GEOLOGICAL SURVEY OF CANADA
BULLETIN 437

PLIENSBACHIAN (LOWER JURASSIC) BIOSTRATIGRAPHY AND AMMONITE FAUNA OF THE SPATSIZI AREA, NORTH-CENTRAL BRITISH COLUMBIA

R.C. Thomson, P.L. Smith

1992

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Canada

THE ENERGY OF OUR RESOURCES

THE POWER OF OUR IDEAS

GEOLOGICAL SURVEY OF CANADA
BULLETIN 437

PLIENSBACHIAN (LOWER JURASSIC) BIOSTRATIGRAPHY AND AMMONITE FAUNA OF THE SPATSIZI AREA, NORTH-CENTRAL BRITISH COLUMBIA

R.C. Thomson and P.L. Smith

1992

Available in Canada through authorized
bookstore agents and other bookstores

or by mail from

Canada Communication Group–Publishing
Ottawa, Canada K1A 0S9

and from

Geological Survey of Canada offices:

601 Booth Street
Ottawa, Ontario K1A 0E8

3303 - 33rd Street N.W.
Calgary, Alberta T2L 2A7

100 West Pender Street
Vancouver, B.C. V6B 1R8

A deposit copy of this publication is also available
for reference in public libraries across Canada

Cat. No. M42-437E
ISBN 0-660-14440-9

Price subject to change without notice

Cover Description
Fossiliferous siltstone of the Joan Formation, containing the ammonite *Metadoceras* and the bivalve *Weyla*.

Critical readers

C. Evenchick
T.P. Poulton
H.W. Tipper

Scientific editor

N.C. Ollerenshaw

Editor

L. Reynolds

Typesetting and layout

L.S. Cheung
P.L. Greener

Cartography

Camera-ready illustrations provided by authors

Authors' addresses

R.C. Thomson
Chevron Canada Resources Ltd.
500 - 5th Avenue S.W.
Calgary, Alberta T2P 0L7

P.L. Smith
Department of Geological Sciences
University of British Columbia
6339 Stores Road
Vancouver, British Columbia V6T 1Z4

Manuscript submitted: 91.01.28
Approved for publication: 91.01.28

PREFACE

Study of the copious ammonite fauna described in this report has enabled accurate age relationships to be established between rock units in the Spatsizi area of the Western Cordillera. Ongoing mapping and mineral exploration in the Western Cordillera continue to uncover geological problems that can be resolved by paleontological research. The complex geology of this area is now better understood because of the biostratigraphic, biogeographic, and taxonomic information derived from the ammonite studies. The study has allowed the accurate dating of lithological units using a zonal scheme that permits regional and global correlation.

Elkanah A. Babcock
Assistant Deputy Minister
Geological Survey of Canada

PRÉFACE

L'étude de l'abondante faune d'ammonites décrite dans le présent rapport a permis d'établir des relations d'âge précises entre des unités lithologiques de la région de Spatsizi dans la Cordillère occidentale. Les travaux de cartographie et d'exploration minérale en cours dans la Cordillère occidentale soulèvent continuellement des problèmes géologiques qui peuvent être résolus par la recherche paléontologique. La géologie complexe de cette région est maintenant mieux connue grâce à l'information biostratigraphique, biogéographique et taxonomique issue des études sur les ammonites. L'étude a permis de dater avec précision des unités lithologiques au moyen d'une zonation qui permet d'établir des corrélations à l'échelle régionale et planétaire.

Elkanah A. Babcock
Sous-ministre adjoint
Commission géologique du Canada

CONTENTS

Figures

PLIENSBACHIAN (LOWER JURASSIC) BIOSTRATIGRAPHY AND AMMONITE FAUNA OF THE SPATSIZI AREA, NORTH-CENTRAL BRITISH COLUMBIA

Abstract

In the northern Spatsizi area where lateral variations in facies and structural complexity are common, the age relationships between rock units can be accurately established using ammonite faunas. The Pliensbachian ammonites described in this bulletin were collected as part of a biostratigraphic study of the Spatsizi Group and Cold Fish volcanics, which collectively range in age from Pliensbachian to Bajocian. The study area includes most of the Eaglenest Range in the Spatsizi Plateau Wilderness Park, an area situated on the Stikine Terrane — one of several geologically distinct crustal blocks that constitute the Western Cordillera. The Spatsizi area is bounded to the north by the Stikine Arch, a major east-west trending tectonic feature that was a fundamental influence on the pattern of deposition in north-central British Columbia during the Jurassic.

The ammonite fauna was collected from sedimentary and volcanic rocks distributed along the southern flank of the Stikine Arch and exposed from beneath the Bowser Lake Group in small inliers. The Pliensbachian part of this sequence is represented by sedimentary strata interbedded with the Cold Fish volcanics; conglomerate and siltstone of the Joan Formation, and dark shale of the lower Wolf Den Formation.

The ammonite fauna is dominated by Tethyan and east Pacific forms. Nearly 500 specimens are assigned to more than 27 species representing 17 genera. *Metaderoceras talkeetnaense* is described as new. The biostratigraphy is referred to the North American zonal scheme demonstrating that the Cold Fish volcanics west of Cold Fish Lake are Early Pliensbachian (Imlayi and Whiteavesi zones); the Joan Formation, Early Pliensbachian (Whiteavesi and Freboldi zones), and the lower Wolf Den Formation Late Pliensbachian (Kunae and Carlottense zones) in age.

Résumé

Dans le nord de la région de Spatsizi où les variations latérales de faciès et la complexité des structures sont choses courantes, les relations d'âge entre les unités lithologiques peuvent être établies avec précision à l'aide des faunes d'ammonites. Les ammonites du Pliensbachien décrites dans le présent bulletin ont été récoltées dans le cadre d'une étude biostratigraphique du Groupe de Spatsizi et des volcaniques de Cold Fish qui, collectivement, varient en âge du Pliensbachien au Bajocien. La région d'étude comprend la majeure partie du chaînon Eaglenest dans le parc naturel du plateau de Spatsizi, région située dans le terrane de Stikine qui constitue l'un des nombreux blocs crustaux géologiquement distincts qui composent la Cordillère occidentale. La région de Spatsizi est limitée au nord par l'arche de Stikine, une importante entité tectonique d'orientation est-ouest qui a eu un effet déterminant sur la configuration de la sédimentation dans le centre nord de la Colombie-Britannique pendant le Jurassique.

La faune d'ammonites a été récoltée dans les roches sédimentaires et volcaniques qui se répartissent le long du flanc méridional de l'arche de Stikine et qui affleurent dans de petites boutonnières qui laissent voir les unités sous-jacentes au Groupe de Bowser Lake. La partie pliensbachienne de cette séquence est représentée par des couches sédimentaires interstratifiées avec les volcaniques de Cold Fish; conglomérat et siltstone de la Formation de Joan, et shale foncé de la partie inférieure de la Formation de Wolf Den.

La faune d'ammonites est dominée par des formes de la Téthys et du Pacifique Est. Près de 500 échantillons appartiendraient à plus de 27 espèces représentant 17 genres. L'espèce *Metaderoceras talkeetnaense* est décrite comme nouvelle. La biostratigraphie est rattachée à la zonation nord-américaine et révèle que les volcaniques de Cold Fish à l'ouest du lac Cold Fish remontent au Pliensbachien précoce (zones à Imlayi et à Whiteavesi); que l'âge de la Formation de Joan correspond au Pliensbachien précoce (zones à Whiteavesi et à Freboldi); et que la partie inférieure de la Formation de Wolf Den est du Pliensbachien tardif (zones à Kunae et à Carlottense).

Summary

Understanding the complex geology of the Spatsizi area has been facilitated by information derived from the ammonite faunas. The area, which includes most of the Eaglenest Range in the Spatsizi Plateau Wilderness Park, is situated on the Stikine Terrane and is covered predominantly by sedimentary strata of the Bowser Lake Group that were deposited in the Bowser Basin. Along the northern rim of the basin, Lower and Middle Jurassic sedimentary and volcanic rocks are exposed along the southern flank of the Stikine Arch, a major east–west tectonic feature that began to rise in the Late Triassic.

Two units are partly Pliensbachian in age: 1) the informally named Cold Fish volcanics, which are probably genetically related to the Stikine Arch and consist of rhyolitic to andesitic lavas and tuffs; 2) the Spatsizi Group, which consists of sediments with varying amounts of pyroclastic and epiclastic input derived from the Cold Fish and other volcanic units. The Spatsizi Group is divided, from the base up, into five formations (Joan, Wolf Den, Melisson, Abou, and Quock formations) of which the Joan and the Wolf Den formations are Pliensbachian in age. Regional maps and a geological map of the Joan Lake area show the distribution of these units; their stratigraphy is documented by four measured sections.

The Joan Formation at its type locality rests unconformably on the Cold Fish volcanics. A basal conglomerate of volcanic clasts grades upward into siltstone that constitutes most of the unit. In addition to the ammonites, a diverse benthonic fauna of abundant bivalves and brachiopods is present, along with rarer gastropods, corals, echinoids, and bryozoa. In contrast, the dark concretionary shales of the lower Wolf Den Formation have yielded only ammonites, aptychi, and rarely the trace fossil *Chondrites*.

The Pliensbachian ammonite fauna is dominated by east Pacific and Tethyan forms and is referred to the North American Standard Zonation. The Cold Fish volcanics near Cold Fish Lake are Early Pliensbachian (Imlayi and Whiteavesi zones) in age but volcanics exposed in the anticline near Joan Lake can only be dated as no younger than the Whiteavesi Zone. The Joan Formation ranges in age from the Whiteavesi to the Freboldi Zone, whereas the Wolf Den Formation has yielded an Upper Pliensbachian fauna of the Kunae and Carlottense zones.

Representatives of the ammonite families Polymorphitidae, Eoderoceratidae, Dactylioceratidae, Oxynoticeratidae, and Hildoceratidae were collected during this study. Nearly 500 specimens are assigned to more than 27 species, possibly representing 17 genera. Numerically most abundant are the genera *Dubariceras* (represented by two species) and *Metaderoceras* (represented by six species). *Metaderoceras talkeetnaense* is described as a new species, so far only reported from North America (Nevada, Oregon, British Columbia, and Alaska). *Dayiceras, Reynesocoeloceras*, and *Miltoceras* are recorded for the first time from British Columbia.

This study demonstrates that the Cold Fish volcanic rocks and the Spatsizi Group are partly coeval and accurately dates the lithological units using a zonal scheme that permits regional and global correlation. The study also adds to our understanding of the biostratigraphy, biogeography, and taxonomy of Pliensbachian ammonite faunas.

Sommaire

L'information provenant des faunes d'ammonites a permis de mieux comprendre la géologie complexe de la région de Spatsizi. La région, qui comprend la majeure partie du chaînon Eaglenest dans le parc naturel du plateau de Spatsizi, est située dans le terrane de Stikine et est essentiellement constituée de couches sédimentaires du Groupe de Bowser Lake qui ont été déposées dans le bassin de Bowser. Le long de la bordure septentrionale du bassin, des roches sédimentaires et volcaniques du Jurassique inférieur et moyen affleurent le long du flanc méridional de l'arche de Stikine, une importante entité tectonique d'orientation est-ouest dont le soulèvement a commencé au Trias tardif.

Deux unités sont en partie d'âge pliensbachien : 1) les volcaniques de Cold Fish (appellation informelle), qui sont probablement liées génétiquement à l'arche de Stikine et qui sont composées de laves et de tufs rhyolitiques à andésitiques; 2) le Groupe de Spatsizi, qui est constitué de roches sédimentaires contenant des quantités variables de produits pyroclastiques et épiclastiques provenant des volcanites de Cold Fish et d'autres unités volcaniques. Le Groupe de Spatsizi est divisé, de la base au sommet, en cinq formations (Joan, Wolf Den, Melisson, Abou et Quock) dont celles de Joan et de Wolf Den remontent au Pliensbachien. Les cartes régionales et une carte géologique de la région du lac Joan montrent la répartition de ces unités; leur stratigraphie est documentée par quatre coupes mesurées.

La Formation de Joan à son stratotype repose en discordance sur les volcaniques de Cold Fish. Un conglomérat de base à clastes de roches volcaniques passe progressivement vers le sommet à un siltstone qui constitue la plus grande partie de l'unité. En plus des ammonites, une faune benthonique variée, contenant des bivalves et des brachiopodes en abondance, est accompagnée de populations moins nombreuses de gastéropodes, de coraux, d'échinoïdes et de bryozoaires. Par ailleurs, les shales concrétionnaires foncés de la partie inférieure de la Formation de Wolf Den n'ont fourni que des ammonites, des aptychi et, par endroits, l'ichnofossile *Chondrites*.

La faune d'ammonites du Pliensbachien est dominée par des formes du Pacifique Est et de la Téthys, et est rattachée à la Zonation standard nord-américaine. Les volcaniques de Cold Fish près du lac de ce nom remontent au Pliensbachien précoce (zones à Imlayi et à Whiteavesi), mais les roches volcaniques exposées dans l'anticlinal près du lac Joan ne pourraient être guère plus jeunes que la Zone à Whiteavesi. L'intervalle d'âges de la Formation de Joan s'étend de la Zone à Whiteavesi à la Zone à Freboldi, tandis que la Formation de Wolf Den contient une faune du Pliensbachien tardif correspondant aux zones à Kunae et à Carlottense.

Des représentants des familles d'ammonites des Polymorphitidés, des Éodérocératidés, des Dactyliocératidés. des Oxynoticératidés et des Hildocératidés ont été récoltés au cours de cette étude. Près de 500 échantillons ont été rapportés à plus de 27 espèces pouvant représenter quelque 17 genres. Les plus nombreux sont les genres *Dubariceras* (représenté par 2 espèces) et *Metaderoceras* (représenté par 6 espèces). *Metaderoceras talkeetnaense* est décrit comme une nouvelle espèce, n'ayant été signalé jusqu'à ce jour qu'en Amérique du Nord (Nevada, Oregon, Colombie-Britannique et Alaska). C'est la première fois que *Dayiceras, Reynesocoeloceras* et *Miltoceras* sont relevés en Colombie-Britannique.

Les résultats de la présente étude démontrent que les volcaniques de Cold Fish et le Groupe de Spatsizi sont en partie contemporains, et permettent de dater avec précision les unités lithologiques au moyen d'une zonation qui rend possible les corrélations à l'échelle régionale et planétaire. L'étude nous permet aussi de mieux comprendre la biostratigraphie, la biogéographie et la taxonomie des faunes d'ammonites du Pliensbachien.

INTRODUCTION

The northern part of the Spatsizi map area (104 H) of north-central British Columbia is underlain primarily by Mesozoic plutonic, volcanic, and sedimentary rocks that formed in the eugeocline of western North America. Understanding the complex geology of this area has been aided by the study of ammonite faunas. Pliensbachian ammonites described in this report were collected as part of a stratigraphic and biostratigraphic study of the Pliensbachian to Bajocian Spatsizi Group sedimentary strata and the partly coeval Cold Fish volcanics. In addition to providing the basis for correlation, this study represents the first detailed paleontological account of the Lower Jurassic fauna of the Spatsizi area and updates the status of the Pliensbachian faunas in north-central British Columbia.

Previous work

The only recent publications describing Pliensbachian ammonites from northern British Columbia are those of Frebold (1964a, 1970). A more detailed study of Pliensbachian faunas of north-central British Columbia has been necessitated by more recent work in three areas: 1) revisions to the classification of Liassic ammonites (Donovan and Forsey, 1973; Donovan et al., 1981); 2) important works on the taxonomy and biostratigraphy of Pliensbachian faunas of both Europe and the Americas (for example: Geczy, 1976; Wiedenmayer, 1977, 1980; Schlatter, 1980; Hillebrandt, 1981a; Imlay, 1981; Braga, 1983; Smith et al., 1988); and 3) new approaches to the Lower Jurassic paleobiogeography and tectonic evolution of western North America (Tipper, 1981; Taylor et al., 1984; Smith and Tipper, 1986).

Acknowledgments

This report is based on a Master of Science thesis by R.C. Thomson at the University of British Columbia. The study was supported, in part, by grants to P.L. Smith from the Natural Science and Engineering Research Council of Canada and Chevron Canada Limited. We would like to thank H.W. Tipper of the Geological Survey of Canada (GSC) for access to fossil collections and stratigraphic data, for critically reviewing the manuscript, and for many helpful discussions during the course of the study. The study also benefited from the helpful comments of D. Donovan (London), J.-L. Dommergues (Dijon), A. von Hillebrandt (West Berlin), M.K. Howarth (British Museum, London), and R. Mouterde (Catholic University, Lyon). D.V. Ager (Swansea) kindly helped with identifying the brachiopods. The manuscript was reviewed by T. Poulton, B. Norford, and C. Evenchick (GSC); we appreciate the constructive comments of these colleagues. Photography by K. Gordanier-Smith, typing by B. Vanlier, and drafting by T. Oliveric are gratefully acknowledged.

Location and regional geology

The study area includes most of the Eaglenest Range in the Spatsizi Plateau Wilderness Park. It is confined geographically by the Stikine, Klappan, Little Klappan, and Spatsizi rivers and by Cold Fish Lake and the Spatsizi Plateau to the northeast (Fig. 1). The Spatsizi region is situated on the Stikine Terrane (or Stikinia), one of several geologically distinct crustal fragments that constitute the western Cordillera. Each terrane is characterized by an internally consistent tectono-stratigraphic assemblage and is separated from surrounding terranes by major fault zones. The nature of these terranes and their history of accretion to, and interaction with, the North American continental margin are described by Coney et al. (1980), Monger et al. (1982), and Monger (1984).

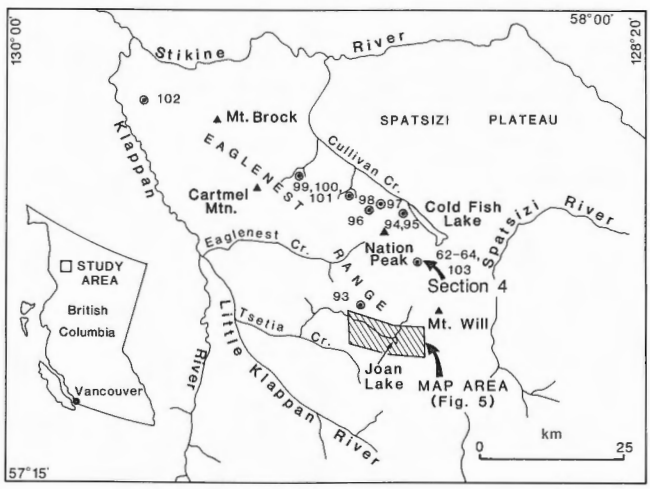


Figure 1. Location map. Numbers indicate fossil localities.

Stikinia consists mainly of upper Paleozoic–lower Mesozoic volcanic and sedimentary rocks (Fig. 2). Much of the northern part of Stikinia is covered by sedimentary strata of the Bowser Lake Group that were deposited in the Bowser Basin, a successor basin that was formed during the Middle and Late Jurassic.

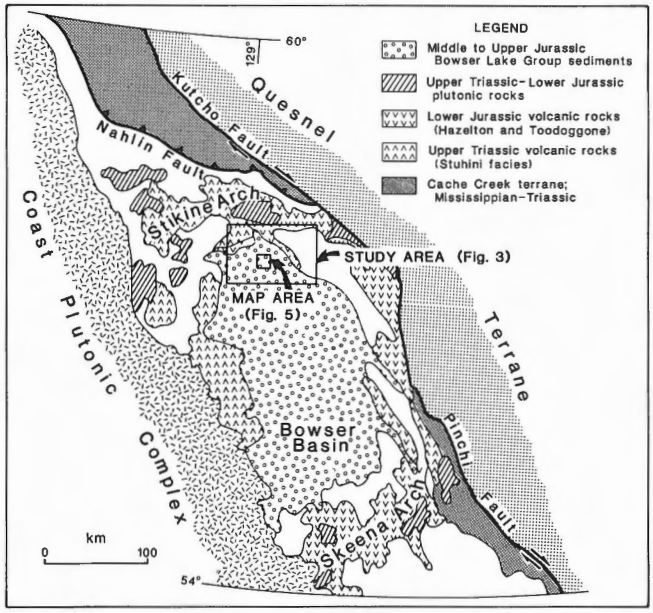


Figure 2. Geological map of northern Stikinia and surrounding terranes, outlining the distribution of the major Triassic and Jurassic rock units and tectonic features. (Modified from Thomson et al., 1986.)

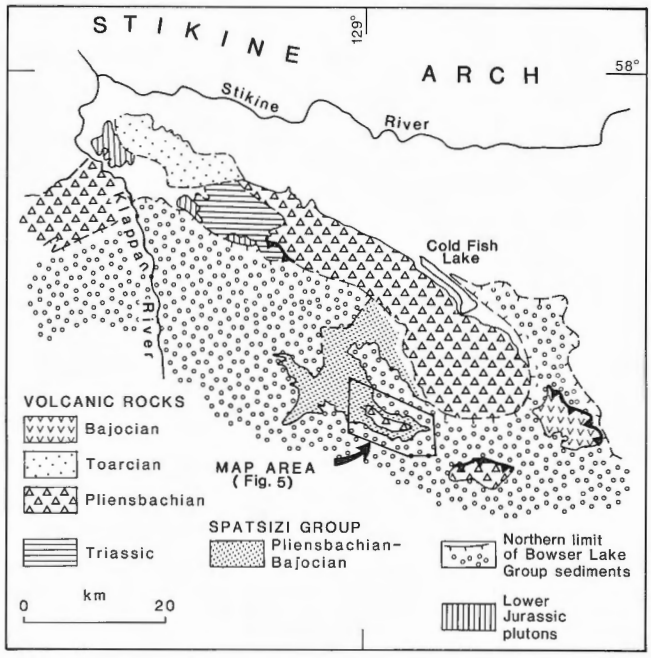


Figure 3. Geological map of the northern Spatsizi area showing the distribution of the Cold Fish and other volcanic units, and the Spatsizi Group strata. (Modified from Gabrielse and Tipper, 1984, and Smith et al., 1984.)

The Spatsizi area is bounded to the north by the Stikine Arch, a major east-west trending tectonic feature that began to rise in the Late Triassic and exerted a fundamental control on the volcanic and sedimentary depositional patterns of the Spatsizi region into the late Mesozoic.

Ammonites examined in this study were collected from the Cold Fish volcanic rocks and the Spatsizi Group sedimentary rocks distributed along the southern flank of the Stikine Arch (Fig. 3). The Cold Fish volcanics are probably genetically related to the Stikine Arch, and the Spatsizi Group sedimentary rocks represent the basinward sedimentary equivalents of the Cold Fish and other volcanic rocks (Thomson et al., 1986). The southward transition from volcanic to sedimentary rocks, illustrated schematically in Figure 4, is not clearly understood due to structural complications. It is not known whether the volcanic rocks thin and grade basinward into sedimentary rocks, or whether the volcanic rocks end abruptly. The Spatsizi Group is exposed from beneath the Bowser Lake Group in an erosional inlier (Figs. 5, 6). The total extent of the Spatsizi Group is unknown due to the otherwise unbroken cover of the Bowser Lake sediments. It is assumed that the Spatsizi Group continues for a considerable distance below the Bowser Lake Group and that Lower to lower Middle Jurassic shale underlies much, if not all, of the Bowser Basin (Thomson et al., 1986).

STRATIGRAPHIC SUMMARY

Cold Fish volcanics

In the vicinity of the Stikine Arch, much of the Lower to Middle Jurassic sequence comprises volcanic rocks, but farther south, where Spatsizi Group sedimentary rocks occur, volcanic rocks account for only the lower portion of the sequence (Smith et al., 1984; Thomson et al., 1986). The stratigraphy of the volcanic rocks west of Cold Fish Lake is poorly understood, but is the subject of ongoing studies and will be described later by others (H. Gabrielse, pers. comm., 1986). In this paper, the term "Cold Fish volcanics" is used informally to refer to volcanic rocks of Pliensbachian age.

Lower Pliensbachian ammonites obtained from strata interbedded with the Cold Fish volcanics were collected from scattered localities to the south and southwest of Cold Fish Lake (Fig. 1). Relative stratigraphic positions of the collections determined

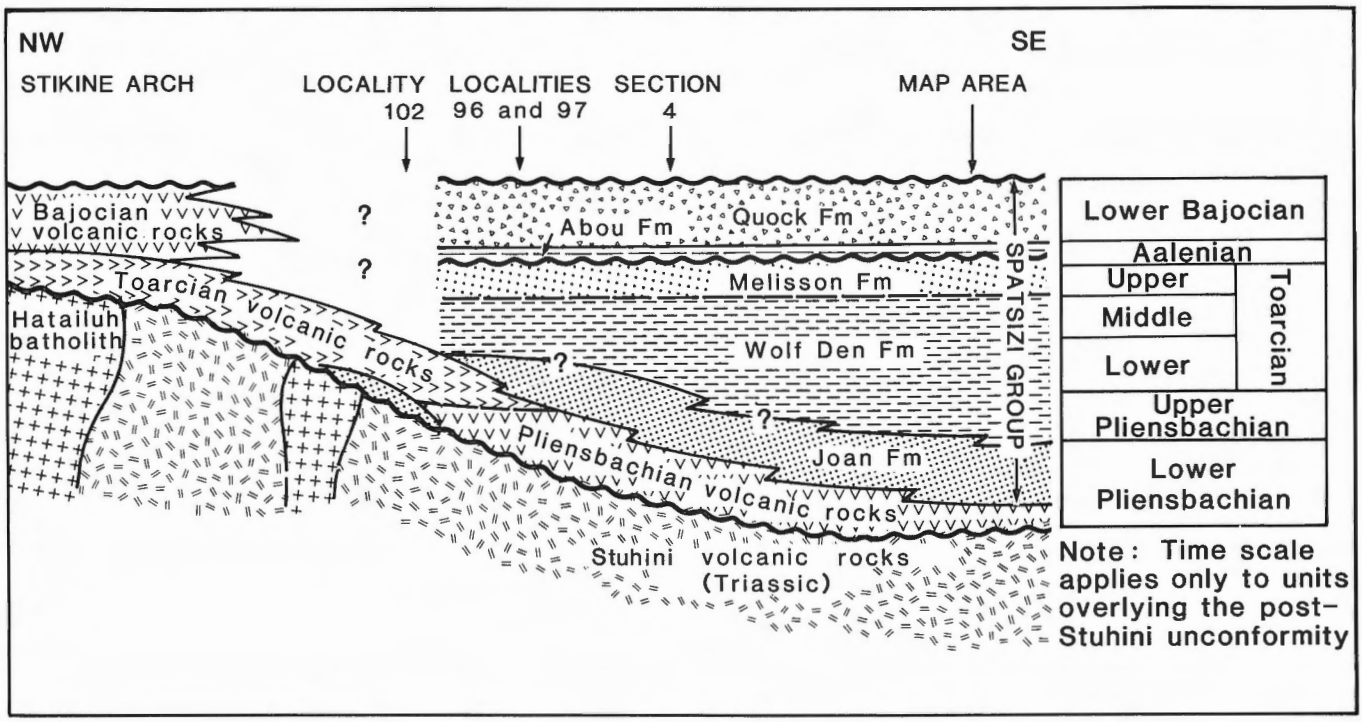


Figure 4. Inferred stratigraphic relationships between the Spatsizi Group strata, the Cold Fish volcanics, and other volcanic units in the northern Spatsizi area. (Modified from Thomson et al., 1986.)

from field studies by H.W. Tipper (pers. comm., 1986) suggest the following biostratigraphic relationships in this area. Sedimentary beds containing *Miltoceras* sp. and a single specimen of a serpulid (Pl. 2, fig. 6) were found at the lowest levels examined in the volcanic sequence and represent the lowest stratigraphic level of the Pliensbachian in the Spatsizi area. Higher in the section, *Tropidoceras* sp. and *Metaderoceras* sp. aff. *M. talkeetnaense* n. sp. suggest a distinctly higher stratigraphic level. At or near the highest level of the Pliensbachian volcanic sequence, *Acanthopleuroceras* sp. aff. *A. stahli* and *Metaderoceras evolutum* (Fucini) were found along with a single specimen of a phylloceratid (Pl. 3, fig. 5). In the Joan Lake map area, *A.* sp. aff. *A. stahli* was found at the base of Section 2 (Fig. 7) overlying the Cold Fish volcanics.

Spatsizi Group

The Spatsizi Group comprises five formations: the Joan, Wolf Den, Melisson, Abou, and Quock formations (in ascending order), together attaining a thickness of up to 750 m (Thomson et al., 1986). The formations are defined from exposures around Joan Lake where they were initially mapped at a scale of 1:25 000 over an area of about 80 km^2 (Figs. 5, 6). Each formation reflects deposition in a different marine sedimentary environment affected by varying degrees of volcanic (epiclastic or pyroclastic) input. The sequence is composed, in order of decreasing abundance, of shale, siltstone, sandstone, conglomerate, and limestone (see Figure 5 for a general lithological description of each formation). The Pliensbachian is represented by the Joan Formation and lowermost Wolf Den Formation, described below (Figs. 7–10).

Joan Formation

In the map area (Fig. 5), the base of the Joan Formation rests unconformably on the uppermost flow of the Cold Fish volcanics; a basal conglomerate less than 10 m thick containing the Lower Pliensbachian ammonite *Acanthopleuroceras* sp. aff. *A. stahli* (Oppel) is present above the contact. The conglomerate grades upward into the siltstone that makes up the bulk of the Joan Formation and which attains a maximum thickness of about 60 m. Lower Pliensbachian ammonites, including *Dubariceras freboldi* Dommergues et al. and several species of the genus *Metaderoceras*, range throughout the Joan Formation siltstones. Three specimens of the nautiloid *Cenoceras* sp. were also found in the formation (Pl. 3, fig. 1).

The Joan Formation contains a diverse bivalve fauna that indicates a relatively shallow to moderately

deep water environment of deposition, corresponding to composite assemblage depth zones B and C of Taylor (1982). Species of the genera *Vaugonia, Jaworskiella, Weyla, Gervillaria*?, *Otapiria*?, *Camptonectes, Cardinia, Oxytoma, Pholadomya, Modiolus*, and *Pleuromya* have been recognized; representatives are shown in Plates 1 and 2. In addition to the ammonites and bivalves that are found throughout the formation, brachiopods, particularly terebratulids and less abundant rhynchonellids, are common but restricted to a few beds near the top of the unit (Pl. 2, fig. 9; Pl. 3, fig. 3). Rare gastropods, colonial and solitary corals, echinoids, and bryozoans are present in the Joan Formation, and fragments of coalified wood are scattered throughout.

Wolf Den Formation

Concretionary shales comprising the lower 40 to 60 m of the Wolf Den Formation are separated from the underlying Joan Formation by an abrupt contact (Figs. 7–10). The two lowermost concretion beds in the Wolf Den Formation contain Upper Pliensbachian ammonites: the lower bed contains the genera *Arieticeras* and *Leptaleoceras*; the higher bed *Tiltoniceras propinquum*, *Protogrammoceras* spp., and associated aptychi (Pl. 3, figs. 2, 4). Trace fossils referable to the ichnogenus *Chondrites* are present in some of the concretions. No bivalves were found in the shales or concretions of the lower Wolf Den Formation, but *Bositra* sp. is locally abundant slightly higher in the section.

The lithology and fauna of the lower Wolf Den Formation are indicative of a deep water, possibly anaerobic, environment of deposition corresponding to composite assemblage depth zone D of Taylor (1982). The abrupt regional transition from the siltstone of the underlying Joan Formation to the Wolf Den shale could correspond to a transgression that has been recognized in rocks of this age at many North American localities and may be of eustatic origin (Taylor et al., 1983; Thomson et al., 1986; Hallam, 1988; Poulton, 1988; Smith and Tipper, 1988).

Biochronology

Lower Jurassic ammonite sequences from western North America have traditionally been referred to the standard Liassic ammonite zones and subzones of the northwest European province erected by Dean et al. (1961). More recently, however, workers have come to realize that most of the North American ammonite faunas are not of northwest European affinity and that the same north–south division into the Boreal, mixed, and Tethyan faunal realms recognized in Europe and north Africa can be distinguished in western North America (Howarth, 1973a; Smith, 1981, 1983; Tipper, 1981; Taylor et al., 1984; Smith and Tipper, 1986). The Spatsizi fauna, for example, is dominated by ammonite taxa that are characteristically Tethyan, although *Fanninoceras* is an east Pacific form, and the Boreal genus *Amaltheus* is known immediately to the north in the Cry Lake area (Tipper, 1978) and to the west in the Telegraph Creek area. Smith et al. (1988) have now developed a Pliensbachian zonal scheme specific to the western Cordillera and this is used here. In this new zonal scheme, approximate correlations between western North American and northwest European Pliensbachian zones (Fig. 11) are based on broad faunal similarities at the familial and generic level, and on sequences in the northern parts of suspect terranes where the Tethyan and Boreal realms overlap.

The upper part of the Cold Fish volcanics west of Cold Fish Lake are Early Pliensbachian in age (Imlayi and Whiteavesi zones)[1] and in part correlative with the Joan Formation, which ranges in age from the Whiteavesi Zone to the Freboldi Zone. The volcanics found unconformably beneath the Joan Formation near Joan Lake can only be dated as no younger than the Whiteavesi Zone. The lower Wolf Den Formation has yielded a fauna characteristic of the Late Pliensbachian (Kunae and Carlottense zones). The geographic distribution of the ammonite localities in the Spatsizi area is shown in Figures 1 and 12. The species associations and zonal designations for each locality are shown in Appendix 2, and relative stratigraphic ranges of species for each measured section are illustrated in Figures 7 to 10.

[1]Our approach to zonations and the naming of zones is as follows (see also Callomon, 1984): (1) No zonation can be worldwide in extent, and some zonations may be restricted to a particular facies. For regionally extensive, biogeographically distinct areas, however, a standard zonation may be erected for a given group of organisms. (2) Standard zones are recognized on the basis of co-occurrences of species that are distinct from superjacent and subjacent co-occurrences. These stratigraphically distinct co-occurrences maintain their superpositional relationships throughout the geographic area in question. (3) Standard zones are characterized by type sections, which most clearly demonstrate these superpositional relationships and where zonal boundaries may be drawn. The base of one zone automatically defines the top of the subjacent zone. (4) Standard zones are named using the non-italicized, capitalized trivial name of a species that is characteristic of that zone. (5) One standard zonation is selected as the primary standard to which all secondary standards are correlated with as much precision as possible. In the case of the Lower Jurassic ammonites discussed in this report, the Northwest European zonation of Dean et al. (1961) is the primary standard and the North American zonation of Smith et al. (1988) is the secondary standard.

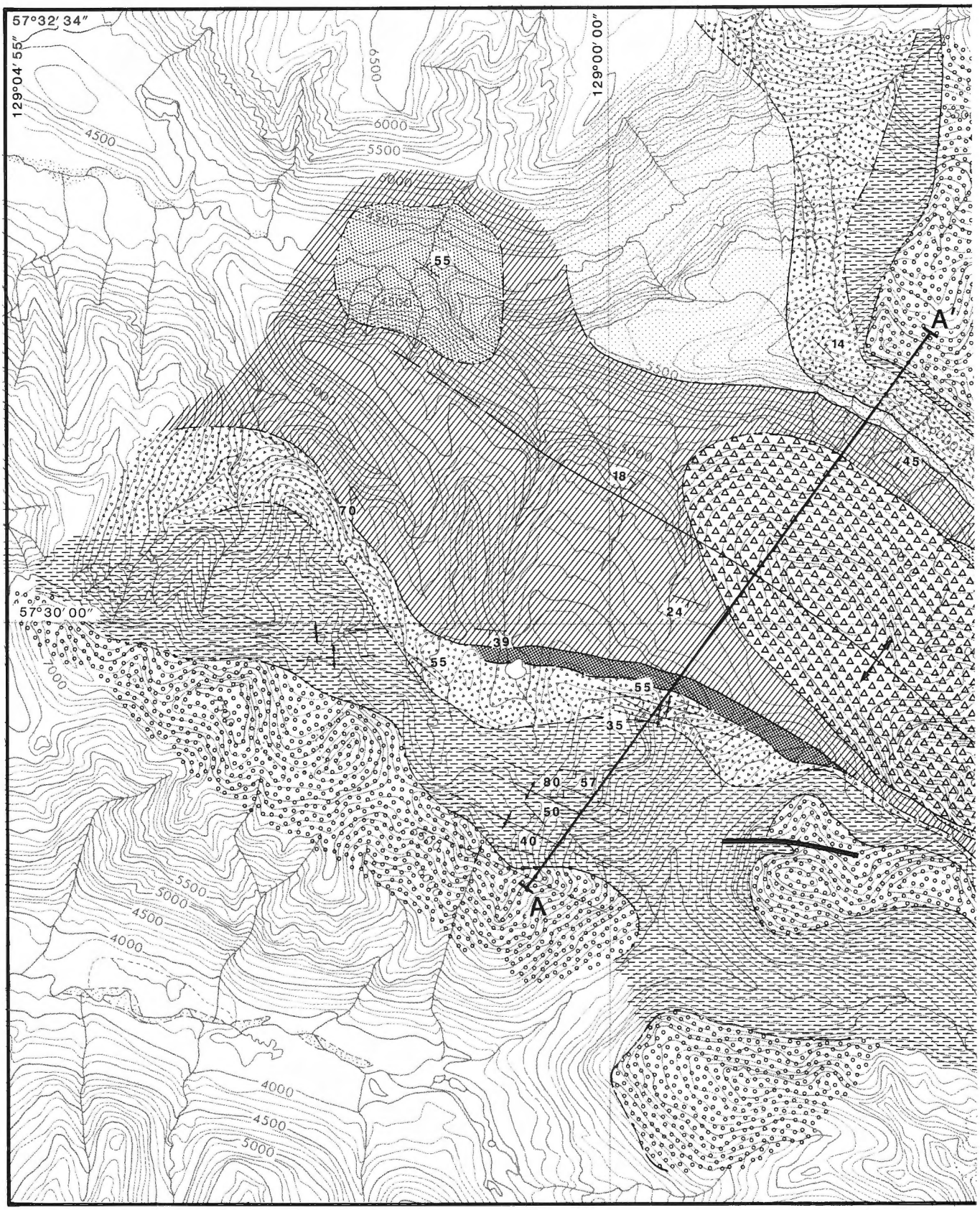


Figure 5. *Distribution of the five formations of the Spatsizi Group in the vicinity of Joan Lake, showing the position of stratigraphic sections 1-3 and structural sections.*

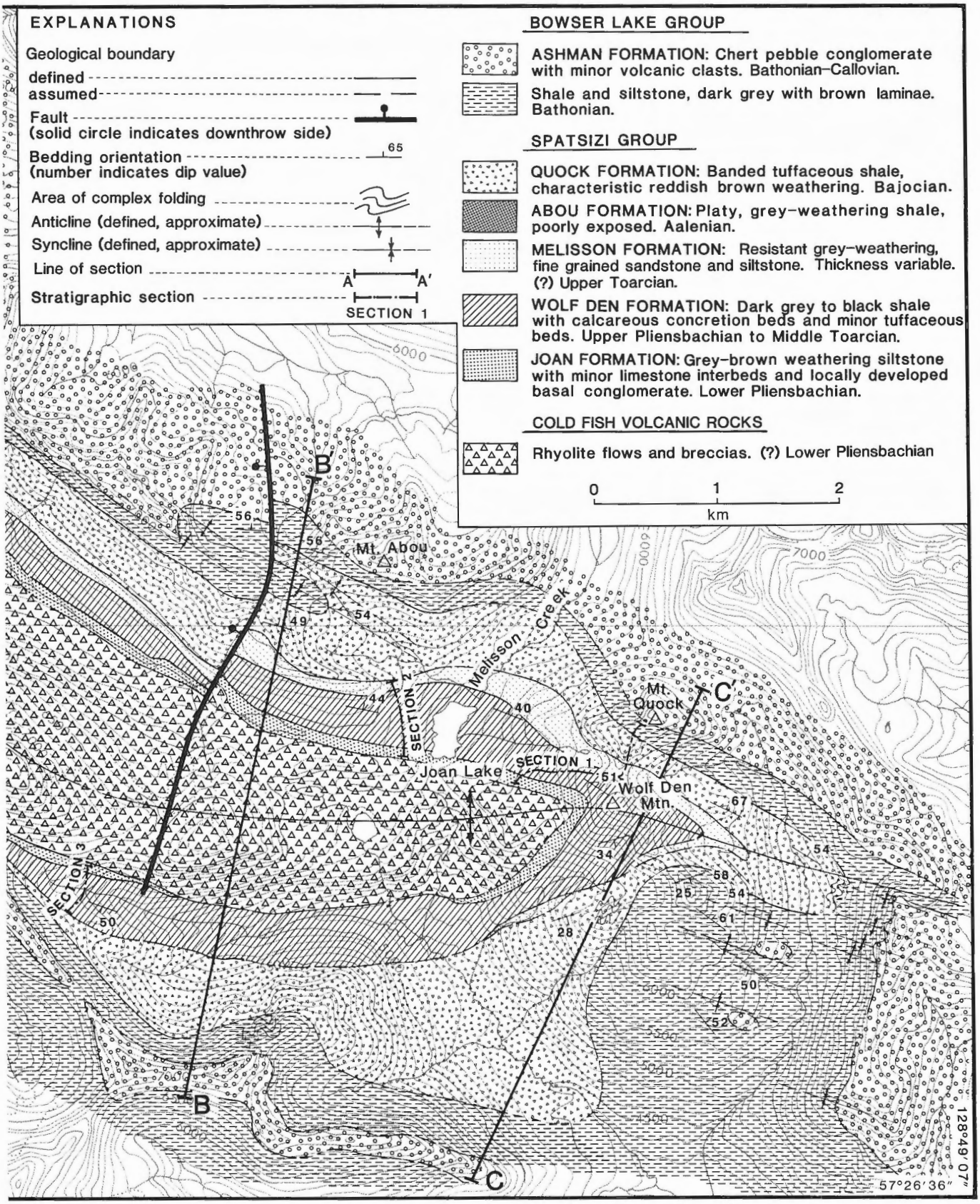


Figure 5. cont'd

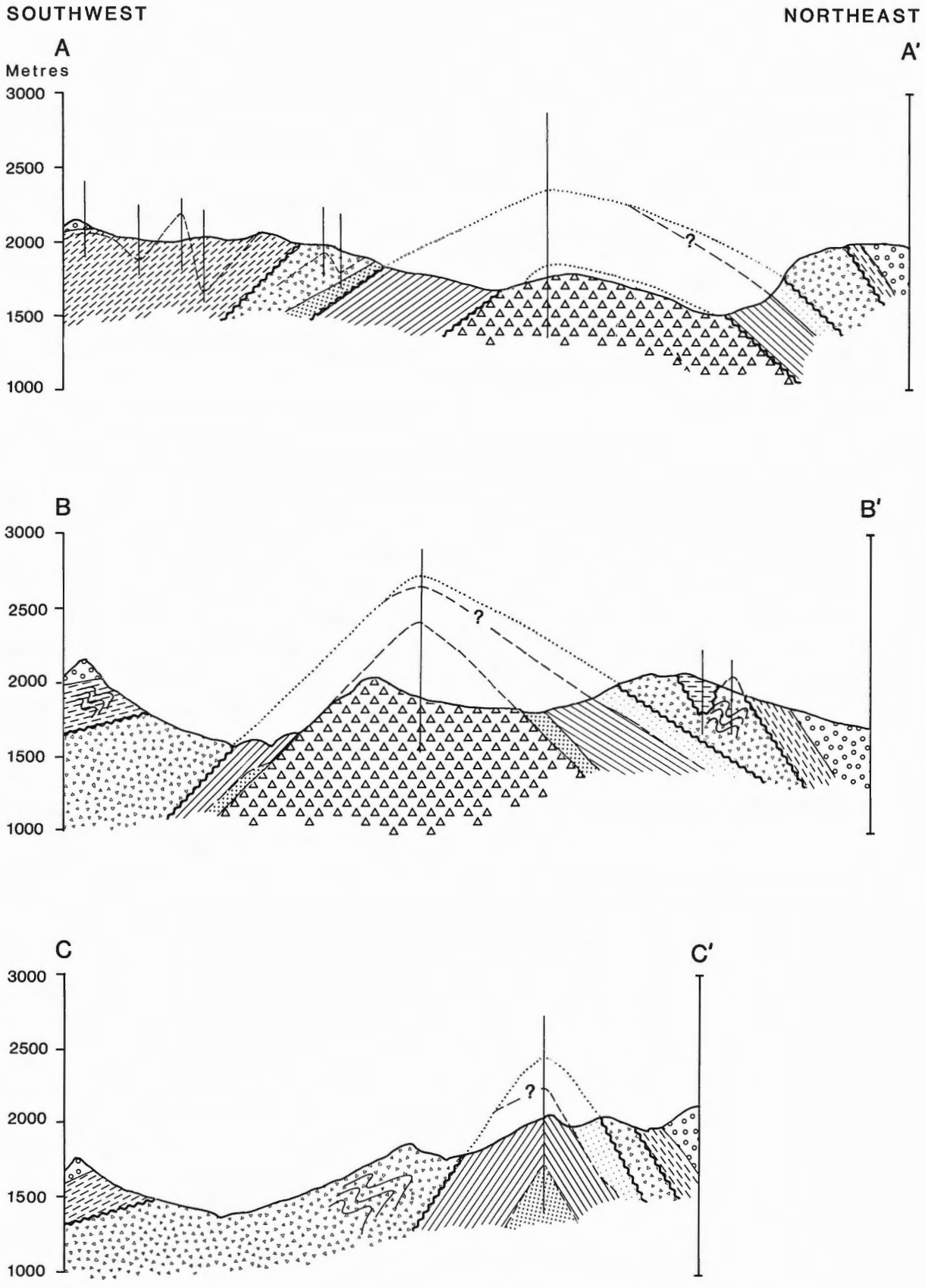


Figure 6. Structural cross-sections. For legend, see Figure 5.

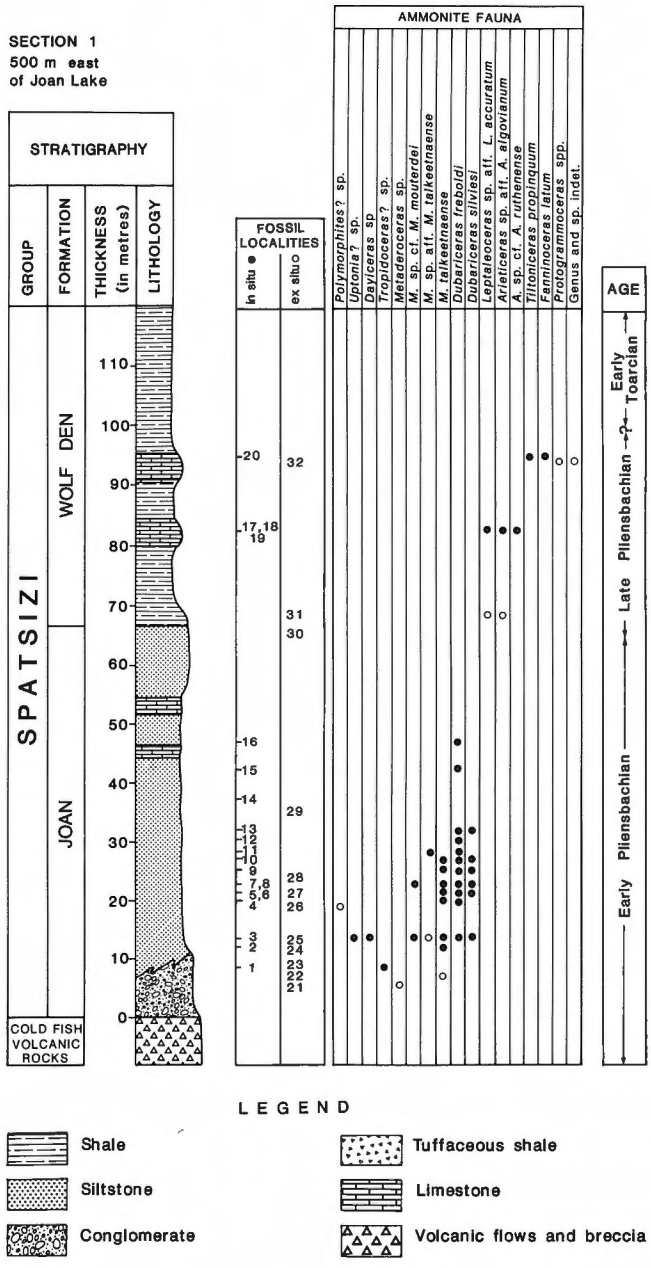


Figure 7. Lithostratigraphy and biostratigraphy of Section 1. See Figure 5 for location of section line.

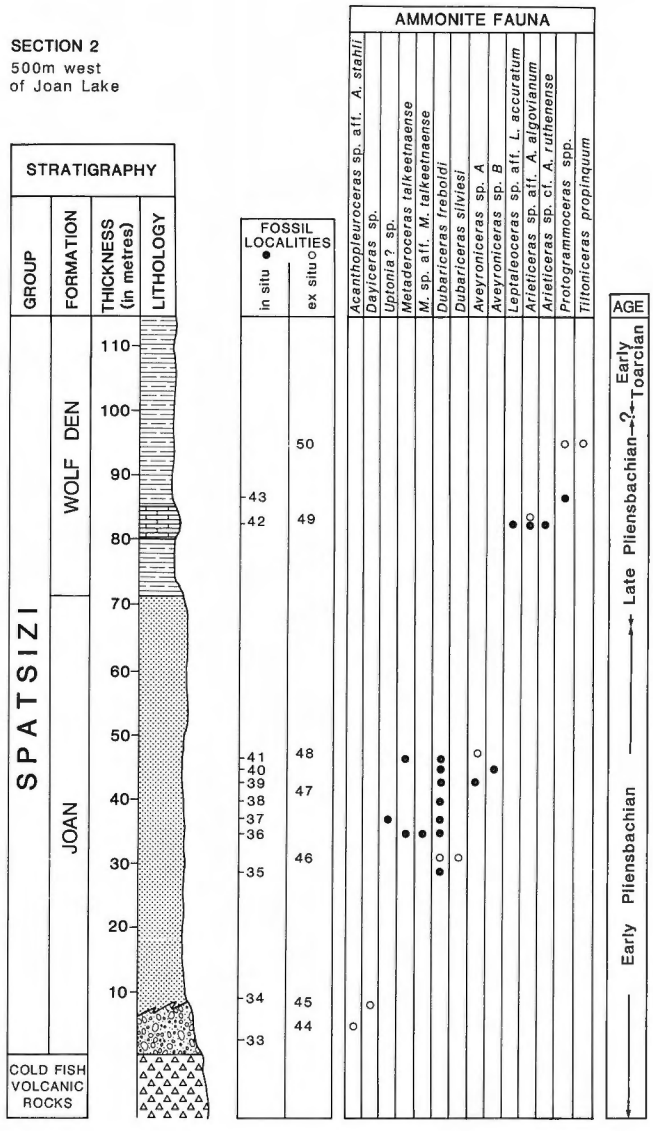


Figure 8. Lithostratigraphy and biostratigraphy of Section 2. See Figure 5 for location of section line. See Figure 7 for legend.

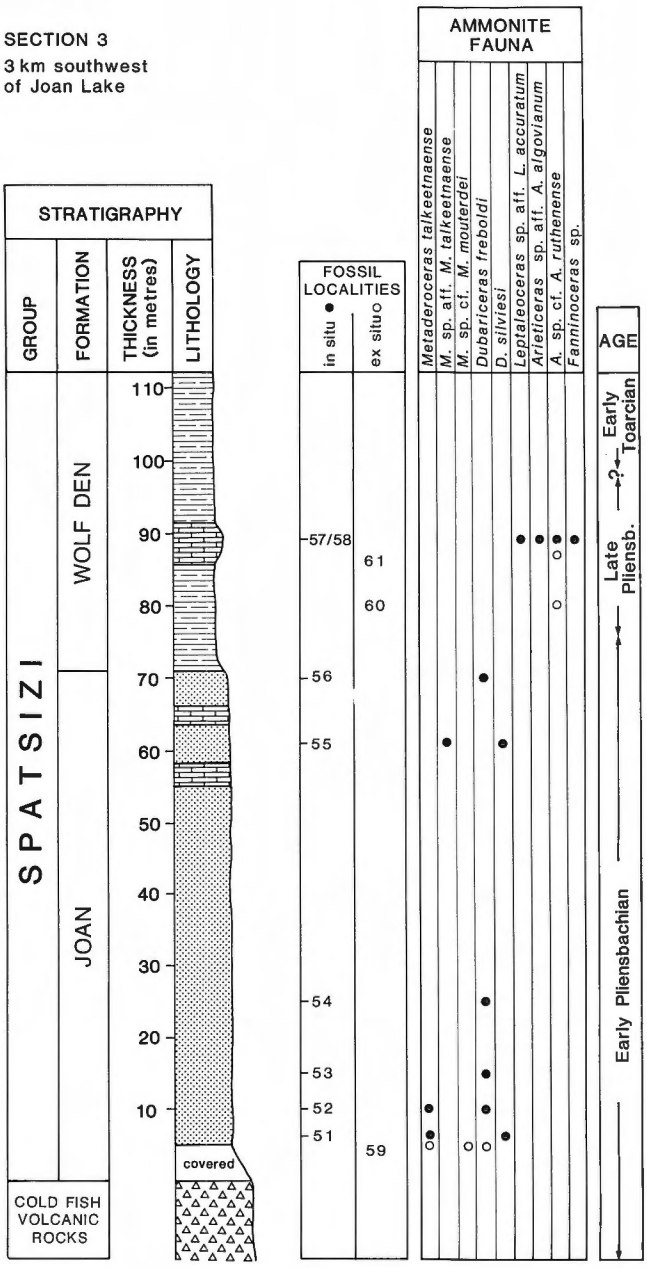


Figure 9. Lithostratigraphy and biostratigraphy of Section 3. See Figure 5 for location of section line. See Figure 7 for legend.

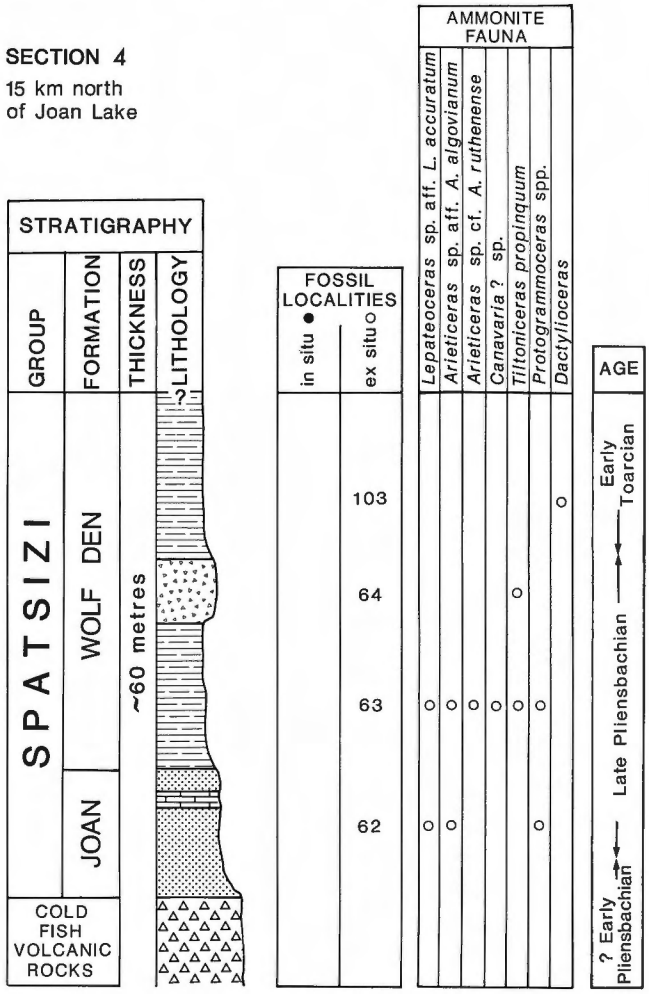


Figure 10. Lithostratigraphy and biostratigraphy of Section 4. See Figure 1 for location of section line. See Figure 7 for legend.

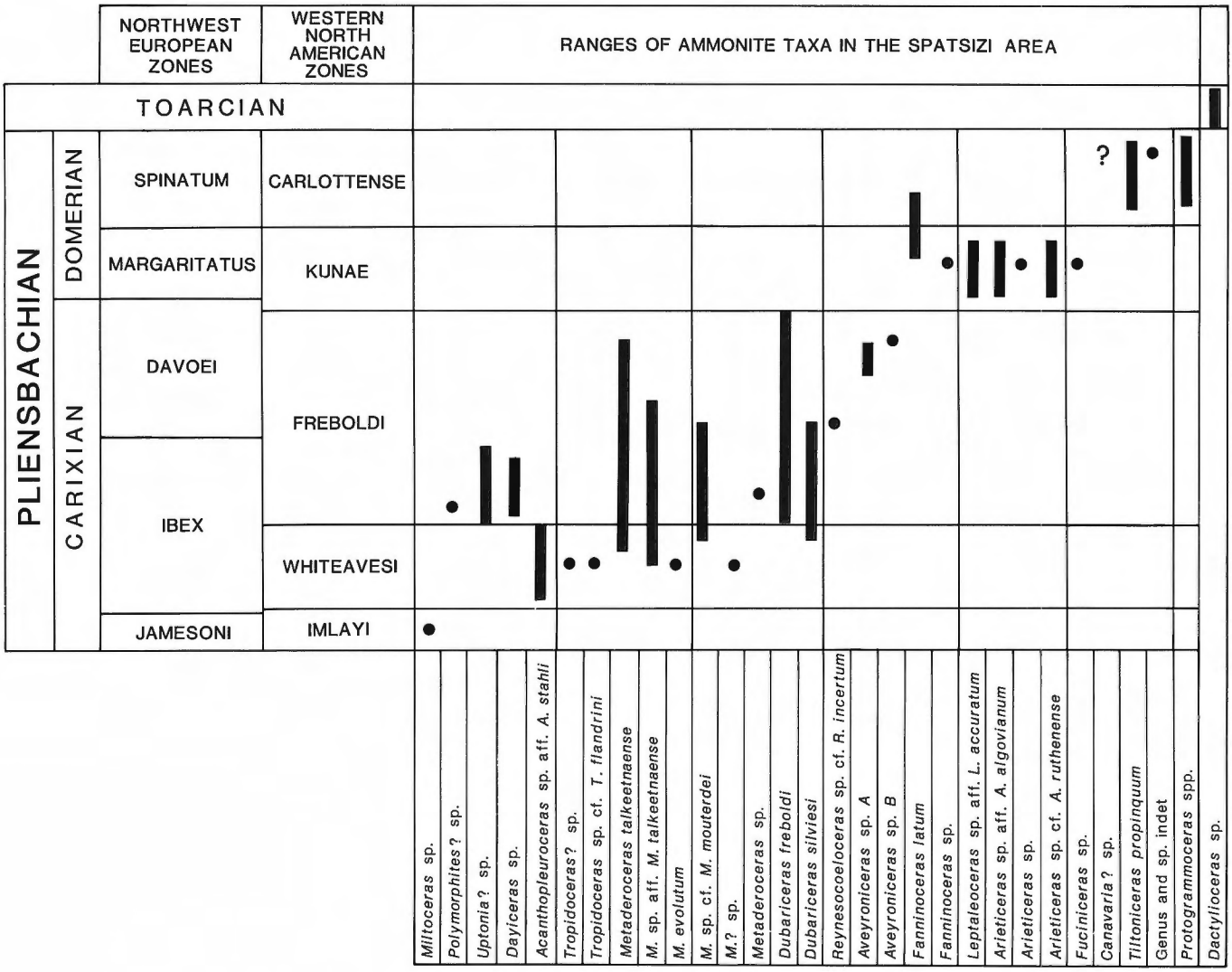


Figure 11. Relative stratigraphic ranges of the Spatsizi area ammonites.

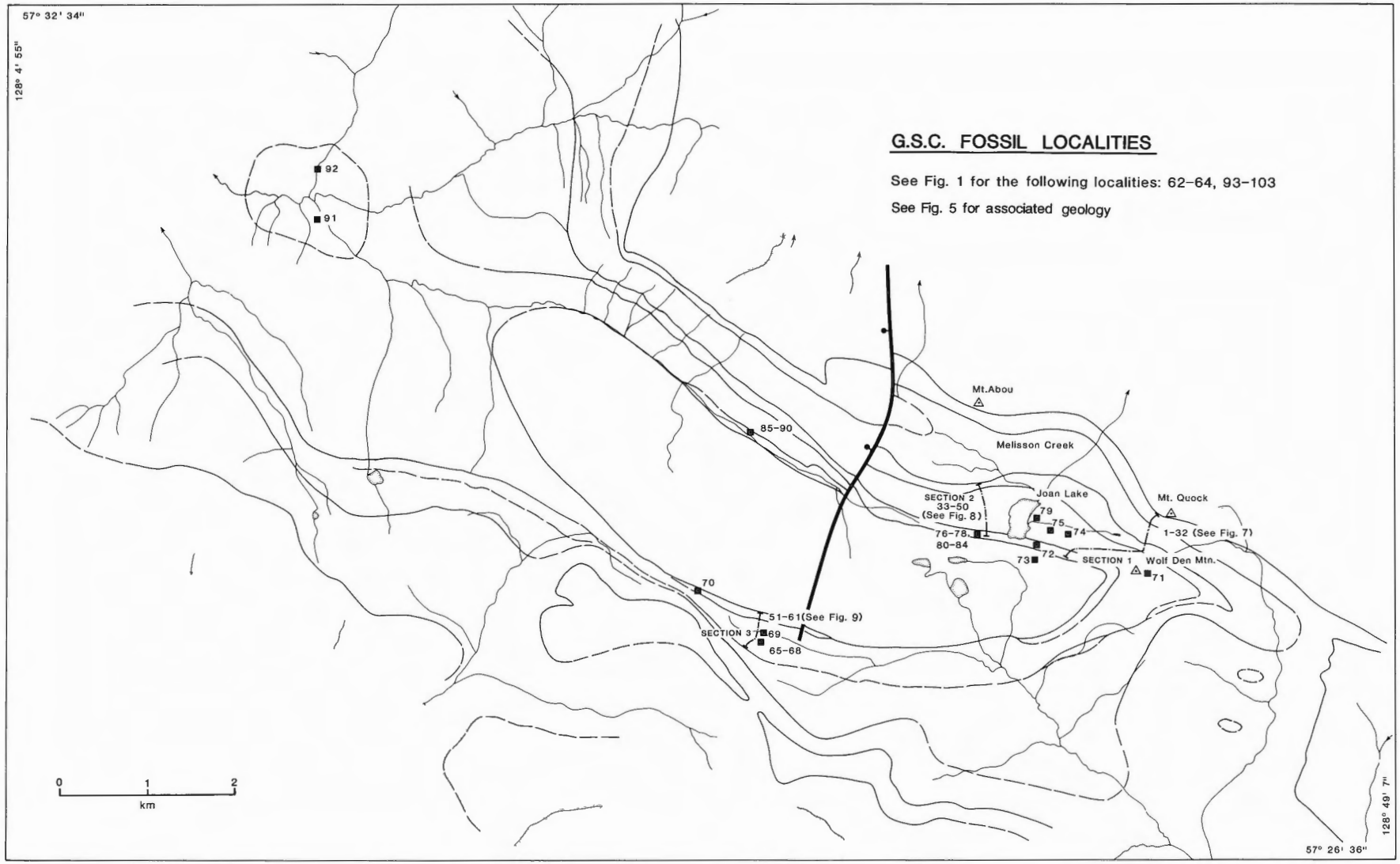


Figure 12. Fossil localities and measured sections in the Joan Lake map area.

SYSTEMATIC PALEONTOLOGY

The classification of Pliensbachian ammonites in this study follows that of Donovan et al. (1981) except for the retention of the Polymorphitinae and Acanthopleuroceratinae as subfamilies of the Polymorphitidae (Arkell et al., 1957).

It should be noted that the preservation of the Spatsizi material is generally poor. External moulds are the most abundant type of preserved fossil; internal moulds and external casts are less common, and shell material and indications of the suture lines are very rarely and poorly preserved. No complete sutures are evident on any of the material illustrated.

Locality and repository information for the collections studied are listed in Appendix 1.

Measurements and abbreviations

Type specimens in a synonymy list are marked with an asterisk. The morphological terminology used in the systematic descriptions follows that of Smith (1986). Systematic, morphological, and stratigraphic data pertaining to the ammonites figured here are stored at the University of British Columbia in the database AMMON (Smith, 1986). All measurements made in this study are in millimetres with approximate figures preceded by "a". The abbreviations denoting the measurements used are defined as follows:

D	=	shell diameter
UD	=	umbilical diameter at diameter = D
U	=	(UD/D) x 100
WH	=	whorl height at diameter = D
WHD	=	(WH/D) x 100
WW	=	whorl width at diameter = D
WWD	=	(WW/D) x 100
WWWH	=	(WW/WH) x 100
PRHW	=	primary ribs per half whorl, counted on the half whorl terminating at diameter = D
SRHW	=	secondary ribs per half whorl, counted on the half whorl terminating at diameter = D
St. Dev.	=	standard deviation

Sets of measurements made at different ontogenetic stages of the same specimen can be identified in the tables of measurements by their being listed under identical type numbers.

Systematic descriptions

Order AMMONOIDEA Zittel, 1884

Suborder AMMONITINA Hyatt, 1889

Superfamily EODEROCERATACEAE Spath, 1929

Family POLYMORPHITIDAE Haug, 1887

Subfamily POLYMORPHITINAE Haug, 1887

Genus *Uptonia* Buckman, 1898

1867 *Microceras* Hyatt
1923 *Jamesonites* Buckman

Type species. Ammonites jamesoni Sowerby, 1827 (p. 105, Pl. 555, fig. 1) by original designation.

Remarks. Shell evolute, whorl section ellipsoidal to ogival. Umbilical wall low, shallow; umbilical shoulder rounded. Ventral shoulder rounded, venter rounded.

Ornament varies with growth. Earliest whorls may possess a keel and ventrolateral tubercles but in the original description, Buckman (1898) stressed the weak development and brevity of this spinous stage. The early spinous stage gives way to a nontuberculate stage marked by strong, prorsiradiate, straight to slightly sinuous ribs that cross the venter to form adorally projecting chevrons.

Age and distribution. Uptonia is most abundant in the northwest European faunal province but is also found in the Mediterranean region, Mexico(?) (Erben, 1956), and Alaska (Imlay, 1981). In northwest Europe, *Uptonia* is restricted to the Jamesoni Zone as defined by Schlatter (1980).

Uptonia? sp.

Plate 4, figures 1, 2

cf. 1981 *Uptonia*? sp. B Imlay, p. 37, Pl. 9, figs. 5–7.

Material. Ten specimens preserved as internal and external moulds in siltstone and fine sandstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83055	25	9.5	38	7	28.0	—	—	—	20
GSC 83056	a29	11.5	40	8.5		a3.5	12	41	22

Description. Shell midvolute, whorl section ellipsoidal. Umbilical wall low, shallow; umbilical shoulder rounded. Flanks convex.

Ornamentation consists of strong, simple rectiradiate and slightly sinuous ribs that arise at the umbilical shoulder. The ribs bend sharply forward just below the ventrolateral shoulder and continue onto the venter to form chevrons.

Discussion. The Spatsizi specimens of *Uptonia*? sp. compare with specimens from Alaska assigned to *Uptonia*? sp. B by Imlay (1981). Although similar to *Uptonia distincta* Tutcher and Trueman (1925), the small size and state of preservation of the material preclude a definite species assignment. Problematical age relationships are discussed below.

Occurrence. In Spatsizi, *Uptonia*? sp. first appears near the base of the range of *Dubariceras freboldi*, above the ranges of the genera *Tropidoceras* and *Acanthopleuroceras*. *Uptonia*? sp. B and *D. freboldi* were not found at the same locality in Alaska, so the relation between their ranges is uncertain (Imlay, 1981). In the Queen Charlotte Islands, a single specimen similar to *Uptonia*? sp. was found in association with *Dubariceras freboldi* and, again, above the ranges of *Ancanthopleuroceras* and *Tropidoceras* (H.W. Tipper, pers. comm., 1985).

A position within the Freboldi Zone (approximately equivalent to the upper Ibex Zone and much of the Davoei Zone) is at variance with the age of *Uptonia* in Europe where it never ranges above the Masseanum Subzone of the Jamesoni Zone. It is possible that the Spatsizi *Uptonia*? sp. is more closely related to the coeval South American genus *Eoamaltheus*. The absence of tubercles and a distinct keel would seem to make this unlikely, but Hillebrandt (pers. comm., 1987) has such forms in his collected material that are probably derived from *Eoamaltheus* (Hillebrandt, 1984, and mostly unpublished; but see, for example, *Galaticeras*? in Hillebrandt, 1987). The exact taxonomic position of the rather rare North American material must therefore await the details of the South American succession.

Uptonia? sp. was found at localities 3, 37, 82, and 98.

Age. Early Pliensbachian (Freboldi Zone).

Genus *Dayiceras* Spath, 1920

Type species. Dayiceras polymorphoides Spath, 1920 (p. 541, Pl. 15, figs. 1–4), by original designation.

Remarks. Shell midvolute, whorl section ellipsoidal to ogival. Ornament consists of fine, dense, sinuous ribs that are rursiradiate on the umbilical wall, sinuous on the flanks, and terminate on the ventrolateral shoulder in radially elongate tubercles. The venter bears a median row of tubercles that commonly coalesce to form a crenulate keel.

Age and distribution. Rare specimens of *Dayiceras* have been found in the Ibex Zone of southern England (Spath, 1920) and possibly northwest Germany (Hoffmann, 1982), but the genus has not been reported from any other part of the northwest European Province. It has been reported from the Ibex Zone of Portugal (Mouterde, 1951; Mouterde and Ruget, 1970), North Africa (Rakus, 1972), and northern Italy (Wiedenmayer, 1977, 1980). This suggests that *Dayiceras* was most common in the Tethyan region rather than being primarily boreal in its distribution, as suggested by Dommergues et al. (1984).

Dayiceras sp.

Plate 4, figures 3–5

Material. Four fragments preserved as internal and external moulds in siltstone.

Measurements. Not available because of poor preservation.

Description. Shell evolute to midvolute; whorl section is compressed-rectangular. Umbilical wall is low, steep; umbilical shoulder rounded. Flanks are convex; ventrolateral shoulder abruptly rounded. The venter is convex, narrow.

Ornament consists of dense, fine sinuous ribs that arise on the umbilical wall where they trend rursiradiately, then become flexuous on the flanks and bend gently forward near the ventrolateral shoulder where they are marked by radially elongate tubercles. The ribs continue weakly past the tubercles onto the venter, but fade rapidly. A low, weakly beaded keel is present on the venter.

Discussion. The Spatsizi specimens of *Dayiceras* sp. are similar to *Dubariceras freboldi* in their form of ribbing and volution, but they differ from *Dubariceras freboldi* by their low median keel, narrower whorl section, and slightly coarser ribbing. These specimens of *Dayiceras* can be distinguished from *Polymorphites* by virtue of their more compressed whorl section, denser and more sinuous ribbing, irregular keel, and large size.

Occurrence. The specimens of *Dayiceras* sp. described here represent the first occurrence of *Dayiceras* in western North America. *Dayiceras* sp. occurs within the range of *Dubariceras freboldi* together with *Uptonia*? sp., *Dubariceras silviesi*, and *M. talkeetnaense*.

Dayiceras sp. was found at localities 3, 45, and 72.

Age. Lower Pliensbachian (Freboldi Zone).

Genus *Polymorphites* Haug, 1887

Type species. Ammonites polymorphus quadratus Quenstedt, 1845 (Pl. 4, fig. 9).

Remarks. Small forms with simple tuberculate ribs. Venter may bear a keel, chevrons, or be featureless.

Age and distribution. A widely distributed form most common in northwest Europe. Characteristic of the Jamesoni Zone.

Polymorphites? sp.

Plate 12, figure 5

Material. A single, small specimen preserved as an internal mould in siltstone.

Measurements.

Specimen	D	UD	U	WH	PRHW
GSC 83102	19	8.2	43	7	14

Description. Shell fairly evolute, whorl section appears elliptical but the specimen has undergone some lateral compression. Umbilical wall is low, shallow; umbilical shoulder rounded; flanks convex. Ventral shoulder gently rounded; venter inflated.

Ornament consists of simple, straight, rectiradiate ribs that arise on the umbilical shoulder. The ribs then terminate at about three quarters of the flank height in sharp tubercles. Some of the ribs continue faintly past the tubercles, but these disappear rapidly leaving the venter smooth.

Discussion. Because of the preservation and uncertain age, the Spatsizi specimen is difficult to identify with confidence. It is similar to a species of *Polymorphites* from the Bosso Valley in Italy figured under the name *Polymorphites granuliferum* (Gemmellaro, 1884) by Ferretti (1975, p. 178, Pl. 24, fig. 3). Gemmellaro's material, however, is more evolute, less densely ribbed (Gemmellaro, 1884, p. 184, Pl. 3, fig. 19, Pl. 4, figs. 3–6) and probably represents the genus *Gemmellaroceras*.

Occurrence. The Italian material originates from beds that correlate with the Jamesoni Zone of the northwest European sequence (Ferretti, 1975).

The Spatsizi specimen was found at locality 26 in float that was probably derived from the Whiteavesi or Freboldi zones.

Age. Early Pliensbachian.

Genus *Miltoceras* Wiedenmayer, 1980

Type species. Aegoceras sellae Gemmellaro, 1884 (p. 179, Pl. 3, figs. 1–5).

Remarks. Midvolute to evolute forms that may have *Coeloceras*-like innermost whorls but the whorl shape quickly becomes more compressed with parallel flanks and a rounded venter. Primary ribs terminate in small tubercles from which a number of finer secondary ribs arise. *Miltoceras* was originally created as a subgenus of *Apoderoceras* by Wiedenmayer (1980) and later raised to generic status by Hillebrandt (1981a).

Age and distribution. Miltoceras is a Tethyan form reported primarily from Italy, Austria, Morocco, and Chile (Wiedenmayer, 1980; Hillebrandt, 1981a). It ranges from the Jamesoni Zone to the Davoei Zone and possibly into the Upper Pliensbachian.

Miltoceras sp.

Plate 12, figures 1–4

Material. Twelve poorly preserved fragmentary specimens in calcareous volcaniclastic siltstone as internal moulds with some original shell material.

Measurements. Not available because of poor preservation.

Description. Probably fairly evolute. The primary ribs are simple, straight, fairly dense, and terminate in ventrolateral swellings or small tubercles that form the base of spines. Beyond the tubercles the primary ribs polyfurcate into several faint, adorally arched, secondary ribs. The venter is fairly broad and gently arched in small specimens but rounded in larger

fragments at which stage the whorl section appears somewhat compressed.

Discussion. The Spatsizi specimens of *Miltoceras* sp. are similar to *Miltoceras* sp. cf. *M. sellae* (Gemmellaro, 1884) from South America (Hillebrandt, 1987), but the poor preservation precludes confident comparison.

Occurrence. The Spatsizi specimens of *Miltoceras* sp. were collected from sediments interbedded in the Cold Fish volcanics at locality 99. They were not found associated with any other ammonites, but field relations suggest they are from a position low in the Pliensbachian section representing the lowest level of the Pliensbachian in Spatsizi. In the Queen Charlotte Islands, comparable specimens of *Miltoceras* have been collected from the Ghost Creek Formation of the Maude Group (listed as *Coeloceras* in Cameron and Tipper, 1985). These specimens occur low in the Pliensbachian within the Imlayi Zone.

Age. Early Pliensbachian (Imlayi Zone).

Subfamily ACANTHOPLEUROCERATINAE Arkell, 1950

Genus *Acanthopleuroceras* Hyatt, 1900

1867 *Cycloceras* Hyatt

Type species. Ammonites valdani d'Orbigny, 1844 (p. 255, Pl. 71), by subsequent designation (Getty, 1970).

Remarks. Shell evolute to slightly midvolute; whorl section quadrate to moderately compressed. Venter is low and bears a blunt keel. Ornament consists of straight, simple, rectiradiate to rursiradiate ribs. The ribs may be bi- or unituberculate and project weakly onto the venter from ventrolateral tubercles. *Acanthopleuroceras* differs from *Tropidoceras* by having a generally less compressed whorl section, straighter, often tuberculate ribs, a less prominent, blunter keel, and a lack of secondary ribbing on the ventral surface.

The phylogenetic relationship between *Acanthopleuroceras* and *Tropidoceras* is subject to debate. Dommergues and Mouterde (1978, 1981) considered that the two genera represent evolution within a single lineage, whereas Wiedenmayer (1977) considered that they belong to separate lineages. Geczy (1976) drew attention to the fact that there exist numerous forms intermediate between *Acanthopleuroceras* and *Tropidoceras*. This point is exemplified by the generically ambiguous nature of certain species, including *Ammonites stahli* Oppel, 1856 and *Ammonites actaeon* d'Orbigny, 1844, which have been assigned to both genera by different workers.

Age and distribution. Acanthopleuroceras is a cosmopolitan form. It is characteristic of the Ibex Zone in Europe and reaches its acme in the middle of this zone (Dean et al., 1961; Geczy, 1976; Hoffmann, 1982).

Acanthopleuroceras sp. aff. *A. stahli* (Oppel, 1853)

Plate 5, figures 1–4

aff. *1853 *Ammonites radians numismalis* Oppel, p. 51, Pl. 3, fig. 2.
aff. 1856 *Ammonites stahli* Oppel, p. 288.
aff. 1976 *Acanthopleuroceras stahli* (Oppel). Geczy, p. 95, Pl. 18, figs. 4–6.
aff. 1977 *Tropidoceras stahli* (Oppel). Wiedenmayer, p. 65, Pl. 14, figs. 3–11 (and synonymy).
aff. 1980 *Tropidoceras stahli* (Oppel). Schlatter, p. 139, Pl. 20, fig. 3, Pl. 21, fig. 1.
1981 *Paltechioceras* cf. *P. harbledownense* (Crickmay). Imlay, p. 34, Pl. 4, figs. 18–21 only.

Material. Fourteen external and internal moulds, all preserved in coarse, poorly sorted, volcaniclastic sandstone and pebbly sandstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83058	43	19	44	13	30.2	—	—	—	17
GSC 83058	—	8	—	—	—	—	—	—	20
GSC 83059	42	19.5	46	13	30.9	7	16.7	53.8	17
GSC 83059	—	9	—	—	—	—	—	—	19
GSC 83060	56	25	45	19	34.0	—	—	—	18
GSC 83061	50	22	44	16	32.0	11	22.0	69.0	18
Mean	—	—	44.8	—	31.8	—	—	—	—
St. Dev.	—	—	1.0	—	1.7	—	—	—	—

Description. Shell evolute, whorl section subquadrate. Umbilicus shallow; umbilical wall low, steep; umbilical shoulder rounded. Flanks convex, ventrolateral shoulder rounded. Venter fairly broad, fastigate, bearing a blunt keel.

Ornament consists of dense, straight, slightly rursiradiate ribs. Ribs are coarse and bear a single row of small ventrolateral tubercles from which the ribs project slightly adorally.

Discussion. The Spatsizi specimens of *A.* sp. aff. *A. stahli* are similar to those figured by Geczy (1976) and Wiedenmayer (1977) in whorl section and form of ribbing. However, the Spatsizi specimens are never bituberculate and the inner whorls are much more densely ribbed than the illustrated European specimens. They belong to a new species that is well represented in the Queen Charlotte Islands, northeastern Oregon, and Nevada and will be fully described in a later work.

Occurrence. Acanthopleuroceras stahli is found in both the Boreal and Tethyan faunal realms. It has been reported from England, Germany, France, Italy, and Hungary where it is restricted to the Ibex Zone. In the Spatsizi area, *A.* sp. aff. *A. stahli* occurs below the range of *Dubariceras freboldi.* Some specimens were recovered from rocks directly overlying the highest flow of the Cold Fish volcanics in the map area, but no other ammonites occur at this locality. Sediment lenses of an equivalent or slightly lower stratigraphic level, found within the volcanic sequence, have yielded collections containing *A.* sp. aff. *A. stahli* with *Metaderoceras evolutum* (Fig. 1, locality 96; Appendix 1).

Acanthopleuroceras sp. aff. *A. stahli* was found at localities 44, 83, 94, and 96.

Age. Early Pliensbachian (Whiteavesi Zone).

Genus *Tropidoceras* Hyatt, 1867

Type species. Ammonites masseanum d'Orbigny, 1844 (p. 225, Pl. 48, figs. 1–3), by subsequent designation (Haug, 1885, p. 606).

Remarks. Shell evolute, whorl section compressed, lanceolate to ellipsoidal. Venter bears a distinct, commonly high keel. Ornament consists of straight to sigmoidal primary ribs that project onto the venter where they are commonly differentiated into numerous, adorally projecting secondary ribs.

The relationship between *Tropidoceras* and *Acanthopleuroceras* is discussed under the generic description of *Acanthopleuroceras.* The Upper Pliensbachian hildoceratids *Arieticeras, Leptaleoceras,* and *Protogrammoceras* are believed to have evolved from *Tropidoceras* (Donovan et al., 1981).

Age and distribution. Like *Acanthopleuroceras, Tropidoceras* is a cosmopolitan genus but is particularly abundant in the Tethyan Realm (Donovan, 1967; Braga and Rivas, 1985). The genus first occurs in the Jamesoni Zone but reaches its acme in the lower part of the Ibex Zone.

Tropidoceras? sp.

Plate 5, figures 6, 7.

Material. Three specimens, poorly preserved as external and internal moulds in siltstone.

Measurements.

Specimen	D	UD	U	PRHW
GSC 83063	a48	a27	56	a20

Description. Whorl section ellipsoidal, venter narrow, bearing a high keel. Umbilical wall low, fairly steep; umbilical shoulder rounded. The ribs arise on or above the umbilical shoulder, trend slightly rursiradiately, then bend forward as they approach the ventrolateral shoulder, where they fade rapidly. The ribs are nontuberculate and there appear to be no secondary ribs on the ventral surface.

Discussion. The fragmentary nature of these specimens precludes confident assignment but they do show similarities to specimens of *Tropidoceras actaeon* (d'Orbigny, 1844) figured by Frebold (1970).

Occurrence. The Spatsizi specimens of *Tropidoceras*? sp. were found just below the base of the range of *Dubariceras freboldi* at localities 1, 73, and 101.

Age. Early Pliensbachian.

Tropidoceras sp. cf. *T. flandrini* (Dumortier, 1869)

Plate 5, figure 5

cf. *1869 *Ammonites flandrini* Dumortier, p. 72, Pl. 14, figs. 1, 2.

cf. 1899 *Tropidoceras flandrini* (Dumortier). Fucini, p. 168, Pl. 23, fig. 2.

Material. A single, large whorl fragment preserved as an internal mould in a tectonically sheared silty mudstone.

Description. The specimen has been tectonically compressed but appears to have had a whorl section that was higher than wide and a convex venter bearing a keel that was almost completely lost during preparation because of the brittle nature of the matrix. Ornament consists of gently rursiradiate, bituberculate primary ribs of moderate density and relief. Dense, strongly prorsiradiate secondary ribs project onto the venter from the ventrolateral tubercles. These secondary ribs extend to the keel and impart a herringbone or feather-like appearance on the ventral surface.

Discussion. Because this specimen is poorly preserved, its original volution and whorl shape are uncertain. It could represent the variety of *T. flandrini obtusa* (Futterer, 1893, Pl. 13, figs. 1a–d), which has a subquadrate as opposed to a compressed subelliptical whorl shape. *Tropidoceras flandrini* sp. cf. *T. obtusa* has been reported from South America (Hillebrandt, 1987).

Occurrence. Subspecies of *T. flandrini* occur in the Jamesoni and Ibex zones of Europe and the Imlayi and Whiteavesi zones of North America. The South American material originates from the "*Tropidoceras*" Zone, which is correlated approximately with the upper Jamesoni Zone and lower Ibex Zone of the northwest European scheme.

Tropidoceras sp. cf. *T. flandrini* was found at locality 92.

Age. Early Pliensbachian (Whiteavesi Zone).

Family EODEROCERATIDAE Spath, 1929

Genus *Metaderoceras* Spath, 1925

Type species. Ammonites muticus d'Orbigny, 1844 (p. 274, Pl. 8), by original designation.

Remarks. The relationship between the species attributed to *Metaderoceras* and other genera of Eoderoceratidae, most notably *Crucilobiceras* and *Eoderoceras*, is problematic. Spath (1925) created the genus *Metaderoceras* and designated *Ammonites muticus* d'Orbigny, 1844 as the type species. This new genus was subsequently placed in synonymy with *Crucilobiceras* in the Treatise (Arkell et al., 1957) and by Donovan and Forsey (1973). Mouterde (1970), however, preferred to retain the genus *Metaderoceras* on the basis of differences between its type, *Ammonites muticus* d'Orbigny, 1844, and the type species of *Crucilobiceras*, *C. crucilobatum* Buckman, 1920. *Crucilobiceras* is characteristically bituberculate and has a narrow whorl section, whereas *Metaderoceras* is unituberculate and has a generally wider whorl section. Furthermore, a range discrepancy exists between the two genera: *Crucilobiceras* is restricted to the Upper Sinemurian Raricostatum Zone, whereas *Metaderoceras* first appears in the Jamesoni Zone and is most abundant in the Ibex Zone.

Subsequent workers adopted different generic assignments. Wiedenmayer (1977, 1980) placed *Crucilobiceras* and *Metaderoceras* in synonymy, whereas Dubar and Mouterde (1978), Rocha (1977), and Geczy (1976) retained *Metaderoceras*, although Mouterde (1977) pointed out that a morphological gradation exists between the genera *Eoderoceras* and *Crucilobiceras* that is bridged by *Metaderoceras beirense*. More recently, Donovan et al. (1981) and Rivas (1983) retained *Metaderoceras*, *Crucilobiceras*, and *Eoderoceras* as distinct genera.

Age and distribution. Metaderoceras is characteristically Tethyan in distribution; it is found in Morocco (Du Dresnay, 1963), the Iberian Peninsula (Mouterde, 1977; Rivas, 1983), Hungary (Geczy, 1976), and western North America (Smith et al., 1988). The genus ranges from the Jamesoni Zone to its acme in the Ibex Zone.

Metaderoceras talkeetnaense n. sp.

Plate 6, figure 1; Plate 7, figures 1–5; Figure 14

1981 *Crucilobiceras* cf. *C. muticum* (d'Orbigny). Imlay, p. 35, Pl. 7, figs. 6–10, 12–15.

1988 *Metaderoceras* aff. *M. muticum* (d'Orbigny). Smith, Tipper, Taylor and Guex, Pl. 2, figs. 7–9.

Etymology. The species name is derived from the Talkeetna Mountains, Alaska, where the type material originates.

Type material. Holotype: Imlay, 1981, Pl. 7, figs. 12, 13. The remainder of Imlay's specimens are paratypes (Pl. 7, figs. 6–10, 14, 15).

Spatsizi material. Forty-three specimens, preserved in siltstone as external and internal moulds.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83065	a184	107	58	a43	23.4	—	—	—	31
GSC 83065	a107	63	59	a26	24.3	—	—	—	21
GSc 83065	a63	30	48	a17	27.0	—	—	—	14
GSC 83066	a107	60	56	a24	22.4	—	—	—	21
GSC 83066	a60	30	50	a16.5	27.5	—	—	—	17
GSC 83067	60	31	52	—	—	—	—	—	18
GSC 83068	a80	a43	51	—	—	—	—	—	a18
GSC 83068	a43	a22	51	—	—	—	—	—	14
GSC 83070	39	19	49	11	28.2	9.5	24.3	86.4	16
GSC 84961	60	31	52	—	—	—	—	—	16
GSC 84961	31	15	48	8.5	27.4	—	—	—	16
Mean	—	—	52.2	—	25.7	—	—	—	—
St. Dev.	—	—	3.8	—	2.3	—	—	—	—

Description. Shell evolute; whorl section rectangular to subquadrate. Umbilicus wide and quite shallow; umbilical wall low, convex; umbilical shoulder rounded. Flanks convex; ventrolateral shoulder abruptly rounded. Venter broad, convex, and smooth except for faint swellings that arch adorally from the ventrolateral tubercles.

This species is costate throughout growth. At diameters less than approximately 20 mm, ribbing consists of fairly dense, simple, straight, rectiradiate to slightly prorsiradiate ribs that arise at or just above the umbilical shoulder and terminate at the ventrolateral shoulder in small tubercles. At diameters greater than 20 mm, the ribs arise faintly on the umbilical wall where they may be slightly rursiradiate. They gradually increase in strength and become rectiradiate to prorsiradiate at about one quarter of the whorl height. They then continue straight to the ventrolateral shoulder where they terminate in large tubercles that represent the bases of long, sharp spines. Rib density is fairly low (between 13 and 18 PRHW up to diameters of about 100 mm) but increases gradually at larger diameters (Fig. 13).

Discussion. Specimens of this species collected from Oregon and Nevada show a change in whorl section at diameters greater than about 100 mm (Smith, 1981). At shell diameters of less than 100 mm, the whorl section is subquadrate (higher than wide), whereas at greater diameters the whorl section is slightly depressed. This change in shape may be indicative of maturity. The poor preservation of the Spatsizi material precludes comment on the whorl section. However, the United States material shows a concomitant increase in ribbing density that is evident in the larger Spatsizi specimens.

Occurrence. In Spatsizi, *Metaderoceras talkeetnaense* occurs within the range of *Dubariceras freboldi*. The type material from Alaska occurs with other species of *Metaderoceras* and specimens that Imlay refers to *Paltechioceras* sp. cf. *P. harbledownense* (Imlay, 1981). These latter specimens, which are tuberculate and have rursiradiate ribbing, are not echioceratids but are referable to *Acanthopleuroceras* sp. aff. *A. stahli*. The age of this association is the Whiteavesi Zone. In the conterminous United States, *Metaderoceras*

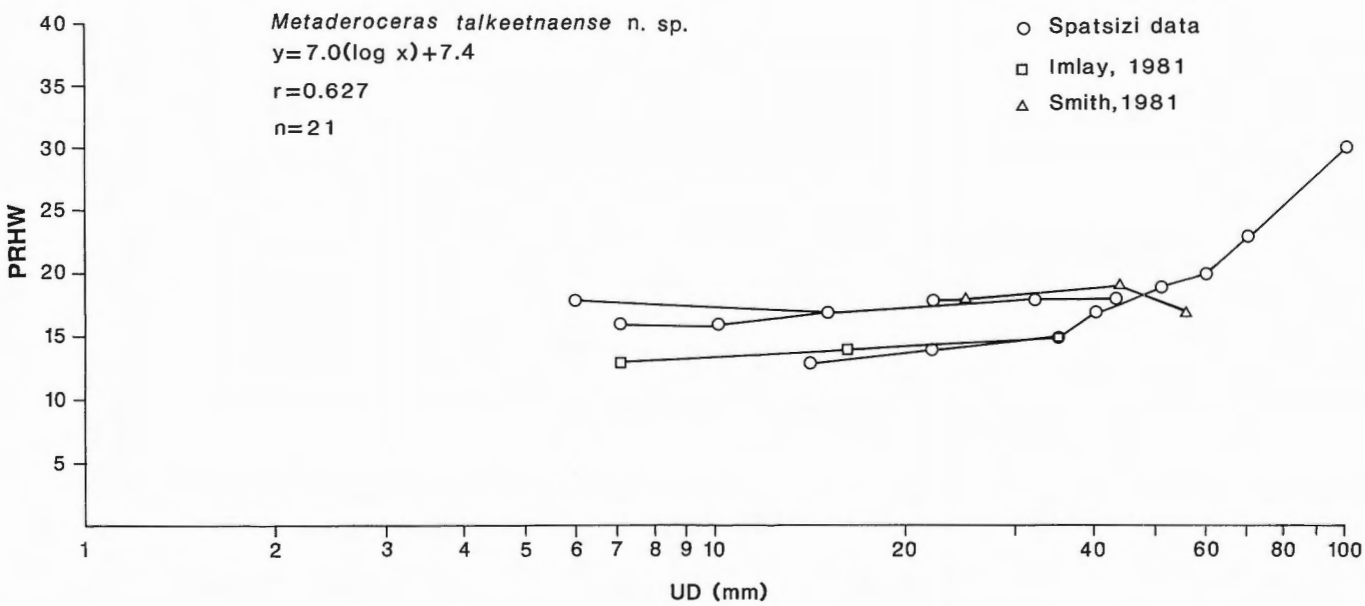


Figure 13. *Semilogarithmic plot of primary ribs per half whorl (PRHW) as a function of umbilical diameter (UD) for* ***Metaderoceras talkeetnaense*** *n. sp.*

talkeetnaense is known from the Freboldi and Whiteavesi zones (Smith et al., 1988).

Metaderoceras talkeetnaense was found at localities 2–5, 8–10, 22, 26–28, 36, 41, 51, 52, 59, 68, 70, 78, 80–82, 84, 88, and 98.

Age. Early Pliensbachian (Whiteavesi and Freboldi zones).

Metaderoceras sp. aff. *M. talkeetnaense* n. sp.

Plate 8, figures 1–3

cf. 1981 *Crucilobiceras* cf. *C. densinodulum* Buckman. Imlay, p. 34, Pl. 7, figs. 4, 5.

Material. Seven specimens, poorly to moderately well preserved as external and internal moulds in siltstone and fine sandstone.

Measurements.

Specimen	D	UD	U	WH	WHD	PRHW
GSC 83071	a180	a100	55.5	a93	21.7	17
GSC 83071	a95	a55	58	a25	26.3	15
GSC 83072	a90	a55	61	a21	23.3	a13

Description. Shell evolute, whorl section rectangular to subquadrate. Umbilical wall low, steep; umbilical shoulder rounded. Flanks are convex; ventrolateral shoulder abruptly rounded; venter is broad and low.

Ribbing on the inner whorls consists of fairly dense, prorsiradiate ribs that arise on the umbilical wall where they trend slightly rursiradiately. Each rib is terminated at the ventrolateral shoulder by a long, sharp tubercle. On the outer whorls the ribs become distant, fairly broad, and faint on the lower flank.

Discussion. The inner whorls (D = 50 mm) of *M.* sp. aff. *M. talkeetnaense* are similar to *M. talkeetnaense* in rib density and form, but the outer whorls have coarser ribs. A single specimen from Alaska, assigned to *Crucilobiceras* sp. cf. *C. densinodulum* by Imlay (1981), is similar to the Spatsizi specimens of *M.* sp. aff. *M. talkeetnaense*, except that the ribs on the outer whorls of the Alaskan material tend to weaken near the middle of the flanks and the whorl section appears more compressed.

In Spatsizi and Alaska, *M. talkeetnaense* and *M.* sp. aff. *M. talkeetnaense* share the same stratigraphic range. A possible exception to this exists in Spatsizi where one specimen of *M.* sp. aff. *M. talkeetnaense* was collected low in the sequence, apparently below the other occurrences of *M. talkeetnaense*.

Occurrence. As noted above, *M.* sp. aff. *M. talkeetnaense* occurs with and possibly below *M. talkeetnaense* in the Spatsizi area. In its lowest position, *M.* sp. aff. *M. talkeetnaense* is associated with *Acanthopleuroceras* sp. aff. *A. stahli* and *M. evolutum*. This range corresponds to the Whiteavesi Zone and lower Freboldi Zone.

At Spatsizi, *M.* sp. aff. *M. talkeetnaense* was found at localities 11, 25, 36, 55, 95, and 100.

Age. Early Pliensbachian (Whiteavesi Zone to Lower Freboldi Zone).

Metaderoceras evolutum (Fucini, 1921)

Plate 9, figures 5, 6

1899 *Deroceras gemmellaroi* Levi. Fucini, p. 16, Pl. 20, figs. 1, 2.
1909 *Deroceras muticum* d'Orbigny. Rosenberg, p. 265, Pl. 13, fig. 7.
*1921 *Deroceras evolutum* Fucini, p. 50, Pl. 1, fig. 14a, b.
1963 *Crucilobiceras* aff. *evolutum* (Fucini). Du Dresnay, p. 147, Pl. 2, figs. 2, 3.
1970 *Crucilobiceras pacificum* Frebold, p. 435, Pl. 1, figs. 4–8.
?1976 *Metaderoceras* sp. aff. *M. evolutum* (Fucini). Geczy, p. 61, Pl. 12, fig. 5.
1977 *Crucilobiceras evolutum* (Fucini) *brutum* Wiedenmayer, p. 59, Pl. 13, figs. 1, 2.
1977 *Crucilobiceras evolutum evolutum* (Fucini). Wiedenmayer, p. 59, Pl. 13, fig. 3.
1978 *Metaderoceras evolutum* (Fucini). Dubar and Mouterde, p. 44, Pl. 2, fig. 1.
1978 *Metaderoceras evolutum* (Fucini) *brutum* (Wiedenmayer). Colera et al., p. 311, Pl. 1, figs. 3a–c, 4.
non 1978 *Metaderoceras* sp. 3 (gr. *M. evolutum* Fucini). Colera et al., p. 314, Pl. 1, fig. 2, Pl. 2, fig. 2.
1980 *Crucilobiceras evolutum evolutum* (Fucini). Wiedenmayer, p. 48, Pl. 1, figs. 3, 4.
cf. 1981 *Crucilobiceras* cf. *C. pacificum* Frebold. Imlay, p. 35, Pl. 8, figs. 10–12, 15–17.

cf. 1983 *Metaderoceras evolutum* (Fucini). Rivas, p. 395, Pl. 1, figs. 1–8.
1988 *Metaderoceras evolutum* (Fucini). Smith, Tipper, Taylor, and Guex, Pl. 1, fig. 11.

Material. Two specimens preserved as internal moulds in limestone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83076	31	16	52	a9	29	a6	19.4	66.7	a13
GSC 83077	—	—	—	12	—	10	—	83.3	—
GSC 84962	a40	a21	52	—	—	—	—	—	—

Description. Shell evolute; whorl section rectangular to subquadrate. Umbilical wall low, gently inclined; umbilical shoulder rounded. Flanks are slightly convex; ventrolateral shoulder abruptly rounded. The venter is fairly broad, convex.

Ornament consists of distant, straight, slightly prorsiradiate ribs of low relief. The ribs arise above the umbilical shoulder and terminate in prominent ventrolateral tubercles. Faint secondary ribs or inter-rib lirae are visible on these specimens.

Discussion. A recent study by Rivas (1983) has shown *M. evolutum* to be a variable species that includes many specimens previously assigned to other species and subspecies. Although Rivas (1983) includes *M. mouterdei* (Frebold) in *M. evolutum, M. mouterdei* is retained in this study on the basis of differences observed in the outer whorls of specimens of *M.* sp. cf. *M. mouterdei* from Spatsizi (see the following discussion of *M.* sp. cf. *M. mouterdei*).

Occurrence. Metaderoceras evolutum is common in Pliensbachian sequences in the Mediterranean region. The Spatsizi specimens of *M. evolutum* were found low in the sequence, at locality 96, below the range of *Dubariceras freboldi*, in association with *Acanthopleuroceras* sp. aff. *A. stahli*. In Alaska (Imlay, 1981), *M. evolutum* is associated with *Tropidoceras actaeon*.

Age. Early Pliensbachian (Whiteavesi Zone).

Metaderoceras sp. cf. *M. mouterdei* (Frebold, 1970)

Plate 9, figures 1–4; Plate 10, figure 1

cf. *1970 *Crucilobiceras mouterdei* Frebold, p. 437, Pl. 1, fig. 2a, b.
cf. 1981 *Apoderoceras* cf. *A. subtriangulare* (Young and Bird). Imlay, p. 35, Pl. 8, figs. 14, 18–23.
cf. 1988 *Metaderoceras mouterdei* (Frebold). Smith et al., Pl. 3, figs. 9, 10.

Material. Seven specimens, preserved in siltstone as external and internal moulds.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83078	78	43	55	—	—	—	—	—	20
GSC 83078	a43	25	58	a11.5	26.7	—	—	—	10
GSC 83078	a25	12	48	—	—	—	—	—	11
GSC 83079	a110	a51	46	28	25.5	17	15.4	60.7	23
GSC 83079	a49	a24	50	—	—	—	—	—	13
GSC 83079	a24	a10	42	—	—	—	—	—	16
GSC 83080	a95	55	58	a24	25.2	—	—	—	20
GSC 83081	44	21	48	12	27.3	—	—	—	11
GSC 83081	a22	10	45	7	31.8	—	—	—	14
GSC 83082	a70	32	45	a8	25.7	—	—	—	14
Mean	—	—	49.5	—	27.0	—	—	—	—
St. Dev.	—	—	5.7	—	2.5	—	—	—	—

Description. Shell evolute; umbilical wall low, convex, gently sloping; umbilical shoulder rounded. Whorl section appears to be subquadrate to slightly coronate. Flanks convex and ventrolateral shoulder angular. Venter broad, slightly convex, and smooth except for very faint swellings that arch adorally from tubercles on the ventrolateral shoulder.

Ornament varies with growth. Ribbing appears at a diameter of less than 5 mm and consists, on the inner whorls, of dense, straight, slender ribs that arise on the umbilical shoulder, trend rectiradially, and terminate in distinct tubercles. At umbilical diameters greater than about 10 mm, rib density undergoes a decrease from 13 to 14 PRHW to 10 to 11 PRHW. This decrease in rib density is most apparent in the holotype figured by Frebold (1970, see the following discussion). The ribs of this reduced-density stage differ from the earlier ribs in that they are indistinct on the lower one third of the flanks then become stronger and quite broad toward the ventrolateral shoulder. The ribs terminate at the ventrolateral shoulder in large tubercles that represent the bases of spines.

The two largest specimens of *M.* sp. cf. *M. mouterdei* in the Spatsizi collections show a dramatic increase in rib density beginning at an umbilical diameter of about 25 mm. At UD = 45 mm, both specimens have exceeded a rib density of 20 PRHW, and reach a maximum density of about 24 PRHW. The ribs of this high density stage are different from those of the preceding stage; they arise on the umbilical wall

where they trend rursiradiately, then curve forward and trend slightly prorsiradiately on the flank where they are gently sinuous. They are terminated at the ventrolateral shoulder by sharp tubercles. The whorl section of this densely ribbed stage appears to be relatively more compressed than earlier whorls.

Discussion. The Spatsizi specimens of *M.* sp. cf. *M. mouterdei* are similar to the holotype (Frebold, 1970) in their volution, whorl shape, and form of ribbing at umbilical diameters less than about 27 mm, although the decrease in rib density, beginning at UD = 10 mm, is of greater magnitude in the holotype. Whereas rib density in the holotype drops from a high of 19 PRHW to a low of 12 PRHW, the corresponding decrease in the Spatsizi material is from 14 to 10 PRHW.

The high rib density stage observed on the outer whorls of the Spatsizi specimens (a stage that possibly represents the body chamber) is not seen in the holotype of *M. mouterdei*. This high density stage first develops at a diameter exceeding the maximum diameter of the holotype, which is septate to the end (UD = 27 mm). In other words, the greatest diameter of the holotype roughly corresponds to the onset of the dense ribbed stage of the Spatsizi specimens. Unfortunately, no sutures are preserved on the Spatsizi specimens, therefore the inference of maturity must go unsubstantiated.

Metaderoceras mouterdei is unique among the species of *Metaderoceras* in its tendency toward decreasing rib density from the inner to middle whorls. The subquadrate to coronate whorl section is also distinctive, suggesting a close relationship to the *Metaderoceras venarense* group. *Metaderoceras mouterdei* differs from *M. talkeetnaense* in having a more variable rib density with growth (Figs. 13–15) and a broader whorl section. Although Rivas (1983) placed both species in synonymy *M. mouterdei* can be distinguished from *M. evolutum* by its stronger ribbing, the absence of ribs joining at the ventrolateral tubercles, and its broader whorl section.

Occurrence. In the Queen Charlotte Islands, *M. mouterdei* has been collected from the Whiteavesi and Freboldi zones. The Alaskan material probably correlates with the Freboldi Zone.

The Spatsizi specimens were found at localities 3, 7, 25, 59, and 98.

Age. Early Pliensbachian (Whiteavesi and Freboldi zones).

Metaderoceras sp.

Plate 8, figure 4

Material. A single specimen preserved as an external mould in fine grained volcaniclastic sandstone.

Measurements.

Specimen	D	UD	U	WH	PRHW
GSC 83074	53	28	53	14	20
GSC 83074	a28	17	61	a8.5	20

Description. Shell is evolute; whorl shape is unknown because of preservation. Umbilical wall low, shallow to moderately steep; umbilical shoulder rounded; flanks are convex. The ventrolateral shoulder appears to be abruptly rounded; the venter is not preserved in this specimen.

Ornament consists of straight, moderately prorsiradiate ribs. Rib density is high, particularly on the inner whorls, and remains fairly constant throughout the ontogeny of this specimen. The ribs arise on the lower flank and attain their maximum relief at about one third of flank height. The ribs are fairly broad and continue to the ventrolateral shoulder where they bear a ventrolateral spine.

Discussion. This specimen differs from *Metaderoceras talkeetnaense* by its higher rib density, but is similar in most other respects. The constant rib density of *Metaderoceras* sp. is in marked contrast to the highly variable rib density seen in the ontogeny of *M.* sp. cf. *M. mouterdei*.

Occurrence. Although the specimen was found *ex situ*, it apparently came from very low in the Pliensbachian section and is possibly from the same stratigraphic level as *Tropidoceras* sp.

The specimen was found at locality 21.

Age. Early Pliensbachian (?Whiteavesi Zone).

Metaderoceras? sp.

Plate 8, figure 5

Material. Fragmentary middle and outer whorls of a single specimen preserved as an internal mould in calcareous siltstone.

Measurements. Not available because of fragmentary nature of the specimen.

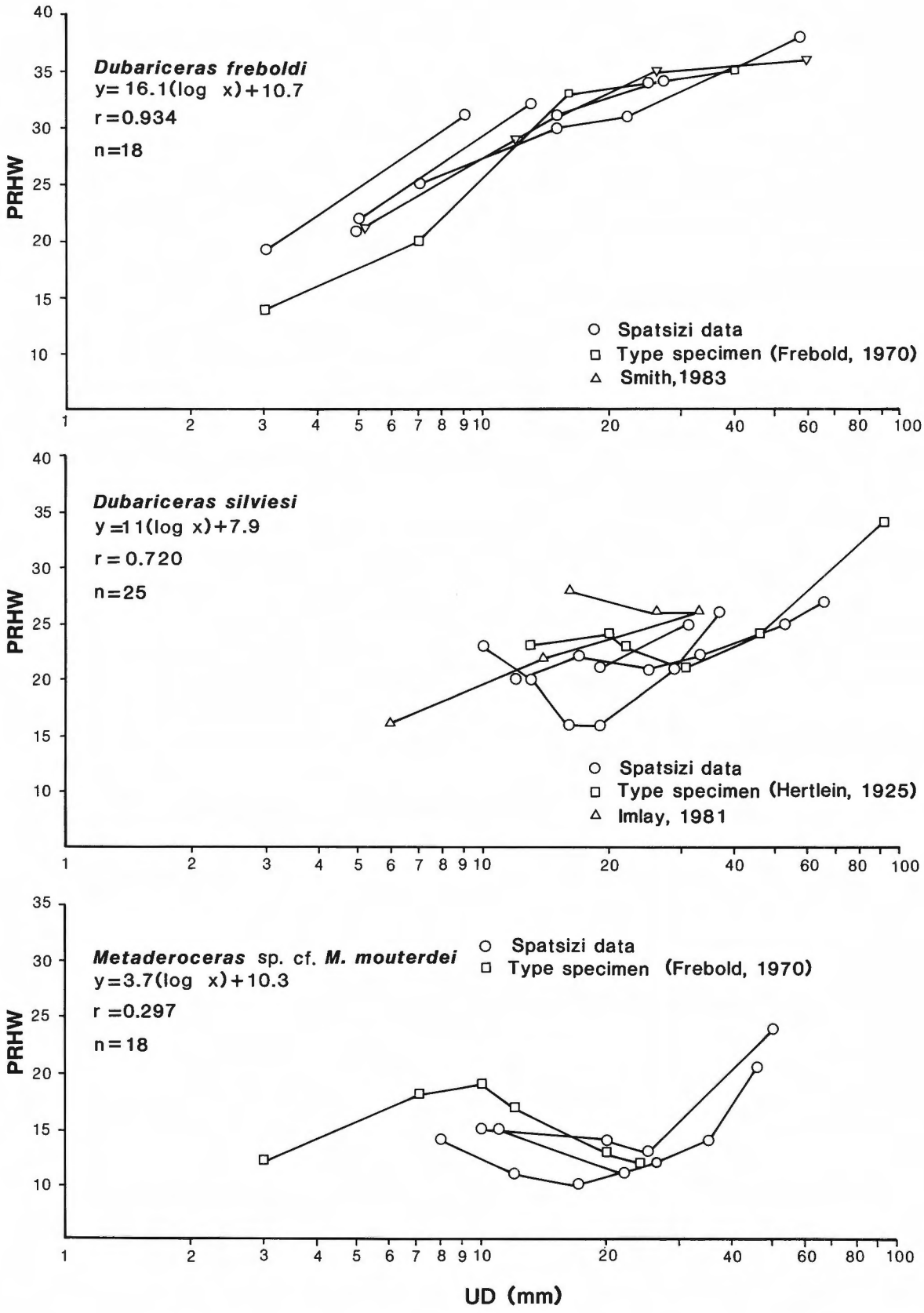


Figure 14. Comparative linear regression data and semilogarithmic plots of primary ribs per half whorl (PRHW) as a function of umbilical diameter (UD) for ***Dubariceras freboldi, Dubariceras silviesi,*** *and* ***Metaderoceras mouterdei*** *(including* ***M. sp. cf. M. mouterdei).***

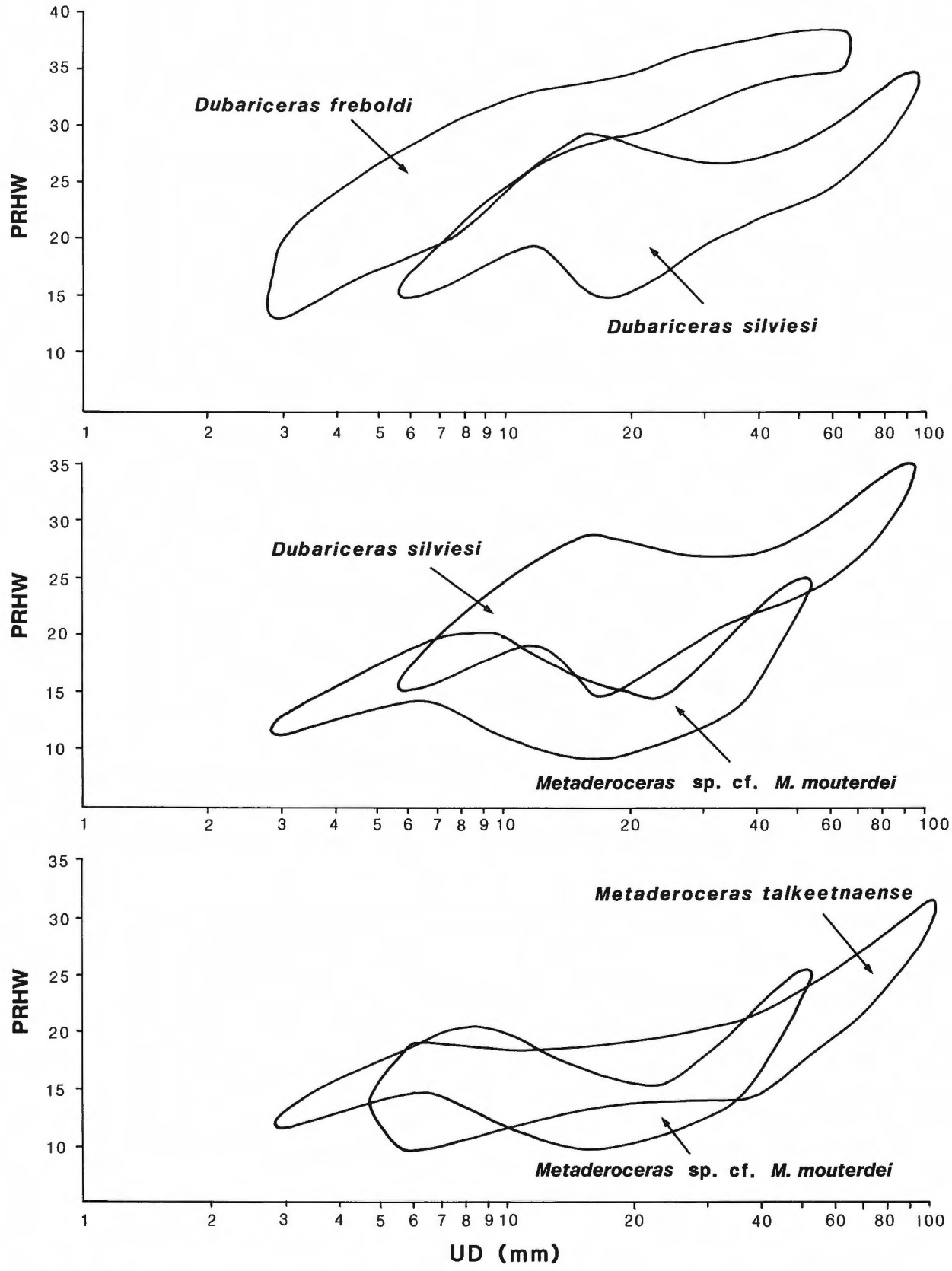


Figure 15. Ornamentation envelopes for species of the genera **Dubariceras** *and* **Metaderoceras**. *Primary ribs per half whorl (PRHW) are plotted as a function of umbilical diameter (UD).*

Description. Shell evolute; whorl section is distorted but appears to be compressed-rectangular on the outer whorls, somewhat more depressed on the inner whorls. Umbilical wall low, moderately steep, umbilical shoulder rounded; flanks gently convex. Ventrolateral shoulder abruptly rounded; venter fairly broad, low.

Ornament varies with growth. Ribs on the innermost preserved whorls are fairly distant, straight, and prorsiradiate. They are strongest on the upper part of the flank and are marked at the ventrolateral shoulder by strong tubercles. The venter is not preserved at this diameter.

At slightly larger diameters, greater than about 30 to 35 mm, the ribs become somewhat finer and more densely spaced. They arise on the umbilical wall, trend prorsiradiately to the midflank, curve gently adapically and trend radially or slightly rursiradiately, and terminate in distinct ventrolateral tubercles. The primary ribs bifurcate and continue across the venter as faint, adorally arched secondaries.

On the largest preserved whorl, ribbing is dense. As in the preceding whorl, the ribs trend prorsiradiately on the lower half of the flank, then curve and trend rursiradiately on the upper part of the flank to the small ventrolateral tubercles. The ribs continue distinctly across the venter to the opposing tubercle; no secondary ribs are present at this stage.

Discussion. The lack of material and the state of preservation of this unusual form makes confident assignment difficult. It shows a certain resemblance to the evolute, compressed, densely ribbed forms of *Metaderoceras* [*M. atlantis* Dubar and Mouterde; *M. kondai* (Geczy) assigned to *M. meneghinii* by Rivas (1983)] except for the distinct pattern of ribbing on the venter and the trend of the primary ribs.

Occurrence. The Spatsizi specimen of *Metaderoceras*? sp. was collected from sediments interbedded in the Cold Fish volcanics near Nation Peak, at locality 94, and is associated with *Acanthopleuroceras* sp. aff. *A. stahli*.

Age. Early Pliensbachian (Whiteavesi Zone).

Genus *Dubariceras* Dommergues, Mouterde, and Rivas, 1984

Type species. Dubariceras dubari Dommergues et al. (1984, p. 832, Pl. 1).

Remarks. Shells evolute, whorl section compressed-rectangular. Umbilical wall low to moderate, convex, steep; umbilical shoulder rounded. Flanks flat to slightly convex. Ventral shoulder abruptly rounded; venter low, slightly convex.

Ornament consists of dense ribs, which arise on the umbilical wall where they trend rursiradiately, then form a slightly flexuous pattern across the flanks to elongate ventrolateral tubercles, beyond which they fade rapidly on the venter.

The genus *Dubariceras* was created to accommodate certain Lower Pliensbachian ammonites of Tethyan aspect that previously had been assigned to the genera *Uptonia, Platypleuroceras*, and *Dayiceras* (family Polymorphitidae). According to Dommergues et al. (1984), the confusion surrounding the generic assignment of the members of *Dubariceras* stems from the fact that, although they are phylogenetically related to *Metaderoceras* (family Eoderoceratidae), they show a remarkable morphological convergence to the polymorphitids. Based on evidence provided by the Spatsizi and other North American collections, the creation of the genus *Dubariceras* appears justified.

Age and distribution. Dubariceras is found in the middle and upper parts of the Lower Pliensbachian of the Tethyan region (Hungary, Italy, Morocco, and the Iberian Peninsula). In the New World, *Dubariceras* occurs in the Andes Mountains, Nevada, Oregon, British Columbia, and southern Alaska (Smith, 1983). The three known species of *Dubariceras, D. freboldi, D. silviesi*, and *D. dubari*, occupy disjoint geographical areas. *Dubariceras dubari* are restricted to the Mediterranean region, whereas *D. freboldi* and *D. silviesi* are restricted to the western Americas. *Dubariceras* is characteristic of the Ibex Zone in Europe and the Whiteavesi and Freboldi zones in North America.

Dubariceras freboldi Dommergues, Mouterde, and Rivas, 1984

Plate 11, figures 1–7

*1970	*Uptonia dayiceroides* Mouterde. Frebold, p. 438, Pl. 1, figs. 9a–c.
1981	*Uptonia* cf. *U. dayiceroides* Mouterde. Imlay, p. 36, Pl. 9, figs. 1–4, 8, 12–16.
1981a	*Uptonia* cf. *U. angusta* (Oppel). Hillebrandt, p. 509, Pl. 5, figs. 3a, b.
1983	*Dayiceras dayiceroides* (Mouterde). Smith, p. 86, figs. 2a–c.

1984 *Dubariceras freboldi* Dommergues et al., figs. 3–A3.

1988 *Dubariceras freboldi* Dommergues et al. Smith et al., Pl. 3, figs. 1–3.

Material. Approximately 180 specimens preserved as external and internal moulds in siltstone and minor limestone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83087	74	30	43	26	35	9	12	34.6	34
GSC 83088	63	25	40	20	31.7	—	—	—	34
GSC 83089	a44	a22	50	a13	29.5	—	—	—	—
GSC 83089	30	14	47	—	—	—	—	—	—
GSC 83090	a105	47	45	31	29.5	12	11	38.7	—
GSC 83090	47	22	47	16	—	—	—	—	27
GSC 83091	—	—	—	15	—	11	—	—	—
GSC 83092	16	6	37	a6	37.5	—	—	—	29
GSC 84964	—	—	—	a43	—	a16	—	37.2	—
GSC 84965	a125	53	42	43	34.4	—	—	—	29
GSC 84966	61	25	41	—	—	—	—	—	29
Mean	—	—	43.6	—	32.9	—	—	—	—
St. Dev.	—	—	4.1	—	3.2	—	—	—	—

Description. Shell evolute; whorl section rectangular, becoming more compressed with growth. Umbilical wall low, steep; umbilical shoulder abruptly rounded. Flanks slightly convex on smaller whorls but become flatter on larger whorls. Ventrolateral shoulder abruptly rounded; venter low, flat to slightly convex.

Ornament consists of simple, dense, sinuous ribs that appear at diameters of about 2 to 3 mm (only a single exception to this was found in a small specimen about 25 mm in diameter, which shows sporadic fasciculation into pairs just above the umbilical shoulder, Pl. 11, fig. 7). The ribs arise on the umbilical wall where they trend rursiradiately. Just above the umbilical shoulder the ribs curve forward to trend prorsiradiately to about one third of the flank height. The ribs then curve gently again to trend rectiradiately to slightly prorsiradiately up the flanks. As the ribs approach the ventrolateral shoulder they become increasingly prorsiradiate. At the ventrolateral shoulder each rib bears a radially elongate tubercle, beyond which are faint, adorally projecting extensions of the ribs. On some of the larger whorls, the ribs project forward onto the venter and form indistinct chevrons. Frebold (1970) also noted this feature in the material from the Queen Charlotte Islands.

Discussion. In the original description of the type material, Frebold (1970) drew attention to the striking similarity between the specimens from the Queen Charlotte Islands and those from Portugal, described as *Uptonia*? *dayiceroides* by Mouterde (1951). Frebold pointed out, however, that "The only difference seems to be the presence of a weakly crenulated faint keel in Mouterde's species." Frebold concluded that the crenulated keel of the Portuguese material may be restricted to the inner whorls and that this difference between the Queen Charlotte and Portuguese material was of little (taxonomic) consequence. Unfortunately, there were no specimens of a size comparable to the smaller Portuguese material present in the Queen Charlotte collections to corroborate Frebold's conclusion. The venters of small specimens in the Spatsizi collections do not show a keel.

Smith (1983) also considered that the Queen Charlotte material, as well as material from Oregon, Nevada, and Alaska, is conspecific with the Portuguese *Uptonia*? *dayiceroides*. Smith concluded, however, that the species *dayiceroides* belonged not to *Uptonia*, but to the genus *Dayiceras*.

Recently, Dommergues et al. (1984) included all the western North American forms attributed to *Uptonia* or *Dayiceras dayiceroides* in *Dubariceras freboldi*. However, they considered that sufficient morphological differences exist between the Portuguese and North American material to retain Mouterde's (1951) *Uptonia dayiceroides* in *Dayiceras dayiceroides*. According to Dommergues et al. (1984), *Dubariceras freboldi* differs from *Dayiceras dayiceroides* as follows:

1. There is never a trace, in *Dubariceras freboldi*, of the "occasionally slightly crenulated, more or less distinct keel" observed in the specimens of *Dayiceras dayiceroides* from Portugal (phrase in quotes translated from Dommergues et al., 1984).

2. The venter of *Dubariceras freboldi* is flatter than that of *Dayiceras dayiceroides*, and the whorl section remains rectangular with growth (i.e., it does not become ogival as in *Dayiceras dayiceroides*).

It may also be significant that in the Portuguese sections *Dayiceras dayiceroides* appears to evolve into other, less ambiguous species of *Dayiceras* in the overlying beds (Mouterde, 1951). In western North America, no such transition has been observed, although a few specimens of *Dayiceras* sp. are found with *Dubariceras freboldi* in the Spatsizi area.

Occurrence. Dubariceras freboldi appears to be restricted to the East Pacific. It is common in

Pliensbachian sections in the accreted terranes that constitute the western Cordillera of North America but is absent in time equivalent sections on the North American craton. In South America, *D. freboldi* is found in Lower Pliensbachian rocks in Chile (Hillebrandt, 1981a). Although *D. freboldi* is unknown in the Mediterranean region, the closely related species *D. dubari* is present.

In the Spatsizi area, *D. freboldi* is very abundant in Lower Pliensbachian rocks that are approximately equivalent to the Ibex and Davoei zones of northwest Europe. In its lowest position, it is associated with *Uptonia*? sp., *Dayiceras* sp., *Metaderoceras talkeetnaense*, and *Dubariceras silviesi*. Higher in the sequence it occurs with *Aveyroniceras* sp. A and B, and *Reynesocoeloceras* sp. cf. *R. incertum*.

The Spatsizi specimens were found at localities 3–13, 15, 16, 25, 26, 28, 35–41, 46, 52–54, 56, 59, 68, 69, 76, 78, 80–82, 84, 85, 89–91, and 97.

Age. Early Pliensbachian (Freboldi Zone).

Dubariceras silviesi (Hertlein, 1925)

Plate 10, figures 2–5

*1925 *Uptonia silviesi* Hertlein, p. 39, Pl. 3, figs. 1, 2, 5.
1981 *Crucilobiceras* cf. *C. submuticum* (Oppel). Imlay, p. 33, Pl. 7, figs. 1–3.
?1981a *Uptonia* cf. *U. obsoleta* (Simpson). Hillebrandt, p. 509, Pl. 5, figs. 1, 2, 5.
1988 *Dubariceras silviesi* (Hertlein). Smith et al., Pl. 2, fig. 5.

Material. Twenty-three specimens preserved as external moulds with rare internal moulds in siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	PRHW
GSC 83083	a150	a75	50	a43	28.7	—
GSC 83083	a106	a53	50	a22	20.8	21
GSC 83084	a70	30	43	a19	27.0	22
GSC 83085	a80	39	49	a23	28.8	23
GSC 84963	37	18	49	a10	27.0	a14
Mean	—	—	48.2	—	26.5	—
St. Dev.	—	—	2.9	—	3.3	—

Description. Shell evolute; whorl section appears to be rectangular but cannot be directly observed in the Spatsizi collections because of poor preservation. The umbilical wall is low, steep; umbilical shoulder rounded. Flanks slightly convex; ventrolateral shoulder abruptly rounded. Venter low, slightly convex, and fairly broad.

Ornament consists of dense, simple, straight to slightly sinuous ribs. The ribs arise on the umbilical wall where they appear to trend slightly rursiradiately, then subsequently become prorsiradiate and continue virtually straight to the ventrolateral shoulder. At the ventrolateral shoulder each rib bears a prominent tubercle. The ribs then project forward and continue onto the venter from the tubercles but decrease in strength. On larger whorls the ribs form ventral chevrons, although the apices of the chevrons tend to be faint.

Discussion. Dubariceras silviesi appears to be morphologically intermediate between the genera *Metaderoceras* and *Dubariceras* (Mouterde, pers. comm., 1985). Its dense, relatively finely ribbed inner whorls are reminiscent of *Dubariceras*, whereas the coarser, robustly tuberculate and less dense ribs of the middle and outer whorls are characteristic of *Metaderoceras* (Figs. 14, 15). The ribs on the outer whorls of *D. silviesi* tend to become slightly sinuous, but again, their coarseness, lower density, and tuberculation set them apart from the ribbing of *D. freboldi*.

In the ventral region of the larger specimens of *D. silviesi* (Pl. 10, fig. 3), the ribs project beyond the ventrolateral tubercles and form chevrons. According to Mouterde (pers. comm., 1985), ventral chevrons are an adult characteristic of *Metaderoceras*, but they also occur faintly on the outermost whorls of some specimens of *Dubariceras dubari* from Italy. As pointed out in the description of *Dubariceras freboldi*, weak ventral chevrons are also found on the outer whorls of some of the Canadian specimens (Frebold, 1970; this study).

Occurrence. Dubariceras silviesi appears to be restricted to the eastern Pacific region; it has been reported from western South America (Hillebrandt, 1981a), western United States (Hertlein, 1925) and Canada, and from southern Alaska (Imlay, 1981).

In Spatsizi, it was found just below and in the lower part of the range of *Dubariceras freboldi* at localities 3, 6, 8–10, 13, 25, 26, 46, 51, 55, 67–70, 81, 82, 84–86, and 90.

Age. Early Pliensbachian (Whiteavesi and Freboldi zones).

Family DACTYLIOCERATIDE Hyatt, 1867

Genus *Reynesocoeloceras* Geczy, 1976

1977 *Cetonoceras* Wiedenmayer
1977 *Indunoceras* Wiedenmayer

Type species. Coeloceras crassum Young and Bird var. *indunensis* Meneghini, 1881 (p. 72, Pl. 16, fig. 4) by original designation.

Remarks. The taxonomic position of the genus *Reynesocoeloceras* and the associated genus *Aveyroniceras* is problematic. For a review of the different systematic treatments, the reader is referred to Fischer (1971), Pinna and Levi-Setti (1971), Schmidt-Effing (1972), Geczy (1976), Wiedenmayer (1977, 1980), Donovan et al. (1981), Hillebrandt (1981a), and Meister (1986).

Reynesocoeloceras, although originally defined as a subgenus of *Coeloceras* by Geczy (1976), is given full generic status here, following the work of Wiedenmayer (1977, 1980), Donovan et al. (1981), Hillebrandt (1981a), and Meister (1986). Geczy (1976) considered the morphological similarities between *Reynesocoeloceras* and *Coeloceras* as evidence of a generic/subgeneric relationship between the two forms. However, *Coeloceras* is restricted to the Jamesoni Zone (Donovan et al., 1981), whereas *Reynesocoeloceras* ranges from the Ibex to the Margaritatus Zone, suggesting that *Reynesocoeloceras* is a derivative of *Coeloceras*.

Geczy (1976) assigned *Reynesocoeloceras* to the Coeloceratinae, a subfamily of the Dactylioceratidae; Wiedenmayer (1977, 1980) and Hillebrandt (1981a) assigned it to the Coeloceratidae (*sensu nova*). Donovan et al. (1981) placed *Reynesocoeloceras* in the family Dactylioceratidae, but stated that *Reynesocoeloceras* was derived from the Coeloceratidae. The possibility that a close phylogenetic relationship exists between the two groups (Dactylioceratidae and Coeloceratidae) was considered in the Treatise (Arkell et al., 1957, p. L252) and by Fischer (1971).

A contrasting view for the origin of *Reynesocoeloceras* was proposed by Dommergues and Mouterde (1982), who stated that the earliest form of *Reynesocoeloceras*, named *Reynesocoeloceras praeincertum*, evolved from the genus *Metaderoceras*, not from *Coeloceras*. Dommergues and Mouterde (1982) attributed the similarity between the inner whorls of *Reynesocoeloceras* and those of *Coeloceras* to morphological convergence between the two genera, indicating a distant common ancestry.

Reynesocoeloceras is characterized by a change in morphology from *Coeloceras*-like inner whorls (cadiconic, tuberculate with bi- or polyfurcating ribs) to *Reynesoceras*-like outer whorls (serpenticonic with simple, nontuberculate ribs). It is this change in morphology that distinguishes *Reynesocoeloceras* from both *Coeloceras* and *Reynesoceras*. *Prodactylioceras* differs from *Reynesocoeloceras* by its finer, denser ribbing, sporadic tubercles on the outer whorls, and its less variable ornament. *Aveyroniceras*, the Tethyan equivalent of *Prodactylioceras*, is similar to *Reynesocoeloceras* in that it undergoes a change in ornamentation with growth from tuberculate, bifurcating ribs on the innermost whorls to non-tuberculate, simple ribs on the outer whorls. However, the early *Coeloceras*-like stage is much more persistent in *Reynesocoeloceras* than in *Aveyroniceras*. In addition, rib density is much greater in *Aveyroniceras*, and some forms possess sporadic tubercles on their body chamber and final whorl of the phragmocone.

Age and distribution. Reynesocoeloceras is restricted to the Tethyan realm. In western North America it is known from east-central Oregon and the Queen Charlotte Islands (Smith et al., 1988). In Europe, *Reynesocoeloceras* ranges from the Jamesoni Zone to the Margaritatus Zone, with its acme in the Davoei Zone. In North America it characterizes the upper Freboldi Zone and lower Kunae Zone.

Reynesocoeloceras sp. cf. *R. incertum* (Fucini, 1905)

Plate 12, figure 6

cf. *1905 *Coeloceras incertum* Fucini, 1905, p. 140, Pl. 11, figs. 4–7.
cf. 1971 *Coeloceras* (*Coeloceras*) *incertum incertum* Fucini. Fischer, p. 110, Textfig. 5j.
cf. 1976 *Coeloceras (Reynesocoeloceras) incertum* Fucini. Geczy, p. 131, Pl. 23, fig. 4.
cf. 1976 *Coeloceras* (*Reynesocoeloceras*) cf. *C.* (*R.*) *incertum* Fucini. Geczy, Pl. 23, fig. 5.

Material. Three specimens, moderately well preserved as external and internal moulds in calcareous siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83098	19	60	a70	a7.0	37	a12	63	171	15

Description. Shell evolute, umbilicus wide and crater-like, deeper on the inner whorls than on the outer

whorls. Whorl section depressed, wide rectangular to coronate. Flanks convex; ventrolateral shoulder angular. The venter is broad and slightly convex.

Ornamentation on the inner whorls consists of short, swollen ribs that become stronger toward the venter and terminate just below the succeeding umbilical seam in large, rounded tubercles. At diameters greater than about 18 mm, the ribs become narrower and prorsiradiate, and the tubercles are reduced somewhat in relation to those on the inner whorls. The tubercles give rise to strong, narrow secondary ribs that curve slightly adorally as they cross the venter, and rejoin at the opposing tubercle. At the largest diameter preserved (D = 31.5 mm) there are about two secondaries per primary rib.

Discussion. According to Geczy (1976), the depressed whorl section seen in all stages of growth, and the relatively invariable ornamentation set *R. incertum* apart from other species of *Reynesocoeloceras*. Whereas the whorl section of most *Reynesocoeloceras* becomes less depressed and the venter more convex with growth, the section remains depressed in *R. incertum*.

Occurrence. Reynesocoeloceras incertum has been reported from Hungary (Geczy, 1976) and northern Italy (Fucini, 1905; Fischer, 1971) where it was first described. In Hungary it is found in the lower Davoei Zone. The Spatsizi specimens are found within the upper Freboldi Zone. *Reynesocoeloceras incertum* also occurs in the Kunae Zone of the Queen Charlotte Islands.

The Spatsizi specimens were found at locality 67.

Age. Early Pliensbachian (Freboldi Zone).

Genus *Aveyroniceras* Pinna and Levi-Setti, 1971

1977 *Bettoniceras* Wiedenmayer

Type species. Ammonites acanthoides Reynès, 1868 (p. 91, Pl. 3, fig. 3) by original designation.

Remarks. The ontogeny of *Aveyroniceras* is characterized by a change from tuberculate, bifurcating ribs on the inner whorls to simple, dense, nontuberculate ribs on the outer whorls. It is this change in morphology that differentiates *Aveyroniceras* from *Prodactylioceras*, which lacks the tuberculate, bifurcating ribs on the inner whorls, but rather, bears sporadic tubercles on all its whorls. Geczy (1976), however, points out that on rare species of *Aveyroniceras*, for example *A. mortilleti*, the outer whorls possess sporadic tubercles, thereby rendering generic distinction between *Aveyroniceras* and *Prodactylioceras* potentially difficult in some cases.

Aveyroniceras differs from *Reynesocoeloceras* in having finer, denser ribs and sporadic tubercles on the outer whorls of some species.

Age and distribution. Aveyroniceras is restricted to the Tethyan Province and is considered to be the Tethyan equivalent of the Boreal *Prodactylioceras* (Pinna and Levi-Setti, 1971; Geczy, 1976). It ranges from the Ibex Zone to the Spinatum Zone. It has been reported from the Lower/Upper Pliensbachian boundary in North America (Smith et al., 1988) and from the Upper Pliensbachian of western South America (Hillebrandt, 1981a).

Aveyroniceras sp. A

Plate 12, figures 7, 8

Material. Four individuals, poorly to moderately well preserved as fragments of internal and external moulds in siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83099	a80	a45	56	16	20	24	30	150	a40
GSC 83100	a80	a45	56	—	—	—	—	—	a43

Description. Evolute, outer whorls serpenticonic with wide-ellipsoid whorl section. Whorl shape on inner whorls unknown because of poor preservation, but comparison with what appears to be a conspecific specimen from the Queen Charlotte Islands suggests that the inner whorls (to a diameter of about 30 mm) are wide-ellipsoid to coronate. The umbilicus is wide and fairly deep as far as can be seen. The umbilical wall is high and fairly steep on the outer whorls; umbilical shoulder rounds gradually onto the inflated flanks. Flanks do not form a ventrolateral shoulder; venter is broad, rounded.

Ornamentation varies with growth. The innermost whorls, to a diameter of about 20 mm, are not preserved. Ribbing on the smallest preserved whorl (D = 25–30 mm) consists of fairly stout, moderately dense ribs, most of which bear distinct ventrolateral tubercles. These *Coeloceras*-like inner whorls are succeeded by *Reynesoceras*-like middle whorls (D = 40–50 mm), which are marked by finer, denser ribs

that bear only sporadic tubercles. Rib spacing on these whorls is somewhat irregular and the ribs show a tendency to occur in pairs. On the outermost preserved whorls (D = 50 mm), ribbing is more consistent. The ribs are simple, nontuberculate, prorsiradiate, and sharp. They arise at the umbilical seam and continue across the flanks and venter without a change in strength.

Discussion. Although the specimens described are somewhat intermediate in nature, they are placed in the genus *Aveyroniceras* rather than *Reynesocoeloceras* due to their relatively dense ribbing and early disappearance of the *Coeloceras*-like inner whorls. These same characters, however, set *Aveyroniceras* sp. A apart from other species of *Aveyroniceras*. The *Coeloceras*-like inner whorls of *Aveyroniceras* sp. A disappear at a larger diameter (D = 25–30 mm) than in most species of *Aveyroniceras* (D = 10–20 mm), and the ribbing is less dense than in the majority of species of *Aveyroniceras*.

Aveyroniceras sp. A is similar to *A. colubriforme* (Bettoni) and *A. inaequiornatum* (Bettoni), both of which are known in western North America. The variable nature of the ornament and the pairing of the ribs on the middle whorls of *Aveyroniceras* sp. A is reminiscent of *A. inaequiornatum*. However, the ribbing of the outermost preserved whorls of the Spatstzi specimens becomes more regular, resembling *A. colubriforme*.

Aveyroniceras sp. A is also very similar in rib form and density, as well as in whorl section, to specimens from South America assigned by Hillebrandt (1981a) to "*Reynesocoeloceras (Bettoniceras)*" sp. cf. *R. (B.) mortilleti*. These South American forms differ from the Spatsizi specimens in possessing sporadic tubercles on their middle and outer whorls.

Occurrence. Aveyroniceras sp. A occurs at the top of, and possibly above the range of, *Dubariceras freboldi*.

The Spatsizi specimens were found at localities 39 and 48.

Age. Early Pliensbachian (Freboldi Zone).

Aveyroniceras sp. B

Plate 12, figure 9

Material. A single specimen preserved as an external mould in siltstone.

Measurements. Not available because of the fragmentary nature of this specimen.

Description. Shell evolute. Ribbing on the outermost preserved whorl is nontuberculate, fine, and very dense. The ribs trend slightly prorsiradiately on the lower flanks and radially on the upper flanks. Ribs on the inner whorl are fine and tuberculate.

Discussion. This specimen is similar to *Aveyroniceras inaequiornatum* but poor preservation precludes confident assignment to this species.

Occurrence. Aveyroniceras sp. B is found in the upper Freboldi Zone. Specimens from the Hurwal Formation of northeastern Oregon, similar to *Aveyroniceras* sp. B and assigned to *A. inaequiornatum*, occur at the boundary between the Lower and Upper Pliensbachian.

The Spatsizi specimen was found at locality 40.

Age. Early Pliensbachian (Freboldi Zone).

Superfamily PSILOCERATACEAE Hyatt, 1867

Family OXYNOTICERATIDAE Hyatt, 1875

Genus *Fanninoceras* McLearn, 1930

Type species. Fanninoceras fannini McLearn, 1930 (p. 4, Pl. 1, fig. 3), by original designation.

Remarks. Involute oxycones with overhanging umbilical wall; early whorls rounded, depressed, becoming compressed with angular venter on later whorls. Ribs on early whorls are short, stout, straight, and distant. On some forms the ribs become finer, denser, and project forward onto the venter with growth. On other forms the ribs disappear with growth, leaving the shell smooth.

Fanninoceras has been placed in synonymy by some workers with the Lower Pliensbachian genus *Radstockiceras* Buckman, 1918 from northwest Europe (Donovan and Forsey, 1973; Donovan et al., 1981). Others, however, have argued for the retention of the genus *Fanninoceras* (Frebold, 1967; Hillebrandt, 1981a; Smith and Tipper, 1984; Smith, 1986) on the basis of its characteristic ontogenetic variations in whorl shape, its undercut umbilical wall, its younger age (Late Pliensbachian), and restricted distribution.

Age and distribution. Fanninoceras is restricted to the eastern Pacific faunal province. It is found in southern

Alaska, western British Columbia, Oregon, Nevada, Argentina, and Chile (Imlay, 1968, 1981; Hillebrandt, 1981a; Smith et al., 1988). The appearance of species of *Fanninoceras* marks the base of the Kunae Zone in western North America and this, in the absence of amaltheids, is taken as the base of the Upper Pliensbachian (Smith et al., 1988).

Fanninoceras latum McLearn, 1930

Plate 12, figures 10, 11

*1930 *Fanninoceras kunae* var. *latum* McLearn, p. 5, Pl. 2, fig. 4.
1932 *Fanninoceras kunae* var. *latum* McLearn. McLearn, p. 78, Pl. 9, figs. 5, 6.
1981a *Fanninoceras kunae* var. *latum* McLearn. Hillebrandt, p. 513, Pl. 6, fig. 6; Pl. 10, fig. 4.

Material. Two specimens preserved as external moulds in siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	PRHW
GSC 83103	28	6.5	23	a11.5	41	a18
GSC 83104	a26	a7	27	12	46	14

Description. Shell is fairly involute but the umbilicus is wider than in most other species of the genus. The whorl section is not preserved, and the umbilical wall and edge have been flattened.

Ornamentation on the inner whorls consists of fairly coarse, strong, and distant ribs that arise near the umbilical shoulder, trend rectiradiately, bend slightly prorsiradiately at about two thirds of the flank height, then fade rapidly. With growth the ribs become finer, denser, gently falcoid, and do not fade on the upper flank.

Discussion. McLearn (1930, 1932) originally defined *Fanninoceras latum* as one of three subspecies of *F. kunae* (*F. kunae kunae, F. kunae crassum*, and *F. kunae latum*).

The Spatsizi specimens of *F. latum* compare well with the holotype from the Queen Charlotte Islands. *Fanninoceras latum* is morphologically intermediate between *F. kunae* and *F. crassum*; it has a wider umbilicus and slightly coarser ribbing than *F. kunae* and is more finely ribbed than *F. crassum*.

Occurrence. Fanninoceras latum is found in Upper Pliensbachian strata of the Queen Charlotte Islands, Alaska, and Chile.

In the Spatsizi area it occurs at locality 20, in association with *Tiltoniceras propinquum*, and at locality 93.

Age. Late Pliensbachian [Kunae(?) and Carlottense zones].

Fanninoceras sp.

Plate 12, figure 12

Material. A single specimen, poorly preserved as an internal mould in limestone.

Measurements.

Specimen	D	PRHW
GSC 83105	a27	a13

Description. Shell involute; whorl section compressed. Flanks convex; venter not exposed.

Ornament consists of strong, distant ribs on the inner whorls, which become finer, denser, and falcoid on the outermost preserved whorl.

Discussion. Specific assignment of this specimen is impossible because of poor preservation, but judging by its coarse ribbing, it could belong to *Faninoceras crassum* or to a species that has coarse ribbing early in ontogeny such as *F. fannini*. It differs from the specimen described above as *F. latum* in that its rib density is lower and its umbilicus, although obscured, appears narrower.

Occurrence. Fanninoceras sp. is found in Upper Pliensbachian strata containing *Arieticeras* and *Leptaleoceras*.

The Spatsizi specimen was found at locality 58.

Age. Late Pliensbachian (Kunae Zone).

Superfamily HILDOCERATACEAE Hyatt, 1867

Family HILDOCERATIDAE Hyatt, 1867

Subfamily ARIETICERATINAE Howarth, 1955

Genus *Leptaleoceras* Buckman, 1918

1931 *Seguentia* Fucini
1931 *Trinacrioceras* Fucini
1970 *Ugdulenia* Cantaluppi

Type species. Leptaleoceras leptum Buckman, 1918 (p. 284, Pl. 26, fig. 1a, b) by original designation.

Remarks. Shells evolute; whorl section compressed, elliptical. Flanks convex, ventrolateral shoulder rounded. Venter narrow, carinate; keel flanked by narrow flat zones that become sulcate on the body chamber of some species.

Ornamentation consists of dense, slightly sinuous ribs that arise at or just above the umbilical shoulder, trend more or less rectiradiately on the flanks, then fade out at the ventrolateral shoulder where they project slightly. Innermost whorls, up to diameters of 10 mm, are smooth.

Leptaleoceras is distinguished from *Arieticeras* by its greater rib density and the nonsulcate venter observed on all but the body chamber of some species of *Leptaleoceras* [e.g., *L. accuratum* and *L. insigne* (Braga, 1983)].

Age and distribution. Leptaleoceras is primarily a Tethyan form but is occasionally found in the Boreal Realm. In Europe it is found in the middle Upper Pliensbachian, in association with *Arieticeras algovianum*. In western North America, *Leptaleoceras* is found associated with *Arieticeras* and *Fanninoceras*, indicating a Late Pliensbachian age (Smith et al., 1988).

Leptaleoceras sp. aff. *L. accuratum* (Fucini, 1931)

Plate 13, figures 1–6

aff. *1931 *Arieticeras*(?) *accuratum* Fucini, p. 107, Pl. 8, fig. 10.
aff. 1934 *Arieticeras pseudoradians* (Reynès). Monestier, p. 63, Pl. 8, fig. 62; *non* figs. 61, 68.
1964a *Leptaleoceras pseudoradians* (Reynès). Frebold, p. 15, Pl. 4, *non* Pl. 5, figs. 4, 5.
1970 *Leptaleoceras pseudoradians* (Reynès). Frebold, p. 443, Pl. 2, fig. 2 (1964 material partly refigured)
aff. 1980 *Arieticeras accuratum* (Fucini). Wiedenmayer, p. 109, Pl. 17, figs. 15–18.
1981 *Leptaleoceras* cf. *L. pseudoradians* (Reynes). Imlay, p. 40, Pl. 11, figs. 12, 13.
?1981 *Arieticeras* cf. *A. domarense* (Meneghini). Imlay, p. 39, Pl. 10, fig. 15; *non* figs. 1, 2, 6–14, 22.
aff. 1983 *Leptaleoceras accuratum* (Fucini). Braga, p. 256, Pl. 11, figs. 27–29; Pl. 12, figs. 1–10.
1988 *Leptaleoceras* aff. *accuratum* (Fucini). Smith et al., Pl. 4, fig. 9.

Material. Eight specimens, poorly to moderately well preserved as external and internal moulds in calcareous concretion matrix.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83106	38.5	17	44	a13	34	—	—	—	26
GSC 83107	39	19	49	a13	33	—	—	—	25
GSC 83109	a25	a10	40	a9	36	—	—	—	a25
GSC 83110	31.5	14	44	11	35	—	—	—	27
GSC 83111	a70	33	47	a18	26	a8	—	—	22
GSC 84967	a45.5	a19	42	a15	33	a5	—	—	27
Mean	—	—	44.3	—	32.8	—	—	—	—
St. Dev.	—	—	3.3	—	3.5	—	—	—	—

Description. Evolute, whorl section compressed, ogival. Umbilical wall low, shallow; umbilical shoulder rounded. Flanks slightly convex; ventrolateral shoulder rounded. Venter bears a distinct keel flanked by two, narrow, flat zones or slight sulci in some larger specimens.

Ornamentation varies with growth. The innermost whorls are smooth to a diameter of 3 to 4 mm. The middle whorls bear fine, dense, sinuous ribs that have a slightly rursiradiate overall trend. On the upper part of the flanks the ribs project strongly adorally. At diameters greater than about 35 mm (or UD = 13–15 mm) ribbing becomes less dense, more sinuous, and more rursiradiate.

Discussion. In his discussion of *L. accuratum*, Braga (1983) defined a new morphotype, *L. accuratum* "*preaccuratum*". This morphotype, which has the same stratigraphic range, differs from typical forms of *L. accuratum* by its slightly more densely ribbed inner whorls and more sinuous ribs that maintain their sinuosity with growth, rather than becoming straighter, as seen in *L. accuratum* proper.

The Spatsizi specimens of *L.* sp. aff. *L. accuratum*, together with the other North American material in the synonomy, compare well with the "*preaccuratum*" material illustrated by Braga (1983), the only difference being the slightly greater rib density of the North American specimens (Fig. 16). Previous assignment of the North American material to *L. pseudoradians* (Frebold, 1964a, 1970; Imlay, 1981) is questioned here due to the significantly greater rib density, maintained throughout growth, of *L. pseudoradians* (Fig. 15). Braga (1983) does note, however, that there is a

resemblance between *L. accuratum* "*preaccuratum*" and *L. pseudoradians*, and in fact they are almost indistinguishable if only the inner whorls are compared.

Our assignment of the species *accuratum* to the genus *Leptaleoceras* agrees with the work of Braga (1983). However, the generically ambiguous nature of the species was noted by Fucini (1931) who assigned the type specimen to *Arieticeras*(?) *accuratum*.

Occurrence. The Spatsizi specimens of *L.* sp. aff. *L. accuratum* are found in the lowermost concretionary bed of the Wolf Den Formation and occur with *A.* sp. aff. *A. algovianum*, *A.* sp. cf. *A. ruthenense*, and rare *Fanninoceras*. *Leptaleoceras* sp. aff. *L. accuratum* has been reported (as *L. pseudoradians*) from the Laberge Group in the southern Yukon (Frebold, 1964a) and from the Talkeetna Formation in southern Alaska (Imlay, 1981). In Europe, *L. accuratum* is found in Tethyan sediments within the range of *A. algovianum* (Wiedenmayer, 1977; Braga, 1983).

The Spatsizi specimens were found at localities 17–19, 31, 42, 57, 58, 62, 63, and 65.

Age. Late Pliensbachian (Kunae Zone).

Genus *Fuciniceras* Haas, 1913

Type species. Harpoceras lavinianum Meneghini *in* Fucini, 1900 (Pl. 11, figs. 6, 7), by original designation.

Remarks. Similar to *Protogrammoceras* in most respects, but ribs trend rursiradiately on upper part of flank and do not project onto the venter.

Age and distribution. A typically Tethyan form that ranges throughout the Pliensbachian (Fischer, 1975; Wiedenmayer, 1980).

Fuciniceras sp.

Plate 13, figure 7

Material. One specimen preserved as an external mould in calcareous concretion matrix.

Description. Evolute (U = approximately 50) form with a flat-sided whorl section. Ventral details obscured. Ribs are strong and rectiradiate on the lower third of the flank but are rursiradiate on the upper two thirds. There are approximately 25 ribs on the last half whorl.

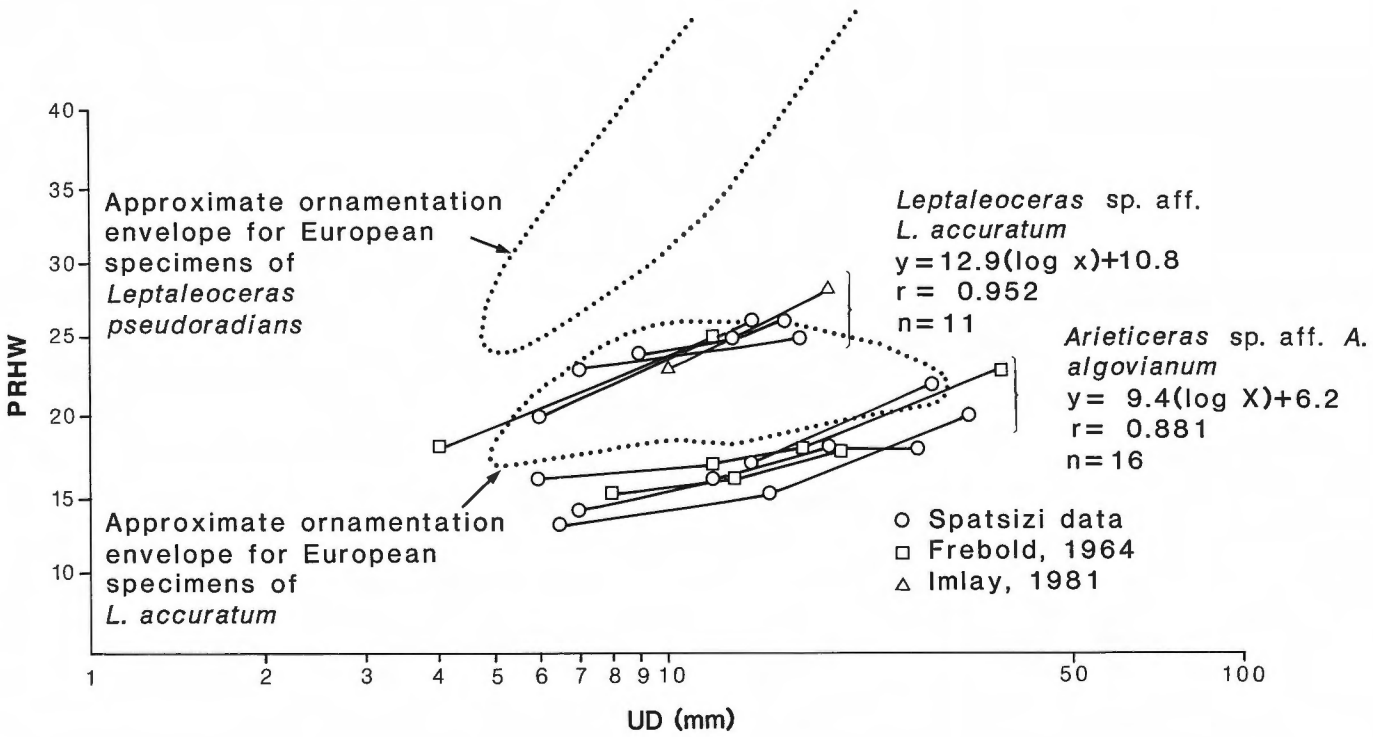


Figure 16. *Comparative linear regression data and semilogarithmic plots of primary ribs per half whorl (PRHW) as a function of umbilical diameter (UD) for* ***Leptaleoceras*** *sp. aff.* ***L. accuratum*** *and* ***Arieticeras*** *sp. aff.* ***A. algovianum.***

Discussion. Specimen is considered to be a *Fuciniceras* because of its distinctive rib pattern, but the poor preservation does not permit confident species assignment.

Occurrence. Fuciniceras is known at many localities in North America but it is never abundant and is restricted to the Upper Pliensbachian.

The Spatsizi specimen was found at locality 66.

Age. Late Pliensbachian (Kunae Zone).

Genus *Arieticeras* Oppel, 1862

1896 *Seguenziceras*, Levi
1931 *Meneghinia* Fucini

Type species. Ammonites algovianus Oppel, 1862 (p. 137), by original designation.

Remarks. Shell evolute, whorl section elliptical to quadrate. Venter unicarinate, flanked either by shallow sulci or flat zones. Ornamentation consists of strong, simple, straight to moderately sinuous ribs of moderately dense to distant spacing. Ribbing may lose relief and become striae on the outer whorls of large, adult specimens.

Arieticeras differs from *Leptaleoceras* by its coarser, less dense ribbing and commonly sulcate venter. *Oregonites* Wiedenmayer, 1980 is distinct from *Arieticeras* in its more irregular, often paired ribbing and generally more depressed whorl section.

Age and distribution. Arieticeras is a Tethyan form, commonly found in southern Europe and North Africa. It has been reported from South America (Hillebrandt, 1981b), northwestern British Columbia, southern Yukon (Frebold, 1964a, 1970), southern Alaska (Imlay, 1981), and from the western United States (Imlay, 1968; Smith et al., 1988).

Arieticeras is characteristic of the Upper Pliensbachian, and is most abundant in the Algovianum Zone of the Tethyan region [approximately equivalent to the Margaritatus Zone of the northwest European province; see Wiedenmayer (1980) and Braga (1983)].

Arieticeras sp. aff. *A. algovianum* (Oppel, 1862)

Plate 14, figures 1–7

aff. *1862 *Ammonites algovianus* Oppel, p. 137.
aff. *1927 *Arieticeras algovianum* (Oppel). Schröder, p. 35, Pl. 9, figs. 6, 7.
1964a *Arieticeras algovianum* (Oppel). Frebold, p. 13, Pl. 3, figs. 4, 5; Pl. 4, fig. 2.
1964a *Arieticeras* cf. *A. algovianum* (Oppel). Frebold, p. 13, Pl. 3, fig. 3; Pl. 5, fig. 3, *non* fig. 2.
?1968 *Arieticeras* cf. *A. algovianum* (Oppel). Imlay, p. C34, Pl. 4, figs. 1–8.
1981 *Arieticeras* cf. *A. domarense* (Meneghini). Imlay, p. 39, Pl. 10, figs. 1, 2, 9, 10, *non* figs. 6–8, 11–15, 22.
1981 *Arieticeras* cf. *A. algovianum* (Oppel). Imlay, p. 40, Pl. 10, figs. 16–20.

Material. Thirty specimens preserved as fragmental external and internal moulds in calcareous concretions and siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 83113	55	24	43	a20	36	—	—	—	19
GSC 83114	43	19	44	a14	33	—	—	—	17
GSC 83115	a60	30	50	a15	25	—	—	—	19
GSC 83116	37	15	41	—	—	—	—	—	17
GSC 83117	a65	30	46	—	—	—	—	—	22
GSC 83119	—	—	—	19	—	10.5	—	55	—
Mean	—	—	44.8	—	31.3	—	—	—	—
St. Dev.	—	—	3.4	—	5.7	—	—	—	—

Description. Shell evolute, whorl section ogival to rectangular. Umbilical wall low, shallow; umbilical shoulder rounded. Flanks are slightly convex, parallel; ventrolateral shoulder abruptly rounded. Venter bears a high keel bordered by flat zones or shallow sulci that, on internal moulds, appear deeper and wider than on external moulds.

Ornamentation consists of strong, slightly to moderately sinuous ribs whose spacing is equal to or just greater than their width. The ribs have an overall, slightly rursiradiate trend. In general, rib density decreases, whereas sinuousity increases with growth. The ribs arise on the umbilical shoulder where they trend prorsiradiately. At about one third of the flank height, the ribs curve gently backward and trend rursiradiately to the ventrolateral shoulder, where they project adorally for a distance about equal to one inter-rib space, then fade along the sulci.

Discussion. The Spatsizi material is conspecific with specimens of *A. algovianum* and *A.* sp. cf. *A. algovianum* from northwest British Columbia as figured by Frebold (1964a, 1970). The Spatsizi

specimens are also similar to Imlay's (1968, 1981) figured specimens of *A.* sp. cf. *A. algovianum* from Alaska and the western United States, except that Imlay's material tends to have a wider whorl section and slightly coarser ribbing.

Wiedenmayer (1980) tentatively placed Imlay's (1968) *A.* sp. cf. *A. algovianum* in the genus *Oregonites* Wiedenmayer (1980), which is characterized by forms with a depressed whorl section and coarse ribs of irregular relief that are often paired at the base of the flanks. Imlay's (1968) material is here retained in the genus *Arieticeras*. The question as to whether or not the genus *Oregonites* is valid, or if the specimens assigned to it (Wiedenmayer, 1980) are variants of the European genera *Arieticeras, Canavaria, Fontanelliceras,* or *Fuciniceras,* was raised by Braga (1983).

The Spatsizi specimens differ from the lectotypes of *A. algovianum* [Schröder, 1927, designated by Wiedenmayer (1977)] by their coarser, more sinuous ribs.

Occurrence. Arieticeras algovianum is common in the Upper Pliensbachian of Tethys. It is reported from Morocco, Spain, southern France, Italy, Switzerland, and as far north as southern Germany. In North America it occurs in the western United States, British Columbia, and southern Yukon where it is found associated with *Leptaleoceras* and *Fanninoceras*.

The Spatsizi material was found at localities 17–19, 31, 42, 49, 57, 58, 62, 63, 66, and 74.

Age. Late Pliensbachian (Kunae Zone).

Arieticeras sp. cf. *A. ruthenense* (Reynès, 1868)

Plate 15, figures 1, 2

cf. *1868 *Ammonites ruthenense* Reynès, p. 94, Pl. 2, fig. 4a–c.
non 1909 *Seguenziceras ruthenense* (Reynès) emend. Meneghini. Rosenberg, p. 291, Pl. 15, fig. 2a–c.
cf. 1934 *Arieticeras ruthenense* (Reynès) var. *typique* Monestier, p. 59, Pl. 8, figs. 2, 4, 5, *non* figs. 1, 12, 19.
cf. 1934 *Arieticeras ruthenense* (Reynès) var. *meneghiniana* Monestier, p. 59, Pl. 8, figs. 39, 40, *non* fig. 38; *non* Pl. 11, fig. 2.
non 1964a *Arieticeras* aff. *A. ruthenense* (Reynès). Frebold, p. 14, Pl. 4, figs. 3, 4 (=*Leptaleoceras* sp.)
?1968 *Fuciniceras* cf. *F. acutidorsatum* Kovacs. Imlay, p. 41, Pl. 7, figs. 22 and 24 only.
cf. 1977 *Arieticeras ruthenense* (Reynès). Wiedenmayer, p. 85, Pl. 16, fig. 17; Pl. 17, fig. 3 (and synonymy).
cf. 1980 *Arieticeras ruthenense* (Reynès). Wiedenmayer, p. 115, Pl. 20, figs. 21–24; Pl. 21, figs. 1, 2.

Material. Nine specimens, poorly to moderately well preserved as external and internal moulds in calcareous concretions.

Measurements.

Specimen	D	UD	U	WH	WHD	PRHW
GSC 83120	47	17	36	15	32	21
GSC 83121	50	21	42	19	38	23

Description. Shell evolute, whorl section elliptical. Umbilical wall low; umbilical shoulder rounds onto convex flanks. Ventrolateral shoulder rounded, venter convex, distinctly carinate; keel bordered by shallow sulci.

Ornament consists of simple, straight to slightly sinuous ribs that arise on the umbilical shoulder, trend rectiradiately to slightly rursiradiately on the flanks, and project slightly at the ventrolateral shoulder. Rib strength may vary with growth on a single specimen or between specimens; both fine to moderately coarse ribs are observed on the Spatsizi material.

Discussion. According to Braga (1983), the status of the species *A. ruthenense*, and its relationship to other species in the genera *Arieticeras* and *Leptaleoceras* is in question, a problem reflected in the complexity and length of the synonymy for *A. ruthenense* in Wiedenmayer (1977). Braga (1983) pointed out the morphological similarity between *Leptaleoceras accuratum* and *A. ruthenense* and concluded that perhaps the two forms are best considered as end members of a continuous morphological series. In this study, *A. ruthenense* is retained, as specimens from the Spatsizi collection assigned to *A.* sp. cf. *A. ruthenense* possess generally coarser, straighter, and less densely spaced ribs, and a less compressed whorl section than specimens here assigned to *L.* sp. aff. *L. accuratum*. *Arieticeras* sp. aff. *A. algovianum* has coarser, more sinuous ribs than *A.* sp. cf. *A. ruthenense*.

Occurrence. Arieticeras ruthenense has been found in the Tethyan region of Europe and North Africa (Wiedenmayer, 1977, p. 85). Its distribution in western

North America is poorly documented. In the Spatsizi area, *A.* sp. cf. *A. ruthenense* is found associated with *L.* sp. aff. *L. accuratum, A.* sp. aff. *A. algovianum*, and rare *Fanninoceras*.

The Spatsizi material was found at localities 17, 18, 42, 57, 60, 61, and 63.

Age. Late Pliensbachian (Kunae Zone).

Genus *Canavaria* Gemmellaro, 1885

Type species. Harpoceras (*Dumortieria*) *haugi* Gemmellaro, 1885 (Pl. 1, figs. 1–3), by subsequent designation (Howarth, 1955).

Remarks. Shell evolute. Venter bears a low keel flanked by two, narrow, flat zones or shallow sulci.

Ornament consists of strong, straight to very slightly sinuous ribs. The ribs of the inner whorls are marked by two rows of tubercles or swellings that commonly fade or disappear with growth.

There is a close relationship between the genera *Canavaria, Emaciaticeras*, and *Tauromenia*, and they have been treated differently by various workers. Fucini (1931) and Dubar and Mouterde (1978) considered the three forms all to be distinct genera, whereas Arkell et al. (1957) and Donovan et al. (1981) placed *Tauromenia* in synonymy with *Canavaria*; Braga (1983) considered *Tauromenia* to be a subspecies of *Canavaria*; and Wiedenmayer assigned both *Emaciaticeras* and *Tauromenia* to *Canavaria* as subgenera.

Age and distribution. Canavaria is a Tethyan form; it has been reported from Italy (Wiedenmayer, 1980), Sicily (Fucini, 1931), Portugal (Mouterde, 1953), southern Spain (Braga, 1983), and Morocco (Dubar and Mouterde, 1978). A single specimen has also been reported from southern England (Howarth, 1955). In Europe, *Canavaria* occurs in the upper part of the Upper Pliensbachian.

Canavaria? sp.

Plate 15, figure 3

Material. A single fragment preserved as an external mould in tuffaceous siltstone.

Measurements. Not available because of the fragmentary nature of the specimen.

Description. Shell is evolute (U = approximately 50), whorl section and venter are unknown because of poor preservation. Ornament consists of strong, fairly distant ribs that arise at the umbilical shoulder, where they appear to be slightly swollen. The ribs trend rursiradiately across the flanks and terminate in weak swellings. On the outermost preserved whorl, the ribs arise at about one quarter of the flank height and are fainter than on preceding whorls. A constriction is evident on the outermost whorl, beyond which the ribbing appears to fade, leaving the flanks smooth.

Discussion. This specimen is similar to a specimen figured by Fucini (1931, Pl. 17, fig. 18) and assigned to *Naxensiceras pulcherrimum* that, with the exception of the figure mentioned, has been placed in synonymy with *Canavaria naxensis* by Braga (1983). *Naxensiceras* was placed in synonymy with *Canavaria* by Arkell et al. (1957) and *Arieticeras* by Donovan et al. (1981). The Spatsizi specimen was found in association with *Arieticeras* but differs from *Arieticeras* by its straighter, stronger ribs with their slight swellings and rare bifurcations at the umbilical shoulder, and by the faded ribbing on the outermost whorl.

Occurrence. In Spatsizi, *Canavaria*? sp. was collected from float material at locality 63 along with specimens of *Arieticeras* sp. aff. *A. algovianum* and *Protogrammoceras* spp. Loosely coiled forms from Oregon assigned to *Canavaria* (Imlay, 1968) are better accommodated in *Fontanelliceras* and possibly *Oregonites*, in the case of irregularly ribbed forms (Wiedenmayer, 1980; Braga, 1983).

Age. Late Pliensbachian (Kunae Zone or ?Lower Carlottense Zone but not in place).

Subfamily HARPOCERATINAE Neumayr, 1875

Genus *Tiltoniceras* Buckman, 1913

Type species. Tiltoniceras costatum Buckman, 1914, Pl. 97, figs. 1–4 [a coarse ribbed variant and synonym of *Tiltoniceras antiquum* (Wright) according to Howarth, 1973a, p. 265].

Remarks. Compressed, fairly involute forms with a rounded umbilical wall and a prominent keel. Ribbing, which is weak and becomes even weaker with growth, consists of flexuous, broad ribs or lirae that project onto the venter.

Age and distribution. The occurrence of this genus has been well documented in northwest Europe, where it appears suddenly over a wide area in the Tenuicostatum Zone (Dean et al., 1961; Fischer, 1975). Occurrences in Siberia are assumed to be Toarcian in age because the specimens occur immediately above amaltheids (Smith et al., 1988). The genus possibly originates from *Protogrammoceras*, and Braga (1983) considered *Tiltoniceras* a junior synonym.

Tiltoniceras propinquum (Whiteaves, 1884)

Plate 15, figures 4–9

*1884 *Schloenbachia propinqua* Whiteaves, p. 274, Pl. 33, fig. 2, 2a.
1930 *Harpoceras propinquum* (Whiteaves). McLearn, p. 4.
1932 *H. propinquum* (Whiteaves). McLearn, p. 66, Pl. 6, figs. 1–4; Pl. 7, fig. 3.
1944 *H. propinquum* (Whiteaves). Shimer and Shrock, Pl. 240, figs. 13, 14.
1964b *H. propinquum* (Whiteaves). Frebold, Pl. 8, figs. 4, 5, 7 [McLearn's (1932) material refigured].

Material. Ninety-nine specimens, poorly preserved as external and internal moulds in calcareous concretions and siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	WW	WWD	WWWH	PRHW
GSC 84877	60	19	32	25	42	—	—	—	—
GSC 84878	49	14	29	20	41	—	—	—	—
GSC 84879	33	10	30	13	39	—	—	—	—
GSC 84880	33	9	28	15	45	—	—	—	—
GSC 84881	39	12	32	13	33	—	—	—	—
GSC 84882	51.5	15	29	21	41	—	—	—	19
GSC 84968	32	8	23	14	44	—	—	—	—
GSC 84969	—	—	—	22	—	a8	—	36	—
GSC 84969	a46	a11	24	19	41	—	—	—	—
Mean	—	—	28.4	—	40.8	—	—	—	—
St. Dev.	—	—	3.3	—	3.7	—	—	—	—

Description. Shell involute to midvolute; whorl section compressed, ellipsoid. Umbilical slope low and gentle, umbilical shoulder rounds evenly onto slightly convex flanks. Venter narrow, bearing a keel flanked by two flat bands sloping toward the flanks; ventrolateral shoulder rounded.

Ornament varies through ontogeny. The innermost whorls (less than 10 mm diameter) are not observed in this collection. From about 10 to 25 mm diameter, specimens show moderately distant, somewhat broad but faint ribs on the lower third of the flank. Just below midflank, these slightly prorsiradiate primary ribs give rise to two or three slender secondary ribs that bend backward from the top of the primary ribs, then arc adorally as they approach the venter, imparting a falcoid appearance to the ribbing. Some of the secondary ribs appear to be intercalated. The relief of the ribbing is greatest at about one third of the flank height. The ribs fade near the ventrolateral shoulder. With growth, the ribbing becomes fainter and the slender secondary ribs no longer join below midflank, but rather become fasciculate and fade just above the umbilical shoulder. At diameters greater than about 35 mm, ribbing fades, leaving the flanks either smooth or marked with faint, densely spaced, falcoid lirae.

Discussion. The Spatsizi material is the same as *Tiltoniceras propinquum* as presently defined (see McLearn, 1932) but the species is in need of careful study. It is apparent from work in progress by one of us (PLS with H.W. Tipper) that the type material and new collections from the Queen Charlotte Islands contain more than one taxon and that the age range is into the Pliensbachian, rather than being restricted to the Toarcian as previously believed. Pending the publication of these results, the Spatsizi material is assigned to *T. propinquum* on a provisional basis; certainly it has much in common with the more involute form *T. facetum* (Polubotko and Repin, 1966; Repin et al., 1968) that Dagis (1974) placed in synonymy with *T. propinquum*.

Occurrence. Tiltoniceras propinquum is abundant at its type locality in the Fannin Formation on the Queen Charlotte Islands and elsewhere in British Columbia (Smith et al., 1988). In North America the species ranges from the Upper Pliensbachian to the Lower Toarcian, but Russian occurrences are all reported as Toarcian (Dagis, 1974).

In the Spatsizi area, *Tiltoniceras propinquum* has been found associated with *Protogrammoceras* spp. and *Fanninoceras latum*. In Section 4 (Fig. 1), *Tiltoniceras propinquum* is found in strata below the first appearance of *Dactylioceras*. These occurrences are consistent with a Late Pliensbachian age.

The Spatsizi material was found at localities 20, 32, 50, 61, 63, 64, 71, 79, and 102.

Age. Late Pliensbachian (Carlottense Zone).

Genus and species indet.

Plate 16, figure 1

cf. 1968 *Lioceratoides*? sp. Imlay, p. C37, Pl. 5, figs. 6–11.

Material. A single specimen, poorly preserved in siltstone as an external mould with part of an internal mould.

Description. Although the specimen is distorted, the whorl section appears to have been ellipsoidal. Shell is midvolute, umbilical slope is gentle, and the umbilical shoulder is rounded. The venter is distinctly carinate.

Ornament consists of irregularly spaced, falcoid ribs of variable relief (possibly due to preservation) that arise above the umbilical shoulder, gain their full relief at midflank, gently flex adorally, then fade below the ventrolateral shoulder.

Occurrence. The specimen was found associated with *Tiltoniceras propinquum* at locality 32.

Age. Late Pliensbachian (Carlottense Zone).

Genus *Protogrammoceras* Spath, 1913

1922 *Paltarpites* Buckman
1923 *Argutarpites* Buckman
1923 *Bassaniceras* Fucini
1970 *Eoprotogrammoceras* Cantaluppi
1970 *Neoprotogrammoceras*

Type species. Grammoceras bassanii Fucini, 1900 (p. 46, Pl. 10, fig. 6) by subsequent designation (Spath, 1919).

Remarks. Protogrammoceras includes midvolute to involute, compressed forms characterized by dense to very dense, flat-topped, falcoid ribs that project strongly onto the venter. The umbilical wall is low and may be steep to shallowly inclined. The venter bears a high keel.

Protogrammoceras is often confused with similar forms belonging to the genus *Fuciniceras*; the two genera can be distinguished by the fact that the ribs are more strongly projecting in *Protogrammoceras* than in *Fuciniceras*.

Age and distribution. Protogrammoceras is most abundant in the Tethyan region but is also common in many other parts of the world (Howarth, 1973b). *Protogrammoceras* has been reported from various points in the circum-Pacific; from Japan (Hirano, 1971), the far east of the Soviet Union (Sey and Kalacheva, 1980), and North America (Frebold, 1964a, 1970; Imlay, 1968, 1981; Hall and Howarth, 1983).

The presence of *Protogrammoceras* in the northwest European province has been well documented in reports from England (Buckman, 1922, 1923, 1927; Howarth, 1973a), eastern France and Luxembourg (Maubeuge, 1948; Maubeuge and Rioult, 1964), and Germany (Fischer, 1975). Fischer (1975) gave an account of how *Protogrammoceras*, in the company of *Arieticeras* and *Fuciniceras*, migrated from northern Tethys to the South-German Liassic sea during the Early Pliensbachian (Ibex Zone), and subsequently to the Northwest-German Jurassic basin during the Late Pliensbachian Margaritatus Zone. The complete range of *Protogrammoceras* in Europe is from the Jamesoni Zone to the Tenuicostatum Zone (Donovan et al., 1981).

Protogrammoceras spp.

Plate 16, figures 2–6

Material. Approximately 25 specimens, poorly to moderately well preserved as external moulds in siltstone and calcareous siltstone.

Measurements.

Specimen	D	UD	U	WH	WHD	PRHW
GSC 84884	48	13	27	27	56	—
GSC 84885	30	9	30	13	43	20
GSC 84886	a68	a18	26	a30	44	a46
GSC 84887	a95	a27	28	a41	43	a50
GSC 84888	a80	a20	25	a40	50	a29
Mean	—	—	27.2	—	47.2	—
St. Dev.	—	—	1.9	—	5.7	—

Description. Shell compressed, fairly involute; whorl section not preserved but appears to be ellipsoid or ogival. Umbilical wall is convex, low, moderately steep; umbilical shoulder rounded. Flanks are convex, ventrolateral shoulder rounded; venter is inflated and bears a high keel.

Ornament consists of dense, falcoid, flat-topped ribs that are strongly projected on the venter. The width of the ribs varies slightly with growth; in general, the ribs become narrower at larger diameters.

Discussion. This poorly preserved collection probably contains representatives of *Protogrammoceras paltum* and *P. argutum*. *Protogrammoceras paltum* has been previously reported from the Tulsequah area of northern British Columbia (as *Harpoceras* sp. cf. *H. exaratum* in Frebold, 1964a; Frebold, 1970). *Protogrammoceras paltum* has a variable morphology as seen in the differences between the holotype (Pl. 362a) and paratype (Pl. 362b) figured by Buckman (1922). The holotype is less involute and has a more variable (and generally greater) rib density than that of the paratype. Some Spatsizi specimens of *Protogrammoceras* spp. have a comparable rib density to that of Buckman's holotype, but are more involute, as is Buckman's paratype. These variations in *P. paltum* have also been observed in collections from Arctic Canada (Hall and Howarth, 1983) and from British Columbia and the Yukon by Frebold (1970), who further stated that the morphological gap between *P. paltum* and the species *P. argutum* is bridged by transitional forms. *Protogrammoceras argutum* is characterized by its ribbing, which is consistently fine and dense throughout growth.

Occurrence. Protogrammoceras argutum has been collected from north-central British Columbia (Frebold, 1970), Alaska (Imlay, 1981), and Oregon (Imlay, 1968). It is also known from South America (Hillebrandt, 1987) and is widely distributed in Europe, perhaps being more characteristic of the Mediterranean countries. In all cases it is Late Pliensbachian in age.

Protogrammoceras paltum is a widespread species common in Europe and also reported from Japan (Hirano, 1971), Alaska (Imlay, 1981), the Canadian Arctic Archipelago (Hall and Howarth, 1983), and the western Cordillera of Canada (Frebold, 1970). In the Spatsizi area, *Protogrammoceras* spp. are found associated with *Tiltoniceras propinquum* and rare *Fanninoceras*, and occur below the first appearance of *Dactylioceras*, suggesting a Late Pliensbachian age. In the Taku River area of northern British Columbia, *P. paltum* is found associated with *Amaltheus* (Frebold, 1970), also indicating a Late Pliensbachian age. Hall and Howarth (1983) have assigned the Arctic specimens of *P. paltum* to the Upper Pliensbachian (Spinatum Zone) although the evidence is weak.

Hall and Howarth (1983) point out that *P. paltum* has a diachronous distribution. Specimens from the Northwest European province, notably England (Howarth, 1973a) and Luxembourg (Maubeuge and Rioult, 1964), are lowest Toarcian in age. Based on biostratigraphic studies of the succession on the Yorkshire coast, Howarth (1973a) proposed the *P. paltum* Subzone as the lowest division of the Tenuicostatum Zone. In the Alpine and Mediterranean region of Europe, however, *P. paltum* is of Late Pliensbachian age, and, as discussed above, *P. paltum* is of Late Pliensbachian age in North America.

The Spatsizi material was found at localities 32, 43, 50, 62, 63, 71, 79, and 102.

Age. Late Pliensbachian (Carlottense Zone).

REFERENCES

Arkell, W.J.
1950: A classification of the Jurassic ammonites. Journal of Paleontology, v. 24, p. 354–369.

Arkell, W.J., Kummel, B., and Wright, C.W.
1957: Mesozoic Ammonoidea; *in* Treatise on Invertebrate Paleontology, Part L, Mollusca 4; Geological Society of America and University of Kansas Press, Lawrence, 490 p.

Behrendsen, O.
1891: Zur Geologie des Ostabhanges der argentinischen Cordillere. I. Teil. Zeitschrift der Deutschen Geologischen Gesellschaft, v. 43, p. 369–420.

Braga, J.C.
1983: Ammonites del Domerense de la Zona Subbetica (Cordilleras Breticas, Sur de Espana). Ph.D. thesis, University of Granada, Spain, 410 p.

Braga, J.C. and Rivas, P.
1985: The Mediterranean *Tropidoceras* (Ammonitina) in the Betic Cordilleras. Eclogae Geologicae Helvetiae, v. 78, p. 567–605.

Buckman, S.S.
1898: On the grouping of some divisions of so-called "Jurassic" time. Quarterly Journal of the Geological Society, v. 54, p. 442–462.

1909–1930: Yorkshire Type Ammonites, I and II, and Type Ammonites, III and VII. Reprinted 1976, Wheldon and Wesley Ltd. and Verlag von Cramer, Herts, England.

Callomon, J.H.
1984: Biostratigraphy, chronostratigraphy and all that—again; *in* Proceedings of the Erlangen Symposium, O. Michelsen and A. Zeiss (eds.); International Subcommission on Jurassic stratigraphy, v. 3, p. 611–624.

Cameron, B.E.B. and Tipper, H.W.
1985: Jurassic stratigraphy of the Queen Charlotte Islands, British Columbia. Geological Survey of Canada, Bulletin 365, 49 p.

Cantaluppi, G.
1970: Le Hildoceratidae del Lias Medio delle regioni mediterranee. Memorie Della Società Italiana di Scienze Naturali, v. 19, p. 1–46.

Colera, I., Rivas, P., Sequeiros, L., and Valenzuela, R.
1978: Algunos *Metaderoceras* (Ammonitina) del Lias inferior de Almonacid de la Cuba (provincia de Zaragoza, Cordillera Iberica). Estudios Geologica, v. 34, p. 309–317.

Coney, P.J., Jones, D.L., and Monger, J.W.H.
1980: Cordilleran suspect terranes. Nature, v. 288, p. 329–333.

Dagis, A.A.
1974: Toarcian ammonites (Hildoceratidae) from the north of Siberia. Transactions of the Institute of Geology and Geophysics, U.S.S.R. Academy of Sciences, Siberian Branch, v. 99, 108 p. (In Russian.)

Davidson, T.
1851: A monograph of the British fossil Brachiopoda: the oolitic and Liassic Brachiopoda. Palaeontographical Society Monograph, 64 p.

Dean, W.T., Donovan, D.T., and Howarth, M.K.
1961: The Liassic ammonite zones and subzones of the northwest European province. British Museum (Natural History), Bulletin of Geology, v. 4, p. 435–505.

Dommergues, J.-L. and Mouterde, R.
1978: Les faunes d'ammonites du Carixien Inférieur et Moyen du gisement des Cottards (Cher). Geobios, v. 11, p. 345–365.

1981: Les acanthopleurocératines Portugais et leurs relations avec les formes subboréales. Ciencias da Terra, no. 6, p. 71–100.

1982: *Reynesocoeloceras praeincertum* nov. sp. (Ammonitina, Carixien Moyen); Remarques sur l'origine du genre *Reynesocoeloceras*. Geobios, v. 15, p. 757–763.

Dommergues, J.-L., Mouterde, R., and Rivas, P.
1984: Un faux Polymorphitiné: *Dubariceras* nouveau genre d'Ammonitina du Carixien Mesogéen. Geobios, v. 17, p. 831–839.

Donovan, D.T.
1967: The geographical distribution of Lower Jurassic ammonites in Europe and adjacent areas; *in* Aspects of Tethyan Biogeography, C.G. Adams and D.V. Ager (eds.); Systematics Association Publication no. 7, p. 111–134.

Donovan, D.T. and Forsey, G.F.
1973: Systematics of Lower Liassic Ammonitina. University of Kansas Paleontology Contributions, Paper 64, 18 p.

Donovan, D.T., Callomon, J.H., and Howarth, M.K.
1981: Classification of the Jurassic Ammonitina; *in* The Ammonoidea, M.R. House and J.R. Senior (eds.); Systematics Association Special Volume, no. 18, p. 101–155.

Du Dresnay, R.
1963: Quelques ammonites de la partie inférieure du Pliensbachien (Carixien et Domérien pro parte) du jbel Bou-Rharraf (Haut Atlas Oriental). Notes du Service Géologique du Maroc, v. 23, n. 172, p. 141–164.

Dubar, G. and Mouterde, R.
1978: Les formations à Ammonites du Lias Moyen dans le Haut Atlas de Midelt et du Tadla. Notes et Mémoirs, Service Géologique du Maroc, no. 274, 101 p.

Dumortier, E.
1864–1874: Études paléontologiques sur les dépôts jurassiques du Bassin du Rhône, I, Infralias; II, Lias inférieur; III, Lias moyen; IV, Lias supérieur. Paris.

Erben, H.K.
1956: El Jurásico inferior de México y sus amonitas. XX Congreso Geológico Internacional, 393 p.

Ferretti, A.
1975: Ricerche biostratigrafiche sul Sinemuriano–Pliensbachiano nella gola del F. Bosso (Appenino Marchigiano). Rivista Italica Paleontologica, v. 81, p. 161–194.

Fischer, R.
1971: Die Coeloceratinen (Ammonoidea) des Monte Cetona (Prov. Siena). Paläontologie, Geologie, und Stratigraphie eines Profils im Mediterranean Carixium und Lotharingium. Geologica et Palaeontologica, v. 5, p. 93–129.

1975: Die deutschen Mittellias-Falciferen (Ammonoidea; *Protogrammoceras, Fuciniceras, Arieticeras*). Palaeontographica Abt. A, v. 151, p. 47–101.

Frebold, H.
1964a: Lower Jurassic and Bajocian ammonoid faunas of northwestern British Columbia and southern Yukon. Geological Survey of Canada, Bulletin 116, 31 p.

1964b: Illustrations of Canadian fossils. Jurassic of western and Arctic Canada. Geological Survey of Canada, Paper 63–4, 107 p.

1967: Position of the Lower Jurassic genus *Fanninoceras* McLearn and the age of the Maude Formation on the Queen Charlotte Islands. Canadian Journal of Earth Sciences, v. 4, p. 1145–1149.

1970: Pliensbachian ammonoids from British Columbia and southern Yukon. Canadian Journal of Earth Sciences, v. 7, p. 435–456.

Fucini, A.
1899–1900: Ammoniti del Lias Medio dell'Appennino centrale. Palaeontographica Italica, v. 5, p. 18–185.

1901–1905: Cephalopodi Liassici del Monte di Cetona. Palaeontographica Italica, Memoir, v. 7, p. 1–89, 1901; v. 8, p. 131–218, 1902; v. 9, p. 125–186, 1903; v. 10, 1904; v. 11, 1905.

1920–1931: Fossili Domeriani dei dintorni di Taormina. Palaeontographica Italica, v. 26, p. 75–116, 1920; v. 27, p. 1–22, 1921; v. 29, 1923; v. 31, 1929–1930.

Futterer, K.
1893: Die Ammoniten des mittleren Lias von Oestringen. Mitteilungen der Grossherzöglichen Badischen Geologischen Landesanstalt, pt. 2, p. 277–343, Pl. 19–21.

Gabrielse, H. and Tipper, H.W.
1984: Bedrock geology of Spatsizi map area (104 H). Geological Survey of Canada, Open File Report 1005, Scale 1:125 000.

Geczy, B.
1976: Les ammonitines du Carixien de la Montagne du Bakony. Akadémiai Kiado, Budapest, 223 p.

Gemmellaro, G.G.
1884: Sui fossili degli strati a *Terebratula aspasia* della contrada Roche Rosse presso Galati. Giornale di scienze naturali ed economiche, Palermo, v. 16, p. 167–218.

1885: Sopra taluni Harpoceratidi del Lias Superior dei dintorini di Taormina. Giornale di scienze naturali ed economiche, Palermo, v. 17, p. 109–125.

Getty, T.A.
1970: *Acanthopleuroceras* Hyatt, 1900 (class Cephalopoda, order Ammonitina). Bulletin of Zoological Nomenclature, London, v. 27, p. 105–109.

Haas, O.
1913: Die Fauna des Mittleren Lias von Ballino in Sudtirol, II: Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients, v. 26, 161 p.

Hall, R.L. and Howarth, M.K.
1983: *Protogrammoceras paltum*, a Late Pliensbachian (Jurassic) ammonite from Axel Heiberg Island, Canadian Arctic Archipelago. Canadian Journal of Earth Sciences, v. 20, p. 1470–1475.

Hallam, A.
1988: A re-evaluation of Jurassic eustasy in the light of new data and the revised Exxon curve. Society of Economic Paleontologists and Mineralogists, Special Publication 42, p. 261–273.

Haug, E.
1885: Beiträge zu einer Monographie der Ammonitengattung *Harpoceras*. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, v. 3, p. 585–782.

1887: Über die Polymorphidae, eine neue Ammonitenfamilie aus dem Lias. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, v. 2, p. 89–163.

Hertlein, L.G.
1925: New species of marine fossil Mollusca from western North America. Southern California Academy of Science, Bulletin, v. 24, p. 39–46.

Hillebrandt, A. von
1981a: Faunas de Amonites del Liásico Inferior y Médio (Hettangiano hasta Pliensbachiano) de America del Sur (excluyendo Argentina). Cuncas Sedimentarias del Jurásico y Cretacico de America del Sur, v. 2, p. 449–538.

1981b: Kontinentalverschiebung und die paläozoogeographischen Beziehungen des Südamerikanschen Lias. Geologische Rundschau, v. 70, no. 2, p. 570–582.

1984: The faunal relations of the Lower Jurassic ammonites of South America; *in* Proceedings of the International Symposium on Jurassic Stratigraphy, O. Michelsen and E. Zeiss (eds.); Erlangen, v. 3, p. 716–729.

1987: Liassic ammonite zones of South America and correlations with other provinces—descriptions of new genera and species of ammonites; *in* Biostratigrafia des los Sistemas Regionales del Jurasico y Cretacico de America del Sur. Mendoza, p. 112–157.

Hirano, H.
1971: Biostratigraphic study of the Jurassic Toyora Group, Part 1. Memoirs of the Faculty of Science, Kyushu University, Series D, Geology, v. 21, no. 1, p. 93–128, Pl. 14–20.

Hoffmann, K.
1982: Die Stratigraphie, Paläogeographie und Ammonitenfuhrung des Unter-Pliensbachium (Carixium, Lias Gamma) in nordwest Deutschland. Geologie Jahrbuch Reihe A, Heft 55, Hannover, 357 p.

Howarth, M.K.
1955: Domerian of the Yorkshire coast. Proceedings of the Yorkshire Geological Society, v. 30, p. 146–175.

1973a: The stratigraphy and ammonite fauna of the Upper Liassic Grey Shales of the Yorkshire coast. British Museum (Natural History), Bulletin of Geology, v. 24, no. 4, p. 237–277.

1973b: Lower Jurassic (Pliensbachian and Toarcian) ammonites; *in* Atlas of Paleobiogeography, A. Hallam (ed.); Elsevier, London, p. 275–283.

Hyatt, A.
1867: Fossil cephalopods of the Museum of Comparative Zoology. Bulletin of the Museum of Comparative Zoology, Harvard, Cambridge, v. 1, p. 71–102.

1875: Remarks on two new genera of Ammonites *Agassiceras* and *Oxynoticeras*. Boston Society of Natural History, Proceedings, v. 17, p. 225–235.

1889: Genesis of the Arietitidae. Smithsonian Contributions to Knowledge, v. 26, 250 p., 14 Pl.

1900: Cephalopoda; *in* Textbook of Paleontology 1, K.A. von Zittel (ed.); London, p. 502–592.

Imlay, R.
1968: Lower Jurassic (Pliensbachian and Toarcian) ammonites from eastern Oregon and California. United States Geological Survey, Professional Paper 593-C, 51 p.

1981: Early Jurassic ammonites from Alaska. United States Geological Survey, Professional Paper 148, 49 p.

Levi, G.
1896: Sui fossili degli strati a *Terebratula aspasia* di Monte Calvi presso Campiglia. Bollettino Società Geologica Italiana, v. 15, p. 262–76, Pl. 8.

McLearn, F.H.
1930: Notes on some Canadian Mesozoic faunas. Transactions of the Royal Society of Canada, sec. 4, ser. 3, v. 24, p. 1–7.

1932: Contributions to the stratigraphy and palaeontology of Skidegate Inlet, Queen Charlotte Islands, British Columbia, (continued). Royal Society of Canada, Proceedings and Transactions, ser. 3, v. 26, p. 51–84.

Maubeuge, P.L.
1948: Sur un nouvel horizon paléontologique du Lias Supérieur et le contact du Lias Moyen et Supérieur dans l'est de la France. Bulletin de la Société Géologique de France, Paris, v. 18, p. 59–68.

Maubeuge, P.L. and Rioult, M.
1964: Présence de *Paltarpites* dans le Lias du Grande-Duche de Luxembourg. Institut du Grande-Ducal de Luxembourg, Section des Science naturelles, physiques, et mathématiques, Archives, v. 30, p. 107–113.

Meister, C.
1986: Les ammonites du Carixien des Causses, France. Mémoires Suisses de Paléontologie, v. 109, 209 p., 23 Pl.

Meneghini, G.
1867–1881: Monographie des fossiles du calcaire rouge ammonitique (Lias supérieur) de Lombardie et de l'Appennin central (p. 1–184); Révision systématique (p. 185–242); Fossiles du Medolo. Appendice à la monographie... (p. 1–56); *dans* Paléontologie lombarde, A. Stoppani (ed.); 4e sér.

Monestier, J.
1934: Ammonites du Domérian de la région sud-est de l'Aveyron et de quelques régions de la Lozère à l'exclusion des Amaltheides. Société Géologique de la France, Mémoire, n. ser., v. 10, pt. 3, mem. 23, 210 p., 11 pl.

Monger, J.H.W.
1984: Cordilleran tectonics: a Canadian perspective. Bulletin du Société Géologique de la France, v. 26, p. 255–278.

Monger, J.H.W., Price, R.A., and Tempelman-Kluit, D.J.
1982: Tectonic accretion and the origin of the two major metamorphic and tectonic welts in the Canadian Cordillera. Geology, v. 10, p. 70–75.

Mouterde, R.
1951: Ammonites du Lias moyen portugais. Boletin da Sociedade Geológica de Portugal, v. 9, p. 175–190.

1953: Études sur le Lias et le Bajocien des bordures Nord et Nord-est du Massif Central français. Bulletin du Service Carte géologique de la France, v. 50 (1952), p. 63–521.

1970: Le Lias moyen de Saõ Pedro de Muel (Part 2, Paléontologie). Communicações dos Serviços Geológicos de Portugal, v. 54, p. 40–74.

1977: Polymorphisme ou variabilité adulte chez un Eoderoceratidae: *Metaderoceras*(?) *beirense*. Halotis, v. 6, p. 179–184.

Mouterde, R. and Ruget, Ch.
1970: Le Lias Moyen de Saõ Pedro de Muel (Deuxième partie: Paléontologie). Comunicações dos Serviços Geológicos de Portugal, v. 54, p. 40–74.

Neumayr, M.
1875: Die Ammoniten der Kreide und die Systematik der Ammonitiden. Zeitschrift der Deutschen Geologischen Gesellschaft, XXVII, p. 854–942.

Oppel, A.
1853: Der mittlere Lias Schwabens neu bearbeitet. Württemburg naturwissenschaftliches Jahresheft, Stuttgart, v. 10, 92 p., 4 Pl.

1856–1858: Die Jura Formation Englands, Frankreichs und das südwestlichen Deutschlands nach ihren einzelnen Gliedern Eingeteilt und verglichen. Württemburg naturwissenschaftliches Jahresheft, Stuttgart, v. 12–14, 857 p.

1862: Über Jurassischen Cephalopoden. Paläontologische Mittheilungen, v. 1, p. 127–162, Pl. 40–50.

d'Orbigny, A.
1842–1860: Paléontologie française, Terrains jurassiques, Part 1, Céphalopodes. Masson, Paris, 642 p., 234 Pl.

Pinna, G. and Levi-Setti, F.
1971: I Dactylioceratidae della provincia Mediterranea (Cephalopoda Ammonoidea). Memoirie della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano, v. 19, no. 2, p. 49–161.

Polubotko, I.V. and Repin, Y.S.
1966: Stratigrafiya i ammonity Toarskogo yarusa tsentral'noy chasti Omolonskogo Massiva. Materialy Geologii Poleznym Iskopaemym Severo-Vostoka, v. 19, p. 30–55, Pl. 1–4. (In Russian.)

Poulton, T.P.
1976: Some Lower Jurassic trigonid bivalves from southwestern British Columbia. Geological Survey of Canada, Bulletin 256, p. 41–53.

1979: Jurassic trigonid bivalves from Canada and western United States of America. Geological Survey of Canada, Bulletin 282, 82 p.

1988: Major interregionally correlatable events in the Jurassic of Western Interior, Arctic, and eastern offshore Canada; *in* Sequences, Stratigraphy, Sedimentology: Surface and Subsurface, D.P. James and D.A. Leckie (eds.); Canadian Society of Petroleum Geologists, Memoir 15, p. 195–206.

Quenstedt, F.A.
1845–1849: Petrefactenkunde Deutschlands. Die Cephalopoden, Fues, Tübingen, 580 p.

Rakus, M.
1972: Sur la présence du genre *Dayiceras* Spath (Ammonoidea, Cephalopoda) dans la Carixien de Tunisie. Bulletin du Laboratoire Géologique, Mineralogique, et Géophysique, Musée de Géologie, Université de Lausanne, Bulletin 195, 3 p.

Repin, Y.S., Effimova, A.F., Kinasov, V.P., Paraketsov, K.V., Polubotko, I.V., and Dagis, A.S.
1968: Polevoy Atlas yurskoy fauni i flory serevo-vostoka, S.S.S.R. Ministry of Geology, U.S.S.R., Publishing House of Madakansk, 382 p., 114 Pl. (In Russian.)

Reynès, P.
1868: Essai de géologie et de paléontologie Aveyronnaises. J.-B. Baillière et fils, Paris, 108 p.

Rivas, P.
1983: El genero *Metaderoceras* (Eoderoceratacea, Ammonitina) en las Cordilleras Beticas. Estudios Geológicos, v. 39, p. 387–403.

Rocha, R.B. da
1977: Estudio estratigrafico e paleontologico do Jurassico do Algarve occidental. Universidad Nova de Lisbõa, Ciencias Terra, Lisbon, 178 p.

Rosenberg, P.
1909: Die Liasische cephalopodenfauna der Kratzalpe im Hagenbirge. Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients, v. 22, p. 193–345.

Schlatter, R. von
1980: Biostratigraphie und Ammonitenfauna des Unter-Pliensbachium im Typusgebiet (Pliensbach, Holzmaden und Nurtingen; SW-Deutchland). Stuttgarter Beiträge zur Naturkunde, Serie B (Geologie und Paläontologie), 257 p., 21 Pl.

Schmidt-Effing, R.
1972: Die Dactylioceratidae, eine Ammoniten-Familie des Unteren Juras (Systematik, Stratigraphie, Zoogeographie, Phylogenie mit besonderer Berücksichtigung spanischen Materials). Münstersche Forschungen zur Geologie und Paläontologie, v. 25/26, p. 1–255.

Schröder, J.
1926–1927: Die Ammoniten der Jurassischen Fleckenmergel in den bayerischen Alpen. Palaeontographica, Abt. B, v. 58/59, p. 111–232.

Sey, I.I. and Kalacheva, E.P.
1980: Biostratigraphy of the Lower and Middle Jurassic deposits of the Far East. Ministry

of Geology, U.S.S.R. Geological Institute, Nedra, 187 p. (In Russian.)

Shimer, H.W. and Shrock, R.R.
1944: Index fossils of North America. John Wiley and Sons, New York, 837 p.

Smith, P.L.
1981: Biostratigraphy and ammonoid fauna of the Lower Jurassic of eastern Oregon and western Nevada. Ph.D. thesis, McMaster University, Hamilton, Ontario, 368 p.

1983: The Pliensbachian ammonite *Dayiceras dayiceroides* and Early Jurassic paleogeography. Canadian Journal of Earth Sciences, v. 20, p. 86–91.

1986: The implications of data base management systems to paleontology: a discussion of Jurassic ammonoid data. Journal of Paleontology, v. 60, p. 327–340.

Smith, P.L., Thomson, R.C., and Tipper, H.W.
1984: Lower and Middle Jurassic sediments and volcanics of the Spatsizi map area, British Columbia; *in* Current Research, Part A; Geological Survey of Canada, Paper 84–1A, p. 117–120.

Smith, P.L. and Tipper, H.W.
1984: The distribution and affinity of the Pliensbachian ammonite genus *Fanninoceras*. (Abstract.) Canadian Paleontology and Biostratigraphy Seminar, September, 1984, Ottawa, Canada, Programme with Abstracts, Paleontology Division, Geological Association of Canada, p. 8.

1986: Plate tectonics and paleobiogeography: Pliensbachian (Early Jurassic) endemism and diversity. Palaios, v. 1, p. 399–412.

1988: Biochronology, stratigraphy and tectonic setting of the Pliensbachian of Canada and the United States; *in* Proceedings of the Second International Symposium on Jurassic Stratigraphy, R.B. Rocha and A.F. Soares (eds.); Lisbon, v. 1, p. 119–138.

Smith, P.L., Tipper, H.W., Taylor, D.G., and Guex, J.
1988: An ammonite zonation for the Lower Jurassic of Canada and the United States: the Pliensbachian. Canadian Journal of Earth Sciences, v. 25, no. 9, p. 1503–1523.

Sowerby, J.
1812–1846: The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times and depths in the earth. In 7 volumes, London, 383 Pl.

Spath, L.F.
1913: On Jurassic ammonites from Jebel Zaghuan (Tunisia). Geological Society of London, Quarterly Journal, v. 69, p. 540–580, Pl. 52, 53.

1919: Notes on ammonites. Geological Magazine, London, v. 6, p. 27–35, 65–71, 115–122, 170–177, 220–225.

1920: On a new ammonite genus (*Dayiceras*) from the Lias of Charmouth. Geological Magazine, v. 57, p. 538–543.

1925: Notes on Yorkshire ammonites. Naturalist, no. 819, p. 107–112; no. 820, p. 137–141; no. 821, p. 167–172; no. 822, p. 201–206; no. 824, p. 263–269; no. 825, p. 299–306; no. 826, p. 327–331; no. 827, p. 359–364.

1929: Corrections of cephalopod nomenclature. Naturalist, no. 871, p. 269–271.

Taylor, D.G.
1982: Jurassic shallow marine invertebrate depth zones, with exemplification from the Snowshoe Formation, Oregon. Oregon Geology, v. 44, p. 51–56.

Taylor, D.G., Callomon, J.H., Hall, R., Smith, P.L., Tipper, H.W., and Westermann, G.E.G.
1984: Jurassic ammonite biogeography of western North America: the tectonic implications; *in* Jurassic-Cretaceous Biochronology and Paleobiogeography of North America, G.E.G. Westermann (ed.); Geological Association of Canada, Special Paper 27, p. 121–142.

Taylor, D.G., Smith, P.L., Laws, R.A., and Guex, J.
1983: The stratigraphy and biofacies trends of the Lower Mesozoic Gabbs and Sunrise formations, west-central Nevada. Canadian Journal of Earth Sciences, v. 20, p. 1598–1608.

Thomson, R.C., Smith, P.L., and Tipper, H.W.
1986: Lower to Middle Jurassic (Pliensbachian to Bajocian) stratigraphy of the northern Spatsizi area, north-central British Columbia. Canadian Journal of Earth Sciences, v. 23, no. 12, p. 1963–1973.

Tipper, H.W.
1978: Jurassic stratigraphy, Cry Lake map area, British Columbia; *in* Current Research, Part A; Geological Survey of Canada, Paper 78–1A, p. 25–27.

1981: Offset of an Upper Pliensbachian geographic zonation in the North American Cordillera by transcurrent movement. Canadian Journal of Earth Sciences, v. 18, p. 1788–1792.

Tutcher, J.W. and Trueman, A.E.
1925: The Liassic rocks of the Radstock district (Somerset). Quarterly Journal of the Geological Society of London, v. 81, p. 595–666.

Whiteaves, J.F.
1884: Mesozoic fossils. v. 1, part 3, Geological Survey of Canada, Special Reports. Publication no. 437, p. 191–262, Pl. XXI–XXXII.

Wiedenmayer, F.
1977: Die Ammoniten des Besazio-Kalks (Pliensbachian, Südtessin). Schweizerische Paläontologische Abhandlungen, v. 98, 169 p.

1980: Die Ammoniten der mediterranean Provinz im Pliensbachian und unteren Toarcian aufgrund neuer Untersuchungen im Generoso-Becken (Lombardische Alpen). Denkschriften der Schweizerischen Naturforschenden Gesellschaft, v. 93, 261 p.

Zittel, K.A. von
1884: Handbuch der Paläontologie. Band 1, Heft 2, Oldenbourg Verlag, München und Leipzig, p. 329–522.

APPENDICES 1 and 2

APPENDIX 1

Locality and repository data

Repositories

The following Pliensbachian localities are plotted in Figures 1, and 5–10. All specimens with a Geological Survey of Canada type number are housed in the National Type Collection of Plant and Invertebrate Fossils, Geological Survey of Canada, 601 Booth St., Ottawa. All other specimens with GSC locality numbers, but without type numbers, are stored at the Institute of Sedimentary and Petroleum Geology (Calgary, Canada). In situ collections originate from a single bed.

Map sheet

All collections were made from localities in the Buckinghorse Creek map area (NTS 104 H/7).

Section 1 localities

See Figure 5 for position of Section 1; see Figure 7 for position of localities 1-32 in Section 1.

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
1	GAT(F)83-4B	C-103304	83063	*		
2	GAT(F)83-4C	C-103305	83067, 68	*		
3	GAT(F)83-51A	C-90843	83078, 56, 57	*		From Joan Fm., 250 m east of Sec. 1
4	GAT(F)83-6D	C-103317	—	*		
5	GAT(F)83-5C	C-103308	—	*		
6	GAT(F)83-6C	C-103316	—	*		
7	GAT(F)83-5D	C-103309	83081	*		
8	GAT(F)83-6B	C-103315	—	*		
9	GAT(F)83-5E	C-103310	83086	*		
10	GAT(F)83-6A	C-103314	—	*		
11	GAT(F)83-7A	C-103320	—	*		
12	GAT(F)83-7B	C-103321	—	*		
13	GAT(F)83-8B	C-103324	83090	*		
14	GAT(F)83-8C	C-103325	—	*		
15	GAT(F)83-9A	C-103326	—	*		
16	GAT(F)83-9B	C-103327	—	*		
17	GAT(F)83-13A	C-103328	83114	*		
18	GAT(F)83-13B	C-103332	83106, 83109		*	
19	GAT(F)83-13C	C-103325	—	*		
20	GAT(F)83-99A	C-103203	84880, 83103	*		
21	GAT(F)83-4A	C-103303	83074		*	
22	GAT(F)83-43A	C-90839	83065		*	From Joan Fm., 100 m west of Sec. 1
23	GAT(F)83-27A	C-90820	—		*	
24	GAT(F)83-27B	C-90821	—		*	
25	GAT(F)83-5B	C-103307	83073, 83079		*	
26	GAT(F)83-5A	C-103306	83102		*	
27	GAT(F)83-6F	C-103319	—		*	
28	GAT(F)83-6E	C-103318	—		*	
29	GAT(F)83-8A	C-103323	84902		*	
30	GAT(F)83-11A	C-103329	—		*	
31	GAT(F)83-11B	C-103331	—		*	

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
32	GAT(F)83-99B	C-103204	84878, 84879, 84882, 84883, 84887, 84906, 84886		*	

Section 2 localities

See Figure 5 for position of Section 2; see Figure 8 for position of localities 33-50 in Section 2.

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
33	—	C-90909	84889	*		
34	GAT(F)83-33A	C-90828	84904	*		
35	GAT(F)83-33B	C-90829	—	*		
36	GAT(F)83-33C	C-90830	83088	*		
37	GAT(F)83-34B	C-90832	83087	*		
38	GAT(F)83-34C	C-90833	—	*		
39	GAT(F)83-34D	C-90834	83099	*		
40	GAT(F)83-35A	C-90835	83101	*		
41	GAT(F)83-36A	C-90836	83092, 83093	*		
42	GAT(F)83-37A	C-90841	—	*		
43	GAT(F)83-38A	C-90838	—	*		
44	GAT(F)83-32A	C-90827	—		*	
45	PLS83-55	C-156448	98572		*	From lower siltstone of Joan Fm.
46	GAT(F)83-34A	C-90831	—		*	
47	—	C-90922	84903		*	Near Section 2
48	GAT(F)83-36B	C-90837	83100		*	
49	GAT(F)83-37B	C-90842	—		*	
50	—	C-87245	—		*	Near Section 2

Section 3 localities

See Figure 5 for position of Section 3; see Figure 9 for position of localities 51-61 in Section 3.

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
51	GAT(F)83-62A	C-103104	83066, 84898	*		
52	GAT(F)83-62B	C-103105	—	*		
53	GAT(F)83-63A	C-103106	—	*		
54	GAT(F)83-63B	C-103107	—	*		
55	GAT(F)83-64A	C-103108	—	*		
56	GAT(F)83-64B	C-103109	—	*		
57	GAT(F)83-65A	C-103111	83113	*		
58	—	C-90515	83105, 83107,	*		
		—	83108, 83111,			
		—	83119			
59	GAT(F)83-28A	C-103114	83082, 83089		*	
60	GAT(F)83-64C	C-103110	83120		*	
61	GAT(F)83-67A	C-103120	83121		*	

Section 4 localities

Section 4 is located north of the map area, latitude 57°35′00″, longitude 128°55′50″ (Fig. 1). The sequence consists of Joan Formation siltstone (Upper Pliensbachian) overlain by shale and tuffaceous shale of Early Toarcian age (Fig. 10).

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
62	GAT(F)-125A	C-103223	83116, 83117		*	
63	GAT(F)-125B	C-103224	83110, 83122, 84877, 84881		*	
64	GAT(F)-126B	C-103226			*	

Miscellaneous localities

Fossils were collected from the following localities in the Spatsizi area; see Figure 1 and Figure 12 for exact positions.

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
65	—	C-90516	—	*		Near Section 3.
66	—	C-90526	83112	*		
67	—	C-90527	83098, 84908	*		
68	—	C-103119	—	*		
69	—	C-90524	84899	*		
70	GAT(F)83-29A	C-90823	83069, 83070	*		From Joan Fm., 200 m west of Section 3
71	GAT(F)83-100A	C-118682	84888, 84905		*	Very close to Section 1, just east of Wolf Den Mtn.
72	PLS83-56	C-156449	98573	*		From Joan Fm., 150 m east of Joan Lake
73	GAT(F)83-1A	C-103311	83064		*	Float from volcanic core of anticline
74	—	C-90509	83115, 83118		*	
75	—	C-103097	84896	*		
76	—	C-103069	84901	*		
77	—	C-103070	84960, 98571	*		
78	—	C-103093	—	*		
79	—	C-87245	—	*		Near Section 2
80	—	C-90924	—	*		
81	—	C-90925	84893, 84894, 84895		*	Near Section 2
82	—	C-90926	83055, 83085		*	
83	—	C-90930	83058, 83059, 83060, 84890, 84891, 84892		*	
84	81TD-S-2A	C-90902	83084	*		Near Section 2
85	GAT(F)83-54A	C-90950	—	*		
86	GAT(F)83-54C	C-103113	—		*	
87	GAT(F)83-66B	C-103116	—		*	All from Joan Fm., 3 km west of Section 2
88	GAT(F)83-66C	C-103117	—		*	
89	GAT(F)83-66D	C-103118	83091		*	
90	GAS(F)83-106C	C-88231	83083		*	

West end of anticline

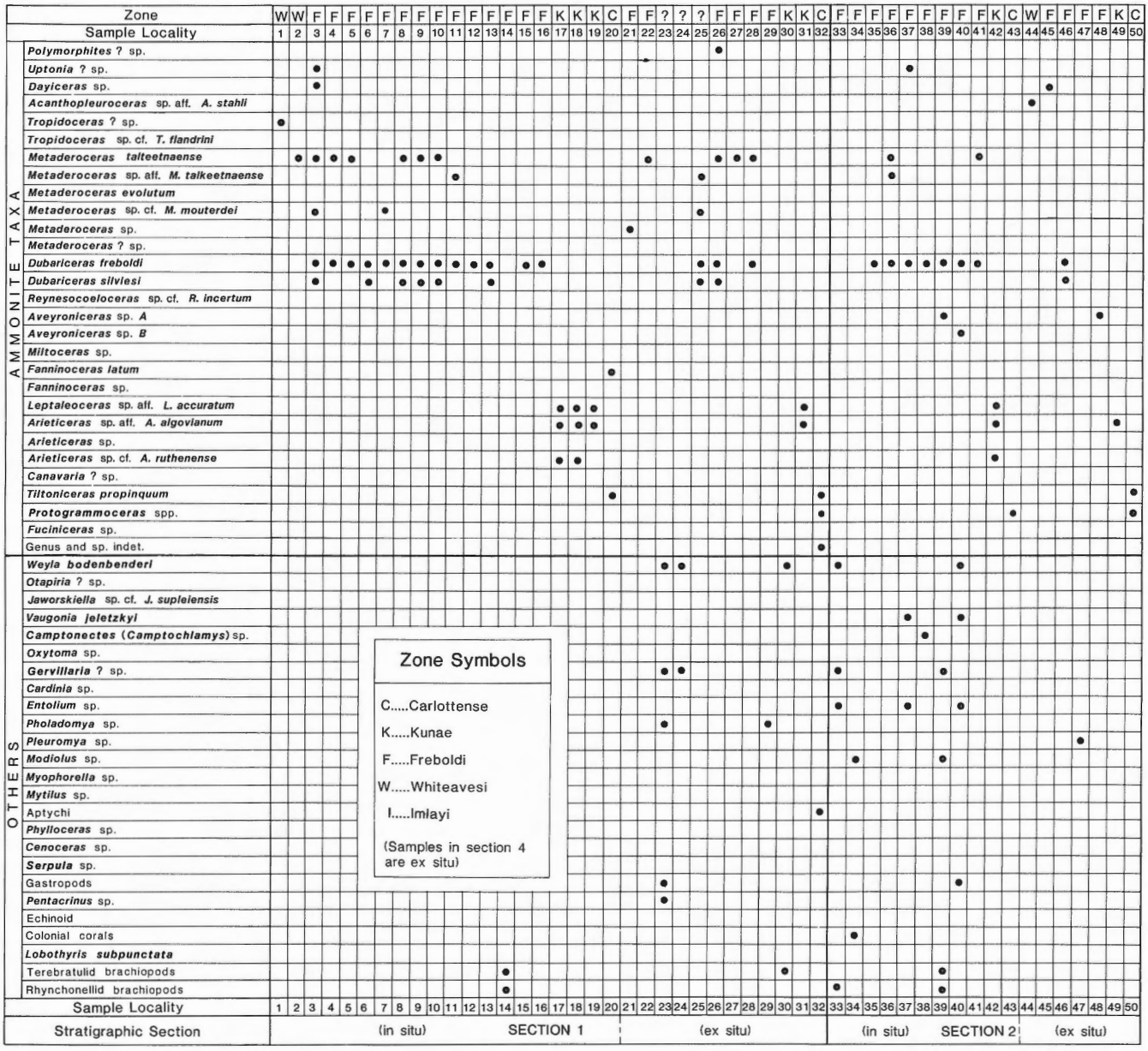
The following localities were found to the west of the westernmost exposure of volcanic rocks in the map area. See Figure 12 for exact positions.

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
91	GAT(F)83-123A	C-103221		*		Lower Pliensbachian inliers, 9 km WNW of Joan Lake
92	GAT(F)83-123B	C-103222	83062	*		

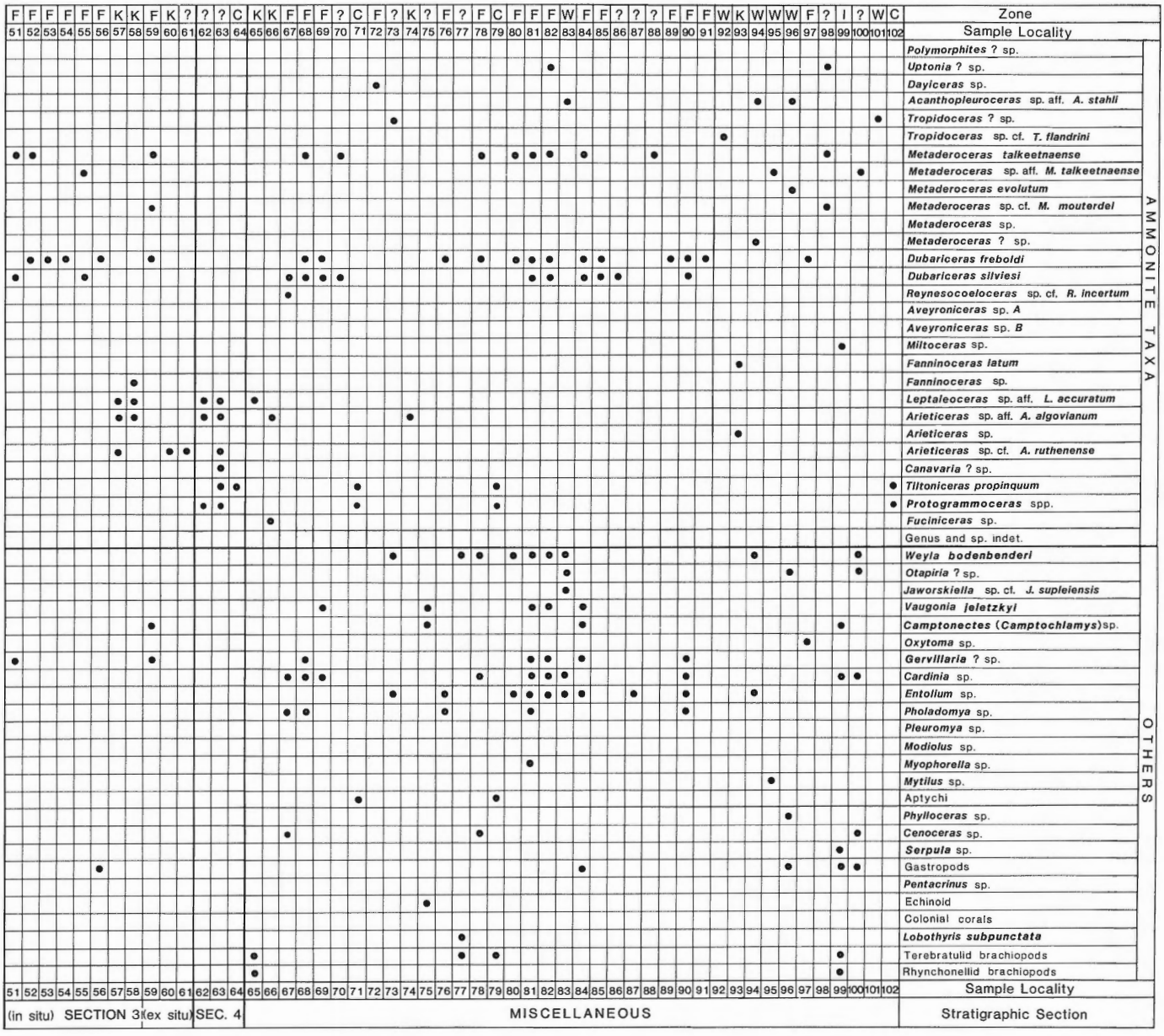
More miscellaneous localities

Locality	Field no.	GSC loc. no.	GSC type no.	in situ	ex situ	Comments
93	GAO(F)83-7B	C-103067	83104	*		Spatsizi Gp. NW of Joan Lake; lat. 57°32′10″W, long. 129°00′50″N
94	GAE85-73	C-117277	83075		*	NE of Nation Pk., Cold Fish vol.; lat. 57°40′00″W, long. 128°51′45″N
95	GAE85-78	C-117276	83071	*		NE of Nation Pk., Cold Fish vol.; lat. 57°40′15″W, long. 128°50′25″N
96	—	C-81970	83061, 83076, 83077, 84907	*		SW of Black Fox Lake; lat. 57°42′00″W, long. 128°55′00″N
97	83TD-38F	C-103412	84897	*		SW of Bug Lake, Cold Fish vol.; lat. 57°43′31″W, long. 128°59′00″N
98	85GA-13F	C-117206	83080	*		W of N end of Cold Fish Lake, Cold Fish vol.; lat. 57°41′00″W, long. 129°02′30″N
99	GAO(F)83-2	C-103052	83094, 83095, 83096, 83097, 84959	*		East of Mt. Cartmel, Cold Fish vol.; Black Fox Lake; lat. 57°43′40″W, long. 129°09′40″N
100	GAO(F)83-4B	C-103056	83072	*		As in 99, slightly upsection; lat. 57°43′30″W, long. 129°10′30″N
101	83TD-8F	C-103429	—		*	As in 99 and 100; lat. 57°43′11″W, long. 129°10′24″N
102	PLS83-29	C-103174	84884, 84885	*		Cold Fish vol.; S of Klappan/Stikine Junc.; lat. 57°51′29″W, long. 129°34′15″N
103	GAT(f)83-126A	C-103225	—		*	From Toarcian rocks at Sec. 4; lat. 57°35′00″W, long. 128°51′50″N

APPENDIX 2



Appendix Figure 1. Distribution of species at Pliensbachian fossil localities in the Spatsizi area. See also Figures 7-10 and 12.



Appendix Figure 1. cont'd

PLATE 1

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. *Weyla bodenbenderi* (Behrendsen, 1891)

Hypotype GSC 84889, lateral view. Joan Formation. GSC loc. C-90909 (locality 33, this report).

Figures 2–4. *Jaworskiella* sp. cf. *J. supleiensis* Poulton, 1979

2. Figured specimen GSC 84890 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

3. Figured specimen GSC 84891 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

4. Figured specimen GSC 84892 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

Figures 5–7. *Vaugonia jeletzkyi* Poulton, 1976

5. Hypotype GSC 84893 (latex cast), lateral view. Joan Formation. GSC loc. C-90925 (locality 81, this report).

6. Hypotype GSC 84894 (latex cast), lateral view. Joan Formation. GSC loc. C-90925 (locality 81, this report).

7. Hypotype GSC 84895 (latex cast), lateral view. Joan Formation. GSC loc. C-90925 (locality 81, this report).

Figure 8. *Gervillaria*? sp.

Figured specimen GSC 84898, Joan Formation. GSC loc. C-103104 (locality 51, this report).

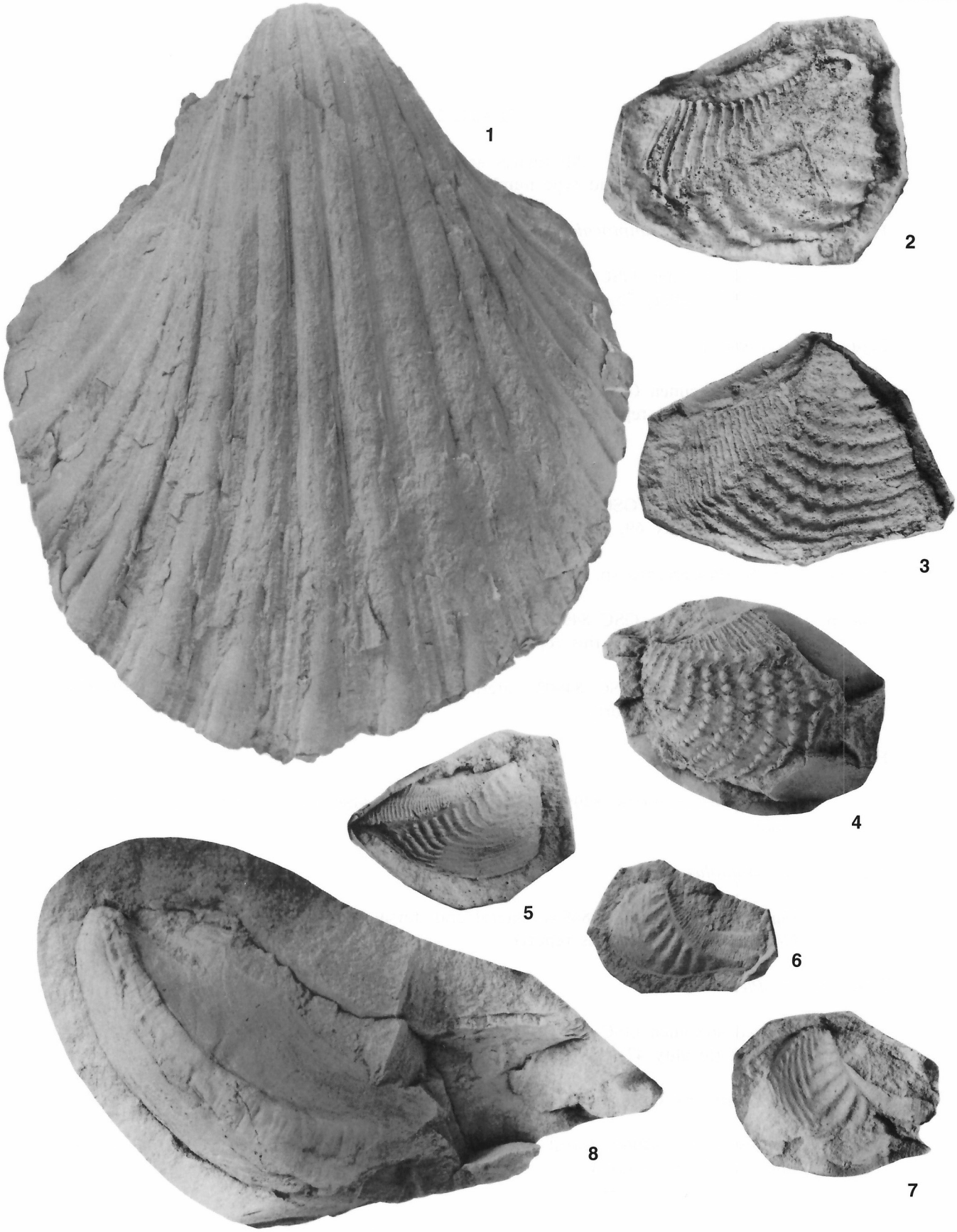

1
2
3
4
5
6
7
8

PLATE 2

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. *Camptonectes (Camptochlamys)* sp.

Figured specimen GSC 84896 (latex cast), lateral view. Joan Formation. GSC loc. C-103097 (locality 75, this report).

Figure 2. *Oxytoma* sp.

Figured specimen GSC 84897, lateral view. Cold Fish volcanics. GSC loc. C-103412 (locality 97, this report).

Figure 3. *Cardinia* sp.

Figured specimen GSC 84899 (latex cast), lateral view. Joan Formation. GSC loc. C-90524 (locality 69, this report).

Figures 4a, b, 5. *Pholadomya* sp.

4a, b. Figured specimen GSC 84901, lateral and dorsal views. Joan Formation. GSC loc. C-103069 (locality 76, this report).

5. Figured specimen GSC 84902, lateral view. Joan Formation. GSC loc. C-103323 (locality 29, this report).

Figure 6. *Serpula* sp.

Figured specimen GSC 84959, Cold Fish volcanics. GSC loc. C-103052 (locality 99, this report).

Figure 7a, b. *Modiolus* sp.

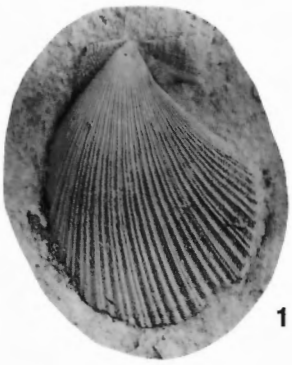
Figured specimen GSC 84904, lateral and dorsal views. Joan Formation. GSC loc. C-90828 (locality 34, this report).

Figure 8a, b. *Pleuromya* sp.

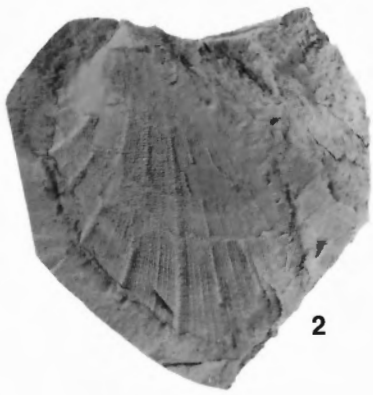
Figured specimen GSC 84903, lateral and dorsal views. Joan Formation. GSC loc. C-90922 (locality 47, this report).

Figure 9a, b. *Lobothyris subpunctata* (Davidson, 1851)

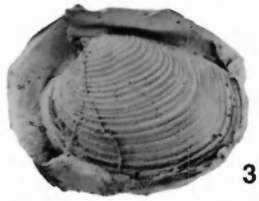
Hypotype GSC 84960, dorsal and lateral views. Joan Formation. GSC loc. C-103070 (locality 77, this report).



1



2



3

4a

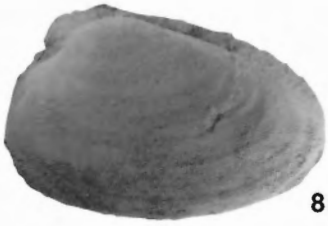
4b

5

6

7a

7b



8a

8b

9a

9b

PLATE 3

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. *Cenoceras* sp.

Figured specimen GSC 84908, lateral view. Joan Formation. GSC loc. C-90527 (locality 67, this report).

Figures 2, 4. Aptychi

2. Figured specimen GSC 84905, Wolf Den Formation. GSC loc. C-118682 (locality 71, this report).

4. Figured specimen GSC 84906, Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

Figure 3a–c. *Zeilleria* (*Cincta*) *numismalis* (Lamarck)

Hypotype GSC 98571, dorsal, anterior and lateral views. Joan Formation. GSC loc. C-103070 (locality 77, this report).

Figure 5a, b. *Phylloceras* sp.

Figured specimen GSC 84907, Cold Fish volcanics. GSC loc. C-81970 (locality 96, this report).

1

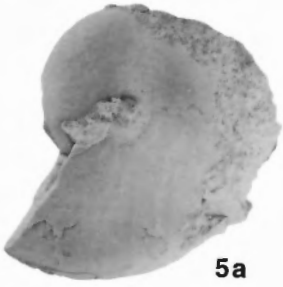
2

3a

3b

3c

4



5a

5b

PLATE 4

All figures are natural size, unless otherwise indicated.
Locality and type numbers are listed in Appendix 1.

Figures 1, 2. *Uptonia*? sp.

1. Figured specimen GSC 83055, 1a, lateral view; 1b, lateral view (x2); 1c, ventral view (x2). Joan Formation. GSC loc. C-90926 (locality 82, this report).

2. Figured specimen GSC 83056, 2a, lateral view of latex cast; 2b, lateral view of whorl fragment; 2c, ventral view of whorl fragment; 2d, lateral view of latex cast (x2); 2e, lateral view of whorl fragment (x2); 2f, ventral view of whorl fragment (x2). Joan Formation. GSC loc. C-90843 (locality 3, this report).

Figures 3–5. *Dayiceras* sp.

3. Figured specimen GSC 98572, 3a, lateral view; 3b, ventral view; 3c, lateral view (x2); 3d, ventral view (x2). Joan Formation (locality 45, this report).

4. Figured specimen GSC 83057, 4a, lateral view (x2); 4b, ventral view (x2). Joan Formation. GSC loc. C-90843 (locality 3, this report).

5. Figured specimen GSC 98573, 5a, lateral view of latex cast; 5b, ventral view of latex cast; 5c, lateral view (x2); 5d, ventral view (x2). Joan Formation (locality 72, this report).

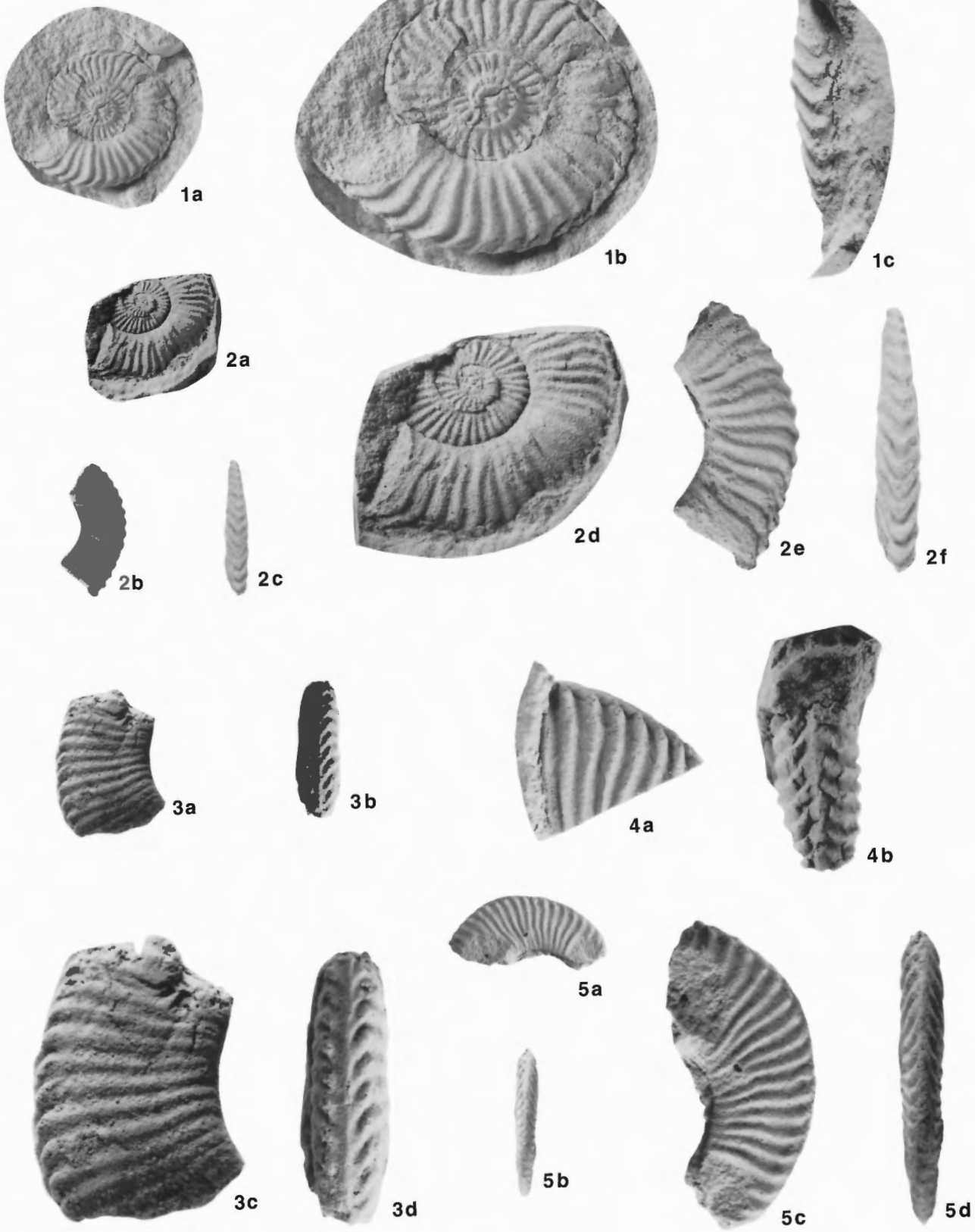

1a
1b
1c
2a
2b
2c
2d
2e
2f
3a
3b
4a
4b
3c
3d
5a
5b
5c
5d

PLATE 5

All figures are natural size, unless otherwise indicated.
Locality and type numbers are listed in Appendix 1.

Figures 1–4. *Acanthopleuroceras* sp. aff. *A. stahli* (Oppel, 1853)

1. Figured specimen GSC 83058 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

2. Figured specimen GSC 83059 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

3. Figured specimen GSC 83060 (latex cast), lateral view. Joan Formation. GSC loc. C-90930 (locality 83, this report).

4. Figured specimen GSC 83061, 4a, lateral view; 4b, ventral view. Cold Fish volcanics. GSC loc. C-81970 (locality 96, this report).

Figure 5a, b. *Tropidoceras* sp. cf. *T. flandrini* (Dumortier, 1869)

Figured specimen GSC 83062, 5a, ventral view; 5b, lateral view. Joan Formation. GSC loc. C-103222 (locality 92, this report).

Figures 6, 7. *Tropidoceras*? sp.

6. Figured specimen GSC 83064 (latex cast), lateral view. ?Joan Formation. GSC loc. C-103311 (locality 73, this report).

7. Figured specimen GSC 83063 (latex cast), lateral view. Joan Formation. GSC loc. C-103304 (locality 1, this report).

1

2

3

4a

4b

5b

5a

6

7

PLATE 6

Figure is natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. *Metaderoceras talkeetnaense* n. sp.

Hypotype GSC 83065 (latex cast), lateral view. Joan Formation. GSC loc. C-90839 (locality 22, this report).

1

PLATE 7

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–5. *Metaderoceras talkeetnaense* n. sp.

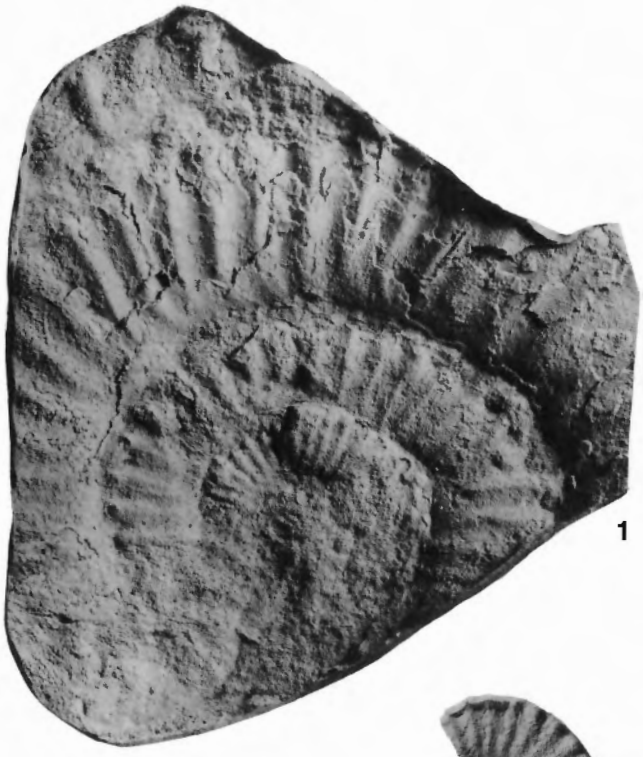
1. Hypotype GSC 83066 (latex cast), lateral view. Joan Formation. GSC loc. C-103104 (locality 51, this report).

2. Hypotype GSC 83067, lateral view. Joan Formation. GSC loc. C-103305(a) (locality 2, this report).

3. Hypotype GSC 83070, 3a, lateral view; 3b, ventral view. Joan Formation. GSC loc. C-90823 (locality 70, this report).

4. Hypotype GSC 83068 (latex cast), lateral view. Joan Formation. GSC loc. C-103305 (locality 2, this report).

5. Hypotype GSC 83069, 5a, lateral view; 5b, ventral view. Joan Formation. GSC loc. C-90823 (locality 70, this report).



1

2

3a

3b

4

5a

5b

PLATE 8

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–3. *Metaderoceras* sp. aff. *M. talkeetnaense* n. sp.

1. Figured specimen GSC 83071 (latex cast), lateral view. Cold Fish volcanics. GSC loc. C-117276 (locality 95, this report).

2. Figured specimen GSC 83072, lateral view. Cold Fish volcanics. GSC loc. C-103056 (locality 100, this report).

3. Figured specimen GSC 83073, lateral view. Joan Formation. GSC loc. C-103307 (locality 25, this report).

Figure 4. *Metaderoceras* sp.

Figured specimen GSC 83074 (latex cast), lateral view. Joan Formation. GSC loc. C-103303 (locality 21, this report).

Figure 5. *Metaderoceras*? sp.

Figured specimen GSC 83075, 5a, ventral view of outer whorl; 5b, lateral view; 5c, ventral view of inner whorl. Cold Fish volcanics. GSC loc. C-117277 (locality 94, this report).

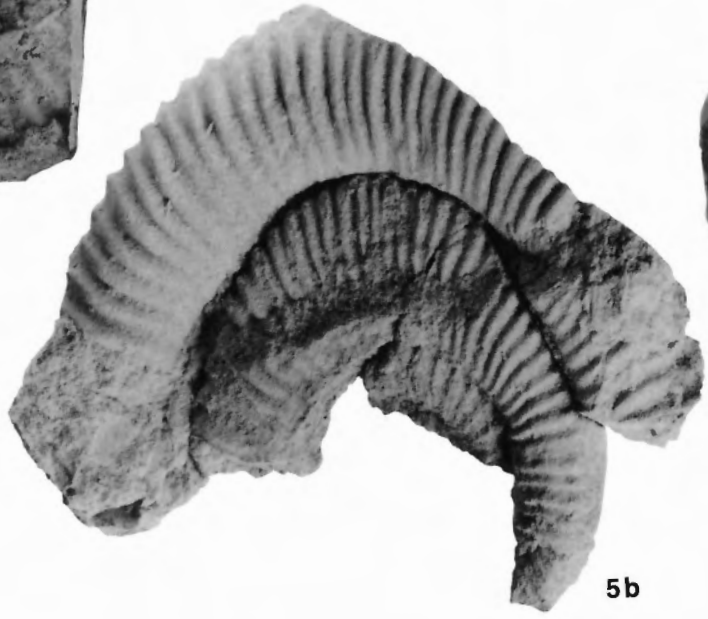
1

2

3

4

5a



5b

5c

PLATE 9

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–4. *Metaderoceras* sp. cf. *M. mouterdei* (Frebold, 1970)

1. Figured specimen GSC 83078, 1a, lateral view of latex cast; 1b, lateral view of whorl fragment; 1c, ventral view of whorl fragment. Joan Formation. GSC loc. C-90843 (locality 3, this report).

2. Figured specimen GSC 83079, 2a, lateral view of latex cast; 2b, lateral view of whorl fragment; 2c, ventral view of whorl fragment. Joan Formation. GSC loc. C-103307 (locality 25, this report).

3. Figured specimen GSC 83080, lateral view. Cold Fish volcanics. GSC loc. C-117206 (locality 98, this report).

4. Figured specimen GSC 83081 (latex cast), lateral view. Joan Formation. GSC loc. C-103309 (locality 7, this report).

Figures 5, 6. *Metaderoceras evolutum* (Fucini, 1921)

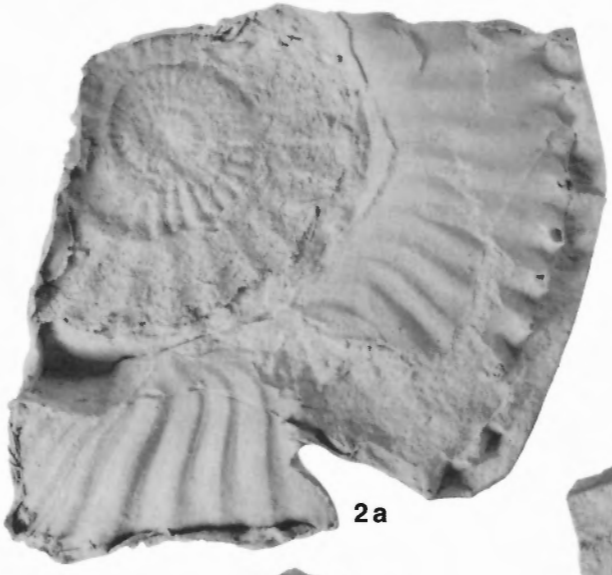
5. Hypotype GSC 83076, lateral view. Cold Fish volcanics. GSC loc. C-81970 (locality 96, this report).

6. Hypotype GSC 83077, 6a, lateral view; 6b, ventral view. Cold Fish volcanics. GSC loc. C-81970 (locality 96, this report).

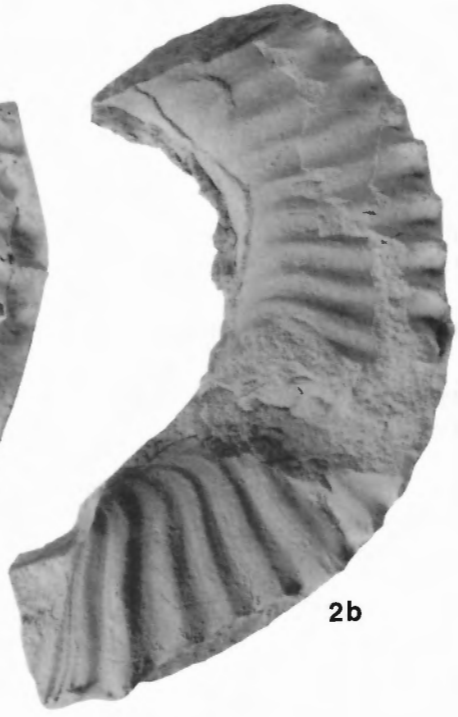
1a

1b

1c



2a



2b

2c

3

4

5

6a

6b

PLATE 10

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. *Metaderoceras* sp. cf. *M. mouterdei* (Frebold, 1970)

Figured specimen GSC 83082 (latex cast), lateral view. Joan Formation. GSC loc. C-103114 (locality 59, this report).

Figures 2–5. *Dubariceras silviesi* (Hertlein, 1925)

2. Hypotype GSC 83084, lateral view. Joan Formation. GSC loc. C-90902 (locality 84, this report).

3. Hypotype GSC 83083 (latex cast), lateral view. Joan Formation. GSC loc. C-88231 (locality 90, this report).

4. Hypotype GSC 83085 (latex cast), lateral view. Joan Formation. GSC loc. C-90926 (locality 82, this report).

5. Hypotype GSC 83086 (latex cast), lateral view. Joan Formation. GSC loc. C-103310 (locality 9, this report).

1

2

3

4

5

PLATE 11

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–7. *Dubariceras freboldi* Dommergues, Mouterde, and Rivas, 1984

1. Hypotype GSC 83090, 1a, lateral view of latex cast; 1b, lateral view of whorl fragment; 1c, ventral view of whorl fragment. Joan Formation. GSC loc. C-103324 (locality 13, this report).

2. Hypotype GSC 83087, lateral view. Joan Formation. GSC loc. C-90832 (locality 37, this report).

3. Hypotype GSC 83088 (latex cast), lateral view. Joan Formation. GSC loc. C-90830 (locality 36, this report).

4. Hypotype GSC 83089 (latex cast), lateral view. Joan Formation. GSC loc. C-103114 (locality 59, this report).

5. Hypotype GSC 83091, 5a, lateral view; 5b, ventral view of outer whorl; 5c, ventral view of inner whorl. Joan Formation. GSC loc. C-103118 (locality 89, this report).

6. Hypotype GSC 83092 (latex cast), lateral view. Joan Formation. GSC loc. C-90836 (locality 41, this report).

7. Hypotype GSC 83093, 7a, lateral view; 7b, ventral view. Joan Formation. GSC loc. C-90836 (locality 41, this report).

1a

1b

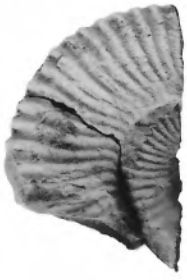
1c

2

3

4

6



5a

5b

5c

7a

7b

PLATE 12

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–4. *Miltoceras* sp.

1. Figured specimen GSC 83094 (latex cast), lateral view. Cold Fish volcanics. GSC loc. C-103052 (locality 99, this report).

2. Figured specimen GSC 83095 (latex cast), lateral view. Cold Fish volcanics. GSC loc. C-103052 (locality 99, this report).

3. Figured specimen GSC 83096 (latex cast), lateral view. Cold Fish volcanics. GSC loc. C-103052 (locality 99, this report).

4. Figured specimen GSC 83097, ventral view. Cold Fish volcanics. GSC loc. C-103052 (locality 99, this report).

Figure 5. *Polymorphites*? sp.

Figured specimen GSC 83102, lateral view. Joan Formation. GSC loc. C-103306 (locality 26, this report).

Figure 6. *Reynesocoeloceras* sp. cf. *R. incertum* (Fucini, 1905)

Figured specimen GSC 83098, 6a, lateral view; 6b, ventral view. Joan Formation. GSC loc. C-90527 (locality 67, this report).

Figures 7, 8. *Aveyroniceras* sp. A

7. Figured specimen GSC 83099, 7a, ventral view of whorl fragment; 7b, lateral view of latex cast. Joan Formation. GSC loc. C-90834 (locality 39, this report).

8. Figured specimen GSC 83100, lateral view. Joan Formation. GSC loc. C-90837 (locality 48, this report).

Figure 9. *Aveyroniceras* sp. B

Figured specimen GSC 83101 (latex cast), lateral view. Joan Formation. GSC loc. C-90835 (locality 40, this report).

Figures 10, 11. *Fanninoceras latum* McLearn, 1930

10. Hypotype GSC 83103 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103203 (locality 20, this report).

11. Hypotype GSC 83104 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103067 (locality 93, this report).

Figure 12. *Fanninoceras* sp.

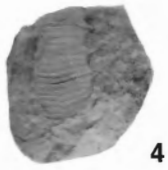
Figured specimen GSC 83105, lateral view. Wolf Den Formation. GSC loc. C-90515(f) (locality 58, this report).

1

2

5

3



4

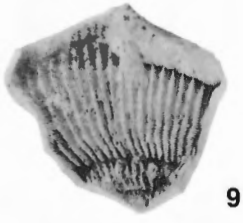
6a

6b

7a

7b

8



9

10

11

12

PLATE 13

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–6. *Leptaleoceras* sp. aff. *L. accuratum* (Fucini, 1931)

1. Figured specimen GSC 83106 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103332 (locality 18, this report).

2. Figured specimen GSC 83107, lateral view. Wolf Den Formation. GSC loc. C-90515 (locality 58, this report).

3. Figured specimen GSC 83108, lateral view. Wolf Den Formation. GSC loc. C-90515 (locality 58, this report).

4. Figured specimen GSC 83109 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103332 (locality 18, this report).

5. Figured specimen GSC 83110 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103224 (locality 63, this report).

6. Figured specimen GSC 83111, lateral view. Wolf Den Formation. GSC loc. C-90515 (locality 58, this report).

Figure 7. *Fuciniceras* sp.

Figured specimen GSC 83112 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-90526 (locality 66, this report).

1

2

3

4

5

6

7

PLATE 14

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1–7. *Arieticeras* sp. aff. *A. algovianum* (Oppel, 1862)

1. Figured specimen GSC 83113 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103111 (locality 57, this report).

2. Figured specimen GSC 83114 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103328 (locality 17, this report).

3. Figured specimen GSC 83115 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-90509 (locality 74, this report).

4. Figured specimen GSC 83116 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103223 (locality 62, this report).

5. Figured specimen GSC 83117 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103223 (locality 62, this report).

6. Figured specimen GSC 83118, lateral view. Wolf Den Formation. GSC loc. C-90509 (locality 74, this report).

7. Figured specimen GSC 83119, 7a, lateral view; 7b, ventral view. Wolf Den Formation. GSC loc. C-90515 (locality 58, this report).

1

2

3

4

5

6

7a

7b

PLATE 15

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figures 1, 2. *Arieticeras* sp. cf. *A. ruthenense* (Reynès, 1868)

1. Figured specimen GSC 83120 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103110 (locality 60, this report).

2. Figured specimen GSC 83121 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103120 (locality 61, this report).

Figure 3. *Canavaria*? sp.

Figured specimen GSC 83122 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103224 (locality 63, this report).

Figures 4–9. *Tiltoniceras propinquum* (Whiteaves, 1884)

4. Hypotype GSC 84877 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103224 (locality 63, this report).

5. Hypotype GSC 84878 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

6. Hypotype GSC 84879 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

7. Hypotype GSC 84880 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103203 (locality 20, this report).

8. Hypotype GSC 84881 (latex cast), lateral view. Note occurrence with *Protogrammoceras* sp. cf. *P. paltum*. Wolf Den Formation. GSC loc. C-103224 (locality 63, this report).

9. Hypotype GSC 84882 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

1

2

3

4

5

6

7

8

9

PLATE 16

All figures are natural size.
Locality and type numbers are listed in Appendix 1.

Figure 1. Genus and species indet.

Figured specimen GSC 84883 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

Figures 2–6. *Protogrammoceras* spp. (Buckman, 1922)

2. Figured specimen GSC 84884 (latex cast), lateral view. ?Wolf Den Formation. GSC loc. C-103174 (locality 102, this report).

3. Figured specimen GSC 84885 (latex cast), lateral view. ?Wolf Den Formation. GSC loc. C-103174 (locality 102, this report).

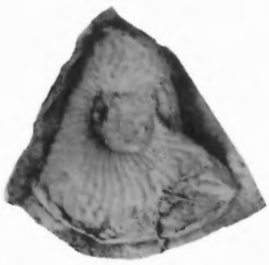
4. Figured specimen GSC 84886 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

5. Figured specimen GSC 84887, lateral view. Wolf Den Formation. GSC loc. C-103204 (locality 32, this report).

6. Figured specimen GSC 84888 (latex cast), lateral view. Wolf Den Formation. GSC loc. C-118682 (locality 71, this report).

1

2



3

4

5

6