceratidae also tend to be more involute than the Phymatoceratidae although it is possible that they did evolve from them.

**Yakounia silvae** sp. nov.

Plate 4, figures 1–6, 9–10; Plate 6, figures 3–4

1987 *Grammoceratinae gen. et sp. indet.*, Hall, p. 1702, pl. 5, figs K–L, Q.

**Derivation of name.** After the thick, old-growth forests that covered the Queen Charlotte Islands (Latin *silva*, wood, forest).

**Material.** Over 100 specimens in calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, loaves 4–5, 7–8, 17; Section 2, loaves 1–6, 8, 10–11, 17; Section 3, loaves 89–92, 105; Section 4, loaves 1–2, 4, 6–8, 10, 14, 16; Section 5, loaves 2–3, 5; Section 6, loaves 1–2). Also specimens from the Manton River area (Text-fig. 2; Collection 30), in the Manning Park area (Text-fig. 2; Collection 44), and in the southern Canadian Rocky Mountains (Collection 45).

**Holotype.** GSC 99525 (Pl. 4, figs 1–2) from the lower part of the Phantom Creek Formation (Yakounensis Zone), Yakoun River, Queen Charlotte Islands.

**Paratypes.** GSC 99526 (Pl. 4, figs 3–4), GSC 99527 (Pl. 4, figs 5–6), GSC 99528 (Pl. 4, figs 9–10), GSC 107262 (Pl. 6, figs 3–4), GSC 107289–107291.
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**Diagnosis.** Moderately evolute planulate; ovoid whorl section; venter carinate-sulcate; ornament prominent, consisting of umbilical tubercles or prorsiradiate bullae from which two or three secondary ribs proceed up the flanks with a gently sinuous to rectiradiate trend.

**Description.** The holotype, GSC 99525, is a moderately well preserved specimen wholly septate to a shell diameter of 83.0 mm. Part of one side of the outer whorl is crushed. The shell is moderately evolute with a compressed ovoidal whorl section. The umbilical wall is gently sloping and the umbilical shoulder is rounded. The flanks are moderately flat to gently convex. The venter is carinate with weak ventro-lateral shoulders. On the inner whorls, prorsiradiate primaries begin high on the umbilical wall and split into two or three primaries at approximately one-third the flank height. On the outer whorls, prorsiradiate umbilical tubercles develop and on the outer whorl are bullate. The tubercles/bullae give rise to two or three gently sinuous secondary ribs. The paratype, GSC 107262, is a moderately well preserved specimen with more than 180° of body chamber ending in an incomplete aperture at 96.9 mm shell diameter. The specimen, especially the body chamber, is partially crushed. The shell is moderately evolute. The umbilical wall is gently sloping with a rounded umbilical shoulder. The flanks are flatish and the venter is carinate. On the inner whorls, umbilical tubercles give rise to two or three secondary ribs. The tubercles become slightly prorsiradiate on the outer whorl. The secondary ribs are almost rectiradiate to gently sinuous. The paratype, GSC 99528, is a moderately well preserved specimen septate to 13.3 mm umbilical diameter with approximately 200° of body chamber ending in an incomplete aperture at 42.8 mm shell diameter. The body chamber is partially crushed. The shell form is similar to those described above. On the inner whorls, gently prorsiradiate primary ribs give rise to two or three secondary ribs at approximately one-third the flank height. Umbilical tubercles develop on the last part of the phragmocone and on the body chamber. The secondary ribs are rectiradiate to gently sinuous. The paratype, GSC 99527, is a moderately well preserved specimen with part of the body chamber ending in an incomplete aperture at 35.3 mm shell diameter. Part of the phragmocone venter is absent, and the body chamber near the aperture is partially crushed. The tubercles begin on the last whorl, and the secondary ribs are almost rectiradiate. The paratype, GSC 99526, is a moderately well preserved specimen, septate to 33.3 mm shell diameter with approximately 160° of body chamber ending in an incomplete aperture at 43.5 mm shell diameter. The body chamber is partially crushed. Tubercles begin on the last whorl, and give rise to two or three gently sinuous secondary ribs.

### Explanation of Plate 6

Figs 1–2. *Yakouina pacifica* gen. et sp. nov; GSC 107261, holotype; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-149652, Section 2, loc. 4.

Figs 3–4. *Yakouina silvae* gen. et sp. nov; GSC 107262, paratype; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-149652, Section 2, loc. 4.

Figs 5–6. *Pseudoheliceras compactum* (Simpson); GSC 107263; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-157742, Section 2, loc. 95.

Figs 7–10. *Sphaeroceleocras brochiforme* Jaworski; Yakouensis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, 7–8, GSC 95584; GSC Loc. No. C-87718, Section 3, loc. 95, 9–10, GSC 99485; GSC Loc. No. C-149652, Section 2, loc. 4.

Arrow marks start of body chamber. All are ×1.
JAKOBS and SMITH, Yakounia, Pseudolioceras and Sphaerocoeiloceras
Remarks. This species has a weaker ornament than *Y. freboldi*, although the prorsiradiate bullae are similar. It lacks the sharp, round tubercles of *Y. yakoumensis* and has more prominent tubercles than *Y. pacifica*. In general, the specimens belonging to *Y. silvae* are alike except that certain features may arise or fade at different points during ontogeny, and ribs and bullae may trend in slightly different directions.

Subfamily HARPOCERATINAE Neumayr, 1875

Genus *Pseudolioceras* Buckman, 1889


Type species. *Ammonites compactus* Simpson, 1855 (subsequent designation by Buckman 1889)

**Diagnosis.** Moderately involute shell with discoidal and compressed triangular whorl section; carinate venter with sharp, hollow keel bordered by narrow, smooth areas; umbilical wall vertical; umbilicus small and deep; ribs sub-falciform, only clearly visible on outer part of whorl where they are broad and rounded; on inner part of whorl, ribs either faint or absent.

**Distribution.** *Pseudolioceras* appears to have Boreal affinities, being common in Arctic Canada, Siberia, Japan and Great Britain.

*Pseudolioceras compactus* (Simpson, 1855)

Plate 6, figures 5–6

1855 *Ammonites compactus* Simpson, p. 75.  
1911 *Pseudolioceras compactus* (Simpson); Buckman, pp. 41b, 41c, pl. 41A, figs 1–2.  
1972 *Pseudolioceras compactus* (Simpson); Guex, pl. 5, fig. 13.  
1974 *Pseudolioceras compactus* (Simpson); Duguy, pl. 18, fig. 1.  
1976 *Pseudolioceras compactus* (Simpson); Schlegelmilch, p. 89, pl. 47, fig. 4.

**Material.** 11 small specimens in sandstones and calcareous concretions of the Phantom Creek Formation, Queen Charlotte Islands (Section 3, loc. 95; Section 4, loc. 12).

**Measurements.**

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**Description.** The involute shell has a triangular whorl section. The umbilical shoulder is rounded, and the umbilical wall steep. The flanks are gently convex. The venter is almost knife-sharp; the flanks converge toward the venter with weak ventro-lateral shoulders. The ribs are gently falcate, projecting along the venter. On the lower flanks, they are faint, becoming more prominent on the upper flank. They are much fainter on the early whorls, appearing almost like growth lines.

**Remarks.** The degree of involution, the discoidal nature of the shell, and the knife-edge venter of the Queen Charlotte Islands specimens are typical of *P. compactus*. *P. lyshennae* (Young and Bird, 1828) has coarser ribbing that is more prominent on the lower flanks. Some specimens are similar to *Leioceras opalinum* (Reinecke, 1818) with fine ribbing, and a similar whorl shape and sulcation. These could be juvenile features of *Pseudolioceras*, as they appear on specimens of small size.

**Distribution.** *Pseudolioceras compactus* has been collected from the Upper Toarcian of north-west Europe, and is common in the Arctoe regions of North America and Siberia.
JAKOBS AND SMITH: TOARCIC AMMONOIDS

Subfamily Hammatomoceratinae Buckman, 1887

Genus Hammatomoceras Hyatt, 1867

[= Ammomoceras Hyatt, 1867; Pachammatomoceras Buckman, 1921]

Type species. Ammonites insignis Zieten, 1831 (subsequent designation by Buckman 1887)

Diagnosis. Moderately evolute shell with sub-triangular to ogival whorl section; umbilical wall becomes vertical and commonly undercut on outer whorls; primary ribs short, with long secondary ribs arising near umbilical shoulder, commonly at tubercles; venter carinate; prorsiradiate ribs approach it at slight angle; ribs fade on outer whorls.

Distribution. With the exception of the Arctic regions, Hammatomoceras is a cosmopolitan genus found in the Upper Toarcian and Lower Aalenian.

Hammatomoceras insignis (Zieten, 1831)

Plate 7, figure 5

1831 Ammonites insignis Zieten, pl. 15, fig. 2.
1874 Ammonites insignis (Schubler); Dumortier, pl. 17, figs 1–3 (non 4–5).

Material. Only three specimens known, collected from calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 2, loc. 4, Section 3, locs 71, 93).

Description. The shell is involute with a triangular whorl section. Flanks are convex to the carinate venter. On the outer whorls, the keel is bordered by smooth bands. The ornament is prominent with sharp umbilical tubercles from which two or three rectiradiate secondary ribs arise which approach the venter at an angle of approximately 90°.

Remarks. This species can be distinguished from H. speciosum by the latter’s more compressed whorl section, and ribs that approach the venter with a slightly prorsiradiate trend.

Distribution. Hammatomoceras insignis is well known from the Upper Toarcian of Europe (Guex 1975; Schlegelmich 1976; Elmi and Ruelle 1991).

Hammatomoceras speciosum (Janensch, 1902)

Plate 7, figures 1–4, 6

1874 Ammonites insignis (Schubler); Dumortier, pl. 18.
1885 Ammonites insignis variabilis Quenstedt, pl. 50, fig. 1.
*1902 Ammonites speciosum Janensch, pl. 10, fig. 1.
1974 Hammatomoceras speciosum (Janensch); Elmi et al., pl. 5, fig. 1.
1975 Hammatomoceras speciosum (Janensch); Guex, p. 111, pl. 9, fig. 8; pl. 10, figs 1, 3.
1976 Hammatomoceras speciosum (Janensch); Schlegelmich, p. 91, pl. 49, fig. 2.
1991 Hammatomoceras speciosum (Janensch); Tipper et al., pl. 7, fig. 1.
1992 Hammatomoceras speciosum (Janensch); Hillebrandt and Smith, pl. 4, fig. 1.

Material. 20 specimens from calcareous concretions and sandstone of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, loc. 3; Section 2, loc. 4; Section 3, locs 90, 99–100, 105; Section 4, loc. 2; Section 5, locs 1–2, 5). Two poorly preserved specimens from the Snowshoe Formation, east-central Oregon (Text-fig. 2; Section 7, locs 4–5).
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**Description.** The shell is moderately evolute with an ovate to triangular whorl section. The umbilical wall is steep, becoming vertical and undercut on the outer whorls. The umbilical shoulder is rounded but abrupt. The flanks are gently convex, converging toward the carinate venter. The ornament is coarse, consisting of strong umbilical tubercles from which two or three secondary ribs arise. The primary ribs are prorsiradiate on the umbilical wall. The secondary ribs are gently curved and approach, but do not reach, the venter at an angle of approximately 70°.

**Remarks.** The whorls are much taller and narrower than those of *Hammatoceras insigne*, and the ribbing is finer and denser. In addition, the ribs of *H. insigne* approach the venter at an angle of almost 90°. *H. bonarelli* Parish and Viale, 1906, is more evolute, and the whorls are not as high as those of *H. speciosum*.

**Distribution.** *Hammatoceras speciosum* is common in Europe and the Mediterranean region: in Algeria from the Insigne Zone (Elmi et al. 1974), in southern Germany from the Levesquei Zone (Schlegelmilch 1976), and in France from the Insigne Zone (Gueux 1975; Elmi and Rulkeau 1991).

*Hammatoceras* sp. nov.

Plate 7, figures 7-8

**Material.** Three incomplete specimens in sandstones and calcareous concretions of the Phantom Creek Formation, Queen Charlotte Islands (Section 5, loc. 2)

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**Description.** The shell is moderately evolute with a depressed, almost wide oval whorl section. The flanks are flat, becoming convex on the outer whorls. The venter is carinate with a subdulced keel. The ornament is coarse and sparse. Umbilical tubercles give rise to two or three secondary ribs which are rectiradiate on the flank, but become prorsiradiate and approach the venter at an angle of approximately 70°.

**Explanation of Plate 7**

Figs 1-4. *Hammatoceras speciosum* Janensch: Yakounensisis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands. 1, 4, GSC 95583; GSC Loc. No. C-87215, Section 2, loc. 4. 2-3, GSC 107264, GSC Loc. No. C-87216, Section 2, loc. 4.

Fig. 5. *Hammatoceras insigne* (Zieten); GSC 107265; Hillebrandt Zone, upper part of the Whiteaves Formation; Queen Charlotte Islands, GSC Loc. No. C-159396, Section 3, loc. 71.

Fig. 6. *Hammatoceras speciosum* Janensch: UBC 017; Yakounensisis Zone, Warm Springs Member of the Snowshoe Formation; Izee area, eastern Oregon, UBC Loc. No. F4-4-E, Section 7, loc. 5.

Figs 7-8. *Hammatoceras* sp. nov.; GSC 107266; Yakounensisis Zone, lower part of the Phantom Creek Formation; Queen Charlotte Islands, GSC Loc. No. C-158077, Section 3, loc. 2.

All are × 1.
Remarks. This species is similar to *H. insignis* but differs in possessing much coarser and more distant ribbing, and in that the ribs approach the venter at a more acute angle.

**Genus Sphaeroceloceras** Jaworski, 1926

**Type species.** *Sphaeroceloceras brochiforme* Jaworski, 1926

**Diagnosis.** Small involute shell with wide ellipsoidal to rounded whorl section; venter plain, but sometimes weakly carinate; ribbing blunt, sparse, bifurcating low on flank; no tubercles present.

**Remarks.** This genus has been known previously only from South America. It was placed initially within the Dactylioceratidae by Jaworski (1926) because of the similarity of its suture line to that of *Coeloceras erasmum* Young and Bird, 1828. Arkell *et al.* (1957) retained this classification. Donovan *et al.* (1981) placed it within the Hammatoeratinae. It is similar to small specimens of *Hammatoceras* in appearance except for the missing keel. The genus is of Late Toarcian age in South and North America.

*Sphaeroceloceras brochiforme* Jaworski, 1926

Plate 6, figures 7–10

*1926 Sphaeroceloceras brochiforme* Jaworski, p. 259, pl. 1, fig. 10; pl. 3, fig. 10; pl. 4, fig. 23.

v 1987 *Sphaeroceloceras brochiforme* Jaworski; Hillebrandt, pl. 13, fig. 9a-c; pl. 14, fig. 10a-b.

v 1987 *Hammatoceras erasmum* (Jaworski) Hall, p. 1702, pl. 5, figs. R-V.

v 1991 *Sphaeroceloceras brochiforme* Jaworski; Tipper *et al.*, pl. 7, fig. 2.

v 1992 *Sphaeroceloceras brochiforme* Jaworski; Hillebrandt and Smith, pl. 4, fig. 2.

v 1994 *Sphaeroceloceras brochiforme* Jaworski; Jakobs *et al.*, pl. 5, figs. 7-8.

**Material.** 40 specimens in calcareous concretions and sandstones of the Phantom Creek Formation, Queen Charlotte Islands (Section 1, loc. 17; Section 2, locs 3–4, 17; Section 3, locs 55, 97–98; Section 4, locs 2, 6, 10; Section 5, loc. 5). Poorly preserved specimens from the southern Canadian Rocky Mountains (Text-fig. 2; Collection 45).

**Measurements.**

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**Description.** The shell is moderately evolute with a depressed, rounded whorl section. The umbilical wall is gently sloping and the umbilical shoulder is weak. The flanks are gently convex, converging towards the plain venter. No keel is evident but a faint ridge may sometimes be present. The ornament is generally faint. Ribs are blunt and begin near the umbilical shoulder, prorsiradiate to the upper flank, then rursiradiate to the venter. The ribs approach the venter with an angle of slightly less than 180°, and their ventral ends may be separated by a smooth area. They commonly bifurcate at the top of the flank, and single intercalatory ribs may also appear. The venter is similar to that of *Hammatoceras* except for the absence of a keel. Ribbing strength and density vary slightly between the specimens.

**Remarks.** Slight variations in ribbing density and strength are not considered sufficiently important to warrant splitting the group into several species.

**Distribution.** *Sphaeroceloceras brochiforme* has been collected in South America, from the *Phyllogrammoceras* (*?*) temnicostatum, *Pleydellia lotharingica* and *Pleydellia fluitans* zones of Hillebrandt (1987).
CONCLUSIONS

The latest Toarcian ammonite fauna of North America contains endemic Athabascan (sensu Taylor et al. 1984) and eastern Pacific taxa, as well as pandemic taxa. Eastern Pacific taxa such as Sphaeroconoceras brochiforme and Damorteria pusilla provide correlative ties with South American faunas described by Hillebrandt (1981, 1987). Pandemic taxa, such as Pleydellia aulensis, Hammatoceras spectosum, Damorteria levesquei, and D. insignissimus, allow correlation with European successions. Athabascan forms are the most widespread and prolific taxa in western North America; these include Yakouania yakouensis, Y. freboldi, Y. silicae, and Pleydellia maundensis. A global sea-level fall during the Late Toarcian (Hallam 1988; Haq et al. 1985) may have encouraged endemism by restricting migration between the eastern Pacific and western Tethys.

Acknowledgements. Most of this study was part of the doctoral research of Gkj, supported by a NSERC research grant to PLS and by the Geological Survey of Canada. We thank H. W. Tipper for making available old collections and sharing his extensive knowledge of the Canadian Jurassic, Beth Carter for identifying Radiolaria, and Dave Taylor for identifying Middle Jurassic ammonites. Photographs were taken by K. Gordanier-Smith.

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JAKOBS AND SMITH: TOARCIAN AMMONOIDS


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Typescript received 29 November 1993
Revised typescript received 31 March 1995