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AALENIAN AMMONITES AND STRATA OF WESTERN CANADA

T.P. Poulton and H.W. Tipper

1991

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PREFACE

The value of fossils in geological mapping and mineral exploration has been recognized for over 200 years. Ongoing mapping and exploration in the Canadian Cordillera continue to uncover problems and to yield surprising discoveries that can be resolved by paleontological research. Ongoing paleontological research, in turn, produces results that require reassessment of geological maps and interpretations, and inspires new exploration incentives. The fossils described in this bulletin are of exceptional value in providing age control and correlation in a previously neglected period of the Middle Jurassic.

The results derived from this study of the Aalenian ammonites of British Columbia and southern Yukon permit new interpretations of the ancient disposition of marine basins and their relationship to centres of volcanism and mobile terranes. In particular, a previously unrecognized episode of volcanism — widespread in western British Columbia — has been documented. This has important implications for the mineral exploration industry.

Elkanah Babcock
Assistant Deputy Minister
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PRÉFACE

On reconnaît depuis plus de 200 ans la valeur des fossiles dans les domaines de la cartographie géologique et de l'exploration minérale. Lors des travaux de cartographie et d'exploration en cours dans la Cordillère canadienne, on continue à découvrir de nouveaux problèmes, et à réaliser des découvertes surprenantes que la recherche paléontologique permettra d'expliquer. La recherche paléontologique en cours donne à son tour des résultats qui exigent une réévaluation des cartes et des interprétations géologiques, et stimule à nouveau l'exploration. Les fossiles décrits dans le présent bulletin sont d'une valeur exceptionnelle du point de vue du contrôle des datations et des corrélations des niveaux correspondant à une période jusque-là négligée du Jurassique moyen.

Les résultats fournis par cette étude des ammonites de l'Aalénien de la Colombie-Britannique et du sud du Yukon permettent de nouvelles interprétations relativement à la répartition ancienne des bassins marins, et à leurs relations avec les centres volcaniques et les terranes mobiles. En particulier, un épisode de volcanisme jusque-là non reconnu — qui s'est produit sur une vaste étendue de la Colombie–Britannique occidentale — a été étudié. Les résultats obtenus ont aussi eu d'importantes conséquences au niveau de l'industrie de l'exploration minérale.

Elkanah Babcock
Sous-ministre adjoint
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Abstract

Marine Aalenian deposits containing ammonites are widespread in the allochthonous, or possibly allochthonous, terranes of the Canadian Western Cordillera.

The lowest Aalenian strata contain *Tmetoceras scissum* (Benecke) and *Troitsaia westermanni* gen. et sp. nov. This is the *Troitsaia westermanni* Zone, which is correlated with the lower parts of the *Leioceras opalinum* Standard Zone. Higher beds, containing *T. scissum* alone, may approximately represent the upper parts of the *L. opalinum* Zone, i.e., the *L. comptum* Subzone. On Queen Charlotte Islands, probable lower Aalenian rocks yield species of *Bredyia* similar to the Andean species *B. manflasensis* Westermann, as well as *T. scissum*. These are correlated with the South American *Bredyia manflasensis* Zone. Lower Aalenian ammonites had previously been unknown or poorly known in western North America.

Erycitoides howelli (White), with a few specimens that are probably *Planammatoceras* s.l. and other genera, indicate the *Erycitoides howelli* Zone, which is correlated with the upper *Ludwigia murchisonae* and *Graphoceras concavum* Standard zones. Except for the abundant cosmopolitan *Tmetoceras*, and rare *Planammatoceras* and *Pseudolioceras*, the ammonites have western American, i.e., East Pacific (including South American) affinities.

Troitsaia westermanni gen. et sp. nov. appears to be an endemic derivative from the Toarcian *Dumortieria*, and a reliable index for the basal Aalenian of western British Columbia.

Résumé

Les sédiments marins de l'Aalénien contenant des ammonites s'observent fréquemment dans les terranes allochtones, ou allochtones avec plus ou moins de certitude, de la partie ouest de la Cordillère canadienne.

Les strates basales de l'Aalénien comprennent les ammonites suivantes : *Tmetoceras scissum* (Benecke) et *Troitsaia westermanni* gen. et sp. nov. Elles forment la zone à *Troitsaia westermanni*, associée aux sections inférieures de la zone caractéristique à *Leioceras opalinum*. Les couches situées stratigraphiquement plus haut, dont le seul fossile est *T. scissum*, pourraient correspondre approximativement aux sections supérieures de la zone à *L. opalinum*, soit la sous-zone à *L. comptum*. Dans les îles de la Reine-Charlotte, des roches de la partie inférieure de l'Aalénien (âge plus ou moins certain) présentent les fossiles suivants : *Bredyia*, une ammonite qui s'apparente à l'espèce andéenne *B. manflasensis* Westermann, et *T. scissum*. Une corrélation a été établie entre ces espèces et la zone à *Bredyia manflasensis* de l'Amérique du Sud. Auparavant, les ammonites de l'Aalénien inférieur étaient inexistantes ou se rencontraient peu fréquemment en Amérique du Nord occidentale.

La zone à *Erycitoides howelli* est caractérisée par la présence d'*Erycitoides howelli* (White), mais aussi de quelques individus qui sont peut-être des *Planammatoceras* s.l. et d'autres genres; elle est associée à la partie supérieure des zones caractéristiques à *Ludwigia murchisonae* et à *Graphoceras concavum*. À l'exception du fossile *Tmetoceras*, abondant et à répartition mondiale, mais aussi de quelques *Planammatoceras* et *Pseudolioceras observées*, les ammonites présentent des affinités avec leurs pairs de l'Amérique occidentale, c'est-à-dire du Pacifique Est (y compris l'Amérique du Sud).

Troitsaia westermanni gen. et sp. nov. semble être endémique et dériver de l'ammonite *Dumortieria* du Toarcien; elle constitue un fossile caractéristique fiable, identifiant la base de l'Aalénien dans la partie ouest de la Colombie-Britannique.

Summary

The Pacific margin of the Canadian Cordillera was tectonically mobile throughout Mesozoic time. Several distinct terranes have been recognized within the Cordillera. Aalenian sedimentary and volcanic rocks accumulated in widely distributed areas throughout the Cordillera and have been found to some degree in all of the major allochthonous terranes in which Jurassic rocks are preserved. The Aalenian sea was widespread.

The Aalenian strata are characteristically shale and siltstone with interbedded, intermediate to acid, tuffaceous volcanic rocks; much of the sequence is a mixture of pelitic sediment and fine ash. Fine to coarse volcanogenic sandstone and moderately coarse volcanic breccia occur in some areas, but conglomerate is rare. It is unclear whether the Aalenian strata were deposited in several distinct basins, or in a broad sea with a few islands, some of which were volcanic centres.

Volcanic debris is an important part of the Aalenian sequence wherever volcanic rocks are prominent in the Jurassic record. Air-fall tuffs as well as redeposited volcaniclastic detritus are common; volcanic flow rocks or very coarse pyroclastics are generally absent. The centres of eruption probably were distributed along the eastern flank of the Coast Mountains along the entire length of the Canadian Cordillera.

Aalenian sections are thin compared with the Bajocian sequences above or the Toarcian below. Wherever the relationships can be determined, the Aalenian and Bajocian sequences are conformable, and frequently difficult to delineate without fossils. Where paleontological control is not available, Aalenian beds may have been mapped indiscriminately with the more fossiliferous and prominent Bajocian strata. Aalenian and underlying Toarcian sections are usually conformable or are marked by minor erosion recording a short hiatus; usually the uppermost Toarcian is missing.

The lowest Aalenian strata contain *Tmetoceras scissum* (Benecke) and *Troitsaia westermanni* n. gen. et sp. and belong to the *Troitsaia westermanni* Zone, which is correlated with the lower parts of the *Leioceras opalinum* Standard Zone. Higher beds, containing *T. scissum* alone, may approximately represent the upper parts of the *L. opalinum* Zone, i.e. the *L. comptum* Subzone. On Queen Charlotte Islands, lower Aalenian rocks yield species of *Bredyia* similar to the Andean species *B. manflasensis* Westermann, as well as *T. scissum*. These strata are correlated with the South American *Bredyia manflasensis* Zone. Lower Aalenian ammonites had previously been unknown or poorly known in western North America.

Erycitoides howelli (White), with a few probable *Planammatoceras* s.l. and other genera, indicate the *Erycitoides howelli* Zone, which is correlated with the upper *Ludwigia murchisonae* and *Graphoceras concavum* Standard zones. Except for the abundant cosmopolitan *Tmetoceras*, and rare *Planammatoceras* and *Pseudolioceras*, the ammonites have western North American affinities (i.e., East Pacific and South American).

Troitsaia westermanni appears to be an endemic derivative from the Toarcian *Dumortieria*, and a reliable index for the lowest Aalenian in western British Columbia.

Sommaire

La marge pacifique de la Cordillère canadienne a été tectoniquement mobile pendant tout le Mésozoïque. Plusieurs terranes distincts ont été reconnus dans la Cordillère. Des roches sédimentaires et volcaniques d'âge aalénien se sont accumulées sur de nombreuses étendues de la Cordillère, et se sont mainfestées de façon plus ou moins importante dans tous les grands terranes allochtones où subsistent des roches d'âge jurassique. La mer aalénienne occupait des étendues importantes.

Les strates de l'Aalénien se composent typiquement de shale et de siltstone contenant des interstrates de roches volcaniques tufacées, de nature intermédiaire à acide; la séquence se compose en grande partie d'un mélange de sédiments pélitiques et de cendres fines. Dan certaines régions, on trouve de grès volcanogénique fin à grossier et des brèches volcaniques relativement grossières, mais les conglomérats sont rares. Il est difficile de dire si les strates de l'Aalénien se sont accumulées dans plusieurs bassins distincts, ou dans une vaste mer contenant quelques îles, dont certaines constituaient des centres volcaniques.

Les débris volcaniques représentent une importante partie de la séquence aalénienne, partout où les roches volcaniques sont un élément bien visible de la stratigraphie du Jurassique. Les ignimbrites et débris volcanoclastiques redéposés sont abondants; on ne trouve généralement pas de coulées volcaniques ni de roches pyroclastiques très grossières. Les centres éruptifs étaient probablement répartis sur le flanc est de la chaîne Côtière sur toute la longueur de la Cordillère canadienne.

Les coupes de l'Aalénien sont minces compartivement aux séquences du Bajocien sus-jacentes ou aux séquences du Toarcien sous-jacentes. Partout où elles sont reconnaissables, les séquences de l'Aalénien et du Bajocien sont concordantes, et souvent difficiles à délimiter san l'utilisation de fossiles. En l'absence d'un contrôle paléontologique, on a pu cartographier les couches de l'Aalénien en même temps que les strates du Bajocien, plus fossilifères et évidentes, sans les différencier. Les coupes de l'Aalénien et du Toarcien sous-jacent sont habituellement concordantes, ou caractérisées par une érosion mineure indiquant un bref hiatus; habituellement, la partie sommitale du Toarcien a disparu.

Les strates inférieures de l'Aalénein contiennent *Tmetoceras scissum* (Benecke) et *Troitsaia westermanni* n. gen. et sp., et appartiennent à la Zone à *Troitsaia westermanni*, qui a été corrélée avec les parties inférieures de la Zone standard à *Leioceras opalinum*. Les lits supérieurs, qui contiennent *T. scissum* seul, pourraient approximativement représenter les parties supérieures de la Zone à *L. opalinum*, c'est-à-dire la Sous-zone à *L. comptum*. Dans les îles de la Reine–Charlotte, les roches de la partie inférieure de l'Aalénien contiennent des espèces de *Bredyia* semblables à l'espèce andéenne *B. manflasensis* Westermann, de même que *T. scissum*. Ces strates sont corrélées avec la Zone à *Bredyia manflasensis* d'Amérique du Sud. Les ammonites de l'Aalénien inférieur étaient jusque-là inconnues ou peu connues dans l'ouest de l'Amérique du Nord.

Erycitoides howelli (White), en même temps que quelques spécimens probables de *Planammatoceras* s.l. et d'autres genres, indiquent la Zone à *Erycitoides howelli*, qui a été corrélée avec la partie supérieure des zones standard à *Ludwigia murchisonae* et *Graphoceras*. Sauf l'ammonite cosmopolite abondante *Tmetoceras*, et les ammonites rares *Planammatoceras* et *Pseudolioceras*, les ammonites présentent des affinités nord-américaines occidentales, c'est-à-dire des affinités avec des faunes du Pacifique oriental et de l'Amérique du Sud.

Il semble que *Troitsaia westermanni* soit une espèce endémique apparentée à l'espèce toarcienne *Dumortieria*, et constitue un fossile stratigraphique fiable de la partie inférieure de l'Aalénien dans l'ouest de la Colombie-Britannique.

INTRODUCTION

Aalenian fossils are widely distributed in the Western Cordillera of Canada and indicate the presence of marine Aalenian strata. Only a few Aalenian fossils have been illustrated previously (Frebold, 1951; Frebold et al., 1969), and the widespread character of the Aalenian deposits has not been previously noted in the literature. In this report all of the currently known fossil localities are documented, and the more significant ammonites are illustrated.

Only recently has the Aalenian come to be accepted worldwide as a stage in its own right. It is most commonly considered to be the basal stage of the Middle Jurassic. As now used, it is synonymous with what has previously been called the Lower Bajocian substage in Canada and the United States (see Westermann, 1979).

Aalenian fossils occur in many localities in the Western Cordillera, commonly in successions that appear by lithology and structural relationships to be stratigraphically continuous. This suggests that Aalenian marine deposits were deposited widely but are now preserved only as remnants in scattered areas.

BIOSTRATIGRAPHY

The most significant previous taxonomic and biostratigraphic reports dealing with the Aalenian of North America are those of Westermann (1964b) for southern Alaska and Taylor (1988) for Oregon. Imlay (1973) also described Aalenian fossils and strata from Oregon and discussed these and the Alaskan Aalenian ammonites in a biostratigraphic framework. The important Aalenian guide ammonite *Tmetoceras* was also described from east-central California (Imlay, 1973). In both Oregon and California, Imlay noted the association of *Tmetoceras* with *Bositra buchi* (Römer). This association is not of great significance in Canada, as *Bositra* is more commonly present in Toarcian strata. The lower Aalenian is apparently poorly represented in Oregon and southern Alaska; the present report therefore contains data that fill a major gap in western North American Jurassic biostratigraphy.

The succession of *Tmetoceras* species through the Aalenian as suggested by Westermann (1964b) seems to be confirmed by the Canadian material. *Tmetoceras scissum* (Benecke) occurs together with *Troitsaia westermanni* gen. et sp. nov. in beds thought to be lower Aalenian by their stratigraphic position, whereas *T. kirki* Westermann and *T. flexicostatum* Westermann are probably upper Aalenian.

Erycitoides howelli (White), and other *Erycitoides* species, occur with the long-ranging *T. scissum* and with the younger *T. kirki* Westermann in Western Canada, indicating a late Aalenian age.

Specimens that are probable *Planammatoceras* species are not well enough preserved in the Canadian collections, nor is the genus as a whole sufficiently short-lived worldwide, for it to have detailed biostratigraphic significance here. Specimens perhaps related to *Zurcheria* are also not well enough preserved or sufficiently abundant in Canada, nor is the age significance of the Aalenian species of that genus sufficiently well understood worldwide, for them to be biostratigraphically useful.

Bredyia is known so far only from the Queen Charlotte Islands. It is not directly associated with other ammonites, but occurs closely above *Tmetoceras scissum* in the same thick bed. Its stratigraphic position suggests an early Aalenian age, consistent with the range of the genus in Europe and South America (Hillebrandt and Westermann, 1985; Senior, 1977).

Fossils other than ammonites are generally less useful for identification and subdivision of Aalenian strata, but some are significant. Among the bivalves, certain species of *Myophorella* are characteristic, such as *M. taylori* Poulton and others not yet described. Those in the Aalenian collections mentioned here differ from the Aalenian *Myophorella* species of Oregon (Poulton, 1980) and southern Alaska (work in progress). A small, thin- and crinkly shelled species of an ostreiid bivalve, sometimes encrusting *Tmetoceras* shells, is characteristic of many Canadian Aalenian strata. It is most abundant in basinal laminated deposits where *Tmetoceras* is the dominant ammonite. Another characteristic Aalenian bivalve is a small species of *Grammatodon*, which occurs commonly in the shelly facies.

CANADIAN ZONES AND CORRELATION

The following tentative zonation is constructed from stratigraphic sections and ammonite associations in isolated outcrops from all of Western Canada. Most of the fossil occurrences are primarily of importance for dating the strata in which they occur, as many of the collections come from isolated localities or result from regional mapping, but few come from specifically biostratigraphic studies. Only a few are from sections that are sufficiently complete stratigraphically to be of importance for building up a regional biostratigraphic zonation in their own right. Further collecting can be expected to refine significantly the zonation presented here. The Aalenian is relatively thin everywhere; undisturbed, continuously fossiliferous sections are rare. Each zone rarely, if ever, exceeds 100 m in thickness.

Toarcian-Aalenian boundary

The base of the Aalenian in Canada is here somewhat arbitrarily defined by the first appearance of *Tmetoceras scissum* (Benecke), as there is no evidence anywhere that *Tmetoceras* occurs in the Toarcian. In the Whitesail Lake, Smithers, and Spatsizi map areas, *Troitsaia westermanni* sp. nov. is associated with *T. scissum* probably in the lowest Aalenian beds (Tables 1-3). *Troitsaia westermanni* sp. nov. differs from Toarcian and Aalenian species of *Dumortieria* in having tiny umbilical nodes. This species seems to be a good index species for the basal Aalenian in Canada. It is not known to extend far up into the Aalenian, in contrast to *T. scissum* and other *Tmetoceras* species, as well as a variety of other ammonite genera.

Troitsaia westermanni Assemblage Zone (new)

This zone is characterized by the association of *Troitsaia westermanni* with *Tmetoceras scissum. Troitsaia westermanni* is taken to indicate an earliest Aalenian age, even where it occurs alone, without *Tmetoceras* (e.g., Manning Park, Whitesail Range). The *T. westermanni* Zone is correlated with at least part of the *Leioceras opalinum* Standard Zone[1], which is particularly well developed in the Canadian Arctic islands (Table 2).

TABLE 1

Chart showing correlations of western Canadian assemblage zones and northwest European standard zones in the Pacific area

	NORTH-WEST EUROPEAN STANDARD ZONES		SOUTH AMERICA	EASTERN AND NORTHERN USSR	OREGON	SOUTHERN ALASKA	WESTERN CANADA
AALENIAN	CONCAVUM		*Puchenquia malarguensis*	*Pseudolioceras tugurense*	*Eudmetoceras* unnamed (with *Tmetoceras, Praestrigites*)	*Eudmetoceras amplectens* *Erycitoides howelli*: *Tmetoceras tenue*; *Erycitoides teres*	? *Erycitoides howelli*
	MURCHISONAE		*Zurcheria groeberi*	?	unnamed (with *Tmetoceras*)	unnamed (with *Tmetoceras scissum*)	*Tmetoceras scissum*
	OPALINUM	COMPTUM SUBZONE	*Bredyia manflasensis*	*Pseudolioceras mclintocki*	absent?	absent?	
			?	*Pseudolioceras (P.) rosenkrantzi*			*Troitsaia westermanni*

References: South America (Hillebrandt and Westermann, 1985), eastern and northeastern U.S.S.R. (Sei et al., 1985), Oregon (Imlay, 1973; Taylor, 1988), southern Alaska (Westermann, 1964b, 1969), Western Canada (this report).

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[1] The term "Standard Zone" is used here to refer to those northwest European zones that serve internationally as a reference to a worldwide standard scale. Assignment of a regional "Zone" to a Standard Zone communicates interpretations of correlation with northwest Europe in this report. There is a growing tendency among Jurassic workers to think of the Standard zones or "International" standard zones as worldwide in extent, and therefore as chronozones, but the degree and manner to which this is expressed is highly variable, and there is no consistent orthography or terminology (see Callomon, 1984, for example).

TABLE 2

Chart showing correlations of western Canadian assemblage zones and northwest European standard zones in Arctic areas

	NORTHWEST EUROPEAN STANDARD ZONES		EASTERN AND NORTHERN USSR	NORTHERN ALASKA	NORTHERN YUKON		ARCTIC ISLANDS		WESTERN CANADA
AALENIAN	CONCAVUM		*Pseudolioceras tugurense*	? *Erycitoides howelli*	? *Erycitoides howelli*		? *Erycitoides howelli*		? *Erycitoides howelli*
	MURCHISONAE		?	*Pseudolioceras whiteavesi*	?	*Pseudolioceras mclintocki*	?	*Pseudolioceras mclintocki*	*Tmetoceras scissum*
	OPALINUM	COMPTUM SUBZONE	*Pseudolioceras mclintocki*	*Pseudolioceras mclintocki*	*Leioceras opalinum*		*Leioceras opalinum*		
			Pseudolioceras rosenkrantzi						*Troitsaia westermanni*

References: Eastern and northern U.S.S.R. (Sei et al., 1985), northern Alaska (Imlay, 1955; Imlay and Detterman, 1973), northern Yukon Territory (Poulton, 1978, 1991), Canadian Arctic Islands (Poulton, in press), Western Canada (this report).

TABLE 3

Chart showing dominant Aalenian faunas and correlations in the Western Canadian Cordillera

	NW EUROPEAN STANDARD ZONES		WESTERN CANADIAN ASSEMBLAGE ZONES	BASINS OF THE WESTERN CANADIAN CORDILLERA					
				METHOW TROUGH	TYAUGHTON TROUGH	QUESNEL TROUGH	HAZELTON TROUGH	WHITEHORSE TROUGH	INSULAR TROUGH
AALENIAN	CONCAVUM		? *Erycitoides howelli*	? *Erycitoides* (?) sp. *Tmetoceras* sp. aff. *T. flexicostatum* *Planammatoceras* sp.	? *Erycitoides howelli* *Tmetoceras flexicostatum* *Planammatoceras* sp. *Pseudolioceras whiteavesi*		? *Erycitoides howelli* *Tmetoceras flexicostatum* *Pseudolioceras* sp. cf. *P. whiteavesi* *Pseudolioceras* sp. *Planammatoceras* sp. *Lissoceras* sp. *Tmetoceras kirki* *Tmetoceras* sp.	? *Tmetoceras flexicostatum* *Planammatoceras* sp.	
	MURCHISONAE		*Tmetoceras scissum*	*Tmetoceras scissum*	*Tmetoceras scissum* ?	? *Erycitoides* sp. *Tmetoceras scissum* ?	*Tmetoceras scissum* *Leioceras* (?)	?	*Bredyia* sp. cf. *B. manflasensis* *Tmetoceras scissum*
	OPALINUM	COMPTUM SUBZONE							
			Troitsaia westermanni	*Troitsaia westermanni*			*Troitsaia westermanni*		

Tmetoceras scissum Assemblage Zone

There appears to be an interval above the *Troitsaia westermanni* Zone, and below the first appearance of *Erycitoides*, that is characterized by *T. scissum* alone. This interval is analogous with what has been called the acme of *T. scissum* in Europe, in the upper *L. opalinum* Standard Zone, i.e., the *T. scissum* Zone of Arkell (1956) and Rieber (1963), or the *Leioceras comptum* Subzone. However, such a correlation is imprecise because of the long range of *T. scissum*, the replacement in western North America of *L. opalinum* with *Troitsaia westermanni*, and the uncertainty of the correlation of the base of the *Erycitoides howelli* Zone with the standard zonation. The name *Tmetoceras scissum* Zone is used in Western Canada for want of a better name for the interval represented almost exclusively by *T. scissum*. The degree to which it is controlled by facies distributions is unknown.

Bredyia sp. aff. *B. manflasensis* Westermann and *Bredyia* sp. from the Queen Charlotte Islands probably indicate an Early or early mid-Aalenian age; this is compatible with their stratigraphic occurrence. *Bredyia manflasensis* occurs in South America in the equivalent of the *L. opalinum* through lower *L. murchisonae* standard zones, and *Bredyia* in Europe occurs in the lower (rare) and upper (more abundant) parts of the *Leioceras opalinum* Standard Zone (Hillebrandt and Westermann, 1985).

Bredyia in the Queen Charlotte Islands occurs very closely above *Tmetoceras scissum* in the same bed, as documented in this report. More recently, however, Carter and Jakobs (1991) reported *Bredyia* to occur with *Planammatoceras* and close to *Erycitoides howelli* (White), an association that may suggest correlation with some part of the *Ludwigia murchisonae* Standard Zone. Thus the range of *Bredyia* in Canada remains poorly known.

Pleydellia sp. cf. *P. argentina* is found in the Taseko Lakes area (GSC loc. C-117267) stratigraphically well below the lowest occurrence of *Tmetoceras*, and may be early Aalenian, if not Toarcian, in age.

Erycitoides howelli Assemblage Zone

The first appearance of *E. howelli* (White) and the lowest association of a variety of other ammonites is taken to indicate the base of this zone, which was originally defined in southern Alaska (Kellum et al., 1945; Westermann, 1964b). Westermann (1964b, 1969) concluded that the *E. howelli* Zone in Alaska corresponds to the upper *Ludwigia murchisonae* and *Ludwigia concava* [*Graphoceras concavum*] Standard zones (see also Sei et al., 1985). None of the ammonites in Western Canada is sufficiently abundant, well preserved, or closely similar to those of Europe to give a more precise age for the *E. howelli* Zone, but the presence of *Planammatoceras* at several localities, and the overall interpreted biostratigraphic succession, indicate that it ranges as low as the *Ludwigia murchisonae* Standard Zone, as in southern Alaska. Taylor (1988) recognized two zones in Oregon equivalent to the *E. howelli* Zone. The Canadian material permits neither confident subdivision of the zone, nor confirmation of the previous subdivision of the zone in Alaska into subzones (Kellum et al., 1945) or zonules (Westermann, 1964b). However, the evolutionary trend within *Tmetoceras* (Westermann, 1964b) seems to be supported, and the associations of *T. flexicostatum* Westermann and Riccardi with other ammonites may be indicative of the youngest part of the *E. howelli* Zone in Canada.

It is not clear how high in the Aalenian the *E. howelli* Zone should extend. Westermann (1964b, 1969) and Westermann and Riccardi (1972) considered the zone to range through the latest Aalenian but Hall and Westermann (1980, p. 19) extended the *Eudmetoceras amplectens* Zone of the lowest Bajocian in southern Alaska down into the uppermost Aalenian. Taylor (1988) erected the *Packardi* Zone in Oregon as a latest Aalenian equivalent to the *Amplectens* "zonule" of Alaska. These questions are not resolved by the Canadian material. The presence in the Spatsizi map area of one small fragment possibly representing *Planammatoceras* (*Pseudaptetoceras*) (Pl. 5, fig. 7) suggests that the highest Aalenian beds may be present there.

AALENIAN FOSSIL OCCURRENCES AND STRATIGRAPHY

The Aalenian ammonite faunas in the Canadian Western Cordillera are dominated by *Tmetoceras*, associated with a rich variety of other ammonites, bivalves, brachiopods, and belemnites in some facies. In others, they occur in rich but nearly monospecific faunas, commonly in finely laminated, basinal shale and siltstone. In the latter facies, *Tmetoceras* is commonly associated only with small *Inoceramus* or ostreiid shells, the latter often attached to the ammonite shell.

The Aalenian is known from the Canadian Western Interior only from palynomorphs from the subsurface of northern Alberta (Poulton et al., 1991), where they occur in the upper part of the Poker Chip Shale Member of the Fernie Formation. No Aalenian fossils are known from the Williston Basin, although some parts of the Watrous and Amaranth formations may be Aalenian, on the basis of their stratigraphic position (Poulton, 1984).

Tectonic setting of the Western Cordillera

The Pacific margin of the Canadian Cordillera was characterized by tectonic mobility from late Paleozoic time to the present. Various interpretations have been considered, which rely heavily on plate tectonic theories of subduction, collision, and accretion of terranes along the Pacific margin. Many suspect or allochthonous terranes have been described (Coney et al., 1981) and are interpreted as having arrived at their present locations by accretion or movement along transcurrent faults. Stratigraphically, each terrane has an internal consistency that distinguishes one from another; the most distinct differences are seen in the older rocks, those of late Paleozoic or Triassic age. The Jurassic rocks show greater lithological similarity between terranes. Many sequences can be described as overlap assemblages that tie older, dissimilar terranes together (Tipper, 1984), but which have been kept virtually distinct by recurring transcurrent movements along sutures between terranes.

Several lines of evidence, lithological, paleomagnetic, paleontological, and structural (Irving et al., 1980; Tipper, 1981) support the concept that the sutures between the terranes are the site of transcurrent faults with dextral movement. Certainly the terrane boundaries are zones of intense structural dislocation, but just when these dislocations occurred is not yet fully understood. Some of the movement is unquestionably very young (Tertiary?), some may be very old (Triassic?), but the last structural dislocation seems to have been largely Tertiary normal faulting.

These terranes have been given names such as Wrangellia, Stikinia, and Quesnellia. They are described in this report as depositional troughs that may have been interconnected as one large depositional region, analogous in plan, but not necessarily in origin, to the island regions of the Caribbean.

Aalenian basins

The depositional basins of Aalenian time varied from those with a predominance of volcanic detritus derived from contemporary volcanic activity to those that were mainly shale. In the south (Fig. 1), basic to intermediate volcanics of the Methow Trough and possibly the volcanics of northern Vancouver Island in the Insular Trough may be related as a volcanic belt straddling the site of the southern Coast Plutonic Complex. Near Harrison Lake, there is evidence of sediment transport from the west. Northwestward from the Methow Trough, the Tyaughton Trough was the depositional site of siltstone, shale, and minor sandstone in which there is no indication of sediment transport direction. In the Queen Charlotte Islands of the Insular Trough, coarse sand is predominant and in the Quesnel Trough, shale and siltstone are characteristic; in neither of these basins is there an indication of sediment transport direction. In both basins, ammonites are the only faunas found, and these are rare.

The Hazelton Trough near the Smithers map area appears to have had an uplifted centre of nonmarine intermediate to acid volcanism. Around this centre are volcaniclastic (dacitic to rhyolitic) sedimentary rocks containing a diverse bivalve fauna, gastropods, and corals (i.e., in the Terrace map area and at Troitsa Peak). Farther from this centre (i.e., at Dome Mountain and Michel Lake) the fauna consists only of ammonites, which suggests a greater water depth. Even farther from the centre, in the McConnell Creek and Hazelton map areas, the sediment loses it volcanogenic character entirely and is mainly siltstone and shale.

To the north, in the Spatsizi and Tulsequah map areas, the Aalenian sedimentary rocks comprise thin, rhyolitic tuffs and tuffaceous shale or siltstone. The source of the volcanic material is not known. Farther north still, in Whitehorse and Laberge map areas, there is little, if any, volcanogenic component to the rock assemblages.

Although there is no evidence of thick or extensive volcanic deposits in the northern areas, some Aalenian volcaniclastic eruptive activity, possibly explosive, was probably situated near the present Coast Plutonic Complex.

Relation to other stages

Where contacts are exposed in the Western Cordillera, both the base and the top of the Aalenian are generally conformable. In the Queen Charlotte Islands, Harrison Lake, and Spatsizi areas, Aalenian strata are conformable with the underlying Upper Toarcian beds with *Dumortieria* spp. In the Anderson River, Tyaughton Creek, Spatsizi, Tulsequah, and Hazelton areas, Aalenian beds are conformable with Lower Bajocian beds and there is no indication of a hiatus or discordance. Aalenian rocks show no evidence of contemporaneous orogeny or extreme tectonism, but rather relative quiescence.

Methow Trough–Tyaughton Trough

The Jurassic and Lower Cretaceous succession of the Methow Trough extends northward from the Cascade Mountains in the state of Washington to southern British Columbia (Figs. 1, 2; Table 3). It outcrops in the Hope map area in Manning Park (Frebold et al., 1969), along Harrison Lake (Arthur, 1986, 1987), and extends northward, crossing the Anderson River east of Boston Bar (O'Brien, 1986) and continues into the Taseko Lakes map area. Here, the Tyaughton Trough replaces the Methow Trough. It extends northwestward into the Mount Waddington map area where it is obliterated by the Coast Plutonic Complex.

These two troughs are difficult to delineate and it is impossible to confidently interpret their interrelationship. They are cut by faults across which dissimilar rock types are juxtaposed, and which may have narrowed the belt by transcurrent movement, and may even have rotated blocks with the fault zones. The faults may represent recurring episodes of movement. Some are transcurrent in sense of movement, commonly right-lateral, whereas others are normal or high-angle reverse, and there may be some areas of associated imbricate thrust faults. Consequently, the shapes of the depositional basins are difficult to define and the thin, poorly fossiliferous Aalenian sequences are difficult to recognize within the lithologically similar Jurassic successions.

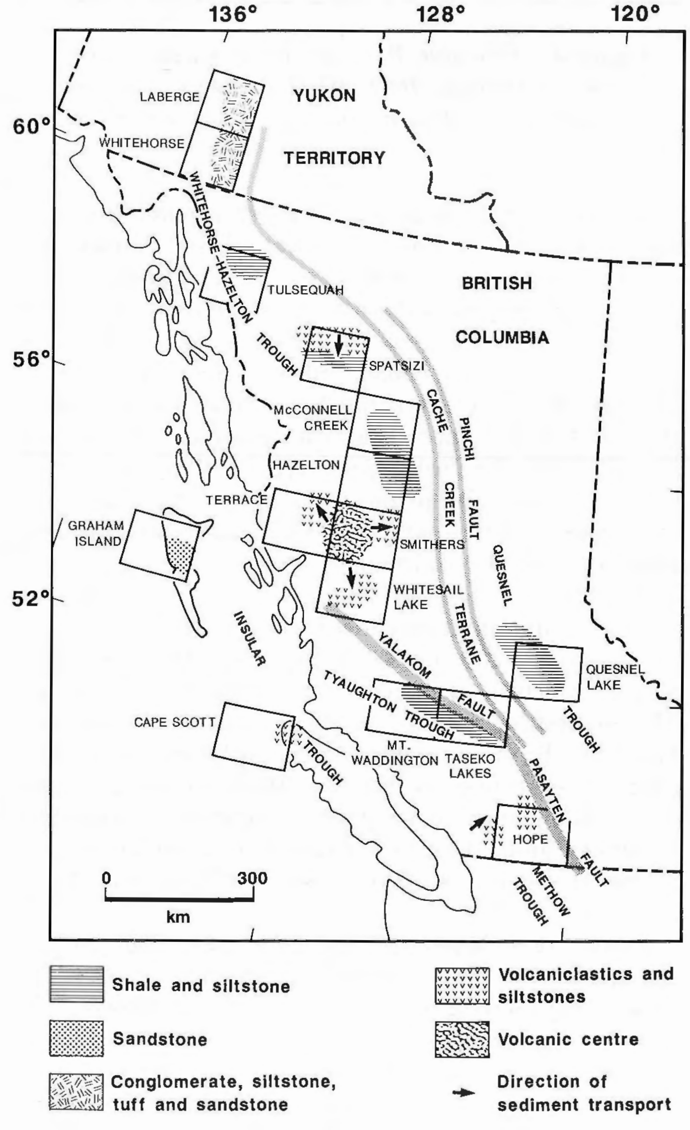

Figure 1. Index map showing map areas, general basin locations, and areas of marine Aalenian outcrops.

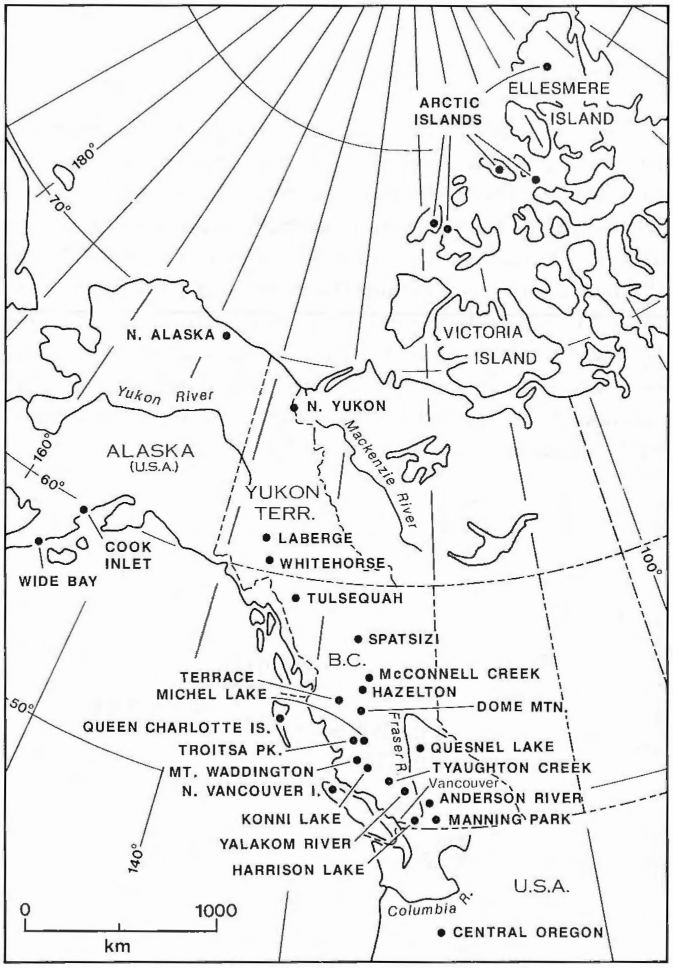

Figure 2. Index map showing localites mentioned in text.

In the Methow Trough there is evidence of shallowing toward the west in the Harrison Lake area. An association with volcanic rocks is noted throughout the trough. The east side of the trough is apparently delimited by the Pasayten Fault.

The Tyaughton Trough yields no evidence of its outline. The common rock types, shale and limy shale with some featureless sandstone, give no evidence of provenance. The fauna is mainly ammonites and a few thin-shelled bivalves suggesting a considerable water depth. Unlike the Methow Trough, the Tyaughton Trough is not completely truncated by a fault. The Yalakom Fault bounds the northeast side of the trough, except along Yalakom River where Aalenian strata are found to the northeast of the fault. These strata disappear beneath Cretaceous sedimentary rocks farther northeast. To the southwest, Aalenian strata are fault bounded and the Coast Plutonic rocks, which contain older Jurassic and Triassic remnants, appear.

Manning Park

The occurrence of Aalenian fossils in the Manning Provincial Park area (Figs. 2-4) has been reported previously (Frebold et al., 1969; Coates, 1974). Two sedimentary sections were described, the Lookout Section and the Divide Section, both of which were placed first in the Dewdney Creek Group (Frebold et al., 1969, p. 1) and later in the Ladner Group (Coates, 1974, p. 13). The Divide Section yielded Aalenian fossils that were collected by Coates and described by Frebold. One collection by Jeletzky from the Lookout Section was not mentioned in earlier reports, but is reported herein.

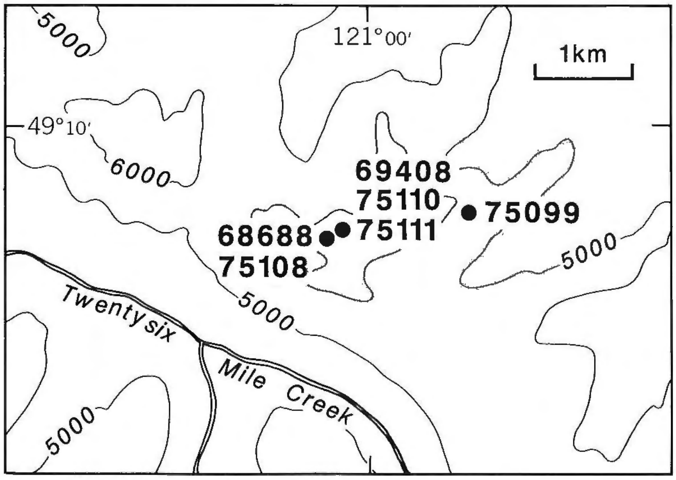

Figure 3. Aalenian fossil localities, southwestern Manning Park (92 H/2) and Skagit River (92 H/3), Hope map area, southwestern British Columbia (contours in feet).

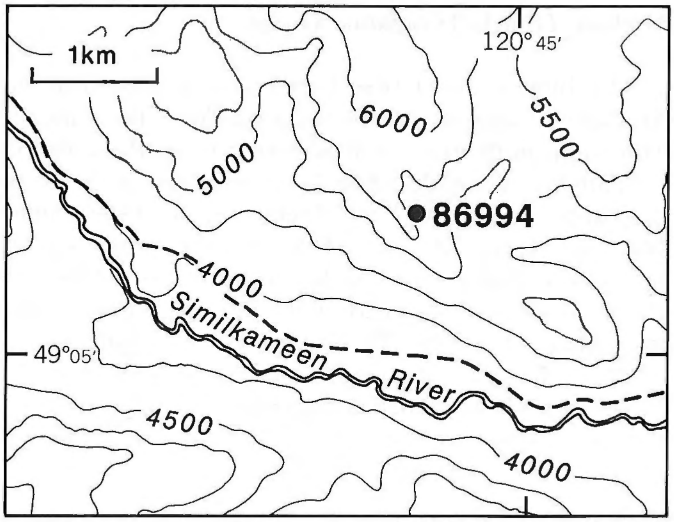

Figure 4. Probable Bajocian fossil locality, south-central Manning Park (92 H/2), Hope map area, southwestern British Columbia (contours in feet).

The Divide Section in the "Western Jurassic Belt" is a succession of turbidites, volcaniclastic sandstone, conglomerate, and argillite (Unit 2d of Coates, 1974), generally dipping steeply to the east. *Tmetoceras scissum* or *T.* sp. aff. *T. scissum* (Benecke) is the characteristic ammonite (GSC locs. 68688, 75099, 75108, 75110, 75111). Two specimens were illustrated and described by Frebold et al. (1969) and specimens from other collections were identified by Frebold (*in* Coates, 1974). A poorly preserved ammonite in one collection (GSC loc. 75111) may represent *Erycitoides*. No significant biostratigraphic subdivision of the Aalenian is apparent.

The stratigraphically lowest occurrence is in fault contact with a 275 m (900 ft) thick argillite unit, at the base of which the Toarcian *Phlyseogrammoceras* occurs. The highest occurrence is separated from beds with probable Bajocian *Chondroceras*(?) and stephanoceratid(?) ammonites by 335 m (1100 ft) of varied volcaniclastic sedimentary rocks, partly unexposed, and intruded by dykes and sills. This faulted and folded section (Table 4) was described by Coates (1974, p. 19, 20).

Elsewhere in Manning Park, ammonites that resemble *Pseudolioceras* may indicate the presence of Aalenian rocks along Lookout Road, north of Allison Pass Summit (Fig. 4, GSC loc. 86994). They are in a thick succession of monotonous greywacke that also contains Lower Jurassic(?) and Bajocian ammonites (Coates, 1974; Jeletzky, 1972, 1973). Similar ammonites from other localities along Lookout Road were figured as "Lower Bajocian" *Graphoceras crickmayi* Frebold (Frebold et al., 1969, Pl. II, figs. 2-4). None of these ammonites is

TABLE 4

Part of the section described by Coates from the Divide Section[1]

Description	Thickness (m)
Mainly hard, grey to black siltstone with some volcanic sandstone interbeds	67
Mainly hard, blocky weathering, thin bedded, dark grey siltstone	70
Mainly grey to black cherty argillite with coarse grained sandstone interbeds, some sills	67
Poorly exposed, some dykes, small outcrop of breccia-conglomerate with granitic pebbles	21
Very thin bedded, dark grey and brown shale, claystone to fine sandstone. *Tmetoceras* sp. aff. *T. scissum*, *Erycitoides*(?), *Inoceramus;* GSC loc. 75111	61
Concealed	6
Dark grey shale, very thin bedded claystone to fine sandstone. *Tmetoceras* sp. aff. *T. scissum*, bivalve fragments; GSC loc. 75110	67
Concealed	122
Soft, black to grey shale, very thin bedded. *Tmetoceras* sp. aff. *T. scissum*; GSC loc. 75108 near top	37
Several dykes or sills with shaly partings	12
Thin bedded argillite, blocky, highly fractured	15
Fault(?)	
Several contiguous felsitic dykes or sills	15
Sheared black argillite, few thin sills, includes 1.2 m (4 feet) of quartz-filled fault breccia	15
Shaly claystone and siltstone, dark grey. *Tmetoceras* sp. aff. *T. scissum*; GSC loc. 68688 near base	15
Dark grey to black argillite, very numerous sills and dykes, minor folding. *Phlyseogrammoceras* (Toarcian)	274
Total thickness	864

[1] Table modified from Coates, 1974, p. 20 (see also Frebold et al., 1969, p. 11, 12).

positively identified at the genus level, nor is the age of all of them firmly established, although some are associated with undoubted Bajocian ammonites. All are treated as Bajocian for present purposes. Imlay (1973) and Hall and Westermann (1980, p. 14) considered them to represent *Poecilomorphus*, of the basal *Stephanoceras humphriesianum* Zone of the Bajocian. Graphoceratidae are generally thought to be absent from North America and the entire Pacific area (e.g., Westermann, 1981).

Poorly preserved ammonites from the ridge south of the Giant Copper Mine (GSC loc. 69408) may also be Aalenian. One specimen is figured here as *Troitsaia westermanni* (Pl. 7, fig. 11); others are not identifiable.

Anderson River

The Methow Trough succession (Table 3), well displayed in Manning Park, extends northward and is exposed along logging roads in Anderson River valley east of Boston Bar, where it has been examined recently by J.W.H. Monger during remapping of the Hope map area.

East of Fraser River and southeast of the town of Boston Bar in the Anderson River watershed, and in the Coquihalla area (Fig. 5), Aalenian fossils have been found by O'Brien (1986, p. 752, 754) in the Dewdney Creek Formation. The fossils are generally deformed and poorly preserved. The section from which they come is described as "Toarcian(?) to lower Bajocian" volcanic strata with subordinate argillaceous interbeds. The volcanic strata consist of crystal and lithic tuffs, tuffaceous siltstone and sandstone, conglomerate, volcanic breccia, and locally preserved andesitic flows (O'Brien, 1986). The Aalenian fossils were mainly from argillaceous and sandy interbeds within the volcanic sequence.

Several Aalenian and possibly Aalenian fossil localities have been discovered, yielding *Tmetoceras* (GSC locs. C-88070, C-118673); probable *Tmetoceras* and *Erycitoides* with other unidentifiable ammonites (C-118676); and *Tmetoceras* sp. aff. *T. flexicostatum* with *Planammatoceras* (C-146151).

In the same general area, a locality at Utilius Creek (GSC loc. C-88069) has yielded *Tmetoceras scissum.* At all of these localities, the structure is too complicated and the outcrop too limited to permit recognition of a faunal succession.

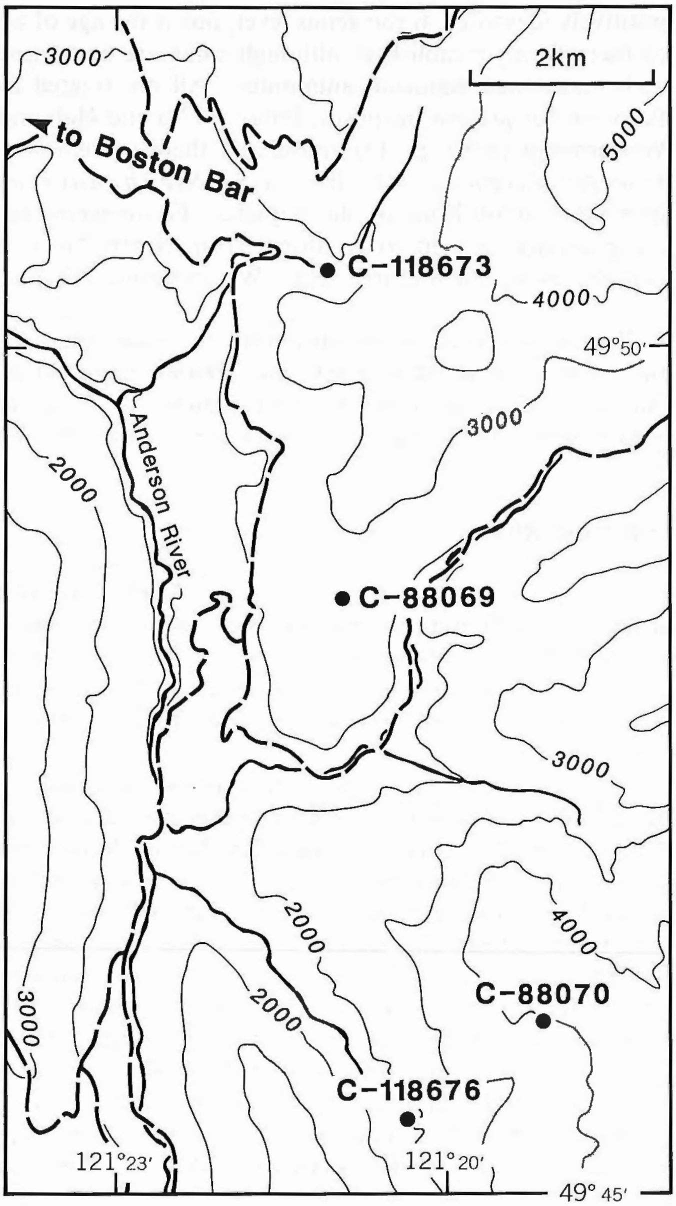

Figure 5. Aalenian fossil localities, Anderson River area, Boston Bar (92 H/14), Hope map area southwestern British Columbia (contours in feet).

Harrison Lake

The Harrison Lake Formation comprises red and green, coarse volcanic breccias, tuffs, and flows with intercalated lenses and thin beds of shale and siltstone, and minor sandstone and conglomerate. The base is characterized by a conglomerate overlain by Lower(?) to Middle Toarcian shale and siltstone, possibly succeeded by an undetermined thickness of volcanics, and overlain by a second sedimentary sequence of Late Toarcian to Aalenian age. This is capped by a thick volcanic sequence. There is no good evidence that any of the volcanics are older than Aalenian. The Aalenian fossils, which include *Tmetoceras*, were first collected by H. Frebold in 1955 and 1956. This group has been recently re-studied by A.J. Arthur as part of a University of British Columbia Master's program, from which study this information is derived.

The sequence in Table 5 was taken from the field notebooks of the late Hans Frebold. The section was not measured by Frebold and the original section cannot be duplicated as thirty or more years have passed, and the road along which it was exposed has been excavated further and is now overgrown. The upper two units (7 and 8) are possibly several hundred metres thick and the lower units (1-6), which are mainly sedimentary and somewhat tuffaceous, are at least 50 to 100 m thick; the base is covered. The Toarcian/Aalenian boundary is uncertain.

TABLE 5

Sedimentary section 1 in the Harrison Lake Formation exposed along "Powerline Road" west of Harrison Lake between 16 and 17 km from Harrison Mills on Highway 7

Unit	Description
8	Volcanic breccias, tuffs, and flows, intermediate in composition
7	Volcanic flows with intercalated conglomerate lenses
6	Volcanic tuff and interbedded thin flows; tuffaceous sands
5	Siltstone with bivalves, gastropods, and rare ammonite fragments; *Erycitoides*(?), *Tmetoceras*, bivalves, gastropods, belemnites; GSC locs. 27995, 25782, 25781
4	Siltstone with belemnites, ostreiid(?) bivalve; GSC loc. 28005
3	Shale-siltstone, well laminated; *Dumortieria*(?); GSC loc. 27999
2	Siltstone; *Troitsaia*(?) or *Dumortieria*(?) and belemnites; GSC loc. 28000
1	Laminated shale-siltstone in beds 2 mm to 3 cm thick; *Dumortieria*; GSC locs. 27997, 25778 (Toarcian).
	Covered

In Table 6, the lower beds of sedimentary section 2 (unit 1) can perhaps be correlated with units 1-3 of the previous section (Table 5), on the basis of ammonite specimens that may represent either *Troitsaia* or *Dumortieria.* The occurrence of belemnites, immediately above these ammonites or with them, may be significant. In the latter section volcanics succeed the strata with belemnites, whereas in the former section, beds with abundant bivalves overlie the belemnites. At another nearby locality (GSC loc. C-118592; Fig. 6) there is a rich bivalve fauna immediately beneath volcanics. This bivalve fauna has associated rare Aalenian ammonites (*Planammatoceras*?).

One of the *Dumortieria* species of the Harrison Lake area is similar to *D. levesquei* (d'Orbigny) and another has been compared to *D. insignesimilis* (Brauns) (Andrew Arthur, pers. comm., 1986). None of the specimens has tubercles such as those exhibited by *Troitsaia westermanni.*

TABLE 6

Sedimentary section 2[1] in the Harrison Lake Formation, exposed on an abandoned road along a power line about 0.5 km west of Celia Cove, Harrison Lake

Unit	Description	Thickness (m) Unit	Total
	Covered		
8	Red and green volcanic flows and breccias; intermediate composition	45+	64.7+
7	Siltstone with belemnites	3.5	19.7
	Covered interval	3.5	16.2
6	Shale with belemnites	0.9	12.7
5	Volcanic breccias	0.2	11.8
4	Shale with belemnites	1.7	11.6
3	Volcanics	0.3	9.9
2	Siltstone with belemnites	0.6	9.6
1	Shale with ammonites; *Tmetoceras*(?), *Troitsaia*(?) or *Dumortieria*(?) 6.1 m below top of unit; GSC loc. 27996	9.0	9.0
	Covered		

[1] Studied and measured by Hans Frebold.

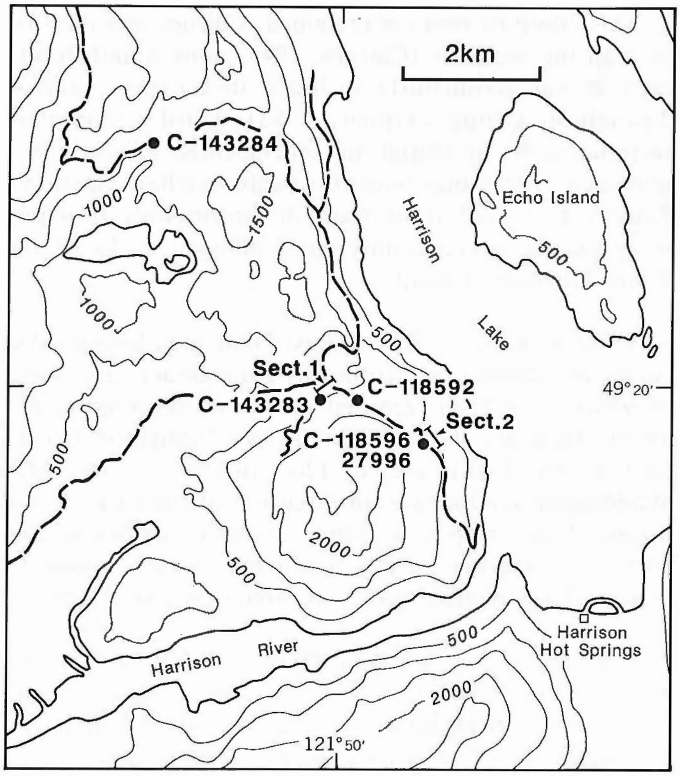

Figure 6. Aalenian fossil localities, Harrison Lake area (92 H/5), Hope map area, southwestern British Columbia (contours in feet).

Taseko Lakes map area

In the Taseko Lakes map area (Figs. 1, 2), and extending northwest into the Mt. Waddington map area, an assemblage of Lower Jurassic to lower Middle Jurassic sedimentary rocks is extensively displayed. This belt lies mainly southwest of the Yalakom Fault and generally in close proximity to it. All stages of the Lower Jurassic and the lower two stages of the Middle Jurassic are present as indicated by a diverse fauna, which includes an abundance of poorly to well preserved ammonites.

The rock types are entirely sedimentary. Rocks of Hettangian age are mainly conglomerate, grading upward into Sinemurian sandstone and into siltstone and shale. Upsection, the rocks become shalier and interbedded shale, siltstone, and sandstone are common. The higher beds are characterized by shale, limy shale, shaly limestone, and concretionary siltstone. In places the rocks are finely laminated and some of the laminae are lighter coloured or cream coloured and may be tuffaceous; generally the rocks show no other evidence of volcanic activity.

This group of rocks is unnamed. Cairnes was the first to map the sequence (Cairnes, 1943, units 8 and 9) and later it was erroneously included in Cairnes' Triassic Tyaughton Group (Tipper, 1963). Until a complete section can be measured and documented it is best left unnamed. The group unconformably overlies uppermost Triassic beds and is overlain disconformably (possibly with angular unconformity) by Callovian rocks of the Relay Mountain Group.

Three areas in the Taseko Lakes map area have yielded fossils of Aalenian age from this sedimentary unit, some of which have been recorded previously (Frebold et al., 1969). They are the Yalakom River, Tyaughton Creek, and Konni Lake areas. The locality in the Mt. Waddington map area is an extension of the rocks of the Taseko Lakes map area. Many of the exposures of this rock unit have not yielded fossils but there is reason to believe that Aalenian rocks are ubiquitous in the unit.

In general, the Aalenian rocks are characterized by shale, siltstone, sandstone, limy siltstone, shaly limestone, and concretionary limy siltstone interbedded in layers varying from several metres thick to thin laminae only a few millimetres thick or less. Sedimentary structures are lacking. The thickness of the Aalenian section is variable, usually thicker where sandstone is a predominant component. In a few sections, the Aalenian strata are apparently conformable with Lower Bajocian beds above and Upper Toarcian beds below. There appears to be a complete, conformable, Aalenian section in the Taseko Lakes map area, but proof is lacking because of a paucity and low diversity of fossils.

Aalenian, and possibly Late Toarcian, fossils have been obtained from highly deformed sedimentary strata along Yalakom River north of Blue Creek (Fig. 7; Table 7). These beds, exposed in one or more fault slices related to the Yalakom Fault (Leech, 1953, p. 111) and in other localities in Taseko Lakes area, lie northeast of the Yalakom Fault. *Tmetoceras* is common along Yalakom River from 100 m to 1.6 km above the mouth of Blue Creek (GSC locs. 13807, 13812, 14153, 17008, 74832, C-117263 to C-117267 in Section 1 of Fig. 7). Frebold (Frebold et al., 1969) illustrated *T.* sp. cf. *T. scissum* and *E.* sp. aff. *E. howelli* from these outcrops. Other ammonites from here include *Pleydellia*(?) sp. cf. *P. argentina* (GSC locs. 13810, C-117267), *Tmetoceras kirki* and *Pseudolioceras* sp. cf. *P. whiteavesi* (GSC locs. 13812, 17008); *Planammatoceras* (GSC loc. 56624), and *T. flexicostatum* (GSC loc. C-117265). A variety of different, probably mid-Aalenian, ammonite genera is described in this report, from the Yalakom River localities and from the head of Relay Creek.

The section described in Table 7 is approximate. Rocks are sheared somewhat between the more competent and less competent beds, but there is no suggestion of repetition or missing segments. The section may be faulted against the Lower Cretaceous Jackass Mountain Group at its easterly (top) end.

TABLE 7

Section of sandstone with shale–siltstone interbeds occurring 300–800 metres upstream from Blue Creek on the east bank of Yalakom River, Taseko Lakes map area

Description	Thickness (m) Unit	Thickness (m) Total
Fault contact(?)		
Coarse sandstone and siltstone with minor shale interbeds reaching 1 m thick. One fossil locality in thin shale interbed; *Tmetoceras*(?), *Astarte*, belemnites; GSC loc. C-117263	150+	538+
Massive coarse sandstone with minor rare siltstone interbeds; no sedimentary structures; in massive layers 1-2 m thick	300+	388
Black to dark grey shale, finely laminated with thin laminae of siltstone or fine sandstone; abundant *Tmetoceras scissum, T. kirki*; GSC locs. C-117264 and C-117265 (3 m lower)	3	88
Thinly interbedded siltstone, shale, and fine sandstone; *Tmetoceras;* GSC loc. C-117266	5	85
Finely laminated sandstone, siltstone, and rare buff to cream coloured laminae that may be tuffaceous; *Pleydellia*(?) sp. cf. *P. argentina*; GSC loc. C-117267	23	80
Buff sandy siltstone, finely banded; (Toarcian?)	7	57
Interbedded coarse shale and sandstone, poorly exposed but appears to be about 50% sandstone beds	50+	50+
Covered		

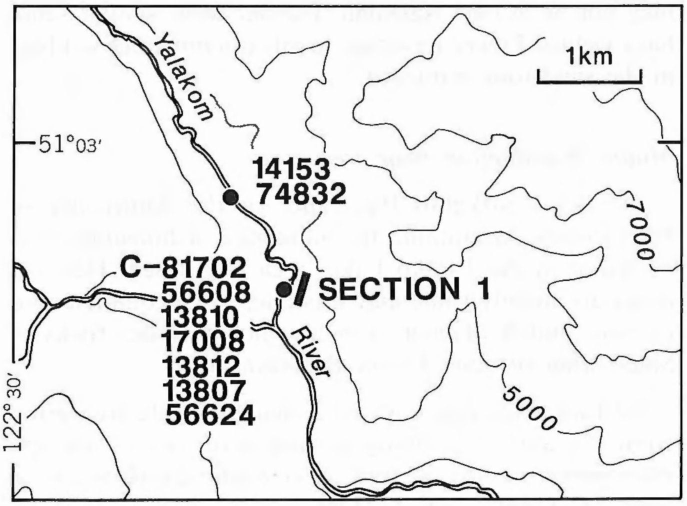

Figure 7. Aalenian fossil localities, Yalakom River area, Big Bar Creek (92 O/1), Taseko Lakes map area, southwestern British Columbia (contours in feet).

Another locality, between 800 and 1600 m upstream from Blue Creek on the east bank of Yalakom River, has also yielded Aalenian fossils (GSC locs. 14153, 74832). This section is separated by faults from the first section.

The section along Yalakom River differs from the other Aalenian localities of the Taseko Lakes map area by the presence of buff to cream coloured beds of probable volcaniclastic sandstone and tuff. The strata in this section resemble those of the Methow Trough because of the presence of volcanic-related rocks.

Leech (1953, p. 22) included in his lithological description of the Yalakom River section "large amounts of conglomerate and small amounts of chert and limestone". In other Aalenian localities of the Taseko Lakes area, conglomerate and chert are unknown. The rocks along Yalakom River seem to be generally unlike the fossiliferous Aalenian strata, and as this is a zone of intense faulting (Yalakom Fault), the conglomerate and chert mentioned by Leech could be fault slices of the Jackass Mountain Group, or other formations.

The Aalenian rocks of the Tyaughton Creek area (Fig. 8) are dominantly pelitic. Shale, siltstone, and limy

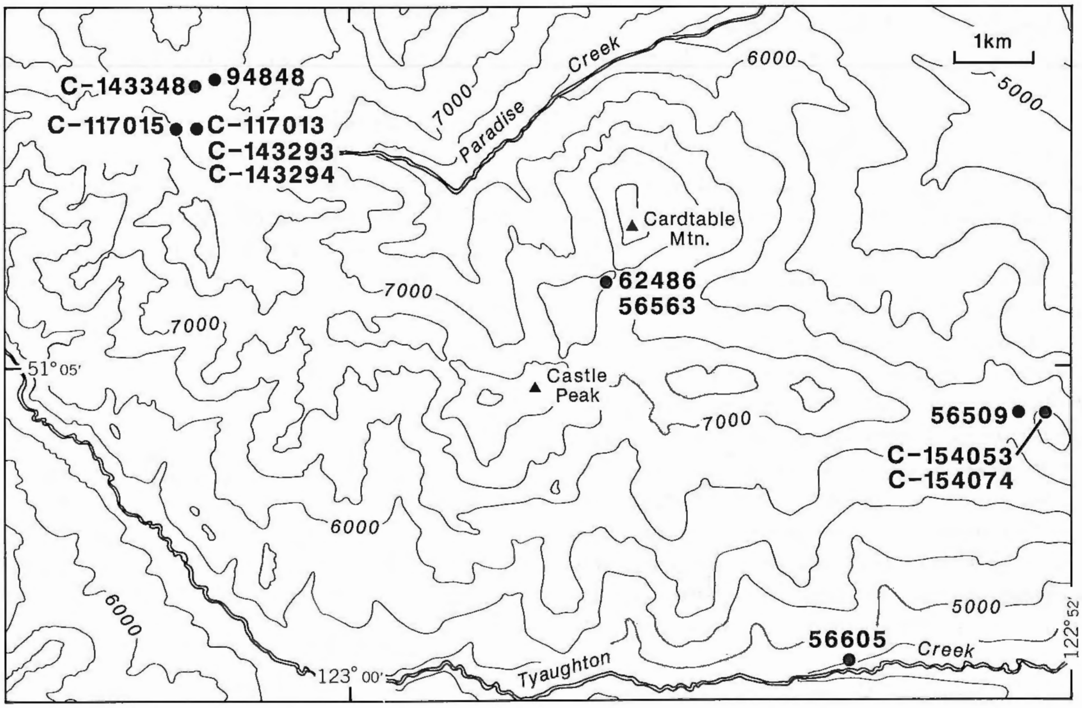

Figure 8. Aalenian fossil localities, Tyaughton Creek–Relay Mountain area, Warner Pass (92 O/3) and Noaxe Creek (92 O/2), Taseko Lakes map area, southwestern British Columbia (contours in feet).

siltstone comprise fully 90 per cent of the whole. Sandstone is of minor importance and conglomerate or grit were not seen. One or two bands of grey-weathering, shaly limestone 1 to 5 m thick are conspicuous and are commonly fossiliferous. One distinctive bed of limy siltstone at least 20 m thick, with abundant grey limestone concretions up to 20 cm in diameter, was noted in several places below the Aalenian fossils. Similar siltstone-shale beds overlying the Aalenian beds have yielded the basal Bajocian ammonite *Docidoceras*. The faunas of the Tyaughton Creek area appear to lie closely below Lower Bajocian faunas stratigraphically, suggesting that most, if not all, of the collections from this area are from the middle or late Aalenian.

No stratigraphic section of Aalenian strata has been measured in Tyaughton Creek area. However, a thickness in excess of 150 m is possible. The beds are highly faulted and somewhat folded so that the true thickness and stratigraphic succession are difficult to determine.

Many Aalenian fossils come from a band of outcrops that extends through spurs of Relay Mountain and Cardtable Mountain between Relay and Tyaughton creeks (GSC locs. 56509, 62486). Frebold (Frebold et al., 1969) illustrated *Erycitoides* sp. aff. *E. howelli* and *E. kialagvikense* from here, and *Tmetoceras scissum* is also present. An assemblage including *Tmetoceras kirki, E. howelli, Erycitoides*(?) sp., *Planammatoceras* sp., and *Zurcheria*(?) sp. is illustrated in this report (GSC loc. 94848).

Tmetoceras scissum comes from the area northwest of Castle Peak and west-southwest of Relay Mountain and is associated with *Holcophylloceras* sp. at one locality (GSC loc. C-117015).

In the western part of the Taseko Lakes map area north of Konni Lake, an unnamed Lower and Middle Jurassic sedimentary sequence is exposed. This unit extends about 25 km westward into the adjoining Mt. Waddington area. Sparse Lower Bajocian, Aalenian, and possibly Lower Jurassic fossils have been recovered. At an isolated locality (GSC loc. 78798) on the north side of Konni Lake, specimens of probable *Tmetoceras* sp. have been found. It is not yet clear whether other poorly preserved and meagre fossil collections from this area are entirely Aalenian, or include some Cretaceous material.

The rocks of the Konni Lake sequence are entirely shale and coarse sandstone but poor exposure has prevented measuring a section; however, a thickness of over 350 m is possible. The lower beds are hard, highly fractured black to dark grey siltstone, with minor sandy interbeds, and weather blue-grey. Overlying strata are massive, coarse, grey-green sandstones, which may or may not be in part Aalenian. Farther west, similar sands have yielded Lower Bajocian fossils (*Stemmatoceras*) high in the sandstone sequence.

Mount Waddington map area

North of Stikelan Pass and on the south end of Huckleberry Mountain, the unnamed sedimentary unit described in the Taseko Lakes area is exposed. Here the rocks are mainly shale and siltstone. They comprise part of map unit 8 (Tipper, 1969), which includes rocks of Sinemurian through Lower Bajocian age.

At least five collections of Aalenian fossils are known from this area, containing specimens of *Tmetoceras* sp., *Planammatoceras*(?), and *Erycitoides*(?) (GSC locs. 78647, C-177414 to C-177424).

Quesnel Trough

The sedimentary rocks of Pliensbachian to Early Bajocian age in this trough (Table 3) are typically shale, siltstone, and sandstone, and those that are considered possibly Aalenian are shale and siltstone with no volcanic content (Figs. 1, 2). Low relief, forest cover, and poor exposure contribute to a general lack of fossil localities.

Quesnel Lake map area

An Aalenian fossil locality (GSC loc. 40030) containing *Erycitoides* was found in the Quesnel Lake map area by R.B. Campbell near Beveridge Lake in the southwest quarter of the area (Fig. 9). One other locality (not shown in Fig. 9) along a farm road in the Beaver Creek Valley 24.2 km northwest of the Beveridge Lake locality has yielded poorly preserved ammonites that may be *Tmetoceras* sp. and *Erycitoides* sp. (GSC locs. 91755, C-149638).

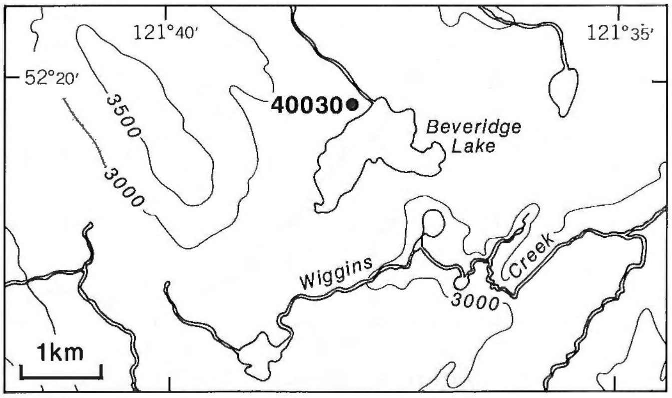

Figure 9. Aalenian fossil locality, Beaver Creek (93 A/5) Quesnel Lake map area, south-central British Columbia (contours in feet).

These are the only Aalenian collections in the Quesnellia terrane, but several unfossiliferous sections that include shale and siltstone in Quesnel Lake area, in the Prince George map area to the northwest, and in the Bonaparte River area to the south could be partly Aalenian in age.

Hazelton Trough

The well developed Jurassic succession of Hazelton Trough (Fig. 1) has been described by Tipper and Richards (1976). Aalenian beds occur at many localities in the Smithers and adjacent map areas. They overlie fossiliferous Toarcian strata, and are overlain by Bajocian strata. The Hazelton Trough Jurassic succession extends northward from the Whitesail Lake and Smithers areas into Hazelton, McConnell Creek and beyond, where it underlies much of the younger Bowser Basin, extending as far north as the Spatsizi and Cry Lake areas (Fig. 2) where it is interrupted by the Stikine Arch.

Whitesail Lake map area

The first Aalenian ammonites in Canada were identified in 1947 in the Whitesail Lake map area (Frebold, 1951; Frebold *in* Duffell, 1959, p. 49) and several more localities with additional species have since been found by various workers in that area. Two separate areas containing Aalenian strata have been mapped, near Troitsa Peak and near Michel Lake, but additional work is needed to fully understand the sequences.

A significant succession of Aalenian–Toarcian fossiliferous strata in the southern part of the Hazelton Trough outcrops in Whitesail Range, near Troitsa Peak (Fig. 10). It is characterized by rhyolite to dacite flows and tuffs and interbedded shale-siltstone sequences. Thick rhyolite pyroclastics form significant units. In the upper beds, greywacke and pebble conglomerate are prominent, overlain by red to green andesitic breccia and tuff. The thickness is not well determined but is in excess of 1700 m.

Two stratigraphic sections from the Troitsa Peak area (Fig. 10) are described here (Tables 8, 9). Section 1 is a measured section and represents the lower part of the sequence but the base is not exposed; it may rest on Lower Jurassic volcanic rocks as suggested from other areas. Section 2 is believed to represent the upper part of the succession and is perhaps largely or entirely Bajocian in age; the highest part (unit 3) may be part of the overlying Smithers Formation. Section 2 was not measured precisely. There appears to be little or no gap between the two sections.

The following collections come from the upper 425 m of the section described in Table 8: GSC localities 13753, 13754, 13758, 88606, 88607, and 88610.

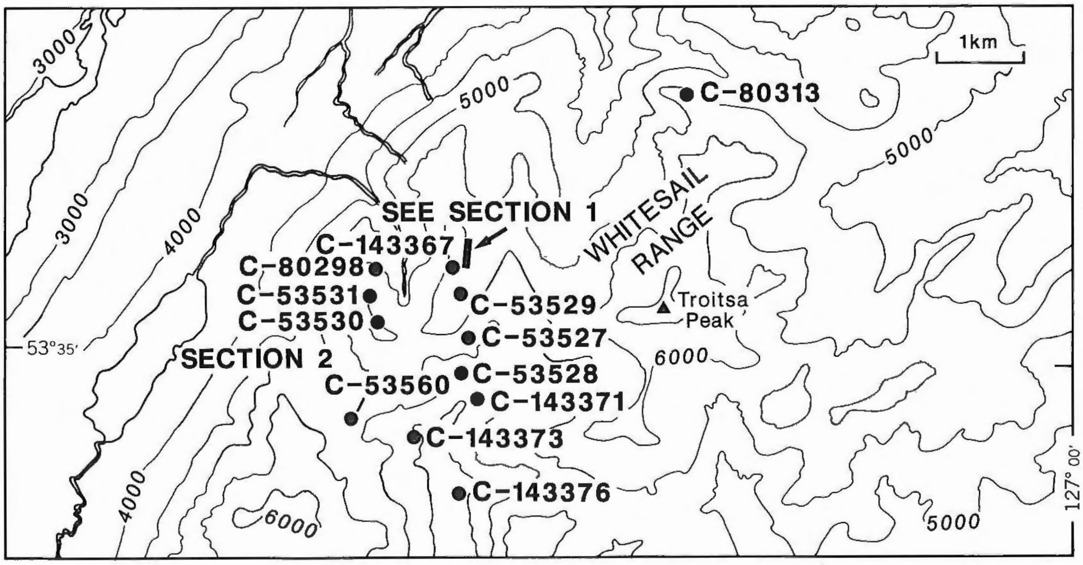

Figure 10. Aalenian fossil localities, Troitsa Peak area, Troitsa Lake (93 E/11) Whitesail Lake map area, west-central British Columbia (contours in feet).

TABLE 8

Section 1, measured on the ridge, 2.4 km (on a bearing of 285°) from Troitsa Peak

Unit	Description	Thickness (m)	
		Unit	Total
	Fault		
14	Tuff and breccia; well bedded acid tuff and fine breccia, water-laid. Strike 110° dip 35° SW; alternating layers of fine tuff to fine breccia up to 1 m thick; highest bed is fossiliferous, weathers brown, finely laminated in places; *Erycitoides howelli, Tmetoceras scissum*, many bivalves, belemnoids, gastropods, brachiopods; GSC loc. C-53520.	66	1649
13	Siltstone; brownish, interbedded with medium to fine breccia and pinkish tuff beds 1-2 m thick. Strike 115°, dip 25° SW; well bedded but not laminated	37	1583
12	Pale green rhyolite tuff; fairly massive and layered but may not be water-laid	34	1546
11	Siltstone and fine tuff; well bedded and fossiliferous, brownish to light buff; *Erycitoides,* gastropods, brachiopods, and many pelecypods; GSC loc. C-53521	21	1512
10	Rhyolite breccia; medium to coarse, weathers grey, white, and buff	27	1491
9	Brown siltstone	2	1464
8	Fine grey tuff to cream tuff; rhyolitic	25	1462
7	Brown to green greywacke and siltstone; strike 130°, dip 25° SW; a few interbedded siliceous rhyolite tuff beds; unit has many bivalves, corals, belemnites; GSC loc. C-53599. Includes some coarse sand and tuff that weather brown	45	1437
6	Interbedded siltstone; brown and cream weathering, grey siliceous tuff and fine breccia, mostly siltstone in 4 m beds *T. westermanni* 60 m below top; GSC loc. C-53519 *T. westermanni* 90 m below top; GSC loc. C-53518 *Tmetoceras, Troitsaia* 150 m below top; GSC loc. C-53517	169	1392
5	Siliceous tuff; weathers buff and cream coloured, becomes coarser downsection; no fossils, tuff are hard and chert-like, coarser fraction is grey and softer	207	1223
4	Dark grey siltstone	9	1016
3	Massive beds of rhyolite tuff; top of unit is tuffaceous shale, weathering brown, that grades to fine siliceous grey tuff, weathering cream coloured; tuff gradually coarsens downsection, is less well sorted and the lower part is massivebeds that may not be water-laid	657	1007
2	Grey siliceous silty tuff with fragmentary fossils; in places cherty, no banding, hard, weathering dark blue-grey Unit varies from grey to cream weathering tuff but is mainly blue-grey on fresh surface. Base of unit is coarse tuffaceous greywacke and tuff, generally coarsening downward, appears water-laid	150	350
1	Acid tuff; fossiliferous, mostly bivalves; section is mainly coarse acid tuffs in massive beds; may not be water-laid in lower part. Beds become very massive in lower 60 m and coarsen, forming a fine to medium breccia	200	200

TABLE 9

Section 2, ridge, 4.7 km south-southwest of Troitsa Peak, on a bearing of 250°, Whitesail Range

Unit	Description	Thickness (m)
3	Breccias; massive bedded red breccia and tuff	60+
2	Sandstone and pebble conglomerate; sands are greenish and tuffaceous; weather rust coloured or grey; vary from hard and tough beds to soft and crumbly; conglomerate is poorly sorted in beds 30 cm to 60 cm thick, containing rounded pebbles of rhyolite, grey tuff, and green and red volcanic rock; a few beds of red tuff are included, general acid volcanics of variegated colours; bivalves, gastropods, undeterminable ammonite fragments (Bajocian?)	100+
1	Interbedded sediments; tuff, sandstone, greywacke, siltstone rhyolite tuff; scattered bivalves and belemnites; partly Aalenian(?) (GSC loc. C-53560) partly Bajocian(?)	120+
	Covered	

Frebold (1951) had previously described *Tmetoceras regleyi* Dumortier and "*Polymorphites*" cf. *senescens* Buckman from the Troitsa Peak area. Both species are here considered to represent *T. scissum*, the latter presumably a pathological form, not represented in more recent collections, in which the ribs extend continuously across the venter.

The following additional Aalenian localities, from which specimens were not collected in the context of a stratigraphic section, are shown in Figure 10 or are described in the appendix: GSC localities 88142, 88745, C-53527 to C-53531, C-53561, C-53562, C-80298, C-80300, C-80313, C-143367, C-143371, C-143373, and C-143376.

In the Troitsa Peak area, there is an upward succession of *Troitsaia* or *Dumortieria* sp., *Troitsaia westermanni*, *T. westermanni* with *Tmetoceras*(?) sp., and then *Erycitoides howelli* with *Tmetoceras scissum*. In the collections from the measured section, it is not entirely clear whether the lowest, poorly preserved specimens identified as *Troitsaia* or *Dumortieria* are in fact directly associated with *Tmetoceras*, as is clearly the case in other collections. Two interpretations are possible: 1) the entire section is Aalenian, and the lack of *Tmetoceras* in some collections of *Troitsaia westermanni* from higher levels, above those yielding poorly preserved specimens (probably *Dumortieria* or *Troitsaia* sp. indet.), is therefore due to a failure to collect, or 2) poorly preserved ammonites that resemble both *Dumortieria* and *Troitsaia* occur in beds that span the Toarcian-Aalenian boundary. The possibility of mixing of some collections cannot be ignored but there is insufficient evidence to favour either possibility. The presence of unequivocal *Dumortieria* alone would appear to favour a Toarcian age, but its full range in Western Canada is not yet firmly established.

A few collections of Aalenian fossils were obtained from the Michel Lake and Wells Gray Peak areas in the central part of the Whitesail Lake map area. Exposure is poor and stratigraphic relationships are in doubt. The rocks are generally shale, siltstone, tuff, and tuffaceous siltstone. Thickness is not known because sections are poorly exposed and no section was measured. The section west of Michel Lake is thought to rest unconformably on Lower Jurassic volcanics and sediments, exposed immediately to the northwest. The three localities are apparently in descending stratigraphic sequence from north to south (Fig. 11). Aalenian fossils found near Michel Lake include *Tmetoceras flexicostatum* (GSC loc. C-53541), *Pseudolioceras* sp. cf. *P. whiteavesi* with probable *Lissoceras* sp. (GSC loc. C-53542), and *Tmetoceras* sp. cf. *T. scissum* (GSC locs. C-53544 and C-146155). G.J. Woodsworth collected a probable *Lissoceras* from Wells Gray Peak (GSC loc. C-80299). It is similar to those from the Michel Lake area.

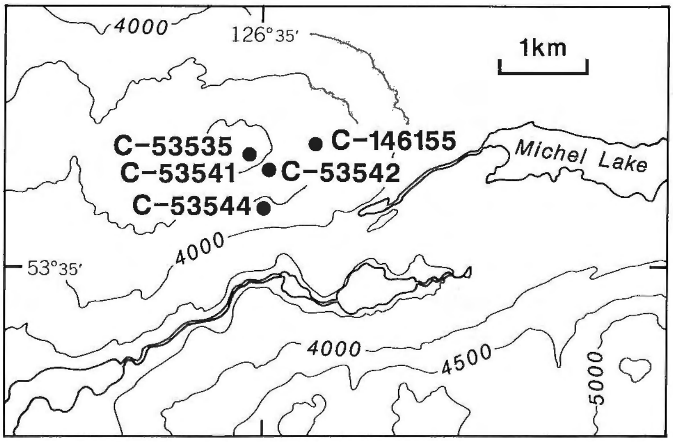

Figure 11. Aalenian fossil localities, Michel Lake area, Whitesail Reach (93 E/10) Whitesail Lake map area, west-central British Columbia (contours in feet).

Smithers map area

In the Smithers map area (Fig. 1), Aalenian fossils have been collected from sedimentary rocks in a mainly volcanic sequence. Although not typical of the Smithers Formation, the sequence has been included in that formation (Tipper and Richards, 1976). In other areas (Whitesail Lake, Hazelton, and Terrace) the Aalenian strata are typical of the Smithers Formation.

The Aalenian strata about 4 km west of Dome Mountain (Fig. 12), southeast of the town of Smithers, are in a fault block. The area is wooded and the rocks are poorly exposed. The strata are tightly folded and fractured and no complete, well exposed section is available for measurement. The sequence consists of interbedded volcanic fragmental rocks and fine grained sedimentary rocks. The volcanics consist of volcanic breccia and tuff, red, blue-green, light green, and creamy white in colour. The strata are mainly highly fractured blue-grey siltstone, shaly tuff, fine grained grit or fine volcanic conglomerate, and limy siltstone or limestone bands. Beds are commonly 0.5 m to 2 m thick. The section may not be very thick, although at least 12 fossil localities have been recorded.

Aalenian ammonites occur abundantly in the Dome Mountain area, although they are not well preserved. *Tmetoceras scissum* is common (GSC locs. 83996, 85251, 85316) and has been found in association with *T. kirki* (GSC loc. 87393) and with *Troitsaia westermanni* (GSC locs. 85328, 87401, and 87409).

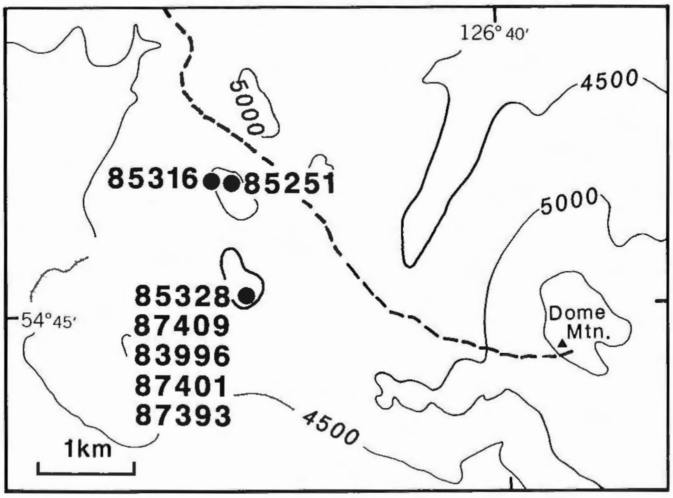

Figure 12. Aalenian fossil localities, Dome Mountain area, Driftwood Creek (93 L/15) and Quick (93 L/10), Smithers map area, west-central British Columbia (contours in feet).

In the western half of the Smithers map area a brick-red tuff unit is exposed in many sections. It has been named the Red tuff member of the Nilkitkwa Formation and is Middle and Late(?) Toarcian in age (Tipper and Richards, 1976, p. 25-27). This member is believed to underlie the Aalenian section described from west of Dome Mountain (preceding section). Underlying these red tuffs are shales that at several localities have yielded a small bivalve referred to *Bositra*. This bivalve is widespread in northern British Columbia, usually in beds of Early and Middle Toarcian age. In places, the highest beds appear to interfinger with the Red tuff member. There is no evidence that the Red tuff member extends into the Aalenian stage.

In the western half of the Smithers map area, the Red tuff member is overlain, on Ashman Ridge, by Lower Bajocian sedimentary rocks; in Tenas Creek, by Upper Bajocian sedimentary rocks; along Zymoetz (Copper) River, by Lower Callovian sedimentary strata; and on Hudson Bay Mountain, by Lower Bajocian strata. In this area there is no evidence of Aalenian strata above the Red tuff member. It is suggested that either this area was one of nondeposition during Aalenian time or the deposits have been completely removed by subsequent erosion.

In the same area are extensive exposures of Sinemurian volcanics, the Telkwa Formation, which in this report is considered to be of nonmarine origin. There is some question about the age of several rhyolite domes in the formation. A radiometric age (1971, unpublished data) for one rhyolitic or dacitic volcanic unit in the formation gave 173 ± 8 Ma, suggesting that some volcanics mapped as Telkwa Formation may be as young as early Middle Jurassic. Andesitic, dacitic, and rhyolitic volcanics of proven Aalenian age found to the east (Hazelton area and Dome Mountain, of Smithers area), to the south (Whitesail Lake), and to the west (Terrace) indicate that the west half of the Smithers map area may have been a centre of intermediate to acid volcanism in the Aalenian.

Hazelton map area

In the Hazelton map area (Figs. 1, 13), the basal beds of the Smithers Formation are of Aalenian age and comprise buff-weathering, fine to coarse grained, volcaniclastic sandstone; light grey, medium grained greywacke; and black to dark grey, flaggy siltstone. In places the rocks are highly feldspathic and may be tuffaceous. The Middle Toarcian Red tuff member of the Nilkitkwa Formation locally underlies the Aalenian beds. The thickness of the Aalenian section may be in excess of 200 m and it is probably conformable with overlying Bajocian beds, but possibly disconformable on older rocks.

Poorly preserved Aalenian fossils have been collected from the Smithers Formation at several localities in the Hazelton map area by T.A. Richards. A fauna with an overall Aalenian affinity was found about 500 m west of the north end of Nakinilerak Lake (GSC loc. 89616), but the ammonites are too poorly preserved to be positively identified. *Tmetoceras* has been collected from the area of Hatchery Arm of Babine Lake (GSC loc. 89624). In the southern Bait Range, *Tmetoceras* has been found at Frypan Creek in a section between Toarcian and Bajocian strata (GSC loc. 89626; Tipper and Richards, 1976, p. 59), and other undeterminable ammonites from this area may also be Aalenian (GSC locs. 89642, 89649). Probable *Pseudolioceras* and *Tmetoceras* occur southeast of Mt. Netalzul (at GSC locs. 89632 and 91098, and 91060, respectively). These last collections are located in a stratigraphic section below fossiliferous Bajocian beds (Tipper and Richards, 1976, p. 58). None of these localities yields sufficient data to contribute to an Aalenian biostratigraphic succession.

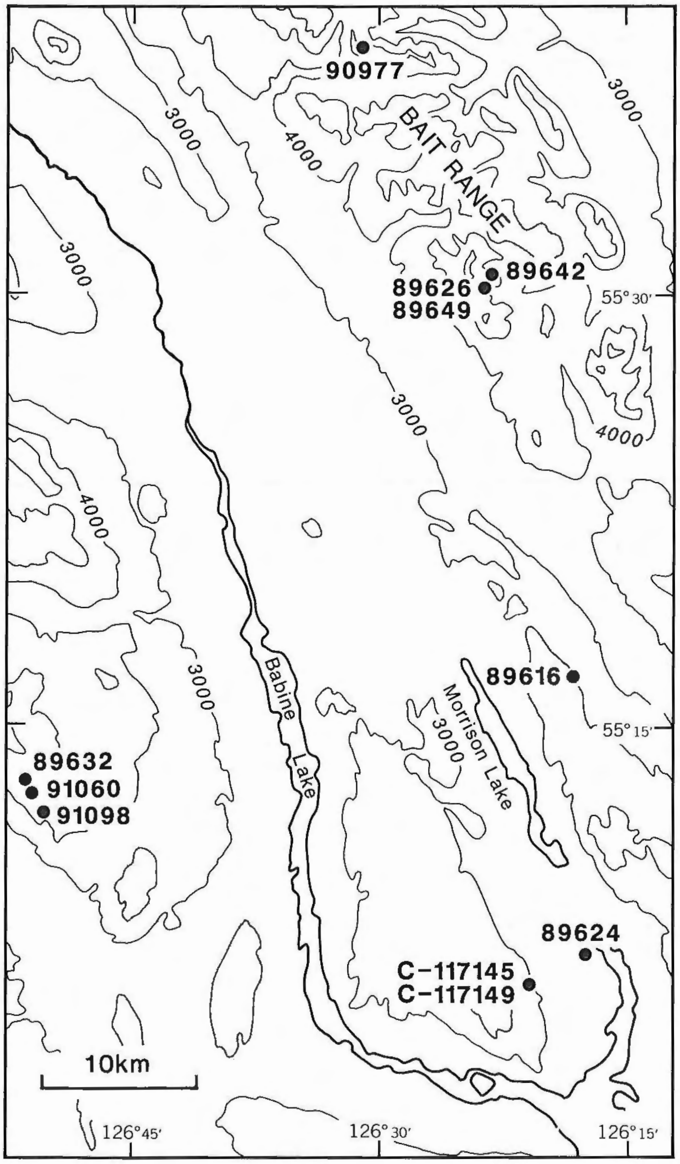

Figure 13. Aalenian fossil localities, Hazelton map area (93 M), west-central British Columbia (contours in feet).

Terrace map area

One rich collection of Aalenian fossils, collected by G.J. Woodsworth 5.4 km north of Mt. Sir Robert (GSC loc. C-101443), contains *Tmetoceras scissum, Erycitoides howelli,* probable *Sonninia* (*Euhoploceras*) and *Phylloceras*, all illustrated in this report. The rocks are water-laid intermediate tuffs and volcaniclastic sandstone containing a coquina of bivalves, corals, and the few ammonites mentioned. These shallow marine rocks are mapped as the Smithers Formation, which everywhere is volcanogenic.

McConnell Creek map area

A rich assemblage of bivalves of Aalenian affinity has been collected on the southeast spur of Scallop Mountain (GSC loc. 93637). No ammonites were found associated with them. The collection is from a limy tuffaceous siltstone-sandstone, probably from the Bait Member of the Smithers Formation, which thus extends from the Hazelton map area to the south.

Spatsizi map area

The Jurassic succession extensively displayed in the Spatsizi area (Fig. 1) of northwestern Bowser Basin has yielded Aalenian fossils at several localities. The Aalenian rocks (Fig. 14) are characteristically laminated, platy, calcareous to siliceous shale, dark grey-brown on fresh surfaces and weathering to a light grey. They have been mapped as the Abou Formation of the Spatsizi Group (Thomson et al., 1986). The siliceous nature of the shale is attributed to fine volcanic ash, and in places beds of cream coloured ash and fine breccia are interbedded. The strata were deposited in relatively deep water under anaerobic to dysaerobic conditions. Some beds are replete with somewhat flattened ammonites, which commonly have small ostreiid bivalves attached. The formation is widespread and recognizable in almost any unfaulted section that spans this interval.

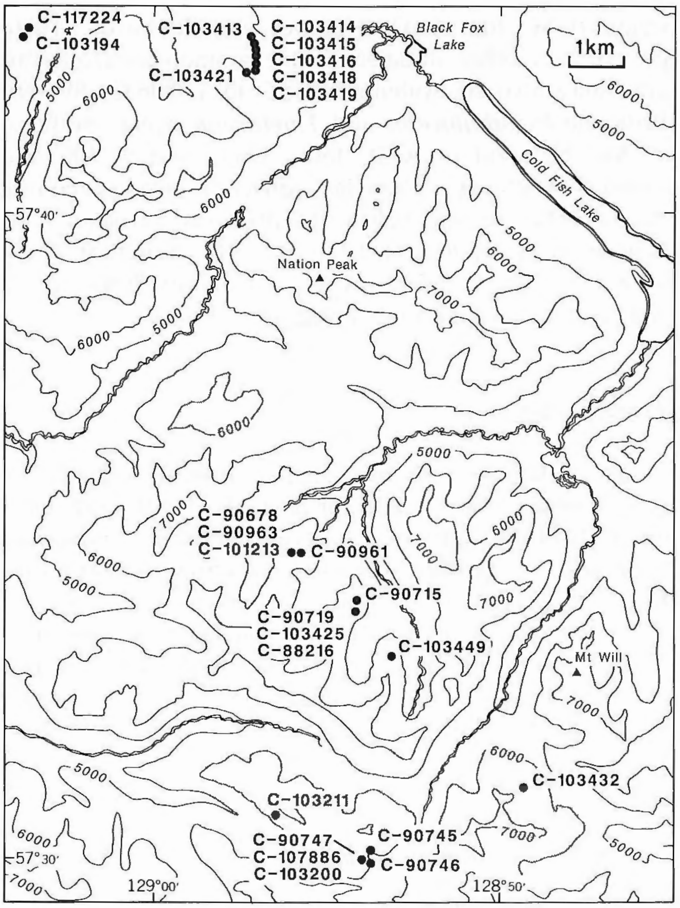

Figure 14. Aalenian fossil localities, Eaglenest Creek (104 H/11), Cold Fish Lake (104 H/10) and Buckinghorse Creek (104 H/7), Spatsizi map area, northwestern British Columbia (contours in feet).

The Cold Fish volcanics west of Cold Fish Lake include several fossiliferous localities that may be Aalenian (GSC locs. C-103413 to C-103421). The ammonites include specimens that are probably *Tmetoceras, Planammatoceras,* and *Pseudolioceras.*

Erycitoides howelli has been collected from one locality in the Nation Peak area west of Cold Fish Lake (GSC loc. C-90963), *Tmetoceras* from another (GSC loc. C-90961), and a rich assemblage including *Tmetoceras kirki* and probable *Erycitoides, Zurcheria,* and *Leioceras* sp. from another (GSC loc. C-101213). Ammonites that may be Aalenian in age have been collected from Mount Will (GSC loc. C-103432). They are not determinable, but the association with ostreiid bivalves nucleated onto the ammonite shells is characteristic of the Aalenian elsewhere.

In the vicinity of Joan Lake, several richly fossiliferous localities have yielded the following: *Tmetoceras scissum, T. kirki, Troitsaia westermanni, Phylloceras*(?) sp. and *Planammatoceras* sp. (GSC loc. C-90715), *Leioceras*(?) sp., *Pseudolioceras* sp. and *P.* sp. cf. *P. whiteavesi, Planammatoceras, Zurcheria*(?) sp., *Erycitoides howelli,* and *E. levis,* (GSC loc. C-90719), and *Leioceras*(?) (GSC loc. C-107886). The ammonite association in the first collection (GSC loc. C-90715) suggests that it was derived from several different horizons. Other localities in the Joan Lake area have yielded *Erycitoides howelli* (GSC loc. C-90745), *Planammatoceras* sp. (GSC loc. C-90746), *Tmetoceras scissum* (GSC loc. C-90747), and *Tmetoceras* sp. (GSC loc. C-103200).

At another particularly rich locality (GSC loc. C-103194), P.L. Smith collected *Tmetoceras kirki, Erycitoides howelli, Planammatoceras,* and *Pseudolioceras* sp., which are all illustrated in this report.

Since this report was prepared, D. Thorkelsen has collected *Erycitoides howelli* and *Tmetoceras*(?) from north of Ice Box Canyon (GSC loc. C-116448).

Two collections, from the Telegraph Creek map area just west of Spatsizi, that contain ammonites previously identified by H. Frebold (Souther, 1972, p. 36) as "*Leioceras*(?)" have been re-examined and contain unidentifiable harpoceratid ammonites.

Whitehorse Trough

Northwest of the Spatsizi map area and the Stikine Arch is the Whitehorse Trough, a basin with Lower and Middle Jurassic strata, which extends into the southern Yukon (Fig. 1). Although volcanic rocks are a minor component, this trough corresponds in age and structural position to the largely volcanic Hazelton Trough and is probably an extension of that basin northwest of the Stikine Arch.

The Jurassic rocks belong to the Laberge Group, initially described in the Whitehorse map area (Wheeler, 1961) and subsequently subdivided into several formations in the Carmacks and Laberge map areas (Tempelman-Kluit, 1984), and two facies or formations in the Tulsequah map area (Souther, 1971). The strata vary from boulder conglomerate through pebble conglomerate, sandstone, siltstone, and shale to minor silty limestone. Tuffs and fine breccias of andesitic to dacitic composition are interbedded in places.

Tulsequah map area

Beneath the Lower Bajocian tuffaceous shale-siltstone sequence of the Takwahoni Formation, a single collection (GSC loc. C-86522) with two small fragments of probable *Planammatoceras* may be of Aalenian age. The rocks are strongly indurated, well bedded siltstone cut by Tertiary rhyolite dykes and sills and are underlain by pebble conglomerate and Middle Toarcian shale.

Southern Yukon

Aalenian strata are known from a few sparsely fossiliferous localities in southern Yukon. Their distribution suggests that rocks of this age were widespread but thin.

Aalenian fossils at several localities in the Laberge map area (Fig. 15), probably are in the upper part of the Laberge Group. *Tmetoceras* and *Planammatoceras,* collected 6 km east of Long Lake (GSC loc. C-107856), and *Tmetoceras*(?) collected 7 km northeast of Miller Lake (GSC locs. C-81320, C-81321, C-86803) are from localities that yield no detailed information on the succession of Aalenian fossils. The latter collections, in a thin unit of water-laid acid tuff and fine volcaniclastic breccia, also contain a rich and varied bivalve assemblage.

The age of *Grammoceras*? *boreale* (Whiteaves) (Frebold, 1964) from Rink Rapids, Yukon River (GSC loc. 43825) remains uncertain, but the species appears to be more closely related to Bajocian *Asthenoceras* than to any Toarcian or Aalenian genus.

One small specimen of the bivalve *Myophorella* from Toric Mountain (GSC loc. 83477) was illustrated by Poulton (1979). Associated belemnites are probably Toarcian or Aalenian according to J.A. Jeletzky (pers. comm.).

Insular Trough

Queen Charlotte Islands

Only recently have Aalenian ammonites been found in the Queen Charlotte Islands, confirming the suggestion, on the basis of microfossil data (Carter et al., 1988), that thin Aalenian strata are present between the exceptionally rich Toarcian and Bajocian fossiliferous sections (see Cameron and Tipper, 1981, 1985) (Fig. 16). *Bredyia* sp. was found at Yakoun River, Graham Island (GSC loc. C-117482). At another locality (GSC locs. C-39516, C-90567, C-157552) on Road 59, Graham Island, *Bredyia* sp. aff. *B. manflasensis* occurs, and, within inches below it in the same bed, *Tmetoceras scissum*. In each case, the Aalenian fossils occur only a short distance stratigraphically below Bajocian strata. Their probable

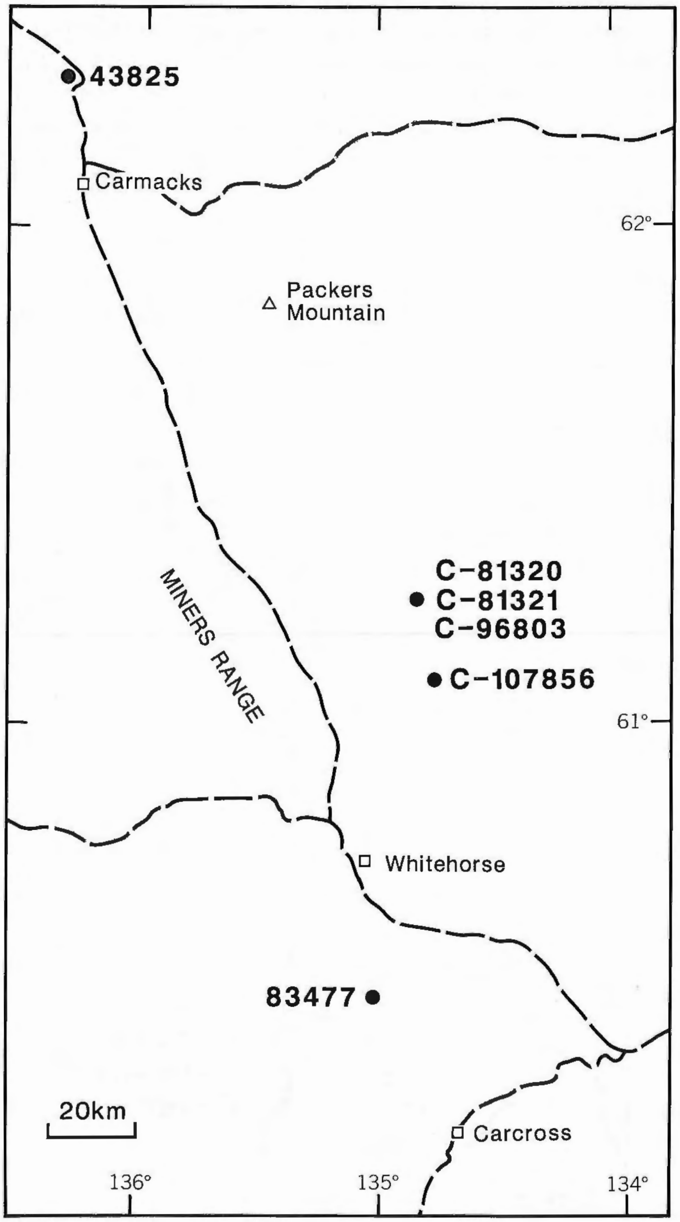

Figure 15. Aalenian fossil localities, Carmacks (115 I), Laberge, and Whitehorse (105 D, E) map areas, south-central Yukon Territory.

early Aalenian or early mid-Aalenian age, together with the very thin development of Aalenian strata, suggest that a sub-Bajocian unconformity has cut down into early Aalenian strata on Queen Charlotte Islands. The early or mid-Aalenian age is suggested by the range of *Bredyia* in Europe and South America, as discussed under "Canadian Zones and Correlation". Since this manuscript was written, Carter and Jakobs (1991) have identified *Planammatoceras* in association with *Bredyia*, and *Erycitoides howelli* (White) nearby in the same formation. Presumably these data indicate that the Queen Charlotte Aalenian faunas represent the latest part of the early Aalenian or the mid-Aalenian, in the range of overlap of lower and upper Aalenian genera, in about the *Ludwigia murchisonae* Standard Zone.

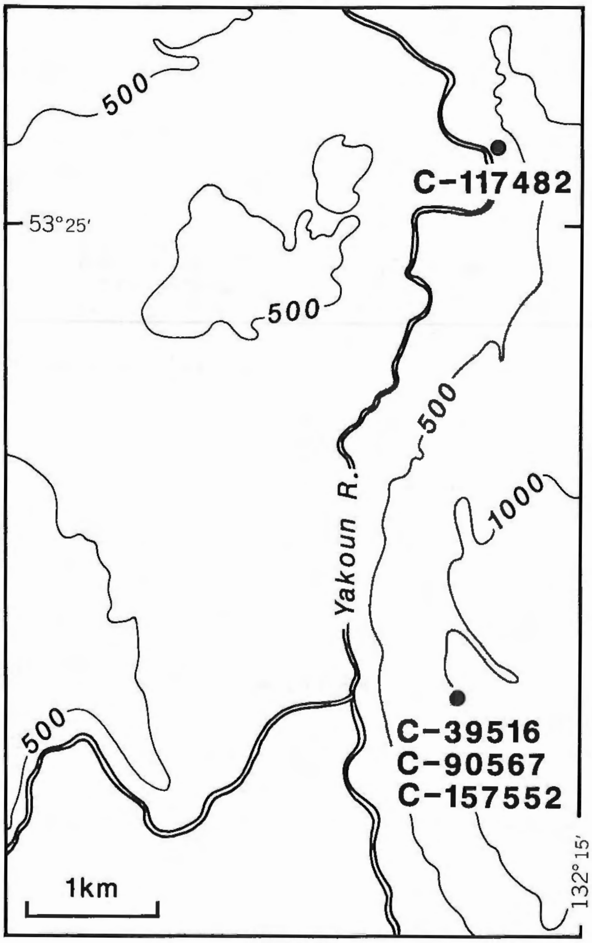

Figure 16. Aalenian fossil localities, Yakoun Lake (103 F/8 W), Queen Charlotte Islands, western British Columbia (contours in feet).

The Aalenian rocks of Queen Charlotte Islands are the highest beds of the Phantom Creek Formation (Cameron and Tipper, 1985, p. 27). This formation is composed essentially of pale brown- to buff-weathering, fine to coarse grained sandstones, partly calcareous and commonly argillaceous. The uppermost sandstones, the Aalenian beds, are more massive and have some calcareous green sandstone interbeds. These upper sandstones are at the top of a conformable sequence, as suggested by rare fossils and a lack of sedimentary evidence of a hiatus. The upper contact of the Phantom Creek Formation with the Lower Bajocian Graham Island Formation is a paraconformity.

Northern Vancouver Island

The presence of *Myophorella taylori* Poulton, found with other bivalves in water-laid tuffs or volcaniclastic sediments in the open pit of the Island Copper mine at Quatsino Inlet (GSC loc. C-80878), suggests that the age of these beds of the Bonanza Group volcanics is Aalenian. The age is based on a correlation with strata in central Oregon, where *M. taylori* is restricted to the upper *Ludwigia murchisonae* Standard Zone according to D.G. Taylor (Poulton, 1980), and with the Whitesail Lake area, where specimens that are probably *M. taylori* occur with probable *Erycitoides*.

PALEOBIOGEOGRAPHIC AFFINITIES

Comparisons with nearby areas

Southern Alaska

Aalenian strata in southern Alaska are represented by lower parts of the Kialagvik Formation in the Wide Bay area, and of the Red Glacier Formation (basal Tuxedni Group) in Cook Inlet area. Elsewhere in southern Alaska, the Aalenian was a time of deformation and intrusion (Imlay and Detterman, 1973).

Characteristic Aalenian fossils in the Red Glacier Formation, listed by Detterman and Hartsock (1966), include *Pseudolioceras whiteavesi, Tmetoceras regleyi, T.* sp. cf. *T. scissum, Erycitoides howelli,* and *E.* sp. cf. *E. kialagvikensis.* Those authors assigned the assemblages to the *Tmetoceras scissum* Zone. They placed other occurrences of *Pseudolioceras* in the basal Aalenian *Leioceras opalinum* Zone, but Imlay and Detterman (1973) considered earliest Aalenian beds to be absent or at least not represented by diagnostic fossils throughout southern Alaska (Table 1).

Kellum et al. (1945) first studied the ammonite biostratigraphy of the Kialagvik Formation at Wide Bay. They attributed all the Aalenian strata to the "*Hammatoceras*" Zone and subdivided it into a lower "*Hammatoceras*" *howelli* subzone and a higher *H.*? *kialagvikensis* subzone. Westermann (1964b, 1969) recognized a lower assemblage, which he called the *Tmetoceras scissum* "zonule", and a rich, higher assemblage in the upper part of the Aalenian, which he called the *Erycitoides howelli* Zone. He noted that index species for the supposed subzones of Kellum et al. (1945) are in fact associated sexual dimorphs of a single species. He discussed the range of *T. scissum* as extending above the *Leioceras opalinum* Zone in Europe, and suggested that its occurrence alone below *E. howelli* in southern Alaska as well as in British Columbia, indicated an early Aalenian age. Westermann (1964b) also suggested that lowest Aalenian beds, i.e., the *Leioceras opalinum* Zone, may not be present in southern Alaska. It now appears that lowest Aalenian beds may in fact be present in British Columbia, but that the index fossil *Leioceras opalinum* is absent throughout the northeastern Pacific faunal province and perhaps the entire Pacific area.

Tmetoceras scissum and *Eudmetoceras* (*Euaptetoceras*) occur in southern Alaska and Oregon (Westermann, 1964b; Imlay, 1973). The similarities of the faunas in these regions during Aalenian time (as opposed to Bajocian time) were emphasized by Imlay (1973), who correlated the lowest exposed beds containing *Erycitoides howelli* in southern Alaska with the *Tmetoceras*-bearing beds in the lower part of the Weberg Member of Oregon.

Westermann (1964b) showed that there are distinctive *Tmetoceras* species in the younger Aalenian beds of southern Alaska; i.e., *T. kirki* and *T. flexicostatum*, and he subdivided the younger Aalenian *Erycitoides howelli* Zone into three zonules on the basis of the ranges of all the 22 species present: the *E. howelli* zonule, *E. teres-profundus* zonule, and *Eudmetoceras/Erycitoides tenue-Tmetoceras flexicostatum* zonule (*E. tenue* zonule, Westermann, 1969) in ascending order. In the last, he recognized an uppermost *tenue-flexicostatum* portion. The superjacent *Eudmetoceras* (*Euaptetoceras*) *amplectens* assemblage, earlier assigned to the basal Bajocian (Westermann, 1964b, 1969) or to the Aalenian-Bajocian boundary interval (Hall and Westermann, 1980), is uppermost Aalenian according to G. Westermann (pers. comm., 1987). Although some of the same species found in the *E. howelli* Zone of southern Alaska are also described in this report from British Columbia, there are significant differences in the specific and generic composition between the two areas, and only general correlations can be made between them.

Oregon

The Aalenian of Oregon (Table 1) comprises the lower parts of the Weberg and Warm Spring members of the Snowshoe Formation in the Suplee area, and part of the lower member of the Snowshoe Formation of the Izee area (Imlay, 1973). The lower part of the Weberg Member contains *Tmetoceras scissum* (Benecke), *Praestrigites* cf. *P. deltotus* (Buckman), "*Eudmetoceras* (*Euaptetoceras*)", *Phylloceras*, and *Holcophylloceras* according to Imlay (1973), who dated this association as *Graphoceras concavum* Standard Zone. Unnamed beds in the Juniper Mountain and Huntington areas also contain *T. scissum* (Imlay, 1973, p. 13, 16-18, 30, 31). The basal beds of the Warm Springs Member west of Warm Springs Creek also yielded a very small fragment of *Tmetoceras* (Imlay, 1973, p. 18). The Snowshoe Formation in the Izee area contains *T. scissum*, which, in the upper part of its range, is associated with specimens that are probably *Planammatoceras*, considered by Imlay (1973, p. 25) to indicate the *Ludwigia murchisonae* Standard Zone.

Taylor (1988) erected a sequence of three new zones for the Oregon Aalenian ammonites. The lower zone, equivalent to the upper *Ludwigia murchisonae* Standard Zone, contains *Abbasites sparsicostatus* (Imlay), ?*A.* n. sp., *Eudmetoceras moerickei*? Jaworski, *Strigoceras harrisense* Taylor, *Tmetoceras scissum* (Benecke), and ?*Bradfordia* sp. Above this zone is the Mowichense Zone, containing *Eudmetoceras mowichense* Taylor. *Eudmetoceras* aff. *E. amaltheiforme* (Vacek) occurs in both these zones. The highest Aalenian zone, the Packardi Zone, contains species of *Eudmetoceras, Fontannesia*, and *Euhoploceras*, as well as *Docidoceras schnabelei* Taylor and *Hebetoxyites* aff. *H. snowshoensis* Taylor.

Northern Yukon and northern Alaska

Since Frebold (1961) illustrated one small fragment of *Erycitoides* from northern Yukon (Table 2), the genus has been found at many other localities (Poulton, 1978; 1991). In addition, *Leioceras* sp. aff. *L. opalinum* (Reinecke) has been found at one locality and *Pseudolioceras* at many others. The Aalenian faunas do not occur in sequence in any single undisturbed section and are rarely abundant. On the southeastern margin of the Brooks-Mackenzie Basin (Balkwill et al., 1983), the Bajocian sandstones are in a transgressive facies overlapping an Aalenian coarsening-upward cycle that is progressively truncated southeastward (Poulton et al., 1982).

In adjacent northern Alaska, shales of the Kingak Formation have yielded *Erycitoides howelli, Pseudolioceras whiteavesi, Tmetoceras* sp. and rare phylloceratids (Imlay, 1955; Westermann, 1981), but no succession of faunas had been recognized there either.

Canadian Arctic Archipelago

The Aalenian of the Sverdrup Basin in the Canadian Arctic Islands is characterized above all by ammonites that have been identified as *Leioceras opalinum* in association with *Pseudolioceras mclintocki* (Frebold, 1957, 1960, 1975; Poulton, in press). This fauna occurs in an interval about 30 m thick, above a similar thickness of Toarcian strata with *Peronoceras, Pseudolioceras spitsbergense, Pseudolioceras* spp., and in places *Pleydellia*, and it probably represents the lowest Aalenian *Leioceras opalinum* Standard Zone. *Erycitoides howelli*, as well, is now known from one locality on Ellesmere Island (work in progress). It seems that there is a regional basin-margin hiatus in the western Arctic between the lower Aalenian and the Bajocian beds which are characterized by *Arkelloceras* spp. (Poulton, in press). This hiatus is at the unconformity where the transgressive basal beds of the McConnell Island Formation overlie lower Aalenian beds of the Sandy Point Formation (Embry, 1985).

Northeastern Asia

The lower Aalenian of eastern Siberia contains *Pseudolioceras mclintocki* and possibly also *Leioceras*, suggesting the *Leioceras opalinum* Standard Zone. In the northwest Pacific area, beds with these boreal faunas have been referred to the *P. mclintocki* Zone by Sei et al. (1985). *Tmetoceras* and the endemic *Hosoureites* occur with *Pseudolioceras* and *Leioceras*(?) in northern Honshu, Japan (Westermann, 1981).

Pseudolioceras whiteavesi, P. tugurense, P. crassifalcata (Imlay), *Erycitoides howelli* (White) and other *Erycitoides* species, as well as scarce phylloceratids, represent the upper Aalenian *E. howelli* Zone in eastern Siberia (Sei and Kalacheva, 1968, 1974; Westermann, 1981; Sei et al., 1985). A mixed fauna of *Planammatoceras, Erycites*(?), *Pseudolioceras*(?) and *Tmetoceras* occurs in northern Japan (Westermann, 1981).

Discussion

The Aalenian ammonite faunas of Western Canada have affinities with those of South America, eastern and northeastern Asia. The dominant genus in Western Canada, *Tmetoceras*, is apparently cosmopolitan (except Boreal), as is the less abundant *Planammatoceras*.

Species in the Aalenian of Western Canada that have closest similarities to those of South America include *Bredyia* sp. cf. *B. manflasensis*, and *Pleydellia*(?) sp. cf. *P. argentina*. The common European Aalenian genera *Ludwigia* and *Stauffenia* have not been identified in Canada, and other European genera, *Pleydellia* and *Leioceras*, are rare or have only been questionably identified in Western Canada. *Pseudolioceras* and *Erycitoides* characterize the Aalenian of eastern U.S.S.R. and Japan as well as Western Canada and southern Alaska. The characteristic species of these genera, described in this report, are mainly North Pacific in distribution. Their restricted geographic distribution led to discrimination of the Bering subprovince of the Boreal Realm for the Aalenian and Early Bajocian (Taylor et al., 1984; see also Westermann, 1984).

Troitsaia westermanni gen. et sp. nov. is thought to be an endemic descendant of the Toarcian *Dumortieria*.

In Jurassic rocks of ages other than Aalenian, the boreal affinities of the Canadian Western Interior ammonites, versus Tethyan affinities of those from the Western Cordillera, have been used previously as an indicator of paleolatitudes for the so-called allochthonous or suspect terranes of Western Canada. In particular, Tipper (1981, 1984; *in* Taylor et al., 1984) has shown that the western terranes are dominated by hildoceratid ammonites of Tethyan affinity in the Pliensbachian, whereas autochthonous North American strata are dominated by boreal amaltheids. A similar biogeographic distinction cannot be shown for the Aalenian ammonite fauna because no Aalenian ammonites are known from autochthonous North America in Canada south of northern Yukon.

The Aalenian ammonite faunas of the Canadian Arctic and other boreal areas differ strikingly from those described here from the Canadian Western Cordillera. The dominance in the Arctic of ammonites close to *Leioceras opalinum* (Reinecke) and *Pseudolioceras mclintocki* (Haughton) in the lower Aalenian contrasts with the dominance of *Tmetoceras scissum* and the presence of *Troitsaia westermanni* in the western Cordillera. Differences in younger Aalenian faunas are perhaps largely a result of preservation, as there is little Aalenian preserved above the *L.* sp. aff. *L. opalinum*-bearing beds in the Arctic Islands. *Erycitoides* is present there but rare, whereas it and *Tmetoceras* are relatively common in Western Canada.

In the northern Yukon, *Leioceras* is rare, perhaps because of thin or unfavourable Aalenian facies or sparse outcrop. More commonly, the Aalenian is represented by *Pseudolioceras whiteavesi* and *Erycitoides howelli* (Poulton, 1978). Specimens of *Tmetoceras* have not been found in Arctic Canada, but small fragments have been described from northern Alaska (Imlay, 1955, p. 89, Pl. 12, figs. 7-10).

The presence in northwestern Canada of *Leioceras* sp. aff. *L. opalinum, Pseudolioceras whiteavesi,* and *Erycitoides howelli* suggests mixing of North Pacific and Northwest European faunas during a time of weak worldwide Boreal/Tethyan faunal differentiation. The absence in the Arctic of *Tmetoceras, Planammatoceras* and other cosmopolitan ammonites may be the result of some combination of distance from the southern seas and of physical or ecological barriers separating those areas.

Previous summaries of Aalenian ammonite paleobiogeography that include Canadian ammonites have been published by Westermann (1981, 1984) and Taylor et al. (1984). In particular, the mixed nature of the Aalenian ammonite faunas in western North America was emphasized (Westermann, 1981, Fig. 2; Taylor et al., 1984, Fig. 9).

SYSTEMATIC PALEONTOLOGY

Most Aalenian faunas of British Columbia and southern Yukon are dominated by *Tmetoceras*. Only the best specimens of this genus, from localities that represent its broad distribution, are illustrated in this report. A disproportionately greater number of other ammonite genera are illustrated, in spite of their rarity and poor state of preservation over such a broad region of Western Canada. These belong primarily to the families Hammatoceratidae and Hildoceratidae. Most specimens of all taxa are incomplete impressions or are otherwise poorly preserved, so that many morphological characteristics, especially the suture patterns, cannot be seen.

Superfamily HILDOCERATACEAE Hyatt, 1867

Family HILDOCERATIDAE Hyatt, 1867

Subfamily TMETOCERATINAE Spath, 1936

Genus *Tmetoceras* Buckman, 1892

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

Type species. Ammonites scissus Benecke, 1865.

Discussion. The genus is known in the western Cordillera almost everywhere that Aalenian beds are present. It commonly occurs in great quantities, littering bedding planes together with small encrusting bivalves whose shells are sometimes nucleated on the ammonites. In most of the collections, the *Tmetoceras* specimens are fragmentary or otherwise poorly preserved, so that only a generic identification is possible. Specimens from Whitesail Lake and Taseko Lakes map areas have been figured by Frebold (1951; Frebold et al., 1969).

Westermann (1964b) suggested a succession of three *Tmetoceras* species in southern Alaska, in which the younger species, appearing in the Upper Aalenian, are progressively larger, have a narrower ventral groove, and more strongly curved ribs. In addition, the oldest species, *T. scissum*, appears to include a greater proportion of specimens with round whorl cross-sections, although this may be partly a function of the much greater number of reasonably well preserved specimens. The species described in this report are based on these morphological criteria, except where the range of variation in the population available indicates placement of most or all specimens into a single variable species. The difference in size between older and younger species may be subtle and is recognized on an assemblage rather than an individual basis, because some specimens of *T. scissum* from the Taseko Lakes area, for example, reach sizes as large as specimens of the younger species.

Westermann (1964b) subdivided specimens of *Tmetoceras* from southern Alaska, into *T.* (*Tmetoceras*) s. str. and a new subgenus *T.* (*Tmetoites*). He considered these to represent macro- and microconchs, respectively. Amongst the Canadian specimens figured in this report, none has observable lateral lappets, and some specimens that exhibit oral modifications (e.g., Pl. 1, figs. 17, 28) are probably too large to be microconchs. For these reasons, the subjects of dimorphism and the status of the subgenus *Tmetoites* are not treated at length in this report.

Tmetoceras scissum (Benecke, 1865)

Plate 1, figures 1-32

Ammonites scissus Benecke, 1865, p. 170, Pl. 6, figs. 4a, b.

Tmetoceras regleyi (Thollière) Dumortier. Frebold, 1951, p. 18, 19, Pl. XV, figs. 1-4.

"*Polymorphites*" cf. *senescens* Buckman. Frebold, 1951, p. 19, Pl. XV, fig. 5.

?*Tmetoceras* sp. Imlay, 1955, p. 89, Pl. 12, figs. 7-10.

Tmetoceras (*Tmetoceras*) *scissum* (Benecke). Westermann, 1964b, p. 428, Pl. 72, figs. 1a, b, 2a, b; Textfigs. 32, 34.

Tmetoceras scissum (Benecke). Imlay, 1973, p. 59, Pl. 2, figs. 1-6.

See Westermann (1964b) for an extended synonymy list.

Discussion. Westermann (1964b) described and discussed *T. scissum* at length and, following Buckman (1892), demonstrated the synonymy of *T. regleyi* (Dumortier), which had been distinguished by some authors primarily on the basis of the absence of constrictions. Consequently, this character is not considered to be of value for specific identification. The western Canadian specimens figured here are rarely constricted although this might be in part a function of the style of preservation, only exceptionally strong constrictions being visible on internal moulds. Previous workers (e.g., Buckman, 1892; Westermann, 1964b), in studies of collections from the United Kingdom and southern Alaska, have pointed out the considerable infraspecific variation of other characters as well, such as the whorl cross-section, spacing of the ribs, and the degree of involution. The Canadian specimens are also highly variable and specimens illustrated from southern Alaska and Europe (e.g., Benecke, 1865; Vacek, 1886) fall within their range of variation. The large number of specimens illustrated in this report reflects not only the morphological variability of the species, but also its broad geographic distribution in Western Canada. The specimens are characterized by prominent, nearly rectiradiate ribbing and a well developed ventral groove, features which separate them from *T. kirki* Westermann. These differentiating features are sometimes subtle and would not be considered specifically diagnostic were it not for their biostratigraphic value that has been demonstrated for southern Alaska.

Two morphotypes appear to be present in the Canadian material. Some specimens (e.g., Pl. 1, figs. 10, 16, 21) reach a diameter of at least 6 cm without any sign of apertural modification. Others (Pl. 1, figs. 17, 18) exhibit apertural ribbing modification at a much smaller diameter. These two types may represent macro- and microconchs of the same species, i.e., corresponding sexual dimorphs, although the size at which apertural modification appears varies greatly from one specimen to another.

The specimen illustrated by Frebold (1951, p. 19, Pl. XV, fig. 5) as "*Polymorphites*" cf. *senscens* Buckman is assumed to be a pathological variant of its associate *T. scissum*, without the interruption of ribs on the venter.

Age and association. *Tmetoceras scissum* probably ranges throughout the Aalenian worldwide (e.g., Westermann, 1964b). In the Canadian collections, from thin bedded, argillaceous deposits that are probably of basinal origin, *T. scissum* commonly is the only ammonite species present. In British Columbia, it occurs sometimes with *Troitsaia*, and this association is taken to indicate an earliest Aalenian age. In other collections from the Whitesail Lake and Terrace areas, *Erycitoides* is associated with *T. scissum*, suggesting a somewhat younger, Late Aalenian, age. *Tmetoceras scissum* has not been positively identified in Canadian collections that contain ammonites of very Late Aalenian age, although it may occur in rocks of this age in Oregon.

Figured specimens. From Smithers map area (Dome Mountain), Whitesail Lake map area (Troitsa Peak area, Whitesail Range), Terrace map area (Mt. Sir Robert), Spatsizi map area (Joan Lake area), Queen Charlotte Islands (Graham Island).

Tmetoceras kirki Westermann, 1964

Plate 2, figures 1-12

?*Tmetoceras scissum* (Benecke). Rieber, 1963, Pl. 8, figs. 2, 3.

Tmetoceras (*Tmetoceras*) *kirki* Westermann, 1964b, p. 437, Pl. 72, figs. 4-6, ?7, 8-10; Textfigs. 35, 36.

?*Tmetoceras scissum* (Benecke). Westermann and Riccardi, 1972, p. 22, Pl. 1 (part).

Discussion. Gently flexicostate specimens of *Tmetoceras* (see especially Pl. 2, figs. 4, 11, 12) are assigned to *T. kirki*, a young, but not the youngest, representative of Westermann's (1964b) *Tmetoceras* lineage. *Tmetoceras kirki* accounts for at least half, if not more of, *Tmetoceras* specimens in Western Canada. This probably reflects the absence or rarity of earliest Aalenian rocks as indicated by the paucity of *Leioceras* and *Pseudolioceras mclintocki* in Western Canada. Some of the specimens from Argentina illustrated as *T. scissum* by Westermann and Riccardi (1972, Pl. 1, figs. 1-5) have faintly flexed ribs suggestive of the younger species, an extreme end member of which was also identified there (*ibid.*, Pl. 1, fig. 6; Hillebrandt and Westermann, 1985, Pl. 1, fig. 4). This may partly account for the diminished biostratigraphic significance of the Tmetoceras species implied in the correlation chart by Westermann and Riccardi (1972, Table 1).

Age and association. The ammonite associates of *T. kirki* in the Canadian collections are many, including *Erycitoides howelli, Pseudolioceras whiteavesi*, and *Planammatoceras*(?) sp., but definite *T. scissum* and *Troitsaia* are not normally among them. This tentatively confirms the biostratigraphic conclusions of Westermann (1964b) that *T. kirki* is of a later, rather than earlier, Aalenian age.

Figured specimens. From Smithers map area (Dome Mountain), Whitesail Lake map area (Whitesail Range), Spatsizi map area (Nation Peak area, Joan Lake), Taseko Lakes map area (Yalakom River, north of Blue Creek; head of Relay Creek).

Tmetoceras flexicostatum Westermann, 1964

Plate 2, figures 13-18

Tmetoceras (Tmetoceras) kirki flexicostatum Westermann, 1964b, p. 440, Pl. 72, figs. 8-10, Textfig. 37.

Discussion. This taxon was elevated to species rank by Westermann and Riccardi (1972). It is distinguished by its large size, dense and flexicostate ribs, subquadrate and higher than wide cross-section, and extremely narrow ventral groove. This is the youngest member of the *Tmetoceras* lineage according to Westermann (1964b). If the North American succession of *Tmetoceras* species is valid worldwide, then several poorly known European species, such as *T. difalense* (Gemmellaro, 1886; Bonarelli, 1893) and *T. hollandae* (Buckman, 1886, 1892) may be senior synonyms of *T. flexicostatum.*

Age and association. The association of *T. flexicostatum* and *Planammatoceras*(?) in Canada is compatible with a Late Aalenian age, as suggested by Westermann (1964b) for this species in Alaska.

Figured specimens. From Whitesail Lake map area (Michel Lake area), Laberge area (Long Lake).

Subfamily HARPOCERATINAE Neumayr, 1875

Genus *Pseudolioceras* Buckman, 1889

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

Type species: *Ammonites compactilis* Simpson, 1855.

Discussion. A revised diagnosis of *Tugurites*, controversial when first erected as a genus by Kalacheva and Sei (1970), was given by Sei et al. (1985). They considered the question of the close relationship of *Tugurites* to *Pseudolioceras* raised by Donovan et al. (1981), and treated the former as a subgenus of *Pseudolioceras.* They differentiated *Tugurites* from the nominate subgenus *P.* (*Pseudolioceras*) primarily by its sharp and elevated umbilical edge and the persistence on the inner flank of the falcate ribs. They also included the presence of a well developed, floored hollow keel in the revised diagnosis of *Tugurites* and proposed that the two subgenera have different ranges, *P.* (*Tugurites*) primarily Aalenian and Early Bajocian and *P.* (*Pseudolioceras*) primarily Toarcian. However, in Canada their ranges overlap and they have morphological characteristics in common. The subgenera are therefore not employed for present purposes (see Poulton, 1991). Aalenian beds in British Columbia contain specimens the could be referred to both *P.* (*Pseudolioceras*) and *P.* (*Tugurites*).

Pseudolioceras sp.

Plate 3, figure 11; Plate 6, figures 1-4, 7

Description. Two specimens (Pl. 6, figs. 2, 4) exhibit a small but distinctive degree of irregularity in the strength and spacing of the primary ribs. On these and two other specimens with regularly spaced ribs (Pl. 6, figs. 1, 3), the ribs are falcoid. They fade umbilically so that the umbilical half of the flank is nearly smooth. The umbilical margin is not clearly seen. In the largest growth stages preserved, the ribs fade abruptly ventrally from ventrolateral swellings, so that the narrow ventrolateral shoulder is smooth and the ribs are subradial. In addition, very fine intercostal striae are present, particularly along the median part of the flank.

Three small fragments [Pl. 6, fig. 7 (both specimens), Pl. 3, fig. 11] are similar to those described above in the fading of the ribs onto the smooth inner half of the flank. The ribs are regular in their strength and spacing, but the specimens are too poorly preserved to show any intercostal striae. The ribs of these two specimens are less strongly curved than in any of the other *Pseudolioceras* specimens described in this report.

Discussion, age, and association. None of the specimens illustrated in this report is sufficiently well preserved to be compared meaningfully with known species. They are associated with a rich variety of other ammonite and bivalve taxa, including *Tmetoceras, Erycitoides*, and *Planammatoceras*(?), which indicate a probable Late Aalenian age.

Figured specimens. From Spatsizi map area (Joan Lake).

Pseudolioceras sp. cf. *P. whiteavesi* (White, 1889)

Plate 6, figures 8, 12-15

cf. *Ammonites* (*Amaltheus*) *whiteavesi* White, 1889, p. 69(499), Pl. 13, figs. 1-5.

cf. *Pseudolioceras whiteavesi* (White). Imlay, 1955, p. 89, Pl. 12, figs. 15, 16.

cf. *Pseudolioceras mclintocki whiteavesi* (White). Westermann, 1964b, p. 421, Pl. 68, fig. 2; Pl. 69, figs. 1-6; Pl. 70, figs. 1-4; Pl. 71, figs. 1-2; Textfig. 331.

cf. *Pseudolioceras* (*Tugurites*) *whiteavesi* (White). Sei, Kalacheva and Westermann, 1985, p. 1045, Pl. 3, figs. I-M.

Discussion. Two specimens (Pl. 6, figs. 12, 13) from Taseko Lakes map area, and possibly also three very poorly preserved impressions of juveniles [Pl. 6, figs. 8 (lower specimen), 14, 15 (lower specimen)] from Spatsizi and Whitesail Lake map areas, exhibit primary ribs extending onto the umbilical half of the flank and a raised umbilical rim. The falcoid curvature of the ribs is stronger than in the other species described here as *Pseudolioceras* s.s. and, on the least abraded specimen (Pl. 6, fig. 12), the ribs are stronger and more regular. *Pseudolioceras whiteavesi* is closely related to the perhaps slightly older Arctic species *P. mclintocki* (Haughton), but the latter lacks the distinctly raised umbilical rim, and the ribs commonly are stronger.

Age and associations. The collections from the Taseko Lakes and Spatsizi map areas that contain *P.* cf. *P. whiteavesi* also contain a variety of other ammonite taxa (see Appendix, GSC locs. 13812, C-90719). They include *Erycitoides howelli* (White) and *Tmetoceras kirki* Westermann, indicating the *E. howelli* Zone. This conforms with the occurrence of *P. whiteavesi* in the *P. tugurense* Zone of the northwest Pacific area (Sei et al., 1985).

Figured specimens. From Taseko Lakes map area (Yalakom River above Blue Creek), Whitesail Lake map area (Michel Lake), Spatsizi map area (Joan Lake).

Subfamily LEIOCERATINAE Spath, 1936

This subfamily is placed in the family Hildoceratidae following Donovan et al. (1981), who considered the family Graphoceratidae, in which the Leioceratinae was placed by Arkell et al. (1957), to be an independent group, characterized by unfloored keels.

Genus *Leioceras* Hyatt, 1867

Synonyms. See Arkell et al., 1957, p. L262; Donovan et al., 1981, p. 141.

Type species. *Nautilus opalinus* Reinecke, 1818.

Leioceras(?) sp.

Plate 6, figures 5, 6

Discussion. The two specimens from the Spatsizi map area illustrated here are poorly preserved impressions with equally close similarities to other leioceratinid genera. One (Pl. 6, fig. 5) appears to be smooth, the other (Pl. 6, fig. 6) may have subdued, nearly radial folds in the middle parts of the flank. The latter specimen may become uncoiled at its largest preserved diameter, but this is not entirely clear because of the extreme crushing.

Age and association. *Leioceras*(?) occurs with a rich variety of other ammonites, including *Erycitoides howelli, Tmetoceras kirki,* and probable *Planammatoceras*, suggesting its occurrence in some part of the upper, but not uppermost, Aalenian.

Figured specimens. From Spatsizi map area (Joan Lake, Nation Peak).

Subfamily GRAMMOCERATINAE Buckman, 1904

Genus *Troitsaia* gen. nov.

Type species. *Troitsaia westermanni* sp. nov.

Diagnosis. Resembling *Dumortieria* Haug, 1885 but with small spines or nodes on the ribs around the umbilical margin. *Troitsaia* also has a slightly lower whorl height in the juvenile and intermediate growth stages.

Discussion. *Troitsaia* is monospecific as far as is presently known. Because of its close resemblance to *Dumortieria* Haug, 1885, it is assumed to be a direct descendant of that genus, endemic to Western Canada. The presence of umbilical spines differentiates it not only from the Upper Toarcian species of *Dumortieria* worldwide, including those that occur in Upper Toarcian strata of British Columbia, but also from those few that occur in the Lower Aalenian of Europe (e.g., Benecke, 1905; Siemiradzki, 1923; Renz, 1925; Gerard and Bichelonne, 1940). *Dumortieria*(?) *pusilla* Jaworski (1926, Pl. XII, figs. 1, 2) may represent another, South American, occurrence of *Dumortieria* in the Aalenian (Westermann, 1964a), although the smooth inner whorls of *D.* (?) *pusilla* are not typical of the genus.

Derivation of name. From Troitsa Peak, Whitesail Lake map area, on whose northern and western ridges lie exceptional Aalenian sections in which reasonably well preserved specimens of *Troitsaia* can be found.

Troitsaia westermanni sp. nov.

Plate 7, figures 1-19

Holotype. GSC 89746 from GSC locality C-143367, Whitesail Lake area (Pl. 7, fig. 17).

Description. The ribs are straight and rectiradiate on the main part of the flank and projected strongly toward the venter. They die out as they approach the venter. A distinct keel, with smooth sides, without sulci, is present (Pl. 7, figs. 8, 14). Each rib has a small, pointed tubercle at the umbilical margin. These tubercles disappear when the shell is about 2.5 cm in diameter. The spacing and prominence of the ribs is uniform at different growth stages except in the holotype (Pl. 7, fig. 17), in which denser spacing occurs at a whorl height of about 1 cm. In larger growth stages, beyond a diameter of about 5 to 6 cm, the ribs fade in strength, and their ventral, projected parts disappear completely so that the outer half of the flank is smooth (Pl. 7, figs. 18, 19).

The shell is moderately evolute and compressed. Except for the presence of tubercles on the ribs, the umbilical margin is rounded and the umbilical wall steep but not vertical; the umbilicus is shallow.

Discussion. Troitsaia westermanni differs from species of the similar genus *Dumortieria* in the presence of minute umbilical tubercles on the inner whorls and in the relatively coarse spacing of the ribs.

Age and association. In most collections, *T. westermanni* occurs with *Tmetoceras scissum* and a variety of bivalves, but no other ammonites. This association at various localities throughout British Columbia conforms with the stratigraphic observation that the species characterizes what could well be lowest beds of the Aalenian. In two collections, from the Whitesail Lake and Spatsizi map areas, the associated ammonites, *Euhoploceras*(?) (GSC loc. C-53517), and *Phylloceras* and *Planammatoceras*(?) (C-90715) could fall within this age range. Other specimens from the latter locality (C-90715), figured here as *Tmetoceras kirki*, are thought on the basis of field relationships to be a result of admixing in the collection of younger material.

Figured specimens. From Manning Park (north of 26 Mile Creek), Whitesail Lake map area, Smithers map area (near small lake west of Dome Mountain), Spatsizi map area (Joan Lake).

Derivation of name. The species is named to recognize the contributions of Dr. G.E.G. Westermann to Jurassic ammonite paleontology and biostratigraphy.

Genus *Pleydellia* Buckman, 1899

Synonyms. See Arkell et al., 1957, p. L261; Donovan et al., 1981, p. 141.

Type species. Pleydellia comata Buckman, 1899.

Pleydellia(?) sp. cf. *P. argentina*
Maubeuge and Lambert, 1955

Plate 7, figures 26-28

cf. *Pleydellia argentina* Maubeuge and Lambert, 1955, p. 622, Pl. I, figs. 2-6.

non Witchellia argentina Burckhardt, 1903, Pl. 1, figs. 15-17.

Discussion and description. Three small specimens may represent the variable and long-ranging genus *Pleydellia*. They appear to be particularly close to some specimens of the South American species, *P. argentina*, although this species is poorly known, and lacks good illustrations. The Canadian material exhibits gently sigmoidal ribs, which gradually swell ventrally and either terminate just before the venter, or have a very weakly developed adorally directed hook at the ventrolateral edge. The ribs have a rounded cross-section and equally wide interspaces in two specimens (Pl. 7, figs. 26, 27), but appear to be sharper and more strongly flexuous in the third (Pl. 7, fig. 28). The spacing of the ribs is variable.

The shell is evolute. The umbilical edge is rounded, the umbilicus shallow. There appears to be a weak keel with very narrow smooth shoulders (Pl. 7, fig. 26).

The general similarity of the ribbing and coiling characteristics with another South American species, *Fontannesia*(?) *austroamericana* Jaworski (e.g., Westermann and Riccardi, 1982; Hillebrandt and Westermann, 1985), must also be acknowledged. The characteristics of the venter of the Canadian species are unknown, but the shell does not appear to be inflated. The Canadian specimens are not clearly different from some European figured specimens, such as some assigned to *Brodieia* (*Pseudomercaticeras*) (e.g., Geczy, 1966, Pl. 2, fig. 6) and to *Ludwigia torta* Buckman and *Pleydellia folliatum* Buckman by Siemiradzki (1922, p. 23, Pl. 3, figs. 5, 6). *Pseudomercaticeras* is generally considered to be restricted to the Toarcian, but *Brodieia* can range into the Aalenian and occurs in South America, according to Geczy (1966, p. 25, 26).

Age and association. Neither of the collections from which *Pleydellia*(?) cf. *P. argentina* is described contains other diagnostic ammonites in direct association. One of them (GSC loc. C-117267 from Taseko Lake map area) was found as much as 23 m below the lowest *Tmetoceras* and is therefore probably Early Aalenian, if not Toarcian, in age.

Figured specimens. From Taseko Lakes map area (Yalakom River above Blue Creek).

Family HAMMATOCERATIDAE Buckman, 1887

Genus *Erycitoides* Westermann, 1964

Synonyms. non Podagrosiceras Maubeuge and Lambert, 1955 (see Donovan et al., 1981).

Type species. Ammonites (*Lillia*) *howelli* White, 1889.

Discussion. Westermann (1964b) erected the genus, designated the lectotype of its type species, and gave an extensive discussion of the genus and its species. He erected two subgenera, *Erycitoides* s.s. and *Kialagvikes*, suggesting they were corresponding macro- and microconchs. Large and small specimens of these types are associated in collections from southern Alaska, Western Canada and northern Yukon Territory. The western Canadian specimens do not exhibit lateral lappets that would prove the presence of microconchs, so that no further discussion of their differentiation is undertaken here. Westermann (pers. comm., 1987) recently considered the two subgenera to be synonymous. The specimens illustrated in this report from Western Canada confirm the morphological variability of the genus and its species, but insufficient material is available to discuss meaningfully infraspecific variability. There is a notable absence of spinose forms in British Columbia, in contrast to southern Alaska, unless the undeterminable specimens compared elsewhere in this report with *Sonninia* represent this group.

The Argentine genus *Podagrosiceras* Maubeuge and Lambert of similar age, differs from *Erycitoides* by the absence of a keel and the presence of alternating ribs on the venter, as well as a different septal suture (Westermann, 1964a, p. 391, Textfig. 18; Westermann and Riccardi, 1980). However, Donovan et al. (1981) considered the two genera to be synonymous, *Podagrosiceras* having priority, supposing the absence of a keel in normally keeled forms to be a recurring, occasional phenomenon. The differentiating morphological characters are consistently present in these geographically exclusive genera.

Erycitoides howelli (White, 1889)

Plate 3, figures 1-7, 10-14, 18, 19, 21, 22;
Plate 4, figures 5, 6, 13-15; Plate 5, figures 1-3

Ammonites (*Lillia*) *howelli* White, 1889, p. 68, Pl. 12, figs. 1, 2; Pl. 14, figs. 1-3.

Hammatoceras howelli (White). Pompeckj, 1900, p. 275.

Erycites howelli (White). Imlay, 1955, p. 90, Pl. 13, figs. 12, 13.

?*Erycites* cf. *E. howelli* (White). Frebold, 1961, p. 7, Pl. 5, fig. 2.

Erycitoides (*Erycitoides*) *howelli* (White). Westermann, 1964b, p. 360, Pls. 44-58, Textfigs. 6-15; Sei and Kalacheva, 1968, p. 39, Pl. 7, figs. 1-3; Pl. 8, figs. 4-6.

Erycitoides howelli (White). Carter and Jakobs, 1991, Pl. 1, figs. 1a, b.

Discussion. Erycitoides howelli has been exhaustively described by Westermann (1964b) from southern Alaskan collections, so the description is not repeated here. The specimens illustrated in this report are entirely typical of the species as recorded from southern Alaska and far eastern USSR, and contain the entire range of infraspecific variation. They are relatively evolute and planulate compared to other species of the genus. The ribs are closely spaced and flexuous in juvenile growth stages (Pl. 3, figs. 1, 2, 5) but nearly straight and rectiradiate in larger growth stages. There is considerable variation in the degree of projection near the venter at different growth stages (compare Pl. 3, figs. 3, 4, 21, 22).

One fragmentary specimen (Pl. 3, fig. 3) from the Whitesail Lake map area resembles the internal whorls of another, more typical adult (Pl. 3, figs. 19, 21) in that the ribs at intermediate growth stages are unusually strongly projected adorally. This specimen resembles *Bredyia* which, however, has a rounder and broader cross-section, is more involute, and has ribs which bifurcate lower on the flank (compare Pl. 3, fig. 3 and Pl. 4, figs. 2, 7).

Age and association. Erycitoides howelli occurs with *Tmetoceras scissum* in some collections, and with *T. kirki* (but not *T. flexicostatum*) in others, suggesting that it is mainly distributed through the middle and upper, but not uppermost, parts of the Aalenian. *Erycitoides howelli* commonly occurs with a variety of other ammonites, including *Pseudolioceras* and *Planammatoceras*(?), although it is the only ammonite in several collections. It was reported in strata that also contain *Bredyia* in Queen Charlotte Islands (Carter and Jakobs, 1991) but is not associated with the Lower Aalenian *Troitsaia*.

Figured specimens. From Taseko Lakes map area (head of Relay Creek), Whitesail Lake map area, Terrace map area (Mt. Sir Robert), Spatsizi map area (Joan Lake area, Nation Peak).

Erycitoides and *Erycitoides*(?) spp.

Plate 3, figures 8, 9, 15-17, 20

Discussion. Three specimens cannot be assigned to any known species, and their generic assignment is questionable because of the great strength and coarse spacing of their primary ribs. One of the specimens (Pl. 3, fig. 8) has falcoid ribs. They are all more evolute than *Bredyia*, and the primary ribs are more dominant. Another small fragment (Pl. 3, fig. 20) is undeterminable because of its poor preservation, but is figured because of its possible stratigraphic significance. Other small fragments figured may represent *Erycitoides*, judging by the general ribbing and coiling characteristics. Some of these closely resemble *E. levis* Westermann (1964b) in the strength of the primary ribs. Another, from the Taseko Lakes map area (GSC loc. C-62486, unfigured) apparently represents *E. kialagvikensis* (White).

Age and association. The various ammonites associated with *Erycitoides*(?) spp., including *Tmetoceras kirki*, indicate a mid-Aalenian age.

Figured specimens. From Taseko Lakes map area (head of Relay Creek), Whitesail Lake map area (Troitsa Peak), Spatsizi map area (Joan Lake).

Genus *Bredyia* Buckman, 1910

Synonyms. Burtonia Buckman, 1910; *Pseudammatoceras* Elmi, 1963.

Type species. Burtonia crassornata Buckman, 1910.

Discussion. The genus has been discussed extensively by Senior (1977) and Westermann (*in* Hillebrandt and Westermann, 1985). Its known distribution has been hitherto restricted to Europe and the Chilean Andes.

Bredyia sp. aff. *B. manflasensis* Westermann, 1985

Plate 2, figures 19, 20; Plate 4, figures 11, 12

Hammatoceras cf. *semilunatum* (Quenstedt). Cameron and Tipper, 1985, p. 21.

aff. *Bredyia manflasensis* Westermann *in* Hillebrandt and Westermann, 1985, p. 24, Pl. 2, figs. 2-4, Pl. 3, figs. 1-3, Pl. 4, figs. 1-4, Textfigs. 7-9, 10a, b.

Discussion. Bredyia sp. aff. *B. manflasensis* from Queen Charlotte Islands is perhaps slightly stouter than typical specimens of equivalent size of the South American species. *Bredyia manflasensis* is distinguished from *Erycitoides howelli* by being more involute, with a broader, more rounded cross-section, longer secondary ribs (Westermann, 1964a, b; Hillebrandt and Westermann, 1985), and a different septal suture pattern. The presence of a keel, characteristic of the genus, is not proven in the Canadian specimens, because of the imperfect preservation.

Age. The specimens described here as *Bredyia* sp. aff. *B. manflasensis* were not found in association with other ammonites. *Bredyia manflasensis* in South America is Early Aalenian in age (Hillebrandt and Westermann, 1985) as is the genus *Bredyia* in Europe (Senior, 1977) i.e., lower and (mainly) upper, *Leioceras opalinum* Standard Zone. An Early Aalenian age is entirely consistent with the stratigraphic occurrence of the Canadian specimen – immediately above Toarcian beds.

Figured specimens. From the Queen Charlotte Islands (Graham Island).

Bredyia sp.

Plate 4, figures 1-4, 7-10

Discussion. Bredyia is probably also represented by four fragmentary specimens from Queen Charlotte Islands that also have not been found in direct association with other ammonites. In the smallest specimen (Pl. 4, figs. 9, 10), the ribs are relatively closely spaced, the shell is moderately involute and compressed, the cross-section is oval, the keel is poorly developed or absent, and there is a suggestion that ribs alternate in the ventral view. These characters, in combination, differentiate the specimen from the species described in this report, and the character of the venter allies it with *Podagrosiceras*, a genus so far known only from South America (Maubeuge and Lambert, 1955; Westermann, 1964a; Westermann and Riccardi, 1975, 1980; Hillebrandt and Westermann, 1985). The ribs of the Canadian specimens are, however, weaker and more irregularly developed than in any described species of that genus. Coarse, slightly sinuous, and clearly opposed ribs are seen in the largest specimen (Pl. 4, figs. 1, 8), which also bears a faintly developed keel characteristic of *Bredyia*. Two of the specimens (Pl. 4, figs. 2, 7, 9, 10) resemble *Bredyia* sp. aff. *B. manflasensis* described above in their coiling and cross-section.

Age. The specimens illustrated in this report as *Bredyia* sp. have not been found in association with other ammonites but their Early Aalenian age suggested by its occurrence immediately above Toarcian beds is consistent with the range of the genus worldwide.

However, since this report was written, Carter and Jakobs (1991) have identified *Bredyia* sp. together with *Planammatoceras* sp. and close to *Erycitoides howelli* (White) suggesting overlap between the range of *Bredyia* and these mainly Upper Aalenian genera.

Figured specimens. From the Queen Charlotte Islands (Yakoun River).

Genus *Planammatoceras* Buckman, 1922

Type species. Planammatoceras planiforme Buckman, 1922.

A diagnosis of the genus was given by Westermann and Riccardi (1982), who also discussed its relationship with *Eudmetoceras* (*Euaptetoceras*) and its age significance.

Planammatoceras(?) spp.

Plate 5, figures 4-12

Discussion. Several flattened impressions of whorl fragments are referred to *Planammatoceras*(?). They cannot be identified with great confidence, and are not complete enough to be compared in detail with known species, or be meaningfully differentiated from each other. *Planammatoceras planiforme* Buckman is typical of the genus in Europe, as is *P. gerthi* (Jaworski) in South America, and the Canadian material resembles both those species as far as can be determined. One of the Canadian specimens (Pl. 5, figs. 4, 5) has a moderately stout cross-section, and exhibits a low keel.

The ribs on some of the specimens bifurcate (e.g., Pl. 5, fig. 6), those of other specimens (e.g., Pl. 5, fig. 12) trifurcate from swollen primary ribs, and one (Pl. 5, fig. 10) shows minor intercalation of secondary ribs between trifurcating ribs. Two stages of bifurcation are seen in yet another specimen (Pl. 5, fig. 11). All the ribs are very gently sigmoid.

None of the three small fragments figured by Imlay (1973) from Oregon as *Planammatoceras*(?) sp. is generically identifiable, and some of those that Imlay (1973, Pl. 6) figured as *Eudmetoceras* (*Euaptetoceras*) could represent *Planammatoceras* or other genera just as well. Thus, apparently, only the two specimens figured as such by Westermann (1964b) probably represent *Euaptetoceras* in the Aalenian of western North America, and the record of definite *E.* (*Euaptetoceras*) is equivocal. The Canadian specimens figured here probably do not represent *Euaptetoceras* because of the relatively short primary ribs in some, and the persistence of coarse ribbing to large growth stages in others. One of the Canadian specimens (Pl. 5, fig. 9) could possibly represent *Praestrigites* Buckman, an Aalenian genus that has been recorded in Oregon (Imlay, 1973), but the fragment is too small for identification to be conclusive. Another of the Canadian specimens (Pl. 5, fig. 7) may represent *Planammatoceras* (*Pseudaptetoceras*) and thus indicate a latest Aalenian age, but it also is not identifiable with certainty.

Age and association. Planammatoceras(?) in the Canadian collections is generally associated with a rich variety of other ammonites, mainly *Tmetoceras* and *Erycitoides*, and bivalves. Presumably it spans most of the Aalenian stage, as the genus does worldwide (Westermann and Riccardi, 1982; Hillebrandt and Westermann, 1985).

Figured specimens. From Taseko Lakes map area (Yalakom River above Blue Creek), Spatsizi map area (Joan Lake), Laberge map area (Long Lake).

Genus *Parammatoceras* Buckman, 1925

Discussion. Parammatoceras has been variously considered a subgenus of *Planammatoceras* (e.g., Arkell et al., 1957) or *Euaptetoceras* Buckman. It has been discussed recently by Hillebrandt and Westermann (1985), who also described its distinguishing characteristics from *Hammatoceras* Hyatt, *Eudmetoceras* Buckman, and *Planammatoceras*.

Type species. Parammatoceras obtectum Buckman, 1925.

Parammatoceras(?) sp.

Plate 7, figure 20

Discussion and association. A small fragment from the Whitesail Lake area shows the ventral portions of ribs, rectiradiate and straight, extending entirely up to, but not onto, a ventral keel (or possibly a ventrolateral carina). Its affinities are totally unknown, and no other Aalenian ammonite known to the writers exhibits such a feature, although some species of *Parammatoceras* are somewhat similar. It occurs together with *Tmetoceras scissum* and *Erycitoides*(?) sp.

Figured specimen. From Whitesail Lake map area (Troitsa Peak).

Family SONNINIIDAE Buckman, 1892

Genus *Sonninia* Bayle, 1879

Synonyms. See Arkell et al., 1957, p. L267; Donovan et al., 1981, p. 143.

Type species. Waagenia propinquans Bayle, 1878.

Subgenus *Euhoploceras* Buckman, 1913

Synonyms. See Donovan et al., 1981.

Type species. Sonninia acanthodes Buckman, 1889.

Sonninia(?) (*Euhoploceras*?) spp.

Plate 7, figures 21, 22

Discussion. Two poorly preserved specimens from the Whitesail Lake and Terrace map areas are not generically identified nor are they necessarily congeneric or conspecific. They are morphologically distinctive in the presence of a weak tubercle on each primary rib half way up the flank, just below the line of overlap of each succeeding whorl. The primary ribs are rectiradiate, strong, and moderately to widely spaced. Secondary ribs cannot be clearly seen. On the smaller specimen (Pl. 7, fig. 22) the simple primaries continue ventrally beyond the tubercles, but their ventralmost terminations cannot be discerned clearly. On the larger specimen (Pl. 7, fig. 21), there is a suggestion that one or two primaries bifurcate at the tubercle, but this is unclear, and the ventralmost parts of the whorls are entirely undecipherable. The shell appears to become smooth in the largest growth stages preserved.

The larger specimen was seen by G.E.G. Westermann, who commented (pers. comm., 1987):

> "The impression shows prominent primaries on the nucleus and rectiradiate ribs with small lateral tubercles on the ultimate half-whorl; shell crushed and venter not preserved.
>
> "I believe that this is a *Sonninia* s.l., and probably *S.* (*Papilliceras*) rather than *S.* (*Euhoploceras*), although the ribs on the inner whorl are very distant as in the latter, but without tubercles or spines as in the former; weakening of ribs on ultimate half-whorl where tubercles occur is typical of *S.* (*Papilliceras*). For example see *S.* (*P.*) *espinazitensis* as illustrated plentifully by Westermann and Riccardi 1972 from the *Emileia giebeli* Zone of the Andes.
>
> "The subgenus occurs in Western Europe and Andes in the uppermost Laeviuscula and Sauzei zones. The alternative is that it is an unusual *S.* (*Euhoploceras*) with missing tubercles on inner whorl, of Concava-Discites zones. . . ."

The tentative assignment of these specimens to *Sonninia* (*Euhoploceras*) is based on their probable Aalenian age, and partly on Westermann's comments on the larger specimen.

These specimens differ from *Erycitoides paucispinosus* Westermann from southern Alaska and *Puchenquia* (*Gerthiceras*) *mendozana* from Argentina (Westermann and Riccardi, 1982) in the presence of tubercles on each primary rather than every second or third rib.

Two Aalenian and earliest Bajocian species illustrated from Europe by Renz (1925) – "*Hammatoceras*" *diadematoides* Mayer and "*H.* " *buxtorfi* Renz – have similar, or perhaps stronger nodes and coiling, but the Canadian specimens are not well enough preserved to compare other characteristics. The same is true for somewhat similar *Puchenquia* (*Gerthiceras*) *mendozana spinosa* Westermann (*in* Hillebrandt and Westermann, 1985).

Age and association. The two Canadian specimens are associated with ammonites suggestive of the lower part of the Aalenian in one case (*Troitsaia westermanni, Tmetoceras* sp.; GSC loc. C-53517 from the Whitesail Lake map area) and perhaps a higher part in the other (*Erycitoides howelli, Tmetoceras scissum*; GSC loc. C-101443 from the Terrace map area).

Figured specimens. From Whitesail Lake map area, Terrace map area (Mt. Sir Robert).

Genus *Zurcheria* Douvillé, 1885

Type species. *Zurcheria ubaldi* Douvillé, 1885.

The taxonomy and suprageneric classification of *Zurcheria* were discussed by Westermann and Riccardi (1972).

Zurcheria(?) sp.

Plate 6, figures 9-11

Discussion. Three poorly preserved specimens appear to be moderately evolute, and have sinuous ribs, a few of which may bifurcate. Their taxonomic affinities are uncertain. The shape of the ribs, and the coiling characteristics of one of them (Pl. 6, fig. 9) resemble that of *Zurcheria* and *Ludwigia*. The ribs appear to die out at the ventrolateral rounded edge. The venter cannot be seen and the specimens are not completely enough preserved to compare other characteristics. *Zurcheria*, normally thought to be Early Bajocian in age, has been recorded from the Aalenian of Argentina (Westermann and Riccardi, 1972; Hillebrandt and Westermann, 1985) and Europe (e.g., Lelievre, 1960), and the Canadian specimens, poorly preserved as they are, resemble the Argentine species *Z. groeberi* Westermann and Riccardi. Some specimens identified as closely superjacent *Sonninia* (*Euhoploceras*) *amosi* Westermann and Riccardi (1972) from Argentina, in which bifurcation of the ribs is not clearly developed (e.g., Westermann and Riccardi, 1975, Pl. 1, fig. 8) are also similar. Schindewolf (1964) and Linares and Sandoval (1986) created new genera for Aalenian species in Spain that had previously been assigned to *Zurcheria*, emphasizing what they considered to be the restricted Bajocian age of *Zurcheria* itself. The Canadian and Argentine species are not easily assigned to their new Aalenian genera, however, and may well represent yet another new genus.

Age and association. Each of the three Canadian specimens occurs in faunas that contain several other ammonite taxa which are not, however, reliably diagnostic of any particular part of the Aalenian stage.

Figured specimens. From Taseko Lakes map area (head of Relay Creek), Spatsizi map area (Joan Lake, Nation Peak).

Superfamily HAPLOCERATACEAE Zittel, 1884

Family LISSOCERATIDAE Douvillé, 1885

The classification follows Donovan et al. (1981).

Genus *Lissoceras* Bayle, 1879

Type species. *Ammonites psilodiscus* Schloenbach, 1865.

Lissoceras(?) sp.

Plate 6, figures 15-18

Discussion. Four small specimens resemble *Lissoceras* and other Lissoceratidae. If they belong to this group they represent its earliest known occurrence, no member of the family having been reported from pre-Bajocian strata before. The specimens are smooth, involute, and relatively compressed, with rounded umbilical edges, and (apparently) a rounded venter and no keel.

Age and association. The association of *Lissoceras*(?) with only *Pseudolioceras* in one collection (GSC loc. C-53542) and its occurrence without other diagnostic ammonites in another, also from the Whitesail Lake map area (C-80299) prevent its precise dating within the Aalenian.

Figured specimens. From Whitesail Lake map area (Wells Grey Peak area), Smithers map area (Michel Lake).

Superfamily PHYLLOCERATACEAE Zittel, 1884

Family PHYLLOCERATIDAE Zittel, 1884

Genus *Phylloceras* Suess, 1865

Synonyms. See Arkell et al., 1957; Joly, 1975.

Type species. *Ammonites heterophyllus* J. Sowerby, 1820.

Phylloceras sp.

Plate 7, figure 25

Discussion. One small fragment of a large, finely ribbed specimen (Pl. 7, fig. 25), and possibly also an extremely poorly preserved, crushed impression of a small, smooth ammonite (unfigured specimen GSC 83392 from GSC loc. C-90715; Spatsizi map area) represent *Phylloceras*.

Figured specimen. From Terrace map area (Mt. Sir Robert).

Genus *Holcophylloceras* Spath, 1927

Synonyms. See Arkell et al., 1957; Joly, 1975.

Type species. *Phylloceras mediteranneum* Neumayr, 1871.

Holcophylloceras sp.

Plate 7, figures 23, 24

Discussion. Two small fragments (one unfigured) from Taseko Lakes area are available. They are smooth, except for sigmoid constrictions, and compressed.

Figured specimen. From Taseko Lakes map area.

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APPENDIX: LIST OF GSC FOSSIL LOCALITIES AND FOSSILS

All localities preceded by "C-" were originally catalogued at the Institute of Sedimentary and Petroleum Geology in Calgary, all the others were catalogued in Ottawa.

All specimens are housed in the National Type Collection of Plant and Invertebrate Fossils, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8.

The locality descriptions are organized by map area, as in the text.

HOPE MAP AREA, B.C. (NTS 92 H)

25778. H. Frebold, 1955. Same as GSC loc. 27997. (Section 1.)
Dumortieria sp.
bivalves, indet.

25781. H. Frebold, 1955. West side of Harrison Lake, 17.7 km from Agassiz-Mission Highway. (Section 1.)
Tmetoceras sp.
Myophorella sp.
Coelastarte(?) sp.
Oxytoma sp.
Pinna(?) sp.
Pleuromya(?) sp.
other bivalves
belemnites

25782. H. Frebold, 1955. West side of Harrison Lake, 17.7 km from Agassiz. Same as GSC loc. 27995. (Section 1.)
ammonite, undetermined, could be *Erycitoides*(?)
Coelastarte(?) sp.
Variamussium(?) sp.
Camptochlamys sp.
bivalves

27995. H. Frebold, 1956. West side of Harrison Lake, 17.7 km from Agassiz. Same as GSC loc. 25782. (Section 1.)
Pecten sp.
Oxytoma sp.
Trigonia sp.
Grammatodon(?) sp.
Camptochlamys(?) sp.
Variamussium(?) sp.
Thracia(?) sp.
Coelastarte(?) sp.
Meleagrinella(?) sp.
gastropods
belemnites

27996. H. Frebold, 1956. West of Harrison Lake. Ammonite bed.
Troitsaia(?) or *Dumortieria*(?) sp.
Tmetoceras(?) sp.
Lima(?) sp.
bivalves
belemnites

27997. H. Frebold, 1956. West of Harrison Lake about 17.7 km from Harrison Mills. (Section 1.)
Dumortieria sp.
Leda? sp.
Pecten sp.
Thracia(?) sp.
belemnites

27999. H. Frebold, 1956. Roadcut west of Harrison Lake, a few hundred feet (100 m?) down the road from GSC loc. 27995. (Section 1.)
Dumortieria sp.
belemnites

28000. H. Frebold, 1956. West of Harrison Lake, on abandoned lumber road, at turnoff from Powerline Road, 16 to 17 km from Harrison Mills. (Section 1.)
Troitsaia(?) sp. or *Dumortieria*(?) sp.
belemnites
bivalves

28005. H. Frebold, 1956. West of Harrison Lake. (Section 1.)
ostreiid(?) bivalve
belemnites

68688. J.A. Coates, 1965. In saddle at head of north-south fork of creek, Canan Copper Mine. Elevation 1860 m (6100 ft.), a few yards inside the boundary of Manning Park. Locality 46 of Divide Section.
Tmetoceras sp. aff. *T. scissum* (Benecke)
Inoceramus? sp.

69408. J.A. Coates, 1965. Elevation 1973 m (6475 ft.) on west side of 1981 m (6500 ft.) summit on ridge north of 26 Mile Creek, a few hundred metres (yards) west of east boundary of Map 92 H/3E1/2.
Troitsaia westermanni gen. et sp. nov.

75099. J.A. Coates, 1966. Approximately 168 m stratigraphically below GSC loc. 75097, on east side of a 15 m wide chimney outcrop; lat. 49°09′45″N, long. 120°59′20″W. Divide Section.
Tmetoceras? sp. aff. *T. scissum* (Benecke)

75108. J.A. Coates, 1966. About 76 m west of GSC loc. 75110. On north side of east-trending ridge; lat. 49°09′29″N, long. 121°00′20″W. Divide Section, from float and outcrop. Divide Section 46A.
Tmetoceras sp. aff. *T. scissum* (Benecke)
Inoceramus sp.

75110. J.A. Coates, 1966. North side of east-west ridge. Small patch of shale talus with dykes outcropping at west side; lat. 49°09′20″W, long. 121°00′20″W. Divide Section, locality 121B.
Tmetoceras sp. aff. *T. scissum* (Benecke)
bivalve fragments

75111. J.A. Coates, 1966. From 37 m wide talus-covered area just below crest of ridge on north side, and on west side of north-trending spur. All from talus; lat. 49°09′25″N, long. 121°00′20″W. Divide Section, locality 121A.
Tmetoceras sp. aff. *T. scissum* (Benecke)
Erycitoides(?) sp.

Inoceramus sp.

C-88069. J.W.H. Monger, 1985. Major unnamed creek north of Utilius Creek; lat. 49°50′25″N, long. 121°21′05″W. Dewdney Creek Group, near green volcaniclastic sandstone.
Tmetoceras scissum (Benecke)
bivalves
belemnites

C-88070. J.W.H. Monger, 1985. East Anderson River; lat. 49°46′N, long. 121°19′12″W. Dewdney Creek Group.
Tmetoceras sp.

C-118592. A. Arthur for J.W.H. Monger, 1985. Southwest side of Harrison Lake, 2.5 km northwest of outlet of lake; lat. 49°19′48″, long. 121°49′25″W. (?)Harrison Lake Formation.
Planammatoceras(?) sp.

C-118673. J.W.H. Monger, 1985. Anderson River; lat. 49°48′25″N, long. 121°20′56″W. Dewdney Creek Group.
Tmetoceras sp.

C-118676. J.H.W. Monger, 1985. East Anderson River Road at first bridge; lat. 49°45′27″N, long. 121°20′28″W. Dewdney Creek Group, isolated outcrop.
Tmetoceras(?) sp.
Erycitoides(?) sp.
Sonninia(?) sp.
Bositra(?) sp.
Inoceramus sp.

C-143283. A. Arthur for J.W.H. Monger, 1986. West of Harrison Lake, 2.2 km west-northwest of Celia Cove; lat. 49°19′51″, long. 121°50′12″W. Harrison Lake Formation.
Tmetoceras(?) sp.

C-143284. D. Pearson (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1973. On old road in creek, north of Weaver Lake about 3 km west of Camp Cove; lat. 49°21′58″N, long. 121°52′02″W. Harrison Lake area, Harrison Lake volcanics.
Trigonia sp.
other bivalves
gastropods
corals
terebratulid brachiopods
rhynchonellid brachiopods

C-146151. J.W.H. Monger, 1985. Quarry, south side of Anderson River near head; lat. 49°42′55″N, long. 121°15′42″W. Dewdney Creek Group, isolated outcrop, collected in float.
Tmetoceras flexicostatum Westermann
Planammatoceras(?) sp.
Astarte sp.
Trigonia sp.
Myophorella sp.
Inoceramus? sp.
belemnites

TASEKO LAKES MAP AREA, B.C. (NTS 92 O)

13807. G.B. Leech, 1947. Northeast bank of Yalakom River, about 366 m above mouth of Blue Creek. Shulaps Range, Bridge River District. Same as GSC locs. 13810, 13812, 17008.
Tmetoceras sp. cf. *T. scissum* (Benecke)
ostreiid bivalve

13810. G.B. Leech, 1947. Northeast bank of Yalakom River, about 366 m above mouth of Blue Creek. Shulaps Range, Bridge River District. Same as GSC locs. 13807, 13812, 17008.
Pleydellia(?) sp. cf. *P. argentina* Maubeuge and Lambert
Inoceramus? sp.

13812. G.B. Leech, 1947. Northeast bank of Yalakom River, about 366 m above mouth of Blue Creek. Shulaps Range, Bridge River District. Same as GSC locs. 13807, 13810, 17008.
Tmetoceras sp. cf. *T. scissum* (Benecke)
Tmetoceras kirki Westermann
Pseudolioceras sp. cf. *P. whiteavesi* (White)
Pseudolioceras(?) or *Ludwigia*(?) sp.

14153. G.B. Leech, 1947. Shulaps–Yalakom area. On east bank of the Yalakom River, about 1.6 km north of the mouth of Blue Creek.
Tmetoceras sp. cf. *T. scissum* (Benecke)

17008. G.B. Leech, 1948. On northeast bank of Yalakom River, 366 m above Blue Creek. Same as GSC locs. 13807, 13810, 13812.
Tmetoceras sp. cf. *T. scissum* (Benecke)
Tmetoceras kirki Westermann

56509. H.W. Tipper, 1963. On saddle 6.4 km east of Castle Peak, just west of porphyry dyke.
Erycitoides sp. aff. *E. howelli* (White)
Tmetoceras sp.
Inoceramus sp.

56608. H.W. Tipper, 1963. 188 m up Yalakom River from mouth of Blue Creek. 13.7 m stratigraphically above major ammonite horizon.
Tmetoceras sp.
ostreiid bivalve

56624. H.W. Tipper, 1963. 274 m up Yalakom River from mouth of Blue Creek, just south of precipitous spur.
Tmetoceras sp. cf. *T. scissum* (Benecke)
Erycitoides sp. aff. *E. howelli* (White)
Planammatoceras(?) sp.
other ammonite, indet.
Inoceramus sp.

62486. H.W. Tipper, 1964. Saddle south of Cardtable Mountain; lat. 51°06′N, long. 122°57′W.
Erycitoides kialagvikensis (White)

74832. H.W. Tipper, 1966. 0.8 km north of Blue Creek on Yalakom River, east side; lat. 51°02′10″N, long. 122°27′40″W.
ammonite, indet.
Inoceramus sp.

78798. J.A. Jeletzky, 1967. Northern shore of Konni Lake about 46 m above the water level and about 1066 m from northeast corner of the lake.
Tmetoceras(?) sp.
Oxytoma sp.
Inoceramus sp.
bivalves
belemnites

94848. H.W. Tipper and T.P. Poulton, 1976. On ridge, at head of Relay Creek; lat. 51°07′05″N, long. 123°01′34″W.
Tmetoceras kirki Westermann
Erycitoides howelli (White)
Erycitoides(?) sp.
Planammatoceras(?) sp.
Zurcheria(?) sp.
Pleuromya sp.
ostreiid bivalve
gastropods
rhynchonellid(?) brachiopods

C-81702. H. Sargent, 1941. Upper Yalakom River, west of Fraser River upstream from mouth of Blue Creek.
Tmetoceras flexicostatum Westermann
Tmetoceras sp.
Pseudolioceras(?) sp.
Inoceramus sp.
Oxytoma(?) sp.
ostreiid bivalve

C-117013. H.W. Tipper, 1986. West-southwest of Relay Mountain, 4.8 km northwest of Castle Peak; lat. 51°06′52″N, long. 123°01′39″W. Talus.
Tmetoceras sp. cf. *T. scissum* (Benecke)
bivalves

C-117015. H.W. Tipper, 1986. West-southwest of Relay Mountain, 4.8 km northwest of Castle Peak; lat. 51°06′52″W, long. 123°01′39″W. Talus.
Tmetoceras scissum (Benecke)
Tmetoceras sp. cf. *T. flexicostatum* Westermann
Holcophylloceras sp.
other ammonite, indet.

C-117263. H.W. Tipper, 1985. Yalakom River, 0.8 km above Blue Creek, Tadekahi; lat. 51°01′50″N, long. 122°27′30″W. Believed to be stratigraphically above GSC loc. C-117264. (Section 1.)
Tmetoceras(?) sp.
Astarte sp.
belemnite

C-117264. H.W. Tipper, 1985. Yalakom River, 0.8 km above Blue Creek; lat. 51°01′50″N, long. 122°27′30″W. Same as old locality of Leech and H. Sargent (GSC loc. C-81702). (Section 1.)
Tmetoceras scissum (Benecke)
Inoceramus sp.

C-117265. H.W. Tipper, 1985. Yalakom River, 0.8 km above Blue Creek; lat. 51°01′50″N, long. 122°27′30″W. 3 m below GSC loc. C-177264. (Section 1.)
Tmetoceras scissum (Benecke)
Tmetoceras kirki Westermann
Inoceramus sp.

C-117266. H.W. Tipper, 1985. Yalakom River, 0.8 km above Blue Creek; lat. 51°01′50″N, long. 122°27′30″W. 5.6 m below GSC loc. C-117265. (Section 1.)
Tmetoceras sp.

C-117267. H.W. Tipper, 1985. Yalakom River, 0.8 km above Blue Creek; lat. 51°01′50″N, long. 122°27′30″W. About 23 m below GSC loc. C-117266. (Section 1.)
Pleydellia(?) sp. cf. *P. argentina* Maubeuge and Lambert

C-143293. H.W. Tipper, 1986. Tyaughton Creek, northwest of Castle Peak, southwest of Relay Mountain; lat. 51°06′42″N, long. 123°01′44″W.
Tmetoceras scissum (Benecke)
Pseudolioceras(?) sp.

C-143294. H.W. Tipper, 1986. Tyaughton Creek, west-northwest of Castle Peak, west-southwest of Relay Mountain, elevation 2316.5 m (7600 ft.); lat. 51°06′40″N, long. 123°02′21″W.
Erycitoides(?) sp.
Planammatoceras(?) sp.
Phylloceras sp.
cephalopod arm hooks (?)

C-143348. H.W. Tipper, 1986. Tyaughton Creek; ridge west-southwest of Relay Mountain, northwest of Cardtable Mountain; lat. 51°09′03″N, long. 123°01′39″W.
Tmetoceras scissum (Benecke)
Lissoceras(?) sp.
Pseudolioceras(?) sp.
Inoceramus sp.

C-154053. J.K. Glover (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1987. UTM 508460E, 5658380N; lat. 51°04′44″N, long. 122°52′45″W. North of Lower Tyaughton Creek. Same as GSC loc. C-154074.
Tmetoceras kirki Westermann
Pseudolioceras sp.
Erycitoides(?) sp.
Planammatoceras(?) sp.
ostreiid(?) bivalves

C-154074. J.K. Glover (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1987. UTM 508460E, 5658380N; lat. 51°04′44″N, long. 122°52′45″W. North of Lower Tyaughton Creek. Same as GSC loc. C-154073.
Tmetoceras kirki Westermann
Pseudolioceras sp.
ostreiid bivalves

MOUNT WADDINGTON MAP AREA, B.C (NTS 92 N)

78647. H.W. Tipper, 1967. North of Stikelan Pass. Talus; lat. 51°27′N, long. 124°17′W.
Tmetoceras(?) sp.

C-177414. H.W. Tipper, 1990. South end of Huckleberry Mountain; lat. 51°27′32″N, long. 124°16′40″W.
Planammatoceras(?) sp.
Tmetoceras(?) sp.
ammonites, indet.

C-177419. H.W. Tipper, 1990; lat. 51°27′30″N, long. 124°16′35″W.
Tmetoceras sp. aff. *kirki* Westermann
Planammatoceras(?) (*Pseudaptetoceras*?) sp.
ammonite, indet.

C-177420. H.W. Tipper, 1990. South end of Huckleberry Mountain.
Tmetoceras(?)

C-177424. H.W. Tipper, 1990. South end of Huckleberry Mountain; lat. 51°27′25″N, long. 124°16′58″W.
Tmetoceras sp. cf. *T. kirki* Westermann
Erycitoides(?) sp.
ammonites, indet.

QUESNEL LAKE MAP AREA, B.C (NTS 93 A)

40030. R.B. Campbell, 1959. 122 m northwest of Island Lake. 7.4 km on a bearing of 40° from Miocene outcrop on Horsefly Road.
Erycitoides sp.

91755. H.W. Tipper, 1974. East side of Beaver Valley on road 4.8 km north of Likely Road.
Tmetoceras(?) sp.
other ammonites, indet.
bivalves

C-149638. H.W. Tipper, 1986. East side of Beaver Valley on road 4.8 km north of Likely Road. Same locality as GSC loc. 91755.
Tmetoceras(?) sp.
Erycitoides(?) sp.

WHITESAIL LAKE MAP AREA, B.C (NTS 93E)

13753. S. Duffell, 1947. Northwest ridge of Troitsa Peak, 1.6 km south of GSC loc. 13758. At or near GSC loc. 88610. (Section 1). Frebold (1951; *in* Duffell, 1959) reported *Tmetoceras*, bivalves and gastropods.

13754. S. Duffell, 1947. Northwest ridge of Troitsa Peak, 0.8 km south of GSC loc. 13753. At or near GSC loc. 88610. (Section 1). Frebold (1951; *in* Duffell, 1959) reported *Tmetoceras*, bivalves and gastropods.

13758. S. Duffell, 1947. Northwest ridge of Troitsa Peak, north end. At or near GSC loc. 88610. (Section 1). See also Frebold (1951; *in* Duffell, 1959).
Tmetoceras scissum (Benecke)
Erycitoides(?) sp.
"*Tellina*" sp.
Inoceramus? sp.
belemnites

88142. H.W. Tipper, 1971. Whitesail Range; lat. 53°38′N, long. 127°05′W. (Section 1.)
Tmetoceras sp.
ammonites, undetermined
Inoceramus sp.

88606. T.P. Poulton, 1971. Ridge of Troitsa Peak, small saddle due west of north point of glacier. East of ridge, 1.6 km north of highest point; lat. 53°35′45″N, long. 127°06′05″W. Same general area as GSC loc. 88607. (Section 1.)

Troitsaia westermanni gen. et sp. nov.
Myophorella sp. aff. *M. yellowstonensis* Imlay
Protocardia sp.
Astarte? sp.
Pleuromya sp.
other bivalves
belemnoids
gastropod

88607. T.P. Poulton, 1971. About same as GSC loc. 88606. Troitsa Peak. (Section 1.)

Tmetoceras sp.
Troitsaia westermanni gen. et sp. nov.
Myophorella sp. aff. *M. yellowstonensis* Imlay
Myophorella spp.
Pleuromya sp.
Entolium sp.
Astarte sp.
Lima? sp.
Grammatodon spp.
Protocardia sp.
"*Liogryphaea*"? sp.
Goniomya sp.
other bivalves, indet.

88608. T.P. Poulton, 1971. About same as GSC loc. 88606. Troitsa Peak. (Section 1.)

Erycitoides? sp.
Myophorella sp. aff. *M. yellowstonensis* Imlay
Myophorella sp. aff. *M. tipperi* Poulton
Vaugonia sp.
Trigonia sp.
"*Ostrea*"? sp.
Grammatodon spp.
Lima sp.
Pholadomya sp.
Astarte? sp.
Pinna sp.
Ctenostreon? sp.
bivalves, indet.
belemnoids
gastropods
corals

88609. T.P. Poulton, 1971. Northwest ridge of Troitsa Peak, 1.13 km northwest of highest point; a siltstone unit south of and stratigraphically above GSC loc. 88608; and separated from it by about 30 m of coarse volcaniclastic sandstone; lat. 53°35′45″N, long. 127°06′05″W. (Section 1.)

Modiolus sp.
"*Liostrea*" sp.
Pleuromya(?) sp.
Lima? sp.
other bivalves
belemnites
rhynchonellid brachiopods
terebratulid brachiopods

88610. T.P. Poulton, 1971. Northwest ridge of Troitsa Peak. Small white-weathering saddle 0.8 km northwest of highest point, an 18 m interval south of and stratigraphically above GSC loc. 88609, and separated from it by about 62 m stratigraphically; lat. 53°35′45″N, long. 127°06′05″W. (Section 1.)

Tmetoceras scissum (Benecke)
Erycitoides(?) spp.
Parammatoceras(?) sp.
Pleuromya sp.
Gervillia sp.
Lima sp.
Gryphaea? sp.
"*Ostrea*" sp.
Modiolus sp.
Grammatodon sp.
Camptonectes(?) (*Mclearnia*?) sp.
Myophorella spp.
Inoceramus(?) sp.
Liostrea(?) sp.
other bivalves, indet.
rhynchonellid brachiopods

88745. H.W. Tipper, 1971. Ridge west of Troitsa Peak; lat. 53°38′N, long. 127°05′W. (Section 1.)

Tmetoceras sp.
Posidonomya sp.

C-53517. H.W. Tipper, 1978. Same as GSC loc. C-53518.

Tmetoceras sp.
Troitsaia westermanni gen. et sp. nov.
Sonninia(?) (*Euhoploceras*?) sp.
Myophorella yellowstonensis Imlay
Protocardia? sp.
Pleuromya sp.
corals

C-53518. H.W. Tipper, 1978. Whitesail Range. 2.4 km on a bearing of 285° from Troitsa Peak, Whitesail Lake map area. (Section 1.)

Troitsaia westermanni gen. et sp. nov.
"*Astarte*" sp.
other bivalves, indet.

C-53519. H.W. Tipper, 1978. Same as GSC loc. C-53518.
Troitsaia westermanni sp. nov. (?)

C-53520. H.W. Tipper, 1978. About 3 km west of Troitsa Peak, Whitesail Range.
Erycitoides howelli (White)
Tmetoceras scissum (Benecke)
Myophorella sp. aff. *M. tipperi* Poulton
Myophorella yellowstonensis Imlay
Myophorella sp.
Grammatodon sp.
Astarte sp.
Pinna sp.
Lima sp.
Ctenostreon sp.
Pleuromya sp.
Ostrea? sp.
Alectryonia sp.
belemnoids
gastropods
rhynchonellid brachiopods

C-53521. H.W. Tipper, 1978. Whitesail Range. Same as GSC loc. C-53518.
Erycitoides sp.
Myophorella sp. aff. *M. yellowstonensis* Imlay
Pleuromya sp.
Alectryonia sp.
Meleagrinella sp.
other bivalves
gastropods
terebratulid brachiopods

C-53527. H.W. Tipper, 1978. South side of Whitesail Range, approximately 4 km west of Troitsa Peak.
Tmetoceras scissum (Benecke)
Tmetoceras sp.
Erycitoides howelli (White)
Erycitoides sp.

C-53528. H.W. Tipper, 1978. Whitesail Range. Same as GSC loc. C-53527.
Tmetoceras sp.
Pleuromya sp.
Protocardia sp.

C-53529. H.W. Tipper, 1978. 3 km west of Troitsa Peak.
Tmetoceras kirki Westermann
Grammatodon spp.
Astarte(?) sp.
Trigonia sp.
belemnoids
corals(?)

C-53530. H.W. Tipper, 1978. 4.8 km west of Troitsa Peak, Whitesail Range.
Erycitoides howelli (White)
Erycitoides(?) sp.
Pleuromya sp.
Myophorella yellowstonensis Imlay
Astarte sp.
Grammatodon sp.
Gresslya(?) sp.
gastropods
rhynchonellids

C-53531. H.W. Tipper, 1978. Whitesail Range. Approximately 650 m south of GSC loc. C-80298.
Tmetoceras(?) sp.
Troitsaia sp.
gastropods

C-53535. M.L. Hill for T.A. Richards, 1979. Smithers Formation, float on top of hill. Same as GSC loc. C-53541.
Tmetoceras sp. aff. *T. scissum* (Benecke)
Myophorella sp.
other bivalves, indet.
gastropods
rhynchonellid brachiopods

C-53541. H.W. Tipper, 1978. Top of mountain west of Michel Lake, above unconformity. Same locality as GSC loc. C-53535.
Tmetoceras flexicostatum Westermann
Myophorella spp.
Grammatodon(?) sp.
Pinna sp.
Trigonia sp.
Astarte(?) sp.
Perna(?) sp.
Lima sp.
other bivalves, indet.
gastropods
belemnoids

C-53542. H.W. Tipper, 1978. South of top of mountain west of Michel Lake; lat. 53°35′N, long. 126°36′W. Closely associated with *Tmetoceras*-bearing beds, but bivalves are not typical of those from Aalenian beds elsewhere.
Pseudolioceras sp. cf. *P. whiteavesi* (White)
Lissoceras(?) sp.
Protocardia(?) sp.
Pinna sp.
Grammatodon(?) sp.

Myophorella sp. aff. *M. billhookensis* Poulton
Trigonia sp.
Vaugonia sp.
Lima sp.
Ostrea(?) sp.
Astarte(?) sp.
Entolium(?) sp.
other bivalves, indet.
belemnoids

C-53544. H.W. Tipper, 1978. Mountain west of Michel Lake, on south slope.
Tmetoceras sp. cf. *T. scissum* (Benecke)
bivalves

C-53560. H.W. Tipper, 1978. Mountain southwest of Troitsa Peak, top of Aalenian unit; lat. 53°34′N, long. 127°05′W.
Grammatodon sp.
Ostrea(?) sp.

C-53561. H.W. Tipper, 1978. Mountain southwest of Troitsa Peak, top of Aalenian unit; lat. 53°34′N, long. 127°05′W.
Grammatodon sp.
Entolium sp.
Lima sp.
Inoceramus sp.
Pleuromya (?) sp.
gastropods
corals

C-53562. H.W. Tipper, 1978. Mountain southwest of Troitsa Peak, top of Aalenian unit; lat. 53°34′N, long. 127°05′W.
Myophorella sp. aff. *M. yellowstonensis* Imlay
Entolium sp.
other bivalves, indet.
gastropods

C-53599. H.W. Tipper, 1978. Ridge southeast of Troitsa Lake. 4.7 km on a bearing of 250° from Troitsa Peak, Whitesail Lake map area. (Section 2.)
Myophorella sp. aff. *M. yellowstonensis* Imlay
Pleuromya(?) sp.
Ctenostreon sp.
Grammatodon sp.
Protocardia sp.
"*Liostrea*" sp.
Astarte(?) sp.
gastropods
corals

C-80298. M.L. Hill for H.W. Tipper, 1978. Approximately 5.8 km on a bearing of 283° from Troitsa Peak.
Erycitoides(?) sp.
Myophorella taylori Poulton(?)
Myophorella sp. aff. *M. tipperi* Poulton
Grammatodon(?) sp.
Astarte sp.
gastropod
rhynchonellid brachiopods

C-80299. M.L. Hill for G.J. Woodsworth, 1978. 1 km north-northeast of Wells Grey Peak, B.C.
Leioceras(?) or *Lissoceras*(?) sp.
Lima sp. aff. *L. tizglensis* McLearn
Pinna sp.
gastropods
rhynchonellid brachiopods

C-80300. G.J. Woodsworth, 1978. Whitesail area, B.C. UTM 659600E 5941100N.
Grammatodon spp.
corals
belemnoid

C-80313. H.W. Tipper, 1978. 3 km north of Troitsa Peak, Whitesail Range, B.C.
Tmetoceras scissum (Benecke)

C-143367. L. Diakow (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1986. Western Whitesail Range; lat. 53°34′12″N, long. 127°06′30″W. Smithers Formation. UTM zone 9u, 252399.
Troitsaia westermanni gen. et sp. nov.
Tmetoceras scissum (Benecke)
Pholadomya sp.
Pleuromya sp.

C-143371. H.W. Tipper, 1986. Northwestern Whitesail Range; lat. 53°35′36″N, long. 127°06′33″W. Smithers Formation. Isolated outcrop. UTM zone 9u, 252398.
Erycitoides howelli (White)

C-143373. L. Diakow (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1986. Troitsa Creek headwaters; lat. 53°34′38″N, long. 127°07′03″W. Whitesail Range, UTM zone 9u, 246379.
Tmetoceras sp.

C-143376. L. Diakow (British Columbia Ministry of Energy, Mines and Petroleum Resources), 1986. Southwest of Troitsa Peak; lat. 53°34′48″N, long. 127°06′12″W. Whitesail Range. Smithers Formation. Isolated outcrop. UTM zone 9u, 256382.
Tmetoceras(?) sp.
other ammonites, indet.

Pleuromya sp.
Corbicula(?) sp.

C-146155. T.P. Poulton and R.L. Hall, 1987. East side of small knob about 1/2 km east of main hill 3 km west of Michel Lake; lat. 53°34′59″N, long. 126°34′30″W.
Leioceras(?) sp.
Tmetoceras sp.
bivalves

SMITHERS MAP AREA, B.C (NTS 93 L)

83996. H.W. Tipper, 1969. 4 km west of Dome Mountain; lat. 54°45′20″N, long. 126°42′55″W.
Tmetoceras scissum (Benecke)
Myophorella sp. aff. *M. tipperi* Poulton
Grammatodon sp.
"*Ostrea*" sp., small spat

85251. H.W. Tipper, 1970. Hazelton Group, on ridge northwest of a small lake; lat. 54°46′N, long. 126°43′W.
Tmetoceras scissum (Benecke)
Entolium sp.
Pinna sp.
"*Ostrea*" sp.
Pleuromya(?) sp.
"*Astarte*" sp.
Grammatodon sp.
Lima spp.
Myophorella sp.
"*Terebratula*" sp.
rhynchonellid brachiopods
belemnoids

85316. H.W. Tipper, 1970. On ridge northwest of a small lake; lat. 54°46′N, long. 126°43′W.
Tmetoceras scissum (Benecke)
"*Ostrea*" sp.
Lima(?) sp.
Modiolus(?) sp.
Grammatodon sp.
other bivalves
belemnites

85328. H.W. Tipper, 1970. Hazelton Group. Small ravine (east-west) at south end of ridge west of a small lake; lat. 54°45′N, long. 126°43′W.
Tmetoceras scissum (Benecke)
Troitsaia westermanni gen. et sp. nov.
Trigonia sp.
Pinna(?) sp.
Pleuromya sp.
Myophorella sp.
"*Astarte*" sp.
Grammatodon sp.
Entolium(?) sp.
rhynchonellid brachiopods

87393. T.P. Poulton, 1971. Same as GSC locs. 87401, 87409. Same strata as GSC loc. 87401. Dome Mountain.
Tmetoceras scissum (Benecke)
Tmetoceras kirki Westermann (?)
Myophorella sp. aff. *M. tipperi* Poulton
Myophorella sp.
Gryphaea? sp.
Pecten sp.
Lima? sp.
Pleuromya? sp.
Grammatodon? sp.
Entolium? sp.
Pholadomya sp.
Astarte? sp.
"*Modiolus*" sp.
Tancredia? sp.
Perna? sp.
Inoceramus? sp.
other bivalves
belemnoids
terebratulid brachiopods
rhynchonellid brachiopods

87401. T.P. Poulton, 1971. Hazelton Group, small north-south trending ridge west of a small lake, 4 km west of peak of Dome Mountain, south end of ridge about 152 m north of small ravine; lat. 54°45′N, long. 126°42′30″W.
Tmetoceras sp.
Troitsaia westermanni gen. et sp. nov.
Myophorella sp. aff. *M. tipperi* Poulton
Myophorella sp.
Pinna(?) sp.
Pleuromya sp.
"*Astarte*" sp.
Grammatodon(?) sp.
Goniomya sp.
Pholadomya(?) sp.
belemnoids
terebratulid brachiopods

87409. T.P. Poulton, 1971. Same as GSC loc. 87401, about 61 m along strike to the south; same as GSC loc. 85328.
Tmetoceras scissum (Benecke)
Troitsaia westermanni gen. et sp. nov.
Pleuromya(?) sp.
Myophorella sp.
"*Astarte*" sp.
Grammatodon sp.
belemnoids

HAZELTON MAP AREA, B.C (NTS 103 M)

89616. T.A. Richards, 1972. 460 m west of north end of Nakinilerak Lake; lat. 55°17′12″N, long. 126° 18′48″W.
ammonites, poorly preserved, undeterminable imprints and fragments
Pinna sp.
other bivalves, indet.
belemnites

89624. T.A. Richards, 1972. Southwest-facing scarp of isolated +760 m (+2500 ft.) hill, some 0.8 km from west shore of Hatchery Arm (Babine Lake), approximately 1.6 km from inflow of Morrison Creek; lat. 55°06.8′N, long. 126°17.4′W.
Tmetoceras sp.
Myophorella
Pinna sp.
Gryphaea sp.
Rhynchonella sp.
belemnites

89626. T.A. Richards, 1972. Southern Bait Range, volcanic siltstone, Hazelton Group; lat. 53°32.3′N, long. 126°22.3′W.
Tmetoceras(?) sp.
belemnite
bivalves

89632. T.A. Richards, 1973. Southeast-trending ridge southeast of Netalzul Mountain, 14.5 km east of Babine Lake; lat. 55°13.2′N, long. 126°50′W.
ammonites, undeterminable fragments
Myophorella sp.
gastropods

89642. T.A. Richards, 1972. Bait Range South; lat. 55°30.7′N, long. 126°23.7′W. Volcanic tuff and sandstone, below *Tmetoceras*.
ammonites, poorly preserved, undeterminable
belemnites
pelecypods
gastropods

89649. T.A. Richards, 1972. Bait Range South; lat. 55°32.3′N, long. 126°22.3′W.
ammonite, undeterminable imprint

90977. T.A. Richards, 1973. On 1996.5 m (6550 ft.) high ridge north of Charleston Creek; lat. 55°38.7′N, long. 126°31.4′W. (Mixed collection?)
Tmetoceras(?) sp.
Phymatoceras sp.
Haugia(?) sp.
Dactylioceras sp.
ammonite, undeterminable

91060. T.A. Richards, 1973. South end of Netalzul Mountain; lat. 55°13.1′N, long. 126°50.5′W.
ammonite, undeterminable

91079. T.P. Poulton, 1973. Small creek flowing into headwaters of Tsezawaka Creek; lat. 55°18.75′N, long. 126°50.2′W.
Trigonia sp.
Myophorella sp.

91098. T.A. Richards, 1973. Southeast of Mount Netalzul; lat. 55°12.0′N, long. 126°50.4′W.
Tmetoceras(?) sp.

C-117145. T.A. Richards, 1973. East side of Old Fort Mountain. Smithers Formation; lat. 53°6′N, long. 126°20′W.
Tmetoceras sp.
Myophorella sp.
Vaugonia sp.
Trigonia(?) sp.
Pleuromya(?) sp.
other bivalves, indet.
belemnites

C-117149. T.A. Richards, 1973. Old Fort Mountain, east flank. Smithers Formation; lat. 55°6′N, long. 126°20′W.
Tmetoceras scissum (Benecke)
Myophorella sp. aff. *M. freboldi* Poulton
Grammatodon(?) sp.
Pronoella(?) sp.
Thracia(?) sp.
Modiolus sp.
Ctenostreon sp.
other bivalves
belemnites
corals
rhynchonellid brachiopods

TERRACE MAP AREA, B.C (NTS 103 I)

C-101443. G.J. Woodsworth, 1984. 5.4 km north of Mt. Sir Robert. UTM Zone 9. 555450E, 6076800N. Smithers Formation.
Tmetoceras scissum (Benecke)
Erycitoides howelli (White)
Sonninia (?) (*Euhoploceras*?) sp.
Phylloceras sp.

Myophorella sp.
Trigonia sp.
Vaugonia(?) sp.
Inoceramus sp.
Lima sp.
Pleuromya sp.
Pholadomya sp.
Pronoella(?) sp.
Pinna sp.
Ctenostreon
other bivalves
gastropods
belemnites
corals

McCONNELL CREEK MAP AREA, B.C (NTS 94 D)

93637. H.W. Tipper, 1975. Limy tuffaceous siltstone-sandstone. Scallop Mountain, southeast spur; lat. 56°03'N, long. 126°25'W.
Myophorella sp.
Grammatodon(?) sp.
Gervillia(?) sp.
Entolium sp.
Plicatula(?) sp.

SPATSIZI MAP AREA, B.C (NTS 104 H)

C-88216. H.W. Tipper, 1983. 6.6 km west-northwest from Mount Will, lat. 57°33'45"N, long. 128°54'12"W. Spatsizi Group.
ammonite, indet.

C-90678. John Reid for H. Gabrielse, 1981. 8.7 km west-northwest of Mount Will, Eaglenest Range; lat. 57°34'20"N, long. 128°56'20"W.
Pseudolioceras sp.
ammonite, indet.
Inoceramus sp.

C-90715. H. Gabrielse, 1981. Joan Lake; lat. 57°33'00"N, long. 128°59'50"W. Bowser Group, tuffaceous sandstone.
Tmetoceras scissum (Benecke)
Tmetoceras kirki(?) Westermann
Troitsaia westermanni gen. et sp. nov.
Phylloceras(?) sp.
Planammatoceras(?) sp.
Inoceramus sp.
belemnites

C-90719. H. Gabrielse, 1981; Joan Lake; lat. 57°33'45"N, long. 128°54'12"W. Bowser Group, tuffaceous sandstone.
Erycitoides howelli (White)
Erycitoides sp.
Erycitoides(?) sp.
Planammatoceras(?) sp.
Zurcheria(?) sp.
Pseudolioceras sp.
Pseudolioceras sp. cf. *P. whiteavesi* (White)
Leioceras(?) sp.
ammonite sp.
Inoceramus sp.

C-90745. H.W. Tipper, 1981. Cirque northwest of Joan Lake; lat. 57°30'00"N, long. 128°54'00"W. Spatsizi Group.
Erycitoides howelli (White)

C-90746. H.W. Tipper, 1981. Cirque northwest of Joan Lake, Spatsizi area; lat. 57°30'00"N, long. 128°54'00"W. Spatsizi Group.
Planammatoceras(?) sp.

C-90747. H.W. Tipper, 1981. Cirque northwest of Joan Lake; lat. 57°30'00"N, long. 128°54'00"W. Spatsizi Group.
Tmetoceras scissum (Benecke)
Inoceramus sp.
Entolium sp.

C-90961. H.W. Tipper, 1983. 8.85 km south of Nation Peak; lat. 57°34'41"N, long. 128°56'08"W. Aalenian tuffs, Spatsizi Group. Float.
Tmetoceras sp.

C-90963. H.W. Tipper, 1983. 8.85 km south of Nation Peak; lat. 57°34'30"N, long. 128°56'09"W. Aalenian tuffs, Spatsizi Group.
Erycitoides howelli (White)

C-101213. H.W. Tipper, 1983. 8.85 km south of Nation Peak; lat. 57°34'31"N, long. 128°56'08"W. Spatsizi Group.
Tmetoceras kirki Westerman
Erycitoides(?) sp.
Zurcheria(?) sp.
Leioceras(?) sp.

C-103194. P.L. Smith for H.W. Tipper, 1983; lat. 57°43'10"N, long. 129°03'51"W.
Tmetoceras kirki Westermann
Erycitoides howelli (White)
Erycitoides(?) sp.
Planammatoceras(?) sp.

Pseudolioceras sp.
Leioceras(?) sp.
Camptonectes(?) sp.
ostreiid bivalves
belemnite
arthropods(?)

C-103200. H.W. Tipper, 1983. In cirque northwest of Joan Lake; lat. 57°29′40″S, long. 128°53′57″W. Spatsizi Group.
Tmetoceras sp.
Inoceramus sp.

C-103211. H. Gabrielse, 1983. West end of anticline; lat. 57°33′N, long. 120°57′W.
Tmetoceras sp.
Pseudolioceras(?) sp.
Erycitoides sp.
Leioceras(?) sp.
Inoceramus sp.

C-103413. H.W. Tipper, 1983. 3 km southwest of Bug Lake; lat. 57°43′00″N, long. 128°57′51″W. Cold Fish Volcanics.
ammonite, indet., could be *Leioceras*(?) sp.

C-103414. H.W. Tipper, 1983. 3 km southwest of Bug Lake; lat. 57°43′00″N, long. 128°57′51″W. Cold Fish Volcanics.
Pseudolioceras(?) sp.

C-103415. H.W. Tipper, 1983. 2.7 km southwest of Bug Lake; lat. 57°42′30″N, long. 128°57′45″W. Cold Fish Volcanics.
Entolium sp.
Aequipecten(?) sp.
other bivalves
gastropod
brachiopods

C-103416. H.W. Tipper, 1983. 2.7 km southwest of Bug Lake; lat. 57°42′28″N., long. 128°54′45″W. Cold Fish Volcanics.
Tmetoceras kirki Westermann
Entolium sp.
Inoceramus sp.

C-103418. H.W. Tipper, 1983. 2.9 km southwest of Bug Lake; lat. 57°43′00″N, long. 128°58′00″W. Cold Fish Volcanics.
Gryphaea(?) sp.
Aequipecten(?) sp.
bivalves

C-103419. H.W. Tipper, 1983. 3.8 km west-southwest of Bug Lake; lat. 57°42′30″N, long. 128°58′42″W. Cold Fish Volcanics.
Astarte sp.
brachiopods

C-103421. H.W. Tipper, 1983. 3.2 km southwest of Bug Lake; lat. 52°43′00″N, long. 128°58′51″W. Cold Fish Volcanics.
Planammatoceras(?) sp.
Tmetoceras(?) sp.
Inoceramus sp.
Aequipecten(?) sp.
Pleuromya(?) sp.
bivalves

C-103425. H.W. Tipper, 1983. 8.85 km south-southeast of Nation Peak; lat. 57°33′45″N, long. 128°54′12″W. Spatsizi Group.
Pseudolioceras sp.
Tmetoceras sp.
Leioceras(?) sp.
Planammatoceras(?) sp.

C-103432. H.W. Tipper, 1983. On ridge 4 km southwest of Mount Will; lat. 57°30′53″N, long. 128°49′36″W. Spatsizi Group.
ammonite, indet.
Entolium sp.
Camptonectes sp.
Inoceramus sp.

C-107886. T.P. Poulton, 1983. Hills north of Joan Lake, Eaglenest Range; lat. 57°29.5′N, long. 128°54′W.
Leioceras(?) sp.

C-116448. D. Thorkelsen, 1987. In creek 6.5 km north of Ice Box Canyon; lat. 57°42′50″N, long. 129°03′40″W.
Erycitoides howelli (White)
Tmetoceras(?) sp.
Inoceramus(?) sp.
ostreiid bivalves

C-117224. H.W. Tipper, 1985. 9 km east of Black Fox Lake; lat. 57°43′10″N, long. 129°03′51″W.
ammonite, indet.

TULSEQUAH MAP AREA, B.C (NTS 104 K)

C-86522. H.W. Tipper, 1979. Bug Mountain syncline, southwest of King Salmon Lake. Section on north limb of syncline, top: lat. 58°39′N, long. 133°05′W; bottom: lat. 58°41′N, long. 133°02′W. Unit 39, Takwahoni Formation.

Planammatoceras(?) sp.
other ammonites, indet.
fish scale(?)

LABERGE MAP AREA, SOUTHERN YUKON (NTS 105 E)

43825. G.M. Dawson, 1887. Rink Rapids; lat. 60°20′N, long. 136°30′W. Laberge Group. Probably Bajocian.

Grammoceras? *boreale* (Whiteaves) see Frebold (1964) = *Asthenoceras*(?)

83477. D.D. Cairnes, 1906. Toric Mountain, 11.3 km west of Robinson. Laberge Group.

ammonite indet., resembling *Dumortieria* sp. or *Troitsaia* sp.
Myophorella sp.
belemnites

C-81320. T.P. Poulton, 1979. 21 km south of Hootalinqua, 7.2 km northeast of Miller Lake; lat. 61°24′N, long. 134°53′W. Laberge Group. Same as GSC locs. C-81321, C-86803.

Tmetoceras(?) sp.
Myophorella sp.
Trigonia sp.
Thracia sp.
other bivalves
gastropods
serpulids

C-81321. T.P. Poulton, 1979. 21 km south of Hootalinqua, 7.2 km northeast of Miller Lake; lat. 61°14′N, long. 134°53′W. Laberge Group. Same as GSC locs. C-81320, C-86803.

Tmetoceras(?) sp.
Trigonia sp.
Myophorella sp.
bivalves sp.

C-86803. D.J. Tempelman-Kluit, 1979. 7 km northeast of Miller Lake; lat. 61°14′00″N, long. 134°53′00″W. Laberge Group. Same as GSC locs. C-81320, C-81321.

Myophorella sp.
Trigonia sp.
Astarte sp.
Camptonectes sp.
other bivalves
gastropods
serpulids(?)

C-107856. P. Reid, 1982. 6 km east of west end of Long Lake; lat. 61°07′N, long. 134°43.5′W. Laberge Group.

Tmetoceras flexicostatum Westermann
Planammatoceras(?) sp.
Entolium sp.
Gresslya(?) sp.
Astarte(?) sp.
other bivalves, indet.

GRAHAM ISLAND MAP AREA, QUEEN CHARLOTTE ISLANDS, B.C (NTS 103 F)

C-39516. H.W. Tipper, 1983. Road 59; lat. 53°23′N, long. 132°16′W. Top of Phantom Creek Formation, in place, within inches of *Tmetoceras* sp. (GSC loc. C-90567). It is probably above *Tmetoceras* sp. in the same thick bed and it is above *Dumortieria* sp.

Bredyia sp. aff. *B. manflasensis* Westermann

C-90567. H.W. Tipper, 1980. Road 59; lat. 53°23′N, long. 132°16′W. Top of Phantom Creek Formation, within inches of GSC loc. C-39516.

Tmetoceras scissum (Benecke)

C-117482. H.W. Tipper, 1984. Yakoun River, Phantom Creek Formation, Maude Group.

Bredyia sp.
Oxytoma sp.

C-157552. Road 59; Phantom Creek Formation; lat. 53°23′N, long. 132°16′W. Same as GSC locs. C-39516, C-90567.

Bredyia sp.

ALERT BAY MAP AREA, NORTHERN VANCOUVER ISLAND, B.C. (NTS 92 L)

C-80878. J. Lamb, 1979. From the mine pit of Island Copper Mine of Utah Mines, Quatsino Inlet. Bonanza Volcanics.

Lima sp. cf. *L. tizglensis* McLearn
Myophorella taylori Poulton
Pinna(?) sp.
Pholadomya(?) sp.
Barbatia(?) sp.
Pleuromya(?) sp.
Thracia(?) sp.
other bivalves

PLATES 1-7

All specimens are illustrated at natural size and are stored in the National Type Collection, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario.

PLATE 1

Tmetoceras scissum (Benecke, 1865)

Figure 1. Latex cast of figured specimen GSC 83459 from GSC locality 85328, Smithers map area; lateral view, distorted.

Figure 2. Latex cast of figured specimen GSC 83461 from GSC locality 83996, Smithers map area; ventral view, distorted.

Figure 3. Latex cast of figured specimen GSC 83462 from GSC locality 83996, Smithers map area; ventral view.

Figure 4. Latex cast of figured specimen GSC 83463 from GSC locality 87409, Smithers map area; lateral view.

Figure 5. Latex cast of figured specimen GSC 83464 from GSC locality 87409, Smithers map area; ventral view.

Figure 6. Latex cast of figured specimen GSC 83465 from GSC locality 88610, Whitesail Lake map area; lateral view.

Figure 7. Latex cast of figured specimen GSC 83450 from GSC locality 85328, Smithers map area; lateral view, distorted.

Figure 8. Latex cast of figured specimen GSC 83449 from GSC locality 85251, Smithers map area; lateral view, distorted.

Figure 9. Latex cast of figured specimen GSC 83460 from GSC locality 85316, Smithers map area; ventral view of fragment of an exceptionally broad specimen.

Figure 10. Figured specimen GSC 83477 from GSC locality C-90715, Spatsizi map area; lateral view of a moderately large specimen.

Figure 11. Latex cast of figured specimen GSC 83468 from GSC locality C-101443, Terrace map area; lateral view.

Figure 12. Latex cast of figured specimen GSC 83470 from GSC locality C-80313, Whitesail Lake area; lateral view with unidentified ostreiiform bivalves nucleated on umbilicus.

Figure 13. Latex cast of figured specimen GSC 83472 from GSC locality C-53527, Whitesail Lake area; lateral view.

Figures 14, 15. Latex cast of figured specimen GSC 89740 from GSC locality C-143367, Whitesail Lake area; lateral and ventral views.

Figure 16. Latex cast of figured specimen GSC 83474 from GSC locality C-90747, Spatsizi map area; lateral view of large specimen.

Figure 17. Figured specimen GSC 89741 from GSC locality C-143367, Whitesail Lake area; lateral view of a possible microconch, showing incipient forward flexing of lateral parts of ribs in oralmost preserved growth stage.

Figure 18. Figured specimen GSC 83469 from GSC locality C-53527, Whitesail Lake area; ventral view of exceptionally broad specimen, with broad ventral groove.

Figure 19. Latex cast of figured specimen GSC 83471 from GSC locality C-53527, Whitesail Lake area; lateral view.

Figure 20. Latex cast of figured specimen GSC 83473 from GSC locality C-53527, Whitesail Lake area; ventral view of part of a strongly distorted specimen.

Figure 21. Figured specimen GSC 83475 from GSC locality C-90715, Spatsizi map area; lateral view of a large specimen.

Figure 22. Figured specimen GSC 83476 from GSC locality C-90747, Spatsizi map area; lateral view.

Figure 23. Latex cast of figured specimen GSC 83479 from GSC locality 88610, Whitesail Lake map area; lateral view.

Figure 24. Latex cast of figured specimen GSC 83478 from GSC locality 88610, Whitesail Lake map area; ventral view.

Figures 25, 26. Latex cast of figured specimen GSC 83480 from GSC locality C-90567, Queen Charlotte Islands; lateral and ventral views.

Figure 27. Latex cast of figured specimen GSC 83452 from GSC locality 88610, Whitesail Lake map area; lateral view.

Figures 28, 29. Figured specimen GSC 83467 from GSC locality C-53520, Whitesail Lake area; lateral and ventral views, showing flexing of ribs and constriction near aperture.

Figure 30. Latex cast of figured specimen GSC 83451 from GSC locality C-53520, Whitesail Lake area; lateral view.

Figures 31, 32. Figured specimen GSC 83466 from GSC locality C-53520, Whitesail Lake area; lateral and ventral views of unusually broad fragment with broad ventral groove and incipient ventrolateral tubercles; perhaps slightly flattened ventrodorsally.


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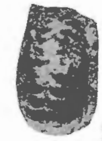
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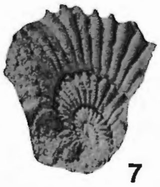
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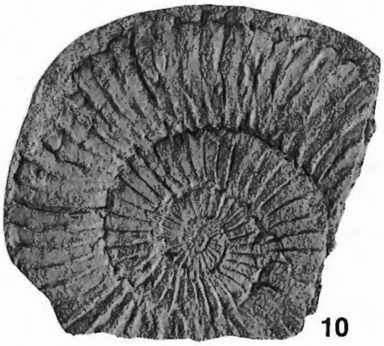
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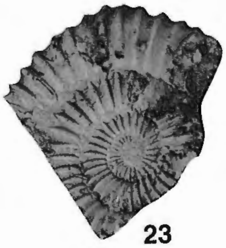
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PLATE 2

Tmetoceras kirki Westermann, 1964

Figure 1. Latex cast of figured specimen GSC 83456 from GSC locality C-101213, Spatsizi map area; lateral view of poorly preserved specimen of typical size.

Figure 2. Figured specimen GSC 83487 from GSC locality 94848, Taseko Lakes map area; lateral view.

Figure 3. Figured specimen GSC 83482 from GSC locality C-117265, Taseko Lakes area; lateral view.

Figure 4. Latex cast of figured specimen GSC 83457 from GSC locality C-90715, Spatsizi map area; lateral view showing characteristic slightly flexed ribs even at early growth stages, and constrictions on internal mould.

Figure 5. Figured specimen GSC 83486 from GSC locality 17008, Taseko Lakes map area; lateral view.

Figure 6. Figured specimen GSC 83458 from GSC locality C-90715, Spatsizi map area; lateral view.

Figure 7. Figured specimen GSC 83485 from GSC locality C-117265, Taseko Lakes area; lateral view.

Figure 8. Figured specimen GSC 83483 from GSC locality C-117265, Taseko Lakes area; lateral view.

Figure 9. Latex cast of figured specimen GSC 83455 from GSC locality C-53529, Whitesail Lake area; ventrolateral view, showing narrow ventral groove.

Figure 10. Figured specimen GSC 83454 from GSC locality C-103194, Spatsizi map area; lateral view of poorly preserved specimen covered with many unidentified ostreiiform bivalve spat.

Figure 11. Figured specimen GSC 83484 from GSC locality 13812, Taseko Lakes map area; lateral view.

Figure 12. Latex cast of figured specimen GSC 83448 from GSC locality 87393, Smithers map area; lateral view.

Tmetoceras flexicostatum Westermann, 1964

Figure 13. Latex cast of figured specimen GSC 83453 from GSC locality C-53541, Whitesail Lake area; lateral view.

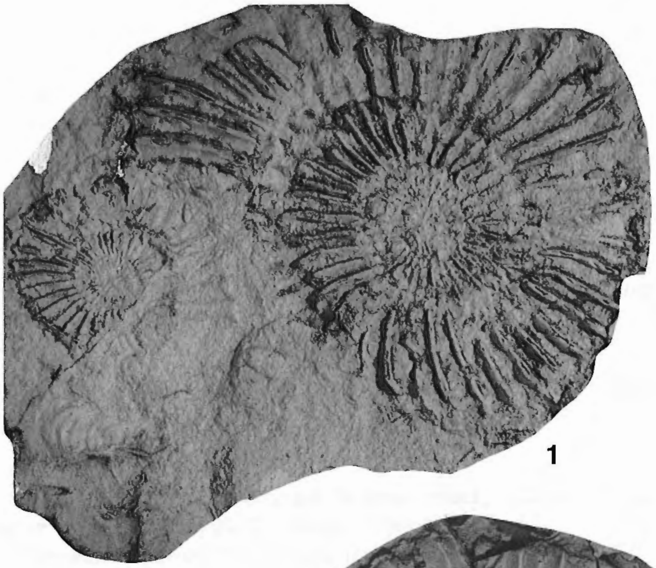
Figure 14. Latex cast of figured specimen GSC 83488 from GSC locality C-53541, Whitesail Lake area; lateral view.

Figures 15, 16. Figured specimen GSC 83481 from GSC locality C-53541, Whitesail Lake area; lateral and ventral views.

Figures 17, 18. Figured specimen GSC 83447 from GSC locality C-107856, southern Yukon; ventral and lateral views showing characteristic large size and narrow ventral groove.

Bredyia sp. aff. *B. manflasensis* Westermann, 1985

Figures 19, 20. Figured specimen GSC 89742 from GSC locality C-157552, Queen Charlotte Islands; lateral and ventral views.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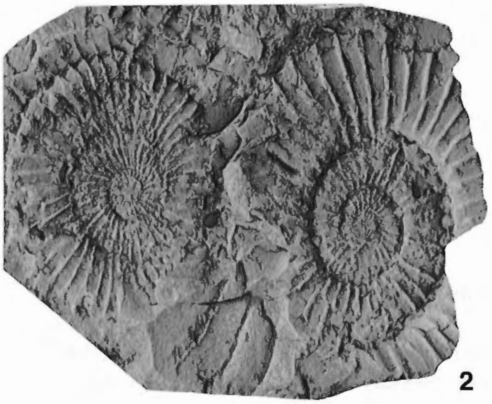
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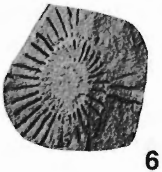
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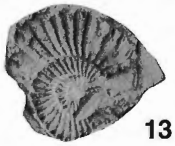
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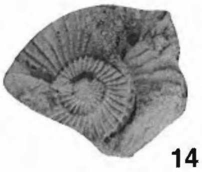
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PLATE 3

Erycitoides howelli (White, 1889)

Figure 1. Figured specimen GSC 83416 from GSC locality 94848, Taseko Lakes map area; lateral view.

Figure 2. Figured specimen GSC 83417 from GSC locality 94848, Taseko Lakes map area; lateral view.

Figure 3. Latex cast of figured specimen GSC 83437 from GSC locality C-53520, Whitesail Lake area; lateral view.

Figure 4. Latex cast of figured specimen GSC 83420 from GSC locality C-53520, Whitesail Lake area; lateral view.

Figures 5, 6. Latex cast of figured specimen GSC 83418 from GSC locality C-53520, Whitesail Lake area; lateral and ventral views, showing inner whorls and keel particularly well.

Figure 7. Figured specimen GSC 83421 from GSC locality C-90719, Spatsizi map area; lateral view.

Figure 10. Latex cast of figured specimen GSC 83422 from GSC locality C-103194, Spatsizi map area; lateral view.

Figure 11. Figured specimen GSC 83423 (left) from GSC locality C-103194, Spatsizi map area; lateral view, associated with *Pseudolioceras* sp. (GSC 83446).

Figure 12. Latex cast of figured specimen GSC 83438 from GSC locality C-103194, Spatsizi map area; lateral view.

Figure 13. Latex cast of figured specimen GSC 83439 from GSC locality C-103194, Spatsizi map area; lateral view.

Figure 14. Latex cast of figured specimen GSC 83440 from GSC locality C-103194, Spatsizi map area.

Figure 18. Latex cast of figured specimen GSC 83424 from GSC locality C-53530, Whitesail Lake area; oblique ventral view showing keel.

Figures 19, 22. Latex cast of figured specimen GSC 83425 from GSC locality C-101443, Terrace map area; ventral and lateral views, intermediate whorls.

Figure 21. Same specimen as in figures 19, 22, lateral view.

Erycitoides(?) spp.

Figure 8. Latex cast of figured specimen GSC 83443 from GSC locality C-103194, Spatsizi map area; lateral view.

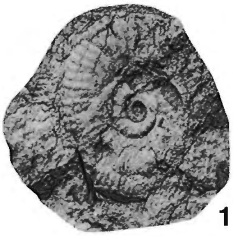
Figure 9. Latex cast of figured specimen GSC 83444 from GSC locality C-90719, Spatsizi map area; lateral view.

Figure 15. Latex cast of figured specimen GSC 83433 from GSC locality C-90719, Spatsizi map area; lateral view.

Figure 16. Figured specimen GSC 83434 from GSC locality C-53527, Whitesail Lake area; lateral view.

Figure 17. Latex cast of figured specimen GSC 83445 from GSC locality 94848, Taseko Lakes map area; lateral view.

Figure 20. Figured specimen GSC 83442 from GSC locality C-53530, Whitesail Lake area.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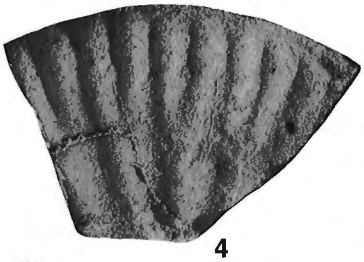
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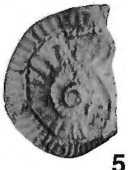
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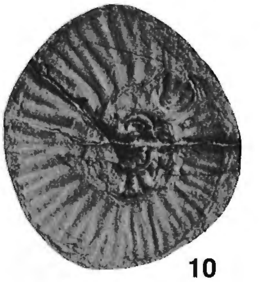
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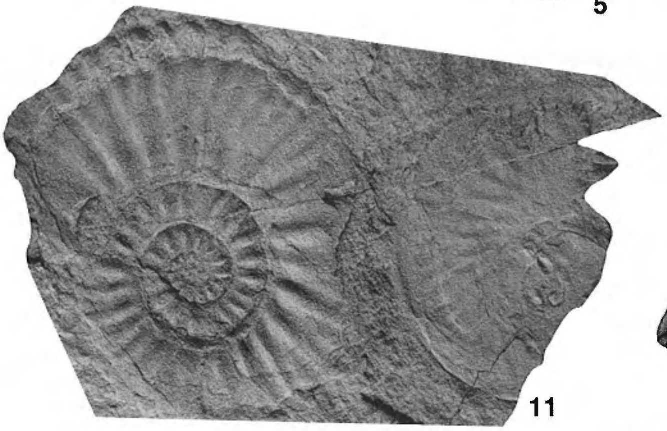
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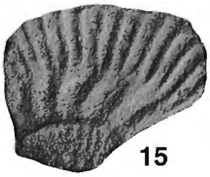
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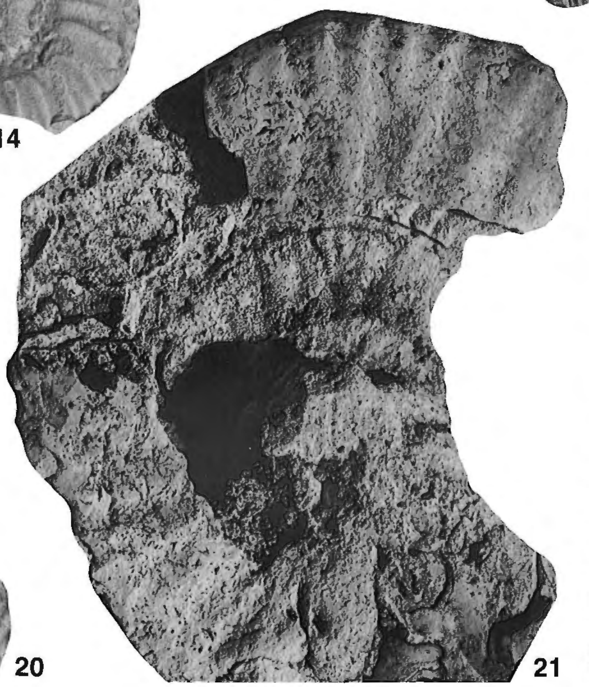
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PLATE 4

Bredyia sp.

Figures 1, 8. Figured specimen GSC 83435 of largest specimen from GSC locality C-117482, Queen Charlotte Islands; lateral and ventral views.

Figures 2, 7. Figured specimen GSC 83436 from GSC locality C-117482, Queen Charlotte Islands; lateral and ventral views.

Figures 3, 4. Figured specimen GSC 83432 from GSC locality C-117482, Queen Charlotte Islands; lateral and ventral views.

Figures 9, 10. Figured specimen GSC 83430 of smallest specimen from GSC locality C-117482, Queen Charlotte Islands; lateral and ventral views.

Bredyia sp. aff. *B. manflasensis* Westermann, 1985

Figures 11, 12. Figured specimen GSC 83431 from GSC locality C-39516, Queen Charlotte Islands; lateral and ventral views.

Erycitoides howelli (White, 1889)

Figures 5, 6. Latex cast of figured specimen GSC 83419 from GSC locality C-53527, Whitesail Lake area; lateral and ventral views.

Figure 13. Figured specimen GSC 83427 from GSC locality C-90745, Spatsizi map area; lateral view.

Figure 14. Figured specimen GSC 83428 from GSC locality C-90747, Spatsizi map area; lateral view.

Figure 15. Figured specimen GSC 83429 from GSC locality C-90963, Spatsizi map area; lateral view.

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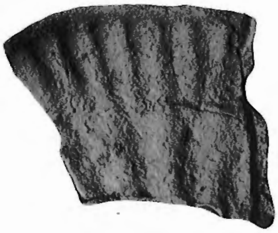

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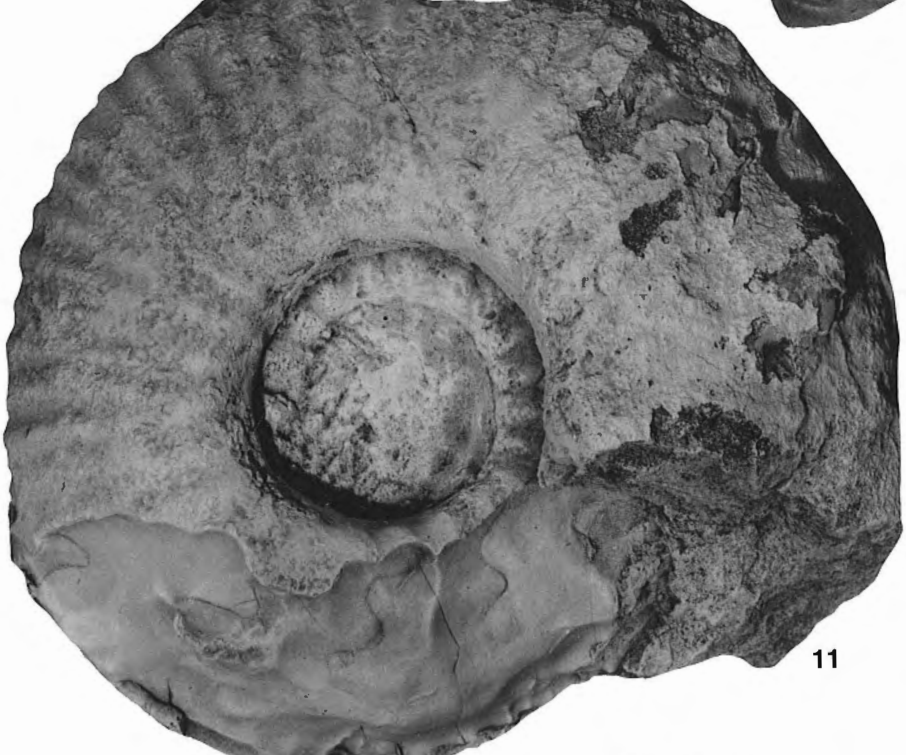

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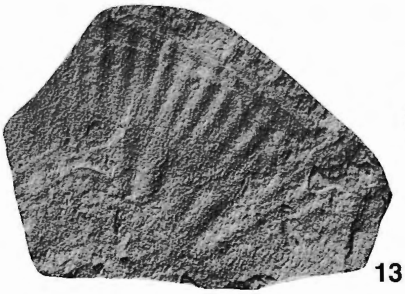

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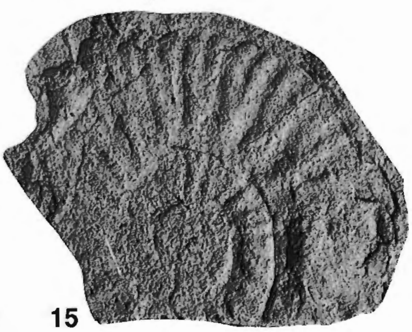

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PLATE 5

Erycitoides howelli (White, 1889)

Figures 1, 2. Figured specimen GSC 89743 from GSC loc. C-143371, Whitesail Lake area; lateral and ventral views.

Figure 3. Latex cast of figured specimen GSC 89744 from GSC locality C-143371, Whitesail Lake area; lateral view.

Planammatoceras(?) spp.

Figures 4, 5. Figured specimen GSC 83381 from GSC locality C-107856, southern Yukon; lateral and ventral views.

Figure 6. Figured specimen GSC 83383 from GSC locality 56624, Taseko Lakes map area.

Figure 8. Figured specimen GSC 83384 from GSC locality C-103194, Spatsizi map area.

Figure 9. Figured specimen GSC 83386 from GSC locality C-90715, Spatsizi map area.

Figure 10. Figured specimen GSC 83385 from GSC locality C-90719, Spatsizi map area.

Figure 11. Figured specimen GSC 83389 from GSC locality C-90746, Spatsizi map area.

Figure 12. Figured specimen GSC 83387 from GSC locality C-103194, Spatsizi map area.

Planammatoceras(?) (*Pseudaptetoceras*?) sp.

Figure 7. Figured specimen GSC 83388 from GSC locality C-90719, Spatsizi map area.


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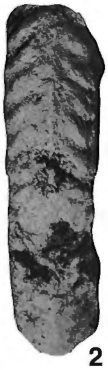
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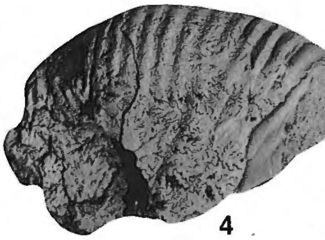
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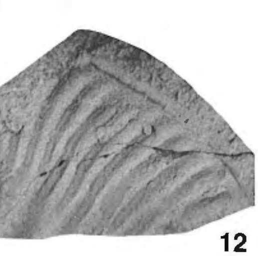
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PLATE 6

Pseudolioceras sp.

Figure 1. Figured specimen GSC 83361 from GSC locality C-103194, Spatsizi map area; lateral view of regularly ribbed specimen with growth lines superimposed on ribs.

Figure 2. Latex cast of figured specimen GSC 83362 from GSC locality C-103194, Spatsizi map area; lateral view of irregularly ribbed specimen.

Figure 3. Latex cast of figured specimen GSC 83363 from GSC locality C-103194, Spatsizi map area; lateral view of regularly ribbed specimen.

Figure 4. Figured specimen GSC 83364 from GSC locality C-103194, Spatsizi map area; lateral view of irregularly ribbed specimen.

Figure 7. Latex cast of figured specimens GSC 83372 (top) and GSC 83373 (bottom) from GSC locality C-90719, Spatsizi map area.

Leioceras(?) sp.

Figure 5. Figured specimen GSC 83367 (right) from GSC locality C-107886, Spatsizi map area; with *Tmetoceras* sp. (top left).

Figure 6. Latex cast of figured specimen GSC 83368 from GSC locality C-101213, Spatsizi map area; lateral view showing very weak, irregular, widely spaced corrugations on outer whorl.

Pseudolioceras sp. cf. *P. whiteavesi* (White, 1889)

Figure 8. Latex cast of figured specimen GSC 83369 (lower specimen) from GSC locality C-90719, Spatsizi map area; with fragment of unidentified hammatoceratid or hildoceratid ammonite.

Figure 12. Figured specimen GSC 83366 from GSC locality 13812, Taseko Lakes map area; showing raised umbilical edge.

Figure 13. Latex cast of figured specimen GSC 83365 from GSC locality 13812, Taseko Lakes map area.

Figure 14. Latex cast of figured specimen GSC 83370 from GSC locality C-53542, Whitesail Lake area.

Figure 15. Latex cast of figured specimen GSC 83371 (lower specimen) from GSC locality C-53542, Whitesail Lake area; with *Lissoceras*(?) sp. (upper specimen).

Lissoceras(?) sp.

Figure 15. Latex cast of figured specimen GSC 83374 (upper specimen) from GSC locality C-53542, Whitesail Lake area, with *Pseudolioceras* sp. (lower specimen).

Figure 16. Latex cast of figured specimen GSC 83375 from GSC locality C-80299, Whitesail Lake area.

Figure 17. Latex cast of figured specimen GSC 83376 from GSC locality C-80299, Whitesail Lake area.

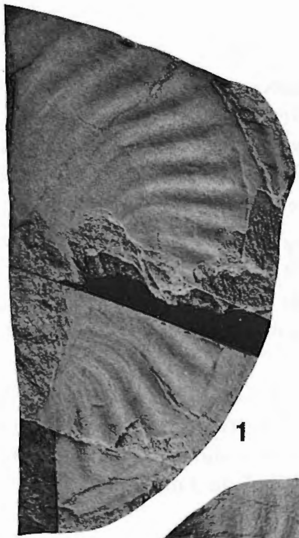
Figure 18. Latex cast of figured specimen GSC 83377 from GSC locality C-80299, Whitesail Lake area.

Zurcheria(?) sp.

Figure 9. Figured specimen GSC 83378 from GSC locality C-90719, Spatsizi map area; with aptychus located near aperture.

Figure 10. Latex cast of figured specimen GSC 83380 from GSC locality C-101213, Spatsizi map area.

Figure 11. Latex cast of figured specimen GSC 83379 from GSC locality 94848, Taseko Lakes map area.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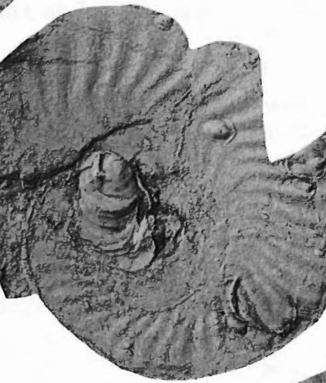
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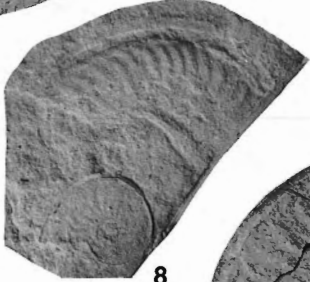
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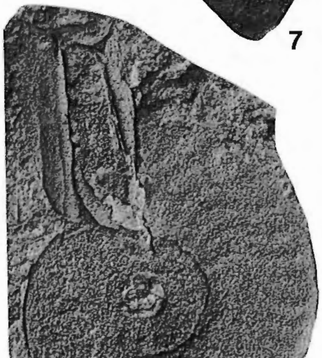
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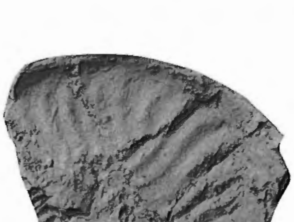
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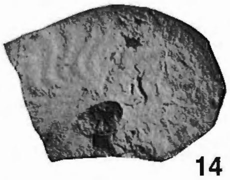
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PLATE 7

Troitsaia westermanni gen. et sp. nov.

Figure 1. Latex cast of figured specimen GSC 83395 from GSC locality 87401, Smithers map area; lateral view.

Figure 2. Latex cast of figured specimen GSC 83396 from GSC locality 87401, Smithers map area; lateral view, showing inner whorls particularly well.

Figure 3. Latex cast of figured specimen GSC 83397 from GSC locality 87401, Smithers map area; lateral view showing well developed small, pointed umbilical tubercles.

Figure 4. Latex cast of figured specimen GSC 83398 from GSC locality 87401, Smithers map area; lateral view.

Figure 5. Latex cast of figured specimen GSC 83400 from GSC locality 87401, Smithers map area; lateral view.

Figure 6. Latex cast of figured specimen GSC 83401 from GSC locality 88606, Whitesail Lake map area; lateral view.

Figure 7. Latex cast of figured specimen GSC 83402 from GSC locality 87409, Smithers map area; ventrolateral view.

Figure 8. Latex cast of figured specimen GSC 83403 from GSC locality 87409, Smithers map area; ventrolateral view, showing well developed smooth-sided keel.

Figure 9. Latex cast of figured specimen GSC 83399 from GSC locality 87401, Smithers map area; lateral view.

Figure 10. Latex cast of figured specimen GSC 83404 from GSC locality 87409, Smithers map area; lateral view.

Figure 11. Latex cast of figured specimen GSC 83410 from GSC locality 69408, Hope map area; lateral view.

Figure 12. Latex cast of figured specimen GSC 83405 from GSC locality 85328, Smithers map area; lateral view.

Figures 13, 14. Latex cast of figured specimen GSC 89745 from GSC locality C-143367, Whitesail Lake area; lateral and ventral views showing inner whorls, umbilical tubercles, and keel.

Figure 15. Figured specimen GSC 83407 from GSC locality 88607, Whitesail Lake map area; lateral view.

Figure 16. Latex cast of figured specimen GSC 83408 from GSC locality C-53517, Whitesail Lake area; lateral view of large specimen.

Figure 17. Latex cast of holotype GSC 89746 from GSC locality C-143367, Whitesail Lake area; lateral view showing well developed small, pointed, umbilical tubercles and finer spaced ribbing where the whorl height is about 1 cm.

Figure 18. Latex cast of figured specimen GSC 83409 from GSC locality C-53517, Whitesail Lake area; lateral view of large specimen showing ribs fading on ventral parts of flank in late growth stages.

Figure 19. Figured specimen GSC 83411 from GSC locality C-90715, Spatsizi map area; lateral view of large specimen showing ribs fading on ventral parts of flank in late growth stages.

Parammatoceras(?) sp.

Figure 20. Latex cast of figured specimen GSC 83412 from GSC locality 88610, Whitesail Lake map area; ventrolateral view showing ribs abutting ventral keel.

Sonninia(?) (*Euhoploceras*?) sp.

Figure 21. Latex cast of figured specimen GSC 83394 from GSC locality C-101443, Terrace map area; lateral view showing distinctly developed tubercles on ribs half way up the flank.

Figure 22. Latex cast of figured specimen GSC 83393 from GSC locality C-53517, Whitesail Lake area; lateral view showing swelling of ribs part way up the flank, below the umbilical seam.

Holcophylloceras sp.

Figures 23, 24. Figured specimen GSC 89747 from GSC locality C-117015, Taseko Lakes area; ventral and lateral views.

Phylloceras sp.

Figure 25. Figured specimen GSC 83391 from GSC locality C-101443, Terrace map area.

Pleydellia(?) sp. cf. *P. argentina* Maubeuge and Lambert, 1955

Figure 26. Figured specimen GSC 83413 from GSC locality C-117267, Taseko Lakes area; lateral view showing coarsely spaced, gently flexuous ribs with rounded profiles.

Figure 27. Figured specimen GSC 83414 from GSC locality 13810, Taseko Lakes map area; lateral view showing closely spaced, gently flexed ribs.

Figure 28. Figured specimen GSC 83415 from GSC locality 13810, Taseko Lakes map area; lateral view showing closely spaced, moderately falcoid, sharply defined ribs.


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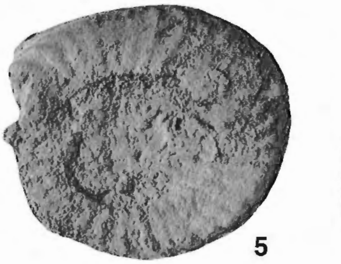
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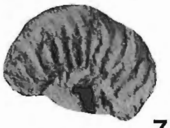
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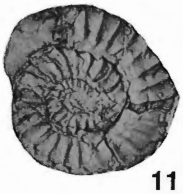
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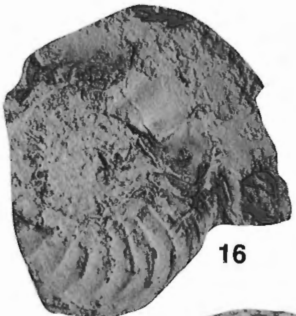
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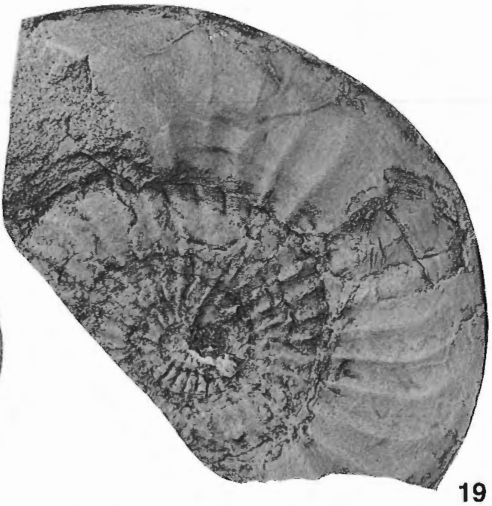
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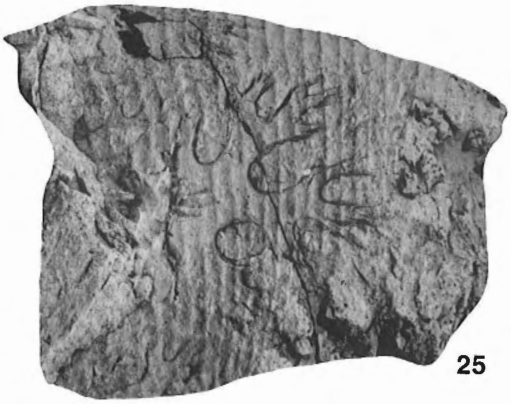
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