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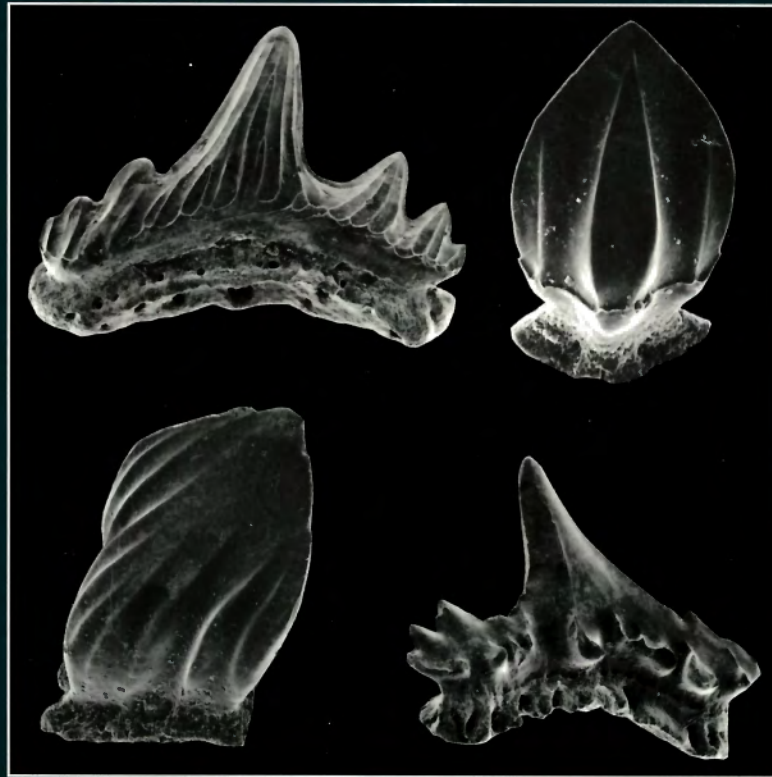
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GEOLOGICAL SURVEY OF CANADA  
BULLETIN 502

**TAXONOMY AND BIOSTRATIGRAPHY  
OF MIDDLE AND LATE TRIASSIC  
ELASMOBRANCH ICTHYOLITHS FROM  
NORTHEASTERN BRITISH COLUMBIA**

M.J. Johns, C.R. Barnes, and M.J. Orchard



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#### **Cover illustration**

Teeth and scales of new species of Middle Norian and Late Carnian elasmobranchs from northeastern British Columbia: *Synechodus incrementum* n. sp. (Pl. 4, fig. 3), *Fragilicorona labricuspis* n. sp. s.f. (Pl. 23, fig. 3), *Labascicorona mediflexura* n. sp. s.f. (Pl. 21, fig. 9), and *Synechodus multinodosus* n. sp. (Pl. 8, fig. 3).

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## Preface

For the first time in Canada, Middle and Late Triassic fish teeth and scales (ichthyoliths) are extensively described and illustrated. The ichthyoliths include 7 species of teeth (4 new species), and 53 new form species of scales (19 new form genera). New approaches to ichthyolith identification are addressed and binomial, form, and utilitarian taxonomic systems are applied.

The fish teeth and scales were recovered from sedimentary rocks of the Liard, Baldonnel, Ludington, and Pardonet formations (Ladinian, Carnian, and Norian) of northeastern British Columbia.

The strata on the surface and in the subsurface in this region are part of comprehensive Triassic reference sections in the Canadian Cordillera where biostratigraphic control has been established from studies of conodonts, ammonoids, and bivalves. Samples of known age were required for this study so that ranges of the ichthyoliths could be recognized to build a zonation.

Interest in the northeastern British Columbia Triassic has grown with recent exploration and assessment of the rocks for their hydrocarbon potential. Data and interpretations from the study of fish teeth and scales not only contribute more complete biostratigraphic information but initial results (not discussed herein) show that ichthyoliths can be indicators of basin thermal maturation.

M.D. Everell  
Assistant Deputy Minister  
Geological Survey of Canada

## Préface

Pour la première fois au Canada, des dents et des écailles de poissons (ichthyolithes) du Trias moyen et tardif sont décrits et illustrés de façon détaillée. Les ichthyolithes incluent 7 espèces de dents (4 nouvelles espèces) et 53 nouvelles espèces de formes d'écailles (19 nouveaux genres de formes). De nouvelles méthodes d'identification des ichthyolithes sont abordées et des systèmes taxonomiques faisant appel à la systématique binominale, à la taxonomie de formes et à un système d'identification utilitaire sont utilisés.

Les dents et les écailles de poissons ont été récoltées dans les roches sédimentaires des formations de Liard, de Baldonnel, de Ludington et de Pardonet (Ladinien, Carnien et Norien) dans le nord-est de la Colombie-Britannique.

Dans cette région de la Cordillère canadienne, les couches affleurantes et enfouies font partie de coupes de référence complètes du Trias où un bon contrôle biostratigraphique a été établi par l'étude des conodontes, des ammonoïdes et des bivalves. Des échantillons d'âge connu étaient nécessaires à cette étude de façon à ce que l'extension stratigraphique des ichthyolithes puisse être établie afin d'élaborer un schéma de zonation.

L'intérêt suscité par le Trias du nord-est de la Colombie-Britannique a été ravivé par les récents travaux d'exploration et d'évaluation des lithologies visant à déterminer leur potentiel pétrolifère et gazéifère. Les données et les interprétations résultant de l'étude des dents et des écailles de poissons contribuent non seulement à recueillir des informations biostratigraphiques plus poussées, mais les résultats initiaux (non traités dans la présente étude) montrent que les ichthyolithes peuvent être des indicateurs de maturation thermique des bassins.

M.D. Everell  
Sous-ministre adjoint  
Commission géologique du Canada



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# TAXONOMY AND BIOSTRATIGRAPHY OF MIDDLE AND LATE TRIASSIC ELASMOBRANCH ICHTHYOLITHS FROM NORTHEASTERN BRITISH COLUMBIA

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## *Abstract*

*Diverse and abundant Middle and Late Triassic elasmobranch ichthyoliths (microscopic shark teeth and scales) coexisting with conodonts, ammonoids, and bivalves were recovered from carbonates of the Pardonet, Baldonnel, Ludington, and Liard formations in the Peace River area of British Columbia. These faunas provide an excellent biostratigraphical framework for Triassic strata. Results from this study demonstrate that ichthyoliths can be used in basin analyses to date and correlate strata.*

*The following summarizes the main achievements of this project.*

- 1. Systematic description and illustration of Triassic elasmobranch ichthyoliths include seven species of teeth and nineteen new form genera and fifty-three new form species of scales.*
- 2. Ichthyolith distributions consist of distinct faunal assemblages for the Ladinian, Upper Carnian, and Middle Norian. The Carnian/Norian boundary is marked by the disappearance of many Ladinian and Carnian elasmobranch species. In the Middle Norian, elasmobranch faunas reached a new peak of diversity and abundance.*
- 3. A provisional ichthyolith zonation for the Middle and Upper Triassic is proposed for the Peace River area. The sequence of coeval conodonts and (or) ammonoids indicate that the Coniunctio aquirugosa ichthyolith Zone is Ladinian, the Synechodus multinodosus ichthyolith Zone is Upper Carnian, and the Synechodus incrementum ichthyolith Zone is Lower and Middle Norian.*
- 4. New approaches to ichthyolith identification include recognizing diagnostic characteristics of scale and tooth bases, and using binomial, form, and utilitarian taxonomic systems.*
- 5. Interpretations of histological and morphological features of elasmobranch teeth suggest that more derived neoselachian species than were originally known are present in the Triassic.*

## *Résumé*

*Divers et d'abondants ichthyolithes d'élasmobranches (dents et écailles de requins microscopiques) du Trias moyen et tardif coexistant avec des conodontes, des ammonoïdes et des bivalves ont été extraits de roches carbonatées des formations de Pardonet, de Baldonnel, de Ludington et de Liard dans la région de la rivière de la Paix en Colombie-Britannique. Les faunes récoltées permettent de dégager un excellent cadre biostratigraphique applicable aux couches du Trias. Les résultats de la présente étude montrent que les ichthyolithes peuvent servir, dans les analyses de bassin, à dater et à corrélérer les couches.*

*Voici un résumé des principales réalisations du présent projet :*

- 1. Description systématique et illustration des ichtyolithes d'élasmobranches du Trias incluant sept espèces de dents et dix-neuf nouveaux genres de formes et cinquante-trois espèces de formes d'écailles.*
- 2. Les ichtyolithes définissent des associations fauniques distinctes au sein des unités du Ladinien, du Carnien supérieur et du Norien moyen. La limite Carnien/Norien est marquée par la disparition de nombreuses espèces d'élasmobranches du Ladinien et du Carnien. Au Norien moyen, les faunes d'élasmobranches ont atteint un maximum de diversité et d'abondance.*
- 3. Une zonation provisoire des ichtyolithes du Trias moyen et supérieur est proposée pour la région de la rivière de la Paix. La séquence des conodontes et (ou) des ammonoïdes contemporains des ichtyolithes indique que la Zone à Coniunctio aquirugosa se situe au Ladinien, que la Zone à Synechodus multinodosus remonte au Carnien supérieur et que la Zone à Synechodus incrementum s'insère dans le Norien inférieur et moyen.*
- 4. De nouvelles méthodes d'identification des ichtyolithes ont été utilisées. Ces méthodes se fondent sur les caractéristiques diagnostiques de la base des écailles et des dents et sur l'application de la systématique binominale, de la taxonomie de formes et d'un système d'identification utilitaire.*
- 5. L'interprétation des caractéristiques histologiques et morphologiques des dents des élasmobranches indiquent qu'un plus grand nombre d'espèces dérivées de néosélachiens ont existé au Trias qu'on ne l'avait d'abord cru.*

## SUMMARY

Studies of Triassic ichthyoliths from British Columbia and Canada are few. This report discusses taxonomy and biostratigraphy of Middle to Late Triassic ichthyoliths from the Peace River-Williston Lake areas, northeastern British Columbia.

Ichthyoliths for this study were recovered from 167 limestone samples. The Triassic sedimentary rocks in the Peace River region consist of shelf, platform, and shoreline facies which were part of a North American western margin embayment. Productive formations include the Liard, Ludington, Baldonnel, and Pardonet (Ladinian, Carnian, and Norian).

Strata exposed on the surface and subsurface in the Peace River area are part of the most complete Triassic reference sections in the Canadian Cordillera. Stratigraphy and tectonics have been described by Gibson and Barclay (1989), Gibson and Edwards (1990), Gibson (1990, 1992a,b, 1993), and Thompson (1989). Excellent biostratigraphic control has been established from studies of conodonts, ammonoids, and bivalves (Orchard, 1983, 1991a,b,c; Tozer, 1961, 1963, 1965, 1979, 1982a, 1994). Since Triassic ichthyoliths are not well known, samples of known age provided data to recognize ranges of ichthyoliths and build an initial zonation.

Common and diverse Triassic elasmobranch ichthyoliths in the Peace River strata include distinct faunal assemblages for the Ladinian, Upper Carnian, and Middle Norian. Upper Carnian strata included some of the Ladinian ichthyolith faunas in addition to new taxa (e.g. *Synechodus multinodosus* n. sp.) with restricted ranges. Across the Carnian/Norian boundary and during the Lower Norian, most of the earlier elasmobranch species disappeared. In the Middle Norian, there evolved a new peak in diversity and abundance of elasmobranch faunas.

A provisional ichthyolith zonation is proposed for Ladinian, Carnian, and Norian strata. Three ichthyolith zones are designated as local range zone units.

The *Coniunctio aequirugosa* ichthyolith Zone fauna occurs in the Ladinian *Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones. Its base is currently not formally defined because older ichthyolith faunas have not yet been studied. The *C. aequirugosa* Zone is extremely diverse. It includes 4 elasmobranch teeth species, and all 26 of the truncate and 12 of the 28 elasmobranch tetrahedroid scale form species. *C. aequirugosa* n. sp. is abundant in the *M. maclearni* ammonoid Zone and last appears in the *F. sutherlandi* ammonoid Zone. The most abundant or common faunas in the zone include

## SOMMAIRE

Les études portant sur les ichthyolithes du Trias de la Colombie-Britannique et du Canada sont peu nombreuses. Le présent rapport traite de la taxonomie et de la biostratigraphie des ichthyolithes du Trias moyen et tardif dans la région de la rivière de la Paix et du lac Williston, dans le nord-est de la Colombie-Britannique.

Les ichthyolithes étudiés ont été extraits de 167 échantillons de calcaires. Dans la région de la rivière de la Paix, les roches sédimentaires du Trias se composent de faciès de plate-forme continentale, de plate-forme et de littoral déposés dans un rentrant de la marge ouest de l'Amérique du Nord. Les unités stratigraphiques riches en tels fossiles sont notamment les formations de Liard, de Ludington, de Baldonnel et de Pardonnet (Ladinien, Carnien et Norien).

Dans la région de la rivière de la Paix, les couches affleurantes et enfouies font partie des coupes de référence les plus complètes du Trias de la Cordillère canadienne. La stratigraphie et le style structural de cette région ont été décrits par Gibson et Barclay (1989), Gibson et Edwards (1990), Gibson (1990, 1992a, b, 1993) et Thompson (1989). Un excellent contrôle biostratigraphique a été établi à partir d'études sur les conodontes, les ammonoïdes et les bivalves (Orchard, 1983, 1991, a, b, c; Tozer, 1961, 1963, 1965, 1979, 1982a, 1994). Puisque les ichthyolithes triasiques ne sont pas bien connus, des échantillons d'âge connu ont permis d'établir l'extension stratigraphique des ichthyolithes et ainsi d'élaborer un schéma de zonation provisoire.

Les ichthyolithes d'élasmobranches du Trias, qui sont nombreux et diversifiés dans les couches de la région de la rivière de la Paix, définissent des associations fauniques distinctes au sein des unités chronostratigraphiques du Ladinien, du Carnien supérieur et du Norien moyen. Les couches du Carnien supérieur renferment certaines faunes d'ichthyolithes du Ladinien en plus de nouveaux taxons (p. ex. *Synechodus multinodosus* n. sp.) à extension stratigraphique limitée. En traversant la limite séparant le Carnien du Norien et dans l'intervalle de temps représenté par les couches du Norien inférieur, la plupart des espèces d'élasmobranches plus anciennes ont disparu. Au Norien moyen, la diversité et l'abondance des faunes d'élasmobranches ont connu un nouveau sommet.

Un schéma de zonation provisoire des ichthyolithes est proposé pour les couches du Ladinien, du Carnien et du Norien. Trois zones d'ichthyolithes ont été désignées comme zones d'extension locales.

La faune de la Zone d'ichthyolithes à *Coniunctio aequirugosa* se situe dans les zones d'ammonoïdes à *Maclearnoceras maclearni* et à *Frankites sutherlandi* du Ladinien. À l'heure actuelle, sa base n'est pas définie de façon formelle étant donné que les faunes d'ichthyolithes plus anciennes n'ont pas encore été étudiées. La Zone à *C. aequirugosa* affiche une grande diversité. Elle inclut 4 espèces de dents d'élasmobranches ainsi que les 26 espèces de formes d'écaillés tronquées et 12 des 28 espèces de formes d'écaillés tétraédriques d'élasmobranches. *C. aequirugosa* n. sp. est abondant dans la Zone d'ammonoïdes à *M. maclearni* et est présent pour la dernière fois dans la Zone d'ammonoïdes à *F. sutherlandi*. Les faunes les plus abondantes

elasmobranch scale new form genera *Coniunctio*, *Duplisuggestus*, and *Labrilancea*. In addition, *Undulaticorona profundifossae* n. sp. s.f. and *Labascicorona trifastigia* n. sp. s.f. are confined to the *M. maclearni* ammonoid Zone, and *Proprigalea medirugosa* n. sp. s.f., and *Suaviloquentia obliquilingua* n. sp. s.f. to both the *M. maclearni* and *F. sutherlandi* ammonoid zones.

An interval, wherein only a few samples were collected and rare ichthyoliths recovered, spans the Lower Carnian and the lowermost Upper Carnian. The strata of the Charlie Lake Formation in this unit are sandy, poorly fossiliferous, and characteristic of shallow water conditions (Gibson and Edwards, 1990; Gibson, 1992a).

The *Synechodus multinodosus* ichthyolith Zone in the Upper Carnian corresponds to the *Metapolygnathus nodosus* and *Metapolygnathus communisti* conodont zones, and the *Tropites welleri* and part of the *Klamathites macrolobatus* ammonoid zones. Near the base of this ichthyolith zone (Lower *M. nodosus* conodont Zone), *Acroodus?* sp. 1 first appears, and *Polyacrodus contrarius* n. sp. and *P. mediglabra* n. sp. s.f. disappear. The last and common appearance of *Acroodus?* sp. 1., and the first appearances of *S. multinodosus* n. sp. and *Synechodus cf. multinodosus* n. sp. occur within the Upper *M. nodosus* conodont Zone. *Labascicorona mediflexura* n. sp. s.f. was abundant to common throughout the *M. nodosus* conodont Zone. The last and abundant appearances of *S. multinodosus* n. sp. and *Glabrisubcorona?* sp. 1, and the first abundant and final appearance of *Minuticorona* n. gen. s.f. occur within the *M. communisti* conodont Zone.

The top of the *S. multinodosus* ichthyolith Zone corresponds with the *M. communisti*/Lower *Metapolygnathus primitius* conodont Zone boundary. This boundary marks a dramatic disappearance of twenty-eight elasmobranch taxa. Almost all of the Ladinian and Carnian elasmobranch taxa are gone with only a few passing into the Lower Norian.

The *S. incrementum* ichthyolith Zone occurs in the uppermost Upper Carnian, Lower Norian, and Middle Norian. Conodont zones in ascending order include: *M. primitius*, *Epigondolella quadrata*, *E. triangularis*, *E. multidentata*, *E. spiculata*, *E. elongata*, *E. postera*, and *E. serrulata*. These correspond to the ammonoid zones of the: *K. macrolobatus* (part), *Stikinoceras kerri*, *Malayites dawsoni*, *Juvavites magnus*, *Drepanites rutherfordi*, and *Mesohimavatites columbianus*. The *S. incrementum* ichthyolith Zone is characterized by rare elasmobranchs in the Lower Norian but includes several new taxa in the Middle Norian. The nominate ichthyolith species is particularly abundant in the middle of this zone within the *E. multidentata* conodont Zone.

ou les plus communes dans la zone sont les nouveaux genres de formes d'écaillés d'élasmobranches *Coniunctio*, *Duplisuggestus* et *Labrilancea*. De plus, *Undulaticorona profundifossae* n. sp. s.f. et *Labascicorona trifastigia* n. sp. s.f. sont confinés à la Zone d'ammonoïdes à *M. maclearni*, alors que *Proprigalea medirugosa* n. sp. s.f. et *Suaviloquentia obliquilingua* n. sp. s.f. le sont aux deux zones d'ammonoïdes à *M. maclearni* et à *F. sutherlandi*.

Un intervalle, dans lequel quelques échantillons seulement ont été prélevés et de rares ichthyolithes ont pu être extraits, s'étend du Carnien inférieur à la base du Carnien supérieur. Dans cette unité, les couches de la Formation de Charlie Lake sont gréseuses, peu fossilifères et témoignent de manière caractéristique d'un dépôt en milieu d'eau peu profonde (Gibson et Edwards, 1990; Gibson, 1992a).

La Zone d'ichthyolithes à *Synechodus multinodosus* dans le Carnien supérieur correspond aux zones de conodontes à *Metapolygnathus nodosus* et à *Metapolygnathus communisti* ainsi qu'à la Zone d'ammonoïdes à *Tropites welleri* et à une partie de la Zone d'ammonoïdes à *Klamathites macrolobatus*. Près de la base de cette zone d'ichthyolithes (la partie inférieure de la Zone de conodontes à *M. nodosus*), *Acroodus?* sp. 1 est présent pour la première fois et *Polyacrodus contrarius* n. sp. et *P. mediglabra* n. sp. s.f. disparaissent. La dernière présence en abondance de *Acroodus?* sp. 1. et la première présence de *S. multinodosus* n. sp. et *Synechodus cf. multinodosus* n. sp. se situent dans la partie supérieure de la Zone de conodontes à *M. nodosus*. *Labascicorona mediflexura* n. sp. s.f. était abondant à commun dans toute la Zone de conodontes à *M. nodosus*. La dernière présence en abondance de *S. multinodosus* n. sp. et *Glabrisubcorona?* sp.1 et la première présence en abondance et la dernière présence de *Minuticorona* n. gen. s.f. se situent dans la Zone de conodontes à *M. communisti*.

Le sommet de la Zone d'ichthyolithes à *S. multinodosus* correspond à la limite séparant la Zone de conodontes à *M. communisti* de la partie inférieure de la Zone de conodontes à *Metapolygnathus primitius*. Cette limite marque la disparition dramatique de vingt-huit taxons d'élasmobranches. Presque tous les taxons d'élasmobranches du Ladinien et du Carnien ont disparu, sauf quelques-uns qui ont subsisté et apparaissent dans le Norien inférieur.

La Zone d'ichthyolithes à *S. incrementum* est située dans la partie sommitale du Carnien supérieur, le Norien inférieur et le Norien moyen. Parmi les zones de conodontes, on reconnaît par ordre ascendant : *M. primitius*, *Epigondolella quadrata*, *E. triangularis*, *E. multidentata*, *E. spiculata*, *E. elongata*, *E. postera* et *E. serrulata*. Elles correspondent aux zones d'ammonoïdes suivantes : *K. macrolobatus* (en partie), *Stikinoceras kerri*, *Malayites dawsoni*, *Juvavites magnus*, *Drepanites rutherfordi* et *Mesohimavatites columbianus*. La Zone d'ichthyolithes à *S. incrementum* est caractérisée par la présence de rares élasmobranches dans le Norien inférieur mais inclut plusieurs nouveaux taxons dans le Norien moyen. L'espèce d'ichthyolithes qui donne son nom à la zone est particulièrement abondante dans la partie intermédiaire de celle-ci, au sein de la Zone de conodontes à *E. multidentata*.

Near the base of the *S. incrementum* ichthyolith Zone in the Lower Norian, *S. incrementum* n. sp., *Suaviloquentia longilingua* n. sp. s.f., *Fragilicorona labricuspis* n. sp. s.f., *Fragilicorona labribrevirostrum* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., *Glabrisubcorona arduidevexa* n. sp. s.f., *Glabrisubcorona tendibasis* n. sp. s.f., *Rugosicorona* n. gen. s.f., and *Carinasubcorona* n. gen. s.f. first appear. The Middle Norian is characterized by the greatest abundance and diversity of the Norian elasmobranchs. In the Lower *E. multidentata* conodont Zone, *Fragilicorona unicuspis* n. sp. s.f., *Fragilicorona labritricuspis* n. sp. s.f., *Ornatilabrilancea solicarina* n. sp. s.f., and *Complanicorona subrugosa* n. sp. s.f. first appear, and *S. longilingua* n. sp. s.f., *Lobaticorona floridibasis* n. sp. s.f., and *G. tendibasis* n. sp. s.f. are common. The Upper *E. multidentata* and the lowermost *E. spiculata* conodont zones include the last appearances of *S. incrementum* n. sp., *Lobaticorona floriditurris* n. sp. s.f., *L. floridibasis* n. sp. s.f., and *C. subrugosa* n. sp. s.f. The top of the *S. incrementum* ichthyolith Zone is characterized by the first and last common appearances of *Fragilicorona tricuspis* n. sp. s.f. and *Fragilicorona brevirostrum* n. sp. s.f. and final appearances of most of the remaining elasmobranch taxa. A single species, *S. longilingua* n. sp. s.f. was recovered from the Upper Norian.

Identification of ichthyoliths in this report was accomplished using three taxonomic methods: 1) the traditional Linnaean binomial system, 2) form taxonomy, and 3) a coded utilitarian system. The Linnaean system was used for elasmobranch teeth whenever identifications could be made through review of literature and specimens. Form taxonomy was adopted to identify disarticulated scales until the many different types (several of which could be found on a single fish) can be compared to articulated material. Type and subtype additions and revisions to the utilitarian code plus the code for each elasmobranch species are provided for future enhancement of a computer database. A new approach is applied to identify and describe Triassic elasmobranch scales (Johns, 1993, 1996). It recognizes and elevates the importance of diagnostic features of the scale pedicle in addition to integrating other diagnostic characters of the subcrown, crown position on the pedicle, and upper crown surface ornamentation.

Identification and description of new species of elasmobranch teeth in this study substantiate rather sparse previous evidence of neoselachian sharks in the Triassic. Acid etched sections of Peace River tooth crown enameloid of *Synechodus* species reveal parallel fibre layers with single crystallite layers above and sometimes visible haphazard layers below. The arrangement of these layers indicate the more advanced enameloid condition as seen in younger Mesozoic sharks (Jurassic and Cretaceous).

Près de la base de la Zone d'ichthyolithes à *S. incrementum* dans le Norien inférieur, les premiers taxons à apparaître sont *S. incrementum* n. sp., *Suaviloquentia longilingua* n. sp. s.f., *Fragilicorona labricuspis* n. sp. s.f., *Fragilicorona labribrevirostrum* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., *Glabrisubcorona arduidevexa* n. sp. s.f., *Glabrisubcorona tendibasis* n. sp. s.f., *Rugosicorona* n. gen. s.f. et *Carinasubcorona* n. gen. s.f. Le Norien moyen se caractérise par la plus grande abondance et la plus grande diversité d'élasmobranches noriens. Dans la partie inférieure de la Zone de conodontes à *E. multidentata*, les premiers taxons à apparaître sont *Fragilicorona unicuspis* n. sp. s.f., *Fragilicorona labritricuspis* n. sp. s.f., *Ornatilabrilancea solicarina* n. sp. s.f. et *Complanicorona subrugosa* n. sp. s.f.; alors que *S. longilingua* n. sp. s.f., *Lobaticorona floridibasis* n. sp. s.f. et *G. tendibasis* n. sp. s.f. sont communs. La partie supérieure de la Zone de conodontes à *E. multidentata* et la partie basale de la Zone de conodontes à *E. spiculata* contiennent les dernières présences de *S. incrementum* n. sp., *Lobaticorona floriditurris* n. sp. s.f., *L. floridibasis* n. sp. s.f. et *C. subrugosa* n. sp. s.f. Le sommet de la Zone d'ichthyolithes à *S. incrementum* est caractérisée par la première présence et la dernière présence en abondance de *Fragilicorona tricuspis* n. sp. s.f. et *Fragilicorona brevirostrum* n. sp. s.f. et les dernières présences de la plupart des autres taxons d'élasmobranches. Une seule espèce, *S. longilingua* n. sp. s.f. a été extraite du Norien supérieur.

L'identification des ichthyolithes dans le présent rapport a été réalisée en appliquant trois méthodes taxonomiques : 1) le système binominal classique introduit par Linné, 2) la taxonomie de formes et 3) un système utilitaire codé. Le système linnéen a été appliqué aux dents des élasmobranches lorsqu'une identification était possible par l'étude de la littérature scientifique et des spécimens. La taxonomie de formes a servi à identifier les écailles désarticulées jusqu'à ce que l'on puisse comparer les nombreux types différents (dont plusieurs peuvent se retrouver sur un seul poisson) à des matériaux articulés. Les ajouts et les révisions au niveau des types et des sous-types apportés au code utilitaire ainsi que le code de chaque espèce d'élasmobranches sont présentés dans le but éventuel d'augmenter le contenu d'une base de données informatisée. Pour identifier et décrire les écailles d'élasmobranches du Trias (Johns, 1993, 1996), une nouvelle méthode a été adoptée qui s'attarde plus particulièrement aux éléments diagnostiques du pédicule des écailles. Cette méthode, qui démontre l'importance de ces attributs dans le processus d'identification, intègre en outre les données à provenir de l'examen d'autres caractéristiques diagnostiques de la sous-couronne, de la position de la couronne sur le pédicule et de l'ornementation supérieure de la surface de la couronne.

L'identification et la description des nouvelles espèces de dents d'élasmobranches dans la présente étude corroborent les indices peu nombreux présentés antérieurement de l'existence de requins néosélachiens au Trias. Des coupes attaquées à l'acide de l'émail de couronnes de dents d'espèces du genre *Synechodus* provenant de la région de la rivière de la Paix révèlent l'existence de couches de fibres parallèles qui sont surmontées de couches uniques de cristallite et qui reposent parfois sur des couches de fibres nettement désordonnées. La



Seven species of elasmobranch teeth (four new species), and nineteen new form genera and fifty-three new form species of elasmobranch scales are described and illustrated. New species of elasmobranch teeth include: *Polyacrodus contrarius*, *Synechodus incrementum*, *Synechodus multinodosus*, and *Synechodus volaticus*. Species of elasmobranch teeth described in open nomenclature include *Acrodus?* sp. 1, and *Synechodus* sp. 1 and sp. 2. New elasmobranch scale form genera include: *Parviscaptha* (2 n. sp.), *Lobaticorona* (6 n. sp.), *Proprigalea* (3 n. sp.), *Undulaticorona* (2 n. sp.), *Parvidiabolus* (4 n. sp.), *Duplisuggestus* (2 n. sp.), *Coniunctio* (2 n. sp.), *Labascicorona* (5 n. sp.), *Rugosicorona* (1 n. sp.), *Gracilisuggestus* (2 n. sp.), *Fragilicorona* (6 n. sp.), *Labrilancea* (2 n. sp.), *Ornatilabrilancea* (2 n. sp.), *Minuticorona* (2 n. sp.), *Sacrisubcorona* (2 n. sp.), *Carinasubcorona* (1 n. sp.), *Glabrisubcorona* (3 n. sp., 1 open nomenclature), *Complanicorona* (3 n. sp.), and *Suaviloquentia* (3 n. sp.).

This study presents notable new information on the biostratigraphy and taxonomy of Triassic ichthyoliths. It provides a foundation for future work on Triassic elasmobranch scales which formerly have not been well documented. With this database, future work can test the strength of this Peace River zonation and determine faunal ranges more precisely.

Results of this study indicate that Triassic ichthyoliths have biostratigraphical utility.

## INTRODUCTION

Ichthyoliths are microscopic, disarticulated skeletal remains of fishes and include teeth, mucous membrane denticles, scales, and bones. Most fossil ichthyoliths are isolated, disarticulated specimens but occasionally they may be assembled such as tooth plates. Their main inorganic component is calcium phosphate (hydroxyapatite) (Ørving, 1967; Trautz, 1967).

The potential stratigraphic and paleoenvironmental value of ichthyoliths is great because they may be recovered from marine and nonmarine sediment lithologies, have a wide stratigraphic range (Upper Cambrian to Recent), occur in most pelagic sediments where other microfossils are few or absent (Helms and Riedel, 1971), and they are resistant to natural diagenetic and laboratory processes.

Ichthyoliths also provide useful information on the thermal maturation of sediments. Similar to conodonts, ichthyoliths show progressive and irreversible chemical and colour alteration in response to burial time and thermal conditions in sedimentary basins (Tway, 1982a, b; Tway et al., 1986; Johns et al., 1993a, b, 1995).

disposition de ces couches révèle que l'émail témoigne d'un état plus avancé semblable à celui rencontré chez les requins plus récents du Mésozoïque (Jurassique et Crétacé).

Sept espèces de dents d'élasmobranches (quatre nouvelles espèces) et dix-neuf nouveaux genres de formes et cinquante-trois nouvelles espèces de formes d'écaillés d'élasmobranches sont décrits et illustrés. Les nouvelles espèces de dents d'élasmobranches incluent : *Polyacrodus contrarius*, *Synechodus incrementum*, *Synechodus multinodosus* et *Synechodus volaticus*. Les espèces de dents d'élasmobranches décrites en nomenclature ouverte incluent *Acrodus?* sp. 1 et *Synechodus* sp. 1 et sp. 2. Les nouveaux genres de formes d'écaillés d'élasmobranches sont notamment : *Parviscaptha* (2 n. sp.), *Lobaticorona* (6 n. sp.), *Proprigalea* (3 n. sp.), *Undulaticorona* (2 n. sp.), *Parvidiabolus* (4 n. sp.), *Duplisuggestus* (2 n. sp.), *Coniunctio* (2 n. sp.), *Labascicorona* (5 n. sp.), *Rugosicorona* (1 n. sp.), *Gracilisuggestus* (2 n. sp.), *Fragilicorona* (6 n. sp.), *Labrilancea* (2 n. sp.), *Ornatilabrilancea* (2 n. sp.), *Minuticorona* (2 n. sp.), *Sacrisubcorona* (2 n. sp.), *Carinasubcorona* (1 n. sp.), *Glabrisubcorona* (3 n. sp., 1 nomenclature ouverte), *Complanicorona* (3 n. sp.) et *Suaviloquentia* (3 n. sp.).

Cette étude présente de nouvelles informations sur la biostratigraphie et la taxonomie des ichthyolithes du Trias. Elle jette la base sur laquelle pourront reposer les travaux futurs sur les écaillés d'élasmobranches du Trias, des fossiles qui jusqu'à ce jour n'avaient pas été bien documentés. Grâce à cette base de données, les travaux futurs permettront de mettre à l'épreuve la validité du schéma de zonation établi dans la région de la rivière de la Paix dans le cadre de la présente étude et de déterminer l'extension stratigraphique des faunes avec plus de précision.

Les résultats de l'étude démontrent que les ichthyolithes du Trias ont une utilité biostratigraphique certaine.

Another important feature of ichthyoliths is that their chemical composition allows for the concentration of rare-earth and trace elements (Wright et al., 1984). Ichthyolith geochemical studies may:

1. provide distinct chemical "signatures" for strata giving an alternative method of intra- and inter-basinal correlation (Wright et al., 1987);
2. enhance paleoenvironmental studies, e.g. by indicating anoxic oceanic conditions (Wright, 1982, 1985; Elderfield and Pagett, 1986); and
3. from study of neodymium and strontium isotopes, provide evidence on the timing and break-up of large land masses, age of exposed crustal material, and evolution of the crust (Shaw and Wasserburg, 1985).

The value of fossil ichthyoliths, especially in biostratigraphy, geothermometry, and paleoceanic environmental studies, has been much overlooked. This report addresses the first of the above topics. The main objectives were to:

1. systematically describe, illustrate, and identify Triassic ichthyoliths from the Peace River region;
2. develop and apply a Triassic ichthyolith identification system and description format;

3. develop a preliminary ichthyolith zonation; and
4. calibrate the Middle to Upper Triassic ichthyolith zonation with the conodont and ammonoid zonations in the Peace River region.

### **Methods**

One hundred and sixty-seven limestone samples were used in this study. In all cases, the ichthyoliths were recovered from concentrates prepared from conodont samples originally collected by M.J. Orchard and D.W. Gibson. In many of the sections, ammonoids were collected by T.E. Tozer and are correlated with conodont localities. The samples are from Triassic reference sections along the shores of Williston Lake, British Columbia and other nearby localities (Fig. 1).

Ichthyolith collections were selected on the basis of their diversity and position within established zones of conodonts, ammonoids, and bivalves. The position of samples within these zones and stratigraphic correlation of the sections are shown in Figure 2 (in pocket). McLearn (1960), Gibson (1990, 1992a, 1993), and Gibson and Edwards (1990), describe the lithology of strata at most of these localities. A locality register and detailed sample information are included in Appendices 1 and 2.

Conodonts and ichthyoliths were removed from the rocks by applying acetic acid and "acetate soup" (Jeppsson et al., 1985, p. 955) to approximately two kilograms of sample material, then sieving (1 mm, 75  $\mu$ m, and 63  $\mu$ m screens) and washing, and optionally magnetic separations, and heavy liquid separations using tetrabromoethane or sodium polytungstate (s.g. 2.81-3.00). Laboratory residues were hand-picked using a "000" camel-hair brush, picking tray, and a binocular microscope. Microfossils were mounted with water soluble glue (gum tragacanth) onto cardboard microslides.

Up to 200 specimens of each ichthyolith species or form were counted in each sample. Ichthyoliths are designated: rare (1-9 specimens), common (10-49 specimens), and abundant (50-199 specimens). In a few samples, counts of over 200 specimens/species or forms were observed. Very abundant implies 200-999 specimens, and extremely abundant implies greater than 1000 specimens.

A goal of this study was not to obtain specific abundance data but to arrive at an initial estimation of whether or not there were enough ichthyoliths in the samples to make adequate identifications and subsequently recognize and develop a biostratigraphic zonation. Exact counts of specimens are not appropriate because the range of variation in total numbers of ichthyoliths probably does not reflect true abundance. Some of the reasons that may account for variability in ichthyolith numbers are: their dilution by terrigenous clastic materials, their concentration in lag deposits, differential preservation, and sample preparation (samples were screened and only residues with grain size less than 1 mm were studied). In addition, determining the number of individuals or fishes from studying ichthyoliths would be a complex (if not an impossible) task. Teeth and scales may be numerous and variable on a single fish. Observations and more detailed description of teeth and scales on articulated specimens

would be essential to identify the types of fishes, determine their number, and recognize their distribution. Teeth and (or) scales also may be lost and replaced throughout the life of many fishes. The rate of this loss and replacement on fossil fishes is not well known.

Some broken ichthyolith specimens were selected for histological study. Each specimen was separately etched in 1-5% hydrochloric acid (HCl) for 5 to 60 seconds. The reaction was stopped sooner for small specimens (under 500  $\mu$ m) and those that effervesced rapidly. Each specimen was rinsed thoroughly in deionized water and then air dried.

Ichthyoliths were mounted with nail polish on aluminum stubs and coated with gold/palladium for observation and photography in a Cambridge Stereoscan S-100 scanning electron microscope (SEM). Specimens were photographed using Kodak Technical Pan and Polaroid #53 or #54 films. Photographs were cut and mounted on black or white matt board for illustration.

### **Repository**

Holotypes, paratypes, and figured specimens used in this study were removed from SEM stubs and mounted on cardboard micropaleontological slides with gum tragacanth. These specimens and some unfigured specimens are catalogued (GSC 105092 to GSC 105385) and stored at the National Type Collection of Invertebrate and Plant Fossils at the Geological Survey of Canada (GSC), 601 Booth Street, Ottawa, Ontario, K1A 0E8.

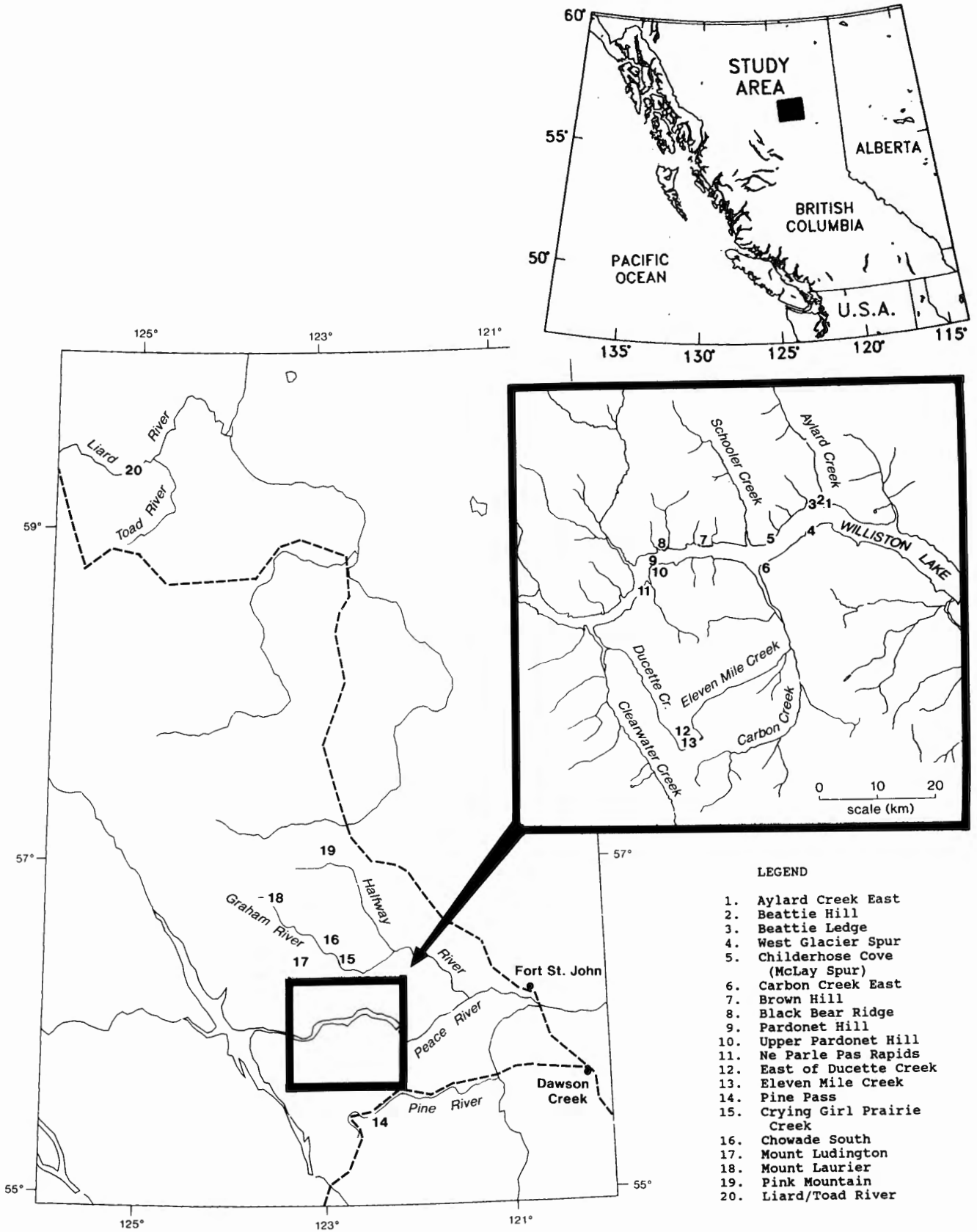
In addition, a registered GSC sample locality number (e.g. GSC loc. C-101064) is provided for each type specimen listed. GSC locality numbers with a C- prefix are registered at the GSC Calgary office. A GSC locality number is assigned for each microfossil sample that is collected at a different location. A microfossil sample may contain many faunal elements. The sample can be cross referenced for additional locality and sample information in Appendices 1 and 2.

### **Responsibilities**

Most of this work was part of M.J. Johns' MSc. thesis program at the University of Victoria. C.R. Barnes supervised the project providing suggestions, guidance, and extensive critical review of manuscript drafts throughout the project. In addition, he partially supported the project through his research grants. M.J. Orchard collected most field samples, and supplied all laboratory processed residues, some faunal slides, and all information on samples and conodonts in the study area. In addition, he provided comprehensive review of the manuscript.

### **Acknowledgments**

E.T. Tozer (GSC) provided invaluable advice, suggestions, and information on ammonoid zones and the geology of the Peace River area. In addition, D.W. Gibson collected some of the samples, interpreted the lithostratigraphy in the study area, and supplied Figure 3.



**Figure 1.** Index map illustrating important Middle and Upper Triassic outcrop localities in northeastern British Columbia.

Z. Ji picked most of the ichthyoliths and assisted with line drawing illustrations. Richard Franklin and Brian Sawyer are especially thanked for drafting and preparing Figures 1, 2, 4, 8 (part), and 13. F.H.C. O'Brien helped with the preparation and photography of ichthyolith thin sections. R. Sielecki spent hours in the darkroom printing many of the ichthyolith images seen in the plates.

V. Tunnicliffe, P.L. Smith, and E. Richards assisted with the Latinization of the new ichthyolith genera and species names. Many interlibrary loans were required, some of which were requests for very old literature. The interlibrary loan staff at the GSC, Cordilleran Division (M. Akehurst and F. Hwang); University of Victoria (C. Churchill, K. Carter, J. Horner, and A. Tulloch); and the Institute of Ocean Sciences (S. Thomson) diligently and cheerfully obtained all literature requested.

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## STRATIGRAPHY

*M.J. Johns, C.R. Barnes, and M.J. Orchard*

### *Previous work, Peace River area*

Geological and paleontological studies in the Peace River region date back to the 1870s. A.R.C. Selwyn, the second Director of the GSC, crossed the Rockies by way of the Peace River en route to the Pacific coast. On his return journey in 1875, he found *Monotis* (a bivalve typical of the Late Triassic) near Ne Parle Pas Rapids on the Peace River and became the first to prove Triassic rocks were present in the Canadian Cordillera (Tozer, 1984).

F.H. McLearn (1919, 1921, 1930, 1937, 1940, and 1947) was the first to study the Peace River Triassic strata. He made detailed lithological descriptions and comprehensive fossil collections at Brown Hill, Pardonet Hill, and Black Bear Ridge. From collections at these localities he recognized several ammonoid genera previously known only from Europe (Tozer, 1984). The best summary of his work in the Peace River area is condensed in McLearn (1960).

With the building of the Alaska Highway in the early 1940s, northeastern British Columbia was opened for further geological exploration, particularly along road cuts. Important ammonoid collections were made by E.D. Kindle, C.O. Hage, M.Y. Williams, and others (Tozer, 1984).

The nature of the Peace River valley was drastically changed in 1967 with the completion of the W.A.C. Bennett Dam. Williston Lake, a giant reservoir, submerged many of the fossil ammonoid and *Monotis* beds (Tozer, 1984). However, new exposures were later uncovered and kept free of plant growth by rising and falling water levels from industrial use of water in the dammed lake.

Stratigraphic revisions and mapping of new areas in the Peace River area were published by Hunt and Ratcliffe (1959), Colquhoun (1962), Irish (1962, 1970), and Pelletier (1963, 1964). D. Gibson most recently refined the Peace region stratigraphy (1970, 1971a, b, 1975, 1990, 1992a, b, 1993; Gibson and Barclay, 1989; Gibson and Edwards, 1990). An overview of the Halfway map area (including the Peace River region) by Thompson (1989), addressed the structure and tectonic evolution of the region. Geological maps were prepared by McMechan (1987) and Thompson (1989).

Triassic ammonoid research was continued by E.T. Tozer. Much of this work focused on the development of a standard for Triassic time (Tozer, 1967) and classification of the marine Triassic succession (Silberling and Tozer, 1968; Tozer, 1971). In the Peace River region, Tozer recognized faunal zones, new genera, and new species (Tozer, 1961, 1963, 1965, 1979, 1982a), and discovered a fault that resolved the problems associated with an unusual distribution of faunas at Pardonet Hill (Tozer, 1965). His most recent work (Tozer, 1994) is an extensive review of the Canadian Triassic ammonoids.

Pioneer Triassic conodont studies in the Canadian Cordillera were made by Mosher (1968, 1973). Research on Triassic conodonts was expanded by Orchard (1981, 1983, 1984, 1988, 1991a, b, c). He addressed biostratigraphy, and conodont phylogeny, biochronology and description of index species. By including study of faunas from several areas (northeastern British Columbia, Queen Charlotte Islands, south central British Columbia, Yukon Territory, and Northwest Territories) Orchard recognized thirteen conodont zones of the Upper Carnian and Norian. He calibrated each of these zones with the ammonoid zonation.

Studies on Triassic elasmobranch fishes in the Canadian Rockies include identification and description of a few faunas mainly from the Lower Triassic (Sulphur Mountain Formation) of the Wapiti Lake area (Raymond, 1925; Schaeffer and Mangus, 1976; Brinkman and Neuman, 1987). Published detailed description of teeth and scales in these collections was minimal.

### *Lithostratigraphy, paleoenvironments, and tectonic setting*

Current information on the Triassic stratigraphy of the Peace River region is provided by Gibson and Barclay (1989), Gibson and Edwards (1990), and Gibson (1990, 1992a, b, and 1993). Rocks in this region are included in the Peace River Arch area and "exceed 1200 metres in thickness in the western foothills, thin eastward to 600 metres at the British Columbia/Alberta border and to a zero edge near the

town of Peace River, Alberta” (Gibson and Barclay, 1989, p. 220; Gibson and Edwards, 1990, p. 147). The sediments are mainly siliciclastics, carbonates, and minor evaporites. The source of the siliciclastics was from the north to northeast from low relief cratonic rocks believed to be Permian, Carboniferous, and older (Gibson and Barclay, 1989). The sediments were “deposited within an embayment of the Western Sedimentary Basin along the passive western margin of the Pangean North American craton” (Gibson and Edwards, 1990, p. 147). The embayment formed during the Carboniferous and Permian, possibly as a response to block faulting and tectonic subsidence (Richards, 1989; Henderson, 1989; Gibson and Edwards, 1990). The embayment endured into the Triassic and was influenced by minor tectonic adjustments and faulting (Gibson and Edwards, 1990; Gibson, 1992a).

The Panthalassa Ocean existed west of the embayment and continental shelf. It was dotted with volcanic islands, archipelagoes, shoals, and carbonate banks between which were deep water basins and troughs (Tozer, 1982b). Some of these islands were tropical with coral reefs and faunas typical of warm shallow seas. Paleoclimate in the Peace River Embayment ranged from subtropical to midtemperate (Gibson and Barclay, 1989). The evaporitic sediments of the Charlie Lake Formation indicate arid and probably hot subtropical conditions (Gibson and Barclay, 1989). Lower and Middle Triassic rocks suggest more temperate conditions. Similarly, the Upper Triassic Norian appears to be too cool to support corals and other warm water faunas (Tozer, 1982b).

Sometime during the Middle to Late Triassic, rifting began on the supercontinent Pangea resulting in separation of our modern continents (Gibson and Barclay, 1989). In addition, the Panthalassan terranes moved northward towards the westward-moving craton.

Gibson and Barclay (1989) believed that sea level changes in the Peace River area could be a response to the initial break-up of Pangea. They recognized three facies assemblages that represent three transgressive-regressive cycles. The first of these depositional cycles in the Peace River area comprises the Grayling and Toad formations of Early Triassic age; the second cycle is composed of the Liard and Charlie Lake formations of Middle to early Late Triassic age; and the third comprises the rocks of the Baldonnell, Pardonet, and Bococek formations, Late Triassic age. In each case, the transgressive-regressive cycle is represented by marine flooding over a disconformity surface, and with deposition of a transgressive facies followed by a gradational facies indicating the regressive phase (Gibson and Barclay, 1989).

Nomenclature and correlation of Triassic Formations in northeastern British Columbia (illustrated by Gibson, 1993, p. 59) are shown in Figure 3. This study includes samples from outcrops in the Liard, Ludington, Baldonnell, Pardonet, and Bococek formations. Ichthyoliths are particularly rich in the Liard, Baldonnell, and Pardonet formations.

## Biostratigraphy

Biostratigraphic control for this study is provided by previously developed conodont, ammonoid, and bivalve zones. Conodont zones referred to throughout this report are derived from Orchard (1983, 1991a, c). This zonation has been extensively calibrated with ammonoid and bivalve zones that constitute a biochronological standard for Triassic time (Tozer, 1967, 1994). Conodont and ammonoid zones are illustrated in Figure 2.

In all cases, ichthyoliths have been obtained from the same samples as conodonts, recovered from the matrix of existing ammonoid collections, or collected concurrently from conodont-, ammonoid-, and (or) bivalve-bearing strata. Calibration of ammonoid, conodont, and ichthyolith zones increases the resolving power of Triassic fossils in the Peace River area and builds a foundation for future ichthyolith studies.

## Ladinian

Ladinian samples containing ichthyoliths (from the *Maclearnoceras maclearni* ammonoid Zone) were collected from thin nodular lime beds between more massive siltstones or sandstones in the Williston Lake area at Aylard

PERIOD/ EPOCH / AGE		FOOTHILLS	
		OUTCROP	SUBSURFACE
JURASSIC		FERNIE FM	FERNIE FM
		BOCOCK FM	
NORIAN		PARDONET FM	PARDONET FM
		BALDONNEL F M Ducette Mbr	BALDONNEL FM Ducette Mbr
CARNIAN		CHARLIE LAKE FM	CHARLIE LAKE FM
		LIARD FM	HALFWAY FM
LADINIAN			DOIG FM
ANISIAN		TOAD FM	
SPATHIAN			
SMITHIAN			
DIENERIAN		GRAYLING FM	MONTNEY FM
GRIESBACHIAN			
PERMIAN		ISHBEL GROUP	

Figure 3. Nomenclature and correlation chart of Triassic formations, northeastern British Columbia (from Gibson, 1993). The extent of the hiatus at the Early and Late Triassic boundary contacts is uncertain.



Creek East (GSC loc. C-101064 to C-101066), Beattie Hill (GSC loc. C-101067 to C-101070), Beattie Ledge (GSC loc. C-153074 to C-153078), Brown Hill (GSC loc. C-153069 to C-153071), Toad River (GSC loc. C-090874); and from the *Frankites sutherlandi* ammonoid Zone of Brown Hill (GSC loc. C-087972 and C-153072) and Toad River (GSC loc. C-103858 to C-103862). Conodonts from the latest Ladinian include *Budurovignathus mungoensis*.

Ladinian samples contain excellent, diverse, and common to abundant ichthyoliths (Fig. 4, in pocket). All of the 26 types of truncate elasmobranch scales are present in addition to 12 of the 28 tetrahedral scale types. Diagnostic new form genera include *Coniunctio*, *Duplisuggestus*, and *Labri lancea*. Also the new form species *Parvidiabolus obliquus* and *Parvidiabolus acutus* are common. Teeth include four species of elasmobranchs.

### Lower Carnian

Only nondiagnostic ichthyoliths were recovered in association with ammonoids in the *Trachyceras desatoyense* Zone. Uncommon conodonts are assigned to the *T. desatoyense* and *Austrotrachyceras obesum* ammonoid zones (Orchard, 1991c).

### Upper Carnian

Upper Carnian samples yielding ichthyoliths are from the Ludington, Charlie Lake, and Baldonnel formations. Two important sections are along Williston Lake at Brown Hill (BH) and Black Bear Ridge (BBR). The outcrop at Brown Hill is one of the best and most continuously exposed Middle and Upper Triassic sections of northeastern British Columbia (Gibson, 1992a). It includes facies of the Toad, Liard, Charlie Lake, Baldonnel, and Pardonet formations. The outcrop at Black Bear Ridge contains strata of the Pardonet Formation and well exposed contacts with the underlying Baldonnel Formation (Gibson, 1992a). Detailed lithological descriptions of both Brown Hill and Black Bear Ridge sections are provided in Gibson (1992a).

Collections from the Upper Carnian at McLay Spur include one sample GSC loc. C-101753 (MS-GB) which is from the undifferentiated *Metapolygnathus nodosus* conodont Zone. The ichthyolith fauna is diverse containing elasmobranch forms such as *Polyacrodus contrarius* n. sp., *Acrodus?* sp. 1, *Labascicorona mediflexura* n. sp. s.f., and *Sacrisubcorona circabasis* n. sp. s.f.

Upper Carnian samples from Brown Hill GSC loc. C-087901 (BH-62), GSC loc. C-177682 (BH-61B), GSC loc. C-177683 (BH-61), GSC loc. C-086792 (BH-60), GSC loc. C-087903 (BH-59), and GSC loc. C-087904 (BH-58) also contain undifferentiated *M. nodosus* Zone conodonts and some good ichthyolith faunas. Ichthyoliths are best represented by *Acrodus?* sp. 1 and *L. mediflexura* n. sp. s.f.

Upper Carnian samples from Black Bear Ridge GSC loc. C-101002 to C-101005 (BBR-1 to BBR-4), GSC loc. C-101118 (BBR-310B) and GSC loc. C-101119 (BBR-311A) contain excellent and well preserved ichthyoliths.

Sample BBR-311A, represents the Upper *M. nodosus* conodont Zone and contains abundant *L. mediflexura* n. sp. s.f. *Synechodus multinodosus* n. sp., *Synechodus* sp. 2, and a variety of elasmobranch scales also are present. Samples BBR-1 and BBR-310B, representing the *M. communisti* conodont Zone contain peak abundances of *S. multinodosus* n. sp. and the elasmobranch scale form genus *Minuticorona*.

The *Metapolygnathus communisti*/Lower *M. primitius* conodont Zone boundary is marked by the striking disappearance of most of the Ladinian and Carnian elasmobranchs (Fig. 4). In one sample (GSC loc. C-101003, BBR-2) near this boundary, ichthyoliths are common to abundant and diverse representing 2 elasmobranch tooth species, and 17 truncate and 9 tetrahedral scale forms. Above this sample position, most earlier elasmobranch taxa disappear with only rare occurrences of a few taxa in the Lower Norian and one genus in the Upper Norian.

In the uppermost Upper Carnian (in the Lower *M. primitius* conodont Zone), no elasmobranch taxa were found. Instead the samples are dominated by a few types of actinopterygian ichthyoliths. The samples represent Black Bear Ridge GSC loc. C-101004 (BBR-3) and GSC loc. C-101005 (BBR-4), Pardonet Hill GSC loc. C-101770 (PH-218A), and Upper Pardonet Hill GSC loc. C-101058 to C-101063 (UPH-1 to 6).

### Lower Norian

Samples containing ichthyoliths from the Lower Norian mainly are from higher in the sections above the Baldonnel Formation at Black Bear Ridge and Brown Hill and from localities at Pardonet Hill, Childerhose Cove (McLay Spur), and Pine Pass.

Elasmobranchs in the Lower Norian are sparse to absent at the base in the *M. primitius* and *Epigondolella quadrata* conodont zones (Fig. 4) and rare to common for a few form species near the top in the *Epigondolella triangularis* conodont Zone. Actinopterygian ichthyoliths are common to abundant but they are not as diverse as in the Carnian and Ladinian stages. One type of actinopterygian ichthyolith becomes extremely abundant in the Upper *M. primitius* conodont Zone.

The section at Brown Hill contains the best representation of Lower Norian ichthyoliths. Sample GSC loc. C-302386 (BH-51A) in the Upper *M. primitius* conodont Zone contains the first rare *Synechodus incrementum* n. sp. and the last *Sacrisubcorona submedicarina* n. sp., and some abundant to common actinopterygian ichthyoliths. In the *E. quadrata* conodont Zone (GSC loc. C-087908, C-087909, C-087910, and C-302385, (BH-51, BH-48, BH-47/48, and BH-46/47B)) elasmobranchs remain rare or absent and some actinopterygian types are common to abundant. The *E. triangularis* conodont Zone includes samples GSC loc. C-087911 (BH-41), GSC loc. C-087915 (BH-30/31), GSC loc. C-087916 and C-087917 (BH-30 top and BH-29U), GSC loc. C-087973 (BH-28U), GSC loc. C-302384 (BH-27 base), GSC loc. C-177684 (BH-27), GSC loc. C-087918 (BH-27 top), and GSC loc. C-087919 (BH-26) which contain the first

important Norian elasmobranchs *Fragilicorona labricuspis* n. sp. s.f., *Fragilicorona labribrevirostrum* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., *Glabrisubcorona arduidevexa* n. sp. s.f., and *Rugosicorona devexa* n. sp. s.f. which begin to increase in number towards the top of the *E. triangularis* conodont Zone.

The Lower Norian ichthyoliths recovered from Black Bear Ridge are similar to those found at Brown Hill. GSC loc. C-101009 (BBR-8) from the Upper *M. primitius* conodont Zone contains abundant to common actinopterygian ichthyoliths. From the residue of GSC loc. C-101033 (BBR-33) in the Middle *E. triangularis* conodont Zone, rare *F. labribrevirostrum* n. sp. s.f. and a common actinopterygian type were found.

The Lower Norian samples at Pardonet Hill are dominated by a few types of common actinopterygians. In the Lower *E. triangularis* conodont Zone, rare elasmobranch scales begin to appear with *Suaviloquentia longilingua* n. sp. s.f., *F. labricuspis* n. sp. s.f., *F. labribrevirostrum* n. sp. s.f. (common), *G. vadosidevexa* n. sp. s.f., *G. arduidevexa* n. sp. s.f., and *Carinasubcorona subradiciplana* n. sp. s.f. This pattern is similar to other Lower Norian Peace River sections.

Ichthyoliths from the Lower Norian at Childerhose Cove/McLay Spur (MS) occur in three samples: GSC loc. C-101149 (MS-244A), GSC loc. C-101148 (MS-243C), and GSC loc. C-101034 (MS-1) from the Middle and Upper *E. triangularis* conodont zones. These samples contain rare elasmobranch scales and actinopterygians which also are found at other localities in this level (see above).

## Middle Norian

Rocks of the Middle Norian Pardonet Formation are well exposed in the Peace River-Williston Lake area. Ichthyoliths have been recovered at Brown Hill (BH), Black Bear Ridge (BBR), Pardonet Hill (PH), Childerhose Cove (MS), Crying Girl Prairie Creek (TE-217, TE-220), Carbon Creek (MJO-119), and Ne Parle Pas Rapids (NPP). At all these localities, ichthyolith taxa correlate well and are in general agreement with existing conodont and ammonoid zones and positions.

The beginning of the Middle Norian, in the Lower *E. multidentata* conodont Zone, marks a sharp increase in ichthyolith diversity and abundance. Most are elasmobranchs including *S. incrementum* n. sp., *S. longilingua* n. sp. s.f., *Fragilicorona* n. gen. s.f., *Rugosicorona* n. gen. s.f., *Ornatilabrilancea solicarina* n. sp. s.f., *G. vadosidevexa* n. sp. s.f., *Glabrisubcorona tendibasis* n. sp. s.f., *G. arduidevexa* n. sp. s.f., and *C. subradiciplana* n. sp. s.f. A few actinopterygian types also occur.

Two samples in the Lower *Epigondolella multidentata* conodont Zone, GSC loc. C-101036 (MS-3) from Childerhose Cove and GSC loc. C-302382 (BH-20) from Brown Hill, contain most of the taxa of the Middle Norian (listed above). Two of the elasmobranch scale forms (*S. longilingua* n. sp. s.f. and *G. tendibasis* n. sp. s.f.) are only common or abundant within the Lower *E. multidentata* conodont Zone and might be proven diagnostically useful with additional sampling and study.

Three ichthyolith samples collected within the Upper *E. multidentata* conodont Zone (GSC loc. C-101038 (MS-5) from Childerhose Cove; GSC loc. C-101754 (NPP-Low) from Ne Parle Pas Rapids; and GSC loc. C-302390 (TE-220A) from Crying Girl Prairie Creek) contain most of the important and common to abundant Middle Norian ichthyolith taxa. Two of the elasmobranch scales, *O. solicarina* n. sp. s.f. and *C. subradiciplana* n. sp. s.f., reach their maximum common frequency. The *E. multidentata* conodont Zone is further characterized by a peak in abundance of *S. incrementum* n. sp. and *R. devexa* n. sp. s.f.

The *Epigondolella spiculata* conodont Zone contains one important ichthyolith sample at its base (GSC loc. C-087924 (BH-8) from Brown Hill) which corresponds to the uppermost *Drepanites rutherfordi* ammonoid Zone (Fig. 4). The ichthyolith faunas in this sample closely match those found in the *E. multidentata* conodont Zone. Samples above BH-8 in the *E. spiculata* conodont Zone and also the *Epigondolella elongata* conodont Zone are noted by a drop in abundance of elasmobranch faunas with usually only rare occurrences.

The *Epigondolella postera* conodont Zone is characterized by the resurgence of some ichthyolith faunas such as *F. labricuspis* n. sp. s.f., *F. labritricuspis* n. sp. s.f., *G. vadosidevexa* n. sp. s.f., and *G. arduidevexa* n. sp. s.f. which were common or abundant in the *E. multidentata* conodont Zone. In addition, there are several last appearances of elasmobranch scales. Samples in the *E. postera* conodont Zone that contain good ichthyoliths include: GSC loc. C-101150 (MS-247A) from Childerhose Cove, GSC loc. C-101778 (PH-227A) from Pardonet Hill, and several from Black Bear Ridge (GSC loc. C-101013 to C-101017 (BBR-12 to BBR-16), GSC loc. C-101114 (BBR-305B), and GSC loc. C-101115 (BBR-306A)).

The *Epigondolella serrulata* conodont Zone contains one good elasmobranch sample from Crying Girl Prairie Creek (GSC loc. C-302387 (TE-217D)). The faunas include the common and only appearances of *Fragilicorona tricuspis* n. sp. s.f. and *Fragilicorona brevirostrum* n. sp. s.f. Also within this level *Fragilicorona unicuspis* n. sp. s.f. is common.

## Upper Norian

Several samples from the Upper Norian Pardonet and Bocock formations were examined for their ichthyolith content. Sample localities included Black Bear Ridge, Bocock Peak, Pine Pass, Pardonet Hill, and Ne Parle Pas Rapids. Most of these only contained an actinopterygian type common to abundant in many of the Peace River samples. Only one sample (GSC loc. C-302391 (TE-314B)) from near Bocock Peak contained an elasmobranch taxon, *S. longilingua* n. sp. s.f., which probably had its last appearance in the Lower *Epigondolella bidentata* conodont Zone.

## Ichthyolith zonation

Three provisional ichthyolith zones are proposed and described for Ladinian to Norian strata of the Peace River-Williston Lake areas. These ichthyolith zones are local



concurrent-range zones (defined in Hedberg, 1976) because this study has been geographically restricted to the Peace River area.

Ichthyolith zones are based on first and final appearances of common to abundant ichthyoliths. The *Coniunctio aequirugosa* ichthyolith Zone is Ladinian. It is followed by a Lower Carnian and lowermost Upper Carnian interval where no significant collections were available. The *Synechodus multinodosus* ichthyolith Zone corresponds to the Upper Carnian. The *Synechodus incrementum* ichthyolith Zone occurs within the Lower and Middle Norian. The Upper Norian has no proposed ichthyolith zone. Ichthyolith zones are illustrated in Figure 4.

### ***Coniunctio aequirugosa* ichthyolith concurrent-range Zone**

*Index species.* *Coniunctio aequirugosa* n. sp. s.f. (Pl. 20, fig. 1-7).

*Type locality and lithology.* Halfway River, 94B, along Williston Lake at Aylard Creek East, GSC loc. C-101065 (ACE-2). The section commonly has thick bedded yellow-brown weathered siltstone, thin beds of dark grey shale, and thin nodular beds of limestone. The section samples GSC loc. C-101064 to C-101066 (ACE-1 to ACE-3) are from nodular limestones.

*Other occurrences.* Samples in addition to the type locality containing *C. aequirugosa* n. sp. s.f. are from Beattie Hill, GSC loc. C-101067 to C-101070 (BEH-1 to BEH-4); Beattie Ledge, GSC loc. C-153075 (GK-4-11) and GSC loc. C-153076 (GK-4-17); and Brown Hill, GSC loc. C-087972 (Sutherland Zone) and GSC loc. C-153069 (GK-1-19).

*Formation and associated faunal zones.* The Liard Formation includes strata in which the *Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones have been reported (Tozer, 1967, 1994). Conodont species of *Budurovignathus hungaricus?* and *B. mungoensis* are associated.

*Age.* Ladinian, Middle Triassic.

*Definition.* The *C. aequirugosa* ichthyolith Zone is characterized by the presence of distinct, diverse, and abundant ichthyolith faunas found in most of the samples, and a limited range of a few ichthyolith forms. The base of this zone is currently undefined because samples and specimens below the *M. maclearni* ammonoid Zone were not studied. Similarities of ichthyoliths from the *C. aequirugosa* ichthyolith Zone to those in the lower Middle and Lower Triassic are unknown. The upper limit of the *C. aequirugosa* ichthyolith Zone is at the base of the Charlie Lake Formation. No ichthyoliths have been recovered from this shallow water and coarse grained evaporitic sequence.

At the type locality, within the proximity of the *M. maclearni* Zone ammonoids at Beattie Hill and Beattie Ledge, *C. aequirugosa* n. sp. s.f. is common, however, it is

rare at Brown Hill in the younger *F. sutherlandi* ammonoid Zone. Abundant and diverse truncate elasmobranch scales also are diagnostic of the *C. aequirugosa* ichthyolith Zone.

*Remarks.* Ichthyoliths in almost all the Ladinian samples studied are diverse, and common to abundant. All of the 26 truncate and 12 of the 28 tetrahedroid new form species of elasmobranch scales are present (Fig. 4). In addition, 4 species of elasmobranch teeth and several types of actinopterygian ichthyoliths are recognized.

The frequency of occurrence of some taxa is noted by a pattern of decrease from the *M. maclearni* to the *F. sutherlandi* ammonoid zones. The following elasmobranch scale taxa decrease from: 1) abundant or common to rare: *Parviscapa trivela* n. sp. s.f., *Proprigalea languidula* n. sp. s.f., *Undulaticorona propensa* n. sp. s.f., *Parvidiabolus obliquus* n. sp. s.f., *Parvidiabolus acutus* n. sp. s.f., *Parvidiabolus longisulcus* n. sp. s.f., *Duplisuggestus profundisulcus* n. sp. s.f., *C. aequirugosa* n. sp. s.f., *Coniunctio multirugosa* n. sp. s.f., *Labascicorona longifossae* n. sp. s.f., *Gracilisuggestus triapices* n. sp. s.f., *Gracilisuggestus uniapex* n. sp. s.f., and *S. submedicarina* n. sp. s.f.; and 2) abundant to common: *Duplisuggestus duplirugosus* n. sp. s.f., *Labascicorona alata* n. sp. s.f., *Labrilancea glabrisubtricuspis* n. sp. s.f., and *Complanicorona glabra* n. sp. s.f. Elasmobranch scales equally abundant or common in both subzones are: *Labrilancea glabrisubtricuspis* n. sp. s.f., *Ornatilabrilancea circacarina* n. sp. s.f., and *S. circabasis* n. sp. s.f.

Only two form species (*Undulaticorona profundifossae* n. sp. s.f. and *Labascicorona trifastigia* n. sp. s.f.) are restricted to the *M. maclearni* ammonoid Zone. An additional two form species (*Proprigalea medirugosa* n. sp. s.f. and *Suaviloquentia obliquilingua* n. sp. s.f.) are restricted to both the *M. maclearni* and *F. sutherlandi* ammonoid zones. All are distinctive in appearance but unfortunately rare and therefore not very reliable indices.

An elasmobranch tooth common in the *M. maclearni* and rare in the *F. sutherlandi* ammonoid zones is *Synechodus volaticus* n. sp. *Synechodus* sp. 1 is rare but restricted to these two ammonoid zones. *Polyacrodus contrarius* n. sp. and *Synechodus* sp. 2 are similarly rare but also ranged up into the Carnian.

### **Unzoned interval**

The Lower Carnian *Trachyceras desatoyense*, *Austrotrachyceras obesum*, and *Sirenites nansenii* ammonoid zones and lowermost Upper Carnian *Tropites dilleri* ammonoid Zone, includes an interval where only a few samples were collected in the Peace River area. Diagnostic ichthyolith specimens were not recovered. The facies within this level are from the Charlie Lake Formation which is characteristically shallow water and commonly contains coarser grained sands (Gibson, 1992a). In strata such as these, microfauna preservation is generally poor and faunas may be difficult to locate in abundant clastic materials.

### ***Synechodus multinodosus* ichthyolith concurrent-range Zone**

*Index species.* *Synechodus multinodosus* n. sp. (Pl. 8, fig. 1-24; Pl. 9, fig. 1-12; Pl. 10, fig. 1-8). *S. multinodosus* n. sp. was chosen as the zone index fossil because of its abundance, distinct appearance, and short range.

*Type locality and lithology.* Halfway River, 94B, along Williston Lake at Black Bear Ridge, GSC loc. C-101002 (BBR-1). The lower part of the Black Bear Ridge section contains GSC loc. C-101119 (BBR-311A), GSC loc. C-101118 (BBR-310B), GSC loc. C-101002 (BBR-1), and GSC loc. C-101003 (BBR-2). The strata consist of grey and brown weathered banded siltstones which are variously calcareous with nodules and brachiopod beds.

*Other occurrences.* *S. multinodosus* n. sp. also was found at Black Bear Ridge (GSC loc. C-101118 and C-101119, BBR-310B and BBR-311A) and Chowade South (GSC loc. C-145780, GK-68-8-27).

The *S. multinodosus* ichthyolith Zone contains concurrent-range zone taxa from the type locality (in the uppermost part of the zone) and other localities (generally below the uppermost part) at Brown Hill (GSC loc. C-087901, BH-62; GSC loc. C-177682, BH-61B; GSC loc. C-177683, BH-61; GSC loc. C-086792, BH-60; and GSC loc. C-087904, BH-58) and Childerhose Cove (GSC loc. C-101753, MS-GB).

*Formations and associated faunal zones.* The Baldonnel and Ludington (part) formations include *M. nodosus* and *M. communisti* conodont zones (Orchard, 1991c), and *Tropites welleri* and *Klamathites macrolobatus* (part) ammonoid zones (Tozer, 1984, 1994).

*Age.* Late Carnian, Late Triassic.

*Definition.* The *S. multinodosus* ichthyolith Zone is recognized by concurrent range taxa including the common to rare appearance of *Acrodus?* sp. 1 at the base (unzoned interval below). The lower part of this ichthyolith zone, within the *M. nodosus* conodont Zone (Orchard, 1991c), is recognized by the last appearance of *Polyacrodus contrarius* n. sp. and *Propriogalea mediglabra* n. sp. s.f. which were known from the Ladinian. In the upper part of the *S. multinodosus* ichthyolith Zone, *S. multinodosus* n. sp. s.f. is restricted to the Upper *M. nodosus* and *M. communisti* conodont zones, and *Minuticorona* n. gen. s.f. to the *M. communisti* conodont Zone.

*Remarks.* Common or abundant ichthyoliths in the part of the *S. multinodosus* ichthyolith Zone that corresponds to the *M. nodosus* conodont zone include: *Acrodus?* sp. 1 (limited to this Zone), *Labascicorona mediflexura* n. sp. s.f. (common or abundant), and *Sacrisubcorona circabasis* n. sp. s.f. Several other ichthyoliths known from the Ladinian are rare.

In ichthyolith collections from the Upper *M. nodosus* conodont Zone, *S. multinodosus* n. sp. and *S. cf. multinodosus* n. sp. make their first appearances, and by the top of the *S. multinodosus* ichthyolith Zone (*M. communisti* conodont Zone) they disappear. This latter conodont zone is further characterized by the first, abundant, and final appearance of *Minuticorona triculmina* n. sp. s.f. and *Minuticorona*

*uniculmen* n. sp. s.f. *Glabrisubcorona?* sp. 1 and *Complanicorona glabra* n. sp. s.f. reappear abundantly and then disappear. The remaining elasmobranch scales are rare including: 1) the continued appearance of *Undulaticorona propensa* n. sp. s.f. and *Labascicorona alata* n. sp. s.f.; 2) the reappearance of *Parviscaptha univelum* n. sp. s.f. and *Parvidiabolus longisulcus* n. sp. s.f. that occur in the Ladinian; and 3) the abrupt decrease of *Labascicorona mediflexura* n. sp. s.f.

The top of the *S. multinodosus* ichthyolith Zone includes one sample (GSC loc. C-101003, BBR-2) that is referred to the *M. communisti* conodont Zone which correlates with part of the *Klamathites macrolobatus* ammonoid Zone. The ichthyoliths in this sample are diverse. Several taxa known from the Ladinian but not from elsewhere in the Carnian, occur in this sample (Fig. 4). This pattern may indicate the uppermost range of the taxa, or possibly sediment reworking. However, in overlying collections, many of the Ladinian and Carnian ichthyolith faunas disappear.

### ***Synechodus incrementum* ichthyolith concurrent-range Zone**

*Index species.* *Synechodus incrementum* n. sp. (Pl. 4, fig. 1-18; Pl. 5, fig. 1-17; Pl. 6, fig. 1-18; Pl. 7, fig. 1-9). *S. incrementum* was chosen as the index species based on its distinct appearance, robustness, and abundance in the middle of the zone. Several types of elasmobranch scales range concurrently within the zone.

*Type locality and lithology.* Halfway River, 94B, along Williston Lake at Childerhose Cove (McLay Spur), GSC loc. C-101036 (MS-3). The Childerhose Cove section includes 20 samples in the *S. incrementum* ichthyolith Zone which are part of the Pardonet Formation, Lower and Middle Norian (GSC loc. C-101034 to C-101047, C-101147 to C-101150, C-101751, and C-101752). The strata consist of calcareous siltstone, silty limestone, and shale.

*Other occurrences.* *S. incrementum* n. sp. also was found at Brown Hill (GSC loc. C-302386, BH-51A; GSC loc. C-302382, BH-20; and GSC loc. C-087924, BH-8), Crying Girl Prairie Creek (GSC loc. C-302390, TE-220A), McLay Spur (GSC loc. C-101038, MS-5), and Ne Parle Pas Rapids (GSC loc. C-101754, NPP-Low).

*Formation and associated faunal zones.* All collections are from the Pardonet Formation and found with associated conodonts in the *M. primitius* to the *E. serrulata* zones (Orchard, 1991c), and ammonoids in the *K. macrolobatus* to the *Mesohimavatites columbianus* IV zones (Tozer, 1984, 1994) (see Fig. 2).

*Age.* Uppermost Late Carnian, and Early and Middle Norian, Late Triassic.

*Definition.* The *S. multinodosus* ichthyolith Zone is defined by concurrent range taxa including the index species and all elasmobranch scales in *Fragilicorona* n. gen. s.f., plus *G. vadosidevexa* n. sp. s.f., *G. arduidevexa* n. sp. s.f., *G. tendibasis* n. sp. s.f., and *S. longilingua* n. sp. s.f. The *S.*

*incrementum* ichthyolith Zone includes ichthyolith samples from Black Bear Ridge and Pardonet Hill in addition to those listed above.

Collections from the type locality are rich and diverse. They contain all representatives of the most abundant to common elasmobranch scales including: *Rugosicorona devexa*, *Fragilicorona unicuspis*, *F. labricuspis*, *F. labritricuspis*, *F. labribrevirostrum*, *Ornatilabrilancea solicarina*, *Carinasubcorona subradiciplana*, *Glabrisubcorona vadosidevexa*, *G. arduidevexa*, *G. tendibasis*, and *Suaviloquentia longilingua*.

**Remarks.** The elasmobranchs in the lowermost part of the *S. incrementum* ichthyolith Zone (equivalent to the *M. primitius* and *E. quadrata* conodont zones) are rare. Ichthyolith collections in the Upper *M. primitius* conodont Zone, include the last appearance of *Sacrisubcorona submedicarina* n. sp. s.f. and in those from the *E. quadrata* conodont Zone, the first rare appearance of *S. incrementum* n. sp. Only a few elasmobranch faunas pass over the Carnian/Norian boundary and continue beyond the *S. multinodosus* ichthyolith Zone. They include: *S. submedicarina* n. sp. s.f., *Lobaticorona floriditurris* n. sp. s.f., *L. floriditabella* n. sp. s.f., *L. floridibasis* n. sp. s.f., and *L. tumiditurris* n. sp. s.f. Actinopterygians were more abundant than elasmobranchs in ichthyolith collections from the Upper *M. primitius* conodont Zone. In one sample, over 1000 specimens were found.

Ichthyolith collections from the *E. quadrata* conodont Zone are characterized by the last occurrence of *Lobaticorona tumiditurris* n. sp. s.f. and the first appearances of *Fragilicorona labricuspis* n. sp. s.f., *F. labribrevirostrum* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., and *G. arduidevexa* n. sp. s.f.

The first elasmobranch scale appearances of *Suaviloquentia longilingua* n. sp. s.f. and *Carinasubcorona subradiciplana* n. sp. s.f. were found in ichthyolith collections from the Lower *E. triangularis* conodont Zone. In addition, *Fragilicorona labricuspis* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., and *G. arduidevexa* n. sp. s.f. are rare and *Fragilicorona labribrevirostrum* n. sp. s.f. is common. In ichthyolith collections from the Upper *E. triangularis* conodont Zone, *Rugosicorona devexa* n. sp. s.f. and *Glabrisubcorona tendibasis* n. sp. s.f. first appeared, and *Glabrisubcorona vadosidevexa* n. sp. s.f. became common.

The middle of the *S. incrementum* ichthyolith Zone corresponding to the *E. multidentata* conodont Zone is marked by a peak in diversity and abundance of Norian elasmobranch faunas. The elasmobranch assemblage consists of one tooth species and twelve forms of tetrahedroid scales. Truncate scales are represented only by *Lobaticorona* n. gen. s.f.

Ichthyolith collections from the Lower *E. multidentata* conodont Zone include: 1) the first and common occurrences of elasmobranch scales *Fragilicorona unicuspis* n. sp. s.f., *F. labritricuspis* n. sp. s.f., and *Ornatilabrilancea solicarina* n. sp. s.f.; and 2) the first and rare appearance of *Complanicorona subrugosa* n. sp. s.f. Elasmobranch numbers increase to common or abundant for *S. incrementum* n. sp., *Lobaticorona floridibasis* n. sp. s.f., *Suaviloquentia longilingua* n. sp. s.f.,

*Fragilicorona labricuspis* n. sp. s.f. (very abundant), *F. labribrevirostrum* n. sp. s.f., *Rugosicorona devexa* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f. (very abundant), *G. arduidevexa* n. sp. s.f., and *G. tendibasis* n. sp. s.f. Distinctive taxa that are only common or abundant in ichthyolith collections from the Lower *E. multidentata* conodont Zone, are *Lobaticorona floridibasis* n. sp. s.f., *Suaviloquentia longilingua* n. sp. s.f., and *Glabrisubcorona tendibasis* n. sp. s.f.

Ichthyolith collections from the Upper *E. multidentata* conodont Zone are characterized by: 1) the last abundant occurrence of *S. incrementum* n. sp. and the last rare account of *Lobaticorona floriditurris* n. sp. s.f. Several elasmobranch scales remain common or abundant (*Fragilicorona unicuspis* n. sp. s.f., *F. labricuspis* n. sp. s.f., *F. labribrevirostrum* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., *G. arduidevexa* n. sp. s.f., and *Rugosicorona devexa* n. sp. s.f.) or is only common within this interval (*Carinasubcorona subradiciplana* n. sp. s.f.).

From the base of the *E. spiculata* conodont Zone one good sample (BH-8, GSC loc. C-087924) has ichthyolith faunas similar in diversity and abundance to those found in the *E. multidentata* conodont Zone. Above this sample, in the *E. spiculata* and the *E. elongata* conodont zones, elasmobranchs are rare. In the sample BH-8, *S. incrementum* n. sp., *Lobaticorona floriditurris* n. sp. s.f., and *Complanicorona subrugosa* n. sp. s.f. make their last appearances.

In the *E. elongata* conodont Zone, *Fragilicorona labribrevirostrum* n. sp. s.f. is rare and does not extend beyond this level.

Within the *E. postera* conodont Zone, there is a resurgence in abundance of several of the elasmobranch scales. The abundant or common types include *Fragilicorona labricuspis* n. sp. s.f., *F. labritricuspis* n. sp. s.f., *Glabrisubcorona vadosidevexa* n. sp. s.f., and *G. arduidevexa* n. sp. s.f. However, at the top of this conodont zone, several of the ichthyolith taxa disappear including *Fragilicorona labritricuspis* n. sp. s.f., *Rugosicorona devexa* n. sp. s.f., *Ornatilabrilancea solicarina* n. sp. s.f., *Glabrisubcorona tendibasis* n. sp. s.f., *G. arduidevexa* n. sp. s.f., and *Carinasubcorona subradiciplana* n. sp. s.f.

Ichthyolith collections from the *E. serrulata* conodont Zone include: first and last appearances of *Fragilicorona tricuspis* n. sp. s.f. and *F. brevisrostrum* n. sp. s.f., increase to common occurrence and then last appearance of *F. unicuspis* n. sp. s.f., and last appearances of *Fragilicorona labricuspis* n. sp. s.f., and *Glabrisubcorona vadosidevexa* n. sp. s.f.

### Upper Norian ichthyolith fauna

Above the *S. incrementum* ichthyolith Zone, in the Pardonet and Bocock formations, within the Upper Norian interval containing the Upper and Lower *Epigondolella bidentata* conodont Zone faunas, few ichthyoliths have been found. These lack diversity and include rare occurrences of the elasmobranch *Suaviloquentia longilingua* n. sp. s.f. (GSC loc. C-302391, TE-314B) and two types of actinopterygian tooth. No ichthyolith zone has been established.

## Discussion

In this proposed provisional ichthyolith zonation, three zones are recognized: *Coniunctio aequirugosa* (Ladinian), *Synechodus multinodosus* (Upper Carnian), and *Synechodus incrementum* (Norian) with an interval in the Lower Carnian. Each of the ichthyolith zones has a longer range than, and usually correlates with two or more conodont or ammonoid zones within that same range. Both conodont and ammonoid zones have been recognized after extensive study of these faunas within and outside the Peace River area. These broader studies have allowed for considerable refinement to each of the zonations.

Narrow ranges of some of the ichthyolith forms are indicated (examples: *Fragilicorona tricuspis*, *Fragilicorona brevirostrum*, *Fragilicorona unicuspis*, *Fragilicorona labritricuspis*, *Rugosicorona*, *Ornatilabrilancea solicarina*, *Minuticorona*, and *Synechodus multinodosus*). Expanding the sample area to include other regions will help provide additional information on the distribution of ichthyolith forms and test the ichthyolith zonation for broader application. These studies could strengthen interpretation of the narrower ranges of the above ichthyolith forms and may lead to subdivision of an ichthyolith zone.

## SYSTEMATICS

M.J. Johns

Most of this section includes detailed descriptions of elasmobranch teeth and scales. Morphological features and terms are defined to clarify taxa descriptions. A summary of early Mesozoic elasmobranch classification systems, and taxonomy and studies on the evolution this group is provided followed by an interpretation of the relationships of the Triassic northeastern British Columbia ichthyoliths. In addition, three taxonomic methods used to identify ichthyoliths in this study are discussed. A key to genera, species, and forms is supplied.

## Histology and terms

Scales and teeth of fishes are thought to be at least in part homologous structures (Hertwig, 1874; Moss, 1977; Reif, 1985a; Smith and Hall, 1990). Two main theories addressed the formation of a tooth or scale unit. They included the Lepidomorial Theory introduced by Stensiö (1961) and the Odontode Regulation Theory proposed by Reif (1982a) with the concept of the odontode suggested by Ørvig (1967, 1977). In addition, Ørvig (1968), Patterson (1977), Schaeffer (1977), and Smith and Hall (1990) listed previous work on the origin, evolution, and histology of vertebrate skeletal tissues and provided their own interpretations.

Both internal histological and external morphological features are important for characterization of elasmobranch species, forms, or types.

## Histology

A typical elasmobranch tooth or scale consists of a crown with an outermost shiny layer of enameloid followed by dentine (Reif, 1982a; Smith and Hall, 1990). Dentine layers enclose the pulp cavity which is filled with blood and nerve tissues. The crown sits on a base (tooth) or pedicle (scale) which may be formed of other types of dentine or acellular material.

Enameloid (also called vitrodentine) mineralization forms first followed by dentine (Shellis, 1978). Reif (1973, 1974a, b, 1977, 1978a, b, 1979, 1980) found that variations in enameloid crystal orientation were important for the identification of certain elasmobranch groups. The more primitive condition consisted of single layered, randomly oriented crystals (hybodont sharks *Hybodus* and *Acrodus*). More derived neoselachian sharks and actinopterygian bony fishes have enameloids that are triple layered (with an outer shiny layer followed by parallel and woven structures commonly forming bundles). Reif attributed these advances in structure as giving the tooth more strength and flexibility (bending capability to minimize breakage).

Dentine is the main mass and hard component of teeth. Both dentine and enameloid are composed of hydroxyapatite ( $\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F},\text{Cl})$ ) and other calcium phosphates (Urist, 1961). Dentine formation occurs from the outside towards the pulp cavity where cell bodies deposit carbonate salts and organic material along the inner surface of the basal membrane (Peyer, 1968). Two main types of dentine found in elasmobranchs are orthodentine and trabecular dentine (Fig. 5). Orthodentine forms concentric layers enclosing the pulp cavity. The outermost layer (pallial orthodentine) is thin, followed by a thick inner layer (circumpulpar orthodentine) (Ørvig, 1951). Orthodentine is distinguished from enameloid by the presence of dentinal tubes. Trabecular dentine (term proposed by Röse, 1897) or osteodentine (Ørvig, 1951) is vesicular, spongy, or networked and is commonly found in the basal portion of elasmobranch teeth.

Some of the Peace River elasmobranch teeth were prepared for histological study. Specimens of *Acrodus?* (Pl. 1, fig. 11-16) show outermost single crystallite enameloid with osteodentine below, an arrangement which is typical for this elasmobranch group (Rieppel, 1981). Etched sections of the Triassic Peace River neoselachian teeth identified in this report as *Synechodus incrementum* (Pl. 7), *S. multinodosus* (Pl. 10), and *S. volaticus* (Pl. 12) show outer single crystallite, parallel fibred and woven or haphazard enameloid layers.

The histology of elasmobranch scales is similar to teeth. A scale has a crown with enameloid and dentine surrounding a pulp cavity with radiating tubules (Van Oosten, 1957; Reif, 1982a, 1985a). The scale pedicle is composed of acellular bone that is embedded and attached in the upper layer of the dermis by collagen fibres (Reif, 1985a). Cross-sections through two different HCl etched elasmobranch scales are illustrated in Plate 38 showing enameloid, orthodentine, and the pulp cavity. Extensive histological preparations of each elasmobranch scale type was beyond the scope of this project.

### Features of elasmobranch teeth

Teeth of elasmobranchs do not continue to grow after initial formation and are frequently shed and replaced (Applegate, 1967; Peyer, 1968; Cappetta, 1987). The teeth are anchored by connective tissue that covers the cartilaginous tissues of the jaw (Peyer, 1968). Elasmobranch teeth are not rooted into jaw bone as in mammals, however, the term "root" is frequently used for elasmobranchs when referring to the basal portion of the tooth (Peyer, 1968; Cappetta, 1987).

Elasmobranch teeth may be heterodontous (having more than one type in the jaw) (Cappetta, 1987). An example of heterodonty in this study is shown in *S. incrementum* (Pl. 4-6). Variation in tooth morphology is present in organisms that have varied diets, for example, where both prey are grasped and torn (elongate teeth with sharp edges) and crushed (flattened teeth for grinding or breaking shellfish). Cappetta (1987) recognized six types of dentition in elasmobranchs: clutching, tearing, cutting, crushing, grinding, and clutching-grinding.

The description of elasmobranch teeth involves observing features on different faces of the tooth. These views are termed: lingual (inner tooth face on tongue side), labial (outer tooth face on lip side), mesial (towards the symphysis), distal (towards the commissure), occlusal (uppermost biting surface), profile (mesial or distal surface), and basal (underneath the crown or root base).

A number of other terms are used to identify regions and features on elasmobranch teeth (Fig. 6). The tooth crown usually has a shiny surface and commonly overhangs part or all of the root which is less shiny and has a more pitted external texture. The principal cusp (main cusp) commonly terminates in an apex which is the highest point on the crown. Lateral cusps are usually in pairs (one or more on each side of the principal cusp) and positioned mesially or distally spreading out towards the crown heels. In the Peace River specimens,

the height of the cusps decrease from the principal cusp to each heel. Some species have an occlusal crest (a cutting edge or line that extends longitudinally over top of the cusps and commonly from crown heel to heel).

The crown shoulder is a region near the base of the crown where the curvature of the crown changes by curving down and (or) under to the root. A longitudinal line or ridge may be present on the crown shoulder and commonly extends mesio-distally (mesially to distally). A transverse line or ridge may be present and extends from shoulder to shoulder labiolingually (labially to lingually over top of the principal cusp or a lateral cusp and forms a primary line or ridge). Other surface features include: lines or striae (minor raised linear markings), ridges (well raised lines or wrinkles), keels (prominently raised ridges with breadth), hollows (concave depressions in the surface), furrows or channels (broadened and extended concave depressions in the surface), nodes (nodular protrusions usually on crown shoulders), and peg (prominent protrusion usually on shoulder of principal cusp).

Terms specifically used for root features (in addition to the above) include torus (rounded bulge on the lingual face), lip or rim (thin raised surface usually separating the upper and lower labial root faces), and canal opening(s) (openings that penetrate the root linked by channels [containing blood vessels and nerves] connecting the pulp cavity and the dermis [skin layer below the epidermis]). Canal openings are found at various positions on the root labial, lingual, and basal faces.

Casier (1947a, b, c, 1961) found canal openings on the root basal surface were important for the recognition of different elasmobranch groups since morphology of the roots change little within a group. He defined four structural stages of root vascularization (anaulacorhize, hemiaulacorhize, holaulacorhize, and polyaulacorhize) based on the arrangement of canal openings in and on the root basal surface. These

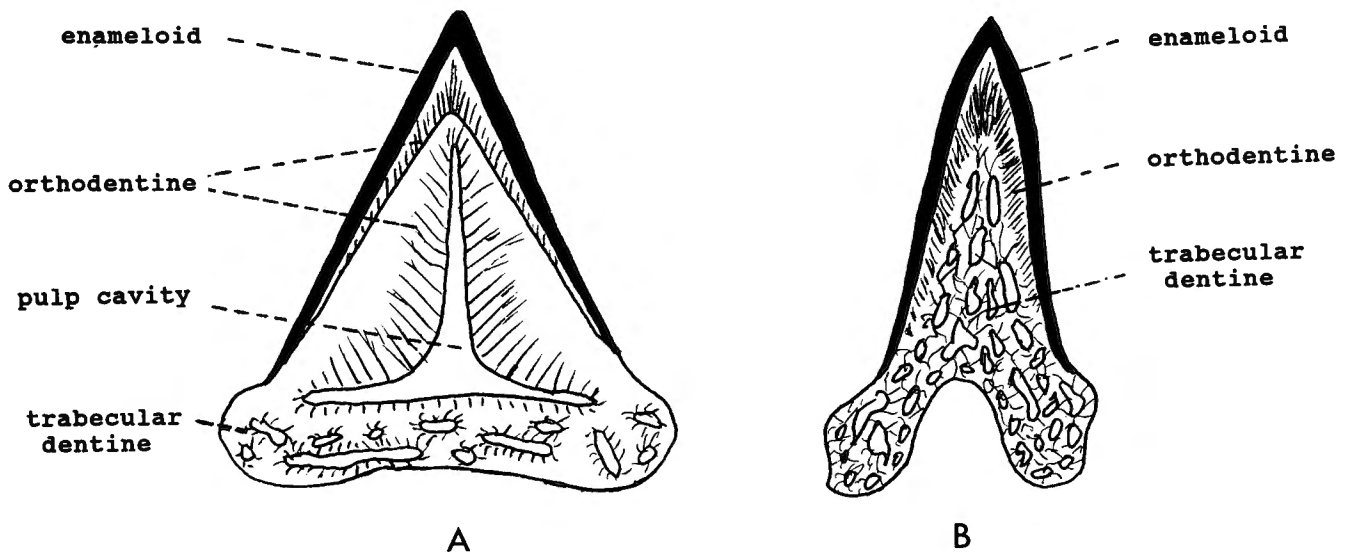


Figure 5. Chondrichthyan tooth histology: A) orthodont type; B) osteodont type (redrawn from Cappetta, 1987 and Thomasset, 1930).



stages reflect levels of development reached by different groups. Each of the stages are summarized and illustrated (from Casier) in Cappetta (1987).

The Triassic Peace River tooth specimens include the anaulacorhize vascularization stage. This stage is the most archaic seen in many Paleozoic species in addition to the hybodonts (Paleozoic and Mesozoic) and Hexanchiformes (Recent). The root has a flat basal face without grooves and may have many small pores randomly distributed or located at specific positions (Fig. 7A). Variations of this stage include a root basal surface that is subperpendicular to the axis of the crown, a labio-lingual compression of the root resulting in the basal face being subparallel to the axis of the crown (Fig. 7B), and a type that is pseudo-polyaulacorhize having many laminae and grooves with canal openings at their ends (Fig. 7C, 7D).

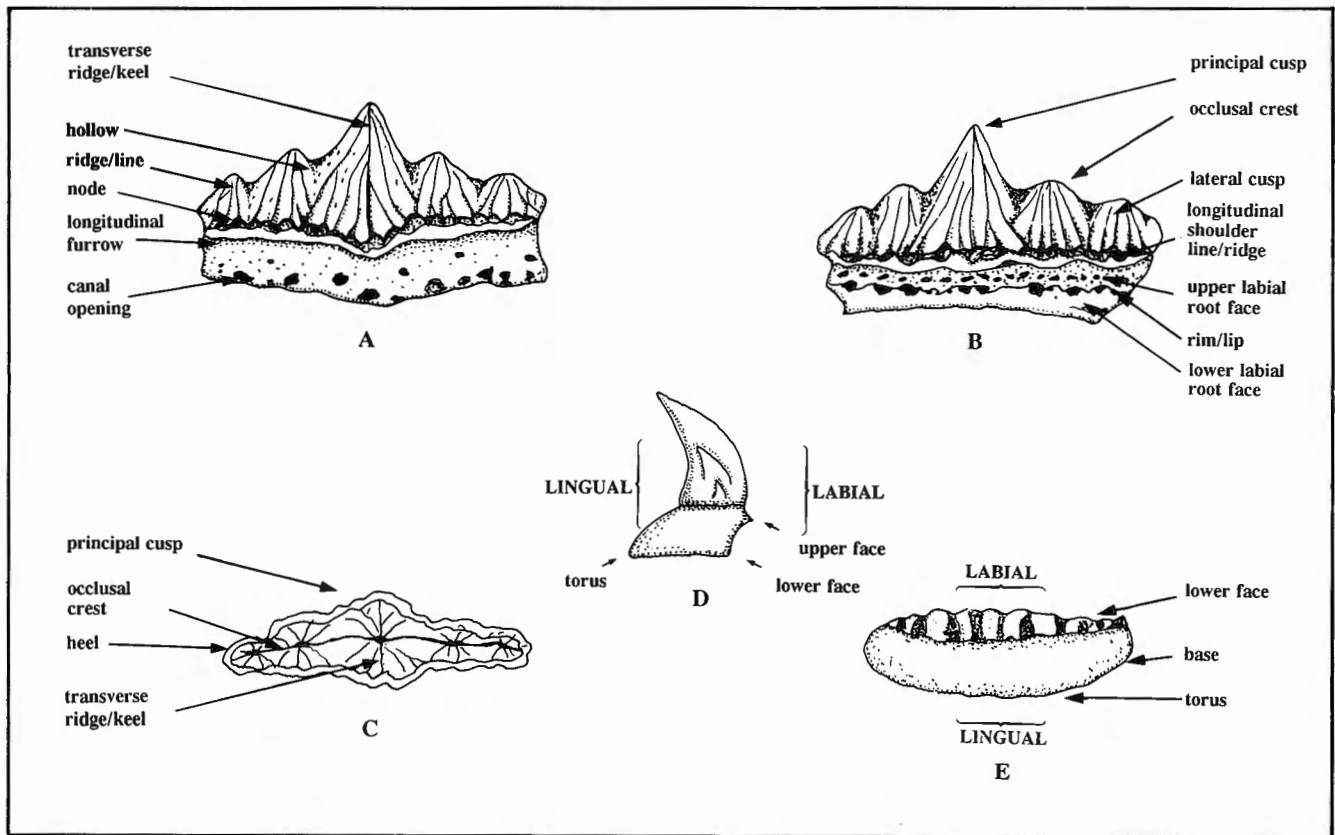
The hemiaulacorhize stage appears in more advanced elasmobranch groups and was not found on any of the Triassic Peace River teeth. However, this vascularization was common on the elasmobranch scales. The basal face is approximately subperpendicular to the axis of the crown and contains a basal hollow from which a central canal opens to the exterior. Interior to this hollow and opening, are interconnecting canals that run parallel to the basal surface (Fig. 7E).

Holaulacorhize and polyaulacorhize vascularization (Fig. 7F, 7G) were not found on specimens from the Triassic Peace River samples.

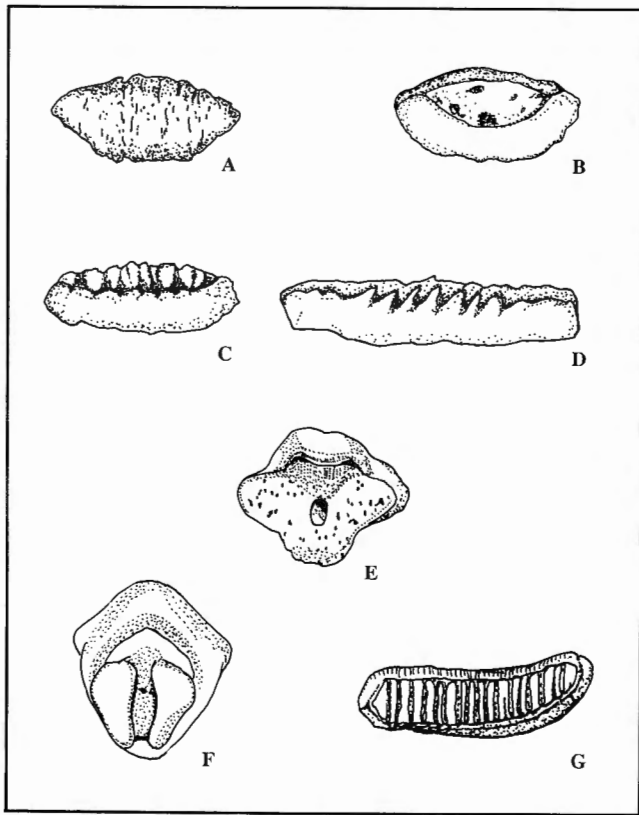
### Features of elasmobranch scales

Elasmobranch scales are hard mineralized components covering the exterior of the fish. They may be all one type (homosquamous) or variable in form (heterosquamous). Reif (1978b, c, 1982a, b, 1985a, b, 1988) found shark scale variation to be related to function. He concluded that different crown lineations, surface ornamentations, cusp arrangements, angles, thicknesses, etc. could have been developed to lessen drag resistance (improve locomotion), form sharp surfaces to discourage predation, produce thickened surfaces to resist abrasion, or yield specialized structures around tissues or organs to facilitate luminescence or assist in reproduction.

Elasmobranch scales (Fig. 8) consist of a crown or cap that is exposed externally and sits obliquely or horizontally on a pedicle or base. In many scales, the peak is positioned to the posterior and may have one or three cusps. The pedicle is composed of acellular bone that is embedded and attached in the upper layer of the dermis by collagen fibres (Reif, 1985a). On the Peace River specimens, the pedicle is narrowest near the crown and widens or flares towards its base. The base is



**Figure 6.** Chondrichthyan external tooth terminology: A) lingual view and B) labial view of the crown and root; C) occlusal view of the crown; D) profile view; and E) basal view of the root.



**Figure 7.** Stages of root vascularization: **A)** anaulacorhize stage; **B)** anaulacorhize stage with a concave lower labial root face; **C)** and **D)** pseudo-polyaulacorhize/anaulacorhize stage; **E)** hemiaulacorhize stage; **F)** holaulacorhize stage; **G)** polyaulacorhize stage (A, E, F, & G redrawn from Cappetta, 1987)

perforated by one or more canal openings. It is through these openings that the pulp maintains contact with the dermis and where blood vessels, nerves, etc. enter the scale pulp cavity.

Description and identification of Triassic elasmobranch scales has been included in papers by Stensiö (1921, 1932), Sykes et al. (1970), Sykes (1974b), Koehler (1975), Duffin and Gazdzicki (1977), Reif (1978b), and Duffin (1993a). The general paucity of literature on elasmobranch scales may have been caused by the complexity of identifying scales of heterosquamous sharks and mainly only having access to disarticulated elasmobranch collections. An extensive study by Reif (1985a) addressed details of crown features of Recent elasmobranch scales. In addition, he discussed and illustrated crown variability at different positions on the fish. In studying disarticulated materials, Johns (1993, 1996) recognized pedicle features useful for identifying Triassic elasmobranch scales. This conclusion was based on two types of scale pedicle, truncate and tetrahedroid (Fig. 9), in addition to other scale features (subpedicle surface outline, curvature and canal openings (Fig. 10); pedicle position and anterior crown overhang (Fig. 11); subcrown surface (Fig. 12); and features of the crown upper surface).

Changes in the Peace River elasmobranch scales were observed across the Carnian/Norian boundary (Johns, 1993, 1996). A hierarchy was proposed placing pedicle features at higher levels (useful for recognizing group characteristics) and crown features at lower levels (to identify species, forms, or types). This hierarchy is maintained for this study. An updated version of the key from Johns (1993, 1996) is provided (see *Key to Triassic Peace River elasmobranch teeth and scales*, below) and includes form generic and form species names in addition to supergroup, group, and subgroup descriptions.

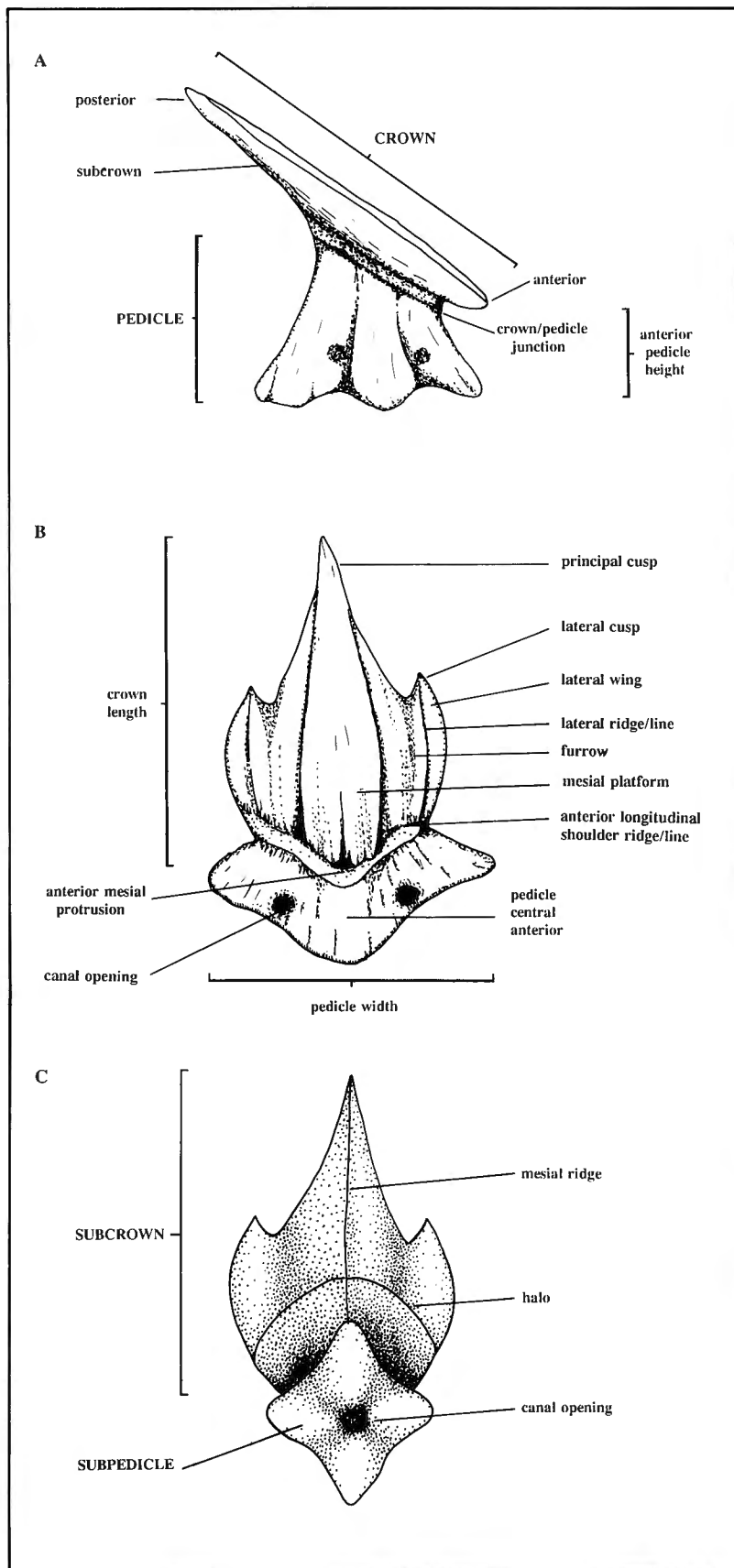
### **Early Mesozoic elasmobranch studies and classification**

Study of most fossil fishes has been stimulated by the discovery of the unusual exoskeletons or carapaces of Paleozoic agnathans and placoderms, and commonly preserved articulated endoskeletons of Paleozoic to Cenozoic bony fishes. Recovery of articulated skeletons of fossil elasmobranchs, however, is rare due to a weakly mineralized and poorly preserved cartilaginous skeleton. Instead, research on fossil elasmobranchs commonly has been limited to their harder mineralized disarticulated remains such as teeth, scales, and fin spines.

The first comprehensive documentation of fossil fishes and agnathans (including elasmobranchs) was presented in Agassiz's five volume set "Recherches sur les poissons fossiles" (1834-1844). This extensive and well presented work encouraged further study. Taxonomic work on Triassic elasmobranchs in the 1900s has focused on the description and identification of teeth and spines such as in: Evans (1904), Wemple (1906), Jordan (1907), Stensiö (1921, 1932), Schmidt (1928), Brough (1931, 1935), Nielsen (1936, 1952), Seilacher (1943), Stefanov (1966), Schaeffer (1967), Sykes et al. (1970), Sykes (1971, 1974a), Koehler (1975), Schaeffer and Mangus (1976), Duffin and Gazdzicki (1977), Reif (1977, 1978a, 1980), Duffin (1980, 1981, 1982a, b, 1985, 1993a, b), Johnson (1980), Tintori (1980), Murry (1981), Rieppel (1981, 1982), Maisey (1982, 1990), Thies (1982), Antunes et al. (1990), Duffin and Delsate (1993), and Liszkowski (1993).

Several classification systems have been proposed for elasmobranchs. Some of these systems date back to the 1800s as discussed in White (1938). Most classification systems today are based in part by that developed in Russia by L.S. Berg (1940, 1947). The systems including: Moy-Thomas (1939), Arambourg and Bertin (1958), Glickman (1964), Patterson (1965), Romer (1966), Blot, (1969), Moy-Thomas and Miles (1971), Nelson (1976, 1984), Zangerl (1981), Thies and Reif (1985), Cappetta (1987), Carroll (1988), and Frickhinger (1991) have evolved as new thinking on the evolution of elasmobranchs has matured. Glickman's classification system (1964) was based on the recognition of two infraclasses Osteodonti and Orthodonti. The Osteodonti have a tooth pulp cavity that is filled with osteodentine or trabecular dentine whereas the Orthodonti cavity is open and free of trabecular dentine. While Cappetta (1987) and others disputed this classification (indicating that closely related





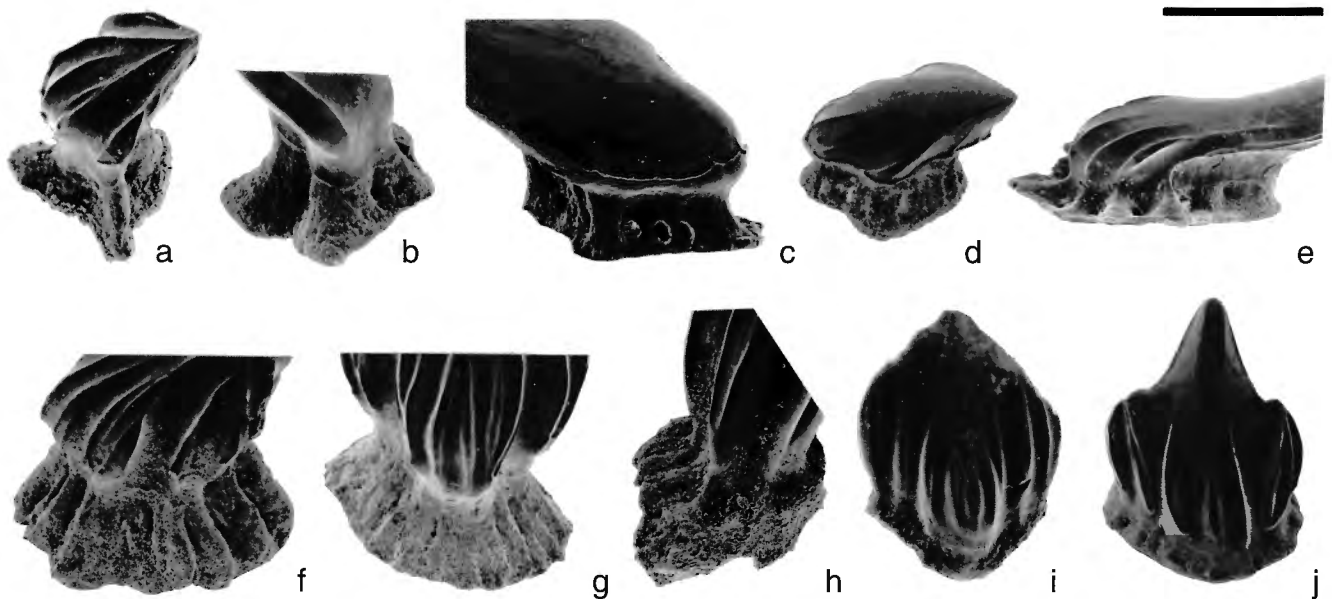
**Figure 8.**  
*Elasmobranch scale terminology: A) profile view; B) anterior and upper view of crown and pedicle; and C) subcrown and subpedicle view.*

forms were separated and nonrelated forms united), Glickman's system did promote further exploration of tooth and scale internal structure and histology.

Some classification systems suggested for elasmobranchs have dealt only with Recent forms (White, 1938; Compagno, 1973, 1977, 1984). The criteria used to describe and identify Recent forms in comparison to fossil forms may be different. For example, Recent faunas are whole animals and one can recognize and distinguish identifying characteristics of form and body colour, position of fins, specific anatomy of soft body components, and (or) details of the nasal cavity (Cappetta, 1987). Many of these features are not recognized or preserved in fossil fishes and therefore not useful. In

addition, small teeth and scales on modern or fossil articulated specimens are incompletely described at the level needed for micropaleoichthyological studies of disarticulated remains.

Other classification systems have integrated both Recent and fossil groups (Regan, 1906; Berg, 1947; Arambourg and Bertin, 1958; Blot, 1969; Nelson, 1976, 1984). Schaeffer (1964), using anatomical characters, segregated elasmobranchs into levels of organization (cladodont, hybodont, and modern) corresponding to evolutionary grades. Blot (1969) revised Schaeffer's terms to Cladodontiformes, Hybodontiformes, and Euselachiformes. Cappetta (1987) found this division unsatisfactory because: 1) Heterodontidae, Hexanchidae, and Anacoracidae were completely separated from



*Simple tetrahedroid:*

- a) *Ornatilabrilancea solicarina n. gen. et sp. s.f., Type B, GSC 105186, holotype, (see also Pl. 27, fig. 17), scale bar = 250  $\mu$ m.*
- b) *Fragilicorona tricuspis n. gen. et sp. s.f., GSC 105148, holotype, (see also Pl. 24, fig. 2), scale bar = 200  $\mu$ m.*

*Expanded tetrahedroid:*

- c) *Glabrisubcorona vadosidevexa n. gen. et sp. s.f., Type D, GSC 105195, paratype, (see also Pl. 33, fig. 12), scale bar = 250  $\mu$ m.*
- d) *Sacrisubcorona submedicarina n. gen. et sp. s.f., Type B, GSC 105226, holotype, (see also Pl. 30, fig. 13), scale bar = 400  $\mu$ m.*

*Expanded, stretched, and keeled tetrahedroid:*

- e) *Suaviloquentia longilingua n. gen. et sp. s.f., GSC 105239, holotype, (see also Pl. 37, fig. 8), scale bar = 350  $\mu$ m.*

*Fluted truncate:*

- f) *Undulaticorona profundifossae n. gen. et sp. s.f., GSC 105277, holotype, (see also Pl. 17, fig. 8), scale bar = 500  $\mu$ m.*
- g) *Coniunctio multirugosa n. gen. et sp. s.f., GSC 105261, paratype, (see also Pl. 20, fig. 14-15), scale bar = 550  $\mu$ m.*

*Plain truncate:*

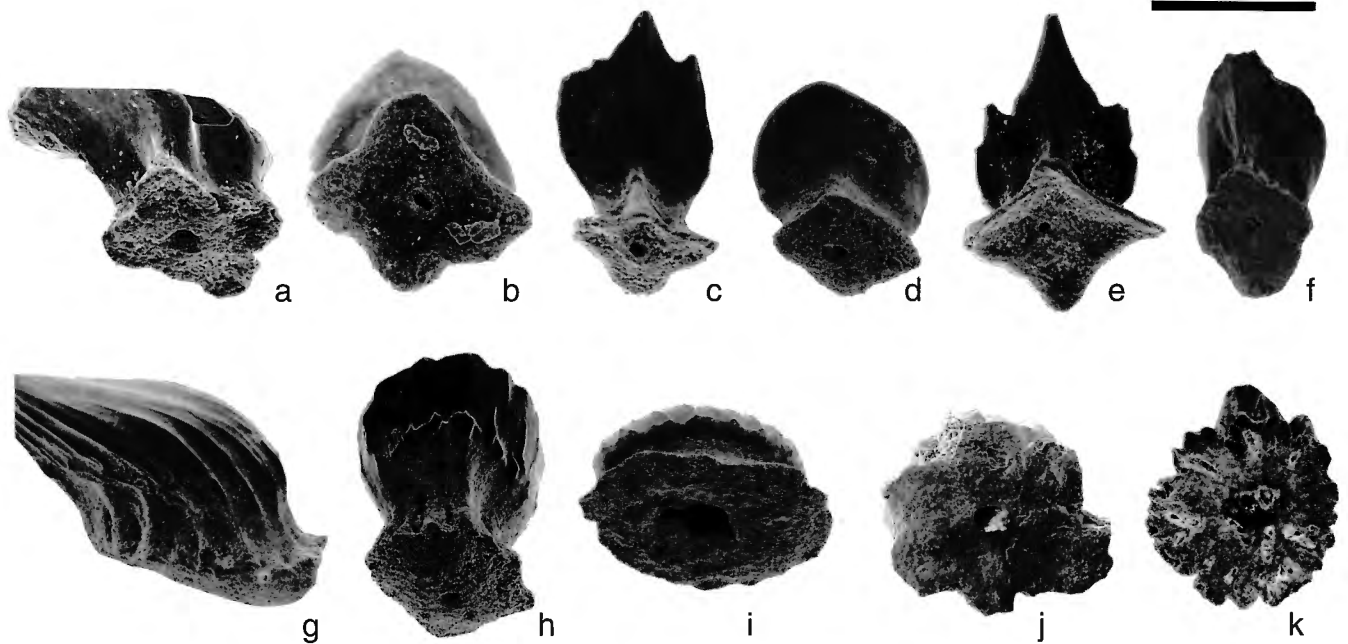
- h) *Labascicorona alata n. gen. et sp. s.f., Type A, GSC 105246, paratype, (see also Pl. 21, fig. 5), scale bar = 500  $\mu$ m.*
- i) *Labascicorona mediflexura n. gen. et sp. s.f., GSC 105149, paratype, GSC loc. C-101119 (BBR-311A), scale bar = 750  $\mu$ m.*
- j) *Labascicorona trifastigia n. gen. et sp. s.f., GSC 105256, holotype, (see also Pl. 22, fig. 6), scale bar = 770  $\mu$ m.*

**Figure 9.** Elasmobranch scale pedicle types.

the remaining forms; and 2) the number of orders (Selachii, Euselachii, and Rajiformes) was too reduced for the groups which interested paleoichthyologists.

Cappetta (1987) accepted Compagno's (1973) classification based on the morphology and anatomy of Recent genera and the recognition of four superorders (Squalomorpii, Squatinomorpii, Galeomorpii, and Batoidea). Cappetta emphasized the importance of studying elasmobranch dental features since they represent most of fossil elasmobranch remains. In addition, their detailed descriptions are necessary to differentiate a rather limited number of tooth types.

For the elasmobranch genera and species identified in this study, the classification system used by Cappetta (1987, p. 26-27) modified from Compagno (1973) and revisions to palaeospinacid sharks by Duffin and Ward (1993) were followed. The dental descriptions of Cappetta are particularly convenient. They contain more detail at the generic level than other systems, and provide an easier format to assist in preliminary identification of teeth.



*Tetrapetaloid* (showing 4 petal-like margins; surface flat or concave):

- a) *Fragilicorona labricuspis* n. gen. et sp. s.f., GSC 105147, paratype, (see also Pl. 23, fig. 13-14), scale bar = 200  $\mu$ m.
- b) *Fragilicorona brevirostrum* n. gen. et sp. s.f., GSC 105158 paratype, (see also Pl. 25, fig. 12-13), scale bar = 250  $\mu$ m.
- c) *Fragilicorona labritricuspis* n. gen. et sp. s.f., GSC 105375, paratype, GSC loc. C-101150 (MS-247A), scale bar = 250  $\mu$ m.

*Rhomboid* (surface flat [d], concave [e], convex [h] or convex with an anterior bulge [f,g]):

- d) *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f., Type A, GSC 105383, paratype, GSC loc. C-302390 (TE-220A), scale bar = 500  $\mu$ m.
- e) *Labrilancea glabrisubtricuspis* n. gen. et sp. s.f., GSC 105180, paratype, (see also Pl. 26, fig. 9), scale bar = 500  $\mu$ m.

- f) *Labascicorona alata* n. gen. et sp. s.f., Type C, GSC 105250, paratype, (see also Pl. 21, fig. 14), scale bar = 950  $\mu$ m.

- g) *Suaviloquentia brevilingua* n. gen. et sp. s.f., GSC 105236, holotype, (see also Pl. 37, fig. 7), scale bar = 500  $\mu$ m.

- h) *Coniunctio aequirugosa* n. gen. et sp. s.f., GSC 105384, paratype, GSC loc. C-101069 (BEH-3), scale bar = 500  $\mu$ m.

*Circular/sub-circular*:

- i) *Proprigalea mediglabra* n. gen. et sp. s.f., GSC 105280, holotype, (see also Pl. 16, fig. 1), scale bar = 500  $\mu$ m.

*Multipetaloid* (showing multiple petal-like structures at margins; surface flat or concave):

- j) *Lobaticorona floridibasis* n. gen. et sp. s.f., GSC 105289, paratype, (see also Pl. 14, fig. 18), scale bar = 250  $\mu$ m.
- k) *Parvidiabolus convexus* n. gen. et sp. s.f., GSC 105269, paratype, (see also Pl. 18, fig. 5), scale bar = 700  $\mu$ m.

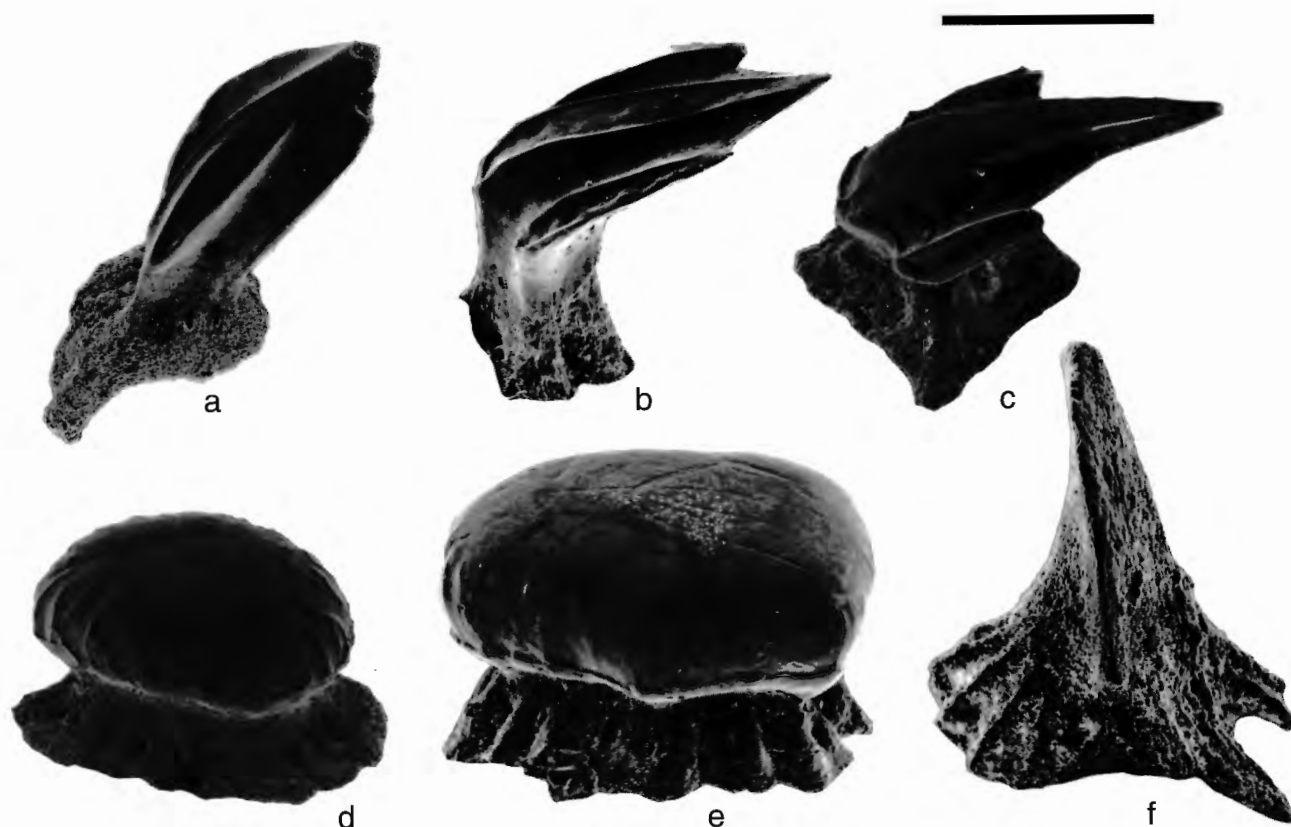
**Figure 10.** Elasmobranch scale subpedicle surface.

**Evolutionary relationships and stratigraphic distribution of Triassic Peace River elasmobranchs**

**History of elasmobranch evolutionary studies**

A history of early work on elasmobranchs (including their evolution) is summarized in White (1938). Shortly after, Moy-Thomas (1939) concluded that early Paleozoic elasmobranchs became divided into two groups – Selachii and Bradyodonti. Schaeffer (1964) proposed an initial cladodont level followed by a hyodontoid radiation, and then a modern level radiation of the galeoids, squaloids, and batoids. Zangerl (1973) suggested that the Paleozoic elasmobranch radiation consisted of six shark designs (anacanthous, phalacanthous, squatinoid, edestoid, xenacanthid, and bradyodont)

and that Mesozoic and Recent elasmobranchs probably originated from phalacanthous forms. Further, Maisey (1975) indicated the dominance of the hyodonts in the Mesozoic resulting in the decline of the ctenacanth in the Triassic followed by the establishment of the neoselachians (which eventually displaced the hyodonts in the Jurassic and Cretaceous). Cladistic analyses by Schaeffer and Williams (1977) led to conclusions that Elasmobranchii and Holocephali are sister groups and that chondrichthyans are more closely related to acanthodians and osteichthyans than to placoderms. They also presented relationships of *Xenacanthus*, *Danaea*, *Cladoselache*, *Hybodus*, *Ctenacanthus*, and *Palaeospinax* based on skeletal structures.



*Pedicle anterior; no anterior crown overhang:*

a) *Labascicorona alata* n. gen. et sp. s.f., Type B, GSC 105247, holotype, (see also Pl. 21, fig. 6), scale bar = 550  $\mu$ m.

*Pedicle anterior; minor anterior crown overhang:*

b) *Fragilicorona labritricuspis* n. gen. et sp. s.f., GSC 105376, paratype, GSC loc. C-101114 (BBR-305B), scale bar = 250  $\mu$ m.

*Pedicle anterior; prominent anterior crown overhang:*

c) *Labrilancea glabrisubtricuspis* n. gen. et sp. s.f., Type A, GSC 105177, holotype, (see also Pl. 26, fig. 8), scale bar = 200  $\mu$ m.

*Pedicle subcentral; prominent crown overhang on all margins:*

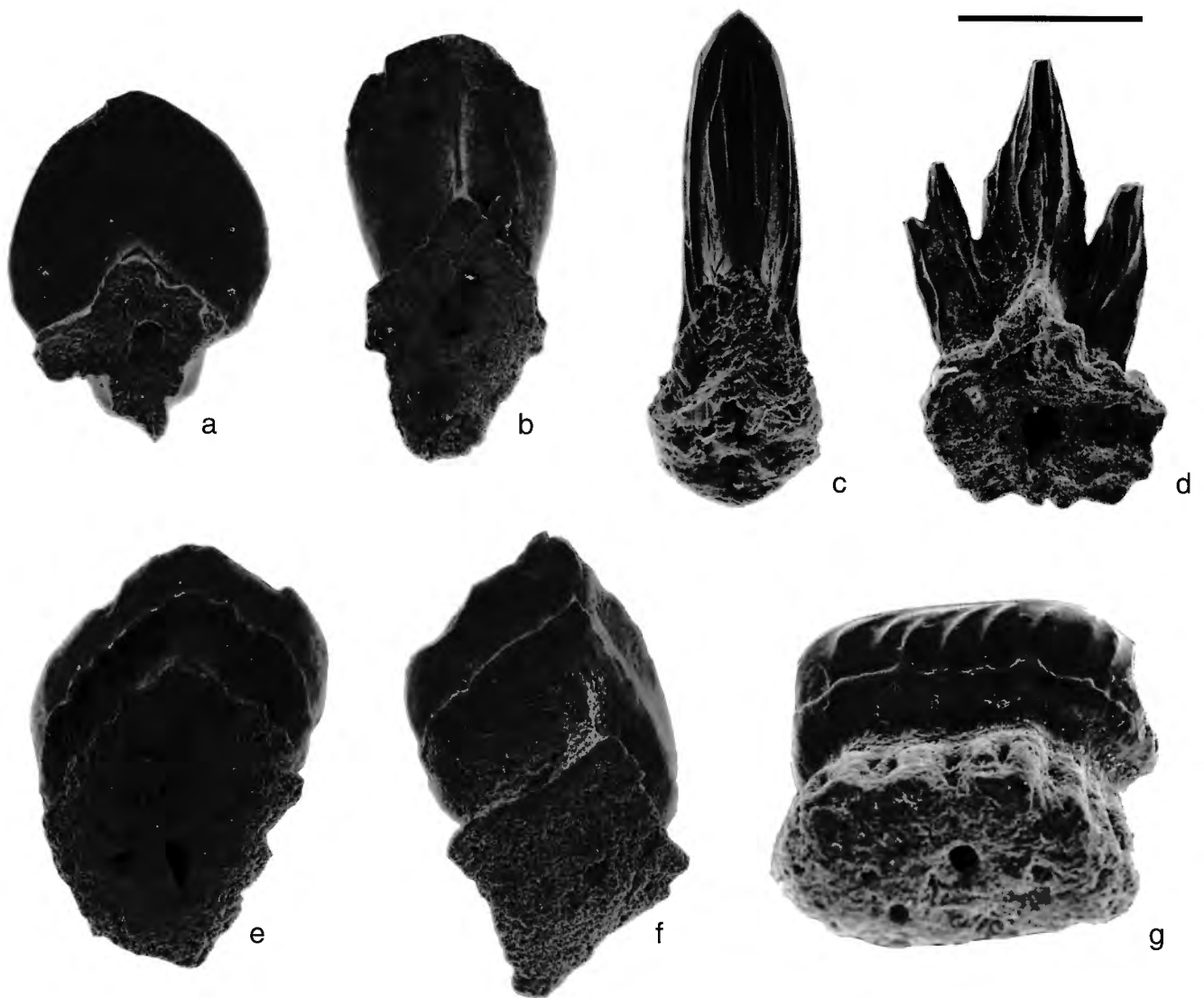
d) *Proprigalea mediglabra* n. gen. et sp. s.f., GSC 105377, paratype, GSC loc. C-101069 (BEH-3), scale bar = 400  $\mu$ m.

e) *Complanicorona rugosimargines* n. gen. et sp. s.f., GSC 105378, paratype, GSC loc. C-101119 (BBR-311A), scale bar = 500  $\mu$ m.

*Pedicle supracentral; no crown overhang, crown same width as pedicle:*

f) *Parviscapha univelum* n. gen. et sp. s.f., GSC 105296, holotype, (see also Pl. 13, fig. 13), scale bar = 350  $\mu$ m.

**Figure 11.** Elasmobranch scale crown position on the pedicle and overhang of the crown/pedicle junction.



- a) *Smooth and unornamented*, *Glbrisubcorona vadosidevexa* n. gen. et sp. s.f., Type B, GSC 105192, paratype, (see also Pl. 33, fig. 4-5), scale bar = 250  $\mu$ m.
- b) *One mesial (central) ridge or keel*, *Labascicorona alata* n. gen. et sp. s.f., Type B, GSC 105251, paratype, (see also Pl. 21, fig. 15), scale bar = 500  $\mu$ m.
- c) *Many long ridges and a broad mesial keel*, *Suaviloquentia longilingua* n. gen. et sp. s.f., GSC 105380, paratype, GSC loc. C-101036 (MS-3), scale bar = 350  $\mu$ m.
- d) *Many long ridges and a mesial keel*, *Parvidiabolus longisulcus* n. gen. et sp. s.f., GSC 105274, holotype, (see also Pl. 18, fig. 8), scale bar = 500  $\mu$ m.
- e) *Halo*, *Sacrisubcorona circabasis* n. gen. et sp. s.f., Type F, GSC 105222, holotype, (see also Pl. 29, fig. 16-18), scale bar = 450  $\mu$ m.
- f) *Halo and rounded mesial keel or ridge*, *Ornatilabrilancea circacarina* n. gen. et sp. s.f., Type B, GSC 105183, holotype, (see also Pl. 27, fig. 5), scale bar = 250  $\mu$ m.
- g) *Upper crown ridges curve under to subcrown halo*, *Complanicorona rugosimargines*, GSC 105382, paratype, GSC loc. C-101119 (BBR-311A), scale bar = 200  $\mu$ m.

**Figure 12.** Elasmobranch scale subcrown surface.

Relationships of Mesozoic elasmobranchs were further explored as interest grew on the transition of the more primitive elasmobranchs to the neoselachians. Maisey (1982) claimed that hybodonts and neoselachians were sister groups. He also indicated (Maisey, 1981) that some forms of ctenacanth dorsal spines were similar to those of hybodonts and neoselachians. Thies and Reif (1985) did not make any commitments on the hybodonts being a sister group of, or an ancestor to, the neoselachians. However, they did acknowledge that there was no known taxon linking the groups. The range of the hybodonts was from the Carboniferous to the Cretaceous (Andrews et al., 1967; Maisey, 1982) whereas the oldest known neoselachian had been traced to the Early Triassic (Thies, 1982; Thies and Reif, 1985). Also during this time, Duffin and Ward (1983) discovered Early Carboniferous and Early Permian neoselachian teeth and extended the range of the cohort downwards. To date, relations between neoselachians and other groups remains obscure.

Radiations of the various elasmobranch groups are illustrated in Carroll (1988) (from Compagno, 1977 and Zangerl, 1981) showing the initial expansion of the Elasmobranchii and Holocephali in the Devonian through the Permian, the dominance of the hybodonts through the Mesozoic, and a neoselachian radiation in the Upper Mesozoic giving rise to today's species.

### Peace River hybodont teeth

Hybodont (Superfamily Hybodontioidea) shark's teeth recovered from the Triassic Peace River samples included specimens from the families Acrodontidae and Polyacrodontidae. No representatives of the Hybodontidae (e.g. *Hybodus*), previously described from other Triassic localities, were recovered. The absence of the Hybodontidae appears to be in part attributed to new observations and definitions of some of the hybodonts and neoselachians. Interpretations based on observations of tooth histology by Reif (1973, 1974b, 1977, 1978a, 1980) found triple layered enameloid was present in neoselachians and absent in hybodonts (having only single crystallite enameloid). In addition, root furrows or channelling were found to be diagnostic of palaeospinacids (Duffin, 1987). In some neoselachians an arcuate root basal surface and pseudo-polyaulacorhize-anulacorhize root vascularization (Fig. 7B, C, D) was common (Duffin, 1981; Thies and Reif, 1985; Duffin and Ward, 1993).

Two recent papers have dealt with the above new and other observations resulting in complete reassessment of a genus of an Early Mesozoic hybodont – *Lissodus* (Polyacrodontidae) (Duffin, 1985) and a neoselachian – *Synechodus* (Palaeospinacidae) (Duffin and Ward, 1993). Johnson (1981, p. 4) commented that hybodont taxonomy was in "serious need of review". This observation remains particularly evident for the Triassic hybodont shark genera *Hybodus*, *Acrodus*, and *Polyacrodus*.

A questionable form of Acrodontidae (*Acrodus?* sp. 1) was recovered from the Peace River samples and compared to *Palaeobates* (Polyacrodontidae) and *Asteracanthus* (Acrodontidae). The choice of *Acrodus* over *Palaeobates* and

*Asteracanthus* was made on general tooth morphology and histology (see *Acrodus?* sp. 1 description below, and Rieppel, 1981). In the Peace River samples, *Acrodus?* sp. 1 has a short range and was only found in the *Metapolygnathus nodosus* conodont Zone (*S. multinodosus* ichthyolith Zone in part).

A Peace River species of *Polyacrodus* was recognized by a moderately low pyramidal principal cusp and crown ridges that extend from the occlusal crest to the shoulders. It did not have a prominent crown labial peg or protrusion. *Polyacrodus contrarius* n. sp. is rare in several samples and ranges from the Ladinian to the lowermost Lower Carnian.

### Peace River neoselachian teeth

Triassic neoselachians are limited to a few genera such as *Synechodus*, *Reifia*, *Hueneichthys*, *Vallisia*, and *Raineria* (Reif, 1977; Duffin, 1980, 1982a, b; Thies, 1982; Thies and Reif, 1985; Cappetta, 1987). New discoveries of Triassic neoselachians are particularly exciting because previous finds are not common and new material could help our understanding of the relationships of earlier neoselachians.

A palaeospinacid, *Synechodus incrementum* n. sp., was found in the Peace River Middle Norian samples. This species is rare in the Lower Norian and abundant in the Middle Norian. It has considerable tooth crown heterodonty and because it may have an elongate principal cusp, it could be considered similar to some *Hybodus* species. The generic identity of *Synechodus* for the Peace River specimens was favoured based on the presence of parallel structured enameloid (suggesting the possibility of triple layered enameloid), canal channelling on the root base, and canal notches of the root labial face rim. These features are considered diagnostic of neoselachians and are not found in hybodonts such as *Lissodus*, *Hybodus*, and others (Reif, 1973; Maisey, 1977; Duffin, 1981, 1985, 1987; Rieppel, 1981; Thies and Reif, 1985; Duffin and Ward, 1993).

Important discoveries were the teeth of a new species, *Synechodus multinodosus*. It has a moderately limited range in the Upper Carnian for this region, where it was rare in the Upper *Metapolygnathus nodosus* and abundant in the *Metapolygnathus communisti* conodont zones. The teeth show heterodonty with a long principal cusp on some specimens and a reduced principal cusp with a laterally elongated crown on others. In addition, they have prominent nodes along the crown lingual and labial shoulders which may develop into a peg. *S. multinodosus* n. sp. teeth have triple layered enameloid and specialized root canal openings typical of the neoselachians.

An unusual palaeospinacid, *Synechodus volaticus* n. sp. was found in the Peace River Carnian and Ladinian samples. The specimens are small (commonly less than 400 µm) and have a prominent labial shoulder rim, and labial and lingual nodes. They are usually rare, except in a few Ladinian samples where they were common. The presence of and arcuate root with pseudo-polyaulacorhize – anulacorhize vascularization, and triple layered tooth enameloid establishes this group as neoselachian.



## Discussion

The Peace River samples are not in a single sequence and the identifiable elasmobranch tooth specimens are generally not abundant. Relationships between the species in this region are speculative. However, the pattern of their distribution might indicate a restricted range related to environment or competition for prey. For example, the hybodont *Polyacrodus contrarius* n. sp. and the neoselachian *Synechodus volaticus* were found in the Ladinian and Carnian; specimens of *Acrodus?* sp. 1 and *S. multinodosus* n. sp. appear to be restricted to the Upper Carnian; and *S. incrementum* n. sp. ranged mainly in the Middle Norian. Close similarities of external tooth crown morphology among the Peace River elasmobranchs was not apparent. Therefore, a shared ancestor is probably in the more distant past such as in the Early Triassic or Late Paleozoic.

## Elasmobranch scales and dermal denticles

Changes in the Peace River elasmobranch scales occur near the Carnian/Norian boundary. There is a dramatic termination or decrease in diversity and abundance of faunas. The cause for this event is unknown but may reflect a change from shallower to deeper water conditions as indicated by the lithologies of the Charlie Lake, Baldonnel, and Pardonet formations. Also during this time, conodonts had widespread changes in their populations and taxa (Orchard, 1991a; pers. comm., 1992).

Most of the Ladinian and Carnian ichthyoliths are characterized by a truncate pedicle (Johns, 1996). Only the truncate forms *Lobaticorona floriditurris* n. sp. s.f., *L. floriditabella* n. sp. s.f., and *L. floridibasis* range well up into the Norian and *Lobaticorona tumiditurris* n. sp. s.f. and *Sacrisubcorona submedicarina* n. sp. s.f. extend just into the base of the Norian. The *Lobaticorona* form genus shows a transition noted in many of the elasmobranch scales where the pedicle base in Ladinian and Carnian specimens is commonly convex or convex with a bulge (such as found in *Lobaticorona tumiditurris* n. sp. s.f.) and in the Norian scales (such as in *Lobaticorona floriditurris* n. sp. s.f.) the pedicle base is flat or concave. Additional features of Ladinian and Carnian elasmobranch scales include: 1) a pedicle base outline that is rhomboid, multipetaloid, or approximately cycloid; and 2) a subcrown that is commonly ornamented with ridges or lines and (or) a halo.

Figure 13 illustrates patterns observed for the pedicle and subcrown of various elasmobranch scale form species in the Ladinian/Carnian and the Norian. Most of the truncate pedicle types either have a multipetaloid or rhomboid pedicle base outline. If the pedicle is truncate and multipetaloid, then the pedicle base surface is flat or concave. However, if the pedicle is truncate and rhomboid then the pedicle base is convex with a bulge, convex, or rarely flat.

Tetrahedroid pedicle types are found in the Ladinian, Carnian, and Norian (with about half the number of elasmobranch scale form species in the Norian). Ladinian and Carnian tetrahedroid pedicle types have a rhomboid pedicle base outline that is convex with a bulge, convex, or rarely flat.

Norian tetrahedroid elasmobranch scales have a subpedicle surface that is flat or concave and either have a tetrapetaloid or rhomboid (may have concave sides) pedicle margin outline. Subcrown ornamentation of tetrahedroid types may vary but there is a tendency towards less ornamentation in the Norian (with a number of species with no subcrown ornamentation).

The choice of closely related truncate pedicle type elasmobranch scale form taxa in this study is usually determined by a few diagnostic and similar characters. For example, *Parvidiabolus* n. gen. s.f. has an almost erect crown with ridges on its upper and lower surfaces and a fluted truncate pedicle with a concave multipetaloid base; *Duplisuggestus* n. gen. s.f. has closely paired platform ridges or lines and a fluted truncate pedicle; and *Labascicorona* n. gen. s.f. has a plain truncate pedicle, a subcrown usually with one mesial ridge, and a convex rhomboid pedicle base with a bulge. Figure 4 illustrates groupings of the form genera and some of their shared and different features. The relationships of the Ladinian and Carnian truncate form genera are unknown at this time because they appear to have evolved from an ancestral stock older than the Ladinian samples collected in this study.

No cladistic analyses were completed in this study, so that when potential relationships between forms are discussed below they are based on observations of morphological similarities.

Several new Norian form genera and species were observed. Some of these may have been derived from Carnian and Ladinian forms. For example, from observing their distribution and distinct appearance, *Suaviloquentia longilingua* n. sp. s.f. probably evolved from *S. obliquilingua* or *S. brevililingua*; and *Complanicorona subrugosa* likely developed from *C. glabra* n. sp. s.f. or *C. rugosimargines* n. sp. s.f. The remainder of tetrahedroid pedicle types are divided into two large groups where the upper crown ridges or lines are either long (extend to the posterior margin) or short (near the anterior margin).

*Fragilicorona* n. gen. s.f. has long upper crown ridges, a steeply oblique crown, and an unornamented subcrown surface. Possible Ladinian/Carnian related groups could be: 1) *Gracilisuggestus* n. gen. s.f. that has the same former two features but has a subcrown mesial ridge; 2) *Labrilancea* n. gen. s.f. that has a similar unornamented subcrown and long upper crown ridges or lines but has a more prominent anterior shoulder longitudinal ridge and does not have a steeply oblique crown; or 3) *Minuticorona* n. gen. s.f. that also has a similar unornamented subcrown and commonly has long upper crown ridges or lines but the crown has a prominent anterior shoulder overhang of the crown/pedicle junction, is less steeply oblique, and is flattened anterior to posterior and side edge to side edge.

*Rugosicorona* n. gen. s.f. is distinct in the Norian with its generally long upper crown ridges that are similarly raised and spaced, a steeply erect crown, a tetrahedroid pedicle, and a subcrown ornamented with mesial and other ridges or lines. The long upper crown and subcrown ridges and the almost



erect nature of the crown suggest an affiliation with *Parvidiabolus* n. gen. s.f. where they mainly differ in their pedicle types.

*Ornatilabrilancea* n. gen. s.f. is characterized by long upper crown ridges or lines, a shallowly oblique crown and a subcrown mesial ridge. *Ornatilabrilancea solicarina* n. sp. s.f. (Norian) probably evolved from *O. circacarina* n. sp. s.f. (Ladinian and Carnian) as the former only differs from the latter by not having a subcrown halo and by having a flat (not convex) rhomboid pedicle basal surface.

Short upper crown ridges or lines are typical on *Glabrisubcorona* n. gen. s.f., *Carinasubcorona* n. gen. s.f., and *Sacrisubcorona* n. gen. s.f. The form species of *Glabrisubcorona* n. gen. s.f. all have an unornamented subcrown surface. *G. vadosidevexa* n. sp. s.f., *G. tendibasis* n. sp. s.f., and *G. arduidevexa* n. sp. s.f. are all restricted to the Norian, whereas *Glabrisubcorona?* sp. 1 is found in the Ladinian and Carnian and could be the form from which the former three species were derived. Other options might include *Minuticorona* n. gen. s.f. or *Labrilancea* n. gen. s.f. but their upper crown ridges or lines are long. *Sacrisubcorona* n. gen. s.f. has subcrown ornamentation but is otherwise similar to *Glabrisubcorona* n. gen. s.f.

*Sacrisubcorona* n. gen. s.f. (with subcrown ornamentation of a halo and mesial ridge, or halo only) is probably more closely related to *Carinasubcorona* n. gen. s.f. (which only has a subcrown mesial ridge). These faunas show the typical Ladinian/Carnian transition from the convex or convex with a bulge pedicle base to the Norian flat or concave type.

### Discussion

In this study, there were a large number of different types of elasmobranch scales and significantly fewer numbers of different elasmobranch teeth (Fig. 4). This distribution could be the result of one or more of the following factors:

1. elasmobranch teeth may be larger than scales and may not be well represented in the microfossil residues (sample residues were sieved at 1 mm mesh openings and only the fines portion studied);
2. the form taxonomy method may result in naming more species than the binomial taxonomic system because parts are named instead of the whole organism;
3. elasmobranchs may have greater scale than tooth variation on an individual fish;

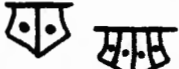
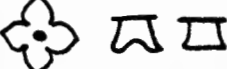



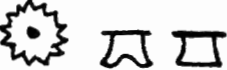
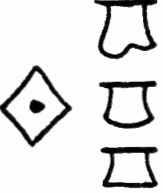

AGE	PEDICLE TYPE	PEDICLE BASE OUTLINE & CURVATURE		SUBCROWN ORNAMENTATION
		PETALOID	RHOMBOID	PEDICLE ANTERIOR & SIMPLE OR EXPANDED TETRAHEDROID
NORIAN	TETRAHEDROID 	TETRAPETALOID 	CONCAVE or FLAT 	LESS ORNAMENTED 
LADINIAN & CARNIAN	TRUNCATE 	MULTIPETALOID 	CONVEX or FLAT 	MORE ORNAMENTED 

Figure 13. Features of elasmobranch scale pedicles and subcrowns illustrating differences in Ladinian and Carnian ichthyoliths from those in the Norian (from Johns, 1996).

4. elasmobranchs may have a greater number of scales than teeth on an individual fish (some elasmobranchs may not have teeth); and
5. elasmobranch teeth may have fewer diagnostic features than scales.

All these possibilities need to be further explored and tested. While additional work was beyond the scope of this project, looking at coarse sample residues, samples from different regions, and comparing faunal data and information to results in this project would be an appropriate place to begin a new study.

### *Taxonomic methods*

Recovery of disarticulated remains of fishes has increased considerably as a result of their discovery in residues from which other fossils (e.g. conodonts) are recovered. Determining diagnostic features of ichthyoliths, so that distinct forms may be recognized, is becoming increasingly important in biostratigraphic studies. For an identification to be made and the Linnaean binomial system to work, links need to be made between disarticulated remains and identified articulated specimens such as those in type collections. In addition, descriptions of teeth and scales from type specimens, and articulated specimens paleoichthyologists are currently studying, need to be revised and expanded to include more diagnostic information.

Classification of disarticulated faunas can pose problems if an identification cannot be made when the material cannot be compared to known articulated species. The risk in basing a new species name on a disarticulated material, involves the high probability that many specimens may be from the same species and therefore a species could be given several names. Looking back in literature such as that on Mesozoic hybodonts, it is quite common to find several names applied to different tooth forms which are probably from the same species.

When unidentified species are few, informal naming can be accomplished by calling a species, for example, "unidentified elasmobranch tooth sp. 1". However, this becomes awkward and complex if there are many species and the group is demonstrated to be useful such as for stratigraphic zonation or correlation and dating of sedimentary rocks. Alternative methods need to be used to conveniently recognize and identify these fossils until a binomial identification is confirmed.

In this study, binomial systematics, form taxonomy, and a utilitarian identification system were used and integrated. Each is discussed below.

1. All the elasmobranch teeth were identified to the generic level using the traditional Linnaean (binomial nomenclature) system whenever the identification could be confirmed based on literature and type specimens. When a species remained uncertain, the informal designation of sp. 1, sp. 2, etc. was applied. Nomenclature rules are documented by the International Trust for Zoological Nomenclature (1985).

2. None of the elasmobranch scales (dermal denticles) could be identified in the traditional fashion. Scale number and diversity was considerable in the study samples. In addition, there was the possibility that some forms may belong to the same species. The nomenclature system of "form taxa" was adopted in addition to group designations at higher hierarchic levels. The form taxonomy system provides names for components (e.g. tooth, scale, or bone) instead of a whole organism. Naming and nomenclature is similar to the Linnaean binomial system format.

The form taxon system has been applied in conodont systematics. Conodonts are dental and jaw fragments believed to belong to a group of primitive chordates. Since 1966 as conodont collections became substantial, attempts have been made to recognize multi-element taxa (bringing together all the form elements which belong in the same dental apparatus).

Barnes and Poplawski (1973) refer to individual morphotypes by using the binomial name followed by the suffix "s.f." (*sensu formo*). Other suffixes after a name continue to follow the rules of Latin terminology, abbreviations in Schenk and McMasters (1956), and those outlined by the International Trust for Zoological Nomenclature (1985).

3. Utilitarian identification provides a unique alternative system to recognize ichthyoliths based strictly on specimen morphology and with no implications for biological relationships or function (Doyle et al., 1974; Doyle and Riedel, 1979). Since this system has been used by some researchers and shows promise for computer database applications, the utilitarian code is provided for all species and form taxa. Revisions to the utilitarian coded system, so that Triassic forms from the Peace River area may be recognized, are included in Appendix 3.

Coded utilitarian identification of microscopic disarticulated fish fossils was initiated by Doyle et al. (1974). They were continuing studies started by Helms and Riedel (1971) using ichthyoliths for biostratigraphic correlation of pelagic clays otherwise lacking fossils. An identification system was necessary to flexibly handle the variety of ichthyolith specimens. They contended that when the true binomial identity of the fishes could not be obtained from the fragments recovered, that an artificial (or utilitarian) system should be adopted until the identity could be made. Their system is based on describing skeletal debris in two dimensions (as seen in transmitted light), carries no implications for biological relationships or function, and is computer compatible. It is based on "Types" describing specimen outline and prominent features, and "Subtypes" with a variety of features important to the unique identity of the Type. The main component of the system is a string of letters and numbers which are a code to each of the descriptors. A Subtype identification generally includes the code, plate and figures, a colloquial name (descriptive name assigned to a Subtype, e.g. triangle hooked margin), and a summary of the diagnostic characters.

Success in applying this system for recognizing deep sea ichthyoliths and correlating sediments is demonstrated by the many papers published using the system (Dengler et al., 1975; Dunsworth et al., 1975; Ramsey et al., 1976; Doyle et al., 1977, 1978; Edgerton et al., 1977; Doyle and Riedel, 1979, 1980, 1981, 1985a, 1985b; Kozarek and Orr, 1980; Kaneps et al., 1981; Gottfried et al., 1984a, 1984b; Tway et al., 1985; Gebhardt, 1986; Hart and Mountain, 1987; Winfrey et al., 1987, Doyle, 1988).

Tway (1977, 1979, 1982a, 1984) and Tway and Zidek (1982, 1983) modified and applied the two dimensional (2D) utilitarian system to incorporate three dimensional (3D) features so that ichthyoliths recovered from conodont and other microfossil limestone and argillaceous samples could be identified. In addition, Riedel and Tway (1989) and Tway (1991, 1992) have developed "Expert" computer applications for paleontology and stratigraphy. Part of their applications include a computer module (FossilWise) that is in part a key to identify ichthyoliths based on the utilitarian 2D and 3D systems. In addition, the system can include the more traditional binomial names (when known) and incorporate graphic images of specimens introducing capabilities for a tremendous database, image, and key identification computer system for ichthyoliths.

The biggest advantage of the utilitarian system includes the direct application onto a computer and the development of a database and graphic illustrated key. With an increase in the number of described species, forms, or types, a computer system becomes very attractive. In addition, as computers and programming advance, the capabilities of "Expert" systems could, for example, provide quick links to similar genera or species, geological age estimates based on known taxa ranges, information on taxa distributions, a key for preliminary identification by nonexperts, and confirmations on accuracy of data input (L.E. Tway, pers. comm., 1992).

### **Key to Triassic Peace River elasmobranch teeth and scales**

Descriptions of Triassic Peace River elasmobranch ichthyoliths are based on external morphological features and internal histological structure. Ichthyoliths are grouped, and genera, species, and forms described in this study are listed below. In addition, elasmobranch scales are organized into a proposed hierarchy (Johns, 1993, 1996) and arranged as a key (including brief diagnostic features) to simplify recognition of the form genus.

#### **Section IA. Elasmobranch teeth**

- Acrodus?* sp. 1 (Pl. 1).
- Polyacrodus contrarius* n. sp. (Pl. 2-3).
- Synechodus incrementum* n. sp. (Pl. 4-7).
- Synechodus multinodosus* n. sp. (Pl. 8, 10, Pl. 9, fig. 1-12).
- Synechodus* cf. *multinodosus* n. sp. (Pl. 9, fig. 13-17).
- Synechodus volaticus* n. sp. (Pl. 11, fig. 9-22; Pl. 12).
- Synechodus* sp. 1 (Pl. 11, fig. 1-5).
- Synechodus* sp. 2. (Pl. 11, fig. 6-8)

#### **Section IB. Elasmobranch scales (all new form genera and species: 19 form genera and 53 form species)**

- Part 1. Pedicle vascularization anaulacorhize
- Part 2. Pedicle vascularization hemiaulacorhize

##### **Supergroup I. Pedicle truncate**

###### **Group A. Pedicle fluted truncate**

Subgroup 1. Pedicle supracentral; crown erect; pedicle base outline circular to oval, may have undulating margins.

- 1a. Crown sail-like, surface commonly granular; subpedicle surface flat to concave; *Parviscaptha* n. gen. s.f. (Pl. 13), *P. trivela* n. sp. s.f., *P. univelum* n. sp. s.f.

Subgroup 2. Pedicle subcentral; crown erect, may have flat upper surface; pedicle base outline multipetaloid, circular, or rhomboid.

- 2a. Crown lobate; subpedicle surface flat, concave or convex; *Lobaticorona* (Pl. 14-15), *L. floriditurris* n. sp. s.f., *L. floriditabella* n. sp. s.f., *L. floridibasis* n. sp. s.f., *L. tumiditurris* n. sp. s.f., *L. tumiditabella* n. sp. s.f., *L. tumidibasis* n. sp. s.f.

- 2b. Crown dome-shaped; pedicle base outline circular to rhomboid and may have undulating margins; subpedicle surface flat, concave or convex; *Proprigalea* n. gen. s.f. (Pl. 16; Pl. 17, fig. 9-15), *P. languidula* n. sp. s.f., *P. mediglabra* n. sp. s.f., *P. medirugosa* n. sp. s.f.

Subgroup 3. Pedicle anterior; crown inclined may be steeply inclined to almost erect; pedicle base outline multipetaloid, circular, or rhomboid and may have undulating margins.

- 3a. Crown lanceolate to circular with ridges curving over undulating margins; subpedicle surface flat or concave; *Undulaticorona* n. gen. s.f. (Pl. 17, fig. 1-8), *U. propensa* n. sp. s.f., *U. profundifossae* n. sp. s.f.

- 3b. Crown lanceolate, steeply inclined to almost erect with long multiple upper and subcrown ridges; subpedicle surface concave; *Parvidiabolus* n. gen. s.f. (Pl. 18), *P. obliquus* n. sp. s.f., *P. acutus* n. sp. s.f., *P. convexus* n. sp. s.f., *P. longisulcus* n. sp. s.f.

- 3c. Crown lanceolate and steeply inclined with multiple paired ridges; subpedicle surface flat, concave or convex; *Duplirugosus* n. gen. s.f. (Pl. 19), *D. duplirugosus* n. sp. s.f., *D. profundisulcus* n. sp. s.f.

- 3d. Crown lanceolate with multiple long upper crown ridges and anterior overhang; subcrown with ridges, may have halo; subpedicle surface flat, concave or convex; *Coniunctio* n. gen. s.f. (Pl. 20), *C. aequirugosa* n. sp. s.f., *C. multirugosa* n. sp. s.f.

###### **Group B. Pedicle plain truncate**

Subgroup 1. Pedicle anterior; crown inclined; pedicle base outline rhomboid.

- 1a. Crown lanceolate; subpedicle surface convex or convex with bulge; subcrown with mesial keel or ridge, may have other ridges; *Labascicorona* n. gen. s.f. (Pl. 21; Pl. 22, fig. 1-7), *L. alata* n. sp. s.f., *L. longifossae* n. sp. s.f., *L. mediflexura* n. sp. s.f., *L. nitidifastigia* n. sp. s.f., *L. trifastigia* n. sp. s.f.

Supergroup II. Pedicle tetrahedroid

Group A. Pedicle simple or expanded tetrahedroid

Subgroup 1. Pedicle anterior; crown inclined lanceolate with long upper crown ridges and furrows; pedicle base outline tetrapetaloid, rhomboid, or stretched rhomboid; crown anterior overhang absent or minor.

- 1a. Subcrown with mesial ridge or keel and additional ridges; subpedicle surface flat or concave; *Rugosicorona* n. gen. s.f. (Pl. 28, fig. 9-13), *R. devexa* n. sp. s.f.  
 1b. Subcrown with mesial ridge or keel; subpedicle surface flat or convex; *Gracilisuggestus* n. gen. s.f. (Pl. 22, fig. 8-15), *G. triapices* n. sp. s.f., *G. uniapex* n. sp. s.f.  
 1c. Subcrown unornamented; subpedicle surface flat or concave; *Fragilicorona* n. gen. s.f. (Pl. 23-25), *F. labricuspis* n. sp. s.f., *F. brevirostrum* n. sp. s.f., *F. labribrevirostrum* n. sp. s.f., *F. labritricuspis* n. sp. s.f., *F. tricuspis* n. sp. s.f., *F. unicuspis* n. sp. s.f.

Subgroup 2. Pedicle anterior; crown inclined lanceolate with long upper crown ridges and furrows; pedicle base outline tetrapetaloid or rhomboid; crown anterior overhang prominent.

- 2a. Crown anterior shoulder longitudinal ridge or line well raised; subcrown ornamentation absent or with discontinuous halo; subpedicle surface flat or convex; *Labrilancea* n. gen. s.f. (Pl. 26), *L. glabrisubcuspis* n. sp. s.f., *L. glabrisubtricuspis* n. sp. s.f.  
 2b. Crown anterior shoulder longitudinal ridge or line well raised; subcrown with mesial ridge or keel, may have halo; subpedicle surface flat, concave, or convex; *Ornatilabrilancea* n. gen. s.f. (Pl. 27), *O. circacarina* n. sp. s.f., *O. solicarina* n. sp. s.f.  
 2c. Crown anterior shoulder longitudinal ridge or line absent; subcrown ornamentation absent; subpedicle surface flat or concave; *Minuticorona* n. gen. s.f. (Pl. 28, fig. 1-8), *M. triculmina* n. sp. s.f., *M. uniculmen* n. sp. s.f.

Subgroup 3. Pedicle anterior; crown inclined lanceolate with short upper crown ridges and furrows; pedicle base outline tetrapetaloid, rhomboid, or stretched rhomboid.

3a. Subcrown with halo, may have mesial ridge or keel; subpedicle surface convex or convex with bulge; *Sacrisubcorona* n. gen. s.f. (Pl. 29-31), *S. circabasis* n. sp. s.f., *S. submedicarina* n. sp. s.f.

3b. Subcrown with mesial ridge or keel; subpedicle surface flat or concave; *Carinasubcorona* n. gen. s.f. (Pl. 32), *C. subradiciplana* n. sp. s.f.

3c. Subcrown ornamentation absent; subpedicle surface flat or concave; *Glabrisubcorona* n. gen. s.f. (Pl. 33-35), *G. vadosidevexa* n. sp. s.f., *G. arduidevexa* n. sp. s.f., *G. tendibasis* n. sp. s.f., *Glabrisubcorona?* sp. 1 s.f.

Subgroup 4. Pedicle subcentral; crown horizontal, margins rounded to irregular; pedicle base outline similar to crown.

4a. Upper crown ornamentation absent or with short ridges at margin(s); *Complanicorona* n. gen. s.f. (Pl. 36), *C. glabra* n. sp. s.f., *C. rugosimargines* n. sp. s.f., *C. subrugosa* n. sp. s.f.

Group B. Pedicle keeled expanded and stretched tetrahedroid

Subgroup 1. Pedicle anterior; crown inclined and stretched elongate lanceolate; pedicle base outline oval to ovate.

1a. Subcrown with multiple ridges; subpedicle surface flat, convex or convex with bulge; *Suaviloquentia* n. gen. s.f. (Pl. 37), *S. longilingua* n. sp. s.f., *S. brevilingua* n. sp. s.f., *S. obliquilingua* n. sp. s.f.

Part 3. Pedicle vascularization holaulacorhize

Part 4. Pedicle vascularization polyaulacorhize

## Descriptions

A format for the description of taxa in this study has been adopted based on recommendations in Schenk and McMasters (1956), International Trust for Zoological Nomenclature (1985), and the Geological Survey of Canada style guidelines (Blackadar et al., 1980).

## Section IA. Elasmobranch teeth

Teeth of the Triassic Peace River elasmobranchs are commonly multicusped and may have a high principal cusp and lateral cusps that decrease in size to the crown heels. Some of the teeth have no cusps, are flattened, and have a crown ornamented with ridges or lines. Most of the teeth are extended mesiodistally and narrower labially to lingually. The tooth base (or root) is positioned approximately central under the base of the tooth crown, and is commonly high and penetrated by canal openings. All described species are known only from isolated teeth.

Phylum Chordata

Class Chondrichthyes

Subclass Elasmobranchii

Cohort Euselachii Hay, 1902  
Superfamily Hybodontoida Zangerl, 1981  
Family Acrodontidae Casier, 1959  
Genus *Acrodus* Agassiz, 1837

*Acrodus* Agassiz, 1837, v. III, p. 149.

*Type species.* *Acrodus gaillardoti* Agassiz in Geinitz, 1837, Muschelkalk, Lunéville, Northeastern France, Middle Triassic.

*Diagnosis.* See Stensiö (1921), Rieppel (1981), and Cappetta (1987).

*Acrodus?* sp. 1

Plate 1, figures 1-16

*Utilitarian identification.* Subtype a15/b2+6/c1+3

*Description.* Teeth commonly fragmented, most less than 2 mm, elongate (approximately 2-4 times longer than wide). Crown flattened to weakly convex (approximately centrally highest mesiodistally); may have margin with rounded bulbous protrusion (Pl. 1, fig. 1, 3); principal cusp absent or flattened; no lateral cusps present. Labial and lingual crown shoulders convex; overhang crown/root junction and furrow (underneath).

Crown surface ridges or lines centrally shallow, rounded, and run labially-lingually; commonly originate from occlusal crest and run approximately perpendicular to crown labial and lingual margins; on shoulders slightly more raised, closer spaced, and may bifurcate basally forming a network extending mesiodistally. Occlusal crest shallow, rounded and irregular; approximately central and runs mesiodistally; may be absent.

Crown enameloid with shiny outer layer formed of small crystallites (size approximately 1 µm), and layer below (approximately 40 µm thick) with fibre bundles perpendicular to crown's outer surface (Pl. 1, fig. 14-15).

Root commonly absent and poorly preserved. When present in fragmented specimens, root high (root height usually greater than crown height), lingual and labial faces not discernible, dotted with small canal openings, and may have rim parallel to and near crown/root junction. Crown commonly separated from root, has thin shell-like structure with concave subsurface (Pl. 1, fig. 5, 11-13).

*Comparisons.* Similar external morphological features of some *Acrodus*, *Palaeobates*, and *Asteracanthus* species made identification of the Peace River specimens difficult. Rieppel (1981) discussed these genera and described species from *Acrodus lateralis* Agassiz, 1837, *Palaeobates angustissimus* (Agassiz, 1837), and *Asteracanthus* sp. All of these genera appear to share the following: 1) a low to flat crown with a low or absent principal cusp and lateral cusps; 2) a weakly raised or absent occlusal crest; and 3) ridges that originate or radiate from a cusp or occlusal crest and extend to the crown labial or lingual margin where they commonly anastomose or form a network. Some features that can be used to distinguish *Palaeobates* and *Asteracanthus* from

*Acrodus* are the presence of a labially displaced occlusal crest, a concave crown labial margin, a convex crown lingual margin, and at the lingual margin, a distinct transversely plicated rim that overlaps the root. This rim fits into a similarly plicated groove on the concave labial crown of a neighbouring tooth.

In the Peace River specimens, anastomosed or plicated crown margins are common, however, a labially displaced occlusal crest and a concave labial crown shoulder (for the crown interlocking feature) are not present. Therefore, the choice of *Palaeobates* and *Asteracanthus* are less likely. *Asteracanthus* is further dismissed because the crown of the Peace River specimens is elongate and rounded, and not rectangular or rhomboid.

External tooth crown features that favour *Acrodus* over *Palaeobates* and *Asteracanthus* are: 1) the presence of a rounded crown bulbous protrusion that may be lingual (the lingual or labial position of the protrusion cannot be determined because most of the Peace River specimens are without roots); and 2) ridges that radiate from the occlusal crest and meet the crown margins approximately at right angles.

Differences in the tooth histology of *Acrodus*, *Palaeobates*, and *Asteracanthus* are discussed in Jaekel (1889), Seilacher (1943), Peyer (1946), Radinsky (1961), and Rieppel (1981). In *Acrodus lateralis* Agassiz (see Rieppel, 1981), a single crystallite enamel sits on top of osteodentine. The osteodentine has vascular canals that branch into a tree-like pattern with fine dentinal tubules that radiate into dentine of each denteon. The crown of *Palaeobates* differs by having a crown entirely made of orthodentine. The osteodentine is restricted to the root. Above the root is the pulp cavity from which dentine tubules radiate into the crown. A thin layer of single crystallite enamel caps the crown. The base of *Asteracanthus* consists of circumpulpar dentine that grades into osteodentine (with straight, parallel, and sometimes bifurcating vascular canals running perpendicular to crown surface). Around the canals, dentine is deposited concentrically (called dentinal osteons by Ørvig, 1951). A thin layer of enameloid caps the osteodentine layer (Radinsky, 1961).

To study the histology of the Peace River specimens, acid etched specimens were prepared and photographed in the SEM. Plate 1, figures 14-16 illustrate three views of one specimen. Figure 14 shows a tooth with a thin (40 µm) upper crown unit. The outermost layer of this unit includes single crystallites (size approximately 1 µm). Below the outermost layer (Pl. 1, fig. 15, which is an enlargement of the top left of fig. 14) are parallel fibres or tubules that are perpendicular to the outer surface. In other areas (Pl. 1, fig. 16 which is an enlargement of the top right of fig. 14) the fibres/tubules are more irregular to networked. Many of the crowns separate from the roots near the base of the upper crown unit (Pl. 1, fig. 4-5, 11-13). Below this upper unit, the structure is rather uniform, probably representing osteodentine in the lower crown and root.

Seilacher (1943) illustrates *Acrodus substriatus* Schmid, 1862 showing an upper crown unit of multiple tubules that are part of the upper osteodentine. This histology appears to be

most similar to the Peace River specimens and not Seilacher's illustrations of *Palaeobates* species (with the arrangement of the orthodontine tubules radiating from the crown base).

**Remarks.** Unfortunately, additional sectioning was necessary to fully understand the crown histology. This was not possible because the specimens are rare. With these uncertainties in the Peace River specimens and the required future histological work, *Acrodus?* sp. 1 is only questionably assigned.

Six specimens are illustrated (Pl. 1, fig. 1-16) showing variation in the flattened crown ornamentation, features of the root, and internal histology including: a) a narrow intact crown with a shallow occlusal crest and ridges perpendicular to it (fig. 1-2); b) a network pattern of ridges on the crown shoulders (fig. 3-4); c) a crown with dense networked ridges (fig. 8-9); d) prominent crown shoulders, furrow underneath, a shallow rim at the crown/root junction, and small canal openings on the root face (fig. 6-7, 10); e) subcrown and internal surfaces (fig. 5, 11-13); and f) HCl etched broken surface with an approximately 40  $\mu\text{m}$  thick upper crown unit (Pl. 1, fig. 14 top) and fibre-like bundles that are perpendicular to an outer surface layer of single crystallite enameloid (Pl. 1, fig. 15-16 top). Figures 11-13 show views of the subcrown surface (not etched in HCl) where these teeth commonly separate from the root. At the top of figures 12 and 13 the thin (nonetched) upper crown unit is seen.

**Material.** Figured specimens GSC 105098 and GSC 105099 from GSC locality C-177682 (BH-61B), and GSC 105100, GSC 105101, GSC 105102, and GSC 105103 from GSC loc. C-101753 (MS-GB).

Additional specimens from GSC loc. C-086792 (BH-60), C-101753 (MS-GB), C-145774 (GK-3-20C), C-145780 (GK-68-8-27), C-172263 (GK-2-12), and C-177682 (BH-61B).

**Peace River occurrence.** Ludington, Charlie Lake, and Baldonnel formations; Brown Hill, Childerhose Cove, Chowade South, Laurier Pass, and Pardonet Hill.

**Range.** *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus nodosus* conodont Zone (Orchard, 1991c); *Tropites welleri* ammonoid Zone (Tozer, 1994); Upper Carnian, Upper Triassic.

Family Polyacrodontidae Glickman, 1964

Genus *Polyacrodus* Jaekel, 1889

*Polyacrodus* Jaekel, 1889, p. 273-332.

*Hybodus* Jaekel, 1889, p. 273-332 (part).

**Type species.** *Hybodus polycyphus* Agassiz, 1837, Muschelkalk, Lunéville, northeastern France, Middle Triassic.

**Diagnosis.** See Jaekel (1889, p. 324), Stensiö (1921, p. 27-29), and Cappetta (1987, p. 36-37).

*Polyacrodus contrarius* n. sp.

Plate 2, figures 1-14; Plate 3, figures 1-15

**Utilitarian identification.** Subtype a11/b2+6/c1/d2,6/e2/f1,  $\geq 3/g1,2/h2/i(2,4)\pm(3,5)+7\pm 8+10/j(2,4)\pm(3,5)+7\pm 8+10$

**Etymology.** Latin, *contrarius*, contrary or opposite (with reference to the presence of a prominent crown lingual instead of labial shoulder protrusion).

**Diagnosis.** Crown with prominent to moderate lingual shoulder protrusion; labial shoulder protrusion rounded, reduced, or absent; principal cusp low and pyramidal but higher than reduced lateral cusps; labial face enlarged and oblique or concave; lingual face reduced and steeply oblique; occlusal crest displaced lingually; labial and lingual shoulders with many reduced nodes joined by one or two longitudinal lines or ridges; vertical lines or ridges long, well raised, and more numerous on lingual than on labial face. Root vascularization anaulacorhize.

**Description.** Crown small (about 1 mm or less); elongate (3-6 times longer than wide) and low (crown about equally as high or less than height of lingual root face); outline (occlusal view) fusiform to oblong with bulge at principal cusp (especially on lingual face). Principal cusp low and pyramidal but higher than several reduced lateral cusps; positioned to lingual side and approximately central (mesiodistally); shape pyramidal with short oblique sides. Occlusal crest entire; moderately acute; displaced lingually; traverses crown mesiodistally over cusps/apices. Cusps (profile view) vertical to slightly inclined lingually. Depression between cusps broad and shallowly U-shaped.

Most prominent crown surface features: many vertical lines or ridges, displaced occlusal crest, lingual protrusion, lingual and labial shoulder nodes, and longitudinal lines or ridges traversing crown shoulders mesiodistally.

Crown (lingual view) lateral cusps each have one ridge that extends from occlusal crest and joins peak of node and dentate longitudinal shoulder line or ridge near crown base. Additional vertical lines or ridges may be located between cusps. Principal cusp with ridge that bifurcates midway or near crown shoulder on rounded protrusion that frequently extends beyond crown shoulder. Cusp and shoulder ridges all well raised; with concave hollow between each. Below shoulder, crown curves in towards root forming overhang and then slightly recurves out creating shallow furrow that extends root length. Crown/root junction marked by thin line on root side of furrow where lustrous crown surface changes to more porous root texture.

Crown (labial view) surface features similar to lingual face; differ by there may be one half as many crown ridges (with only a few that are vertical); principal cusp shoulder protrusion reduced or rounded; crown face broader (from lingual displacement of occlusal crest); crown less steeply inclined to shoulder ridge.

Cusps with thicker transparent enameloid portion at apices and along occlusal crest. Remainder of tooth crown opaque. Enameloid ultrastructure not studied.

Root (profile view) narrowest at crown/root junction and broadens obliquely to root base on lingual face; labial face double concave shape, slopes briefly out (upper face) and then in (lower face) towards root base. Height of lingual face greater than upper labial face, about equal when both labial faces included.



Root (occlusal view of tooth) similar width as crown, may have slight bulge on lingual central face. Upper root lingual face (lingual view) straight or forms convex arch (centrally highest) underneath straight or weakly arched crown base. Many circular to vertical short oblong canal openings penetrate root lingual face approximately perpendicular to crown (or parallel to root base). Largest canal openings near root base; smallest on middle and upper lingual face.

Upper labial root face (labial view) height moderately narrow; top edge horizontal or forms centrally convex arch underneath horizontal or arched crown; canal openings in row along base penetrate approximately perpendicular to crown. Canal openings also break thin lip that separates upper and lower faces. Broken lip appears slightly nodular and sometimes undulating. Lower labial face centrally arched and drops into shallow and short concave surface sloping in towards root base; several canals open onto surface.

Root basal surface outline oblong to weakly crescentic (convex to lingual and concave to labial face); edges may be undulating to crenulated; base flat to weakly arched (convex); surface pitted to slightly rough; vascularization anaulacorhize.

*Comparisons.* *Polyacrodus* was chosen instead of *Hybodus*, *Acrodus*, or *Lissodus* because it has squat pyramidal crown cusps, ridges that commonly extend from the occlusal crest to the crown shoulders, and no labial peg/protrusion.

The asymmetrical nature of the *P. contrarius* crown where it has lingual displacement of the occlusal crest (increased surface area of the labial crown face and decreased surface slope from the occlusal crest to the crown shoulder), a low pyramidal noninflated principal cusp (sides not prominently convex), a prominent lingual principal cusp shoulder protrusion, and labial and lingual shoulder nodes linked by long lines/ridges, distinguishes it from other *Polyacrodus* species such as *P. polycyphus* (Agassiz, 1937), *P. pyramidalis* Stensiö, 1921, and *P. grewincki* Dalinevicius, 1935. *P. claveringensis* Stensiö, 1932 differs by having an elongated tooth with a low principal cusp and no or minor lateral cusps. *Lissodus angulatus* (Stensiö, 1921) has a labial protrusion (instead of a prominent lingual protrusion) and generally an absence of crown striations or ridges. *P. brevicostatus* (Patterson, 1966), *Lissodus heterodon* (Patterson, 1966, text. fig. 25 A, B), *P. lapalomensis* Johnson, 1981 and *P. ritchie* Johnson, 1981, do have a low principal and lateral cusps but do not have a prominent lingual occlusal crest displacement and a prominent lingual principal cusp protrusion.

*Remarks.* Specimens are rare but found in several samples. Not enough material was available for sectioning to view internal tooth and enameloid ultrastructure. It also should be noted that a different interpretation of the definition of the root basal surface might include the above description of the lower labial root face.

Three different types of teeth (based on external morphology) are observed. Teeth with a higher principal cusp were probably positioned in the jaw towards the anterior.

#### Type A (Pl. 2, fig. 1-15)

Lingual principal cusp shoulder protrusion prominent. Number of labial crown face vertical lines or ridges commonly fewer and (or) shorter (do not extend from shoulder to occlusal crest) than those on lingual face. Surface area of labial crown face considerably greater than lingual crown face (occlusal crest well displaced lingually).

Variance in the crown is illustrated on specimen 1 (fig. 1-5) which has a reduced number of lines or ridges on labial crown face, whereas specimen 2 (fig. 6-10) has well developed nodes, short vertical ridges, and shoulder longitudinal double lines or ridges. Specimen 3 (fig. 11-14) has several vertical lines or ridges on labial crown face. Specimens 1 and 3 also have crown heels that are displaced lingually whereas specimen 2 heels are displaced labially. All specimens have a principal cusp with prominent lingual protrusion best illustrated in profile view. Figure 10 (specimen 2) shows the typical anaulacorhize root which was not preserved well in the other two specimens.

#### Type B (Pl. 3, fig. 1-11)

Lingual principal cusp shoulder protrusion less prominent. Number of vertical lines or ridges similar and long (extend from shoulder to occlusal crest) on both labial and lingual crown faces. Surface area of labial crown face slightly greater than lingual crown face (occlusal crest slightly to moderately displaced lingually). Crown elongate and moderately narrow.

Figures 1-5 (specimen 4) shows a well developed principal cusp and lingual protrusion, and a slightly more lingually displaced occlusal crest than specimen 5 in figures 6-11. Both specimens have prominent crown vertical ridges and well preserved roots.

#### Type C (Specimen 6, Pl. 3, fig. 12-15)

Principal and lateral cusps extremely reduced. Labial face enlarged and centrally concave. Lingual and labial shoulder nodes prominent and joined by longitudinal shoulder line or ridge. Labial crown face with short lines or ridges near occlusal crest and below shoulder longitudinal line or ridge. Lingual crown face with long lines or ridges extending from nodes to occlusal crest. Lingual protrusion absent. This type is included in the species based on similarities of the crown lingual face ornamentation to that of Type A.

*Material.* Holotype GSC 105093 from GSC loc. C-101069 (BEH-3); paratypes GSC 105092 and GSC 105094 from GSC loc. C-101064 (ACE-1); paratypes GSC 105095 and GSC 105096 from GSC loc. C-101068 (BEH-2); and paratype GSC 105097 from GSC loc. C-153069 (GK-1-19).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101753 (MS-GB), C-090874 (P82-48F), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153069 (GK-1-19), C-153070 (GK-1-20), C-153072 (GK-1-48), and C-153076 (GK-4-17).



*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Brown Hill, Childerhose Cove, and Toad River.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Tropites welleri* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus nodosus* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

Subcohort Neoselachii Compagno, 1977

Superorder Squalomorphii Compagno, 1973

Order Synechodontiformes Duffin and Ward, 1993

Family Palaeospinacidae Regan, 1906

**Genus *Synechodus*** Woodward, 1888

*Palaeospinax* Egerton, 1872, p. 1-3.

*Synechodus* Woodward, 1888, p. 496-499.

*Type species.* *Synechodus dubriensis* (Mackie, 1863) Duffin and Ward, 1993, *Holaster subglobosus* Zone, England, Cenomanian, Late Cretaceous.

*Remarks.* A history of the palaeospinacids *Palaeospinax* and *Synechodus* is given in Duffin and Ward (1993). Thies (1991) argued that *Palaeospinax*, *Synechodus*, and *Paraorthacodus* (Family Palaeospinacidae) diagnostic dental characters described in Cappetta (1987) are not suitable to separate these genera. Thies based this on species within two different palaeospinacid genera sharing some of the same diagnostic convergent features. Thies (1991, p. 552) recommended that because the current level of information is insufficient to identify a palaeospinacid genus from teeth, "lumping all isolated palaeospinacid teeth together into a single formal genus" would be preferable (that genus being *Palaeospinax* Egerton, (1872) since it was established first).

Most recently, Duffin and Ward (1993) questioned the validity of the genus *Palaeospinax* based on the absence of diagnostic characters to define it. In addition, they noted the comments of Woodward (1889) and Cappetta (1987) where *Palaeospinax* and *Synechodus* mainly differed by the presence or absence of dorsal fin spines. Duffin and Ward (1993) proposed nomenclature revisions to adopt *Synechodus* as a valid name for several *Palaeospinax* species other than those best accommodated in *Paraorthacodus*. In this study, the Duffin and Ward (1993) revisions are accepted.

In this study, the following features are considered diagnostic for the *Synechodus* teeth: anterior teeth high crowned and prehensile; posterior teeth with cusps reduced; one to several pairs of lateral cusps (Woodward, 1889; Cappetta, 1987); principal cusp and lateral cusp not greatly separated (Duffin and Ward, 1993); crown principal cusp commonly overhangs lingual face of root; base of crown commonly overhangs crown/root junction; anterior and lateral teeth may have an expanded root lingual torus (Maisey 1977); root labial face with canals entering at steep angle giving rise to intervening pillars of root tissue (Duffin, 1987); vascularization anaulacorhize to pseudo-polyaulacorhize; root base with

many furrows on labial side (Thies and Reif, 1985); and tooth enameloid formed of three layers: shiny layered enameloid, parallel fibred enameloid, and tangled fibred enameloid (Thies and Reif, 1985; Duffin and Ward, 1993).

*Synechodus incrementum* n. sp.

Plate 4, figures 1-18; Plate 5, figures 1-17;

Plate 6, figures 1-18; Plate 7, figures 1-9

*Utilitarian identification.* Subtype a11/b2+6/c1/d2, 6/e(1,2)±3/f≥3/g1/h2/i2±9+10/j2±9+10

*Etymology.* Latin, *incrementum*, growth or increase (with reference to the principal cusp that may vary in height from short to tall).

*Diagnosis.* Principal cusp higher than reduced lateral cusps; pyramidal; vertical, inclined over lingual root face, or tilting mesially or distally towards lateral cusp. Crown with labial and lingual shoulder that overhangs crown/root junction. Crown ridges radiate from each cusp; bifurcate near shoulder forming single scalloped or multiple networked longitudinal lines or ridges. Root upper labial face narrow with row of small canal openings; undulating or nodular rim separates upper and lower labial faces; lower labial face concave with large and (or) channelled canal openings. Root lingual face high, with larger canal openings near root base; may have bulge or torus. Root vascularization pseudo-polyaulacorhize to anaulacorhize.

*Description.* Species with moderate tooth heterodonty (see Table 1). Multicusp tooth with central principal cusp tallest; commonly three (may be one to five) reduced pairs of lateral cusps decreasing in size from crown centre to heels. Shape of cusps vertical or inclined pyramidal; apices acute. Principal cusp tall or short; when tall inclined over lingual root face, or tilted toward lateral cusp; when short commonly vertical or slightly inclined. Lateral cusps weakly inclined lingually, or tilted mesiodistally except in Type E in which they regularly increase in height and slope towards principal cusp. Depressions between cusps broadly U-shaped. Crown outline (occlusal view) for Type A, triangular (principal cusp vertex placed lingually and crown heels form mesial/distal vertices); Types B-G elongate fusiform (similarly bulging labially and lingually at principal cusp and slightly at lateral cusps); Type H fusiform to rectangular. Occlusal crest traverses crown over cusp apices; displaced lingually in Type A; Types B-H approximately central. Crown shoulders at base of lingual and labial crown faces; overhang concave furrow and crown/root junction.

Long and well raised lines or ridges prominent feature on crown lingual and labial faces. On crowns (Types A-E) most lines or ridges long and radiate from each cusp apex to crown shoulder; commonly bifurcate near shoulder forming longitudinal scalloped line or ridge. On Types F-H, a transverse primary ridge (more elevated or broader than other lines or ridges) on the principal cusp extends to one or both labial or lingual shoulder bulges; may be found on lateral cusps. Other lines or ridges may bifurcate from cusp primary transverse ridge. Lingual crown shoulder scalloped longitudinal line or ridge usually one, may be two or more on lower crowned

specimens (e.g. Types G and H). Labial crown shoulder longitudinal line or ridge commonly two or more; scalloped and networked. Junction of lines or ridges on shoulder do not form nodes; may form acute ridge edges. Crown lines or ridges not found under crown shoulder overhang and do not reach crown/root junction.

Crown surface lustrous. Enameloid layer transparent to translucent especially in small region at cusp apices and on occlusal and labial or lingual face ridges. Layer below enameloid opaque and high in cusps. Plate 7 illustrates series of photographic enlargements of longitudinal section through HCl etched Type A specimen; shows thin (20-50 µm) enameloid layer, many long and thick parallel fibre bundles (fig. 1-3), and enlargement of uppermost enameloid layer with thin single crystallites (size less than 1 µm) perpendicular to crown surface (fig. 4). Variations in the enameloid include single crystallites above fibre-like bundles perpendicular to outer surface and (or) above a woven or haphazard arrangement (fig. 5-7, 9).

Root narrowest at crown/root junction; widens slightly at base. Lingual face (profile view) convex to steeply oblique; Type A with prominent lingual bulge or torus below inclined

principal cusp; Types B-H lingual bulge minor or absent. Labial face (profile view) with double concave shape (upper face supraconcave, lower face subconcave). Height of lingual face much greater than upper labial face; about equal when both labial faces included.

Root (lingual view) on higher principal cusp specimens (Types A-E) forms slight convex arch (centrally highest) under crown, and on lower principal cusp specimens (Types F-H) horizontal. Lingual root face canal openings common; circular to vertically short-oblong; penetrate approximately perpendicular to crown or root base. Largest canal openings commonly on specimens with a tall principal cusp, located under principal cusp near root base, and sometimes create minor bulge on root basal surface. Smaller canal openings on middle and upper lingual face.

Root (labial view) forms prominent convex arch (centrally highest) under crown on high principal cusp specimens (e.g. Types A-E) and less arched to horizontal on low principal cusp specimens (Types F-H). Upper labial face narrow and concave, with row of many small canal openings and lip separating upper and lower face. Lip shallowly undulating in high principal cusp types to broken by canal openings and

**Table 1.** Eight types (A-H) of *Synechodus incrementum* n. sp. (representing species heterodonty) based on tooth crown and root morphology.

Character	Type							
	A	B	C	D	E	F	G	H
height principal cusp: (High, Moderately High, Moderate, Moderately Low, Low)	H	MH	MH	M	M	ML	ML	L
inclination of principal cusp: (Strongly Lingual, Anterior/Posterior, Slight/Vertical, Vertical)	SL	A/P	S/V	S/V	S/V	S/V	S/V	V
crown/root labial arching: (Prominent, Moderate, Slight, Absent)	P	M	M	M	M	S	A	A
lingual root face bulge/torus: (Prominent, Slight, Absent)	P	S	S	S	S	A	A	A
concavity lower labial root face: (Deep, Moderate, Slight)	D	D	D	M	S	S	S	S
canal channelling on lower labial root face: (Slight, Yes)	S	S	S	Y	Y	Y	Y	Y
principal cusp primary ridge: (Yes, No)	N	N	N	N	N	Y	Y	Y
principal cusp labial/lingual rounded shoulder: bulges (Yes, No)	N	Y	Y	Y	Y	Y	Y	Y
lateral cusps regularly inclined towards principal cusp: (Yes, No)	N	N	N	N	Y	N	N	N
Plate no.	4	4	4	5	5	6	6	6
Figure no.	1-6	7-12	13-18	1-6	7-17	1-6	7-12	13-18

somewhat nodular in low principal cusp types. Lower labial face subconcave and drops to root base; under high principal cusp types, prominently subconcave with one or few large canal openings commonly located centrally and smaller canal openings positioned laterally; under low principal cusp types, shallowly subconcave with several channelled openings.

Root basal surface outline crescentic and lingually convex (Types A-D) to oblong or rectangular (Types E-H); lingual margin rounded to shallowly undulating; labial margin undulating, nodular, or channelled (from canal openings); base flat to weakly arched; surface pitted to slightly rough; sometimes with minor indentations or rolls from sides of canal channels; vascularization pseudo-polyaulacorhize to anaulacorhize.

*Comparisons.* Except for Type A, *Synechodus incrementum* has many similarities to *Lissodus minimus* (Agassiz) (Duffin, 1985) as follows: 1) a short (sometimes moderately high) and vertical principal cusp; 2) a labial principal cusp bulge commonly bearing a primary transverse ridge; 3) long crown ridges that may bifurcate near the base at the shoulder; 4) presence of longitudinal shoulder line; 5) undercutting of crown shoulder to crown/root junction; 6) a root upper labial face with row of canal openings; 7) a longitudinal ridge separating upper and lower root labial faces; and 8) a root lower labial concave face with large canal openings. Type A has a tall and lingually inclined principal cusp and lingual root bulge (torus) which are not characteristic of *Lissodus minimus*, otherwise the above described characters (3-8) are similar.

The Genus *Lissodus* (Polyacrodontidae) was not chosen because of the following similar features of the Peace River species to *Synechodus*: 1) canal channelling on root base (pseudo-polyaulacorhize vascularization) and lower labial root face (especially Types D-H); 2) presence of narrow upper labial root face with row of canal openings commonly notching a longitudinal ridge or rim separating upper and lower labial faces (making rim appear nodular); 3) prominent (Type A) to minor (Types B-E) root lingual bulge or torus; 4) crown heterodonty with a tall to short principal cusp; 5) may have an arched root under an arched crown (especially labial faces); and 6) possibility of triple layered enameloid). The triple layered enameloid (shiny layer, parallel structured enameloid, and woven enameloid) is found in modern sharks rather than single crystallite enameloid typical of hybodont or more primitive sharks (Reif, 1973, 1974a, b, 1977, 1978a, b, 1979). *Synechodus* has triple layered enameloid whereas *Lissodus* has single crystallite enameloid.

*S. incrementum* Types B-H mainly differ from *Polyacrodus contrarius* by having canal channelling on the root base (pseudo-polyaulacorhize vascularization), an approximately central positioned crown occlusal crest, and similarly sized labial and lingual faces; and by not having a prominent lingual protrusion.

Type A somewhat resembles species in the Genus *Hybodus* (Hybodontoidae). This group was not chosen because the species have: 1) a tall principal cusp that is erect (instead of considerably inclined over crown lingual face); 2) crown labial and lingual shoulders that do not overhang the

crown/root junction; 3) simple anaulacorhize root vascularization without a specialized root upper labial face row of canal openings, undulating rim separating upper and lower labial faces, and channelled lower labial and partial root base surfaces; and 4) only single crystallite enameloid on the outer surface of the crown.

*S. incrementum* mainly differs from Jurassic species *S. enniskilleni* (Egerton, 1872) Duffin & Ward 1993, *S. occidentens* Duffin & Ward, 1993, *S. pinnai* (Duffin, 1987) Duffin & Ward, 1993, *S. egertoni* (Woodward, 1889) Duffin & Ward 1993, and *S. riegrafi* (Thies, 1983) Duffin & Ward, 1993 by the structure and ornamentation of the root. In labial view, the *S. incrementum* root is divided by a rim that may be broken by canal openings. Just below the crown/root junction, the concave upper labial root face is penetrated by a row of canal openings. The lower labial root face is subconcave (especially evident in high principal cusp specimens) and is penetrated by a few large canal openings. In the Jurassic *Synechodus* species, the vascular canals penetrate the root at the base and labial border. *S. incrementum* also is distinct with a well developed occlusal crest, pyramidal cusps, and prominent ridges and lines that extend from the occlusal crest to the crown shoulders where they commonly bifurcate forming a longitudinal line or ridge and (or) network.

*S. incrementum* is different from the type species, *S. dubrisiensis* by the features of its root (discussed above) and the lateral cusps which are generally not as acute and not as well separated.

*Remarks.* *S. incrementum* n. sp. displays a combination of primitive hybodontoid (*Lissodus*, *Polyacrodus*, *Hybodus*) and more derived neoselachian (e.g. *Synechodus*) shark tooth characters as discussed above. Some of these features could be grouped and lead to splitting into separate species. For example, 1) Types A-C: a) principal cusp moderately tall to tall; inclined over lingual face, mesially or distally, and b) root lower labial face moderately deeply concave with large canal openings that are generally not channelled; and 2) Types D-H: a) principal cusp short and vertical to slightly inclined, and b) root lower labial face shallowly concave with channelled canal openings. However, grouping all these types into one species (representing heterodonty) is preferred based on their many other crown and root similarities in all or most of the types as follows: 1) prominent occlusal crest; 2) long ridges radiating from crown apices to labial and lingual shoulders (but not to crown/root junction); 3) bifurcation of ridges near crown shoulders; 4) crown shoulders forming overhang of crown/root junction; 5) presence of labial and lingual scalloped shoulder longitudinal lines or ridges that are networked when more than one; 6) pyramidal cusps; 7) labial and lingual principal cusp (sometimes lateral cusp) shoulder bulges; 8) root with a) upper labial face row of canal openings, b) undulating to nodular rim separating upper and lower labial face, c) subconcave labial face with large canal openings that may be channelled, and d) high lingual face with large canal openings along base or located under principal cusp; 9) well to slightly arched root (labial view); and 10) general elongate fusiform shape (view over occlusal crest) of tooth.

The main features of heterodonty in this species (a) crown height and inclination, b) crown and root arching, c) root lower labial face concavity and canal channelling, and d) lingual root bulge or torus) could be associated with tooth evolution for a varied diet. Duffin (1985, p. 125) discussed heterodonty in *Lissodus minimus* and suggested it was a result of a varied diet. He observed that the crown profile becomes lower distally. On a similar note, the principal cusp of the Peace River species could decrease in height with less lingual inclination as found distally in the mouth (changing in function from piercing and grasping to crushing). The arched crown and root, increased concavity and larger canal openings on the lower labial root face, and the lingual face bulge/torus tend to be associated with the higher principal cusp and may be of evolutionary morphological significance for efficient tooth function. The shallow lower labial face (under short principal cusp types) may be a response of trying to strengthen the tooth for crushing subsequently resulting in a reduced open area for the canal openings which then resulted in channelling.

**Material.** Holotype GSC 105106 from GSC loc. C-101036 (MS-3); paratypes GSC 105104, GSC 105105, GSC 105107, GSC 105108, GSC 105109, GSC 105115, and GSC 105116 from GSC loc. C-101036 (MS-3), and paratypes GSC 105110, GSC 105111, GSC 105112, GSC 105113, GSC 105114, and GSC 105118 from GSC loc. C-101754 (NPP-Low).

Additional specimens from GSC loc. C-087924 (BH-8), C-101754 (NPP-Low), C-101036 (MS-3), C-101038 (MS-5), C-302382 (BH-20), C-302386 (BH-51A), and C-302390 (TE-220A).

**Peace River occurrence.** Pardonet Formation; Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, and Ne Parle Pas Rapids.

**Range.** *Synechodus incrementum* ichthyolith Zone; Upper *Metapolygnathus primitius* to *Epigondolella spiculata* conodont zones (Orchard, 1991c); *Stikinoceras kerri* II to *Mesohimavatites columbianus* 1a/b ammonoid zones; common to abundant in Upper and Lower *Epigondolella multidentata* conodont zones or *Drepanites rutherfordi* ammonoid Zone; Lower and Middle Norian (common to abundant in Middle Norian), Upper Triassic.

*Synechodus multinodosus* n. sp.

Plate 8, figures 1-24; Plate 9, figures 1-12;

Plate 10, figures 1-8

**Utilitarian Identification.** Subtype a11/b2+6/c1/d2, 6/e2±3/f1, ≥3/g1, 2/h2/i4±5+7±8+10/j4±5+7+10

**Etymology.** Latin, *multus nodosus*, many knobs or nodular.

**Diagnosis.** Crown with high or low principal cusp; reduced or abraded lateral cusps. Prominent multiple nodes common on lower crown labial and lingual face shoulders; not present on lingual face below high principal cusp. Labial shoulder node may be enlarged into peg-like structure near base of principal cusp. Crown vertical striations rare to few. Occlusal crest traverses crown length over cusp apices. Root with prominent

lingual bulge when principal cusp high; lingual face with large canal openings near base; upper labial face with row of small canal openings and nodular rim separating upper and lower faces; lower labial face channelled; vascularization pseudo-polyaulacorhize to anaulacorhize.

**Description.** Tooth multicusp with moderate heterodonty, expanded mesiodistally, heels displaced labially or sinusoidal, size commonly greater than 1 mm. Two forms of teeth recognized: 1) Type A: principal cusp tall (commonly greater than four times higher than lateral cusps (when present)), inclined (about 45-70°) over lingual root face, and may be directed mesially or distally; root lingual face with bulge or torus; and 2) Type B: principal cusp short (not much higher than lateral cusps) and vertical to slightly lingually inclined; crown greatly expanded mesiodistally and shape elongate oblong to fusiform (slightly wider centrally); root lingual face without prominent bulge/torus.

Crown principal cusp side margins concave and entire; lateral cusps reduced, abraded, or absent; mesial and distal heels rounded. Lateral cusps vertical or may be inclined lingually and towards principal cusp; highest near principal cusp; lowest near crown heels. Depressions between cusps broad and shallowly U-shaped. Type A principal cusp labial face slightly flatter than lingual face that may have slight concave curvature. Occlusal ridge traverses crown over cusp apices to heels. Crown (occlusal view) slightly curved and heels displaced labially.

Crown surface lustrous; most prominent features are occlusal crest, many acute nodes on labial and lingual lower crown shoulders, and labial protrusion (peg) at principal cusp shoulder.

Principal cusp (lingual view) commonly devoid of lines or ridges; rarely may have one or two long straight nonbifurcating vertical lines or ridges that originate near apex and terminate before crown base commonly on node. Few other short lines or ridges may be located on lingual faces of lateral cusps or crown heels; commonly vertical and more raised at crown shoulder where they bifurcate forming raised acute protuberance (node). Additional nodes with short bifurcating lines or ridges common along shoulders; absent below lingual face principal cusp on Type A specimens. Hollows between nodes U-shaped and may be united by thin line. This line parallel to crown/root junction; usually terminates at crown heels and base of principal cusp; and joins nodes and their bifurcating lines or ridges. Crown shoulder overhangs crown/root junction but not whole root on Type A specimens because of expanded root lingual bulge/torus. Lingual face lateral cusp vertical lines or ridges do not reach crown/root junction but may reach cusp apex. At crown/root junction a U-shaped furrow is under lingual crown shoulder but reduced under principal cusp of Type A specimens (cusp base more flaring and junction blended).

Crown (labial view) lines or ridges sparse or absent on cusps. At most one weak straight line or ridge extending from cusp apex to shoulder where it bifurcates on shoulder protrusion (peg) or nodes. Many nodes present on labial shoulder; raised and nodular (especially when seen in occlusal view); each with small, moderately acute bifurcating crest. Labial

principal cusp protrusion (peg) usually largest; may be reduced, abraded or even absent. Spaces between protrusions U-shaped and commonly smooth. Labial crown shoulder and nodes overhang crown/root junction and most of root (or equal to it). Cusp or protrusion (node) lines or ridges do not reach crown/root junction. Above this junction (underneath overhang) U-shaped furrow extends length of crown. At crown/root junction, both surfaces blended.

Crown light to medium amber colour with lustrous transparent surface allowing view of internal structure. Pulp cavity extends about 2/3 length up interior of principal cusp. Wispy or feathery structure of orthodontine visible. Outer enameloid layer transparent and thick on principal cusp apex; thinner along cusp edges and occlusal crest.

Five specimens (two of Type A, three of Type B) were etched in 1-5% HCl to reveal enameloid ultrastructure. Specimen 1 (Type A) with broken cross-sectioned surface of portion of crown near apex (Pl. 10, fig. 1). Area at image top right of Figure 1 (labelled OC) and enlarged in Figure 2 shows occlusal crest and thin (commonly etched away) outer shiny layer of crystallites, followed by moderately thick layer of bundles of parallel fibres (pf) parallel to crown surface and running in apical-basal directions. Most internal layer (tf) shows tangled fibres. Illustration of specimen 2 (Type A) shows enlarged view of above layers (Pl. 10, fig. 4) in section, and view of parallel fibre bundles as seen from lingual face of the same etched crown (sectioned edge at top of photo) (Pl. 10, fig. 3). Plate 10, figure 6 illustrates damaged region of occlusal crest (two nodes seen behind) of specimen 3 (Type B). Parallel fibres extend basally-apically. Specimen 4 (Type B) shows etched surface between occlusal crest (oc) and shoulder nodes (Pl. 10, fig. 7). Enlargement of occlusal crest region (fig. 8) illustrates upper single crystallite layer (sc) with crystallites approximately perpendicular to surface. Below this layer, parallel fibre bundles (pf) visible (generally parallel to crown surface; may bend or be irregular at occlusal crest region) (also seen on specimen 5, Type B, Pl. 10, fig. 5).

Root surface texture more pitted and less lustrous than crown. Root (profile view) narrowest at crown/root junction and broadens to root base; lingual face convex (Type A) to slightly convex or oblique (Type B); upper labial face narrow and concave; lower labial face shallowly subconcave sloping towards root base. Height of lingual face much higher than upper labial face; about equal when both labial faces included. Root (occlusal view) with pronounced lingual bulge or torus underneath principal cusp on Type A specimens.

Root lingual face moderately high; upper lingual root forms convex arch (centrally highest) underneath arched Type A crown and horizontal under Type B crown. Lingual face canal openings circular to vertically short-oblong; penetrate root approximately perpendicular to crown (or parallel to root base); in Type A, largest underneath principal cusp near root base in bulge/torus, and smallest positioned laterally along root base and on middle and upper faces; in Type B, no particular placement specialization.

Labial root face moderately narrow; Type A: convex arch highest point underneath principal cusp, curvature decreases near heels and may slightly curve upwards; Type B: with minimal arching, approximately horizontal. Upper labial face with row of large canal openings (Type A largest under principal cusp); and penetrate face approximately perpendicular to principal cusp. Unlike lingual face, upper and lower labial face separated by raised lip broken by nodular protrusions around canal openings. Lower labial face sub-concave and shallowly slopes in towards root base (especially shallow on some Type B specimens); commonly channelled (especially Type B); several canal openings (largest generally two but may be 1 to 4 located centrally under principal cusp).

Root basal surface outline on Type A expanded crescentic or arcuate (convex to the lingual face and concave to the labial) or bulbous reniform, on Type B elongate oblong or slightly fusiform; edges may be undulating (lingual side) to deeply crenulated and notched (especially central labial side); base flat to mildly arched (convex) at centre and on heels; surface pitted or rough with indentations or rolls from the sides of canal channels. Root vascularization pseudo-polyaulacorhize to anaulacorhize.

*Comparisons.* *S. multinodosus* differs from Jurassic *Synechodus* species *S. enniskilleni*, *S. occultidens*, *S. pinnai*, *S. egertoni*, and *S. riegrafi*, and Norian *S. incrementum* n. sp. by having many labial and lingual lower crown shoulder nodes, a lower labial principal cusp node that may be developed into a peg or prominent node, and a crown with rare or absent long vertical lines or ridges.

The characters favouring the choice of *Synechodus* are channelled root and pseudo-polyaulacorhize root vascularization, three layered enameloid, a tall or short principal cusp (heterodonty present), row of canal openings on upper labial root face, nodular rim separating upper and lower labial root faces, labially arched root under arched crown (Type A), arcuate style root base (convex lingually), and labial and lingual crown overhang of crown/root junction. Since there are several similar crown features between Types A and B (three-layered enameloid, lack of long vertical ridges, presence of multiple acute nodes joined by thin shoulder longitudinal line on both lingual and labial faces, shoulder overhang of crown/root junction, occlusal crest, and reduced lateral cusps) species heterodonty is favoured rather than splitting the two types into different species. Further discussion of heterodonty and primitive hyodontoid compared to more advanced neoselachian features is given under "Remarks" for *S. incrementum* n. sp.

*Remarks.* See *S. incrementum* n. sp. "Remarks".

*Material.* Holotype GSC 105119 from GSC locality C-101002 (BBR-1); paratypes GSC 105120 to GSC 105124, and GSC 105126 to GSC 105130 from GSC locality C-101002 (BBR-1).

Additional specimens from GSC loc. C-101002 (BBR-1), C-101118 (BBR-310B), C-101119 (BBR-311A), and C-145780 (GK-68-8-27).

*Peace River occurrence.* Ludington and Baldonnel formations: Black Bear Ridge and Chowade South.



*Range.* *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus communisti* and Upper *Metapolygnathus nodosus* conodont zones (Orchard, 1991c); *Klamathites macrolobatus* and Upper *Tropites welleri* ammonoid zones (Tozer, 1994); Upper Carnian, Upper Triassic.

*Synechodus* cf. *multinodosus* n. sp.

Plate 9, figures 13-17

*Utilitarian identification.* Subtype a11/b2+6/c1/d2, 6/e2/f≥3/g2/h2/i2+7+8+10/j4±5+10

*Description.* Crown overhangs lingual root face with moderately high principal cusp; lateral cusps moderately elevated (but not as high as principal cusp). Multiple nodes common on lower labial and lingual crown face shoulders; not present on lingual face below principal cusp. Labial shoulder node may be enlarged into peg-like structure near base of principal cusp. Several well raised vertical ridges on crown labial face terminate in prominent shoulder nodes. Lingual face lines or ridges fewer and less raised, or absent. Occlusal crest traverses crown length over cusp apices. Root with lingual bulge and pseudo-polyaulacorhize to anaulacorhize vascularization.

*Remarks.* Specimens of this type are rare and similar to *S. multinodosus* n. sp. Type A. They differ by having a shorter principal cusp, prominent labial face ridges, and distinct lateral cusps that are higher with well raised long ridges and very prominent labial shoulder nodes.

The specimens have a similar range in the Upper Carnian as *S. multinodosus* n. sp. They probably further represent the heterodont condition where the crown ridges and nodular shoulder are especially featured.

Sections of the crown were not made for study of enameloid ultrastructure because of the rarity of specimens.

*Material.* Figured specimen GSC 105125 from GSC loc. C-101119 (BBR-311A). Additional specimens from GSC loc. C-101002 (BBR-1), C-101003 (BBR-2), C-101118 (BBR-310B), C-101119 (BBR-311A), and C-145780 (GK-68-8-27).

*Peace River occurrence.* Ludington and Baldonnel formations; Black Bear Ridge and Chowade South.

*Range.* *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus communisti* and Upper *Metapolygnathus nodosus* conodont zones (Orchard, 1991c); *Klamathites macrolobatus* and Upper *Tropites dilleri* ammonoid zones (Tozer, 1994), Upper Carnian, Upper Triassic.

*Synechodus volaticus* n. sp.

Plate 11, figures 9-22; Plate 12, figures 1-4

*Utilitarian identification.* Subtype a11/b2+6/c1/d6/e2±4/f1-5/g1,2/h2/i(3,5)+(6,7)+10/j4±5±(6,7)+10

*Etymology.* Latin, *volaticus*, winged or fleeting.

*Diagnosis.* Teeth small (commonly less than 400 µm) with lingually inclined principal cusp and one to two pairs reduced lateral cusps. Labial crown shoulder overhangs crown/root

junction with prominent longitudinal rim or ridge traversing crown (on Type A) from which a few short ridges arise forming acute nodes. Lingual crown face unornamented or with few short ridges and less prominent nodes. Root lingual face high; several large canal openings along base; with prominent central bulge. Root upper labial face narrow with irregular sized pillars from canal channels; lower labial face shallow and channelled usually with three large canal openings. Enameloid ultrastructure with outer single crystallite layer, parallel fibred layer, and possible (not seen) haphazard/tangled layer.

*Description.* Teeth small (commonly less than 400 µm); not expanded mesiodistally. Crown sits on large root (lingual face may be higher than crown); usually with three (rarely one, may have five, rarely more) cusps; may be slightly curved with heels displaced lingually. Occlusal crest traverses crown mesiodistally over cusps. Principal cusp moderately high or low, inclined lingually. Tooth with moderate heterodonty. Two forms of teeth recognized: Type A and Type B.

Type A with higher principal cusp (1 to 4 times higher than lateral cusps); moderately robust with convex lingual and labial faces. Lateral cusps reduced, decrease in height from principal cusp to crown heels. Depressions between cusps broadly U-shaped. Cusp apices rounded (commonly abraded). Ridges commonly short on shoulder nodes, occasionally extend to lateral cusp apex. Crown labial face shoulder prominently overhangs crown/root junction; with longitudinal (mesiodistal) rim and a few short ridges perpendicular to rim forming acute nodes. Rounded furrows between nodes may break the longitudinal rim. Crown lingual face without shoulder and nodes below principal cusp; may have a few lateral short vertical lines or ridges and reduced nodes.

Type B with low principal cusp, not much higher than reduced lateral cusps. Cusp apices rounded (commonly abraded). Depressions between cusps broadly U-shaped. Crown labial and lingual shoulders prominently overhang crown/root junction, with broken longitudinal rim/ridge and a few short ridges perpendicular to rim forming acute and moderately large nodes (larger than Type A). A few long vertical lines or ridges may be located on labial or lingual crown faces (usually on principal cusp and nearest lateral cusp); may bifurcate near principal cusp labial shoulder forming enlarged node. Regions between crown ridges, nodes, and longitudinal rim smooth and concave.

Crown amber colour with lustrous transparent surface allowing view of internal structure. Pulp cavity extends about 3/4 height of principal cusp. Wispy or feathery structure of orthodontine visible. Outer enameloid layer transparent and thick on principal cusp apex; thinner along cusp edges and occlusal crest. A cusp of a Type A specimen etched in HCl reveals a thin layer of single crystallites perpendicular to crown surface and below a thicker layer of parallel fibre bundles (parallel to crown's outer surface and oriented in an apex-basal direction) (Pl. 12, fig. 1-4). Tangled fibre layer not visible (probably due to preparation). Attempts to etch Type B specimens were unsuccessful.

Root narrowest at crown/root junction and broadens to base. Root lingual face high with convex arcuate lingual bulge under principal cusp that extends to heels and several large circular to vertically oblong canal openings in a row near and perpendicular to the base. Root upper labial face narrow; lower labial face shallowly concave. Both faces share one to four (occasionally more) large circular canal openings that plunge into the root.

Root basal surface arcuate with rounded apex on lingual face; labial margin broken by channels from canal openings; base flat to slightly arched at centre sometimes with indentations or rolls from sides of canal channels; no canals open onto basal face. Root vascularization pseudo-polyaulacorhize to anaulacorhize.

**Comparisons.** The presence of crown shoulder nodes, low lateral cusps, moderately sparse and short crown ridges, and a similar root structure indicate similarities between *S. volaticus* and *S. multinodosus*. Table 2 outlines the differences between these two species. In summary, *S. volaticus* has fewer and less prominent crown shoulder nodes, a more prominent labial shoulder rim, a lower principal cusp

(on Type A specimens), commonly one pair of lateral cusps, a high root lingual face with an arcuate lingual bulge that extends to the heels, root heels that may be displaced lingually, and a tooth size that is commonly less than 400 µm.

**Remarks.** The decision to group *S. volaticus* Types A and B as representing a heterodont condition was made based on the root structure being identical (especially the high lingual face with an arcuate bulge, and the arrangement of the canal openings), the presence of crown shoulder nodes and rim/ridge, a similar tooth size, and their occurrence together in the same samples.

Several unsuccessful attempts were made to etch Type B specimens in HCl to reveal enameloid ultrastructure. Specimens were either over-etched (totally disintegrated) or did not appear etched at all. Since the specimens are so small, a new technique will need to be addressed in future studies.

**Material.** Type A, holotype GSC 105135 and paratypes GSC 105133 and GSC 105134 from GSC loc. C-101065 (ACE-2); and paratype GSC 105136 from GSC loc. C-101069 (BEH-3). Type B, paratype GSC 105137 from GSC loc. C-101003 (BBR-2).

**Table 2.** Comparison of *Synechodus multinodosus* n. sp. and *Synechodus volaticus* n. sp.

Feature	<i>Synechodus multinodosus</i>		<i>Synechodus volaticus</i>	
	Type A	Type B	Type A	Type B
number of nodes	multiple, on labial & some on lingual shoulders	common on labial & lingual shoulders	some on labial & lingual shoulders, usually one/cusp, occasionally 2, rarely 3	common on labial & lingual shoulders
node prominence	well raised, protrude more labially	well raised, similar on labial & lingual shoulders	moderately raised, protrude more labially, may notch labial shoulder rim	moderately well raised, similar on labial & lingual shoulders
principal cusp ridges	short, associated with nodes, may have 1 long ridge on labial face	commonly 1 long ridge on labial & lingual faces	short, associated with nodes	commonly 1 long ridge on labial & lingual faces
mesiodistal lip/rim/ridge	ridge faint, broken by high nodes & deep furrows	ridge faint, broken by high nodes & deep furrows	distinct lip/rim, may be broken by nodes & furrows	lip/rim less distinct, broken by nodes & furrows
principal cusp	long, commonly greater than 4 times height of lateral cusps	low	less than 4 times height of lateral cusps	low
lateral cusps	may be none, occasionally 1 or more reduced	may be none, occasionally 1 or more very reduced	commonly 1 pair, rarely 2 pair, rarely none	may be similar height to principal cusp, lower or absent
crown curvature mesiodistally	heels displaced labially or sinusoidal	not curved, moderately straight	heels displaced lingually	heels commonly slightly displaced lingually
tooth labial arch	common (Pl. 8, fig. 3, 9, 15, & 21)	slight or absent (Pl. 9, fig. 3 & 9)	absent, rarely slight (Pl. 11, fig. 11 & 16)	absent (Pl. 11, fig. 20)
Tooth appearance mesiodistally	expanded arcuate	greatly expanded	not expanded	not expanded
root	expanded arcuate	moderately straight	arcuate	arcuate
root lingual face	moderately high, with lingual bulge below principal cusp	moderately high, may slightly bulge under a cusp	high with arcuate lingual bulge that extends to heels	high with arcuate lingual bulge that extends to heels
tooth size	commonly greater than 1000 µm	commonly greater than 1500 µm	commonly less than 400 µm	commonly less than 300 µm



Additional Type A specimens from GSC loc. C-086792 (BH-60), C-087904 (BH-58), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-145768 (GK-88-1-11), and C-153075 (GK-4-11). Additional Type B specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), and C-101069 (BEH-3).

*Peace River occurrence.* Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Laurier Pass.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

*Synechodus* sp. 1

Plate 11, figures 1-5

*Utilitarian identification.* Subtype a11/b1,2/c1/d6/e2±3/f1-3/g2/h2/i1/j1,4,5

*Description.* Tooth not expanded mesiodistally, size 0.5 to 1.0 mm. Crown with occlusal crest traversing mesiodistally over principal cusp and at most one pair of lateral cusps. Principal cusp four or more times higher than reduced lateral cusps, labial face slightly inflated. Cusps inclined lingually and may be angled mesially or distally. Crown labial face with no ridges or lines; with shallow rounded shoulder forming minor overhang of crown/root junction. In labial view, (Pl. 11, fig. 4) tooth with distinctive arch under principal cusp. Crown heels displaced labially but may be sinusoidal (recurving lingually). Crown lingual face commonly without ornament, occasionally may have vertical line associated with a lateral cusp, or a line plunging from the occlusal crest.

Root narrowest at crown/root junction and broadens at its base. Root lingual face high with arcuate lingual bulge under principal cusp that extends to the heels; several large circular to vertically oblong canal openings in a row near and perpendicular to the base. Root upper labial face narrow, canal openings may be absent (not discernable); surface concave between crown/root junction and undulating rim separating root upper and lower labial faces. Lower labial root face sub-concave and penetrated by several circular canal openings. Root basal surface arcuate with rounded apex on lingual face and heels positioned labially; labial margin concave and may be broken by channels from canal openings. Root vascularization pseudo-polyaulacorhize to anaulacorhize.

Tooth specimens are rare; none were sectioned to study crown ultrastructure.

*Comparisons.* *Synechodus* sp. 1 has some similarities (especially root morphology) to *S. volaticus* and differs by having: 1) no crown labial face ornament (no ridges, rim, or nodes), 2) a shallowly rounded labial shoulder with minor overhang of the crown/root junction, 3) a distinctive labial crown/root arch under the principal cusp, and 4) crown heels that are displaced labially or sinusoidal.

*S. sp. 1* mainly differs from *Reifia minuta* Duffin, 1980 by having a less inflated crown labial face, a higher and less broad principal cusp, a labial crown/root arch, principal cusp inclination that may be mesial or distal (in addition to lingually), and crown heels that are displaced labially or are sinusoidal.

The Genus *Synechodus* is chosen over *Reifia* because of a similar root morphology with large labial face canal openings that may notch the labial face rim, a lingual face bulge, and pseudo-polyaulacorhize-anaulacorhize vascularization.

*Material.* Figured specimen GSC 105132 from GSC loc. C-153075 (GK-4-11). Additional specimens from GSC loc. C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101069 (BEH-3), C-103858 (SZ-1), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, Beattie Ledge, and Toad River.

*Range of Peace River specimens.* *Coniunctio aequirugosa* ichthyolith Zone; ?*Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones (Tozer, 1994); Ladinian, Middle Triassic.

*Synechodus* sp. 2

Plate 11, figures 6-8, Figure 14a, b

*Utilitarian identification.* Subtype a11/b1,2/c1/d6/e2±3/f1-3/g2/h2/i1,5/j1,5

*Description.* Tooth not expanded mesiodistally. Crown with occlusal crest traversing mesiodistally over principal cusp and at most one pair of lateral cusps (Fig. 14a, b; Pl. 11, fig. 8). Lateral cusp pair very reduced, may be absent. Principal cusp long, lingually inclined, may be mesially or distally tilted, lower faces inflated (Fig. 14a, b, Pl. 11, fig. 8), commonly circular in cross-section.

Crown ornament commonly absent; occasionally a vertical ridge associated with a lateral cusp. Crown heels displaced labially, labial shoulder rounded with moderate to minor overhang of the root, may have rounded protrusion (uvula) (Pl. 11, fig. 6).

Root not well preserved except in part on illustrated specimen (Pl. 11, fig. 7-8) where it has a lingual bulge and canal openings near the base. It is probably similar to the type seen in *S. multinodosus* Type A.

Tooth specimens rare; none were sectioned to study crown ultrastructure.

*Comparisons.* *Synechodus* sp. 2 has some similarities to *S. multinodosus* and mainly differs by not having shoulder nodes, and by having a principal cusp that is more inflated and a rounded labial shoulder that may have an uvula.

*Material.* Figured specimens GSC 105131 from GSC loc. C-101119 (BBR-311A) and GSC 105381 (Fig. 14a, b) from GSC loc. C-087972 (Sutherland Zone). Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101002 (BBR-1), and C-101119 (BBR-311A).

*Peace River occurrence.* Liard and Baldonnel formations; Black Bear Ridge, and Brown Hill.

*Range of Peace River specimens.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; *Frankites sutherlandi* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

## Section IB. Elasmobranch scales

Elasmobranch scales have a lustrous crown that sits on a pedicle or base. The crown may have a variety of shapes (e.g. lanceolate, rhomboid, circular, lobate, etc.); be horizontal, inclined, erect, or curved; and may be variously ornamented (e.g. lines, ridges, platforms, etc.) on its upper and subsurfaces. The pedicle has a neck (a region just below the crown that is usually narrower than the base of the crown at their junction), and a base (a basal region that broadens or slightly flares). The junction of the crown and pedicle is marked by a thin circumferential line where the crown overlaps the pedicle (Fig. 9b; and Pl. 24, fig. 1-2) and usually occurs basally under a crown overhang and at the top of the pedicle where it narrows.

Triassic Peace River elasmobranch scales differ from teeth in commonly having an anterior to posterior inclined crown with a pedicle positioned to the anterior (leaving a large area of the posterior subcrown unoccupied by the pedicle). If the scale pedicle is positioned centrally under the crown, then the crown is circular to rounded, lobed in outline, flat-topped, or dome-shaped. Peace River elasmobranch teeth commonly have more than one crown apex that may be inclined lingually. The tooth base is almost always directly below the crown base and occupies most of the subcrown surface.

Elasmobranch scales mainly differ from actinopterygian ganoid scales by not having ganoin and by having a pedicle with two regions (neck and base). Elasmobranch scales are commonly lanceolate in outline and elevated whereas ganoid scales are rhomboid and flattened.

*Remarks.* Some of the elasmobranch scale specimens show postmortem damage (e.g. cracking, Pl. 23, fig. 9, 11; or pitting, Pl. 25, fig. 11). These features are not considered to be diagnostic characters of the scale. Because of these preservation problems and that one specimen may not have all surface views preserved well, additional specimens have been photographed to more clearly illustrate the important morphological features.

Descriptions of all of the elasmobranch scales are based on isolated specimens found in the samples.

Part 1: Pedicle vascularisation anaulacorhize

Part 2: Pedicle vascularisation hemiaulacorhize

Supergroup I: Pedicle truncate

Group A: Pedicle fluted truncate

Subgroup 1: Pedicle supracentral; crown erect; pedicle base outline circular to oval, may have undulating margins.

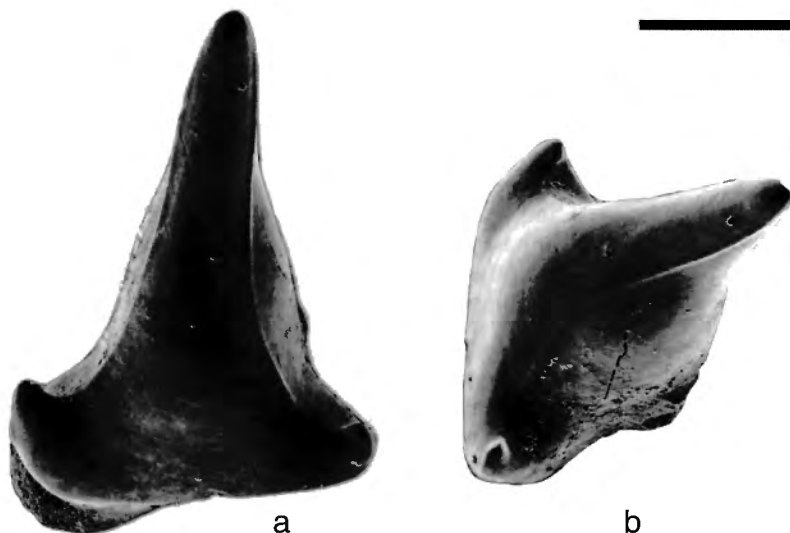
Subgroup 1a: Crown sail-like, surface commonly granular; subpedicle surface flat to concave.

*Parviscapa* n. gen. s.f.

*Etymology.* Latin, *parvus scapha*, little boat.

*Type species.* *Parviscapa trivela* n. sp. s.f.

*Diagnosis.* Upper crown with prominent and high triangular mesial keel that looks like a sail; two wings perpendicular to keel may be present; surface commonly granular. Crown posterior vertical, thin near apex and broadens towards base at pedicle; single apex may curve posteriorly. Crown centred on pedicle. Pedicle fluted truncate; wider than crown.



**Figure 14a, b.**

*Synechodus* sp. 2, figured specimen GSC 105381 from GSC locality C-087972 (Sutherland Zone). Labial and profile views of crown showing inflated principal cusp and one pair of reduced lateral cusps. Scale bar = 200  $\mu$ m.

*Description.* Crown with prominent and high triangular mesial keel; surface commonly granular. Keel thin at top and broadens slightly at base; with rounded diagonal that extends anterior to posterior; posterior face vertical or steeply oblique; thin at top and may broaden at base near pedicle. Two crown wings may be present; approximately horizontal and perpendicular to keel. Apex posterior at highest point where keel edges converge; may curve posteriorly. Crown positioned at pedicle centre; intersects pedicle on all faces obliquely or vertically.

Pedicle fluted truncate; wider than crown; and greatly flares to base with oblique faces; vascularization hemiaulacorhize. Subpedicle surface flat or concave; outline oblong, lanceolate or circular with irregular, notched, crenulate or lobate edges.

*Comparisons.* *Parviscaptha* n. gen. s.f. has a distinct crown with a high triangular mesial keel, common granular surface texture, lack of other surface features, and the central position on the pedicle (pedicle is wider than the crown and fluted truncate).

*Parviscaptha univelum* n. sp. s.f. differs from *Parviscaptha trivela* n. sp. s.f. by not having two crown wings at the base and perpendicular to the keel. In addition the posterior face is narrow, where as in *P. trivela* n. sp. s.f. it is narrow at posterior apex and broadens considerably near pedicle.

*Remarks.* The common absence of a lustrous scale crown surface (as noted by "surface commonly granular") may be a result of preservation such as from differential solution. However, lustrous scale crown surfaces were found in all other scale forms from the same samples as *Parviscaptha* n. gen. s.f.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodus* ichthyolith zones; Ladinian and uppermost Upper Carnian, Middle and Upper Triassic.

*Parviscaptha trivela* n. sp. s.f.

Plate 13, figures 1-5

*Utilitarian identification.* Subtype a17/b11/c2

*Etymology.* Latin, *trium velum*, three sails.

*Diagnosis.* Crown with prominent sail-like mesial keel sitting on two wings (one on each side). Posterior face narrow at apex and broadens at base near pedicle; vertical or oblique. One apex at crown posterior.

*Description.* Crown steeply oblique from anterior to posterior; surfaces commonly granular. Prominent crown mesial keel extends anterior to posterior; elongate triangular with rounded diagonal edge; highest centrally; thin at top; broadens slightly at base. Two crown wings perpendicular to mesial keel and at its base extend approximately horizontally to side margins of crown; narrow at posterior and broad at anterior. Single apex at posterior where keel, wings, and crown posterior (or subcrown) converge to a point. Anterior margin of crown intersects pedicle vertically or obliquely (with no overhang). Crown posterior margin or subcrown a

vertical face or steeply oblique from posterior apex to pedicle; narrow near apex; broadens at base; flat or slightly convex from side edge to side edge.

Crown positioned at pedicle centre; intersects pedicle on all faces obliquely or vertically with no (or minor) crown overhang. Pedicle wider than crown; fluted truncate; greatly flares to base with oblique faces. Pedicle vascularization hemiaulacorhize with at least one main canal opening perpendicular to subpedicle surface; other smaller canal openings rare. Subpedicle surface flat or concave; outline circular or irregular; margins notched or crenulated.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105294 from GSC loc. C-101065 (ACE-2). Additional specimens from GSC loc. C-101003 (BBR-2) and C-101065 (ACE-2).

*Peace River occurrence.* Liard, and ?Baldonnel formations; Aylard Creek East and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodus* ichthyolith zones; ?*Maclearnoceras maclearni* and *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) and the *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Upper Carnian, Middle and Upper Triassic.

*Parviscaptha univelum* n. sp. s.f.

Plate 13, figures 6-18; Figure 11f

*Utilitarian identification.* Subtype a17/b11/c1

Supergroup I, Group A, Subgroup 1a, Johns, 1996, Pl. 2, fig. 1

*Etymology.* Latin, *univelum*, one sail.

*Diagnosis.* Crown with prominent sail-like mesial keel; wings absent or reduced at base. Crown posterior face narrow and vertical. One apex at crown highest posterior point.

*Description.* Crown vertical and sail-shaped; with a prominent keel (sail) that extends anterior to posterior; wings absent or reduced at base; surfaces commonly granular. Crown posterior vertical face narrow at top and slightly broadens at base; flat to slightly concave from side edge to side edge; with two vertical rounded edges forming posterior intersect of keel faces.

Keel triangular with two vertical or steeply oblique (may be slightly concave) faces that intersect at an upper edge as a curved and rounded diagonal; narrow at top and broaden slightly at base; anterior margin thin and forms curved keel edge of two side faces. Apex obtuse or acute; position posterior; may be attenuate and curve over posterior vertical face.

Crown positioned at pedicle centre; intersects pedicle (on all faces) obliquely or vertically with no (or minor) crown overhang. Pedicle wider than crown; fluted truncate; greatly flares to base with oblique faces. Pedicle vascularization hemiaulacorhize with at least one main canal opening perpendicular to subpedicle surface; other smaller canal openings may be present. Subpedicle surface flat, concave, and (or)

shallowly undulating with minor bulge(s); outline approximately oblong, lanceolate, or circular; edges irregular, notched, crenulate, or lobate.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Only a few specimens were found in each residue but were recovered from most Ladinian samples.

One specimen (Pl. 13, fig. 17-18), has a fluted truncate pedicle and a simple sail-like crown which is similar to that of *Parviscaptha univelum* n. sp. s.f. It mainly differs by having a crown region that is shorter, less keeled, and is smooth. This may illustrate a specimen that has the outer enameloid layer preserved. Further study and collection of additional specimens is necessary to confirm if these specimens belong to the same species.

*Material.* Holotype GSC 105296 from GSC loc. C-101069 (BEH-3); and paratype GSC 105295 from GSC loc. C-101003 (BBR-2). Questionable specimen (figured specimen) GSC 105297 from GSC loc. C-101118 (BBR-310B).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard, and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Upper Carnian, Middle and Upper Triassic.

Subgroup 2: Pedicle subcentral; crown erect, may have flat upper surface; pedicle base outline multipetaloid, circular, or rhomboid.

2a: Crown lobate; subpedicle surface flat, concave, or convex.

*Lobaticorona* n. gen. s.f.

aff? *Heterodontus* Blainville 1816, p. 121.

aff? Hybodontidae gen. and sp. indet., Reif, 1978b, p. 123, Fig. 10B.

*Etymology.* Latin, *lobatus corona*, lobed crown.

*Type species.* *Lobaticorona floriditurris* n. sp. s.f.

*Diagnosis.* Crown outline irregular with deep vertical furrows and primary lobes that usually split into secondary lobes. Bifurcating lines or ridges common on lobes.

*Description.* Crown outline irregular with deep vertical furrows and primary lobes that usually split into secondary lobes; horizontal, vertical, or oblique; length and width variable; commonly thicker than height of pedicle. Bifurcating lines or ridges common on lobes curve over an approximately

vertical crown margin or shoulder face, and under to crown/pedicle junction. Thin longitudinal line may be on lower crown shoulder commonly broken by furrows. Thin halo may be located around posterior pedicle; commonly continuation of longitudinal line.

Pedicle positioned centrally under crown with overhang of crown/pedicle junction on all sides; fluted truncate; edges wider or equally as wide as crown. Subpedicle surface concave, flat, convex, or convex with shallow bulge; vascularization hemiaulacorhize with small mesial and other canal openings; outline circular, oblong, lanceolate, rounded rhomboid, or irregular; margins may be petaloid and undulating.

*Comparisons.* *Lobaticorona* n. gen. s.f. crowns show resemblance to some of a variety of dermal denticles found on *Heterodontus* species. Reif (1972/1973, 1974a, 1976) discussed the variability of *Heterodontus* dermal denticles and compared *Heterodontus falcifer* (Late Jurassic) to *Heterodontus japonicus* (Recent) where he illustrated different scales at various positions on the body. Reif (1974a) proposed that the different dermal denticle shapes of *Heterodontus* were derived from a single primary form as a result of five geometrical transformations.

Of the variety of *Heterodontus* scale forms (even on a single species), *Lobaticorona* n. gen. s.f. crowns show some resemblance to dermal denticles on the anterior dorsal fin and eye ridge areas of *H. falcifer* (Reif, 1972/1973, p. 20, Fig. 3c, g; 1985a, p. 27, fig. 3) and to some degree more resemblance to *Heterodontus japonicus* and *Heterodontus portusjacksoni* dorsal fin, eye ridge and body surface areas (Reif, 1972/1973, p. 19, Fig. 2e, f; 1974a, p. 28, 29, 38, 39, Fig. 3, 4, 12; 1976, p. 25-27, Fig. 1D, 2, 3). In addition, other forms of these dermal denticles from the edges of fins and the snout areas (Reif, 1972/1973, p. 20, Fig. 3d; 1974a, p. 29, Fig. 4; 1976, p. 26-27, Fig. 2, 3) have upper crowns which resemble *Glabrisubcorona* n. gen. s.f., *Carinasubcorona* n. gen. s.f. or *Sacrisubcorona* n. gen. s.f. Heterodonty in species can cause taxonomic problems. By combining details on crown and pedicle morphologies (particularly the pedicle base curvature), some of the Triassic *Lobaticorona* n. gen. s.f. species could be differentiated. However, more information is still needed on the *Heterodontus* subcrown, pedicle, and subpedicle surface features before the relationships of the Triassic forms can be compared and considered.

Reif (1978b, p. 123, Fig. 10B) illustrated a specimen belonging to the Hybodontidae (genus and species indeterminate) from the Triassic of Spitsbergen which closely resembles the crowns and pedicles of *Lobaticorona floridibasis* n. sp. s.f. and *Lobaticorona tumidibasis* n. sp. s.f. The subpedicle surface was not illustrated, therefore the Reif specimen will need to be viewed before the species can be determined.

*Lobaticorona* n. gen. s.f. mainly differs from the other Peace River elasmobranch scales by having deep vertical crown furrows, distinct lobate margins or shoulders that have bifurcating lines or ridges, and a pedicle that is approximately positioned centrally underneath the crown.

*Lobaticorona floriditurris* n. sp. s.f., *Lobaticorona floriditabella* n. sp. s.f., and *Lobaticorona floridibasis* n. sp. s.f. share in common a lobate crown and a subpedicle surface that is flat to slightly concave with margins that are petaloid and undulating.

*Lobaticorona tumiditurris* n. sp. s.f., *Lobaticorona tumiditabella* n. sp. s.f., and *Lobaticorona tumidibasis* n. sp. s.f. share in common: 1) a lobate crown; and 2) a subpedicle surface that is convex or convex with a shallow bulge, and an outline that is circular, oblong, lanceolate, rounded rhomboid, or irregular.

*L. floriditurris* n. sp. s.f. and *L. tumiditurris* n. sp. s.f. both have deeply lobed crowns with furrows that cut into the crown centre. *L. floriditabella* n. sp. s.f. and *L. tumiditabella* n. sp. s.f. both have a lobed crown with an enlarged central region that is flat. *L. floridibasis* n. sp. s.f. and *L. tumidibasis* n. sp. s.f. both have a lobed crown that is slightly oblique where lines or ridges diverge from a posterior point or area.

**Remarks.** Most *Lobaticorona* n. sp. s.f. specimens in samples from the Middle Norian are commonly smaller and have a shorter pedicle that is more flared at the base than other specimens from the Carnian and Ladinian. Since specimens numbers were low, it was not appropriate to attempt to recognize a new species. Hopefully, this difference can be explored in future studies.

**Range.** Ladinian, Carnian, and Norian; Middle and Upper Triassic.

*Lobaticorona floriditurris* n. sp. s.f.

Plate 14, figures 1-6

**Utilitarian identification.** Subtype a13/b3+6/c7/d5+8/e1, 2/f1,2/g2+4/h2,6,7/i1,2

**Etymology.** Latin, *floridus turris*, flowery tower or turret (referring to the flowery [petaloid] appearance of the subpedicle surface, and a turret-like or lobed crown).

**Diagnosis.** Crown outline irregular with vertical furrows that cut deeply into crown centre. Outer crown with primary and usually secondary lobes. Margins with approximately vertical shoulder faces. Primary ridge traverses crown centre; splits into secondary ridges to crown lobes. Tertiary lines or ridges may diverge from secondary ridges on crown with larger lobes. Lines or ridges continue down shoulder faces and under crown to crown/pedicle junction. Subpedicle surface flat or slightly concave; margins petaloid or irregular.

**Description.** Crown upper surface approximately horizontal; outline irregular; margins deeply furrowed, lobed, and undulating. Crown centre narrow and deeply cut by vertical furrows. Crown margins with primary lobes that may split near crown margins into secondary lobes. Primary lobes separated by rounded vertical, and deep furrows narrower at crown central region than at margins. If secondary lobes present, furrow between each lobe shallower than furrows between primary lobes. Crown shoulders at all margins curve sharply down to an approximately vertical face; then curve under (forming a

slight overhang) to crown/pedicle junction. Pedicle edges wider than crown (or at least as wide as crown) on all margins (anterior, posterior, and sides).

Crown centre with single ridge traversing crown length (or single point approximately central) with secondary ridges diverging from it to primary crown lobes. Tertiary lines or ridges may diverge from secondary ridges. Furrows between lobe lines or ridges shallow. Thin longitudinal line on lower shoulder above overhang and crown/pedicle junction; perpendicular to other lines or ridges; commonly discontinuous (or difficult to see) due to lobate nature of crown/shoulder.

Pedicle positioned approximately centrally under crown; occupies most of subcrown surface. Ridges and shallow furrows from crown shoulder may extend under crown to crown/pedicle junction. Thin pedicle halo may join longitudinal line. Pedicle fluted truncate; vascularization hemiaulacorrhize. Subpedicle surface flat or slightly concave with small circular mesial and rarely other smaller canal openings; outline approximately circular to oblong; margins multipetaloid and undulating.

**Comparisons.** See Genus "Comparisons".

**Material.** Holotype GSC 105283 from GSC loc. C-101754 (NPP-Low), and paratype GSC 105284 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc. C-087924 (BH-8), C-101003 (BBR-2), C-101036 (MS-3), C-101064 (ACE-1), C-101065 (ACE-2), C-101069 (BEH-3), C-153076 (GK-4-17), C-302382 (BH-20), and C-302390 (TE-220A).

**Peace River occurrence.** Liard, Baldonnel, and Pardonet formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, and Ne Parle Pas Rapids.

**Range.** *Coniunctio aequirugosa* to *Synechodus incrementum* ichthyolith zones; ?*Maclearnoceras maclearni* to *Drepanites rutherfordi* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the *Epigondolella spiculata* conodont Zone (Orchard, 1991c); Ladinian, Carnian, and Lower and Middle Norian, Middle and Upper Triassic.

*Lobaticorona floriditabella* n. sp. s.f.

Plate 14, figures 7-11

**Utilitarian identification.** Subtype a13/b±3+6/c6/d5, 8/e1,2/f1,2/g2+4/h2,6,7/i1,2

Supergroup I, Group A, Subgroup 2a, Johns, 1996, Pl. 2, fig. 14.

**Etymology.** Latin, *floridus tabella*, flowery small board (referring to the flowery [petaloid] appearance of the subpedicle surface, and crown surface that is flat and lobed).

**Diagnosis.** Crown erect with flat upper surface; outline irregular to approximately circular or oblong, with moderately deep vertical furrows, primary and secondary lobes, and margin shoulders with approximately vertical faces. Primary ridge on lobes splits into secondary ridge on secondary lobes.



Tertiary lines or ridges may split from primary ridge. Lines or ridges continue down shoulder faces and under crown to crown/pedicle junction. Vertical furrows do not cut deeply into crown centre, instead crown centre region enlarged, flat, may be absent of ornamentation and (or) have lines or ridges from lobes that converge off-centre. Subpedicle surface flat or slightly concave; margins petaloid or irregular.

*Description.* Crown outline irregular to approximately circular or oblong; margins lobed, undulating, and irregular; upper surface flat. Crown shoulders at all margins curve sharply down to an approximately vertical face; then curve under forming a slight overhang of crown/pedicle junction. Pedicle basal edges wider than crown (or at least as wide as crown) on all margins (anterior, posterior, and sides).

Crown margins with primary lobes that may split near crown margins into secondary lobes. Primary lobes separated by rounded vertical and moderately deep furrows narrower at crown margins between secondary lobes. Furrow between secondary lobes shallower than furrows between primary lobes. Main ridge on each primary lobe; splits to each secondary lobe; may curve over shoulder, down shoulder face, and under crown to crown/pedicle junction. Other crown lobe lines or ridges less raised and split from main ridge. Furrows between lobe lines or ridges shallow. Thin longitudinal line on lower shoulder above overhang and crown/pedicle junction; perpendicular to other lines or ridges; commonly discontinuous (or difficult to see) due to lobate nature of crown/shoulder.

Crown central region moderately large; free of vertical furrows and lobes; commonly smooth and unornamented (ridges terminate near crown central end of each lobe); may have lines or ridges that converge to one side of the crown central region.

Subcrown surface and pedicle description same as *L. floriditurris* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105286 and paratype GSC 105285 from GSC loc. C-101119 (BBR-311A).

Additional specimens from GSC loc. C-087901 (BH-62), C-101064 (ACE-1), C-101065 (ACE-2), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-101119 (BBR-311A), C-101150 (MS-247A), C-153069 (GK-1-19), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard, Baldonnel, and Pardonet formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* to *Synechodus incrementum* ichthyolith zones; ?*Maclearnoceras maclearni* to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the *Epigondolella serrulata* conodont Zone (Orchard, 1991c); Ladinian, Carnian, and Lower and Middle Norian, Middle and Upper Triassic.

*Lobaticorona floridibasis* n. sp. s.f.

Plate 14, figures 12-18; Figure 10j

*Utilitarian identification.* Subtype a13/b2+6/c6/d5, 8/e1,2/f1,2/g2+4/h2,6,7/i1,2

Supergroup I, Group A, Subgroup 2a, Johns, 1996, Pl. 1, fig. 18.

*Etymology.* Latin, *floridus basis*, flowery base (referring to the flowery [petaloid] appearance of the subpedicle surface).

*Diagnosis.* Crown oblique; outline irregular with vertical furrows that cut moderately deeply into crown anterior and side margins. Crown furrows separate primary crown lobes which may split into secondary lobes at margins. Anterior and side margins with approximately vertical shoulder faces. Crown posterior with shallower furrows and fewer lobes; with line or ridge or point near margin from which secondary lines or ridges diverge to primary lobes at crown sides and anterior. Posterior subcrown surface may have ridge extending from posterior apex to posterior pedicle in addition to other lines or ridges. Subpedicle surface flat or slightly concave; margins petaloid or irregular.

*Description.* Crown oblique; outline irregular; margins furrowed, lobed, and undulating. Crown centre moderately narrow and cut by vertical furrows. Crown margins with primary lobes which may split near crown margins into secondary lobes. Primary lobes separated by rounded vertical and deep furrows narrower at crown central region than at margins. If secondary lobes present, furrow between each lobe shallower than furrows between primary lobes. Crown shoulders at all margins curve sharply down to an approximately vertical face, then curve under forming a slight overhang of crown/pedicle junction. Pedicle edges wider than crown or at least as wide as crown on all margins (anterior, posterior, and sides).

Crown posterior with shallower vertical furrows, fewer lobes, small overhang of posterior pedicle, and line across (or a point) near posterior margin where crown is highest. Crown lines or ridges diverge from this posterior point or line to primary lobes at crown sides and anterior where they may again split to secondary lobes. Tertiary lines or ridges may diverge from secondary ridges. Furrows between lobe lines or ridges shallow. Thin longitudinal line on lower shoulder above overhang and crown/pedicle junction; perpendicular to other lines or ridges; commonly discontinuous (or difficult to see) due to lobate nature of crown/shoulder.

Pedicle positioned approximately centrally under crown; occupies most of subcrown surface. Ridges and shallow furrows from crown shoulder extend under crown to crown/pedicle junction. Posterior subcrown surface may have short or long mesially higher ridge (extending from posterior crown to posterior pedicle). Subcrown may have thin posterior pedicle halo that anteriorly joins longitudinal line.

Subcrown and pedicle description same as *L. floriditurris* n. sp. s.f.

*Comparisons.* See Genus, "Comparisons".

*Material.* Holotype GSC 105288 from GSC loc. C-101064 (ACE-1); and paratypes GSC 105287 and GSC 105289 from GSC loc. C-101036 (MS-3).



Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101036 (MS-3), C-101038 (MS-5), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101069 (BEH-3), C-101070 (BEH-4), and C-302382 (BH-20).

*Peace River occurrence.* Liard and Pardonet formations; Aylard Creek East, Beattie Hill, Brown Hill, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* to *Synechodus incrementum* ichthyolith zones; ?*Maclearnoceras maclearni* to *Drepanites rutherfordi* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the Upper *Epigondolella multidentata* conodont Zone (Orchard, 1991c); Ladinian, Carnian, and Lower and Middle Norian, Middle and Upper Triassic.

*Lobaticorona tumiditurris* n. sp. s.f.

Plate 15, figures 1-3

*Utilitarian identification.* Subtype a13/b3+6/c7/d5+8/e1, 2/f1,2/g2+4/h1,2,3,7/i3

*Etymology.* Latin, *tumidus turris*, swollen tower or turret (referring to the convex subpedicle surface, and a turret-like or deeply lobed crown).

*Diagnosis.* Crown diagnosis same as *L. floriditurris* n. sp. s.f. Subpedicle surface convex or convex with a shallow bulge; outline circular to rounded rhomboid.

*Description.* Crown same as *L. floriditurris* n. sp. s.f. Pedicle vascularization hemiaulacorhize. Subpedicle surface convex or convex with shallow bulge; with small circular mesial and other smaller canal openings; outline approximately circular, oblong, lanceolate, rounded rhomboid, or irregular; margins rounded or shallowly undulating.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105290 from GSC loc. C-087909 (BH-48). Additional specimens from GSC loc. C-101065 (ACE-2), C-101068 (BEH-2), C-101069 (BEH-3), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard and Pardonet formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* to *Synechodus incrementum* ichthyolith zones; ?*Maclearnoceras maclearni* to *Stikiloceras kerri* II ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the Upper *Epigondolella quadrata* conodont Zone (Orchard, 1991c); Ladinian, Carnian, and Lower Norian, Middle and Upper Triassic.

*Lobaticorona tumiditabella* n. sp. s.f.

Plate 15, figures 4-9

*Utilitarian identification.* Subtype a13/b±3+6/c6/d5, 8/e1,2/f1,2/g2+4/h1,2,3,7/i3

*Etymology.* Latin, *tumidus tabella*, swollen small board (referring to the convex subpedicle surface, and a flat lobed crown).

*Diagnosis.* Crown diagnosis same as *L. floriditabella* n. sp. s.f. Subpedicle surface convex or convex with a shallow bulge; outline circular to rounded rhomboid.

*Description.* Crown description same as *L. floriditabella* n. sp. s.f. Subpedicle surface description same as *L. tumiditurris* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105291 from GSC loc. C-101069 (BEH-3), and paratype GSC 105292 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc C-101067 (BEH-1), C-101069 (BEH-3), C-101119 (BBR-311A), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard and Baldonnel formations; Beattie Hill, Beattie Ledge, and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Upper Carnian, Middle and Upper Triassic.

*Lobaticorona tumidibasis* n. sp. s.f.

Plate 15, figures 10-13

*Utilitarian identification.* Subtype a13/b2+6/c6/d5, 8/e1,2/f1,2/g2+4/h1,2,3,7/i3

cf. Subtype Number 140, Tway and Zidek, 1983, p. 419; Fig. 436, fig. 70a-d.

*Etymology.* Latin, *tumidus basis*, swollen base (referring to the convex subpedicle surface).

*Diagnosis.* Crown diagnosis same as *L. floridibasis* n. sp. s.f. Subpedicle surface convex or convex with a shallow bulge; outline circular to rounded rhomboid.

*Description.* Crown description same as *L. floridibasis* n. sp. s.f. Subpedicle surface description same as *L. tumiditurris* n. sp. s.f.

*Comparisons.* Tway and Zidek (1983) illustrated a Late Pennsylvanian specimen (Subtype Number 140) which is almost identical to *L. tumidibasis* n. sp. s.f. A small difference is that the subpedicle surface is lacking a mesial canal opening.

In addition, see Genus "Comparisons".

*Material.* Holotype GSC 105293 from GSC loc. C-153075 (GK-4-11). Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101069 (BEH-3), C-153075 (GK-4-11), and C-153078 (GK-4-38).

*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994);

Ladinian (unzoned) to the *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Upper Carnian, Middle and Upper Triassic.

Subgroup 2:

2b: Crown dome-shaped; pedicle base outline circular to rhomboid and may have undulating margins; subpedicle surface flat, concave, or convex.

*Proprigalea* n. gen. s.f.

*Etymology.* Latin, *proprius galea*, distinctive helmet (scale named for its similar appearance to a helmet or hat).

*Type species.* *Proprigalea mediglabra* n. sp. s.f.

*Diagnosis.* Crown dome-shaped and convex; outline circular or oblong. Central crown region commonly smooth or with shallow lines that converge to a point; broadly rounded (not peaked). Crown shoulders located close to anterior and side margins with moderately raised lines or ridges and shallow or deep furrows that curve down and under shoulder to subcrown halo or crown/pedicle junction. Subcrown halo thin around pedicle and joins thin anterior longitudinal line on or near shoulder.

*Description.* Crown dome-shaped and convex; outline circular or oblong; equally as long as wide or slightly longer; margins shallowly undulating or crenulated. Central crown region smooth or with shallow lines that converge to point; broadly rounded (not peaked). Crown shoulders located close to anterior and side margins. Crown ridges short or long, moderately raised on shoulders with shallow furrows between; curve over and under shoulder to subcrown halo or crown/pedicle junction. Halo thin line on subcrown surface around pedicle and joins thin anterior longitudinal line on shoulder or above crown/pedicle junction. Crown posterior margin convex, rounded, and (or) with minor cusps (1, 3, or 5). Subcrown reduced on specimens with minor crown overhang of pedicle; specimens with posteriorly expanded crown have mesial ridge or keel that extends from posterior pedicle to crown apex; additional ridges or keels (commonly two) may extend from pedicle to crown sides. Crown/pedicle junction positioned centrally under crown or to anterior.

Pedicle fluted truncate, rarely keeled fluted truncate; vascularization hemiaulacorhize. Subpedicle surface shallowly convex, flat, or slightly concave with mesial canal and other small canal openings; outline approximately circular or rounded rhomboid with irregular or undulating edges.

*Comparisons.* *Proprigalea* n. gen. s.f. is distinct with its domed (convex) crown, a fluted truncate or keeled fluted truncate pedicle, and the undulating side and anterior margins with ridges and furrows that curve down and under crown shoulders to the subcrown halo or crown/pedicle junction.

*Proprigalea mediglabra* n. sp. s.f. differs from *Proprigalea medirugosa* n. sp. s.f. by not having long lines or ridges that converge at a point near the crown centre or posterior. The central crown region is smooth on *P. mediglabra* n. sp. s.f.

*P. mediglabra* n. sp. s.f. and *P. medirugosa* n. sp. s.f. differ from *Proprigalea languidula* n. sp. s.f. by not having the posterior region of crown extended so that it overhangs the pedicle more than at the sides. The posterior crown region of *P. languidula* n. sp. s.f. commonly overhangs the posterior pedicle edge and may have ridges or keels on the subcrown extending from posterior crown/pedicle junction corner to posterior crown.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and Carnian, Middle and Upper Triassic.

*Proprigalea mediglabra* n. sp. s.f.

Plate 16, figures 1-3; Figures 10i, 11d

*Utilitarian identification.* Subtype a13/b±2+6/c3/d2+5+7/e2/f1/g2+4+5/h2,3/i1,2

Supergroup I, Group A, Subgroup 2b, Johns, 1996, Pl. 1, fig. 20; and Pl. 2, fig. 2.

*Etymology.* Latin, *medius glaber*, middle smooth (referring to the centre of the dome-shaped crown that is smooth and unornamented).

*Diagnosis.* Crown dome-shaped and convex; outline approximately circular. Central crown region smooth and without shallow lines that converge to a point. Crown shoulders undulating from moderately raised lines or ridges and shallow furrows that curve down and under to subcrown halo or crown/pedicle junction. Subcrown surface mainly occupied by pedicle. Pedicle positioned centrally under crown. Crown with small overhang of crown/pedicle junction on all sides.

*Description.* Crown outline approximately circular; dome-shaped (convex anterior to posterior and side edge to side edge); centrally highest (or slightly to posterior); broadly rounded (not peaked). Central crown region smooth and absent of ornamentation. Crown shoulders located close to anterior and side margins; generally steeply (sometimes slightly) curve down and under forming an overhang of crown/pedicle junction on all sides. Crown sits approximately centrally on pedicle. Pedicle base edges wider than crown at all positions (anterior, posterior, and sides). Crown shoulders and margins undulating or crenulated. Short and moderately raised ridges and short and moderately shallow furrows common on shoulders; parallel; drop approximately vertically from shoulders and curve under crown to pedicle halo or crown/pedicle junction; thinnest or shallowest at upper shoulder; more raised or deeper near crown base. Subcrown halo thin line around pedicle with slightly concave surface between it and pedicle; joins longitudinal line at anterior. Longitudinal line thin and perpendicular to crown ridges and furrows; on lower crown shoulder above crown/pedicle junction. Subcrown mainly occupied by pedicle.

Pedicle fluted truncate; vascularization hemiaulacorhize. Subpedicle surface shallowly concave or flat; outline approximately circular or rounded rhomboid with irregular or undulating edges. Mesial canal opens perpendicular to subpedicle surface; circular when subsurface flat; large and irregular

when subsurface concave (appears abraded, revealing expanded canal structure). Other small canal openings may be present.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105280 from GSC loc. C-101065 (ACE-2) and paratype GSC 105377 from GSC loc. C-101069 (BEH-3). Additional specimens GSC loc. C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-101753 (MS-GB), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Tropites welleri* II ammonoids zones (Tozer, 1994); Ladinian (unzoned) to Upper *Metapolygnathus nodosus* conodont zones (Orchard, 1991c); Ladinian and Upper Carnian, Middle and Upper Triassic.

*Proprialea languidula* n. sp. s.f.

Plate 16, figures 4-10

*Utilitarian identification.* Subtype  $a13/b\pm2+6/c3/d2\pm(5,6)/e2/f1,2/g2+4+5+6/h2,3/i1,2,3$  and Subtype  $a4/b2\pm6/c2/d4\pm(7,8)/e1,3/f3,4,5/g1,2/h1,2/i1,2/j1/k(1,2)\pm(3,4,5)/l1/m5,6/n,2,3$

*Etymology.* Latin, *languidulus*, drooping (the crown appears to be drooping at the posterior).

*Diagnosis.* Crown dome-shaped and convex; outline approximately oblong; length may increase anterior to posterior. Central crown region smooth and without shallow lines that converge to a point. Crown shoulders undulating from moderately raised lines or ridges and shallow furrows that curve down and under to subcrown halo or crown/pedicle junction. Crown posterior margin overhangs posterior pedicle commonly beyond its edge; may have one, three, or five minor apices. Subcrown surface may have lines, ridges, or keels extending from posterior crown/pedicle junction corner to posterior crown. Pedicle positioned to anterior under crown.

*Description.* Crown outline approximately oblong, longest anterior to posterior; dome-shaped (convex anterior to posterior and side edge to side edge); centrally highest (or slightly to posterior); and shallowly inclined anterior to posterior. Central crown region smooth, absent of ornamentation, and broadly rounded (not peaked). Crown shoulders located close to anterior and side margins; usually steeply curve down and under forming overhang of crown/pedicle junction on all sides. Crown overhangs pedicle at posterior; may extend beyond posterior pedicle edge. Pedicle edges wider than crown at anterior and sides.

Crown anterior and side margins undulating or crenulated. Short and moderately raised ridges and short and moderately shallow furrows common on shoulders; parallel and drop approximately vertically from anterior and side shoulders to subcrown halo or crown/pedicle junction; thinnest or shallowest at upper shoulder; more raised or deeper near

crown base. Anterior longitudinal line typically absent; when present, thin and perpendicular to crown ridges and furrows; commonly discontinuous; located on lower crown shoulder above crown/pedicle junction; joins thin subcrown halo at posterior. Crown posterior margin convex and rounded or with minor cusps (1, 3, or 5) considerably reduced with central apex slightly longer.

Subcrown surface expands to posterior as crown extends over pedicle. On specimens with: 1) small posterior overhang, subcrown shallowly concave and mainly occupied by pedicle; 2) moderate overhang, pedicle anterior and subcrown with mesial ridge that extends from pedicle most posterior corner to crown posterior apex or middle, with shallow concave hollow on each side of ridge and deepest near pedicle; and 3) considerable overhang, pedicle anterior and subcrown mesial ridge well raised or like a keel with deep concave hollow on each side, additional ridges or keels (commonly two) extend from pedicle to crown sides. Crown/pedicle junction central under crown or to anterior.

Pedicle fluted truncate or keeled fluted truncate; vascularization hemiaulacorhize. Subpedicle surface concave, flat, or shallowly convex; outline approximately circular or rounded rhomboid with irregular or undulating edges. Mesial canal opens perpendicular to subpedicle surface; circular when subsurface convex or flat; large and irregular when subsurface concave (appears abraded revealing expanded canal structure). Other small canal openings may be present.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Two variations are grouped according to the extent of posterior pedicle overhang of crown and the ornamentation of subcrown surface as follows:

Form A (Pl. 16, fig. 4-6)

Crown overhangs pedicle to its edge or slightly beyond. Pedicle positioned under crown slightly to anterior; wider than crown at anterior and sides; may not be wider to posterior. Subcrown mainly occupied by pedicle except for small posterior portion that is shallowly concave.

Form B (Pl. 16, fig. 7-10)

Crown considerably overhangs pedicle and its edge. Pedicle positioned under crown to anterior; wider than crown at anterior and sides; not wider to posterior. Subcrown with mesial ridge that extends from posterior pedicle corner to posterior crown apex (or middle region). Additional ridges (commonly two) may be present, extend from crown/pedicle junction to posterior crown margin.

*Material.* Holotype GSC 105282 from GSC loc. C-101065 (ACE-2), and paratype GSC 105281 from GSC loc. C-101068 (BEH-2).

Additional specimens from GSC loc. C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-153074 (GK-4-6), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard, and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* and *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Proprigalea medirugosa* n. sp. s.f.

Plate 17, figures 9-15

*Utilitarian identification.* Subtype a13/b3/c3/d2+5+7/e2/f1, 2/g2+4+5/h2,3/i1,2

*Etymology.* Latin, *medius rugosus*, middle wrinkled (referring to the centre of the dome-shaped crown that has lines or ridges usually radiating from the centre or one side).

*Diagnosis.* Crown dome-shaped and convex; outline approximately circular. Central crown region with reduced lines or ridges and shallow furrows that converge to point near posterior margin. Lines or ridges raised and furrows deeper at crown shoulders where they curve down and under to sub-crown halo or crown/pedicle junction. Subcrown mainly occupied by pedicle. Pedicle positioned centrally under crown. Crown with small overhang of crown/pedicle junction on all sides.

*Description.* Crown outline approximately circular; dome-shaped (convex anterior to posterior and side edge to side edge); centrally highest (or slightly to posterior); broadly rounded (not peaked). Central crown region with height reduced lines and shallow broad U-shaped furrows that converge to a point (commonly near posterior margin); convergence point about same height as lines. Lines more raised and furrows deeper on crown shoulders; curve down and under to subcrown halo or crown/pedicle junction. Subcrown halo thin around pedicle with slightly concave surface between it and pedicle; joins longitudinal line at anterior. Longitudinal line thin and perpendicular to crown ridges and furrows located on lower crown shoulder above crown/pedicle junction. Crown shoulders close to anterior and side margins; generally steeply (sometimes slightly) curve down and under forming overhang of crown/pedicle junction on all sides. Subcrown mainly occupied by pedicle. Crown sits approximately centrally on pedicle. Pedicle basal edges wider than crown at all positions (anterior, posterior, and sides).

Pedicle description same as *P. mediglabra* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species is rare.

*Material.* Holotype GSC 105279 from GSC loc. C-101069 (BEH-3), and paratype GSC 105278 from GSC loc. C-101066 (ACE-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101065 (ACE-2), C-101066 (ACE-3), C-101069 (BEH-3), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, Beattie Ledge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* ichthyolith Zone; ?*Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones (Tozer, 1994); Ladinian, Middle Triassic.

Subgroup 3: Pedicle anterior; crown inclined may be steeply inclined to almost erect; pedicle base outline multipetaloid, circular, or rhomboid and may have undulating margins. 3a: Crown lanceolate to circular with ridges curving over undulating margins; subpedicle surface flat or concave.

*Undulaticorona* n. gen. s.f.

*Etymology.* Latin, *undulatus corona*, undulating crown (the crown has many ridges that curve over its shoulders giving the margins an irregular or undulating appearance).

*Type species.* *Undulaticorona propensa* n. sp. s.f.

*Diagnosis.* Crown outline circular or lanceolate; oblique to steeply oblique; planar or shallowly convex from side edge to side edge; all margins undulating or crenulated. Anterior margin commonly more deeply undulating and with longitudinal line. Crown shoulders on all margins narrow. Ridges or lines on crown short or long, curve over crown shoulders and under crown to near pedicle halo; intersect anterior longitudinal line perpendicularly. Subcrown with posterior pedicle halo, one to three prominent mesial keels and additional lines or ridges. Pedicle base outline circular, multipetaloid, or rounded rhomboid.

*Description.* Crown outline approximately circular or lanceolate; about as long as wide; all margins undulating (may be deep at anterior); posterior margin with one or three apices. Crown oblique to steeply oblique from anterior to posterior and with planar surface; planar or slightly convex from side edge to side edge. Shoulders near crown edges narrow and steeply curve under to crown/pedicle junction. Crown overhang of crown/pedicle junction present on all margins. Longitudinal line on anterior shoulder thin; joins thin halo under crown side shoulders and may appear on posterior upper crown.

Crown lines or ridges short or long; less raised on side shoulders; least raised and shallow centrally; curve over crown shoulders and extend to near pedicle halo; intersect and approximately perpendicular to anterior longitudinal line. Furrows may be deep on anterior crown, less deep on side shoulders, shallowest in central crown region or near posterior margin.

Subcrown with one to three keels extending from posterior pedicle corner to posterior apex; additional lines or ridges common, well raised, and may be on keels. Subcrown furrows moderately deep between lines, ridges, or keels. Crown/pedicle junction positioned to anterior underneath crown.

Pedicle keeled fluted truncate; vascularization hemiaulacorhize. Subpedicle surface concave or flat with one main mesial and smaller canal openings; outline circular, multipetaloid, or rounded rhomboid; base edges crenulated, undulating, and (or) irregular.

*Comparisons.* *Undulaticorona* n. gen. s.f. is distinct with the combination of: 1) an oblique to steeply oblique crown; 2) undulating anterior, side, and commonly posterior margins; 3) halo above and below the crown that joins with the longitudinal shoulder anterior line; 4) upper crown lines or ridges that extend over the shoulders to the subcrown halo; and 5) a keeled fluted truncate pedicle.

*Undulaticorona* n. gen. s.f. has similar lines or ridges that curve over the crown shoulders and a truncate pedicle similar to *Proprigalea* n. gen. s.f. but the crown is planar and sits at an oblique angle with the pedicle to the anterior. These features are different from the dome-shaped nature of the *Proprigalea* n. gen. s.f. crown.

*Undulaticorona propensa* n. sp. s.f. differs from *Undulaticorona profundifossae* n. sp. s.f. by not having deep furrows at the anterior crown which separate moderately broad and rounded platforms with long ridges that converge to the posterior. In addition, the posterior subcrown high ridges group together forming broadly rounded keels separated by deep, moderately broad, smooth furrows.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and Carnian, Middle and Upper Triassic.

*Undulaticorona propensa* n. sp. s.f.

Plate 17, figures 1-4

*Utilitarian identification.* Subtype  $a4/b2+6/c2/d4\pm(7,8)+9/e1,3/f3,4,5,9/g1,2/h1,2/i2/j1/k2\pm(3,4,5)+6\pm7/l3/m6/n1,2$  and Subtype  $a5/b2+6/c1/d4\pm(7,8)+9/e1,5,6/f1,2/g2\pm(3,4,5)+6\pm7/h3/i6/j1,2$

*Etymology.* Latin, *propensus*, inclining (the crown is sloped or inclined anterior to posterior [posterior highest]).

*Diagnosis.* Crown outline circular to lanceolate; posterior margin with one apex; posterior and anterior side margins undulating or crenulated; anterior margin shallowly undulating or crenulated. Crown lines or ridges and furrows commonly short; on anterior and side margins or shoulders; curve down and under crown shoulder to posterior pedicle halo or crown/pedicle junction. Furrows shallow, ridges moderately raised. One to three keels and additional lines or ridges on subcrown surface; not grouped.

*Description.* Crown outline circular to lanceolate; length approximately equals width; posterior margin with one apex; posterior and anterior side margins undulating or crenulated; anterior margin rounded and shallowly undulating or crenulated; sits on pedicle obliquely or steeply oblique from anterior to posterior; planar or shallow convex from side edge to side edge. Crown shoulders at all margins, narrow, convex, and sharply curve down and under (with overhang) to crown/pedicle junction. Crown/pedicle junction in hollow or

furrow underneath crown. Pedicle edges wider than crown at anterior and sides, also may be wider at posterior on steeply oblique specimens (rarely same width as crown).

Crown lines or ridges and furrows commonly short (terminate near crown shoulder); rarely long, extending into crown central region; on anterior and side margins or shoulders; subparallel; may begin to converge towards crown posterior; curve down and under crown shoulder to posterior pedicle halo or crown/pedicle junction. Ridges well raised at anterior; slightly less raised on side margins; thin near crown centre or posterior; well raised on posterior subcrown surface. Furrows may be moderately deep and vary in width at anterior margin; slightly less deep on side margins; shallow near crown centre or posterior; deep on posterior subcrown surface.

One to three keels may be on subcrown; extend from posterior pedicle to posterior crown; have hollows on each side deepest near pedicle. Anterior longitudinal line commonly thin and perpendicular to crown ridges; curves under crown at sides and joins subcrown halo. Halo generally thin; may curve back up onto upper crown posterior surface and then down again to join longitudinal line at other side edge.

Crown/pedicle junction positioned to anterior underneath crown. Pedicle keeled fluted truncate; vascularization hemiaulacorhize. Subpedicle surface concave or flat with small circular or large and irregular mesial and smaller canal openings; outline circular, multipetaloid, or rounded equirhomboid (diagonal lengths approximately equal); margins may be crenulated, undulating, or irregular.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105275 from GSC loc. C-101066 (ACE-3); and paratype GSC 105276 from GSC loc. C-101068 (BEH-2).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101002 (BBR-1), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-101119 (BBR-311A), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Undulaticorona profundifossae* n. sp. s.f.

Plate 17, figures 5-8; Figure 9f

*Utilitarian identification.* Subtype  $a2/b2+6/c3/d1,2/e1,2/f1,2/g1,2/h3/i(2,4)\pm(10,11)+12/j\geq3/k1,5,11/l1,2/m2+5+6\pm7/n1/p3/q6/r1,2/s1,2$  and Subtype  $a4/b2+6/c2/d4\pm(7,8)+9+11/e3/f3,4,5,9/g1,2/h2/i1,2/j1,2/k5+6\pm7/l3/m6/n1,2$



Supergroup I, Group A, Subgroup 3a, Johns, 1996, Pl. 1, fig. 2; Pl. 2, fig. 3.

*Etymology.* Latin, *profundus fossae*, deep trenches or ditches (the crown has prominent and deep furrows).

*Diagnosis.* Crown outline lanceolate; posterior margin with one or three apices; posterior and anterior side margins undulating or crenulated; anterior margin deeply undulating. Crown lines or ridges commonly long; may converge near posterior margin; commonly well raised; located on anterior and side margins or shoulders; curve down and under crown shoulder to posterior pedicle halo or crown/pedicle junction; some grouped on broad platforms near anterior margin separated by deep furrows that notch margin. One to three keels and additional lines or ridges on subcrown surface; commonly grouped and separated by deep furrows.

*Description.* Crown outline lanceolate; longer or equally as long as wide; posterior margin with one or three apices (mesial apex slightly longer, notch between mesial and lateral apex U- or V-shaped); posterior and anterior side margins undulating or crenulated; sits on pedicle at steep oblique angle; shallowly convex and undulating from side edge to side edge. Crown shoulders at all margins narrow, convex, and sharply curve over and then under (with an overhang) to crown/pedicle junction. Crown/pedicle junction in hollow or furrow underneath crown. Pedicle edges wider than crown at anterior, sides, and posterior (may be same width as crown).

Crown lines or ridges and furrows commonly long (terminate near crown middle or posterior); located on anterior and side margins or shoulders; converge towards crown posterior; curve down and under crown shoulder to posterior pedicle halo or crown/pedicle junction. Ridges well raised. Furrows especially deep and broad at anterior crown/margin; separate moderately broad and rounded platforms. Platforms typically with two interior ridges that converge posteriorly. Anterior longitudinal line on shoulder commonly thin; perpendicular to crown ridges; commonly broken by ridges and furrows; curves under crown at sides and joins thin halo that circles posterior pedicle near crown/pedicle junction. Subcrown with at least three moderately broad keels and several ridges that extend from posterior pedicle to posterior crown; deep smooth broad furrows separate keels; less deep furrows separate ridges.

Crown/pedicle junction and pedicle same as *U. propensa* n. sp. s.f.

*Comparisons.* Group B2 (Koehler, 1975) resembles *U. profundifossae* n. sp. s.f. by having multiple platforms with paired ridges, deep long furrows, and an oblique crown. Group B2 differs by having a plain truncate pedicle. The illustration and the diagnosis do not provide details on the subcrown ornamentation and the subpedicle surface. Age: Early Pennsylvanian to Late Triassic.

*U. profundifossae* n. sp. s.f. is similar to Subtype Number 098 (Tway and Zidek, 1982, age: Late Pennsylvanian) where they both have deep upper crown furrows, an oblique crown, and deep furrows and high ridges on the subcrown. *U. profundifossae* n. sp. s.f. differs by not having the curved and

rounded furrows near the cusp region that extend from side edge to side edge, and by having a taller truncate pedicle with well developed ridges and furrows.

*U. profundifossae* n. sp. s.f. mainly differs from *Lobaticorona* n. gen. species by having an oblique to steeply oblique crown with the pedicle positioned to the anterior.

In addition, see Genus "Comparisons".

*Remarks.* Species rare.

*Material.* Holotype GSC 105277 from GSC loc. C-101069 (BEH-3). Additional specimens from GSC loc. C-101066 (ACE-3), C-101069 (BEH-3), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, and Beattie Ledge.

*Range.* *Coniunctio aequirugosa* ichthyolith zone; ?*Maclearnoceras maclearni* ammonoid Zone (Tozer, 1994); Ladinian, Middle Triassic.

#### Subgroup 3:

3b: Crown lanceolate, steeply inclined to almost erect with long multiple upper and subcrown ridges; subpedicle surface concave.

*Parvidiabolus* n. gen. s.f.

*Etymology.* Latin, *parvus diabolus*, little devil.

*Type species.* *Parvidiabolus obliquus* n. sp. s.f.

*Diagnosis.* Crown erect to steeply oblique; elongate lanceolate or elongate oblong-lanceolate; flat or convex and shallowly undulating from side edge to side edge; posterior margin with one or three apices; anterior margin shallowly undulating and without longitudinal line or shoulder. Upper crown surface with several to multiple long lines or ridges separated by narrow long furrows; may have long and height-reduced mesial platform with deeper furrow on each side. Subcrown with large and prominent mesial keel and large concave furrow on each side. Additional subcrown ridges common, long, and higher, with deeper furrows than upper crown surface. Subpedicle surface concave, outline multipetaloid or rounded rhomboid.

*Description.* Crown outline elongate lanceolate or elongate oblong-lanceolate. Anterior margin commonly broad and rounded and shallowly undulating; may have shallowly rounded protrusion. Posterior margin with one attenuate or three acute apices. Crown erect or steeply oblique anterior to posterior; flat or convex and shallowly undulating side edge to side edge; without shoulder or anterior longitudinal line or ridge. Crown overhang of crown/pedicle junction absent at anterior and sides; present at posterior.

Upper crown surface with several to many long lines or ridges. Lines or ridges commonly extend anterior to posterior; may thin before reaching apex or absent at apex; closely spaced; moderately high; commonly parallel or subparallel; may converge near posterior. Furrows long and shallow; may



narrow or shallow near posterior margin. Mesial platform may be present; height reduced with slightly deeper furrow on each side.

Subcrown and pedicle with large and prominent mesial keel that develops from about middle subcrown and extends approximately vertically down into pedicle to its base. Large concave furrow on each side of keel. Additional subcrown ridges common, extend from posterior apex (apices) to pedicle, higher (with deeper furrows on each side) than upper crown surface.

Pedicle keeled fluted truncate (rarely moderate height and more flaring). Subpedicle surface concave with small or large and irregular mesial canal opening; other small canal openings may be present; vascularization hemiaulacorhize; outline rounded rhomboid, multipetaloid, or with irregular edges.

*Comparisons.* The presence of multiple long ridges and furrows on the crown upper and subsurfaces, erect or steep oblique nature of the crown on the pedicle, prominent and large subcrown and pedicle keel, absence of an anterior shoulder and longitudinal line, keeled fluted truncate pedicle, and the attenuate apex or three apices, makes *Parvidiabolus* n. gen. s.f. distinct.

*Parvidiabolus* n. gen. s.f. differs from *Undulaticorona* n. gen. s.f. by having a longer crown and by not having: a) deep anterior crown furrows; b) a pedicle halo and anterior longitudinal line; and c) lines or ridges that curve over crown shoulders to the pedicle halo.

*Parvidiabolus acutus* n. sp. s.f. is distinct from the other three new *Parvidiabolus* species by having a single attenuate apex (instead of 3 apices) and a narrow elongate lanceolate (instead of an elongate lanceolate or elongate oblong-lanceolate) crown outline. *Parvidiabolus convexus* n. sp. s.f. has a well developed convex upper crown surface from side edge to side edge making it different from *Parvidiabolus obliquus* n. sp. s.f. which has a flat surface. *Parvidiabolus longisulcus* n. sp. s.f. has a minor rounded anterior margin mesial protrusion and an upper crown surface mesial platform (which extends from anterior margin to posterior apex) with a shallow long furrow on each side making it distinct from the others.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and Carnian, Middle and Upper Triassic.

*Parvidiabolus obliquus* n. sp. s.f.

Plate 18, figures 1-3

*Utilitarian identification.* Subtype a2/b2/c3/d1/e1/f3/g2/h1, 3/i2,3,4/j≥3/k1,5,11/l1,2/m2+5/n1/p1/q6/r2/s1

*Etymology.* Latin, *obliquus*, oblique (referring to the steeply sloped nature of the crown).

*Diagnosis.* Crown outline elongate oblong-lanceolate; with broadly rounded and shallowly undulating anterior margin; posterior margin with three apices. Crown steeply oblique

anterior to posterior; planar and shallowly undulating from side edge to side edge. Sides of crown near lateral apices straight, entire, slightly curve near anterior margin. No mesial platform or anterior protrusion.

*Description.* Crown outline elongate lanceolate; with broadly rounded and shallowly undulating anterior margin; posterior margin with three apices. Apices entire, acute, close together, and separated by V-shaped notch. Mesial apex three or more times longer than lateral apices. Lateral apices reduced.

Crown steeply oblique to erect from anterior to posterior, planar and shallowly undulating side edge to side edge, longer than wide. Crown side edge below each lateral apex entire, straight, and drops almost vertically to pedicle where it curves slightly at anterior margin. No mesial platform, anterior protrusion, shoulder, and anterior longitudinal line or ridge. Anterior margin and crown sides intersect pedicle obliquely with no crown/pedicle overhang; overhang and hollows present at posterior.

Prominent feature on upper crown surface includes several to multiple moderately raised parallel long ridges that extend anterior to posterior (may be shallow and terminate near base of apices). Furrows between ridges, narrow and shallowly U-shaped at anterior, may be shallower (or absent) near posterior.

Subcrown surface (unoccupied by pedicle) with prominent mesial keel that begins to enlarge at approximately crown centre; greatly expands vertically to pedicle where it continues as large keel to pedicle base. Several additional ridges common on subcrown, extend from posterior apices to pedicle, more raised and with deeper furrows on each side than upper crown ridges. Deep hollows or furrows may extend upwards from pedicle on each side of keel.

Crown/pedicle junction positioned to anterior and under crown. Pedicle (at edges) wider than crown at anterior, sides, and commonly at posterior; may be same width as crown. Pedicle keeled fluted truncate (few specimens with moderate height and flaring). Subpedicle surface concave with small or irregular large canal opening; other smaller canal openings may be present; vascularization hemiaulacorhize; outline circular with irregular edges, multipetaloid, or approximately rhomboid.

*Comparisons.* *P. obliquus* n. sp. s.f. shows some similarities in upper crown and pedicle morphology to Subtype Number 199 (Tway and Zidek, 1982, age: Late Pennsylvanian) but differs by: 1) not having a V-shaped subcrown halo (or two converging ridges near apex); 2) by having subcrown ridges that are higher and furrows that are deeper; and 3) by having a crown that is more erect. In addition, *P. obliquus* n. sp. s.f. is similar to Subtype Number 237 but has deep subcrown furrows and high ridges that are absent in Subtype Number 237.

In addition, see Genus "Comparisons".

*Material.* Holotype GSC 105268 and paratype GSC 105267 from GSC loc. C-101069 (BEH-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard, Ludington, and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Parvidiabolus acutus* n. sp. s.f.

Plate 18, figures 11-15

*Utilitarian identification.* Subtype a4/b2/c1,2/d4/e1,3/f4,5,9/g1,2/h1/i1,4/j1/k2+5/l1/m6/n2

*Etymology.* Latin, *acutus*, sharp or pointed (the crown is long, narrow, and pointed).

*Diagnosis.* Crown outline narrow elongate lanceolate with broadly rounded and shallowly undulating anterior margin and single entire attenuate posterior apex. Crown steeply oblique anterior to posterior; convex and shallowly undulating from side edge to side edge. Sides of crown straight, entire, and oblique. No mesial platform and anterior protrusion. Upper crown surface with moderately raised ridges and shallow narrow furrows that extend anterior to posterior; ridges may thin and converge near apex.

*Description.* Crown outline narrow elongate lanceolate with broadly rounded and shallowly undulating anterior margin and single entire attenuate posterior apex. Crown steeply oblique to erect and slightly convex from anterior to posterior; convex and shallowly undulating from side edge to side edge; much longer than wide; side edges entire, straight, and oblique. Mesial platform, anterior protrusion, shoulder, and anterior longitudinal line or ridge all absent. Anterior margin and crown sides intersect pedicle obliquely with no crown overhang of crown/pedicle junction; overhang and hollows present at posterior.

Prominent feature on upper crown surface includes several to multiple long ridges that extend anterior to posterior, may converge near apex, and moderately raised but may thin near apex. Furrows between ridges shallowly U-shaped and narrower near posterior.

Subcrown surface and pedicle description same as *P. obliquus* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105271 and paratype GSC 105272 from GSC loc. C-101069 (BEH-3); and paratype GSC 105273 from GSC loc. C-153072 (GK-1-48).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067

(BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-153069 (GK-1-19), C-153072 (GK-1-48), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Parvidiabolus convexus* n. sp. s.f.

Plate 18, figures 4-7; Figure 10k

*Utilitarian identification.* Subtype a2/b2/c3/d1/e1/f2,3/g2/h1,3/i2,3,4/j≥3/k1,5,11/l1,2/m2+5/n1/p1/q6/r2/s2

Supergroup I, Group A, Subgroup 3b, Johns, 1996, Pl. 1, fig. 19; and Pl. 2, fig. 4.

*Etymology.* Latin, *convexus*, convex (the crown is convex from side edge to side edge).

*Diagnosis.* Crown outline elongate oblong-lanceolate with a broadly rounded and shallowly undulating anterior margin and posterior margin with three apices. Crown steeply oblique anterior to posterior; convex and shallowly undulating from side edge to side edge. Sides of crown near lateral apices straight and entire; slightly curve near anterior margin. No mesial platform and anterior protrusion.

*Description.* Crown outline elongate oblong-lanceolate with broadly rounded and shallowly undulating anterior margin and posterior margin with three apices. Apices entire, acute, and close together separated by V-shaped notch. Mesial apex three or more times longer than lateral apices. Lateral apices reduced.

Crown steeply oblique to erect from anterior to posterior; convex and shallowly undulating from side edge to side edge; longer than wide. Crown side edge below each lateral apex entire, straight, and drops almost vertically to pedicle where it curves slightly at anterior margin. No mesial platform, anterior protrusion, shoulder, and anterior longitudinal line or ridge. Anterior margin and crown sides intersect pedicle obliquely with no crown overhang of the crown/pedicle junction; overhang and hollows present at posterior.

Prominent upper crown features, subcrown and pedicle description same as *P. obliquus* n. sp. s.f.

*Comparisons.* See Genus.

*Remarks.* *P. convexus* n. sp. s.f. only differs from *P. obliquus* n. sp. s.f. by having a convex and shallowly undulating crown surface from side edge to side edge (instead of planar). The undulating surface is from the presence of moderately raised ridges traversing the crown anterior to posterior.

*Material.* Holotype GSC 105270 from GSC loc. C-101069 (BEH-3), and paratype GSC 105269 from GSC loc. C-101065 (ACE-2).

Additional specimens from GSC loc. C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard, Ludington, and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Parviadiabolus longisulcus* n. sp. s.f.

Plate 18, figures 8-10; Figure 12d

*Utilitarian identification.* Subtype a2/b2/c3,4,5/d1/e1, 2/f2,3/g2/h1,3/i(2,3,4)+13/j≥3/k1,5,11/l1,2/m2+5/n(4,5)+1±13/p1/q6/r2/s2

Supergroup I, Group A, Subgroup 3b, Johns, 1996, Pl. 2, fig. 5-6.

*Etymology.* Latin, *longus sulcus*, long furrow, three apices (the crown has a long furrow on each side of mesial platform).

*Diagnosis.* Crown outline elongate oblong-lanceolate. Anterior margin undulating with shallowly rounded mesial protrusion. Posterior margin with three apices. Crown steeply oblique anterior to posterior; flat, slightly convex, and (or) shallowly undulating from side edge to side edge. Sides of crown near lateral apices straight and entire; slightly curved near anterior margin. Mesial platform on upper crown rounded and shallowly convex from side edge to side edge; with long and parallel moderately high ridges and shallow furrows; with long and broader furrow on each side of platform.

*Description.* Crown outline elongate oblong-lanceolate. Anterior margin undulating with shallowly rounded mesial protrusion. Posterior margin with three apices. Apices entire, acute, and close together separated by V-shaped notch. Mesial apex three or more times longer than lateral apices. Lateral apices reduced.

Crown steeply oblique to erect from anterior to posterior; flat, slightly convex, and (or) shallowly undulating side edge to side edge; longer than wide. Sides of crown near lateral apices straight and entire; slightly curved near anterior margin. No shoulder and anterior longitudinal line or ridge present. Crown overhang of crown/pedicle junction absent at anterior and sides; present at posterior.

Upper crown surface mesial platform rounded and shallowly convex from side to side; extends from anterior to posterior apex; with long, parallel, moderately high ridges and shallow narrow U-shaped long furrows. Each side of platform with broad U-shaped furrow that extends anterior to posterior to "V" junction of mesial and lateral apices. Crown wings slightly lower than, and posterior to mesial platform; with several parallel moderately raised ridges and shallow,

narrow, long furrows that extend anterior to posterior apex. Posterior crown ridges and furrows may shallow or be absent; crown posterior may be smooth.

Subcrown surface (unoccupied by pedicle) with prominent mesial keel that begins to enlarge at approximately crown centre and greatly expands vertically to pedicle where it continues as large keel to pedicle base. Several additional ridges common on subcrown; extend from posterior apex to pedicle; more raised and with deeper furrows on each side than upper crown ridges. Deep hollow present on each side of keel. Moderately deep furrow extends upwards from pedicle to "V" between cusps. Lateral cusps shallowly convex with several long ridges and furrows extending to pedicle.

Pedicle description same as *P. obliquus* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105274 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101118 (BBR-310B), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153074 (GK-4-6), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

Subgroup 3:

3c: Crown lanceolate and steeply inclined with multiple paired ridges; subpedicle surface flat, concave, or convex.

*Duplisuggestus* n. gen. s.f.

*Etymology.* Latin, *duplex suggestus*, double platform (the mesial platform has closely paired ridges with a deep furrow between each resulting in more than one platform on the crown).

*Type species.* *Duplisuggestus duplirugosus* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate to vertically oblong; steeply oblique, may be convex from anterior margin to posterior cusp; convex side edge to side edge. Crown with closely paired long lines or ridges that may converge at posterior margin. Paired lines or ridges on narrow long platforms. Platforms separated by long, deep, and commonly narrow furrows. Subcrown with prominent mesial ridge or keel; other lines or ridges may be present. Crown anterior shoulder, longitudinal line or ridge, and anterior overhang of crown/pedicle junction absent.

*Description.* Crown outline approximately lanceolate to vertically oblong; anterior margin undulating with single or multiple narrow and rounded protrusions; posterior margin irregular and undulating or with single apex. Crown sits on pedicle almost vertically or at steep oblique angle with slight convex curve anterior to posterior; side edge to side edge curvature convex (centrally highest) and undulating. Crown anterior shoulder, longitudinal line or ridge, and anterior overhang of crown/pedicle junction absent. Crown overhang of crown/pedicle junction may be present at posterior.

Prominent crown features include long and commonly closely paired ridges on keels or narrow platforms. Platforms with long, deep furrows on each side. Mesial platform (when present) elongate lanceolate (usually narrow); with at least two pairs of ridges separated by furrow (broader than furrow inside a pair). Keels, ridges, furrows, and platform converge posteriorly. Subcrown with prominent mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex. Additional subcrown lines, ridges, or keels may be present.

Pedicle keeled fluted truncate; vascularization hemiaulacrhize; base outline equirhomboid (diagonal length approximately equal), circular with irregular edges, or multipetaloid.

*Comparisons.* *Duplisuggestus* n. gen. s.f. easily distinguished from all elasmobranch scales in this study by the combination of the following features: 1) keeled fluted truncate pedicle, 2) closely paired lines or ridges on narrow elongate platforms or keels, 3) long deep furrows on each side of a platform, 4) most lines or ridges converge near posterior margin, 5) erect nature of crown from anterior to posterior margins and convexity from side edge to side edge, and 6) prominent subcrown mesial ridge or keel.

*Duplisuggestus profundisulcus* n. sp. s.f. differs from *Duplisuggestus duplirugosus* n. sp. s.f. by: a) having deeper furrows (usually undercutting keels) and higher and narrower keels or platforms; b) the crown is more convex side edge to side edge and sits almost vertically on pedicle; and 3) the pedicle is slightly less flaring, a bit higher, and the base is flat or concave and multipetaloid (or with an irregular edged circular outline).

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and uppermost Upper Carnian, Middle and Upper Triassic.

*Duplisuggestus duplirugosus* n. sp. s.f.

Plate 19, figures 1-4

*Utilitarian identification.* Subtype a4/b2/c2/d4+11/e3/f4/g1, 2/h1,2/i1/j(4,5)+11+14/k2±(3,4,5)/11/m6/n1,2,3,4 and Subtype a6/b2/c5+7/d5/e1,2

Supergroup I, Group A, Subgroup 3c, Johns, 1996, Pl. 2, fig. 8.

*Etymology.* Latin, *duplex rugosus*, double wrinkled (referring to the closely paired nature of the upper crown ridges).

*Diagnosis.* Crown steeply oblique and slightly convex anterior to posterior; moderately convex and undulating side edge to side edge; outline lanceolate to vertically oblong; long

ridges closely paired on moderately high, long, and commonly narrow platforms; furrow between platforms long and deep but does not undercut. Pedicle moderately flaring; subpedicle surface convex (may have bulge), concave, or flat; outline equirhomboid.

*Description.* Crown outline lanceolate to vertically oblong; longer than wide; posterior margin in all specimens abraded (probably one) or irregular; anterior margin with narrow rounded mesial protrusion (other narrow protrusions may be present). Crown steeply oblique and shallowly convex anterior to posterior; convex and undulating side edge to side edge (mesially highest); shoulder approximately at middle with no longitudinal line or ridge. Crown/pedicle overhang absent at anterior and sides; present at posterior.

Mesial platform well raised and narrow elongate to elongate lanceolate in outline; extends anterior to posterior; shallowly convex to almost flat from side edge to side edge. Two pairs of ridges on mesial platform; one ridge forms each edge of platform; second ridge close to first ridge anteriorly and converges with it posteriorly; furrow separates two ridge pairs either deeper or wider than furrow inside a ridge pair. Near posterior apex, platform ridge edges converge to form single ridge (which also terminates furrow between paired ridges).

Two crown wings lower in height than, located on each side of, and posterior to mesial platform. One or more ridges well raised, approximately parallel, equal in height, extend anterior to posterior, and on each wing. Lateral ridges may be paired, extremely close together, and converge posteriorly. Deep and narrow to moderately broad U-shaped furrow on each side of mesial platform on crown wing; extends anterior to posterior. Other furrows on each wing (located between lateral ridges) similar in width and depth (or slightly shallower). Because mesial platform is higher than lateral ridges and furrows similarly deep, crown has convex curvature from side edge to side edge.

Subcrown surface (unoccupied by pedicle) with prominent mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex; additional keel or lines or ridges may be present and approximately parallel to mesial keel. Remainder of surface smooth; side-to-side surface convex (raised at ridge mesially anterior to posterior); deep hollow or furrow on each side of ridge (deepest near crown/pedicle junction). In side profile, subcrown surface concave or oblique anterior to posterior. Crown posteriorly overhangs crown/pedicle junction and may cover pedicle basal edge; sides and anterior do not overhang pedicle at crown/pedicle junction but intersect pedicle obliquely or almost vertically. Pedicle base approximately same width as crown or slightly wider.

Pedicle keeled fluted truncate; vascularization hemiaulacrhize. Subpedicle surface shallowly convex, concave, or flat; slight bulge commonly located anteriorly or centrally, may be posterior; with small canal opening commonly located to posterior of bulge; few other smaller canal openings may be present. On some specimens bulge absent, surface flat or shallowly concave, and mesial canal opening

commonly larger with irregular edges. Outline equirhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* On some specimens the subpedicle surface bulge is absent. The surface is flat or shallowly concave, and mesial canal opening is commonly larger with irregular edges. These specimens appear to be abraded but provide a view of the internal vascular canal structure.

*Material.* Holotype GSC 105263 and paratype GSC 105262 from GSC loc. C-101069 (BEH-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153073 (GK-3-20), C-153074 (GK-4-6), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard, Ludington, and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Ursula Creek.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Duplisuggestus profundisulcus* n. sp. s.f.

Plate 19, figures 5-16

*Utilitarian identification.* Subtype a6/b2/c5+7/d1,5/e1,2 and Subtype a4/b2/c2/d4+12/e3/f4,5/g1,2/h2/i1/j4+14/k2±(3,4,5)/l1/m6/n1,2

Supergroup I, Group A, Subgroup 3c, Johns, 1996, Pl. 2, fig. 7.

*Etymology.* Latin, *profundus sulcus*, deep furrow (referring to the deep furrows that tend to undercut platforms on the upper crown surface).

*Diagnosis.* Crown erect to steep oblique and may be slightly convex anterior to posterior; prominently convex and undulating side edge to side edge; outline vertically oblong to lanceolate; long ridges closely paired on high, long, and commonly narrow platforms; furrow between platforms long and deep, commonly undercut. Pedicle high and slightly flaring; subpedicle surface concave or flat; outline multipetaloid or approximately circular with irregular margins.

*Description.* Crown outline vertically oblong to lanceolate; slightly narrower at anterior; longer than wide. Posterior margin reduced and irregular. Anterior margin irregular and undulating with narrow rounded protrusions. Crown erect to steeply oblique anterior to posterior; convex and undulating from side edge to side edge (mesially highest). Shoulder unrecognizable; no anterior longitudinal line or ridge traversing from crown side edge to side edge.

Narrow and elongate keels with closely paired ridges prominent on upper crown surface; extend anterior to posterior and converge near apex. Furrows between keels long, moderately narrow, and cut deeply (commonly undercut) into crown (leaving a thin amount of crown between furrows).

Crown wings greatly curved to subsurface and posterior creating strongly convex crown from side edge to side edge. On more erect (vertical) specimens, crown edges curve and almost meet on subcrown surface. Oblique crowns slightly convex anterior to posterior; convex curvature from side edge to side edge less severe and opening up subcrown; with mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior crown apex. Two deep concave hollows on each side of keel.

Anterior portion of crown forms crown/pedicle junction where crown sits vertically or steeply oblique on pedicle. Crown does not overhang crown/pedicle junction at anterior or sides; may or may not slightly overhang junction at posterior.

Pedicle keeled fluted truncate; vascularization hemiaulacorhize. Subpedicle surface flat to concave. Mesial canal opens perpendicular to subpedicle surface; small and circular when concavity shallow; large and irregular when concavity deeper revealing more of internal vascular canal structure. Few other smaller canal openings may be present. Pedicle outline multipetaloid or approximately circular with irregular or undulating edges.

*Comparisons.* *Duplisuggestus profundisulcus* n. sp. s.f. shows some similarities in crown and pedicle morphology to Subtype Number 002 (Tway and Zidek, 1982, age: Late Pennsylvanian) but differs by having: 1) paired platform ridges; 2) a more erect crown; and 3) a crown that has a greater diameter.

In addition, see Genus "Comparisons".

*Remarks.* On some specimens a mesial platform is similar to *Duplisuggestus duplirugosus* n. sp. s.f.; however, the furrow between paired ridges is deeper, commonly wider, and undercutting.

*Material.* Holotype GSC 105264 and paratype GSC 105265 from GSC loc. C-101065 (ACE-2); and paratype GSC 105266 from GSC loc. C-153075 (GK-4-11).

Additional specimens from GSC loc. C-101003 (BBR-2), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-153074 (GK-4-6), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.



Subgroup 3:

- 3d: Crown lanceolate with multiple long upper crown ridges and anterior overhang; subcrown with ridges, may have halo; subpedicle surface flat, concave, or convex.

*Coniunctio* n. gen. s.f.

aff? Hybodontidae gen. and sp. indet., Reif, 1978b, p. 122, 123, fig. 9A, 10A.

*Etymology.* Latin, *coniunctio*, union (the crown is made up of a “union” of many ridges or lines).

*Type species.* *Coniunctio aequirugosa* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; convex anterior to posterior and side edge to side edge; posterior margin with one apex; anterior margin rounded or undulating with mesial protrusion. Upper crown surface with many long ridges and furrows of similar height and depth that converge near posterior margin. Mesial platform (when present) with internal lines or ridges and slightly broader furrow on each side than other crown furrows. Crown shoulder broadly rounded; located centrally or near anterior margin, with longitudinal line or ridge and minor crown overhang of crown/pedicle junction. Subcrown surface with mesial keel, additional lines, ridges, or keels, and may have halo.

*Description.* Crown outline lanceolate. Anterior margin broad and rounded or undulating with rounded mesial protrusion. Posterior margin with single apex. Crown commonly convex (may be oblique) anterior to posterior and convex side edge to side edge; posterior may be oblique or flattened; shoulder anterior or central; anterior margin convex and slightly curves under to pedicle (overhang minimal) with no well developed furrow or hollows underneath. Anterior longitudinal line below shoulder and just above crown/pedicle junction; may be discontinuous.

Upper crown surface with or without raised elongate lanceolate mesial platform and furrow on each side; platform with one or more ridges. Other crown ridges common (two or more on each lateral crown wing), long, similarly raised (not particularly high), and most converge posteriorly. Furrows between ridges U-shaped, long, and moderately narrow.

Subcrown with prominent mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex; deep hollow present on each side of keel near pedicle; other keels or ridges usually present; halo around pedicle may be present.

Pedicle keeled fluted truncate. Subpedicle surface convex, convex with shallow bulge, shallowly concave, or flat with small mesial canal opening; other small canal openings may be present; vascularization hemiaulacorhize; outline equirhomboid, or circular with irregular edges.

*Comparisons.* Reif (1978b, Fig. 9A, 10A) illustrated two hybodont dermal denticles from the Lower Muschelkalk (Triassic, Germany) that have upper crown surfaces which

are similar to *Coniunctio aequirugosa* n. sp. s.f. (Pl. 20, fig. 1-3, 6-7) and *Coniunctio multirugosa* n. sp. s.f. (Pl. 20, fig. 8-11). Reif's hybodont dermal denticles differ from *Coniunctio* n. gen. s.f. by having an expanded tetrahedroid pedicle similar to those illustrated in Figures 9c and 9d rather than the truncate type of *Coniunctio* n. gen. s.f. in Figure 9g.

*Coniunctio* n. gen. s.f. differs from many of the other elasmobranch scales in this study by having: 1) a fluted keeled truncate pedicle; 2) an upper crown surface with many long lines or ridges and furrows that converge near the posterior margin; 3) an anterior longitudinal line; and 4) a subcrown surface that has a prominent mesial keel and additional lines, ridges, or keels.

*Coniunctio aequirugosa* n. sp. s.f. differs from *Coniunctio multirugosa* n. sp. s.f. by lacking a well defined furrow on each side of the mesial platform. *C. aequirugosa* n. sp. s.f. crown furrows are approximately equally shallow and broad, ridges are equally raised; shoulder is positioned anteriorly, concavity is mainly at shoulder with a flattened posterior region, and the subcrown commonly has a halo.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and uppermost Upper Carnian, Middle and Upper Triassic.

*Coniunctio aequirugosa* n. sp. s.f.

Plate 20, figures 1-7; Figure 10h

*Utilitarian identification.* Subtype a4/b2+6/c2/d4±7±8/e1, 3/f4,5/g1,2,3/h1/i1,2/j1/k2±(3,4,5)±6/l2/m6/n1,2,3,4

Supergroup I, Group A, Subgroup 3d, Johns, 1996, Pl. 1, fig. 14; and Pl. 2, fig. 9-10.

*Etymology.* Latin, *aequus rugosus*, equally wrinkled (the crown has many ridges or lines that are similarly raised).

*Diagnosis.* Crown convex anterior to posterior; outline lanceolate; anterior margin rounded and shallowly undulating. Upper crown surface with posteriorly converging long ridges approximately equally raised and furrows equally deep and wide at similar positions on crown (anterior to posterior); mesial platform absent or considerably reduced. Crown shoulder convex and positioned at anterior margin; surface flattens near posterior margin. Subcrown with mesial ridge; may have additional lines or ridges and halo.

*Description.* Crown outline lanceolate; equally long or longer than wide; one posterior apex commonly abraded; anterior margin rounded with shallow undulations and no mesial protrusion. Crown shoulder located near or at anterior margin. Crown convex at anterior shoulder and flattens near posterior margin; flat to shallowly convex and undulating side edge to side edge. Anterior crown curves and slightly overhangs crown/pedicle junction (but with no furrow or hollows). Longitudinal line at anterior margin just above crown/pedicle junction, below shoulder, and perpendicular to crown ridges; generally shallowly undulating; commonly continuous to lateral edges.

Ridges prominent on crown upper surface; long (extend anterior to posterior); equally moderately raised; most converge near posterior margin. Furrows between ridges long,



approximately equally shallow, U-shaped, and narrow to posterior where ridges converge. Mesial platform absent or considerably reduced.

Subcrown (unoccupied by pedicle) with prominent mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior apex; additional keels, ridges, or lines (commonly on larger specimens) approximately parallel to mesial keel or radiate from pedicle; halo may be present. In profile, subcrown surface concave or oblique anterior to posterior. Crown posteriorly overhangs crown/pedicle junction and may cover pedicle basal edge; sides and anterior may slightly overhang pedicle at crown/pedicle junction and intersect pedicle obliquely or almost vertically.

Pedicle keeled fluted truncate. Subpedicle surface convex, concave, or flat; bulge usually located anteriorly or centrally, may be posterior; with small canal opening posterior of bulge; few other smaller canal openings may be present. On some specimens bulge reduced or absent, surface flat or shallowly concave, and mesial canal opening commonly large with irregular edges. Pedicle vascularization hemiaulacorhize; outline circular with irregular edges or equirhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* On some specimens the subpedicle surface bulge is absent. The surface is flat or shallowly concave, and mesial canal opening is commonly larger with irregular edges. These specimens appear to be abraded but provide a view of the internal vascular canal structure.

*Material.* Holotype GSC 105257 and paratype GSC 105258 and GSC 105379 from GSC loc. C-101065 (ACE-2); and paratype GSC 105384 from GSC loc. C-101069 (BEH-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153069 (GK-1-19), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, Beattie Ledge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* ichthyolith Zone; ?*Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones (Tozer, 1994); Ladinian, Middle Triassic.

*Coniunctio multirugosa* n. sp. s.f.

Plate 20, figures 8-15; Figure 9g

*Utilitarian identification.* Subtype a4/b2+6/c1,2/d4+7±10/e3/f4,5/g1,2,3/h1/i1,2/j(4,5)+11+13/k2±(3,4,5)/l2/m6/n1,2,3,4

Supergroup I, Group A, Subgroup 3d, Johns, 1996, Pl. 1, fig. 1.

*Etymology.* Latin, *multus rugosus*, many wrinkles (the upper crown surface has many lines or ridges).

*Diagnosis.* Crown convex anterior to posterior and moderately steep; anterior margin undulating with rounded mesial protrusion. Mesial platform on upper crown surface long (extends anterior to posterior), with one or more internal lines or ridges and slightly broader and deeper furrow on each side. Crown lateral wings each with two or more long lines or ridges. Lines or ridges long and converge near posterior margin. Crown shoulder positioned centrally and broadly convex. Subcrown with mesial ridge; additional ridges may be present.

*Description.* Crown outline lanceolate; longer than wide; one posterior apex commonly abraded; anterior margin with rounded moderately broad mesial protrusion. Crown convex anterior to posterior (may be oblique); convex (centrally highest) and undulating side edge to side edge. Shoulder approximately central. Anterior crown oblique or gently curves; may slightly overhang crown/pedicle junction (but with no furrow or hollows). Thin longitudinal line at anterior margin just above crown/pedicle junction; commonly shallowly undulating; may be discontinuous to lateral edges; generally on lowermost anterior mesial platform.

Mesial platform elongate lanceolate in outline; well raised (higher than wings); extends anterior to posterior; edges well separated near anterior and converge at posterior to form one ridge; from side to side, anterior is convex (highest centrally) or almost flat. Mesial platform ridges one or more; long and similarly moderately raised with shallow furrows between; most converge posteriorly with platform edges.

Two crown wings lower in height than, located on each side of, and posterior to mesial platform. Two or more long ridges on each wing; approximately parallel and slightly decrease in height nearer crown edge; extend anterior to posterior. Moderately deep and narrow U-shaped furrow on each side of mesial platform on crown wing. Furrows extend to posterior; may slightly broaden. Other furrows on wing commonly shallower, narrower, and located between ridges. Because ridges decrease in height and furrows shallow away from crown centre, wings have gentle convex curvature.

Subcrown surface (unoccupied by pedicle) with prominent mesial keel extending from most posterior crown/pedicle junction to (or just below) posterior apex; additional keels, ridges, or lines (commonly on larger specimens) approximately parallel to mesial keel or radiate from pedicle. Deep hollow or furrow on each side of keel (deepest near crown/pedicle junction) may be present. In profile, subcrown surface concave or oblique anterior to posterior. Crown posteriorly overhangs crown/pedicle junction and may cover pedicle basal edge; sides and anterior may slightly overhang pedicle at crown/pedicle junction and intersect pedicle obliquely or almost vertically.

Pedicle description same as *C. aequirugosa* n. sp. s.f.

*Comparisons.* See Genus "Comparisons". In addition, *C. multirugosa* n. sp. s.f. closely resembles *Duplisuggestus duplirugosus* n. sp. s.f. It mainly differs by not having closely paired ridges and deep furrows, and by having a less steeply inclined crown and a crown anterior longitudinal line.

*Remarks.* See *C. aequirugosa* n. sp. s.f. "Remarks".

**Material.** Holotype GSC 105259 and paratype GSC 105261 from GSC loc. C-101065 (ACE-2); and paratype GSC 105260 from GSC loc. C-101066 (ACE-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), and C-153075 (GK-4-11).

**Peace River occurrence.** Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

Group B: Pedicle plain truncate

Subgroup 1: Pedicle anterior; crown inclined; pedicle base outline rhomboid.

1a: Crown lanceolate; subpedicle surface convex or convex with bulge; subcrown with mesial keel or ridge, may have other ridges.

*Labascicorona* n. gen. s.f.

**Etymology.** Latin, *labasco corona*, tottering crown (subpedicle surface with bulge that makes the scale unstable on a flat surface).

**Type species.** *Labascicorona alata* n. sp. s.f.

**Diagnosis.** Crown outline lanceolate; oblique to convex anterior to posterior. Posterior margin with one to five apices; anterior margin undulating and with rounded mesial protrusion. Mesial platform long; elongate lanceolate, lanceolate, or elongate rhomboid; commonly with interior ridges. Prominent furrow on each side of mesial platform. Crown shoulder located centrally or anteriorly; broadly rounded; without longitudinal line or ridge. Anterior crown overhang of crown/pedicle junction absent. Subcrown with one mesial ridge or keel extending from posterior pedicle corner to posterior mesial crown apex. Pedicle keeled plain truncate. Subpedicle surface convex with prominent surface bulge; outline equirhomboid.

**Description.** Crown outline lanceolate; moderately steeply oblique to convex anterior to posterior; convex (mesially highest) and (or) undulating from side edge to side edge; longer than or equally as long as wide; posterior margin with one to five apices; anterior and posterior side edges entire; anterior margin undulating and with narrow or broad and rounded mesial protrusion; with wing on each side of a mesial platform. Crown shoulder located centrally or anteriorly; broadly rounded; without longitudinal line or ridge. Crown overhang of crown/pedicle junction absent at anterior and sides; present at posterior.

Mesial platform long (extends anterior to posterior); elongate lanceolate, lanceolate, or elongate rhomboid; commonly with interior ridges; with prominent (deep and/or broad) furrow on each side of platform. Additional furrows and at least one long ridge (commonly close to crown edge) or more on each lateral wing.

Crown/pedicle junction to anterior underneath crown. Subcrown surface with one acute or rounded mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex; few short lines or ridges may extend anteriorly from apical region. Pedicle keeled plain truncate; vascularization hemiaulacorhize. Subpedicle surface convex with prominent surface bulge and small main canal opening; other smaller canal openings may be present. Pedicle outline equirhomboid (diagonal lengths approximately equal) with vertices at anterior, posterior, and each side.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Carnian and Ladinian, Middle and Upper Triassic.

**Comparisons.** *Labascicorona* n. gen. s.f. differs from many of the forms by having: 1) a plain keeled truncate pedicle (in all other types the pedicle is fluted truncate, or tetrahedroid); 2) an upper crown surface with a mesial platform, lines or ridges and furrows that extend anterior to posterior; 3) a subcrown that has a prominent mesial ridge or keel; and 4) an equirhomboid subpedicle surface with a prominent bulge.

*Coniunctio* n. gen. s.f. mainly differs from *Labascicorona* n. gen. s.f. by having: a) a keeled fluted truncate (instead of a plain keeled truncate) pedicle; b) a nonprominent (not broad or deep) furrow on each side of a raised mesial platform; and c) an anterior longitudinal line or ridge and crown overhang of crown/pedicle junction.

Table 3 summarizes the main differing features of the five species of *Labascicorona* n. gen. s.f.

*Labascicorona alata* n. sp. s.f.

Plate 21, figures 1-8, 13-15; Figures 9h, 10f, 11a, 12b

**Utilitarian identification.** Subtype a4/b2/c1,2/d4+10/e3/f4/g1,2/h1/i1/j(4,5,8)+11±13/k2/l1/m8/n3,4

Supergroup I, Group B, Subgroup 1a, Johns, 1996, Pl. 1, fig. 5; and Pl. 2, fig. 12-13.

**Etymology.** Latin, *alatus*, winged.

**Diagnosis.** Crown shallowly convex from anterior to posterior; convex (mesially highest) from side edge to side edge; posterior margin with one apex; anterior margin undulating with narrow or moderately broad and rounded mesial protrusion; shoulder shallow and central. Mesial platform elongate rhomboid, elongate lanceolate, or lanceolate; flat to convex from side to side; with or without lines or ridges; with long, broad and deep U-shaped furrow on each side. Each crown wing with none or one long line or ridge. Subcrown with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex.

*Description.* Crown outline lanceolate; longer than wide; shallowly convex from anterior to posterior; convex (mesially highest) from side edge to side edge; posterior margin with one acute or obtuse apex; anterior and posterior side edges entire; anterior margin undulating with narrow or moderately broadly rounded, mesial protrusion; shoulder shallowly rounded and approximately at crown middle; anterior curves down and may intersect pedicle (at crown/pedicle junction) almost vertically. Upper crown surface lacks anterior longitudinal line or ridge.

Mesial platform prominent (well raised) on upper crown surface; elongate rhomboid, elongate lanceolate, or lanceolate in outline; extends anterior to posterior (to apex) with curvature similar to crown; from side to side flat (when absent of ridges) or convex (highest centrally, when ridges present). Mesial platform lines or ridges one to several; typically long (extend more than half the length of the platform); more raised to anterior below shoulder than posterior; parallel to subparallel when more than one. An increase in the number of platform ridges is associated with a broadening of platform from thin elongate to lanceolate.

Two crown wings lower in height than, located on each side of, and posterior to mesial platform. Broad, long, and deep U-shaped furrow extends anterior to posterior on each wing and side of the mesial platform; prominent feature giving each wing a smooth appearance. One ridge present (rarely none) on each wing; usually near crown edge; sits higher than furrow bottom; extends anterior to posterior; lower in height than mesial platform.

Subcrown surface (unoccupied by pedicle) with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior crown apex (Pl. 21, fig. 13-15). Keel highest near pedicle; shallows near crown apex (posterior). Remainder of subcrown smooth; side-to-side surface convex (raised at ridge or keel mesially anterior to posterior); with large shallow hollow on each side of keel near crown/pedicle junction. In profile, subcrown oblique or slightly concave anterior to posterior. Crown posteriorly overhangs crown/pedicle junction; overhang may cover pedicle basal edge; sides and anterior do not overhang pedicle at crown/pedicle junction but intersect pedicle obliquely or almost vertically. Pedicle basal edges as wide or wider than crown at anterior and sides.

**Table 3.** Main features of the species of *Labascicorona* n. gen. s.f.

Feature	<i>L. alata</i>	<i>L. longifossae</i>	<i>L. mediflexura</i>	<i>L. nitidifastigia</i>	<i>L. trifastigia</i>
posterior margin	1 apex	1-3 apices	1 apex	1-5 apices	3 apices
shoulder	central	central	central	central	anterior
convexity from anterior to posterior	shallow/broad	shallow/broad	prominent	prominent	shallow/broad
convexity from side edge to side edge	prominent	shallow	shallow to planar	prominent	shallow
mesial platform shape	elongate lanceolate, elongate rhomboid, or lanceolate	elongate lanceolate or rhomboid	lanceolate	lanceolate to elongate lanceolate	lanceolate
mesial platform protrusion width	narrow to moderately broad, rounded	narrow to moderately broad, rounded	broad and rounded	moderately broad, rounded	broad and rounded
number of mesial platform ridges & length	0-3+, long or short	0-2, short	several, height reduced near apex	1-several, terminate before platform centre	several, 1-2 long (may extend to apex)
furrows next to mesial platform	broad, U-shaped, deep anterior to posterior	broad, trench-shaped, deep anterior to posterior	moderately broad, U-shaped, shallow at posterior	moderately broad, U-shaped, shallow near or absent at posterior	broad, U-shaped, deep anterior to posterior
crown wing ridges	0-1 on each wing	2 or more on each wing	2 or more on each wing	2 or more on each wing	2 or more on each wing
subcrown ornamentation	1 mesial ridge or keel	1 mesial ridge or keel	1 mesial ridge or keel	1 mesial ridge or keel	1 mesial ridge or keel, 1 to several short apical lines or ridges

Pedicle keeled plain truncate; commonly robust; vascularization hemiaulacorhize; anterior crown/pedicle junction edge at anterior crown edge; posterior pedicle edge at anterior side of mid-subcrown surface. Subpedicle surface convex with prominent bulge commonly located at anterior or central, may be posterior; with small canal opening commonly to posterior of bulge; other smaller canal openings may be present; outline equirhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

**Comparisons.** See Genus "Comparisons".

**Remarks.** Species is common in the Ladinian, with some in the Carnian, and absent in Norian samples.

Four variations are grouped according to the number of crown mesial platform lines or ridges. The mesial platform becomes slightly wider with each increase in the number of lines or ridges on its surface. The four types are listed in Table 4.

All or most of these types commonly occur together in samples. Further collection and study is required to determine if variance in the crown morphologies summarized above in Types A-D is significant to separate these types into species. These features are not greatly different and may represent individual variation perhaps attributed to the position of the scale on the fish or the size of the scale.

**Material.** Holotype GSC 105247 (Type B) and paratypes GSC 105246 (Type A), GSC 105249 (Type D), and GSC 105251 (Type B) from GSC loc. C-101065 (ACE-2); and paratypes GSC 105248 (Type C) and GSC 105250 (Type C) from GSC loc. C-153075 (GK-4-11).

Additional specimens from GSC loc. C-087901 (BH-62), C-087972 (Sutherland Zone), C-101002 (BBR-1), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-101118 (BBR-310B), C-101753 (MS-GB), C-145780 (GK-68-8-27), C-153069 (GK-1-19), C-153074 (GK-4-6), C-153075 (GK-4-11), and C-153076 (GK-4-17).

**Peace River occurrence.** Liard, Ludington and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, Childerhose Cove, and Chowade South.

**Table 4.** *Labascicorona alata* n. sp. s.f. Types A-D and mesial platform variations.

Type	No. of lines/ridges	mesial platform shape	Plate 21 figures
A	0	narrow elongate rhomboid narrow elongate lanceolate	1 & 5
B	1	narrow elongate lanceolate	2 & 6
C	2	elongate lanceolate	3 & 7
D	>2	lanceolate	4 & 8

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Labascicorona longifossae* n. sp. s.f.

Plate 22 figures 1-3

**Utilitarian identification.** Subtype a2/b2/c3/d2/e1/f2/g1, 2/h3/i(2,3,4)+13/j≥6/k5/l1,2/m2/n(4,5,8)+11±13/p1/q8/r3,4/s2 and Subtype a4/b2/c1, 2/d4+10/e3/f4/g1, 2/h1, 2/i2/j(4,5,8)+11±13/k2/l1/m8/n3,4

Supergroup I, Group B, Subgroup 1a, Johns, 1996, Pl. 1, Fig. 4

**Etymology.** Latin, *longus fossae*, long trench or furrow (referring to the long and deep furrows on each side of the crown mesial platform).

**Diagnosis.** Crown shallowly convex from anterior to posterior and side edge to side edge; posterior margin with one or three apices; anterior margin undulating with narrow to moderately broad and rounded mesial protrusion; shoulder central. Mesial platform elongate lanceolate or elongate rhomboid; flat or shallowly concave from side to side; with or without few short lines or ridges; with long, broad, and deep trench-shaped furrow on each side. Crown wing with two or more long lines or ridges. Subcrown with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex.

**Description.** Crown outline lanceolate; about equally as long as wide; shallowly convex from anterior to posterior and side edge to side edge (mesially highest); may be undulating from side edge to side edge; posterior margin abraded on all specimens with single (may be attenuate) apex and reduced lateral apex on each crown wing; anterior and posterior side edges entire; anterior margin undulating with narrow to moderately broad and rounded mesial protrusion; shoulder central; anterior curves down obliquely or approximately vertically from shoulder to pedicle. No anterior shoulder longitudinal line or ridge.

Mesial platform prominent; elongate rhomboid or lanceolate; extends anterior to posterior with curvature similar to crown; flat or shallowly concave from side to side. Mesial platform lines or ridges commonly absent; if present one or two; height reduced and short (do not extend to apex).

Two crown wings slightly lower in height than, on each side of, and slightly posterior to mesial platform. Two or more ridges on each wing, well raised, approximately parallel and equal in height; extend anterior to posterior. Broad and deep trench-shaped furrow on each side of mesial platform on each crown wing. Furrows extend to apex region where they broaden and do not shallow significantly. Other furrows between ridges on wing not as pronounced but broad and deep.

Subcrown surface (unoccupied by pedicle) with one mesial rounded ridge extending from most posterior crown/pedicle junction to (or just below) posterior crown apex; remainder of subcrown smooth; side-to-side surface convex (raised at ridge mesially anterior to posterior); shallow hollow on each side of ridge near crown/pedicle junction. Weakly tricuspid nature of crown commonly seen more clearly on subcrown (Pl. 22, fig. 1). Mesial apex has shallow, rounded and broad furrow (on each side of its base) that intersects "V" between mesial and each lateral apex.

In profile, subcrown oblique or slightly concave anterior to posterior. Crown overhang prominent at posterior (may cover pedicle basal edge); absent at sides and anterior where it intersects pedicle obliquely or almost vertically. Pedicle basal edges as wide or wider than crown at anterior and sides.

Pedicle keeled plain truncate and robust; vascularization hemiaulacorhize; anterior crown/pedicle junction edge located at anterior crown edge and posterior pedicle edge at anterior of crown centre. Subpedicle surface same as *Labascicorona alata* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species is common in Ladinian samples. Some specimens also found in the Upper Carnian. Species is not found in Norian samples.

*Material.* Holotype GSC 105255 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc. C-087901 (BH-62), C-086792 (BH-60), C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-101753 (MS-GB), C-153069 (GK-1-19), C-153074 (GK-4-6), C-153075 (GK-4-11), C-153076 (GK-4-17), and C-177692 (BH-61B).

*Peace River occurrence.* Liard and Baldonnell formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Labascicorona mediflexura* n. sp. s.f.

Plate 21, figures 9-10, 16; Figure 9i

*Utilitarian identification.* Subtype a4/b2/c1,2/d4+10/e3/f4/g1,2/h1/i1,2/j5+11+13/k2/l1/m8/n3,4

Supergroup I, Group B, Subgroup 1a, Johns, 1996, Pl. 1, fig. 3.

*Etymology.* Latin, *medius flexura*, middle bending (the crown shoulder is near the middle of the crown).

*Diagnosis.* Crown convex from anterior to posterior; shallowly convex (mesially highest) or planar and undulating from side edge to side edge; posterior margin with one apex;

anterior margin undulating with broad and rounded mesial protrusion; shoulder central. Mesial platform lanceolate; shallowly convex from side to side with several lines or ridges that reduce in height near posterior margin; with moderately broad furrow on each side that shallows at posterior. Crown wing with two or more lines or ridges that shallow towards posterior. Subcrown with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex.

*Description.* Crown outline lanceolate; moderately large; longer than or equally as long as wide; prominently convex from anterior to posterior; shallowly convex (mesially highest) to planar and undulating from side edge to side edge; anterior and posterior side edges entire; posterior margin with one acute or obtuse apex; anterior margin undulating with rounded, convex, and broad mesial protrusion; shoulder centrally located; anterior curves down convexly, obliquely, or approximately vertically from shoulder to crown/pedicle junction. Upper crown surface anterior longitudinal line or ridge absent.

Mesial platform moderately prominent; lanceolate; extends anterior to posterior with curvature similar to crown; from side to side convex (highest centrally). Mesial platform lines or ridges one to commonly several; more raised at anterior below shoulder than at posterior where they are thin and shallow.

Two crown wings lower in height than, on each side of, and posterior to mesial platform. Two or more lines or ridges on each wing; approximately parallel and equal in height; extend anterior to posterior. Moderately broad and deep U-shaped furrow anterior to shoulder on each wing and side of mesial platform. Furrows extend to posterior beyond shoulder, become shallow and broader. Other furrows on wing commonly shallower, less broad, and located between lines or ridges.

Subcrown surface (unoccupied by pedicle) with one mesial rounded ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior crown apex; remainder of surface smooth; side-to-side surface convex (raised at ridge mesially anterior to posterior); shallow hollow on each side of ridge near crown/pedicle junction. In profile, subcrown oblique or slightly concave anterior to posterior. Crown posteriorly overhangs crown/pedicle junction; overhang may cover pedicle basal edge; sides and anterior do not overhang pedicle at crown/pedicle junction but intersect pedicle obliquely or almost vertically. Pedicle basal edges as wide or wider than crown at anterior and sides.

Pedicle keeled plain truncate and robust; vascularization hemiaulacorhize; anterior crown/pedicle junction edge located at anterior crown edge and posterior pedicle edge at anterior of crown centre. Subpedicle surface same as *L. alata* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* This species is common in the Upper Carnian (*Metapolygnathus nodosus* conodont Zone; *Tropites welleri* ammonoid Zone). Rare specimens were found in Ladinian samples and none were found in Norian samples.



**Material.** Holotype GSC 105252 and paratypes GSC 105253 and GSC 105149 from GSC loc. C-101119 (BBR-311A).

Additional specimens from GSC loc. C-086792 (BH-60), C-087901 (BH-62), C-101002 (BBR-1), C-101064 (ACE-1), C-101065 (ACE-2), C-101069 (BEH-3), C-101118 (BBR-310B), C-101119 (BBR-311A), C-101753 (MS-GB), C-145768 (GK-88-1-11), C-145780 (GK-68-8-27), C-153073 (GK-3-20), C-153075 (GK-4-11), C-153076 (GK-4-17), C-177682 (BH-61B), and C-177683 (BH-61).

**Peace River occurrence.** Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, Childerhose Cove, Chowade South, Laurier Pass, and Ursula Creek.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Labascicorona nitidifastigia* n. sp. s.f.

Plate 21, figures 11-12, 17

**Utilitarian identification.** Subtype  $a2/b2/c1,3,5/d1,2/e1/f2,3/g2/h3/i(2,3,4)+13/j\geq6/k5/11,2/m2/n(4,5)\pm(11,12)+13/p1/q8/r3,4/s2$  and Subtype  $a4/b2/c2/d4+10/e3/f4/g1,2/h1,2/i1,2/j(4,5)\pm(11,12)+13/k2/l1/m8/n3,4$

**Etymology.** Latin, *nitidus fastigium*, shining summit (referring to the lustrous and smooth upper crown posterior surface and margin).

**Diagnosis.** Crown with only a few posterior lines or ridges; has smooth and lustrous appearance; convex from anterior to posterior and from side edge to side edge (mesially highest); posterior margin with one to five apices; anterior margin undulating with moderately broad and rounded mesial protrusion; shoulder central. Mesial platform lanceolate to elongate lanceolate and convex from side to side, with several lines or ridges that terminate near middle crown and moderately broad and shallow furrow on each side. Lines or ridges on crown wing two or more; one extends anterior to posterior; others short. Subcrown surface with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex.

**Description.** Crown outline lanceolate; longer than or equally as long as wide; convex from anterior to posterior and from side edge to side edge (mesially highest); posterior margin with one, three, or rarely five acute apices (mesial apex long or short but always longer than lateral apices); lateral apices reduced; notch between mesial and lateral apex V-shaped; anterior margin undulating with rounded, moderately broad mesial protrusion; shoulder broad and central. Anterior margin may intersect pedicle obliquely or vertically with no overhang; without longitudinal line or ridge. Crown posteriorly overhangs crown/pedicle junction; may extend beyond pedicle basal edge.

Mesial platform lanceolate to elongate lanceolate in outline; convex anterior to posterior and side to side; generally extends anterior to posterior but may terminate near mid-crown. Ridges commonly several on mesial platform; parallel to subparallel; terminate before or near platform middle. Posterior platform and most of posterior crown is smooth and lustrous.

Two crown wings lower in height than, on each side of, and posterior to mesial platform. Two or more lines or ridges on each wing; approximately parallel; equal in height; one extends from anterior margin to posterior lateral apex. Shallow and moderately broad U-shaped furrow on each side of mesial platform on crown wing. Furrows extend to posterior (when mesial platform also extends to posterior) where they broaden and terminate between mesial and lateral apex below the "V". Other furrows on wing commonly shallower, less broad, and located between ridges. Edges of wings convex.

Subcrown (unoccupied by pedicle) with well raised mesial keel from most posterior crown/pedicle junction to about middle crown where it begins to shallow and continue to extend to (or just below) mesial posterior cusp apex. Shallow concave furrow or hollow under "V" between each lateral and mesial cusp and on each side of keel near pedicle. If all cusps reduced, concave hollow large and extends to crown edges. No additional lines, ridges, or keels on subcrown. In profile, subcrown concave anterior to posterior. Crown posteriorly overhangs crown/pedicle junction; overhang may cover pedicle basal edge; sides and anterior do not overhang pedicle at crown/pedicle junction but intersect pedicle obliquely or almost vertically. Pedicle basal edges as wide or wider than crown at anterior and sides.

Pedicle keeled plain truncate; may be robust; vascularization hemiaulacorhize; anterior crown/pedicle junction edge located at anterior crown edge; posterior pedicle approximately central. Subpedicle surface same as *L. alata* n. sp. s.f.

**Comparisons.** See Genus "Comparisons". In addition, *L. nitidifastigia* n. sp. s.f. shows some resemblance to *Propriogalea languidula* n. sp. s.f. It mainly differs by having: a) a keeled plain truncate pedicle, b) an upper crown surface mesial platform, and c) distinctive lateral cusps.

**Remarks.** Specimens are moderately rare and only found in Ladinian and Carnian samples.

**Material.** Holotype GSC 105254 from GSC loc. C-153075 (GK-4-11). Additional specimens from GSC loc. C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), and C-153076 (GK-4-17).

**Peace River occurrence.** Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Black Bear Ridge.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and uppermost Upper Carnian; Middle and Upper Triassic.



*Labascicorona trifastigia* n. sp. s.f.

Plate 22, figures 4-7, Figure 9j

*Utilitarian identification.* Subtype a<sup>2</sup>/b<sup>2</sup>/c<sup>3</sup>/d<sup>1</sup>/e<sup>1</sup>/f<sup>2,3</sup>/g<sup>1</sup>, 2/h<sup>3</sup>/i<sup>(2,3,4)+13</sup>/j<sup>≥6</sup>/k<sup>5</sup>/l<sup>1,2</sup>/m<sup>2+4</sup>/n<sup>5+11+13</sup>/p<sup>1</sup>/q<sup>8</sup>/r<sup>3,4</sup>/s<sup>2</sup>

Supergroup I, Group B, Subgroup 1a, Johns, 1996, Pl. 2, fig. 11.

*Etymology.* Latin, *trium fastigium*, three summits (the crown posterior margin has three apices).

*Diagnosis.* Crown shallowly convex from anterior to posterior and side edge to side edge (mesially highest); posterior margin with three apices; anterior margin undulating with broad and rounded mesial protrusion; shoulder anterior. Mesial platform lanceolate; convex from side to side, with several lines or ridges (1-2 may extend to apex) and with long, broad, and especially deep U-shaped furrow on each side. Crown wing with two or more long lines or ridges. Subcrown with one prominent mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex; one to several additional short apical lines or ridges.

*Description.* Crown outline lanceolate; longer than or equally as long as wide; shallowly convex from anterior to posterior and from side edge to side edge (mesially highest); posterior margin with three apices (mesial apex commonly attenuate, lateral apices reduced [two to three times shorter]); anterior and posterior side edges entire; anterior margin undulating with rounded, convex, and broad mesial protrusion; shoulder near anterior margin where crown is more steeply convex and curves down to crown/pedicle junction. Upper crown surface anterior longitudinal line or ridge absent.

Mesial platform prominent; lanceolate; extends anterior to posterior; moderately broad; convex (centrally highest) from side to side. Platform ridges commonly several; some terminate midway to apex on platform side; one or two (normally central) may extend anterior to posterior.

Two crown wings lower in height than, on each side of, and posterior to mesial platform. Two or more ridges present on each wing; approximately parallel and equal in height; extend anterior to posterior. Deep and moderately broad U-shaped furrow on each side of mesial platform on crown wing. Furrows extend to posterior and broaden and terminate between mesial and lateral apex. Other furrows on wing commonly shallower, less broad, and located between ridges. Because these furrows are shallower than those next to mesial platform, crown wings appear slightly raised.

Subcrown (unoccupied by pedicle) with broadly rounded mesial ridge extending from most posterior crown/pedicle junction to (or just below) posterior mesial crown apex; one or a few short lines or ridges may extend down from mesial apex (never to apex base); remainder of surface smooth; side-to-side surface convex (raised at ridge mesially anterior to posterior); shallow hollow on each side of ridge near crown/pedicle junction; short shallow furrow may be below "U" between apices. In profile, subcrown oblique or slightly concave anterior to posterior. Crown posteriorly overhangs

crown/pedicle junction; overhang may cover pedicle basal edge; sides and anterior do not overhang pedicle at crown/pedicle junction but intersect pedicle obliquely or almost vertically. Pedicle basal edges as wide or slightly wider than crown at anterior and sides.

Pedicle keeled plain truncate; robust; vascularization hemiaulacorrhize; anterior crown/pedicle junction edge located at anterior crown edge and posterior pedicle edge slightly to posterior of crown centre. Subpedicle surface same as *L. alata* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species moderately rare in Ladinian samples.

*Material.* Holotype GSC 105256 from GSC loc. C-101069 (BEH-3). Additional specimens from GSC loc. C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, and Beattie Ledge.

*Range.* *Coniunctio aequirugosa* ichthyolith Zone; ?*Maclearnoceras maclearni* ammonoid Zone (Tozer, 1994); Ladinian, Middle Triassic.

Supergroup II. Pedicle tetrahedroid

Group A. Pedicle simple or expanded tetrahedroid

Subgroup 1. Pedicle anterior; crown inclined lanceolate with long upper crown ridges and furrows; pedicle base outline tetrapetaloid, rhomboid, or stretched rhomboid; crown anterior overhang absent or minor.

1a: Subcrown with mesial ridge or keel and additional ridges; subpedicle surface flat or concave.

*Rugosicorona* n. gen. s.f.

*Etymology.* Latin, *rugosus corona*, wrinkled crown (referring to several ridges and lines on upper and sub-crown surfaces).

*Type species.* *Rugosicorona devexa* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; steeply oblique anterior to posterior; posterior margin with one apex or three with reduced laterals; anterior margin rounded or undulating. Anterior shoulder longitudinal line and margin overhang of the crown/pedicle junction minor or absent. Lines or ridges and furrows extend from thin anterior margin longitudinal line to or near posterior margin; may be closely paired anteriorly and converge posteriorly forming raised platforms of similar height and furrows of similar depth. Subcrown with broad mesial cusp keel and additional ridges. Pedicle expanded tetrahedroid. Subpedicle surface flat or concave.

*Description.* Scale small, delicate, and fragile. Crown steeply oblique from anterior to posterior; outline lanceolate; with one apex (if three, laterals reduced and minor); anterior margin broadly rounded and undulating with minor or no shoulder or overhang. Crown lines or ridges and furrows

prominent feature on crown anterior surface. Lines or ridges may be closely spaced anteriorly and merge posteriorly forming moderately high but narrow platforms. Furrows between platforms moderately deep and rounded. Thin longitudinal line may be on anterior crown margin; usually at anterior end of platforms. Subcrown surface with distinctive mesial cusp keel and two or more closely spaced ridges; keel shallows in height to posterior pedicle. Other short lines or ridges may be present on subcrown wing near margins. Pedicle keeled expanded tetrahedroid. Subpedicle surface flat or concave; outline equirhomboid, stretched rhomboid, tetrapetaloid, petaloid, or irregular.

*Comparisons.* *Rugosicorona* n. gen. s.f. is distinct by the presence of the subcrown surface posterior apex keel with two or more ridges that shallow in height to the posterior pedicle. A subcrown posterior pedicle halo is absent. The crown is steeply oblique and intersects the pedicle anteriorly with minor or no overhang. The crown has more than one narrowly raised platform, and ridges and furrows are common and similarly raised. The anterior margin is rounded or undulating.

*Rugosicorona* n. gen. s.f. bears some resemblance to *Parvidiabolus* n. gen. s.f. by its steeply oblique to erect crown and subcrown mesial keel. However, the upper and subcrown ridges are commonly shorter; the subcrown mesial apex is accentuated by lines or ridges; the crown is only weakly triapical; an anterior longitudinal line may be present; and the pedicle is keeled tetrahedroid or keeled expanded tetrahedroid.

*Range.* *Synechodus incrementum* ichthyolith Zone; Middle Norian, Upper Triassic.

*Rugosicorona devexa* n. sp. s.f.

Plate 28, figures 9-13

*Utilitarian identification.* Subtype  $a4/b2\pm6/c2/d4\pm7/e3/f4,8/g1,2/h1,2/i1,2/j2+11/k2\pm(4,5)/l1,2/m4/n1,2$

Supergroup II, Group A, Subgroup 1a, Johns, 1996, Pl. 2, fig. 15-16.

*Etymology.* Latin, *devexa*, sloping (referring to a crown that is commonly steeply sloping anterior to posterior [posterior highest]).

*Diagnosis.* Same as Genus "diagnosis".

*Description.* Scale small, delicate, and fragile; equally as long as or longer than wide. Crown steeply oblique and planar from anterior to posterior; approximately planar and shallowly undulating from side edge to side edge. Crown outline lanceolate; posterior cusp with one acute, obtuse, or rounded apex (plus one minor lateral apex may be present on each crown wing); posterior edges entire; anterior margin broadly rounded and undulating without prominent mesial protrusion. Shoulder minor or absent at anterior margin; crown instead obliquely intersects pedicle (with minor or no crown overhang). Crown posteriorly may extend beyond pedicle edges. Crown side edges approximately equal with width of pedicle base. Anteriorly, pedicle basal edges extend beyond crown.

Several lines or ridges similarly raised and prominent feature on crown surface; usually closely paired and long (extending anterior to posterior); from anterior margin to approximately central crown merge forming raised platform. Several narrow platforms may be present on one crown (Pl. 28, fig. 10-13). Furrows between platforms moderately deep and U-shaped anteriorly; shallow posteriorly. Thin longitudinal line may be on anterior crown near crown/pedicle junction (Pl. 28, fig. 12-13); usually broken by furrows; perpendicular to other lines or ridges.

Subcrown (unoccupied by pedicle) with distinctive posterior apex thickening; two or more closely spaced, moderately short ridges near posterior crown apex; and central broad keel that extends from posterior apex and shallows near pedicle (Pl. 28, fig. 9). Other short lines or ridges may be on wing subcrown surface near margins. Concave hollow located on each side of mesial keel; crown margins and keel sides form part of concavity. Subcrown also concave from anterior to posterior. Pedicle halo absent. Crown/pedicle junction mainly at crown anterior.

Pedicle keeled expanded tetrahedroid. Subpedicle surface flat or concave with small to large mesial canal opening; vascularization hemiaulacorhize; smaller canal openings rarely present; outline equirhomboid, stretched rhomboid, tetrapetaloid, petaloid, or irregular.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105172 and paratypes GSC 105170 and GSC 105171 from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087924 (BH-8), C-101036 (MS-3), C-101038 (MS-5), C-101114 (BBR-305B), C-101150 (MS-247A), C-177684 (BH-27), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, and Crying Girl Prairie Creek.

*Range.* *Synechodus incrementum* ichthyolith Zone; Middle *Epigondolella triangularis* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Malayites dawsoni* III to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); uppermost Lower Norian and Middle Norian, Upper Triassic.

Subgroup 1:

1b: Subcrown with mesial ridge or keel; subpedicle surface flat or convex.

*Gracilisuggestus* n. gen. s.f.

*Etymology.* Latin, *gracilis suggestus*, slender platform (referring to the shape of the mesial platform on the upper crown surface).

*Type species.* *Gracilisuggestus triapices* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; steeply inclined; posterior margin with one or three apices; anterior margin shallowly undulating with short and narrow rounded mesial protrusion. Crown shoulder shallow; approximately central; anterior overhang of crown/pedicle junction minor or absent;

anterior longitudinal line discontinuous or absent. Upper crown surface with long, narrow, and elongate rhomboid mesial platform and narrow furrows. Each crown wing with one or two long lines or ridges. Subcrown surface with mesial ridge or keel; other lines or ridges rare. Pedicle tall and tetrahedroid. Subpedicle surface convex or flat; outline equirhomboid or tetrapetaloid.

*Description.* Crown outline lanceolate. Crown moderately steep to steep oblique; may be slightly convex from anterior margin to posterior cusp; flat or convex and undulating side edge to side edge; longer than wide; posterior margin with one or three acute apices; anterior and posterior side edges entire; anterior margin shallowly undulating with short and narrow rounded mesial protrusion. Crown shoulder shallow; located approximately central; longitudinal line continuous or absent. Crown/pedicle overhang minor or absent at anterior and sides; present at posterior.

Upper crown surface with extremely narrow and elongate rhomboid mesial platform; extends anterior to posterior; commonly without interior lines or ridges. Narrow furrow and crown wing with one long line or ridge (may be two) on each side of platform.

Subcrown surface with mesial ridge or keel extending from posterior crown/pedicle junction corner to (or just below) posterior mesial crown apex; other lines or ridges rare. Crown/pedicle junction positioned anterior at edge and underneath crown. Pedicle commonly keeled simple tetrahedroid, may be keeled expanded tetrahedroid. Subpedicle surface approximately flat or convex with shallow anterior bulge and small- to medium-sized mesial canal opening; outline equirhomboid or tetrapetaloid.

*Comparisons.* *Gracilisuggestus* n. gen. s.f. differs from many of the other elasmobranch scales by having a tall keeled tetrahedroid pedicle, an upper crown surface with long and extremely thin and elongate mesial platform, lines or ridges and furrows that extend anterior to posterior, minor or no crown anterior overhang of the pedicle, and a subcrown surface that has a prominent mesial ridge or keel.

*Gracilisuggestus triapices* n. sp. s.f. differs from *Gracilisuggestus uniapex* n. sp. s.f. by having three posterior apices instead of one.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Carnian and Ladinian, Middle and Upper Triassic.

*Gracilisuggestus triapices* n. sp. s.f.

Plate 22, figures 8-13

*Utilitarian identification.* Subtype a2/b2±6/c3/d1/e1/f2/g1,2/h3/i(2,3,4)±10+13/j≥4/k5,10/l1,2,3/m2/n7+11/p1,2/q2,4/r1,3,4/s1,2

Supergroup II, Group A, Subgroup 1b, Johns, 1996, Pl. 2, fig. 17-18.

*Etymology.* Latin, *trium apices*, three apices.

*Diagnosis.* Crown outline lanceolate with three posterior apices (mesial apex longest, lateral apices approximately equal in height).

*Description.* Crown outline lanceolate; longer than wide; anterior and posterior side edges entire; anterior margin undulating with thin mesial protrusion; posterior margin with three acute or obtuse apices. Apex edges entire; mesial apex longer than approximately equal lateral apices; hollows between mesial and lateral apex U- or V-shaped. Crown steeply oblique and (or) slightly convex anterior to posterior with shallowly rounded shoulder approximately central; flat or convex (mesial highest) and undulating from side edge to side edge. Anterior crown curves down and may intersect pedicle almost vertically or obliquely (with no or minor crown overhang of crown/pedicle junction); posterior crown overhangs crown/pedicle junction and may cover pedicle basal edge. Anterior crown surface and (or) shoulder longitudinal line or ridge absent or discontinuous.

Mesial platform on upper crown surface very narrow and elongate rhomboid in outline; extends anterior to posterior (to mesial apex) with curvature similar to crown; commonly lacking interior lines or ridges.

Two crown wings slightly lower in height than, on each side of, and posterior to mesial platform. Narrow, long, and deep U-shaped furrow extends anterior to posterior (below "U" or "V" between mesial or lateral apex) on each wing and side of mesial platform. One or two long lines or ridges present on each wing; extend from anterior margin to posterior lateral apex; slightly lower in height than mesial platform.

Subcrown (unoccupied by pedicle) with one mesial ridge or keel extending from posterior crown/pedicle corner junction to (or just below) posterior crown apex; highest near pedicle and shallower near crown apex (posterior). Remainder of crown surface smooth; side-to-side surface convex (raised at ridge or keel mesially anterior to posterior); shallow hollow may be present on each side of ridge or keel near crown/pedicle junction.

Crown/pedicle junction positioned at anterior crown edge; posterior pedicle edge at anterior side of mid-subcrown surface. Pedicle keeled tall tetrahedroid or keeled expanded tetrahedroid. Subpedicle surface flat or convex; may have shallow anterior bulge; with small- to medium-sized mesial canal opening; vascularization hemiaulacorhize; outline rhomboid or tetrapetaloid (diagonal lengths approximately equal) with vertices located anterior, posterior, and at each side.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105165 and paratypes GSC 105167 and GSC 105168 from GSC loc. C-101065 (ACE-2); and paratype GSC 105166 from GSC loc. C-101069 (BEH-3).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-087901 (BH-62), C-087904 (BH-58B), C-101003 (BBR-2), C-101065 (ACE-2), C-101066 (ACE-3), C-101069 (BEH-3), C-101070 (BEH-4), C-145768 (GK-88-1-11), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Laurier Pass.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

*Gracilisuggestus uniapex* n. sp. s.f.

Plate 22, figures 14-15

*Utilitarian identification.* Subtype a4/b2±6/c2/d4+7+10/e3/f4,8/g1,2/h1/i1/j7+11±13/k2/l1,2/m2,4/n1,3,4

*Etymology.* Latin, *unus apex*, one apex (referring to the one crown posterior apex).

*Diagnosis.* Crown outline lanceolate with one posterior apex.

*Description.* Crown outline lanceolate; longer than wide; posterior and anterior side edges entire; anterior margin undulating with thin mesial protrusion; posterior margin with one acute or obtuse apex. Crown steeply oblique and (or) slightly convex anterior to posterior; with shallowly rounded shoulder approximately central; flat or convex (mesial highest) and undulating from side edge to side edge. Anterior crown curves down and may intersect pedicle (at crown/pedicle junction) almost vertically or obliquely (with no or minor crown overhang). Posterior crown overhangs crown/pedicle junction and may cover pedicle basal edge. Anterior crown surface and (or) shoulder longitudinal line absent or discontinuous.

Mesial platform on upper crown surface very narrow and elongate rhomboid in outline; extends anterior to posterior (to apex) with curvature similar to crown; commonly absent of interior lines or ridges.

Two crown wings slightly lower in height than, on each side of, and posterior to mesial platform. Narrow, long, and deep U-shaped furrow extends anterior to posterior; on each wing and side of mesial platform. One or two long lines or ridges present on each wing extend from anterior margin to posterior edge; slightly lower in height than mesial platform; close to wing/crown edge.

Subcrown (unoccupied by pedicle) with one mesial ridge or keel extending from most posterior crown/pedicle junction to (or just below) posterior crown apex; highest near pedicle and shallow near crown apex (posterior). Remainder of subcrown surface unornamented; side-to-side surface convex (raised at ridge or keel mesially anterior to posterior); shallow hollow may be present on each side of ridge or keel near crown/pedicle junction.

Crown/pedicle junction and pedicle description same as *G. triapices* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Specimens not abundant and not well preserved (commonly have damaged apex).

*Material.* Holotype GSC 105169 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-087901 (BH-62), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

Subgroup 1:

1c: Subcrown unornamented; subpedicle surface flat or concave.

*Fragilicorona* n. gen. s.f.

*Etymology.* Latin, *fragilis corona*, fragile crown.

*Type species.* *Fragilicorona labricuspis* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; inclined anterior to posterior; curvature shallowly convex anterior to posterior and side edge to side edge; anterior shoulder longitudinal line or ridge and margin overhang of crown/pedicle junction absent or minor; posterior margin with one or three apices; mesial platform, one furrow and one lateral line or ridge on each side of mesial platform extend anterior to posterior. Subcrown surface unornamented. Subpedicle surface approximately flat; outline tetrapetaloid or equirhomboid.

*Description.* Scale delicate. Crown outline lanceolate; posterior margin with one or three acute apices; anterior and posterior side edges entire; inclined anterior to posterior; curvature shallowly convex anterior to posterior and side edge to side edge; anterior margin rounded or with small and narrow, or short and moderately broad rounded mesial protrusion; shoulder anterior with no or slight overhang of crown/pedicle junction; anterior shoulder longitudinal line or ridge absent or minor (not well raised and may be discontinuous); mesial platform elongate rhomboid or narrow to moderately broad elongate lanceolate with or without short lines or ridges; one furrow and one long lateral line or ridge on each side of mesial platform extends anterior to posterior. Subcrown surface unornamented. Pedicle commonly simple tetrahedroid, may be expanded tetrahedroid. Subpedicle surface approximately flat (may be concave) with small- to medium-sized mesial canal opening; vascularization hemiaulacorhize; outline equirhomboid or tetrapetaloid.

*Comparisons.* *Fragilicorona* n. gen. s.f. differs from many of the elasmobranch scales in this study by having a simple tetrahedroid or expanded tetrahedroid pedicle, an upper crown surface with a mesial platform, lines or ridges and furrows

that extend anterior to posterior, minor or no anterior margin overhang of crown/pedicle junction, and a subcrown surface that is predominantly smooth and unornamented.

*Gracilisuggestus* n. gen. s.f. differs from *Fragilicorona* n. gen. s.f. mainly by having: a) a subcrown mesial ridge or keel that extends from the posterior crown/pedicle junction to the posterior margin apex; b) a pedicle that is keeled tetrahedroid; c) a narrower mesial platform; and may have d) an extra wing line or ridge and a convex subpedicle surface.

Six form species are included with *Fragilicorona* n. gen. s.f.; *Fragilicorona unicuspis* n. sp. s.f., *F. tricuspis* n. sp. s.f., and *F. breviostrum* n. sp. s.f. differ from *F. labricuspis* n. sp. s.f., *F. labritricuspis* n. sp. s.f., and *F. labribreviostrum* n. sp. s.f. by not having an anterior shoulder longitudinal line and minor crown anterior overhang of the crown/pedicle junction. *F. unicuspis* n. sp. s.f. and *F. labricuspis* n. sp. s.f. each have a single posterior apex whereas *F. tricuspis* n. sp. s.f. and *F. labritricuspis* n. sp. s.f. each have three posterior apices. *F. breviostrum* n. sp. s.f. and *F. labribreviostrum* n. sp. s.f. also have a single posterior apex but instead have a moderately broad, shallow, and elongate lanceolate crown mesial platform and shallow crown furrows.

*Range.* *Synechodus incrementum* ichthyolith Zone, Lower and Middle Norian, Upper Triassic.

*Fragilicorona labricuspis* n. sp. s.f.

Plate 23, figures 3-8, 11, 13-14; Figure 10a

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+7+10/e3/f4,8/g1,2/h1/i1/j(3,4,7)+11±13/k1/l2/m1,3/n1

Supergroup II, Group A, Subgroup 1c, Johns, 1996, Pl. 1, fig. 16.

*Etymology.* Latin, *labrum cuspis*, rim cusp (referring to the single posterior cusp and the anterior shoulder longitudinal line or rim).

*Diagnosis.* Crown with narrow to moderately narrow short anterior mesial protrusion and one posterior apex. Upper crown surface with prominent long and narrow-elongate rhomboid to elongate lanceolate mesial platform that may have none to several interior lines or ridges; anterior shoulder with longitudinal line that may be discontinuous.

*Description.* Scale small, thin, and delicate. Crown outline lanceolate; longer than wide; anterior and posterior edges entire; posterior margin with one acute apex; anterior margin with small and narrow or short and moderately broad mesial protrusion. Crown moderately steep and oblique anterior to posterior; convex at anterior and flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; approximately half way between crown centre and crown/pedicle junction; curvature moderate. Anterior shoulder longitudinal line or ridge not well raised and located below lower shoulder and above crown/pedicle junction; may be on anterior mesial platform; may extend to crown edges; perpendicular to crown ridges and mesial platform. Anterior crown intersects pedicle vertically, obliquely, or with minimal overhang (shallow furrow or hollows may be present underneath overhang above crown/pedicle junction).

Upper crown surface with moderately raised, narrow elongate rhomboid, narrow elongate lanceolate, or elongate lanceolate mesial platform; extends from anterior margin to posterior apex; flat to convex side to side; slightly curves anteriorly down to crown/pedicle junction. Lines or ridges (when present on platform) parallel and commonly short (extend 1/4 to 1/2 or less than length of platform from anterior margin).

Two crown wings on each side of, and posterior to, mesial platform. One lateral line or ridge on each wing close to crown edge; each extends from an anterior position near crown base to cusp edge near apex (posterior). Broad, U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown (unoccupied by pedicle) mainly unornamented; minor short mesial line or ridge may be near posterior vertex of pedicle and extend towards crown posterior; curvature (from side to side) convex (raised slightly mesially anterior to posterior). In profile, crown concave at anterior and oblique at posterior; posteriorly extends beyond pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly pedicle base extends beyond crown.

Crown/pedicle junction positioned at anterior crown edge; posterior pedicle edge at anterior side of mid-subcrown surface. Pedicle simple tetrahedroid (in specimens with none or one mesial platform ridge) or expanded tetrahedroid (in specimens with more than one mesial platform ridge). Pedicle vascularization hemiaulacorhize. Subpedicle surface approximately flat (may be concave); with small- to medium-sized mesial canal opening; outline rhomboid or tetrapetaloid (diagonals lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* *F. labricuspis* n. sp. s.f. and *F. unicuspis* n. sp. s.f. (Type A) show some similar dermal denticle morphologies to Subtype Number 060 (Tway and Zidek, 1982, age: Late Pennsylvanian) and differ by having a less broad furrow separating each lateral ridge from the mesial platform, the lateral wing ridge is not as close to the crown edge, and the pedicle canal openings are closer to the pedicle base. The illustrations of Subtype Number 060 do not clearly show the region where the anterior longitudinal line would be located (if present).

In addition, see Genus "Comparisons".

*Remarks.* Four variations are grouped according to the shape of the crown mesial platform, the number of internal mesial platform lines or ridges, and the type of pedicle. The mesial platform becomes slightly wider with each increase in the number of lines or ridges on its surface. As the mesial platform widens and its ridge number increases to two or more, additional ridges, furrows, and canal openings may be present on anterior pedicle. The four types are as follows:



Type A (Pl. 23, fig. 3-4)

Mesial platform narrow elongate rhomboid or narrow elongate lanceolate with no internal lines or ridges. Pedicle simple tetrahedroid.

Type B (Pl. 23, fig. 5-6)

Mesial platform narrow elongate lanceolate with one internal line or ridge. Pedicle simple tetrahedroid.

Type C (Pl. 23, fig. 7)

Mesial platform elongate lanceolate with two internal lines or ridges. Pedicle expanded tetrahedroid or simple tetrahedroid.

Type D (Pl. 23, fig. 8)

Mesial platform elongate lanceolate to lanceolate with greater than two internal lines or ridges. Pedicle expanded tetrahedroid or simple tetrahedroid.

All or most of these types usually occur together in the samples. Further collection and study is required to determine if variance in the number of lines or ridges is significant to separate these types into species. At this stage, the number of lines or ridges appears of minor significance and could simply be variation attributed to the position of the scale on the fish or the size of the scale.

**Material.** Holotype GSC 105141 (Type A) and paratype GSC 105142 (Type B) from GSC loc. C-302390 (TE-220A); paratype GSC 105143 (Type C) and GSC 105145 (Type B) from GSC loc. C-101150 (MS-247A); paratype GSC 105144 (Type D) from GSC loc. C-101036 (MS-3); and paratype GSC 105147 from GSC loc. C-087924 (BH-8).

Additional specimens from GSC loc. C-087910 (BH-47/48), C-087918 (BH-27 top), C-087919 (BH-26), C-087924 (BH-8), C-087926 (BH-1), C-101034 (MS-1), C-101035 (MS-2), C-101036 (MS-3), C-101038 (MS-5), C-101056 (PH-9), C-101013 (BBR-12), C-101015 (BBR-14), C-101114 (BBR-305B), C-101115 (BBR-306A), C-101150 (MS-247A), C-101751 (MS-247B), C-101754 (NPP-Low), C-101778 (PH-227A), C-177684 (BH-27), C-089725 (BH-2), C-302382 (BH-20), C-302386 (TE-217D), and C-302390 (TE-220A).

**Peace River occurrence.** Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, Ne Parle Pas Rapids, and Pardonet Hill.

**Range.** *Synechodus incrementum* ichthyolith Zone; Upper *Metapolygnathus primitius* to *Epigondolella bidentata* conodont zones (Orchard, 1991c); *Stikinoceras kerri* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Lower and Middle Norian; Upper Triassic.

*Fragilicorona brevirostrum* n. sp. s.f.

Plate 25, figures 1-2, 12-13; Figure 10b

**Utilitarian identification.** Subtype a4/b2/c2/d4+10/e1, 3/f4,8/g1,2/h1/i1,2/j(4,5,6)+11±13/k1/l1/m1,3/n1

Supergroup II, Group A, Subgroup 1c, Johns, 1996, Pl. 1, fig. 17.

**Etymology.** Latin, *brevis rostrum*, shallow beak or platform (referring to the shallow and broad crown mesial platform).

**Diagnosis.** Crown with shallow and broad short anterior mesial protrusion and one posterior apex. Upper crown surface with shallow and moderately broad elongate lanceolate mesial platform that may or may not have short lines or ridges; anterior shoulder longitudinal line absent.

**Description.** Scale small, thin, and delicate. Crown outline lanceolate; longer than or equally as long as wide; anterior and posterior edges entire; posterior margin with one acute apex; anterior margin with broad, shallow, and short mesial protrusion. Crown moderately steep oblique anterior to posterior, convex at anterior and flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; approximately half way between crown centre and crown/pedicle junction; curvature shallow; anterior longitudinal line or ridge absent. Anterior crown intersects pedicle vertically, obliquely, or with minimal overhang (no furrow or hollows underneath overhang above crown/pedicle junction).

Upper crown surface with shallow (height reduced), moderately broad elongate lanceolate mesial platform. Platform extends from anterior margin to posterior apex; flat to convex from side to side; slightly curves anteriorly down to crown/pedicle junction; flattens and furrows shallow considerably near apex where cusp almost becomes a flat surface. Lines or ridges when present on platform commonly short (extend 1/4 to 1/2 or less than length of platform from anterior margin).

Two crown wings on each side of, and posterior to, mesial platform. One lateral line or ridge on each wing close to crown edge; each extends from an anterior position near crown base to cusp edge near apex. Broad and shallow U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown surface and pedicle descriptions same as *F. labricuspis* n. sp. s.f., except pedicle rarely expanded tetrahedroid.

**Comparisons.** See Genus "Comparisons".

**Remarks.** The illustrations of *F. brevirostrum* n. sp. s.f. (Pl. 25, fig. 1-2) appear to show a short mesial platform and lines or ridges. However, the furrows are deeper anteriorly (even though they shallow posteriorly), the mesial platform is broad but prominent, there is no anterior shoulder longitudinal line and prominent anterior crown overhang of the crown/pedicle junction, and the crown is moderately steeply inclined. All these features favour a *F. brevirostrum* n. sp. s.f. identification rather than *Glabriscorona* n. gen. in descriptions that follow. On *F. brevirostrum* n. sp. s.f. additional pedicle rounded ridges, furrows, and canal openings are rare. If present, then the crown is commonly larger, the mesial platform is broader having interior lines or ridges, and the pedicle rounded ridges are an extension of the crown ridges.

**Material.** Holotype GSC 105157, paratype GSC 105158, and additional specimens from GSC loc. C-302387 (TE-217D).



*Peace River occurrence.* Pardonet Formation; Crying Girl Prairie Creek.

*Range.* *Synechodus incrementum* ichthyolith Zone; *Epigondolella serrulata* conodont Zone (Orchard, 1991c); *Mesohimavatites columbianus* III ammonoid Zone (Tozer, 1994); upper Middle Norian, Upper Triassic.

*Fragilicorona labribrevirostrum* n. sp. s.f.

Plate 25, figures 3-11

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+7+10/e3/f4,8/g1,2/h1/i1/j4+11±13/k1/l2/m1,3/n1

*Etymology.* Latin, *labrum brevis rostrum*, rim shallow beak or platform (referring to the anterior shoulder longitudinal line or rim and the shallow and broad crown mesial platform).

*Diagnosis.* Crown with shallow and broad short anterior mesial protrusion and one posterior apex. Upper crown surface with shallow and moderately broad elongate lanceolate mesial platform that may or may not have short lines or ridges; anterior shoulder with longitudinal line that may be discontinuous.

*Description.* Scale small, thin, and delicate. Crown outline lanceolate; longer than wide; anterior and posterior edges entire; cusp posterior with one acute apex; anterior margin with shallow, short, and moderately broad mesial protrusion. Crown moderately steep oblique anterior to posterior; convex at anterior and flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; approximately half way between crown centre and crown/pedicle junction; curvature moderate. Anterior longitudinal line or ridge below lower shoulder and above crown/pedicle junction; usually on anterior mesial platform; may extend to crown edges; perpendicular to crown ridges and mesial platform. Anterior crown intersects pedicle vertically, obliquely or with moderate overhang (shallow furrow or hollows may be present underneath overhang above crown/pedicle junction).

Upper crown surface with shallow (height reduced), moderately broad, elongate lanceolate mesial platform. Platform extends from anterior margin to posterior apex; flat to convex from side to side; slightly curves anteriorly down to crown/pedicle junction; flattens and furrows shallow considerably near apex where cusp almost becomes a flat surface. Lines or ridges (when present on platform) parallel and commonly short (extend 1/4 to 1/2 or less than length of platform from anterior margin).

Two crown wings on each side of, and posterior to, mesial platform. One lateral line or ridge on each wing; may be close to crown edge; each extends from an anterior position near crown base to cusp edge near apex. Broad and shallow U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown surface and pedicle description same as *F. labricuspis* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Four variations (Types A, B, C, and D) are grouped according to the number of crown mesial platform lines or ridges and pedicle ridges, furrows, and canal openings. See *F. labricuspis* n. sp. s.f. "Remarks" for a list of the different features. The types are illustrated in Plate 25 as follows: Type A, figure 3; Type B, figures 4-6; Type C, figures 7-8; and Type D, figures 9-10.

*F. labribrevirostrum* n. sp. s.f. is common in the lower Middle Norian and uppermost upper Lower Norian (*Epigondolella multidentata* and *Epigondolella triangularis* conodont zones; *Malayites dawsoni* and *Drepanites rutherfordi* ammonoid zones).

*Material.* Holotype GSC 105163 (Type D) and paratypes GSC 105159 (Type A), GSC 105160 (Type B), GSC 105161 (Type B), GSC 105162 (Type C), and GSC 105164 (Type B) from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087910 (BH-47/48), C-087918 (BH-27 top), C-087924 (BH-8), C-087926 (BH-1), C-101033 (BBR-33), C-101034 (MS-1), C-101035 (MS-2), C-101036 (MS-3), C-101038 (MS-5), C-101056 (PH-9), C-101149 (MS-244A), C-101754 (NPP-Low), C-177684 (BH-27), C-302382 (BH-20), C-302383 (BH-24), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, Ne Parle Pas Rapids, and Pardonet Hill.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Metapolygnathus primitius* to *Epigondolella postera* conodont zones (Orchard, 1991c); *Stikinoceras kerri* II to *Mesohimavatites columbianus* II ammonoid zones (Tozer, 1994); Lower and Middle Norian, Upper Triassic.

*Fragilicorona labritricuspis* n. sp. s.f.

Plate 24, figures 3-11, 14-16; Figures 10c, 11b

*Utilitarian identification.* Subtype a2/b2+6/c3/d1/e1/f2, 3/g1,2/h3/i(2,3,4)+10+13/j≥4/k5,10/11,2/m1/n(3,4,7)+11±13/p2/q1,3/r1/s2

Supergroup II, Group A, Subgroup 1c, Johns, 1996, Pl. 1, fig. 6; and Pl. 2, fig. 19-20.

*Etymology.* Latin, *labrum trium cuspis*, rim three cusps (referring to the anterior shoulder longitudinal line or rim and the crown posterior margin with three cusps or apices).

*Diagnosis.* Crown with narrow to moderately narrow short anterior mesial protrusion and three posterior apices (mesial apex longest, laterals apices approximately equal in height). Upper crown surface with prominent long and narrow elongate rhomboid to elongate lanceolate mesial platform that may have none to several interior lines or ridges; anterior shoulder with longitudinal line that may be discontinuous.

*Description.* Scale small, thin, and delicate. Crown outline lanceolate; longer than wide; anterior margin with small and narrow or short and moderately broad mesial protrusion; anterior and posterior edges entire; posterior margin with three apices. Apex edges entire; mesial apex slightly longer than approximately equal length lateral apices; hollows

between mesial and lateral apex moderately broad and U- or V-shaped. Crown moderately steep oblique anterior to posterior; convex at anterior and flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; approximately half way between crown centre and crown/pedicle junction; curvature moderate. Anterior longitudinal line or ridge below lower shoulder and above crown/pedicle junction; not well raised; usually on anterior mesial platform; may extend to crown edges; perpendicular to crown ridges and mesial platform. Anterior crown intersects pedicle vertically, obliquely, or with moderate overhang (shallow furrow or hollows may be present underneath overhang above crown/pedicle junction).

Upper crown surface with moderately raised, narrow elongate rhomboid, narrow elongate lanceolate, or elongate lanceolate mesial platform; extends from anterior margin to posterior apex; flat to convex from side to side; slightly curves anteriorly down to crown/pedicle junction. Lines or ridges (when present on platform) parallel and commonly short (extend 1/4 to 1/2 or less than length of platform from anterior margin).

Two crown wings on each side of, and posterior to, mesial platform. One lateral line or ridge on each wing close to crown edge; each extends from an anterior position near crown base to lateral cusp edge near apex. Broad U-shaped furrow broadens to posterior and located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown surface and pedicle description same as *F. labricuspis* n. sp. s.f.

**Comparisons.** See Genus "Comparisons".

**Remarks.** Four variations (Types A, B, C, D) are grouped according to the number of crown mesial platform lines or ridges and pedicle ridges, furrows, and canal openings. See *F. labricuspis* n. sp. s.f. "Remarks" for a list of the different features. The types are illustrated in Plate 24 as follows: Type A, figures 3-4; Type B, figures 5-8; Type C, figure 9; and Type D, figures 10-11.

**Material.** Holotype GSC 105152 (Type B) and paratypes GSC 105150 (Type A), GSC 105151 (Type B), GSC 105154 (Type D), GSC 105155, GSC 105156, and GSC 105375 (Type B) from GSC loc. C-101150 (MS-247A); and paratypes GSC 105153 (Type C) and GSC 105376 from GSC loc. C-101114 (BBR-305B).

Additional specimens from GSC loc. C-087924 (BH-8), C-101015 (BBR-14), C-101036 (MS-3), C-101114 (BBR-305B), C-101150 (MS-247A), and C-302390 (TE-220A).

**Peace River occurrence.** Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, and Crying Girl Prairie Creek.

**Range.** *Synechodus incrementum* ichthyolith Zone; Upper *Epigondolella triangularis* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Juvavites magnus* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Middle Norian, Upper Triassic.

*Fragilicorona tricuspis* n. sp. s.f.

Plate 24, figures 1-2, 12-13; Figure 9b

**Utilitarian identification.** Subtype a2/b2/c3/d1/e1/f2/g1, 2/h3/i(2,3,4)+13/j4/k5,10/11,2/m1/n7+11/p1/q1,3/r1/s2

Supergroup II, Group A, Subgroup 1c, Johns, 1996, Pl. 2, fig. 21.

aff? selachian dermal denticle, gen. and sp. indet., Duffin and Gazdzicki, 1977, p. 336-337, Fig. 3.

**Etymology.** Latin, *trium cuspis*, three cusps or apices.

**Diagnosis.** Crown with small and narrow anterior mesial protrusion and three posterior apices (mesial apex longest, laterals apices approximately equal in height). Upper crown surface with prominent long, narrow elongate rhomboid mesial platform that has no interior lines or ridges; anterior shoulder longitudinal line absent.

**Description.** Scale small, thin, and delicate. Crown outline lanceolate; longer than wide; anterior margin with small and narrow mesial protrusion; anterior and posterior edges entire; posterior margin with three apices. Apices acute with entire edges; mesial apex slightly longer than approximately equal length lateral apices; hollow between mesial and each lateral apex moderately broad U- or V-shaped. Crown moderately steep oblique anterior to posterior; convex at anterior and flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; approximately half way between crown centre and crown/pedicle junction; curvature shallow; anterior longitudinal line or ridge absent. Anterior crown intersects pedicle vertically, obliquely, or with minimal overhang (no furrow or hollows underneath overhang above crown/pedicle junction).

Upper crown surface with moderately raised narrow-elongate rhomboid mesial platform; extends from anterior margin to posterior apex; flat to convex from side to side; slightly curves anteriorly down to crown/pedicle junction; no lines or ridges present.

Two crown wings on each side of and posterior to mesial platform. One lateral line or ridge on each wing close to crown edge; each extends from an anterior position near crown base to lateral cusp edge near apex. Broad, U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown surface and pedicle description, same as *F. labricuspis* n. sp. s.f., except pedicle rarely expanded tetrahedroid.

**Comparisons.** Duffin and Gazdzicki (1977) described and illustrated a selachian dermal denticle which resembles *F. tricuspis* n. sp. s.f. from the Rhaetian of the Tatra Mountains, Poland. The similarities include crown shape, unornamented subcrown, and the quadrate nature of the pedicle. The Tatra Mountain form differs by potentially having more than one lateral ridge and apex on each crown wing, and lines, ridges or keels that do not reach the posterior margin.

In addition, see Genus "Comparisons".

*Remarks.* Additional pedicle rounded ridges, furrows, and canal openings are rare. If present, then the crown is larger and the mesial platform is broader having interior lines or ridges. The pedicle rounded ridges are commonly an extension of the crown ridges.

*Material.* Holotype GSC 105148, and additional specimens from GSC loc. C-302387 (TE-217D).

*Peace River occurrence.* Pardonet Formation; Crying Girl Prairie Creek.

*Range.* *Synechodus incrementum* ichthyolith Zone; *Epigondolella serrulata* conodont Zone (Orchard, 1991c); *Mesohimavatites columbianus* III ammonoid Zone (Tozer, 1994); upper Middle Norian, Upper Triassic.

*Fragilicorona unicuspis* n. sp. s.f.

Plate 23, figures 1-2, 9-10, 12

*Utilitarian identification.* Subtype a4/b2/c2/d4+10/e3/f4, 8/g1,2/h1/i1/j7+11/k1/l1/m1,3/n1

*Etymology.* Latin, *unus cuspis*, one apex or cusp.

*Diagnosis.* Crown with small and narrow anterior mesial protrusion and one posterior apex. Upper crown surface with prominent long, narrow elongate rhomboid mesial platform that has no interior lines or ridges; anterior shoulder longitudinal line absent.

*Description.* Scale small, thin, and delicate. Crown outline lanceolate; longer than wide; anterior and posterior edges entire; posterior margin with one acute apex; anterior margin with small and narrow mesial protrusion. Crown moderately steep oblique anterior to posterior; convex at anterior; flattens to posterior; convex (mesially highest) and undulating side edge to side edge. Shoulder anterior; about half way between crown centre and crown/pedicle junction; curvature shallow; anterior shoulder longitudinal line or ridge absent. Anterior crown intersects pedicle vertically, obliquely, or with minimal overhang (no furrow or hollows underneath overhang above crown/pedicle junction).

Upper crown surface with moderately raised, narrow elongate rhomboid mesial platform; extends from anterior margin to posterior apex; flat to convex from side to side; slightly curves anteriorly down to crown/pedicle junction; no lines or ridges present.

Two crown wings on each side of, and posterior to, mesial platform. One lateral line or ridge on each wing close to crown edge; each extend anterior to posterior. Broad U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform but higher than bottom of furrow.

Subcrown surface and pedicle description same as *F. labricuspis* n. sp. s.f., except pedicle rarely expanded tetrahedroid.

*Comparisons.* See "Comparisons" of *F. Labricuspis*.

*Remarks.* See *F. tricuspis* n. sp. s.f. "Remarks".

*Material.* Holotype GSC 105138 and paratype GSC 105139 from GSC loc. C-087924 (BH-8); and paratype GSC 105140 from GSC loc. C-302387 (TE-217D).

Additional specimens from GSC loc. C-087924 (BH-8), C-087926 (BH-1), C-101036 (MS-3), C-101114 (BBR-305B), C-101754 (NPP-Low), C-302382 (BH-20), and C-302387 (TE-217D).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, and Ne Parle Pas Rapids.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Epigondolella triangularis* to *Epigondolella bidentata* conodont zones (Orchard, 1991c); *Juvavites magnus* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Middle Norian, Upper Triassic.

Subgroup 2: Pedicle anterior; crown inclined lanceolate with long upper crown ridges and furrows; pedicle base outline tetrapetaloid or rhomboid; crown anterior overhang prominent.

2a: Crown anterior shoulder longitudinal ridge or line well raised; subcrown ornamentation absent or with discontinuous halo; subpedicle surface flat or convex.

*Labrilancea* n. gen. s.f.

*Etymology.* Latin, *labrum lancea*, rim lance (referring to the lance shape of the crown and its anterior shoulder rim or ridge).

*Type species.* *Labrilancea glabrisubcuspis* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; horizontal to shallowly inclined anterior to posterior; flattened from narrow shoulder at anterior margin to posterior cusp and shallowly convex from side edge to side edge. Anterior crown margin shoulder prominently overhangs crown/pedicle junction; shoulder longitudinal line or ridge well raised. Posterior crown margin with one or three apices. Crown mesial platform, one furrow and one lateral line or ridge on each side of mesial platform extend anterior to posterior. Subcrown surface unornamented or may have thin halo. Subpedicle surface flat or shallowly convex; outline equirhomboid or tetrapetaloid.

*Description.* Scale small (approximately 300-400 µm) and thin. Crown outline lanceolate; sits shallowly oblique to almost horizontal on pedicle; flattened from narrow shoulder at anterior margin to posterior cusp; shallowly convex to undulating from side edge to side edge; posterior margin with one or three acute apices; anterior and posterior side edges entire; anterior margin prominently overhangs crown/pedicle junction with prominent longitudinal line or ridge and short and rounded mesial protrusion of average width; mesial platform elongate-lanceolate with or without short lines or ridges; one furrow and one lateral line or ridge on each side of mesial platform extend from anterior to posterior margins. Subcrown surface generally unornamented; may have thin

halo. Subpedicle surface flat or slightly convex with shallow bulge and small- to medium-sized mesial canal opening; outline equirhomboid or tetrapetaloid.

*Comparisons.* *Labrilancea* n. gen. s.f. differs from many of the other elasmobranch scales by having a simple tetrahedroid or expanded tetrahedroid pedicle; a shallowly oblique to horizontal upper crown surface with a mesial platform, lines or ridges and furrows that extend anterior to posterior; and a subcrown surface that is predominantly unornamented or with a thin halo.

Some of these features also are found in the following and *Labrilancea* n. gen. s.f. mainly differs from *Fragilicorona* n. gen. s.f., *Gracilisuggestus* n. gen. s.f., and *Rugosicorona* n. gen. s.f. by having a prominent anterior longitudinal line or ridge on a narrow anterior shoulder, a prominent anterior crown overhang of the crown/pedicle junction, and a shallowly (not steep) oblique crown with a flattened surface from the anterior shoulder to the posterior apex. In addition, *Labrilancea* n. gen. s.f. does not have a subcrown mesial ridge or keel extending from the posterior pedicle to the posterior margin (present in *Gracilisuggestus* n. gen. s.f. and *Rugosicorona* n. gen. s.f.) and other subcrown ridges present on *Rugosicorona* n. gen. s.f.

*Labrilancea glabrisubcuspsis* n. sp. s.f. differs from *Labrilancea glabrisubtricuspsis* n. sp. s.f. by having a single posterior cusp apex instead of three apices.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; Ladinian and uppermost Upper Carnian, Middle and Upper Triassic.

*Labrilancea glabrisubcuspsis* n. sp. s.f.

Plate 26, figures 1-5

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e3/f4,8/g1,2/h1/i1,2/j4+11±13/k1,6/l3/m1,3/n1,3,4

cf. Subtype Number 003, Tway and Zidek, 1982, p. 331; Fig. 19a-e.

*Etymology.* Latin, *glaber sub cuspsis*, smooth under cusp (referring to a crown with one cusp or apex and is smooth underneath).

*Diagnosis.* Crown outline lanceolate with one posterior apex.

*Description.* Crown outline lanceolate; longer than or equally long as wide; anterior and posterior edges entire; posterior margin with one acute apex; anterior margin with short and rounded mesial protrusion of average width (not narrow or broad). Crown moderately shallowly oblique to nearly horizontal anterior to posterior; shoulder close to anterior margin. Upper crown surface approximately flat from shoulder to posterior apex; centrally convex and with convex lateral ridges and flat edges (convex to undulating side edge to side edge). Crown shoulder narrow and curves sharply under crown forming prominent overhang of crown/pedicle junction. Crown anterior longitudinal line or ridge perpendicular to crown ridges and mesial platform; on shoulder edge (not under crown overhang); usually extends length of anterior

shoulder (may be only on anterior mesial platform). Anterior crown intersects pedicle under crown overhang in furrow or hollows.

Upper crown surface with moderately raised elongate lanceolate mesial platform; extends from anterior shoulder to posterior apex; flat to shallowly convex from side to side; may curve slightly down at anterior shoulder. Lines or ridges when present on platform are reduced, parallel, and short (rarely extend beyond 1/4 length of platform from anterior margin).

Two crown wings on each side of and posterior to mesial platform. One lateral line or ridge present on each wing close to crown edge; each extends from anterior position near crown base to cusp edge near apex. U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform; higher than or about equal with bottom of furrow.

Subcrown (unoccupied by pedicle) mainly unornamented; thin halo may be present around pedicle; curvature (from side to side) convex (raised slightly mesially anterior to posterior). In side profile, crown posteriorly extends beyond pedicle edges; side edges about equal with width of pedicle base (or slightly less). Anterior pedicle base edge extends beyond crown.

Crown/pedicle junction positioned at anterior under crown edge and posterior pedicle edge at anterior side of mid-subcrown surface. Pedicle simple or expanded tetrahedroid. Subpedicle surface flat, convex, or slightly convex with shallow bulge; small- to medium-sized mesial canal opens perpendicular to subpedicle surface; vascularization hemiaulacorrhize. Subpedicle outline rhomboid or tetrapetaloid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* *L. glabrisubcuspsis* n. sp. s.f. appears to be identical with Subtype Number 003 (Tway and Zidek, 1982) of Late Pennsylvanian age. A small difference may exist in the crown of *L. glabrisubcuspsis* n. sp. s.f. where it is slightly flatter from anterior to posterior.

In addition, see Genus "Comparisons".

*Material.* Holotype GSC 105173 from GSC loc. C-101068 (BEH-2); and paratypes GSC 105174 and GSC 105176 from GSC loc. C-087972 (Sutherland Zone).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), and C-101069 (BEH-3).

*Peace River occurrence.* Liard and Baldonnel? formations; Aylard Creek East, Beattie Hill, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994);

Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

*Labrilancea glabrisubtricuspis* n. sp. s.f.

Plate 26, figures 6-16; Figures 10e, 11c

*Utilitarian identification.* Subtype  $a2/b2+6/c3/d1,2/e1/f2,3/g1,2/h3/i(2,3,4)+11+13/j\geq 4/k5,10/l1,2/m1,6/n4+11\pm 13/p3/q1,3/r1,3,4/s1,2$

Supergroup II, Group A, Subgroup 2a, Johns, 1996, Pl. 1, fig. 13; Pl. 2, fig. 22-24.

aff? Group B1, Koehler, 1975, p. 39-40, pl. 2, fig. 1-3.

*Etymology.* Latin, *glaber sub tricuspis*, smooth under three cusps (referring to a crown with three cusps or apices and is smooth underneath).

*Diagnosis.* Crown outline lanceolate with three posterior apices (mesial apex longest, lateral apices approximately equal in height).

*Description.* Crown outline lanceolate; longer than or equally long as wide; anterior and posterior edges entire; anterior margin with short and rounded mesial protrusion of average width (not narrow or broad); posterior margin with three apices. Apex edges entire; mesial apex slightly longer than approximately equal length lateral apices; hollows between mesial and lateral apex moderately broad and U- or V-shaped. Crown shallowly oblique to nearly horizontal anterior to posterior; shoulder close to anterior margin. Upper crown surface approximately flat from shoulder to posterior apex; centrally convex with convex lateral ridges and flat edges (convex to undulating side edge to side edge). Crown shoulder narrow; curves sharply under crown; prominently overhangs crown/pedicle junction. Crown anterior longitudinal line or ridge on shoulder edge (not under crown overhang); usually extends length of anterior shoulder (may be only on anterior mesial platform). Anterior crown intersects pedicle under crown overhang in furrow or hollows.

Upper crown surface with moderately raised elongate lanceolate mesial platform that extends from anterior shoulder to posterior central apex; flat to shallowly convex from side to side; may curve slightly down at anterior shoulder. Platform lines or ridges (when present) reduced, parallel, and short (rarely extend beyond 1/4 length of platform from anterior margin).

Two crown wings on each side of and posterior to mesial platform. One lateral line or ridge present on each wing close to crown edge; each extends from an anterior position near crown base to cusp edge near apex. U-shaped furrow broadens to posterior; located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform; higher than or about equal with bottom of furrow.

Subcrown surface and pedicle description, same as *L. glabrisubcusps* n. sp. s.f.

*Comparisons.* Koehler (1975) illustrated three specimens that are similar to *L. glabrisubtricuspis* n. sp. s.f. which have a flattened mesial platform that extends anterior to posterior, a pair of long lateral ridges, and a tetrahedroid style pedicle. The illustrations and the diagnosis do not indicate whether or not an anterior longitudinal line was present, if there was anterior pedicle overhang by the crown, and if the subcrown was unornamented or had a halo. Age: Late Devonian to Middle Triassic.

*L. glabrisubtricuspis* n. sp. s.f. has a similar upper crown ornamentation to Subtype Number 031 (Tway and Zidek, 1982, age: Late Pennsylvanian) and differs by having a subcrown halo or no ornamentation, and well developed lateral apices.

In addition, see Genus "Comparisons".

*Material.* Holotype GSC 105177 (Type A) and paratypes GSC 105178 (Type A), GSC 105179 (Type C), GSC 105180, and GSC 105181 from GSC loc. C-087972 (Sutherland Zone).

Additional specimens from GSC localities C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101065 (ACE-2), C-101068 (BEH-2), and C-153069 (GK-1-19).

*Peace River occurrence.* Liard and Baldonnel? formations; Aylard Creek East, Beattie Hill, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

Subgroup 2:

2b: Crown anterior shoulder longitudinal ridge or line well raised; subcrown with mesial ridge or keel, may have halo; subpedicle surface flat, concave, or convex.

*Ornatilabrilancea* n. gen. s.f.

*Etymology.* Latin, *ornatus labrum lancea*, equipped rim lance (referring to the lance shape of the crown, its anterior shoulder rim or ridge, and subcrown ornament).

*Type species.* *Ornatilabrilancea circacarina* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate; convex at anterior, flattened to oblique at posterior; anterior margin with shoulder that prominently overhangs crown/pedicle junction; anterior shoulder with well raised longitudinal line or ridge; posterior margin with one apex; mesial platform, one furrow and one lateral line or ridge on each side of mesial platform extend anterior to posterior. Subcrown with mesial ridge or keel that extends from posterior pedicle corner to posterior apex; thin halo may be present. Subpedicle surface flat or shallowly convex; outline equirhomboid or tetrapetaloid.



*Description.* Scale small (approximately 250-400 µm) and thin. Crown outline lanceolate. Crown convex at anterior, flat to shallowly oblique at posterior; shallowly convex to undulating from side edge to side edge; posterior margin with one acute apex; anterior and posterior side edges entire; anterior margin with short and rounded mesial protrusion of average width; one furrow and one lateral line or ridge on each side of mesial platform extends anterior to posterior. Shoulder narrow at anterior; with longitudinal line or ridge; prominently overhangs crown/pedicle junction. Mesial platform elongate-lanceolate; with or without short lines or ridges. Subcrown surface with mesial ridge or keel that extends from posterior pedicle corner to posterior apex; thin halo may be on subcrown surface around pedicle. Anterior crown intersects pedicle underneath crown overhang. Subpedicle surface flat or convex with shallow bulge, small- to medium-sized mesial canal opening, and commonly other small canal openings; outline equirhomboid or tetrapetaloid.

*Comparisons.* *Ornatilabrilancea* n. gen. s.f. differs from many of the other elasmobranch scales by having a keeled simple tetrahedroid or keeled expanded tetrahedroid pedicle, an upper crown surface with a mesial platform, lines or ridges and furrows that extend anterior to posterior, a subcrown surface that has a mesial ridge or keel, and may have a posterior subcrown pedicle halo. Some of these features also are found in the following and *Ornatilabrilancea* n. gen. s.f. mainly differs from:

1. *Fragilicorona* n. gen. s.f. by having an ornamented subcrown, a prominent overhang of the crown/pedicle junction; a prominent anterior shoulder longitudinal line or ridge, and a shallowly oblique to nearly horizontal crown;
2. *Gracilisuggestus* n. gen. s.f. by having a prominent overhang of the crown/pedicle junction; a prominent anterior shoulder longitudinal line or ridge, and a shallowly oblique to nearly horizontal crown;
3. *Rugosicorona* n. gen. s.f. by not having: a) a multiple ridged subcrown mesial apical region; b) thin but raised anterior crown platforms that narrow posteriorly; c) a steeply oblique crown; and by having a prominent anterior overhang and shoulder longitudinal line or ridge; and
4. *Labrilancea* n. sp. s.f. by having a) a subcrown mesial ridge or keel that extends from the posterior pedicle vertex to the posterior apex; and b) convex anterior crown with two shoulders (one at anterior margin (like *Labrilancea* n. sp. s.f.) and the other 1/3 to 1/2 distance from anterior margin that is shallowly convex [missing in *Labrilancea* n. sp. s.f.]).

*Ornatilabrilancea circacarina* n. sp. s.f. differs from *Ornatilabrilancea solicarina* n. sp. s.f. by having a subcrown halo in addition to a prominent mesial ridge or keel. If the halo is absent, then the subpedicle surface is convex with a shallow bulge. In addition, the mesial platform near the anterior crown margin of *O. solicarina* n. sp. s.f. is high, convex, moderately broadly rounded, and protruding. The crown also is smaller.

*Range.* Norian, Carnian, and Ladinian, Middle and Upper Triassic.

*Ornatilabrilancea circacarina* n. sp. s.f.

Plate 27, figures 1-12; Figure 12f

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e1,3/f4,8/g1,2/h1/i1,2/j(4,8)+11±13/k2+6+7/l3/m2,4/n1,3,4

Supergroup II, Group A, Subgroup 2b, Johns, 1996, Pl. 2, Fig. 25-26.

*Etymology.* Latin, *circa carina*, around keel (referring to the subcrown ornamentation that includes a halo and mesial keel).

*Diagnosis.* Subcrown surface with prominent mesial ridge or keel extending from posterior pedicle to posterior crown apex; halo may be present around posterior pedicle. If halo absent, then subpedicle surface convex with shallow bulge. If halo present, subpedicle surface convex or flat.

*Description.* Crown outline lanceolate; longer than or equally long as wide; anterior and posterior side edges entire; cusp posterior with one acute apex; anterior margin with short and rounded mesial protrusion of average width (not narrow or broad). Crown convex at anterior and flat to oblique at posterior. Commonly two crown shoulders; one always at anterior margin, narrow, and curves under crown to crown/pedicle junction forming prominent overhang; second shoulder may be 1/3 to 1/2 distance from anterior margin, shallow and broadly convex. Posterior upper crown surface flat to convex from second shoulder to posterior apex; centrally convex and with convex lateral ridges and flat edges (therefore undulating side edge to side edge). Anterior crown convex from first shoulder to second and side edge to side edge (mesially highest). Crown longitudinal line or ridge located on first most anterior shoulder edge (not under crown overhang); usually on anterior mesial platform; may extend to crown edges; perpendicular to crown ridges and mesial platform. Anterior crown intersects pedicle under crown overhang in shallow furrow or hollows.

Upper crown surface with moderately raised elongate lanceolate or elongate rhomboid mesial platform; extends from anterior first shoulder to posterior apex; shallowly convex at anterior; flat to oblique at posterior; flat to shallowly convex from side to side. Platform lines or ridges (when present) one or two, reduced, parallel and short (rarely extend beyond 1/3 length of platform from anterior margin).

Two crown wings on each side of and posterior to mesial platform; anteriorly more convex (with steeper curve to crown/pedicle junction) than mesial platform. One long lateral line or ridge on each wing close to crown edge; each extends from an anterior position near crown base to cusp edge near apex (posterior). U-shaped furrow broadens to posterior and located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform; about same height as bottom of furrow.



Subcrown (unoccupied by pedicle) with prominent mesial ridge or keel that extends from most posterior pedicle corner to posterior crown apex. Shallow and broad concave hollow or furrow may be on each side of ridge or keel; slightly deeper near pedicle; may extend to just below posterior apex. Halo may be present on subcrown surface around posterior pedicle. Aside from ridge or keel and halo, remainder of subcrown surface mainly smooth. Curvature (from side to side) convex (mesially highest anterior to posterior). In profile, crown posteriorly extends beyond pedicle base edges; side edges about equal with width of pedicle base (or slightly less). Anterior pedicle base edge extends beyond crown.

Crown/pedicle junction positioned at anterior under crown edge and posterior pedicle edge at anterior side of mid-subcrown surface. Pedicle keeled simple tetrahedroid or keeled expanded tetrahedroid. Subpedicle surface commonly slightly convex with shallow bulge, may be flat; with small- to medium-sized mesial canal opening; few smaller canal openings may be present; vascularization hemiaulacorhize; outline rhomboid or tetrapetaloid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Three variations are grouped according to the number of crown mesial platform lines or ridges (Type A has none, Type B has one, and Type C has two lines or ridges). Commonly when two platform ridges are present, an additional shallow anterior pedicle ridge, furrow or hollow, and canal opening may be present on pedicle.

If specimens do not have a subcrown halo, then the subpedicle surface is convex with a bulge usually positioned to the anterior. If specimens do not have a convex subpedicle surface (with bulge), then the subcrown surface has a halo. Specimens may have both convex subpedicle surface and subcrown halo.

Type A was not illustrated because of unavailable well preserved specimens. Plate 27, figures 1-4 show Type B with a very short and shallow mesial platform line which would be closely similar to Type A (if the line was missing). Another Type B specimen is illustrated (Pl. 27, fig. 5-8) with a more prominent mesial platform ridge. Type C (Pl. 27, fig. 9-12) show two mesial platform ridges.

*Material.* Holotype GSC 105183 (Type B) from GSC loc. C-153075 (GK-4-11); and paratypes GSC 105182 (Type B) and GSC 105184 (Type C) from GSC locality C-101065 (ACE-2).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-101119 (BBR-311A), C-101753 (MS-GB), C-153075 (GK-4-11), and C-153076 (GK-4-17).

*Peace River occurrence.* Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

*Ornatilabrilancea solicarina* n. sp. s.f.

Plate 27, figures 13-18; Figure 9a

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e1,3/f4,8/g1,2/h1/i1,2/j(4,8)+11±13/k2/l3/m2,4/n1,2

Supergroup II, Group A, Subgroup 2b, Johns, 1996, Pl. 1, Fig. 7.

*Etymology.* Latin, *solus carina*, only keel (referring to the presence of one subcrown mesial keel).

*Diagnosis.* Subcrown surface with prominent mesial ridge or keel extending from posterior pedicle to posterior crown apex; halo absent. Subpedicle surface flat to slightly concave with small mesial canal opening.

*Description.* Crown outline lanceolate; longer than or equally long as wide; anterior and posterior edges entire; posterior margin with one acute apex; anterior margin with moderately short, convex, and rounded mesial protrusion of moderate width. Crown convex at anterior; planar or oblique to shallowly convex at posterior. Commonly two crown shoulders; one always at anterior margin, narrow, and curves under crown to crown/pedicle junction; second shoulder may be 1/3 to 1/2 distance from anterior margin, shallow and broadly convex. Posterior upper crown surface planar or convex from second shoulder to posterior apex; centrally convex with raised lateral ridges and convex margin edges. Anterior crown convex from first shoulder to second and side edge to side edge (mesially highest). Crown longitudinal line or ridge located on first shoulder edge (not under crown overhang); usually on anterior mesial platform; may extend to crown edges; perpendicular to crown ridges and mesial platform. Anterior crown prominently overhangs crown/pedicle junction and intersects pedicle in shallow furrow or hollows.

Upper crown surface with moderately raised elongate lanceolate or elongate rhomboid mesial platform; extends from anterior first shoulder to posterior apex; well raised and convex at anterior margin; convex to planar at posterior margin; convex from side to side. Platform lines or ridges (when present) one or two, reduced, parallel, and short (rarely extend beyond 1/3 length of platform from anterior margin).

Two crown wings on each side of and posterior to mesial platform. One lateral line or ridge present on each wing close to crown edge; each extends from an anterior position near crown base to cusp edge near apex (posterior). U-shaped furrow broadens to posterior and located between mesial platform and each lateral line or ridge. Side edges of crown wing lower than lateral line or ridge and mesial platform; about same height as bottom of furrow.

Subcrown (unoccupied by pedicle) with mesial ridge or keel that extends from most posterior pedicle corner to posterior crown apex; concave hollow on each side of ridge or keel

reduced or absent; halo around posterior pedicle absent. Aside from ridge or keel, subcrown surface mainly smooth. Curvature (from side to side) convex (mesially highest anterior to posterior). In profile, crown posteriorly extends beyond pedicle base edges; side edges about equal with width of pedicle base (or slightly less). Anterior pedicle base edge extends beyond crown.

Crown/pedicle junction positioned at anterior under crown edge and posterior pedicle edge at anterior side of mid-subcrown surface. Pedicle keeled simple tetrahedroid or keeled expanded tetrahedroid. Subpedicle surface flat or slightly concave with small- to medium-sized mesial canal opening; few smaller canal openings may be present; vascularization hemiaulacorhize; outline rhomboid or tetrapetaloid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Two variations are grouped according to the number of crown mesial platform lines or ridges. Type A has none (Pl. 27, fig. 13-15), and Type B (Pl. 27, fig. 16-18) has one line or ridge.

*Material.* Holotype GSC 105186 (Type B) from GSC loc. C-101150 (MS-247A); and paratype GSC 105185 (Type A) from GSC loc. C-101038 (MS-5).

Additional specimens from GSC loc. C-087924 (BH-8), C-101036 (MS-3), C-101038 (MS-5), C-101150 (MS-247A), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Brown Hill, Childerhose Cove, and Crying Girl Prairie Creek.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Epigondolella triangularis* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Juvavites magnus* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Middle Norian, Upper Triassic.

Subgroup 2:

2c: Crown anterior shoulder longitudinal ridge or line absent; subcrown ornamentation absent; subpedicle surface flat or concave.

*Minuticorona* n. gen. s.f.

*Etymology.* Latin, *minutus corona*, miniature crown.

*Type species.* *Minuticorona triculmina* n. sp. s.f.

*Diagnosis.* Scale small. Crown sits on pedicle obliquely (not steep or shallow); flat to shallowly convex from anterior shoulder margin to posterior cusp and from side edge to side edge; anterior margin shoulder narrow, without an anterior longitudinal line; overhangs crown/pedicle junction; posterior margin with one or three apices; mesial platform long; two or more furrows and wing lateral lines or ridges on each side of mesial platform extend anterior to posterior. Subpedicle surface flat; outline equirhomboid or tetrapetaloid.

*Description.* Scale small (commonly less than 275  $\mu\text{m}$ ) and thin. Crown outline lanceolate to rounded rhomboid; posterior side edges entire; posterior margin with one or three apices; anterior margin rounded, undulating, and (or) with rounded narrow mesial protrusion. Upper crown surface planar or slightly convex from side edge to side edge and from anterior to posterior. Crown sits on pedicle obliquely (not steep or shallow). Crown anterior shoulder narrow; curves down and under forming overhang of crown/pedicle junction; longitudinal line absent. Several lines or ridges perpendicular to anterior margin extend to posterior margin. Mesial platform broad or narrow; usually long (extending from anterior to posterior margin); with deeper furrow on each side and two or more lines or ridges and additional shallower furrows on each lateral wing. Pedicle commonly simple tetrahedroid, rarely expanded tetrahedroid. Subpedicle surface flat; with one main small mesial canal opening; other canal openings rare; outline tetrapetaloid or equirhomboid.

*Comparisons.* *Minuticorona* n. gen. s.f. differs from many of the other elasmobranch scales by having a simple tetrahedroid or expanded tetrahedroid pedicle, an upper crown surface with a long to moderately long mesial platform, lines or ridges and furrows that extend anterior to posterior, and a subcrown surface that is unornamented. Some of these features also are found in the following and *Minuticorona* n. gen. s.f. mainly differs from:

1. *Fragilicorona* n. gen. s.f. by having: a) a prominent anterior shoulder overhang of crown/pedicle junction, b) more than one ridge or line and furrow on each lateral wing; and c) a small crown that is less steeply oblique and is flattened anterior to posterior and side edge to side edge;
2. *Gracilisuggestus* n. gen. s.f. and *Rugosicorona* n. gen. s.f. by not having subcrown ornamentation, and by having a less steeply oblique crown and a more prominent anterior crown shoulder overhang of the crown/pedicle junction; and
3. *Labrilancea* n. gen. s.f. and *Ornatilabrilancea* n. gen. s.f. by: a) having more than one ridge or line and furrow on each crown lateral wing; and b) by not having a prominent anterior shoulder longitudinal line. In addition, *Ornatilabrilancea* n. gen. s.f. has subcrown ornamentation that is absent in *Minuticorona* n. gen. s.f.

*Minuticorona unculmen* n. sp. s.f. differs from *G. triculmina* n. sp. s.f. by having a single posterior apex instead of three apices and a crown platform, and lines or ridges that shallow near the crown posterior instead of being equally raised anterior to posterior.

*Remarks.* The small size of specimens in *Minuticorona* n. gen. s.f. could represent ichthyoliths from juveniles. Immature crowns could be missing features that might be more prominent on larger scales of adults. For example, the addition of a prominent anterior longitudinal line would make these specimens increasingly similar to *Labrilancea* n. gen. s.f.

*Range.* *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus communisti* conodont Zone; *Klamathites macrolobatus* ammonoid Zone; uppermost Upper Carnian, Upper Triassic.

*Minuticorona triculmina* n. sp. s.f.

Plate 28, figures 1-3, 7

*Utilitarian identification.* Subtype a2/b2/c3/d1,2/e1/f2/g2/h3/i2+13/j≥6/k5,10/l1,2,3/m1/n(3,7)+11±13/p3/q1,3/r1,2/s1,2

Supergroup II, Group A, Subgroup 2c, Johns, 1996, Pl. 2, fig. 27-28.

*Etymology.* Latin, *trium culmen*, three summits (referring to the three summits or apices on the posterior margin).

*Diagnosis.* Crown outline approximately lanceolate with three posterior apices. Mesial posterior apex longest, lateral apices approximately equal in height; notch between apices V-shaped. Upper crown surface with flattened elongate-lanceolate mesial platform; several lines or ridges, and furrows similarly raised or deep extend from anterior to posterior margins.

*Description.* Crown outline approximately lanceolate; equally as long as wide or longer; posterior side edges entire. Posterior cusp with three moderately short acute apices; mesial apex about twice as long as lateral apices (of similar height); notch between mesial and lateral apex V-shaped and commonly deep. Anterior margin rounded, with narrow and short mesial protrusion. Crown sits on pedicle at moderately shallow oblique angle; upper surface planar or slightly convex side edge to side edge and from anterior shoulder to posterior apex. Upper crown shoulder at anterior margin narrow and sharply curves down and under to crown/pedicle junction forming an overhang; anterior shoulder longitudinal line absent.

Mesial platform long (usually extends from anterior margin to posterior central apex) and narrow with one or two long shallow interior ridges; similar height anterior to posterior. Long and narrow U-shaped furrow on each side of platform about same depth and width from anterior margin to posterior base of "V" notch. Crown wing on each side of and slightly posterior to mesial platform; typically same height as mesial platform (may be slightly lower); with two or more lines. Lines and furrows long (commonly extend to lateral apex); approximately parallel; and similar height anterior to posterior.

Subcrown (unoccupied by pedicle) smooth; side-to-side surface convex or concave; concave or shallowly oblique anterior to posterior; short mesial line may be present near posterior pedicle vertex. Crown/pedicle junction to anterior underneath crown in hollows or furrow. Crown posteriorly extends beyond pedicle base edges; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Pedicle simple tetrahedroid or rarely expanded tetrahedroid; not well preserved. Subpedicle surface flat or shallowly concave with small- to medium-sized mesial canal

opening; smaller canal openings rare; vascularization hemiaulacorhize; outline tetrapetaloid or rhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* This species was found in two samples. The pedicle is commonly missing, and when present, poorly preserved.

*Material.* Holotype GSC 105187 and paratype GSC 105188 from GSC loc. C-101002 (BBR-1). Additional specimens GSC loc. C-101002 (BBR-1) and C-101118 (BBR-310B).

*Peace River occurrence.* Baldonnel Formation; Black Bear Ridge.

*Range.* *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus communisti* conodont Zone (Orchard, 1991c); *Klamathites macrolobatus* ammonoid Zone (Tozer, 1994); uppermost Upper Carnian, Upper Triassic.

*Minuticorona uniculmen* n. sp. s.f.

Plate 28, figures 4-6, 8

*Utilitarian identification.* Subtype a4/b2/c2/d4+10/e3/f4,8/g1,2,3/h1/i1,2/j(3,7)+11±13/k1/l3/m1,3/n1,2

*Etymology.* Latin, *unus culmen*, one summit (referring to the single summit or apex on the posterior margin).

*Diagnosis.* Crown outline approximately lanceolate with one posterior apex. Upper crown surface with flattened elongate-lanceolate mesial platform, several lines or ridges, and furrows that extend from anterior to posterior margins and shallow near posterior apex.

*Description.* Crown outline approximately lanceolate; equally as long as wide or longer; posterior cusp with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, with narrow and short mesial protrusion. Crown sits on pedicle at moderately shallow oblique angle; upper surface planar or slightly convex side edge to side edge and from anterior shoulder to posterior apex. Upper crown shoulder at anterior margin narrow and sharply curves down and under to crown/pedicle junction forming an overhang; anterior shoulder longitudinal line absent. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond pedicle; side edges about equal with width of pedicle (or slightly less). Anteriorly, pedicle edges extend beyond crown.

Mesial platform: long (extends beyond 1/2 crown length usually to posterior apex) and narrow; highest at anterior margin and shallows near apex; has long and narrow U-shaped furrow on each side that is deeper at posterior margin and shallow or near posterior apex; has one or two long shallow ridges. Crown wing: located on each side of and slightly posterior to mesial platform; typically same height as mesial platform (may be slightly lower); has two or more lines. Lines and furrows long (extend beyond 1/3 crown length, commonly beyond 1/2 crown length); approximately parallel; highest and deepest near anterior margin and shallow near posterior apex.

Subcrown surface and pedicle description same as *M. triculmina* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Remarks.* This species was found in two samples. The pedicle is commonly missing, and when present, poorly preserved.

*Material.* Holotype GSC 105189 and paratype GSC 105190 from GSC loc. C-101002 (BBR-1). Additional specimens GSC loc. C-101002 (BBR-1) and C-101118 (BBR-310B).

*Peace River occurrence.* Baldonnel Formation; Black Bear Ridge.

*Range.* *Synechodus multinodosus* ichthyolith Zone; *Metapolygnathus communisti* conodont Zone (Orchard, 1991c); *Klamathites macrolobatus* ammonoid Zone (Tozer, 1994); uppermost Upper Carnian, Upper Triassic.

Subgroup 3: Pedicle anterior; crown inclined lanceolate with short upper crown ridges and furrows; pedicle base outline tetrapetaloid, rhomboid, or stretched rhomboid.

3a: Subcrown with halo, may have mesial ridge or keel; subpedicle surface convex or convex with bulge.

*Sacrisubcorona* n. gen. s.f.

*Etymology.* Latin, *sacer sub corona*, holy under crown (referring to the presence of a halo or circumferential line on the subcrown around the posterior pedicle).

*Type species.* *Sacrisubcorona circabasis* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate to rounded rhomboid; nearly horizontal to shallowly oblique. Posterior crown with one apex and flat to slightly convex from side-edge to side-edge. Anterior crown margin rounded, undulating, and (or) with broad to narrow rounded mesial protrusion. Upper crown lines or ridges parallel to converging; perpendicular to longitudinal ridge or line on anterior shoulder. Subcrown surface with prominent posterior pedicle halo; may have mesial keel. Subpedicle surface equirhomboid; convex and (or) with anterior bulge (rarely flat); one main mesial and other smaller canal openings.

*Description.* Crown outline lanceolate to rounded rhomboid; posterior margin with one apex; posterior side edges entire or undulating; anterior margin rounded, undulating, and (or) with rounded mesial protrusion. Upper crown posterior surface smooth or rugose. Crown shallowly oblique to almost horizontal from upper anterior shoulder to posterior apex; flat to shallowly convex from side edge to side edge. Anterior crown surface at shoulder curves down and under to pedicle; may have rounded and usually broad mesial protrusion with or without short (rarely extend beyond one half crown length from anterior margin) and moderately raised lines or ridges. If mesial protrusion present, lateral wing with short furrows and ridges positioned slightly to each side and posterior of mesial protrusion. Longitudinal line or ridge may be

prominent on anterior shoulder margin or under prominent crown overhang above crown/pedicle junction; usually on mesial protrusion; may extend to lateral wings and crown edge.

Subcrown surface may have prominent ridge or keel that extends from posterior pedicle corner to crown posterior apex; halo on posterior middle subcrown, circles pedicle and joins anterior margin longitudinal line; other lines or ridges may extend from halo to crown upper surface. Pedicle expanded or keeled expanded tetrahedroid. Subpedicle surface outline equirhomboid; vascularization hemiaulacorhize; convex and (or) with anterior bulge (rarely flat), one main mesial and other smaller canal openings.

*Comparisons.* *Sacrisubcorona* n. gen. s.f. differs from many of the forms by having an expanded or keeled expanded tetrahedroid pedicle, a prominent anterior crown overhang, a convex subpedicle surface, a crown upper surface with lines or ridges that are short and rarely extend beyond one half the crown length from the anterior margin, and a subcrown surface that has a posterior pedicle halo and may have a mesial keel and other lines and ridges.

*Minuticorona* n. gen. s.f. differs from *Sacrisubcorona* by its small size, and absence of subcrown ornamentation and a crown anterior shoulder longitudinal line or ridge.

*Sacrisubcorona circabasis* n. sp. s.f. differs from *Sacrisubcorona submedicarina* n. sp. s.f. by lacking: a) a subcrown mesial ridge or keel that extends from the posterior pedicle to the crown posterior apex, and b) a keeled expanded tetrahedroid pedicle.

*Range.* *Coniunctio aequirugosa* to lowermost *Synechodus incrementum* ichthyolith zones; Ladinian and Carnian, Middle and lowermost Upper Triassic.

*Sacrisubcorona circabasis* n. sp. s.f.

Plate 29, figures 1-18; Plate 30, figures 1-7; Figure 12e

*Utilitarian identification.* Subtype  $a_4/b_2+6/c_2/d\pm 4(7,8)+10/e_1,3/f_4/g_1,2,3/h_1/i_1,2/j_{12}\pm 13/k_6+7/13/m_3/n_1,3,4$

cf. Subtype Number 029, Tway and Zidek, 1982, p. 331; Fig. 23a-d.

cf. Subtype Number 195, Tway and Zidek, 1982, p. 333; Fig. 42a-d.

*Etymology.* Latin, *circa basis*, around base (referring to the halo that is on the posterior subcrown surface around the pedicle).

*Diagnosis.* Subcrown surface with posterior pedicle halo; prominent mesial keel and other lines, ridges, or keels absent. Pedicle expanded tetrahedroid.

*Description.* Crown outline approximately lanceolate to rounded rhomboid; equally long as or longer than wide or may be wider than long; posterior margin with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, shallowly undulating and (or) with rounded mesial protrusion. Upper crown posterior and central surfaces

unornamented; surface from upper anterior shoulder to posterior apex shallowly oblique to almost flat, flat to shallowly convex from side edge to side edge. Crown shoulder at anterior crown margin; narrow and sharply curves under crown forming an overhang. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Mesial platform short (rarely extends beyond 1/2 crown length); commonly broad and not high with short and narrow U-shaped furrow on each side (narrowing to posterior); shallowly convex or flat from side to side; may have several short lines or ridges. Crown wing on each side of and slightly posterior to mesial platform; commonly about same height as mesial platform; may have lines or ridges. Crown lines or ridges and furrows short (commonly 1/4 length of crown, rarely extend beyond 1/2 the length); approximately parallel. Anterior longitudinal line or ridge may be well raised when located on lower crown shoulder; less developed (thin and shallow) when underneath anterior crown overhang above crown/pedicle junction; perpendicular to other crown lines or ridges.

Subcrown (unoccupied by pedicle) without prominent mesial ridge or keel. Side-to-side surface convex (raised slightly mesially anterior to posterior); shallowly oblique anterior to posterior. Anterior half of crown (near pedicle) commonly with nonlustrous texture that terminates near crown centre typically at thin curved line forming crown halo around posterior pedicle. Halo extends to anterior crown forming longitudinal line or ridge. Sometimes on anterior side of halo, crown drops into shallow concave hollow around pedicle. Posterior subcrown surface (posterior of halo) smooth; may have shallow undulations.

Crown/pedicle junction mainly positioned at anterior underneath crown; posterior corner may extend into middle crown region. Pedicle expanded tetrahedroid. Pedicle vascularization hemiaulacorrhize. Subpedicle surface convex with: 1) shallow anterior bulge (rarely flat); 2) small- to medium-sized mesial canal opening; 3) common smaller canal openings; 4) outline equirhomboid (diagonal lengths approximately equal); and 5) with vertices located anterior, posterior, and to each side.

*Comparisons.* *S. circabasis* n. sp. s.f. (Type F) is almost identical to Subtype Number 029, *S. circabasis* n. sp. s.f. (Type C or D), and to Subtype Number 195 (Tway and Zidek, 1982). They only differ by having a subpedicle surface that is convex (on Subtype Numbers 029 and 195 the subpedicle surface appears to be flat or concave).

*S. circabasis* n. sp. s.f. (Type D) is similar in crown morphology to Subtype Number 026 (Tway and Zidek, 1982, age: Late Pennsylvanian) and differs by having a convex (commonly with bulge) subpedicle surface, a more developed mesial platform, lines or ridges that are shorter, a less oblique crown from anterior to posterior, and a less broad and curved anterior longitudinal line or rim.

*S. circabasis* n. sp. s.f. (Type B, C, D, or F) have a similar pedicle and subcrown to Subtype Numbers 138 and 145 (Tway and Zidek, 1982) and differ by having a subpedicle surface that is convex (commonly with a bulge) instead of flat or concave, and upper crown ridges that are not long (almost extending anterior to posterior).

In addition, see Genus "Comparisons".

*Remarks.* Seven variations are grouped according to the development of the crown anterior margin and surface ornamentation as follows:

Type A (Pl. 29, fig. 1-3; Pl. 30, fig. 4)

Crown outline approximately lanceolate. Anterior mesial protrusion extended (extension more than 1/3 width of crown) or extension narrow and only more than 1/4 width of crown. Mesial platform and lines or ridges rarely extend beyond 1/2 length of crown. Crown usually longer than wide.

Type B (Pl. 29, fig. 4-6; Pl. 30, fig. 5)

Crown outline approximately lanceolate. Mesial protrusion moderately extended (extension approximately equal to about 1/4 the width of crown) and broad (protrusion width about 1/2 the width of the crown). Mesial platform and lines or ridges short (rarely extend beyond 1/3 crown length). Crown may be slightly longer than wide, commonly equally as long as wide.

Type C (Pl. 29, fig. 7-9)

Crown outline approximately lanceolate. Mesial protrusion short (extends less than 1/4 width of crown) and broad (wider than 1/2 width of crown). Mesial platform and lines or ridges rarely extend beyond 1/3 the crown length. Crown usually equally wide as long, may be slightly longer than wide.

Type D (Pl. 29, fig. 10-12)

Crown outline rounded-rhomboid. Crown about equally as long as wide. Mesial protrusion a rounded rhomboid vertex; may be slightly undulating. Mesial platform hard to distinguish from crown wings. Lines or ridges short.

Type E (Pl. 29, fig. 13-15; Pl. 30, fig. 6)

Crown outline rounded-rhomboid. Crown longer than wide. Mesial protrusion a rounded rhomboid vertex; may be slightly undulating. Mesial platform hard to distinguish from crown wings. Lines or ridges and furrows short; only on anterior crown edges; approximately perpendicular to edges. Crown central region and posterior apex unornamented.

Type F (Pl. 29, fig. 16-18; Pl. 30, fig. 7)

Crown outline lanceolate; usually longer than wide. Anterior margin broadly rounded with moderately deep and rounded undulations. Commonly short line or ridge on each undulation and moderately deep furrow on each side of undulation terminates at each anterior margin



notch. Lines or ridges, and furrows perpendicular to the anterior margin and (or) longitudinal line; commonly short. Mesial platform and protrusion absent.

Type G (Pl. 30, fig. 1-3)

Like Form F, but with undulating mesial protrusion.

**Material.** Holotype GSC 105222 (Type F) and paratypes GSC 105217 (Type A), GSC 105221 (Type E), and GSC 105223 (Type G) from GSC loc. C-101069 (BEH-3). Paratypes GSC 105218 (Type B) and GSC 105219 (Type C) from GSC loc. C-101065 (ACE-2); paratype GSC 105220 (Type D) from GSC loc. C-101067 (BEH-1); and paratype GSC 105224 (Type F) from GSC loc. C-101068 (BEH-2).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-087901 (BH-62), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-101119 (BBR-311A), C-101753 (MS-GB), C-145780 (GK-68-8-27), C-153075 (GK-4-11), C-153076 (GK-4-17), and C-177682 (BH-61B).

**Peace River occurrence.** Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, Childerhose Cove, and Chowade South.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *Metapolygnathus primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian, Middle and Upper Triassic.

*Sacrisubcorona submedicarina* n. sp. s.f.

Plate 30, figures 8-16; Plate 31, figures 1-16; Figure 9d

**Utilitarian identification.** Subtype a4/b2+6/c2/d4+(7,8)+10/e1,3/f4/g1,2,3/h1/i1,2/j12±13/k2+6+7/l3/m4/n1,3,4

Supergroup II, Group A, Subgroup 3a, Johns, 1996, Pl. 2, fig. 29-30.

**Etymology.** Latin, *sub medius carina*, under middle keel (referring to the subcrown mesial ridge or keel extending from the posterior pedicle to the posterior crown apex).

**Diagnosis.** Subcrown surface with prominent posterior pedicle halo and mesial keel; additional lines, ridges, or keels may be present. Pedicle keeled expanded tetrahedroid.

**Description.** Crown equally as long or longer than wide, rarely wider than long; outline lanceolate to rounded rhomboid; posterior margin with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, shallowly undulating, and (or) with rounded mesial protrusion. Upper crown posterior surface unornamented and flat from side-edge to side-edge. Crown shallowly oblique to flat from upper anterior shoulder to posterior apex. Crown upper shoulder near anterior margin gently curves to lower shoulder at anterior margin edge then sharply curves under crown forming overhang. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond

pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Mesial platform short (rarely extends beyond 1/2 crown length); commonly broad and not high; with short and narrow U-shaped furrow on each side (narrowing to posterior); shallowly convex or flat from side to side; may have several short lines or ridges. Crown wing on each side of, and slightly posterior to, mesial platform; usually about same height as mesial platform; anterior margin shallowly convex curving down and under to crown/pedicle junction; may have lines or ridges. Lines or ridges and furrows short, approximately parallel, and extend from anterior margin towards crown posterior but rarely beyond 1/2 crown length. Longitudinal line or ridge well raised when located on lower anterior shoulder; thin and shallow when under overhang above crown/pedicle junction; commonly on mesial protrusion; may extend to wings and crown edge; perpendicular to other crown lines or ridges.

Subcrown surface (unoccupied by pedicle) with prominent mesial ridge or keel that extends from posterior pedicle corner to posterior crown apex. Subcrown halo around posterior pedicle joins anterior margin longitudinal line. Other subcrown ornamentation (e.g. lines or ridges) may be present. Side-to-side subcrown surface convex (raised slightly mesially anterior to posterior); shallowly oblique anterior to posterior.

Crown/pedicle junction mainly positioned at middle and to anterior underneath crown. Pedicle keeled expanded tetrahedroid. Subpedicle surface convex with shallow anterior bulge (rarely flat); with small- to medium-sized mesial canal opening; smaller canal openings may be present; vascularization hemiaulacorhize; outline equirhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

**Comparisons.** See Genus "Comparisons".

**Remarks.** Seven variations are grouped according to the development of the crown anterior margin and surface ornamentation as follows:

Type A (Pl. 30, fig. 8-10; Pl. 31, fig. 13-14)

Crown outline approximately lanceolate. Anterior mesial protrusion considerably extended and approximately 1/2 (or more) width of crown anterior margin. Mesial platform well developed and lines or ridges moderately long (extend 1/3 to 3/4 length of crown but not to posterior apex). Crown commonly longer than wide.

Type B (Pl. 30, fig. 11-13)

Crown outline approximately lanceolate. Mesial protrusion moderately extended and usually about 1/3 to 1/2 the width of crown anterior margin. Mesial platform and lines or ridges rarely extend beyond 1/2 crown length. Crown may be slightly longer than wide, commonly equally as long as wide.

Type C (Pl. 30, fig. 14-16)

Crown outline approximately lanceolate. Mesial protrusion short and broad (extension shorter than 1/3 width of crown anterior margin). Mesial platform and lines or



ridges rarely extend beyond 1/2 the crown length. Crown equally wide as long, may be slightly longer than wide.

#### Type D (Pl. 31, fig. 1-3, 15)

Crown outline rounded-rhomboid. Crown about equally as long as wide. Mesial protrusion a rounded rhomboid vertex. Mesial platform and minor mesial protrusion difficult to distinguish from crown wings. Lines or ridges rarely extend beyond 1/2 crown length. Crown about equally as wide as long.

#### Type E (Pl. 31, fig. 4, 8, 12)

Crown outline rounded-rhomboid. Crown longer than wide. Mesial protrusion a rounded rhomboid vertex. Mesial platform difficult to distinguish from crown wings. Lines or ridges and furrows short; only on anterior crown edges; approximately perpendicular to edges. Crown central region and posterior apex unornamented.

#### Type F (Pl. 31, fig. 5-7, 16)

Crown outline lanceolate. Anterior margin broadly rounded with moderately deep and rounded undulations. Short lines or ridges on each undulation. Moderately deep furrow on each side of undulation terminates at each anterior margin notch. Lines or ridges, and furrows perpendicular to the anterior margin and (or) longitudinal line. Mesial platform and protrusion absent.

#### Type G (Pl. 31, fig. 9-11)

Like Form F, but with undulating mesial protrusion. Lines or ridges may be longer but do not extend to the posterior margin.

*Material.* Holotype GSC 105226 (Type B) and paratype GSC 105227 (Type C) from GSC loc. C-101068 (BEH-2); paratypes GSC 105225 (Type A) from GSC loc. C-101064 (ACE-1), GSC 105231 (Type G) from GSC loc. C-101065 (ACE-2), GSC 105232 (Type A) and GSC 105234 (Type F) from GSC loc. C-101069 (BEH-3), GSC 105228 (Type D) and GSC 105233 (Type D) from GSC loc. C-153069 (GK-1-19); and GSC 105229 (Type E) and GSC 105230 (Type F) from GSC loc. C-153075 (GK-4-11).

Additional specimens from GSC loc. C-087901 (BH-62), C-087972 (Sutherland Zone), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101068 (BEH-2), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), C-153076 (GK-4-17), C-177682 (BH-61B), and C-302386 (BH-51A).

*Peace River occurrence.* Liard, Baldonnel, and lowermost Pardonet formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* to lowermost *Synechodus incrementum* ichthyolith zones; ?*Maclernoceras maclerni* to *Stikinoceras kerri* II ammonoid zones (Tozer, 1994); Ladinian (unzoned) to the Upper *Metapolygnathus primitius*/*Epigondolella quadrata* conodont zones (Orchard, 1991c); Ladinian, Carnian, and lowermost Lower Norian; Middle and Upper Triassic.

#### Subgroup 3:

3b: Subcrown with mesial ridge or keel; subpedicle surface flat or concave.

#### *Carinasubcorona* n. gen. s.f.

*Etymology.* Latin, *carina sub corona*, keel under crown (referring to the presence of a mesial keel or ridge on the subcrown surface).

*Type species.* *Carinasubcorona subradiciplana* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate to rounded rhomboid. Crown oblique from anterior to posterior; flattened to slightly convex from side edge to side edge. Posterior crown smooth and unornamented; margin with one apex. Crown anterior margin rounded, undulating, and (or) with broad to narrow rounded mesial protrusion; shoulder prominent and commonly with longitudinal ridge. Other crown lines or ridges short, parallel, and perpendicular to longitudinal ridge. Subcrown surface with mesial ridge or keel that extends from posterior pedicle corner to posterior crown apex; may have thin, discontinuous pedicle halo. Subpedicle surface flat to slightly concave; outline equirhomboid or tetrapetaloid.

*Description.* Crown outline lanceolate to rounded rhomboid. Crown oblique (not steep or horizontal) from anterior to posterior; flattened to slightly convex from side edge to side edge; longer or equally as long as wide. Posterior crown surface smooth and unornamented; margin with one apex; side edges entire. Anterior margin rounded, undulating, and (or) with broad to narrow rounded mesial protrusion. If mesial protrusion present, lateral wing with furrow and with or without lines or ridges positioned slightly to each side and posterior of mesial protrusion. Anterior crown with prominent overhang; curves down and under to pedicle with approximately parallel lines or ridges perpendicular to anterior margin longitudinal ridge.

Subcrown surface with mesial ridge or keel that extends from posterior pedicle corner to posterior crown apex; may have thin and discontinuous pedicle halo. Pedicle commonly keeled simple tetrahedroid or may be keeled expanded tetrahedroid. Subpedicle surface flat to slightly concave with small mesial canal opening; outline equirhomboid or tetrapetaloid.

*Comparisons.* *Carinasubcorona* n. gen. s.f. differs from many of the other elasmobranch scales by having a simple tetrahedroid or expanded tetrahedroid pedicle, a subcrown surface that has a mesial ridge or keel extending from posterior pedicle corner to posterior crown apex, and a crown upper surface with lines or ridges that rarely extend beyond one half the crown length from the anterior margin (forming a smooth and unornamented posterior cusp region).

*Carinasubcorona* n. gen. s.f. differs from *Sacrisubcorona* n. gen. s.f. by having a subcrown mesial ridge, and halo that is thin and discontinuous or absent (instead of prominent); and subpedicle surface that is flat or concave (instead of convex).

*Minuticorona* n. gen. s.f. differs from *Carinasubcorona* by its small size and lack of subcrown ornamentation and crown anterior shoulder longitudinal line or ridge.

*Range.* *Synechodus incrementum* ichthyolith Zone; Middle Norian, Upper Triassic.

*Carinasubcorona subradiciplana* n. sp. s.f.

Plate 32, figures 1-16

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e1,3/f4/g1,2,3/h1/i1,2/j12±13/k2±6/l3/m2,4/n1,2

Supergroup II, Group A, Subgroup 3b, Johns, 1996, Pl. 1, fig. 9; Pl. 2, fig. 31-32.

*Etymology.* Latin, *sub radix planus*, under root flat (referring to the subpedicle surface which is commonly flat).

*Diagnosis.* Crown oblique; outline lanceolate to rounded rhomboid; posterior surface smooth and unornamented; posterior margin with one apex; anterior margin rounded, undulating, and (or) with narrow to broad mesial protrusion; anterior surface with short lines or ridges, furrows, and mesial platform. Crown shoulder at anterior margin with longitudinal ridge; anterior overhang prominent. Subcrown with mesial ridge or keel that extends from posterior pedicle corner to posterior crown apex; may have thin and discontinuous pedicle halo.

*Description.* Crown about equally as long as wide; outline lanceolate to rounded rhomboid; posterior margin with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, shallowly undulating, and (or) with rounded mesial protrusion. Upper crown posterior surface and central region unornamented. Upper crown surface from upper anterior shoulder to posterior apex oblique (not steep or horizontal) and planar; flat to shallowly convex from side edge to side edge. Crown shoulder at anterior crown margin; moderately narrow; curves under crown forming an overhang. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Mesial platform moderately short (rarely extends beyond 2/3 crown length from anterior margin); commonly broad and not high with short and narrow U-shaped furrow on each side (narrowing to posterior); shallowly convex or flat from side to side; may have several short lines or ridges. Crown wing on each side of, and slightly posterior to mesial platform; usually about same height as mesial platform; may have lines or ridges. Crown lines or ridges and furrows moderately short (commonly 1/4 to 1/2 length of crown, rarely extend beyond 2/3 the length from anterior margin); approximately parallel. Anterior longitudinal ridge located on lower crown shoulder (not underneath crown overhang) and perpendicular to other crown lines or ridges.

Subcrown (unoccupied by pedicle) with prominent mesial ridge or keel that extends from posterior pedicle corner to posterior crown apex; pedicle halo rare and if present thin and discontinuous; side-to-side surface convex (raised slightly mesially anterior to posterior); shallowly oblique anterior to posterior. Crown/pedicle junction mainly positioned at anterior underneath crown; posterior corner may extend into middle crown region.

Pedicle short, commonly keeled simple tetrahedroid, may be keeled expanded tetrahedroid. Subpedicle surface flat or slightly concave with small- to medium-sized mesial canal opening; smaller canal openings may be present; vascularization hemiaulacorhize; outline rhomboid (diagonal lengths approximately equal) or tetrapetaloid; and vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Five variations are grouped according to the development of the crown anterior margin as follows:

Type A (Pl. 32, fig. 1-4)

Anterior mesial protrusion rounded and moderately extended (extension length about equal to or more than 1/3 width of crown anterior margin).

Type B (Pl. 32, fig. 5-8)

Mesial protrusion broadly rounded and poorly extended (extension length much less than 1/3 the width of crown anterior margin).

Type C (Pl. 32, fig. 9-10)

Mesial protrusion and platform absent. Anterior crown margin rounded.

Type D (Pl. 32, fig. 11-13)

Mesial protrusion and platform absent. Anterior margin broadly rounded with undulations.

Type E (Pl. 32, fig. 14-16)

Like Type D, but with undulating mesial protrusion.

*Material.* Holotype GSC 105212 (Type A) and paratypes GSC 105213 (Type B), GSC 105214 (Type C), and GSC 105216 (Type D) from GSC loc. C-302390 (TE-220A); and paratype GSC 105215 (Type D) from GSC loc. C-101036 (MS-3).

Additional specimens GSC loc C-087924 (BH-8), C-101036 (MS-3), C-101056 (PH-9), C-101114 (BBR-305B), C-302382 (BH-20), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, and Pardonet Hill.

*Range.* *Synechodus incrementum* ichthyolith Zone; Lower *Epigondolella quadrata* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Malayites dawsoni* I to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Lower and Middle Norian, Upper Triassic.

Subgroup 3:

3c: Subcrown ornamentation absent; subpedicle surface flat or concave.

*Glabrisubcorona* n. gen. s.f.

*Etymology.* Latin, *glaber sub corona*, smooth under crown.

*Type species.* *Glabrisubcorona vadosidevexa* n. sp. s.f.

*Diagnosis.* Crown outline lanceolate to rounded rhomboid; nearly horizontal to steeply oblique. Posterior crown smooth and unornamented with one apex; flat to slightly convex from side edge to side edge. Anterior crown margin rounded, undulating, and (or) with broad to narrow rounded mesial protrusion; commonly with prominent shoulder and longitudinal ridge or line. Other crown lines or ridges short, parallel, and perpendicular to longitudinal line. Subcrown unornamented. Subpedicle surface flat to shallowly convex; outline equirhomboid to stretched rhomboid.

*Description.* Crown outline lanceolate to rounded rhomboid; nearly horizontal to steeply oblique; posterior margin with one apex; posterior side edges entire; anterior margin rounded, undulating, and (or) with broad to narrow rounded mesial protrusion. Posterior crown surface smooth and unornamented; flat or slightly convex from side edge to side edge. Anterior crown curves down and under to pedicle; may have rounded and broad mesial protrusion with or without short and slightly raised lines or ridges. If mesial protrusion present, lateral wing with furrow and with or without line(s) or ridge(s) positioned slightly to each side and posterior of mesial protrusion. Anterior longitudinal line or ridge commonly well developed; on crown anterior margin shoulder usually on mesial protrusion; may extend to lateral wings near crown base. Subcrown surface smooth. Pedicle commonly expanded tetrahedroid. Subpedicle surface flat or shallowly convex with one main mesial, and may have other smaller canal openings; outline equirhomboid to stretched rhomboid.

*Comparisons.* *Glabrisubcorona* n. gen. s.f. differs from many of the other elasmobranch scales by having a simple or expanded tetrahedroid pedicle, a subcrown surface that is unornamented, and a crown upper surface with lines or ridges that rarely extend beyond one half crown length from anterior margin (forming a smooth and unornamented posterior cusp region).

*Minuticorona uniculmen* n. sp. s.f. may have upper crown ridges that do not extend anterior to posterior but they are longer than 1/2 the crown length. In addition this form species may be distinguished from *Glabrisubcorona* n. gen. s.f. by the absence of an anterior shoulder longitudinal line or ridge.

*Glabrisubcorona* n. gen. s.f. differs from *Sacrisubcorona* n. gen. s.f. and *Carinasubcorona* n. gen. s.f. by having no subcrown ornamentation.

The main differences between the *Glabrisubcorona* n. gen. s.f. species are as follows:

1. *G. vadosidevexa* n. sp. s.f. commonly has an equirhomboid pedicle outline, and a crown that is not steeply oblique and is longer or equally as long as wide with a rounded anterior margin and a mesial protrusion, or is wider than long with a mesial protrusion;
2. *G. tendibasis* n. sp. s.f. has a stretched rhomboid pedicle outline, and a crown that is not steeply oblique and is wider than long with a rounded anterior margin;

3. *G. arduidevexa* n. sp. s.f. commonly has a stretched rhomboid pedicle outline and a crown that is steeply oblique, wider than or equally as wide as long, and with a rounded anterior margin or a mesial protrusion. Also, the anterior crown overhang is less prominent; and
4. *G?* sp. 1 s.f. is a small crown version of *G. vadosidevexa* n. sp. s.f. and has a simple tetrahedroid type pedicle instead of expanded tetrahedroid. In addition, the anterior margin mesial protrusion is commonly narrow.

*Range.* Norian, Carnian, and Ladinian, Middle and Upper Triassic.

*Glabrisubcorona vadosidevexa* n. sp. s.f.

Plate 33, figures 1-21; Figures 9c, 10d, 12a

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e3/f4/g1,2,3/h1/i1,2,3/j12±13/k1/l3/m3/n1

Supergroup II, Group A, Subgroup 3c, Johns, 1996, Pl. 1, fig. 8, 11, 12; and Pl. 2, fig. 34.

*Etymology.* Latin, *vadosus devexus*, shallow sloping (referring to the degree of inclination of the crown).

*Diagnosis.* Crown outline lanceolate or rounded rhomboid; not miniature; shallowly oblique with one posterior apex. Crown anterior margin rounded, undulating and (or) with narrow to broad mesial protrusion. Crown longer than or equally as long as wide (if wider than long, then with mesial protrusion). Crown shoulder at anterior margin with longitudinal ridge; anterior overhang prominent. Pedicle expanded tetrahedroid. Subpedicle surface approximately flat; outline commonly rhomboid with equal length diagonals (occasionally wider than long).

*Description.* Scale commonly larger than 300 µm. Crown outline lanceolate to rounded rhomboid; posterior margin with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, shallowly undulating and (or) with rounded narrow or broad mesial protrusion. Upper crown posterior cusp surface smooth, and unornamented; flat or slightly convex from side edge to side edge and shallowly oblique-flat from upper anterior shoulder to posterior apex. Upper crown upper shoulder at anterior gently curves to lower shoulder (at anterior margin edge), then sharply curves under crown forming an overhang. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Mesial platform short (rarely extends beyond 1/2 crown length); commonly broad; with short and narrow U-shaped furrow on each side (narrowing to posterior); shallowly convex or flat from side to side; may have several short lines or ridges. Crown wing on each side of, and slightly posterior to, mesial platform; may have short lines or ridges. Lines or ridges and furrows short, approximately parallel, and extend towards posterior (apex) but rarely beyond 1/2 length of crown. Longitudinal ridge located between crown/pedicle

junction and lower anterior shoulder margin on mesial platform and (or) on each wing to crown edge; well raised and perpendicular to other crown lines or ridges.

Subcrown (unoccupied by pedicle) unornamented; side-to-side surface convex (raised slightly mesially anterior to posterior); shallowly oblique anterior to posterior.

Crown/pedicle junction positioned to anterior underneath crown. Pedicle expanded tetrahedroid. Subpedicle surface approximately flat; with small- to medium-sized mesial canal opening; smaller canal openings may be present; vascularization hemiaulacorhize; outline rhomboid (diagonals of equal lengths, occasionally wider than long) and vertices located anterior, posterior, and to each side.

*Comparisons.* *G. vadosidevexa* n. sp. s.f. has a similar pedicle (tetrahedroid), subpedicle surface (equirhomboid or tetrapetaloid), and subcrown (unornamented) as Subtype Number 225 (Tway and Zidek, 1982, age: Late Pennsylvanian) and differs by having shorter ridges that do not extend from the anterior margin to near the posterior apex, and has a mesial platform (absent in Subtype Number 225).

In addition, see Genus "Comparisons".

*Remarks.* Five variations are grouped according to the development of the crown anterior margin and surface ornamentation as follows:

#### Type A (Pl. 33, fig. 1-5)

Crown outline approximately lanceolate. Mesial protrusion broad and moderately extended anteriorly; surface convex from side to side and anteriorly; usually ornamented with short, low lines or ridges perpendicular to anterior longitudinal shoulder ridge. Crown posterior cusp region flat to weakly convex side edge to side edge. Lateral wings well developed and positioned posterior and to each side of mesial protrusion; each with short rounded furrow; commonly with short lateral line or ridge near crown side edge.

#### Type B (Pl. 33, fig. 6-8, 18, 19)

Crown outline approximately lanceolate. Mesial protrusion broad and with minor extension anteriorly; surface convex from side to side and anteriorly; may be ornamented with one or a few low lines or ridges perpendicular to anterior longitudinal shoulder ridge or line. Crown posterior cusp region flat to weakly convex side edge to side edge. Lateral wings less well developed and not positioned as far posteriorly and to each side of mesial protrusion. Lateral wing furrows shorter; lines or ridges near each crown edge commonly absent or less raised and short.

#### Type C (Pl. 33, fig. 9-11, 20)

Similar to Type B, differs by crown is smaller and wider than long; apex (posterior) is rounded; and crown surface is all shallowly convex.

#### Type D (Pl. 33, fig. 12-14)

Crown outline rounded-rhomboid; longer than or equally as long as wide. Anterior margin forms rounded rhomboid vertex; lines or ridges absent or very reduced, if present, short and shallow lines perpendicular to anterior longitudinal shoulder ridge. Lateral wings, furrows, and lines or ridges absent or reduced. Crown surface mainly smooth; shallowly convex at anterior; flat to slightly convex side edge to side edge at posterior.

#### Type E (Pl. 33, fig. 15-17, 21)

Crown outline lanceolate. Anterior margin rounded and shallowly undulating with several shallow furrows and lines or ridges perpendicular to the anterior longitudinal shoulder ridge. Anterior margin shallowly convex. Posterior margin flat or slightly convex. Mesial protrusion not prominent.

All or most of these types usually occur together in samples. Further collection and study is required to determine if variance in the crown morphologies summarized above in Types A-E is significant enough to separate these types into species. These features are not greatly different and probably represent individual variation perhaps attributed to the position of the scale on the fish or the size of the scale.

*Material.* Holotype GSC 105193 (Type B) and paratypes GSC 105192 (Type A), GSC 105194 (Type C), GSC 105196 (Type E), GSC 105197 (Type B), and GSC 105383 (Type A) from GSC loc. C-302390 (TE-220A); and paratypes GSC 105191 (Type A) and GSC 105195 (Type D) from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087918 (BH-27 top), C-087924 (BH-8), C-101016 (BBR-15), C-101034 (MS-1), C-101035 (MS-2), C-101036 (MS-3), C-101037 (MS-4), C-101038 (MS-5), C-101056 (PH-9), C-101114 (BBR-305B), C-101147 (MS-243B), C-101148 (MS-243C), C-101149 (MS-244A), C-101150 (MS-247A), C-101754 (NPP-Low), C-101778 (PH-227A), C-177684 (BH-27), C-302382 (BH-20), C-302385 (BH-46/47B), C-302387 (TE-217D), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, Ne Parle Pas Rapids, and Pardonet Hill.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Metapolygnathus primitius* to *Epigonolella bidentata* conodont zones (Orchard, 1991c); *Stikinoceras kerri* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Lower and Middle Norian, Upper Triassic.

*Glabrisubcorona arduidevexa* n. sp. s.f.

Plate 34, figures 1-11

*Utilitarian identification.* Subtype a4/b2+6/c2/d4+8+10/e1,3/f4/g1,2,3/h1/i2,3/j12±13/k1/l2,3/m3/n1

Supergroup II, Group A, Subgroup 3c, Johns, 1996, Pl. 2, fig. 33.

*Etymology.* Latin, *arduus devexus*, steeply sloping (referring to the degree of inclination of the crown).

*Diagnosis.* Crown outline approximately lanceolate; steeply oblique with one posterior apex; not miniature. Anterior margin rounded, undulating, and (or) with narrow to broad mesial protrusion. Crown wider than or equally as wide as long. Crown shoulder at anterior margin with longitudinal line; anterior overhang minor to moderately prominent with furrow or hollows underneath. Pedicle expanded tetrahedroid. Subpedicle surface approximately flat; outline commonly stretched rhomboid (longest diameter from side to side).

*Description.* Crown outline approximately lanceolate or rounded rhomboid; width broad and commonly wider (side to side) than long (anterior to posterior) or dimensions equal. Anterior margin rounded; with or without shallow crenulations and (or) undulations; with or without shallow anterior rounded mesial protrusion. Posterior margin edges entire with one apex obtuse or rounded. Upper crown posterior surface unornamented and flat or slightly convex side edge to side edge. Upper crown anterior surface slightly curves down and slightly under to pedicle. Crown steeply oblique and concave anterior to posterior; posteriorly extends beyond pedicle base; edges about equal with width of pedicle base. Anteriorly, pedicle base extends beyond crown.

Mesial protrusion (when present) at anterior margin, shallow-convex, rounded, commonly broad, and with or without short and slightly raised lines or ridges. Lateral wing and short U-shaped furrow on each side and slightly posterior to mesial protrusion. Lateral wing line or ridge may be near crown edge side of furrow. Lines or ridges and furrows short, approximately parallel and extend towards posterior (apex) but rarely beyond 1/2 length of crown. When mesial protrusion absent, anterior margin rounded or rounded rhomboid vertex. Anterior longitudinal line or ridge forms anterior margin; usually shallowly crenulated and not well raised; located near base of crown anterior rounded margin, mesial protrusion, and (or) lateral wings; perpendicular to any lines or ridges present on crown anterior surface. Anterior crown shoulder not well developed as crown steeply oblique (posterior highest). Shallow furrow or hollows may be underneath anterior crown shoulder; with minor to moderate crown overhang above crown/pedicle junction. Subcrown (unoccupied by pedicle) unornamented; side-to-side surface convex (raised slightly mesially anterior to posterior).

Crown/pedicle junction positioned far to anterior underneath crown. Pedicle expanded tetrahedroid. Subpedicle surface approximately flat; with small- to medium-sized mesial canal opening; smaller canal openings may be present; vascularization hemiaulacorhize; outline commonly stretched rhomboid with vertices located at anterior, posterior, and to each side. Longest rhomboid diameter twice or greater from side to side than from anterior to posterior.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Three variations are recognized according to the dimensions of the crown and the anterior margin.

#### Type A (Pl. 34, fig. 1-3)

Crown commonly broader than long with a shallow, usually broad anterior mesial protrusion and lateral wings; furrows shallow and short; lines or ridges reduced and short.

#### Type B (Pl. 34, fig. 4-6, 10)

Crown about equally as broad as long; generally smaller and more oblique (posterior highest); mesial protrusion moderately thin and short; lateral wings and shallow furrows considerably reduced; lines or ridges may be longer (but not greater than 1/2 length of crown).

#### Type C (Pl. 34, fig. 7-9, 11)

Crown like Type A without an anterior crown mesial protrusion and lateral wings. Crown rounded anterior margin may be crenulated; lines or ridges and furrows reduced and short or commonly absent.

*Material.* Holotype GSC 105199 (Type B) and paratypes GSC 105198 (Type A), GSC 105200 (Type C), GSC 105201 (Type B), and GSC 105202 (Type C) from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087910 (BH-47/48), C-087924 (BH-8), C-101015 (BBR-14), C-101034 (MS-1), C-101036 (MS-3), C-101039 (MS-6), C-101056 (PH-9), C-101114 (BBR-305B), C-101147 (MS-243B), C-101150 (MS-247A), C-101754 (NPP-Low), C-101778 (PH-227A), C-302382 (BH-20), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Black Bear Ridge, Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, Ne Parle Pas Rapids, and Pardonet Hill.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Metapolygnathus primitius* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Stikinoceras kerri* II to *Mesohimavatites columbianus* III ammonoid zones (Tozer, 1994); Lower and Middle Norian, Upper Triassic.

*Glabrisubcorona tendibasis* n. sp. s.f.

Plate 34, figures 12-15

*Utilitarian identification.* Subtype a4/b2+6/c4/d1,8/e3/f3, 6/g1,2 and Subtype a5/b2+6/c2/d1,4+8/e3,5/f1,2,3/g1/h2, 3/i3/j1

*Etymology.* Latin, *tendo basis*, stretched base or pedicle (referring to the shape of the pedicle that is wider from side to side than anterior to posterior).

*Diagnosis.* Crown outline rounded rhomboid; wider than long; not steeply oblique; not miniature. Posterior margin entire and rounded. Anterior mesial protrusion absent; margin rounded and may be shallowly crenulated. Crown upper surface smooth and slightly convex. Anterior crown shoulder with crenulated longitudinal line or ridge; several short, reduced lines may be above or below and perpendicular to longitudinal line or ridge. Shoulder overhang of crown/pedicle junction minor to moderate with furrow or hollows



underneath. Pedicle expanded tetrahedroid. Subpedicle surface approximately flat; outline stretched rhomboid (longest diameter from side to side).

*Description.* Scale not delicate, robust, or miniature. Crown outline rounded rhomboid; much wider (side to side) than long (anterior to posterior). Posterior edges entire; apex rounded. Anterior margin rounded, may be shallowly crenulated; mesial protrusion absent. Crown upper surface smooth; slightly convex side edge to side edge. Anterior crown shoulder with approximately horizontal and crenulated longitudinal line or ridge; several short, reduced lines may be above or below and perpendicular to longitudinal line or ridge. Crown anterior with shallow shoulder overhang of crown/pedicle junction and furrow or hollows underneath. Crown shallowly oblique to almost horizontal; slightly concave anterior to posterior; posteriorly extends beyond pedicle base; edges about equal with width of pedicle base. Anteriorly, pedicle base extends beyond crown. Subcrown (unoccupied by pedicle) unornamented; side-to-side surface convex (raised slightly mesially anterior to posterior).

Pedicle description same as *G. arduidevexa* n. sp. s.f.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105204 and paratype GSC 105203 from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087924 (BH-8), C-101034 (MS-1), C-101036 (MS-3), C-101038 (MS-5), C-101150 (MS-247A), C-302382 (BH-20), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Brown Hill, Childerhose Cove, and Crying Girl Prairie Creek.

*Range.* *Synechodus incrementum* ichthyolith Zone; Middle *Epigondolella triangularis* to *Epigondolella serrulata* conodont zones (Orchard, 1991c); *Malayites dawsoni* III to *Meso-himavatites columbianus* III ammonoid zones (Tozer, 1994); uppermost Lower Norian and Middle Norian, Upper Triassic.

*Glabrisubcorona?* sp. 1 s.f.

Plate 35, figures 1-17

*Utilitarian identification.* Subtype  $a4/b2 \pm 6/c2/d4 \pm (7,8) + 10/e1,3/f4/g1,2,3/h1/i2/j12 \pm 13/k1/l3/m1/n1,2$

*Diagnosis.* Scale small. Crown outline approximately lanceolate; shallowly oblique; about equally as long as wide; with one posterior apex. Anterior margin rounded, undulating, and (or) with broad or narrow mesial protrusion. Crown shoulder at anterior margin narrow and forms prominent anterior overhang. Mesial platform, lines or ridges and furrows short and shallow. Pedicle simple tetrahedroid. Subpedicle surface flat or shallowly concave; outline rhomboid or tetrapetaloid with equal length diagonals (not wider than long).

*Description.* Scale thin and small (size commonly less than 300  $\mu$ m). Crown outline approximately lanceolate; posterior margin with one acute, obtuse, or rounded apex; posterior side edges entire; anterior margin rounded, undulating, and

(or) with rounded narrow to broad mesial protrusion. Upper crown posterior cusp surface unornamented, flat or slightly convex from side edge to side edge; oblique to flat from upper anterior shoulder to posterior apex. Upper crown shoulder at anterior sharply curves down and under to crown/pedicle junction forming an overhang. Crown/pedicle junction in hollows or furrow underneath crown. Crown posteriorly extends beyond pedicle base; side edges about equal with width of pedicle base (or slightly less). Anteriorly, pedicle base edges extend beyond crown.

Mesial platform short (rarely extends beyond 1/2 crown length); narrow to broad and not raised; with short and shallow U-shaped furrow on each side; shallowly convex or flat from side to side; may have short lines or ridges. Crown wing on each side of, slightly lower than, and slightly posterior to, mesial platform; may have short lines. Crown lines or ridges and furrows short, shallow, approximately parallel and extend towards posterior (apex) but rarely beyond 1/3 length of crown. Longitudinal shoulder line may be absent; when present, thin, perpendicular to crown lines or ridges, and on lower narrow anterior shoulder, mesial protrusion and wings.

Subcrown (unoccupied by pedicle) unornamented except short line may be near mesial pedicle ridge; side-to-side surface convex or concave; concave or shallowly oblique anterior to posterior. Crown/pedicle junction positioned to anterior underneath crown.

Pedicle simple tetrahedroid. Subpedicle surface flat or shallowly concave; with small- to medium-sized mesial canal opening; other smaller canal openings rare; vascularization hemiaulacorhize; outline tetrapetaloid or rhomboid (diagonal lengths approximately equal) with vertices located anterior, posterior, and to each side.

*Comparisons.* See Genus "Comparisons".

*Remarks.* The Genus is questioned because the small size of specimens could represent ichthyoliths from juveniles. Immature crowns may be missing features that may be more developed in larger scales or adult forms. Currently, this species most closely resembles *G. vadosidevexa* n. sp. s.f. but differs by having a simple tetrahedroid type pedicle instead of expanded tetrahedroid and an anterior margin mesial protrusion that is usually narrow.

Four variations of *Glabrisubcorona?* sp. 1 s.f. are grouped according to the development of the crown anterior margin as follows:

Type A (Pl. 35, fig. 1-3, 16-17)

Anterior margin rounded; mesial protrusion not differentiated from crown wings.

Type B (Pl. 35, fig. 4-6)

Anterior margin with short and broadly rounded mesial protrusion.

Type C (Pl. 35, fig. 7-9)

Anterior margin undulating with several shallow and short rounded protrusions.



Type D (Pl. 35, fig. 10-15)

Anterior margin with narrow and short mesial protrusion.

*Material.* Figured specimens GSC 105205, GSC 105210, and GSC 105211 from GSC loc. C-087972 (Sutherland Zone); GSC 105206 to GSC 105208 from GSC loc. C-101065 (ACE-2); and GSC 105209 from GSC loc. C-101002 (BBR-1).

Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101002 (BBR-1), C-101065 (ACE-2), and C-101118 (BBR-310B).

*Peace River occurrence.* Liard and Baldonnel formations; Aylard Creek East, Black Bear Ridge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *Metapolygnathus primitius* conodont zones (Orchard, 1991c); Ladinian and uppermost Upper Carnian, Middle and Upper Triassic.

Subgroup 4: Pedicle subcentral; crown horizontal, margins rounded to irregular; pedicle base outline similar to crown.

4a: Upper crown ornamentation absent or with short ridges at margin(s).

*Complanicorona* n. gen. s.f.

aff? Group E9, Koehler, 1975, p. 80-81, Pl. 2, fig. 12.

*Etymology.* Latin, *complano corona*, level or flat crown.

*Type species.* *Complanicorona glabra* n. sp. s.f.

*Diagnosis.* Crown outline circular to rounded polygonal; upper surface flat to slightly convex; margins smooth, crenulated, or undulating; central surface smooth and unornamented; overhangs pedicle on all margins; shoulders or margins may have short lines or ridges and thin anterior longitudinal line. Subcrown surface mainly occupied by pedicle; may be smooth and have undulations; with lines or ridges continued from upper crown shoulders, and (or) with thin halo around pedicle. Pedicle positioned centrally or slightly anterior under crown; moderately robust; narrowest at crown/root junction; and expanded tetrahedroid.

*Description.* Crown outline circular to rounded polygonal; upper surface flat to slightly convex. Margins or shoulders smooth, crenulated, or undulating; anterior and posterior not easily differentiated; convex and curve sharply under to crown/pedicle junction (forming crown overhang of pedicle on all sides); may have short, approximately parallel lines or ridges and furrows. Anterior longitudinal line on shoulder thin; may extend to posterior; perpendicular to other lines or ridges.

Subcrown mainly occupied by pedicle; may have lines or ridges continued from shoulders, shallow undulations, and (or) halo plus shallow concave furrow around pedicle. Crown/pedicle junction positioned centrally or slightly

anterior underneath crown. Pedicle expanded tetrahedroid and moderately robust; narrowest at crown/root junction, vascularization hemiaulacorhize with one to several small canal openings. Subpedicle surface flat, concave, or convex; margins crenulated, undulating, or irregular; outline similar to crown outline.

*Comparisons.* Group E9 (Koehler, 1975) represents specimens similar to *Complanicorona* n. gen. s.f. with a flat smooth crown perpendicular to the pedicle with margins that may be smooth or serrated. Its age ranges from Early Pennsylvanian to Middle Triassic.

*Complanicorona* n. gen. s.f. differs from *Kirkella* Gunnell, 1933 by commonly not having a symmetrical crown, and by having a pedicle (base) which is narrowest at the crown root junction and an ornamented crown (which may include a shoulder longitudinal line, other shoulder lines/ridges, and a subcrown halo).

*Complanicorona* n. gen. s.f. is distinct from the other Triassic elasmobranch scales in this study. The crown has a rounded polygonal outline, flattened surface, smooth centre, and overhangs the pedicle on all sides. The expanded tetrahedroid pedicle is positioned centrally under the crown.

*Proprialea* n. gen. s.f., while similarly having the pedicle positioned centrally under the crown, mainly differs from *Complanicorona* n. gen. s.f. by having a dome-shaped upper crown surface (instead of flat and horizontal) and truncate instead of expanded tetrahedroid pedicle.

*Complanicorona glabra* n. sp. s.f. differs from *Complanicorona rugosimargines* n. sp. s.f. by having a smooth crown with no (or considerably reduced) lines or ridges. *C. glabra* n. sp. s.f. and *C. rugosimargines* n. sp. s.f. differ from *Complanicorona subrugosa* n. sp. s.f. by lacking larger subcrown rounded corner ridges, and more subpedicle surface canal openings with one usually not centrally positioned. Aside from the crown halo, the subcrown surface of *C. glabra* n. sp. s.f. is smooth, *C. rugosimargines* n. sp. s.f. has lines or ridges continued from upper crown shoulders, and *C. subrugosa* n. sp. s.f. has broadly rounded corner undulations or ridges.

*Remarks.* The majority of pedicles of *Complanicorona* n. gen. s.f. are expanded tetrahedroid. In some specimens the corner pedicle rounded ridges are less prominent making the pedicle structure more like a truncate form. Further collections and study are necessary to consider further separate groupings.

*Range.* Norian, Carnian, and Ladinian, Middle and Upper Triassic.

*Complanicorona glabra* n. sp. s.f.

Plate 36, figures 1-5

*Utilitarian identification.* Subtype a13/b±2+6/c3,5/d1+7/e2/f1,2,3/g1+4+5/h1,2,8/i1,2,3

cf. Subtype Number 111, Tway and Zidek, 1982, p. 334; 360, Fig. 65a-d.

*Etymology.* Latin, *glaber*, smooth (referring to the crown upper surface).

**Diagnosis.** Crown outline circular to polygonal. Crown smooth; shoulders or margins may have shallow vertically parallel short lines. Thin longitudinal line on lower crown shoulders. Subcrown surface smooth and with thin halo and shallow concave furrow around pedicle. Subpedicle surface may have several small canal openings.

**Description.** Crown outline polygonal; edges broadly undulate, rounded, and entire; anterior and posterior margins not easily differentiated. Crown upper surface smooth and flat or shallowly convex. Shoulders narrow, convex and at crown margins; curve sharply down and under to crown/pedicle junction (forming overhang on all sides); may have a few shallow vertical parallel lines and furrows. Pedicle about equally as wide as crown (may be slightly wider or narrower). Longitudinal line or ridge on lower shoulders (not under crown); may be continuous around crown. In profile, crown moderately thick; sits approximately horizontal on pedicle. Subcrown (unoccupied by pedicle) smooth and with thin halo and shallow concave furrow around pedicle; surface area reduced (occupied mainly by broad pedicle).

Crown/pedicle junction positioned centrally or slightly to anterior underneath crown; located in smooth shallow furrow. Pedicle commonly missing, leaving hole with steep sides and thin lip (Pl. 36, fig. 4). Pedicle, when present, expanded tetrahedroid; narrowest at crown/root junction; vascularization hemiaulacorhize. Subpedicle surface flat, slightly concave or slightly convex with mesial and several small- to medium-sized circular canal openings; margins crenulated, undulating or irregular; outline similar to crown.

**Comparisons.** Gunnell (1933) gave a diagnosis of a dermal denticle *Kirkella typicalis* (Chanute Shale, Pennsylvanian) which resembles *C. glabra* n. sp. s.f. *C. glabra* differs by having a crown shoulder longitudinal line, a subcrown halo, may have other crown shoulder lines, and has a pedicle which is narrower at the crown/root junction.

The crown, pedicle, and base of *C. glabra* n. sp. s.f. appears to be identical to Subtype Number 111 (Tway and Zidek, 1982, age: Late Pennsylvanian). Some differences may exist in the outline of the crown which is generally rounded and variously polygonal.

In addition, see Genus "Comparisons".

**Material.** Holotype GSC 105241 and paratype GSC 105242 from GSC loc. C-101002 (BBR-1).

Additional specimens from GSC loc. C-087901 (BH-62), C-087972 (Sutherland Zone), C-101002 (BBR-1), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101068 (BEH-2), C-101069 (BEH-3), C-101118 (BBR-310B), C-101119 (BBR-311A), C-101753 (MS-GB), C-145780 (GK-68-8-27), C-153075 (GK-4-11), C-153076 (GK-4-17), and C-177682 (BH-61B).

**Peace River occurrence.** Liard, Ludington, and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, Childerhose Cove, and Chowade South.

**Range.** *Coniunctio aequirugosa* and *Synechodus multinodus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Complanicorona rugosimargines* n. sp. s.f.

Plate 36, figures 6-11; Plate 38, figures 4-6;

Figures 11e, 12g

**Utilitarian identification.** Subtype a13/b±2+6/c3,5/d2±(5,6)+7/e2/f1,2,3/g2+4+5/h1,2,8/i1,2,3

Supergroup II, Group A, Subgroup 4a, Johns, 1996, Pl. 2, fig. 35-36.

**Etymology.** Latin, *rugosus margines*, wrinkled margins.

**Diagnosis.** Crown outline circular to polygonal; shoulders or margins with vertically parallel lines or ridges and furrows. Thin longitudinal line on lower shoulders and perpendicular to other lines or ridges. Subcrown surface with ridges continuing from shoulder to thin halo; shallow concave furrow around pedicle, and (or) crown/pedicle junction. Subpedicle surface may have several small canal openings.

**Description.** Crown outline circular to rounded polygon; edges shallowly undulating. Crown upper central surface flat to shallowly convex; centre smooth; shoulders or margins convex and curve sharply under to crown/pedicle junction (forming crown overhang of pedicle on all sides). Prominent lines or ridges and shallowly U-shaped furrows on shoulders; approximately parallel; curve under crown to thin halo and shallow concave furrow around pedicle or to crown/pedicle junction. Longitudinal line thin; located on lower shoulders; perpendicular to other lines or ridges. Subcrown surface area reduced (occupied mainly by broad pedicle). Crown/pedicle junction positioned centrally or slightly anterior underneath crown. Pedicle base about equally as wide as crown.

Pedicle expanded tetrahedroid; moderately robust and broad; vascularization hemiaulacorhize. Subpedicle surface flat, slightly concave, or slightly convex; with mesial and several small- to medium-sized circular canal openings; margins crenulated, undulating, or irregular; outline similar to crown.

**Comparisons.** See Genus "Comparisons".

**Material.** Holotype GSC 105243 from GSC loc. C-101065 (ACE-2); paratype GSC 105244 from GSC loc. C-101069 (BEH-3); paratypes GSC 105378 and GSC 105382 from GSC loc. C-101119 (BBR-311A); and figured specimen GSC 105299 from GSC loc. C-101065 (ACE-2).

Additional specimens from GSC loc. C-087901 (BH-62), C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-101119 (BBR-311A), C-101753 (MS-GB), C-153075 (GK-4-11), and C-177682 (BH-61B).

**Peace River occurrence.** Liard and Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, Black Bear Ridge, Brown Hill, and Childerhose Cove.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* to *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and Carnian; Middle and Upper Triassic.

*Complanicorona subrugosa* n. sp. s.f.

Plate 36, figures 12-15

*Utilitarian identification.* Subtype a13/b±2+6/c3,5/d±(1,2)±(4,5,6)+7/e2/f2,3/g±2+3+4+5/h1,2,3,8/i1,2

*Etymology.* Latin, *sub rugosus*, under wrinkled (referring to the ornamentation on the subcrown).

*Diagnosis.* Crown outline polygonal; shoulders or margins smooth or with vertically parallel lines or ridges and furrows. Thin longitudinal line on lower shoulders; perpendicular to other lines or ridges. Subcrown surface with corner ridges, and (or) lines continuing from shoulder to thin halo; shallow concave furrow around pedicle, and (or) crown/pedicle junction. Subpedicle surface with main mesial canal opening and may have other smaller canal openings.

*Description.* Crown outline rounded polygon; edges smooth or shallowly undulating; anterior and posterior margins not easily differentiated. In profile, crown moderately thick; sits approximately horizontally on pedicle. Upper crown surface flat or shallowly convex; crown centre smooth. Shoulders narrow and convex at crown margins; curve sharply down and under to crown/pedicle junction (forming overhang on all sides). Longitudinal line or ridge present on lower shoulders; may be continuous around crown. Few short lines or ridges may be on shoulders; perpendicular to longitudinal line; may curve down and under crown to halo or crown/pedicle junction; with short, shallow, U-shaped furrows between ridges. Crown overhangs upper pedicle and most of pedicle base; pedicle base narrower or about equally as wide as crown.

Subcrown surface (unoccupied by pedicle) may have lines or ridges continued from upper crown shoulders; with broad, rounded, and undulating ridges that extend from pedicle corners to crown edges; with thin halo and shallow concave furrow around pedicle; surface area reduced (mainly occupied by broad pedicle). Crown/pedicle junction positioned centrally or slightly to anterior underneath crown; at pedicle side of concave shallow furrow.

Pedicle expanded tetrahedroid; moderately broad and robust; corner ridges usually prominent; vascularization hemiaulacorhize. Subpedicle surface flat or slightly concave; with small to medium size circular mesial and other smaller canal openings; margins crenulated, undulating or irregular; outline rounded rhomboid or similar to crown.

*Comparisons.* See Genus "Comparisons".

*Material.* Holotype GSC 105245 from GSC loc. C-302390 (TE-220A). Additional specimens from GSC loc. C-087924 (BH-8), C-101036 (MS-3), C-101038 (MS-5), C-101754 (NPP-Low), C-302382 (BH-20), and C-302390 (TE-220A).

*Peace River occurrence.* Pardonet Formation; Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, and Ne Parle Pas Rapids.

*Range.* *Synechodus incrementum* ichthyolith Zone; Upper *Epigondolella triangularis* to *Epigondolella spiculata* conodont zones (Orchard, 1991c); *Juvavites magnus* II and *Mesohimavatites columbianus* Ia/b ammonoid zones (Tozer, 1994); Middle Norian; Upper Triassic.

Group B: Pedicle keeled expanded and stretched tetrahedroid

Subgroup 1: Pedicle anterior; crown inclined and stretched elongate lanceolate; pedicle base outline oval to ovate.

1a: Subcrown with multiple ridges; subpedicle surface flat, convex, or convex with bulge.

*Suaviloquentia* n. gen. s.f.

*Etymology.* Latin, *suaviloquentia*, charm of speech (since the appearance of the crown resembles a tongue).

*Type species.* *Suaviloquentia longilingua* n. sp. s.f.

*Diagnosis.* Crown outline elongate lanceolate or narrow elongate lanceolate; oblique, sigmoidal, or sinuous from anterior to posterior. Posterior margin with one apex that may be attenuate; anterior margin undulating and with rounded mesial protrusion. Mesial platform short (when present). Anterior margin without longitudinal line or ridge; curves down and intersects pedicle with minimal or no crown overhang. Subcrown surface with large mesial keel that extends from crown apex to posterior pedicle corner where it greatly expands; several additional lines or ridges common. Pedicle expanded anterior to posterior; keeled and commonly flaring at base. Subpedicle surface flat or convex; outline circular, oblong, or lanceolate.

*Description.* Crown outline elongate lanceolate or narrow elongate lanceolate; oblique, sigmoidal, or sinuous from anterior to posterior; flat to shallowly convex with or without minor undulations from side edge to side edge; longer (may be greatly) than wide; posterior margin with single apex that may be attenuate; anterior margin undulating, rounded, and shallowly undulating, or with narrow or broadly rounded short mesial protrusion; shoulder (when present) located near anterior margin without longitudinal line or ridge; anterior curves down and intersects pedicle vertically, steeply oblique or with slight under-curve (only minor overhang of crown/pedicle junction). Crown posteriorly overhangs crown/pedicle junction and extends beyond pedicle edge.

Upper crown surface may have short and reduced mesial platform; with short internal lines or ridges and furrows. Other lines or ridges and furrows may be absent, short, or long. Lines or ridges may intersect or terminate on crown side margins. Crown posterior region commonly smooth and unornamented.

Subcrown surface (unoccupied by pedicle) with mesial keel that extends from crown apex to posterior pedicle corner; enlarges near crown centre and greatly expands vertically to

pedicle where it continues as a large pedicle keel to pedicle base. Several additional long ridges common on subcrown. Pedicle positioned at crown anterior; anterior crown/pedicle junction edge located at anterior crown edge; posterior crown/pedicle junction near middle or slightly to posterior. Pedicle basal edges at anterior and sides commonly wider than crown. Crown posterior overhangs pedicle posterior basal edge.

Pedicle keeled and posteriorly stretched expanded tetrahedroid; may have flaring base edges; vascularization hemiaulacorrhize. Subpedicle surface flat or convex usually with bulge and small or large irregular mesial and other smaller canal openings; outline approximately circular, oblong, or lanceolate.

*Comparisons.* *Suaviloquentia* n. gen. s.f. is distinct with an elongate lanceolate crown that is commonly narrow. Crown curvature from anterior to posterior is sigmoidal, sinuous, or oblique. The anterior crown shoulder does not have a longitudinal line and the subcrown has a prominent mesial keel and long additional lines or ridges. The pedicle is keeled and stretched expanded tetrahedroid. The subpedicle surface outline is commonly oblong to lanceolate and the surface is flat to convex with a bulge.

*Suaviloquentia brevilingua* n. sp. s.f. differs from *Suaviloquentia longilingua* n. sp. s.f. and *Suaviloquentia obliquilingua* n. sp. s.f. by having an elongate lanceolate crown that is not narrow, the upper crown surface has longer ridges and furrows, and the subcrown surface has a larger and higher mesial keel, ridges are higher, and furrows are deeper.

*S. longilingua* n. sp. s.f. differs from *S. obliquilingua* n. sp. s.f. by having a steeply oblique crown that is sigmoidal or sinuous and its anterior shoulder may intersect the pedicle vertically, obliquely, or with a slight under-curve. *S. obliquilingua* n. sp. s.f. has a steeper oblique crown with no anterior shoulder and intersects the pedicle only obliquely. In addition, the keel on the subcrown surface and pedicle of *S. obliquilingua* n. sp. s.f. is larger, deeper, and placed more to the posterior than *S. longilingua* n. sp. s.f. The pedicle of *S. obliquilingua* n. sp. s.f. has reduced ridges and furrows, and the pedicle base edges are moderately thick and do not slightly curl upwards.

*Range.* Norian, Carnian, and Ladinian, Middle and Upper Triassic.

*Suaviloquentia longilingua* n. sp. s.f.

Plate 37, figures 3-5, 8, 12-13; Figures 9e, 12c

*Utilitarian identification.* Subtype a4/b2/c2/d4+10/e1,3/f3,5,7/g1,2/h1/i4/j12±13/k2+5/l1,2/m4/n1,3

Supergroup II, Group B, Subgroup 1a, Johns, 1996, Pl. 1, fig. 10; Pl. 2, figs. 39-40.

*Etymology.* Latin, *longus lingua*, long tongue.

*Diagnosis.* Crown outline narrow elongate lanceolate; much longer than wide; oblique, sigmoidal, or sinuous from anterior to posterior; posterior margin with single smooth attenuate apex; posterior region unornamented; shoulder near

anterior margin. Anterior margin undulating, rounded and shallowly undulating, or with short narrowly rounded mesial protrusion; with few short ridges, shallow furrows, and reduced mesial platform. Anterior crown curves down and may intersect pedicle vertically, steeply oblique, or with slight under-curve and minor overhang of crown/pedicle junction.

*Description.* Crown outline narrow elongate lanceolate; four or more times longer than wide; oblique, sigmoidal, or sinuous from anterior to posterior; posterior curvature upwards begins at about crown centre; shallowly convex from side edge to side edge; posterior margin entire, smooth, and with single obtuse or acute apex. Apex tip small and clear or transparent. Crown anterior margin undulating, rounded and shallowly undulating, or with short narrowly rounded mesial protrusion. Shoulder located at anterior margin where crown curves down to pedicle vertically, obliquely, or with slight under-curve (overhang of crown/pedicle junction minor without hollow or furrow underneath crown). No longitudinal line or ridge on anterior crown shoulder. Crown posteriorly overhangs crown/pedicle junction and extends well beyond pedicle edge. Anteriorly and to sides, pedicle basal edges wider than crown.

Most prominent feature on upper crown is smooth posterior surface and few anterior ridges. Ridges form edges of crown and shallowly convex short mesial platform (when present). On platform there may be up to four additional ridges; if 2 to 4 ridges, these may be further raised into second small platform. Other ridges (1 to 2) may be positioned laterally between crown edge and platform. Lateral ridges longest near crown edge where they may extend up to 2/3 crown length; commonly terminate on crown edge. Mesial platform edge ridges shorter and terminate at about 1/3 to 1/2 crown length. Ridges on platform interior even shorter and rarely extend more than 1/3 crown length. Ridges not well raised and may bifurcate near crown anterior. Furrows between ridges; about same length as ridges; U-shaped; deepest near anterior margin but may be shallow.

Subcrown surface (unoccupied by pedicle) with broadly rounded mesial keel that extends from posterior crown apex to posterior pedicle; enlarges near pedicle where it drops vertically through pedicle to its base. Several additional long ridges common on subcrown; extend from posterior crown apex and sides to posterior pedicle. Shallow hollow or furrow near crown/pedicle junction on each posterior side under crown. Anterior crown/pedicle junction edge located at anterior crown edge and posterior pedicle edge at anterior side or middle of subcrown surface.

Pedicle keeled and stretched expanded tetrahedroid; expanded from anterior to posterior; base edges may curl upwards; vascularization hemiaulacorrhize. Subpedicle surface convex or flat. Small or large and irregular mesial canal opens perpendicular to subpedicle surface; few other smaller canal openings may be present. Subpedicle surface outline approximately circular, oblong, or lanceolate (apex posterior); edges smooth, crenulated, or undulating.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species is common in the Middle Norian and absent in Carnian or Ladinian samples.

*Material.* Holotype GSC 105239 and paratypes GSC 105238, GSC 105240, and GSC 105380 from GSC loc. C-101036 (MS-3).

Additional specimens from GSC loc. C-087924 (BH-8), C-087926 (BH-1), C-101036 (MS-3), C-101038 (MS-5), C-101056 (PH-9), C-101148 (MS-243C), C-101754 (NPP-Low), C-302382 (BH-20), C-302390 (TE-220A), and C-302391 (TE-314B).

*Peace River occurrence.* Pardonet and Bocoek formations; Brown Hill, Childerhose Cove, Crying Girl Prairie Creek, near Bocoek Peak, Ne Parle Pas Rapids, and Pardonet Hill.

*Range.* *Synechodus incrementum* ichthyolith Zone; *Epigondolella quadrata* to Upper *Epigondolella bidentata* conodont zones (Orchard, 1991c); *Malayites dawsoni* I to *Gnomohalorites cordilleranus* II ammonoid zones (Tozer, 1994); Lower Norian to lowermost Upper Norian, Upper Triassic.

*Suaviloquentia brevilingua* n. sp. s.f.

Plate 37, figures 2, 7, 10-11; Figure 10g

*Utilitarian identification.* Subtype a4/b2/c2/d4/e1,3/f3,5,7/g1,2/h1/i1/j1,2/k2+5/l1,2/m4/n3,4

Supergroup II, Group B, Subgroup 1a, Johns, 1996, Pl. 1, fig. 15; Pl. 2, fig. 37-38.

*Etymology.* Latin, *brevis lingua*, short tongue.

*Diagnosis.* Crown outline elongate lanceolate; oblique or slightly sigmoidal from anterior to posterior; posterior margin with one apex; posterior region smooth and unornamented; shoulder near anterior margin; anterior margin undulating, rounded and shallowly undulating, or with narrow or broadly narrowly rounded mesial protrusion; lines or ridges and furrows commonly long; mesial platform (when present) reduced and lanceolate. Anterior crown curves down and may intersect pedicle vertically, steeply oblique, or with slight under-curve and minor overhang of crown/pedicle junction.

*Description.* Crown outline elongate lanceolate; longer than wide; oblique or slightly sigmoidal from anterior to posterior (curving slightly up at posterior apex and down at anterior margin); flat to shallowly convex with minor undulations from side edge to side edge; posterior margin entire with single obtuse or acute apex; anterior margin undulating, rounded and shallowly undulating, or with narrow or broadly rounded short mesial protrusion; shoulder near anterior margin without longitudinal line or ridge. Anterior crown at shoulder curves down and may intersect pedicle (at crown/pedicle junction) vertically, steeply oblique or with slight under-curve (but with no overhang of crown/pedicle junction and no furrow or hollow underneath). Crown posteriorly overhangs crown/pedicle junction and extends well beyond pedicle edge. Pedicle basal edges wider than crown at anterior and sides.

Upper crown lines or ridges usually parallel to subparallel, long (extend anterior to posterior), and moderately raised. Sometimes crown ridges may be shorter and moderately raised at anterior margin and less raised or absent at crown posterior where apex region may be smooth. Furrows between ridges long and shallowly U-shaped; slightly deeper at anterior margin; may be absent at posterior.

Upper crown surface may have reduced (not well raised) lanceolate mesial platform that forms part of anterior margin mesial protrusion and posteriorly decreases in height where it may be absent. Platform with long ridges (extend more than half length of platform) and minor furrows. Two crown wings lower in height than, and located on each side of and posterior to, mesial platform. Furrow on each wing next to platform. Additional ridges and shallow furrows common on each wing.

Subcrown surface with mesial keel that extends from posterior apex to pedicle; enlarges near crown centre and greatly expands vertically to pedicle where it continues as large pedicle keel to pedicle base. Several additional long lines or ridges common on subcrown; extend from posterior apex to posterior pedicle; raised and with deeper furrows than upper crown ridges and furrows. Hollow or furrow commonly on each side of keel; deepest near pedicle. Anterior crown/pedicle junction edge located at anterior crown edge, and posterior pedicle edge at anterior side or middle of subcrown surface.

Pedicle short, robust, may be expanded to posterior, and narrowest near crown/pedicle junction. Pedicle with short oblique sides that gently flare to base and may slightly curl upwards; prominent posterior mesial keel drops vertically to pedicle base; rounded vertical ridges; shallow U-shaped vertical furrows; common small vertically oblong or slit-like canal openings approximately at pedicle middle in furrows; and with similar but larger canal openings commonly located at pedicle posterior.

Pedicle keeled and stretched expanded tetrahedroid; expanded from anterior to posterior; base edges may curl upwards; vascularization hemiaulacorhize. Subpedicle surface convex, commonly with bulge located anteriorly or centrally, occasionally bulge may be positioned to posterior. Small mesial canal commonly located to posterior of bulge; few other smaller canal openings may be present. Subpedicle surface outline approximately circular, oblong, or lanceolate (apex posterior); edges smooth, crenulated, or undulating.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species is moderately rare in the Ladinian and Carnian and absent in Norian samples.

*Material.* Holotype GSC 105236 and paratype GSC 105237 from GSC loc. C-101003 (BBR-2).

Additional specimens from GSC loc. C-101003 (BBR-2), C-101064 (ACE-1), C-101065 (ACE-2), C-101066 (ACE-3), C-101067 (BEH-1), C-101069 (BEH-3), C-101070 (BEH-4), C-153075 (GK-4-11), and C-153076 (GK-4-17).



*Peace River occurrence.* Liard and ?Baldonnel formations; Aylard Creek East, Beattie Hill, Beattie Ledge, and Black Bear Ridge.

*Range.* *Coniunctio aequirugosa* and *Synechodus multinodosus* ichthyolith zones; ?*Maclearnoceras maclearni* and *Klamathites macrolobatus* ammonoid zones (Tozer, 1994); Ladinian (unzoned) to *Metapolygnathus communisti*/Lower *M. primitius* conodont zones (Orchard, 1991c); Ladinian and uppermost Upper Carnian; Middle and Upper Triassic.

*Suaviloquentia obliquilingua* n. sp. s.f.

Plate 37, figures 1, 6, 9

*Utilitarian identification.* Subtype a4/b2/c2/d1,2/e1/f3,5,7/g1/h1/i4/j1,2/k2±(3,5)/l1/m4/n1,3

*Etymology.* Latin, *obliquus lingua*, oblique tongue.

*Diagnosis.* Crown outline narrow elongate lanceolate; much longer than wide; oblique from anterior to posterior and intersects pedicle with no overhang; shallowly convex from side edge to side edge; posterior margin with single smooth attenuate apex; posterior region and most of crown unornamented (may have one short anterior line or ridge); anterior margin rounded; shoulder absent.

*Description.* Crown outline narrow elongate lanceolate; four or more times longer than wide; oblique from anterior to posterior; shallowly convex from side edge to side edge; posterior margin entire, smooth, and with single obtuse or acute apex. Apex tip small and clear or transparent. Anterior margin rounded; without longitudinal line or ridge; and intersects pedicle obliquely with no overhang. Crown posteriorly overhangs crown/pedicle junction and may extend beyond pedicle edge. Anteriorly and to sides, pedicle edges wider than crown. Most prominent feature on upper crown is smooth surface with at most one short ridge extending from anterior margin to no more than 1/2 crown length.

Subcrown surface (unoccupied by pedicle) with rounded mesial keel that extends from posterior crown apex to posterior pedicle; enlarges at about 1/4 crown length from posterior apex where it drops approximately vertically to pedicle and continues in pedicle to its base. Few additional ridges on subcrown surface; extend from posterior apex and crown sides to posterior pedicle. Shallow hollow or furrow near crown/pedicle junction on each posterior side under crown. Anterior crown/pedicle junction edge at anterior crown edge and posterior pedicle edge at middle or slightly to posterior of subcrown surface.

Pedicle keeled and stretched expanded tetrahedroid; expanded from anterior to posterior; ridges and furrows considerably reduced; base edges do not curl upwards but straight and moderately thick; vascularization hemiaulacorhize. Subpedicle surface convex or flat. Small mesial canal opens perpendicular to subpedicle surface; few other smaller canal openings may be present. Subpedicle surface outline approximately circular, oblong, or lanceolate with apex posterior; edges may be smooth, crenulated, or undulating.

*Comparisons.* See Genus "Comparisons".

*Remarks.* Species is rare in the Ladinian and absent in Carnian or Norian samples.

*Material.* Holotype GSC 105235 from GSC loc. C-101068 (BEH-2). Additional specimens from GSC loc. C-087972 (Sutherland Zone), C-101065 (ACE-2), C-101068 (BEH-2), C-101070 (BEH-4), C-153069 (GK-1-19), and C-153075 (GK-4-11).

*Peace River occurrence.* Liard Formation; Aylard Creek East, Beattie Hill, Beattie Ledge, and Brown Hill.

*Range.* *Coniunctio aequirugosa* ichthyolith Zone; ?*Maclearnoceras maclearni* and *Frankites sutherlandi* ammonoid zones (Tozer, 1994); Ladinian, Middle Triassic.

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# APPENDIX 1

## Locality register

Location names and National Topographic System map sheet name and number, and UTM of the localities cited in the text are listed below.

### SAMPLES COLLECTED BY M.J. ORCHARD AND E.T. TOZER:

<b>East Ducette Creek</b> , Carbon Creek, 93O/15, Zone 10, 503800E, 618500N	<b>West Glacier Spur</b> , Jones Peak, 94B/2, Zone 10, 524000E, 6218500N
<b>near Boccock Peak</b> , Pine Pass, 93O/15, Zone 10, 503800E, 6188500N	<b>Black Bear Ridge</b> , Mount Brewster, 94B/3, Zone 10, 497500E, 6215500N
<b>Pine Pass</b> , Portage Mountain, 93O/16, Zone 10, 528000E, 6152000N	<b>Ne Parle Pas Rapids</b> , Mount Brewster, 94B/3, Zone 10, 495400E, 6210500N
<b>Aylard Creek East</b> , Jones Peak, 94B/2, Zone 10, 527250E, 6223400N	<b>Pardonet Hill</b> , Mount Brewster, 94B/3, Zone 10, 490000E, 6213750N
<b>Beattie Hill</b> , Jones Peak, 94B/2, Zone 10, 525450E, 6223250N	<b>Upper Pardonet Hill</b> , Mount Brewster, 94B/3, Zone 10, 490000E, 6222500N
<b>Brown Hill</b> , Jones Peak, 94B/2, Zone 10, 507000E, 6217000N	<b>Crying Girl Prairie Creek</b> , Hackney Hills, 94B/7, Zone 10, 457500E, 6257500N
<b>Carbon Creek</b> , Jones Peak, 94B/2, Zone 10, 519000E, 6215000N	<b>Liard/Toad River</b> , Grayling River, 94N/6, Zone 10, 368626E, 6573202N
<b>Childerhose Cove</b> , Jones Peak, 94B/2, Zone 10, 518000E, 6218000N	<b>Liard/Toad River</b> , (Sutherland Zone) Grayling River, 94N/6, Zone 10, 368600E, 6573500N

### SAMPLES COLLECTED BY D.W. GIBSON:

<b>Ursula Creek</b> , Point Creek, 93O/14, Zone 10, 489350E, 6205100N	<b>Chowade South</b> , Christina Falls, 94B/11, Zone 10, 483500E, 6280400N
<b>Eleven Mile Creek</b> , Carbon Creek, 93O/15, Zone 10, 504400E, 6183200N	<b>Laurier Pass</b> , Mount Laurier, 94B/14, Zone 10, 470600E, 6297500N
<b>Beattie Ledge</b> , Jones Peak, 94B/2, Zone 10, 525500E, 6223300N	<b>Laurier Pass</b> , Mount Laurier, 94B/14, Zone 10, 472700E, 6295800N
<b>Brown Hill</b> , Jones Peak, 94B/2, Zone 10, 508000E, 6217000N	<b>Laurier Pass</b> , Mount Laurier, 94B/14, Zone 10, 470800E, 6296300N
<b>Brown Hill</b> , Jones Peak, 94B/2, Zone 10, 489350E, 6205100N	<b>Laurier Pass</b> , Mount Laurier, 94B/14, Zone 10, 470800E, 6297500N
<b>McLay Spur</b> , Jones Peak, 94B/2, Zone 10, 518100E, 6218000N	<b>Laurier Pass</b> , Mount Laurier, 94B/14, Zone 10, 472600E, 6296500N
<b>Pardonet Hill</b> , Mount Brewster, 94B/3, Zone 10, 498650E, 6213900N	<b>Pink Mountain</b> , Pink Mountain, 94G/2, Zone 10, 507700E, 6324000N
<b>Mount Ludington</b> , Emerslund Lakes, 94B/6, Zone 10, 484800E, 6257500N	

## APPENDIX 2

### Sample information and faunal lists

Information is provided on the ichthyolith samples collected in the Peace River-Williston Lake area of northeastern British Columbia. Samples were collected in 1980, 1981, 1982, and 1983 by M.J. Orchard and T.E. Tozer (Geological Survey of Canada, Vancouver), and in 1987, 1988, and 1989 by D.W. Gibson (Geological Survey of Canada, Calgary).

Samples in sections are organized in alphabetical order by location. Additional samples (in the GK- series) are included at the end.

Information provided below includes: abbreviated sample name (e.g. ACE-1), field number (e.g. 82-MJO-ACE-1), sample location (e.g. Aylard Creek East), GSC (Calgary office) locality number (e.g. C-101064), formation, series/stage, conodont zone, ammonoid zone, ichthyolith zone, ichthyolith fauna list (includes number of specimens), and collector.

The field number provides additional coded information about the sample. The first two numbers are the last two numbers of the year the sample was collected (e.g. 82-MJO-ACE-1 was collected in 1982). The year code is followed by the collector's officer's code or initials. The following codes have been used: MJO = Michael Orchard's initials used on samples prior to 1985; OF = Michael Orchard's GSC officer's code; TE = Tim Tozer's GSC officer's code; GK = David Gibson's GSC officer's code; and P = Paul Psutka's initial. In some cases, there are two collector's codes. Samples with the combination -(OF)-GK- were collected by David Gibson and processed under Michael Orchard's project in the Vancouver laboratories. Samples with the combination -MJO-(TE)- were collected by Michael Orchard but labelled with the section and sample field number allocated by Tim Tozer because the samples were collected concurrently in the section. The field number collector's code is followed by the sample section code (e.g. ACE or BBR) and the sample number.

Table A2-1 provides listings of the samples in a more condensed format. The table columns are as follows: abbreviated sample name (AFN), full sample code or field number (FIELD NO.), name of the sample location (LOCATION) which may be cross-referenced in the Locality Register, Registered Geological Survey of Canada (GSC) locality number (GSC LOC. NO.), geological formation (FORMATION), and the series/stage (SERIES/STAGE).

ACE-1	82-MJO-ACE-1	Aylard Creek East
GSC locality no.	: C-101064	
Formation	: Liard	
Series/Stage	: upper? Ladinian	
Conodont Zone	: unzoned	
Ammonoid Zone	: ? <i>Maclearnoceras maclearni</i>	
Ichthyolith Zone	: <i>Coniunctio aequirugosa</i>	
Ichthyoliths:		
	<i>Complanicorona glabra</i> n. gen. et sp. s.f. (3)	
	<i>Complanicorona rugosimargines</i> n. gen. et sp. s.f. (1)	
	<i>Coniunctio multirugosa</i> n. gen. et sp. s.f. (2)	
	<i>Duplisuggestus duplirugosus</i> n. gen. et sp. s.f. (12)	
	<i>Gracilisuggestus uniapex</i> n. gen. et sp. s.f. (5)	
	<i>Labascicorona alata</i> n. gen. et sp. s.f. (53)	
	<i>Labascicorona longifossae</i> n. gen. et sp. s.f. (34)	
	<i>Labascicorona mediflexura</i> n. gen. et sp. s.f. (3)	
	<i>Labascicorona nitidifastigia</i> n. gen. et sp. s.f. (1)	
	<i>Labascicorona trifastigia</i> n. gen. et sp. s.f. (2)	
	<i>Labrilancea glabrisubcuspis</i> n. gen. et sp. s.f. (3)	
	<i>Lobaticorona floridibasis</i> n. gen. et sp. s.f. (5)	
	<i>Lobaticorona floriditabella</i> n. gen. et sp. s.f. (3)	
	<i>Lobaticorona floriditurris</i> n. gen. et sp. s.f. (2)	
	<i>Lobaticorona tumidibasis</i> n. gen. et sp. s.f. (3)	
	<i>Ornatilabrilancea circacarina</i> n. gen. et sp. s.f. (16)	
	<i>Parvidiabolus acutus</i> n. gen. et sp. s.f. (1)	
	<i>Parvidiabolus convexus</i> n. gen. et sp. s.f. (1)	
	<i>Parvidiabolus longisulcus</i> n. gen. et sp. s.f. (1)	

*Parvidiabolus obliquus* n. gen. et sp. s.f. (5)  
*Polyacrodus contrarius* n. sp. (2)  
*Proprigalea languidula* n. gen. et sp. s.f. (3)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (16)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (19)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (2)  
*Synechodus volaticus* n. sp. (5)  
*Synechodus* sp. 1 (1)  
*Undulaticorona propensa* n. gen. et sp. s.f. (2)

actinopterygian teeth  
 Collector : M.J. Orchard, 1982

ACE-2                      82-MJO-ACE-2                      Aylard Creek East

GSC locality no. : C-101065  
 Formation : Liard  
 Series/Stage : upper? Ladinian  
 Conodont Zone : unzoned  
 Ammonoid Zone : ?*Maclearnoceras maclearni*  
 Ichthyolith Zone : *Coniunctio aequirugosa*

Ichthyoliths:

*Complanicorona glabra* n. gen. et sp. s.f. (90)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (4)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (13)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (13)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (49)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (12)  
*Glabrisubcorona?* sp. 1 s.f. (210)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (19)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (57)  
*Labascicorona alata* n. gen. et sp. s.f. (162)  
*Labascicorona longifossae* n. gen. et sp. s.f. (19)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (3)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (1)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (8)  
*Labrilancea glabrisubcuspis* n. gen. et sp. s.f. (50)  
*Labrilancea glabrisubtricuspis* n. gen. et sp. s.f. (94)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (6)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (3)  
*Lobaticorona floriditurris* n. gen. et sp. s.f. (4)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (8)  
*Lobaticorona tumiditurris* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (38)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (12)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (4)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (10)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (33)  
*Parviscapa trivela* n. gen. et sp. s.f. (24)  
*Parviscapa univelum* n. gen. et sp. s.f. (2)  
*Polyacrodus contrarius* n. sp. (2)  
*Proprigalea languidula* n. gen. et sp. s.f. (16)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (2)  
*Proprigalea medirugosa* n. gen. et sp. s.f. (4)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (41)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (24)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (2)  
*Suaviloquentia obliquilingua* n. gen. et sp. s.f. (2)  
*Synechodus volaticus* n. sp. (99)  
*Synechodus* sp. 1 (3)  
*Undulaticorona propensa* n. gen. et sp. s.f. (9)

actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1982

**Table A2-1.** Sample information including: abbreviated sample name, field number, location, registered GSC locality number, formation, and series/stage. See Appendix 2 for additional information.

AFN	FIELD NO.	LOCATION	GSC LOC. NO.	FORMATION	SERIES / STAGE
ACE-1	82-MJO-ACE-1	Aylard Creek East	C-101064	Liard	upper? Ladinian
ACE-2	82-MJO-ACE-2	Aylard Creek East	C-101065	Liard	upper? Ladinian
ACE-3	82-MJO-ACE-3	Aylard Creek East	C-101066	Liard	upper? Ladinian
BEH-1	82-MJO-BEH-1	Beattie Hill	C-101067	Liard	upper? Ladinian
BEH-2	82-MJO-BEH-2	Beattie Hill	C-101068	Liard	upper? Ladinian
BEH-3	82-MJO-BEH-3	Beattie Hill	C-101069	Liard	upper? Ladinian
BEH-4	82-MJO-BEH-4	Beattie Hill	C-101070	Liard	upper? Ladinian
GK-4-6	87-(OF)-GK-4-6	Beattie Ledge	C-153074	Liard	upper? Ladinian
GK-4-11	87-(OF)-GK-4-11	Beattie Ledge	C-153075	Liard	upper? Ladinian
GK-4-17	87-(OF)-GK-4-17	Beattie Ledge	C-153076	Liard	upper? Ladinian/Carnian?
GK-4-28	87-(OF)-GK-4-28	Beattie Ledge	C-153077	Liard	upper? Ladinian
GK-4-38	87-(OF)-GK-4-38	Beattie Ledge	C-153078	Liard	upper? Ladinian
BBR-242A	81-MJO-(TE)-BBR-242A	Black Bear Ridge	C-101108	Bocock/Pardonet	Upper Norian
BBR-302B	81-MJO-(TE)-BBR-302B	Black Bear Ridge	C-101110	Bocock/Pardonet	Upper Norian
BBR-304B	81-MJO-(TE)-BBR-304B	Black Bear Ridge	C-101112	Pardonet	Middle Norian
BBR-305A	81-MJO-(TE)-BBR-305A	Black Bear Ridge	C-101113	Pardonet	Middle Norian
BBR-305B	81-MJO-(TE)-BBR-305B	Black Bear Ridge	C-101114	Pardonet	Middle Norian
BBR-306A	81-MJO-(TE)-BBR-306A	Black Bear Ridge	C-101115	Pardonet	Middle Norian
BBR-306B	81-MJO-(TE)-BBR-306B	Black Bear Ridge	C-101116	Pardonet	Middle Norian
BBR-309A	81-MJO-(TE)-BBR-309A	Black Bear Ridge	C-101117	Pardonet	Lower Norian
BBR-310B	81-MJO-(TE)-BBR-310B	Black Bear Ridge	C-101118	Baldonnel	Upper Carnian
BBR-311A	81-MJO-(TE)-BBR-311A	Black Bear Ridge	C-101119	Baldonnel	Upper Carnian
BBR-1	82-MJO-BBR-1	Black Bear Ridge	C-101002	?Baldonnel	Upper Carnian
BBR-2	82-MJO-BBR-2	Black Bear Ridge	C-101003	?Baldonnel	Upper Carnian
BBR-3	82-MJO-BBR-3	Black Bear Ridge	C-101004	?Baldonnel	Upper Carnian
BBR-4	82-MJO-BBR-4	Black Bear Ridge	C-101005	?Baldonnel	Upper Carnian
BBR-5	82-MJO-BBR-5	Black Bear Ridge	C-101006	Pardonet	Lower Norian
BBR-6	82-MJO-BBR-6	Black Bear Ridge	C-101007	Pardonet	Lower Norian
BBR-7	82-MJO-BBR-7	Black Bear Ridge	C-101008	Pardonet	Lower Norian
BBR-8	82-MJO-BBR-8	Black Bear Ridge	C-101009	Pardonet	Lower Norian
BBR-12	82-MJO-BBR-12	Black Bear Ridge	C-101013	Pardonet	Middle Norian
BBR-13	82-MJO-BBR-13	Black Bear Ridge	C-101014	Pardonet	Middle Norian
BBR-14	82-MJO-BBR-14	Black Bear Ridge	C-101015	Pardonet	Middle Norian
BBR-15	82-MJO-BBR-15	Black Bear Ridge	C-101016	Pardonet	Middle Norian
BBR-16	82-MJO-BBR-16	Black Bear Ridge	C-101017	Pardonet	Middle Norian
BBR-18	82-MJO-BBR-18	Black Bear Ridge	C-101019	Pardonet	Middle Norian
BBR-19	82-MJO-BBR-19	Black Bear Ridge	C-101020	Pardonet	Middle Norian
BBR-20	82-MJO-BBR-20	Black Bear Ridge	C-101021	Pardonet	Middle Norian
BBR-21	82-MJO-BBR-21	Black Bear Ridge	C-101022	Pardonet	Middle Norian
BBR-22	82-MJO-BBR-22	Black Bear Ridge	C-101027	Bocock/Pardonet	Upper Norian
BBR-23	82-MJO-BBR-23	Black Bear Ridge	C-101023	Bocock/Pardonet	Upper Norian
BBR-24	82-MJO-BBR-24	Black Bear Ridge	C-101024	Bocock/Pardonet	Upper Norian
BBR-26	82-MJO-BBR-26	Black Bear Ridge	C-101026	Bocock/Pardonet	Upper Norian
BBR-33	82-MJO-BBR-33	Black Bear Ridge	C-101033	Pardonet	Lower Norian
BH-1	80-MJO-BH-1	Brown Hill	C-087926	Pardonet	Middle Norian
BH-2	80-MJO-BH-2	Brown Hill	C-089725	Pardonet	Middle Norian
BH-4	80-MJO-BH-4	Brown Hill	C-302380	Pardonet	Middle Norian
BH-5/6	80-MJO-BH-5/6	Brown Hill	C-302389	Pardonet	Middle Norian
BH-8	80-MJO-BH-8	Brown Hill	C-087924	Pardonet	Middle Norian
BH-14	80-MJO-BH-14	Brown Hill	C-302381	Pardonet	Middle Norian
BH-15	80-MJO-BH-15	Brown Hill	C-087921	Pardonet	Middle Norian
BH-17	80-MJO-BH-17	Brown Hill	C-087920	Pardonet	Middle Norian
BH-20	80-MJO-BH-20	Brown Hill	C-302382	Pardonet	Middle Norian
BH-24	80-MJO-BH-24	Brown Hill	C-302383	Pardonet	Lower Norian
BH-26	80-MJO-BH-26	Brown Hill	C-087919	Pardonet	Lower Norian
BH-27 TOP	80-MJO-BH-27 top	Brown Hill	C-087918	Pardonet	Lower Norian
BH-27	80-MJO-BH-27	Brown Hill	C-177684	Pardonet	Lower Norian



Table A2-1. (cont.)

AFN	FIELD NO.	LOCATION	GSC LOC. NO.	FORMATION	SERIES / STAGE
BH-27 BASE	80-MJO-BH-27 base	Brown Hill	C-302384	Pardonet	Lower Norian
BH-28U	80-MJO-BH-28U	Brown Hill	C-087973	Pardonet	Lower Norian
BH-29U	80-MJO-BH-29U	Brown Hill	C-087917	Pardonet	Lower Norian
BH-30 TOP	80-MJO-BH-30 top	Brown Hill	C-087916	Pardonet	Lower Norian
BH-30/31	80-MJO-BH-30/31	Brown Hill	C-087915	Pardonet	Lower Norian
BH-41	80-MJO-BH-41	Brown Hill	C-087911	Pardonet	Lower Norian
BH-46/47B	80-MJO-BH-46/47B	Brown Hill	C-302385	Pardonet	Lower Norian
BH-47/48	80-MJO-BH-47/48	Brown Hill	C-087910	Pardonet	Lower Norian
BH-48	80-MJO-BH-48	Brown Hill	C-087909	Pardonet	Lower Norian
BH-51	80-MJO-BH-51	Brown Hill	C-087908	Pardonet	Lower Norian
BH-51A	80-MJO-BH-51A	Brown Hill	C-302386	Pardonet	Lower Norian
BH-58 BASE	80-MJO-BH-58 base	Brown Hill	C-087904	Pardonet/Baldonnel	Upper Carnian
BH-59	80-MJO-BH-59	Brown Hill	C-087903	Pardonet/Baldonnel	Upper Carnian
BH-60	80-MJO-BH-60	Brown Hill	C-086792	Baldonnel	Upper Carnian
BH-61	80-MJO-BH-61	Brown Hill	C-177683	Baldonnel	Upper Carnian
BH-61B	80-MJO-BH-61B	Brown Hill	C-177682	Baldonnel	Upper Carnian
BH-62	80-MJO-BH-62	Brown Hill	C-087901	Baldonnel	Upper Carnian
GK-1-19	87-(OF)-GK-1-19	Brown Hill	C-153069	Liard	upper? Ladinian
GK-1-20	87-(OF)-GK-1-20	Brown Hill	C-153070	Liard	upper? Ladinian
GK-1-38	87-(OF)-GK-1-38	Brown Hill	C-153071	Liard	upper? Ladinian
GK-1-48	87-(OF)-GK-1-48	Brown Hill	C-153072	Liard	upper? Ladinian
Suth Zone	80-MJO-Suth. Zone	Brown Hill	C-087972	Liard	upper Ladinian
MJO-119A	83-MJO-(TE)-119A	near Carbon Creek	C-302392	Pardonet	Middle Norian
MJO-119B	83-MJO-(TE)-119B	Carbon Creek	C-302393	Pardonet	Middle Norian
MJO-119D	83-MJO-(TE)-119D	Carbon Creek	C-103869	Pardonet	Middle Norian
TE-217D	80-MJO-(TE)-217D	Crying Girl	C-302387	Pardonet	Middle Norian
TE-217E	80-MJO-(TE)-217E	Crying Girl	C-302388	Pardonet	Middle Norian
TE-220A	80-MJO-(TE)-220A	Crying Girl	C-302390	Pardonet	Middle Norian
EDC-315B	81-MJO-EDC-315B	East of Ducette Creek	C-101138	Bocock	Upper Norian
MS-243B	81-MJO-(TE)-MS-243B	McLay Spur	C-101147	Pardonet	Middle Norian
MS-243C	81-MJO-(TE)-MS-243C	McLay Spur	C-101148	Pardonet	Lower Norian
MS-244A	81-MJO-(TE)-MS-244A	McLay Spur	C-101149	Pardonet	Lower Norian
MS-247A	81-MJO-(TE)-MS-247A	McLay Spur	C-101150	Pardonet	Middle Norian
MS-247B	81-MJO-(TE)-MS-247B	McLay Spur	C-101751	Pardonet	Middle Norian
MS-248A	81-MJO-(TE)-MS-248A	McLay Spur	C-101752	Pardonet	Lower Norian
MS-GB	81-MJO-MS-GB	McLay Spur	C-101753	?Baldonnel	Upper Carnian
MS-1	82-MJO-MS-1	McLay Spur	C-101034	Pardonet	Lower Norian
MS-2	82-MJO-MS-2	McLay Spur	C-101035	Pardonet	Middle Norian
MS-3	82-MJO-MS-3	McLay Spur	C-101036	Pardonet	Middle Norian
MS-4	82-MJO-MS-4	McLay Spur	C-101037	Pardonet	Middle Norian
MS-5	82-MJO-MS-5	McLay Spur	C-101038	Pardonet	Middle Norian
MS-6	82-MJO-MS-6	McLay Spur	C-101039	Pardonet	Middle Norian
MS-7	82-MJO-MS-7	McLay Spur	C-101040	Pardonet	Middle Norian
MS-8	82-MJO-MS-8	McLay Spur	C-101041	Pardonet	Middle Norian
MS-9	82-MJO-MS-9	McLay Spur	C-101042	Pardonet	Middle Norian
MS-10	82-MJO-MS-10	McLay Spur	C-101043	Pardonet	Middle Norian
MS-11	82-MJO-MS-11	McLay Spur	C-101044	Pardonet	Middle Norian
MS-12	82-MJO-MS-12	McLay Spur	C-101046	Pardonet	Middle Norian
MS-12A	82-MJO-MS-12A	McLay Spur	C-101045	Pardonet	Middle Norian
TE-313A	82-MJO-(TE)-313A	McLay Spur	C-101047	Pardonet	Middle Norian
NPP-206-C2	81-MJO-(TE)-NPP-206-C-2	Ne Parle Pas Rapids	C-101765	Bocock/Pardonet	Upper Norian
NPP-LOW	81-MJO-NPP-Low	Ne Parle Pas Rapids	C-101754	Pardonet	Middle Norian
TE-314B	82-OF-(TE)-314B	Near Bocock Peak	C-302391	Bocock/Pardonet	Upper Norian
PH-210B	81-MJO-(TE)-PH-210B	Pardonet Hill	C-101767	Pardonet	Lower Norian

Table A2-1. (cont.)

AFN	FIELD NO.	LOCATION	GSC LOC. NO.	FORMATION	SERIES / STAGE
PH-213B	81-MJO-(TE)-PH-213B	Pardonet Hill	C-101768	Pardonet	Lower Norian
PH-218A	81-MJO-(TE)-PH-218A	Pardonet Hill	C-101770	Pardonet/Baldonnel	Lower Norian/U. Carnian
PH-219B	81-MJO-(TE)-PH-219B	Pardonet Hill	C-101773	Pardonet	Lower Norian
PH-219C	81-MJO-(TE)-PH-219C	Pardonet Hill	C-101774	Pardonet	Lower Norian
PH-221A	81-MJO-(TE)-PH-221A	Pardonet Hill	C-101775	Pardonet	Middle Norian
PH-225A	81-MJO-(TE)-PH-225A	Pardonet Hill	C-101776	Pardonet	Middle Norian
PH-227A	81-MJO-(TE)-PH-227A	Pardonet Hill	C-101778	Pardonet	Middle Norian
PH-227C	81-MJO-(TE)-PH-227C	Pardonet Hill	C-101779	Pardonet	Middle Norian
PH-230A	81-MJO-(TE)-PH-230A	Pardonet Hill	C-101780	Bocock/Pardonet	Upper Norian
PH-237A	81-MJO-(TE)-PH-237A	Pardonet Hill	C-101781	Bocock	Upper Norian
PH-316B	81-MJO-(TE)-PH-316B	Pardonet Hill	C-101782	Pardonet	Lower Norian
PH-317A	81-MJO-(TE)-PH-317A	Pardonet Hill	C-101783	Pardonet	Lower Norian
PH-1	82-MJO-PH-1	Pardonet Hill	C-101048	Pardonet	Lower Norian
PH-2	82-MJO-PH-2	Pardonet Hill	C-101049	Pardonet	Lower Norian
PH-3	82-MJO-PH-3	Pardonet Hill	C-101050	Pardonet	Lower Norian
PH-4	82-MJO-PH-4	Pardonet Hill	C-101051	Pardonet	Lower Norian
PH-5	82-MJO-PH-5	Pardonet Hill	C-101052	Pardonet	Lower Norian
PH-6	82-MJO-PH-6	Pardonet Hill	C-101053	Pardonet	Lower Norian
PH-7	82-MJO-PH-7	Pardonet Hill	C-101054	Pardonet	Lower Norian
PH-9	82-MJO-PH-9	Pardonet Hill	C-101056	Pardonet	Lower Norian
PH-10	82-MJO-PH-10	Pardonet Hill	C-101057	Pardonet	Lower Norian
UPH-1	82-MJO-UPH-1	Pardonet Hill	C-101058	Pardonet/Baldonnel	Lower Norian/U. Carnian
UPH-3	82-MJO-UPH-3	Pardonet Hill	C-101060	Pardonet/Baldonnel	Lower Norian/U. Carnian
UPH-4	82-MJO-UPH-4	Pardonet Hill	C-101061	Pardonet/Baldonnel	Lower Norian/U. Carnian
UPH-5	82-MJO-UPH-5	Pardonet Hill	C-101062	Pardonet/Baldonnel	Lower Norian/U. Carnian
UPH-6	82-MJO-UPH-6	Pardonet Hill (high)	C-101063	Pardonet/Baldonnel	Lower Norian/U. Carnian
GK-1-26	89-(OF)-GK-1-26	Pardonet Hill	C-172264	Charlie Lake	Carnian
GK-2-12	89-(OF)-GK-2-12	Pardonet Hill	C-172263	Charlie Lake	Lower Norian/U. Carnian
GK-2-26	89-(OF)-GK-2-26	Pardonet Hill	C-172266	Charlie Lake	?Carnian
PP-1	80-MJO-PP-1	Pine Pass	C-102782	Pardonet	Lower Norian
PP-2	80-MJO-PP-2	Pine Pass	C-101788	Bocock/Pardonet	Upper Norian
PP-3	80-MJO-PP-3	Pine Pass	C-101135	Bocock/Pardonet	Middle Norian
P82-48F	82-(MJO)-P-82-48F	Toad River	C-090874	Liard	upper? Ladinian
SZ-1	83-MJO-SZ-1	Toad River	C-103858	Liard	upper Ladinian
SZ-2	83-MJO-SZ-2	Toad River	C-103859	Liard	upper Ladinian
SZ-3	83-MJO-SZ-3	Toad River	C-103860	Liard	upper Ladinian
SZ-4	83-MJO-SZ-4	Toad River	C-103861	Liard	upper Ladinian
SZ-5	83-MJO-SZ-5	Toad River	C-103862	Liard	upper Ladinian
MJO-WGS	81-MJO-WGS	West Glacier Spur	C-101814	?Baldonnel	Carnian
GK-68-8-27	88-(OF)-GK-68-8-27	Chowade South	C-145780	Ludington	Carnian
GK-68-8-3	88-(OF)-GK-68-8-3	Chowade South	C-145779	Ludington	upper Ladinian/L. Carnian
GK-68-16-25	88-(OF)-GK-68-16-25	Eleven Mile Creek	C-145788	Baldonnel	Upper Carnian
GK-B	87-(OF)-GK-B	Laurier Pass	C-153083	Ludington	Carnian
GK-LPA	87-(OF)-GK-LPA	Laurier Pass	C-153080	Pardonet	Norian
GK-2-19	88-(OF)-GK-2-19	Laurier Pass	C-145771	Ludington	Carnian
GK-88-1-11	88-(OF)-GK-88-1-11	Laurier Pass	C-145768	Ludington	Upper Carnian
GK-88-1-25	88-(OF)-GK-88-1-25	Laurier Pass	C-145769	Ludington	Upper Carnian
GK-88-3-20C	88-(OF)-GK-88-3-20C	Laurier Pass	C-145774	Ludington	Upper Carnian
GK-1-5	89-(OF)-GK-1-5	McLay Spur	C-172262	Charlie Lake	Carnian
GK-68-10-16	88-(OF)-GK-68-10-16	Mt. Ludington	C-145777	Ludington	Ladinian/Carnian
GK-68-10-18	88-(OF)-GK-68-10-18	Mt. Ludington	C-145778	Ludington	Upper Carnian
GK-69-15-18	88-(OF)-GK-69-15-18	Pink Mountain	C-145789	Pardonet	Lower Norian
GK-3-20	87-(OF)-GK-3-20	Ursula Creek	C-153073	Ludington	Carnian
GK-87-3-14	88-(OF)-GK-87-3-14	Ursula Creek	C-145785	Ludington	Upper Carnian
GK-87-3-16B	88-(OF)-GK-87-3-16 base	Ursula Creek	C-145786b	Ludington	Upper Carnian
GK-87-3-16T	88-(OF)-GK-87-3-16 top	Ursula Creek	C-145786a	Ludington	Upper Carnian

ACE-3                      82-MJO-ACE-3                      Aylard Creek East

GSC locality no.                      : C-101066  
Formation                                : Liard  
Series/Stage                            : upper? Ladinian  
Conodont Zone                         : unzoned  
Ammonoid Zone                        : ?*Maclearnoceras maclearni*  
Ichthyolith Zone                      : *Coniunctio aequirugosa*  
Ichthyoliths:

*Complanicorona glabra* n. gen. et sp. s.f. (2)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (1)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (30)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (42)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (74)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (14)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (4)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (21)  
*Labascicorona alata* n. gen. et sp. s.f. (81)  
*Labascicorona longifossae* n. gen. et sp. s.f. (26)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (2)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (8)  
*Labrilancea glabrisubcuspis* n. gen. et sp. s.f. (3)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (3)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (3)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (15)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (11)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (7)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (17)  
*Parviscapa univelum* n. gen. et sp. s.f. (1)  
*Polyacrodus contrarius* n. sp. (4)  
*Proprigalea languidula* n. gen. et sp. s.f. (5)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (4)  
*Proprigalea medirugosa* n. gen. et sp. s.f. (2)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (27)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (13)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (3)  
*Synechodus volaticus* n. sp. (2)  
*Synechodus* sp. 1 (1)  
*Undulaticorona profundifossae* n. gen. et sp. s.f. (2)  
*Undulaticorona propensa* n. gen. et sp. s.f. (8)  
actinopterygian teeth and scales

Collector                                : M.J. Orchard, 1982

BEH-1                      82-MJO-BEH-1                      Beattie Hill

GSC locality no.                      : C-101067  
Formation                                : Liard  
Series/Stage                            : upper? Ladinian  
Conodont Zone                         : unzoned  
Ammonoid Zone                        : ?*Maclearnoceras maclearni*  
Ichthyolith Zone                      : *Coniunctio aequirugosa*  
Ichthyoliths:

*Complanicorona rugosimargines* n. gen. et sp. s.f. (6)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (11)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (20)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (77)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (14)  
*Labascicorona alata* n. gen. et sp. s.f. (69)  
*Labascicorona longifossae* n. gen. et sp. s.f. (8)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (6)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (2)  
*Lobaticorona tumiditabella* n. gen. et sp. s.f. (3)

*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (16)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (5)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (2)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (8)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (2)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (4)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (10)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (4)  
*Undulaticorona propensa* n. gen. et sp. s.f. (2)  
actinopterygian teeth

Collector : M.J. Orchard, 1982

BEH-2                      82-MJO-BEH-2                      Beattie Hill

GSC locality no. : C-101068  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*

Ichthyoliths:

*Complanicorona glabra* n. gen. et sp. s.f. (13)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (2)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (20)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (23)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (1)  
*Labascicorona alata* n. gen. et sp. s.f. (25)  
*Labascicorona longifossae* n. gen. et sp. s.f. (6)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (1)  
*Labrilancea glabrisubcuspsis* n. gen. et sp. s.f. (6)  
*Labrilancea glabrisubtricuspsis* n. gen. et sp. s.f. (7)  
*Lobaticorona tumiditurris* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (8)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (1)  
*Parviscaptha univelum* n. gen. et sp. s.f. (1)  
*Polyacrodus contrarius* n. sp. (6)  
*Proprigalea languidula* n. gen. et sp. s.f. (1)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (11)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (9)  
*Suaviloquentia obliquilingua* n. gen. et sp. s.f. (2)  
*Synechodus volaticus* n. sp. (6)  
*Undulaticorona propensa* n. gen. et sp. s.f. (2)  
actinopterygian teeth

Collector : M.J. Orchard, 1982

BEH-3                      82-MJO-BEH-3                      Beattie Hill

GSC locality no. : C-101069  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*

Ichthyoliths:

*Complanicorona glabra* n. gen. et sp. s.f. (8)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (11)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (76)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (53)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (127)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (22)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (16)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (39)  
*Labascicorona alata* n. gen. et sp. s.f. (109)

*Labascicorona longifossae* n. gen. et sp. s.f. (53)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (2)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (6)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (6)  
*Labrilancea glabrisubcuspis* n. gen. et sp. s.f. (2)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (4)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (5)  
*Lobaticorona floriditurris* n. gen. et sp. s.f. (3)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (2)  
*Lobaticorona tumiditabella* n. gen. et sp. s.f. (7)  
*Lobaticorona tumiditurris* n. gen. et sp. s.f. (2)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (33)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (22)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (9)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (9)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (26)  
*Parviscapa univelum* n. gen. et sp. s.f. (4)  
*Polyacrodus contrarius* n. sp. (4)  
*Proprigalea languidula* n. gen. et sp. s.f. (9)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (3)  
*Proprigalea medirugosa* n. gen. et sp. s.f. (7)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (25)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (32)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (4)  
*Synechodus volaticus* n. sp. (14)  
*Synechodus* sp. 1 (5)  
*Undulaticorona profundifossae* n. gen. et sp. s.f. (5)  
*Undulaticorona propensa* n. gen. et sp. s.f. (12)  
actinopterygian teeth and scales

Collector : M.J. Orchard, 1982

BEH-4 82-MJO-BEH-4 Beattie Hill

GSC locality no. : C-101070  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*

Ichthyoliths:

*Complanicorona rugosimargines* n. gen. et sp. s.f. (2)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (8)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (5)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (5)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (1)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (6)  
*Labascicorona alata* n. gen. et sp. s.f. (67)  
*Labascicorona longifossae* n. gen. et sp. s.f. (17)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (2)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (1)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (2)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (15)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (6)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (3)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (4)  
*Polyacrodus contrarius* n. sp. (4)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (1)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (7)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (5)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (4)  
*Suaviloquentia obliquilingua* n. gen. et sp. s.f. (1)



- Undulaticorona propensa* n. gen. et sp. s.f. (1)  
actinopterygian teeth
- Collector : M.J. Orchard, 1982
- GK-4-6                      87-(OF)-GK-4-6                      Beattie Ledge
- GSC locality no. : C-153074  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*  
Ichthyoliths:  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (7)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (2)  
*Labascicorona alata* n. gen. et sp. s.f. (6)  
*Labascicorona longifossae* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (1)  
*Proprigalea languidula* n. gen. et sp. s.f. (1)  
actinopterygian teeth
- Collector : D.W. Gibson, 1987
- GK-4-11                      87-(OF)-GK-4-11                      Beattie Ledge
- GSC locality no. : C-153075  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*  
Ichthyoliths:  
*Complanicorona glabra* n. gen. et sp. s.f. (2)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (2)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (43)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (26)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (85)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (7)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (2)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (5)  
*Labascicorona alata* n. gen. et sp. s.f. (85)  
*Labascicorona longifossae* n. gen. et sp. s.f. (20)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (1)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (7)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (3)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (1)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (2)  
*Lobaticorona tumiditabella* n. gen. et sp. s.f. (2)  
*Lobaticorona tumiditurris* n. gen. et sp. s.f. (2)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (11)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (6)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (2)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (14)  
*Parviscapa univelum* n. gen. et sp. s.f. (1)  
*Proprigalea languidula* n. gen. et sp. s.f. (6)  
*Proprigalea medirugosa* n. gen. et sp. s.f. (1)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (9)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (14)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (6)  
*Suaviloquentia obliquilingua* n. gen. et sp. s.f. (1)  
*Synechodus volaticus* n. sp. (4)  
*Synechodus* sp. 1 (1)  
*Undulaticorona profundifossae* n. gen. et sp. s.f. (2)  
*Undulaticorona propensa* n. gen. et sp. s.f. (7)

- actinopterygian teeth and scales  
Collector : D.W. Gibson, 1987
- GK-4-17 87-(OF)-GK-4-17 Beattie Ledge  
GSC locality no. : C-153076  
Formation : Liard  
Series/Stage : upper? Ladinian/Carnian?  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : *Coniunctio aequirugosa*  
Ichthyoliths:  
*Complanicorona glabra* n. gen. et sp. s.f. (1)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (1)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (1)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (1)  
*Labascicorona alata* n. gen. et sp. s.f. (47)  
*Labascicorona longifossae* n. gen. et sp. s.f. (16)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (1)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (3)  
*Labascicorona trifastigia* n. gen. et sp. s.f. (1)  
*Lobaticorona floriditurris* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (6)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (1)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (fragment)  
*Polyacrodus contrarius* n. sp. (1)  
*Proprigalea languidula* n. gen. et sp. s.f. (1)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (1)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (7)  
*Sacrisubcorona submedicarina* n. gen. et sp. s.f. (13)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (3)  
*Synechodus* sp. 1 (1)  
*Undulaticorona propensa* n. gen. et sp. s.f. (2)  
actinopterygian teeth  
Collector : D.W. Gibson, 1987
- GK-4-28 87-(OF)-GK-4-28 Beattie Ledge  
GSC locality no. : C-153077  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : undetermined  
Ichthyoliths : actinopterygian teeth  
Collector : D.W. Gibson, 1987
- GK-4-38 87-(OF)-GK-4-38 Beattie Ledge  
GSC locality no. : C-153078  
Formation : Liard  
Series/Stage : upper? Ladinian  
Conodont Zone : unzoned  
Ammonoid Zone : ?*Maclearnoceras maclearni*  
Ichthyolith Zone : undetermined  
Ichthyoliths:  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (1)  
actinopterygian teeth  
Collector : D.W. Gibson, 1987
- BBR-242A 81-MJO-(TE)-BBR-242A Black Bear Ridge  
GSC locality no. : C-101108  
Formation : Bocoock/Pardonet  
Series/Stage : Upper Norian  
Conodont Zone : Lower *Epigondolella bidentata*  
Ammonoid Zone : *Gnomohalorites cordilleranus* I

- Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- BBR-302B**            **81-MJO-(TE)-BBR-302B**            **Black Bear Ridge**  
 GSC locality no. : C-101110  
 Formation : Bocock/Pardonet  
 Series/Stage : Upper Norian  
 Conodont Zone : Lower *Epigondolella bidentata*  
 Ammonoid Zone : *Gnomohalorites cordilleranus*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- BBR-304B**            **81-MJO-(TE)-BBR-304B**            **Black Bear Ridge**  
 GSC locality no. : C-101112  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella serrulata*  
 Ammonoid Zone : *Mesohimavatites columbianus* III  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- BBR-305A**            **81-MJO-(TE)-BBR-305A**            **Black Bear Ridge**  
 GSC locality no. : C-101113  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- BBR-305B**            **81-MJO-(TE)-BBR-305B**            **Black Bear Ridge**  
 GSC locality no. : C-101114  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Carinasubcorona subradiciplana* n. gen. et sp. s.f. (1)  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (131)  
     *Fragilicorona labritricuspis* n. gen. et sp. s.f. (77)  
     *Fragilicorona unicuspis* n. gen. et sp. s.f. (7)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (38)  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (9)  
     *Rugosicorona devexa* n. gen. et sp. s.f. (4)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- BBR-306A**            **81-MJO-(TE)-BBR-306A**            **Black Bear Ridge**  
 GSC locality no. : C-101115  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (4)  
 Collector : M.J. Orchard, 1981

- BBR-306B            81-MJO-(TE)-BBR-306B            Black Bear Ridge  
 GSC locality no.        : C-101116  
 Formation                : Pardonet  
 Series/Stage            : Middle Norian  
 Conodont Zone         : *Epigondolella postera*  
 Ammonoid Zone         : *Mesohimavatites columbianus* II  
 Ichthyolith Zone       : undetermined  
 Ichthyoliths            : actinopterygian teeth  
 Collector                : M.J. Orchard, 1981
- BBR-309A            81-MJO-(TE)-BBR-309A            Black Bear Ridge  
 GSC locality no.        : C-101117  
 Formation                : Pardonet  
 Series/Stage            : Lower Norian  
 Conodont Zone         : Upper *Metapolygnathus primitius*  
 Ammonoid Zone         : *Stikinoceras kerri*  
 Ichthyolith Zone       : undetermined  
 Ichthyoliths            : actinopterygian teeth  
 Collector                : M.J. Orchard, 1981
- BBR-310B            81-MJO-(TE)-BBR-310B            Black Bear Ridge  
 GSC locality no.        : C-101118  
 Formation                : Baldonnel  
 Series/Stage            : Upper Carnian  
 Conodont Zone         : *Metapolygnathus communisti*  
 Ammonoid Zone         : *Klamathites macrolobatus*  
 Ichthyolith Zone       : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Complanicorona glabra* n. gen. et sp. s.f. (5)  
     *Glabrisubcorona?* sp. 1 s.f. (10)  
     *Labascicorona alata* n. gen. et sp. s.f. (3)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (1)  
     *Minuticorona triculmina* n. gen. et sp. s.f. (2)  
     *Minuticorona uniculmen* n. gen. et sp. s.f. (3)  
     ?*Parviscaptha univelum* n. gen. et sp. s.f. (1)  
     *Parvidiabolus longisulcus* n. gen. et sp. s.f. (1)  
     *Synechodus multinodosus* n. sp. (5)  
     *Synechodus* cf. *multinodosus* n. sp. (2)  
     actinopterygian teeth and scales  
 Collector                : M.J. Orchard, 1981
- BBR-311A            81-MJO-(TE)-BBR-311A            Black Bear Ridge  
 GSC locality no.        : C-101119  
 Formation                : Baldonnel  
 Series/Stage            : Upper Carnian  
 Conodont Zone         : Upper *Metapolygnathus nodosus*  
 Ammonoid Zone         : *Tropites welleri* II  
 Ichthyolith Zone       : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Complanicorona glabra* n. gen. et sp. s.f. (7)  
     *Complanicorona rugosimargines* n. gen. et sp. s.f. (9)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (229)  
     *Lobaticorona floriditabella* n. gen. et sp. s.f. (3)  
     *Lobaticorona tumiditabella* n. gen. et sp. s.f. (5)  
     *Ornatilabrilancea circacarina* n. gen. et sp. s.f. (1)  
     *Synechodus multinodosus* n. sp. (4)  
     *Synechodus* cf. *multinodosus* n. sp. (3)  
     *Synechodus* sp. 2 (3)  
     *Sacrisubcorona circabasis* n. gen. et sp. s.f. (5)  
     *Undulaticorona propensa* n. gen. et sp. s.f. (1)  
     actinopterygian teeth and scales  
 Collector                : M.J. Orchard, 1981

- BBR-1                      82-MJO-BBR-1                      Black Bear Ridge
- GSC locality no.                      : C-101002  
Formation                                : ?Baldonnel  
Series/Stage                             : Upper Carnian  
Conodont Zone                          : *Metapolygnathus communisti*  
Ammonoid Zone                         : *Klamathites macrolobatus*  
Ichthyolith Zone                        : *Synechodus multinodosus*  
Ichthyoliths:  
*Complanicorona glabra* n. gen. et sp. s.f. (55)  
*Glabrisubcorona?* sp. 1 s.f. (152)  
*Labascicorona alata* n. gen. et sp. s.f. (7)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (3)  
*Minuticorona triculmina* n. gen. et sp. s.f. (125)  
*Minuticorona uniculmen* n. gen. et sp. s.f. (77)  
*Synechodus multinodosus* n. sp. (64)  
*Synechodus cf. multinodosus* n. sp. (3)  
*Synechodus* sp. 2 (3)  
*Undulaticorona propensa* n. gen. et sp. s.f. (1)  
actinopterygian teeth and scales  
Collector                                 : M.J. Orchard, 1982
- BBR-2                      82-MJO-BBR-2                      Black Bear Ridge
- GSC locality no.                      : C-101003  
Formation                                : ?Baldonnel  
Series/Stage                             : Upper Carnian  
Conodont Zone                          : *Metapolygnathus communisti*/*Metapolygnathus primitius*  
Ammonoid Zone                         : *Klamathites macrolobatus*  
Ichthyolith Zone                        : *Synechodus multinodosus*  
Ichthyoliths:  
*Complanicorona glabra* n. gen. et sp. s.f. (41)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (1)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (7)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (28)  
*Duplisuggestus profundisulcus* n. gen. et sp. s.f. (4)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (8)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (23)  
*Labascicorona alata* n. gen. et sp. s.f. (60)  
*Labascicorona longifossae* n. gen. et sp. s.f. (18)  
*Labascicorona nitidifastigia* n. gen. et sp. s.f. (2)  
*Labrilancea glabrisubcuspidis* n. gen. et sp. s.f. (6)  
*Labrilancea glabrisubtricuspidis* n. gen. et sp. s.f. (11)  
*Lobaticorona floriditurris* n. gen. et sp. s.f. (2)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (2)  
*Lobaticorona tumiditabella* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (6)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (8)  
*Parvidiabolus convexus* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (3)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (13)  
*Parviscapa trivela* n. gen. et sp. s.f. (6)  
*Parviscapa univelum* n. gen. et sp. s.f. (2)  
*Proprigalea languidula* n. gen. et sp. s.f. (8)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (22)  
*Suaviloquentia brevilingua* n. gen. et sp. s.f. (4)  
*Synechodus volaticus* n. sp. (21)  
*Synechodus cf. multinodosus* n. sp. (1)  
*Undulaticorona propensa* n. gen. et sp. s.f. (2)  
actinopterygian teeth and scales  
Collector                                 : M.J. Orchard, 1982

BBR-3	82-MJO-BBR-3	Black Bear Ridge
GSC locality no.	: C-101004	
Formation	: ?Baldonnel	
Series/Stage	: Upper Carnian	
Conodont Zone	: Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Klamathites macrolobatus</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
BBR-4	82-MJO-BBR-4	Black Bear Ridge
GSC locality no.	: C-101005	
Formation	: ?Baldonnel	
Series/Stage	: Upper Carnian	
Conodont Zone	: Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Klamathites macrolobatus</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
BBR-5	82-MJO-BBR-5	Black Bear Ridge
GSC locality no.	: C-101006	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Upper <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-6	82-MJO-BBR-6	Black Bear Ridge
GSC locality no.	: C-101007	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Upper <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: none found	
Collector	: M.J. Orchard, 1982	
BBR-7	82-MJO-BBR-7	Black Bear Ridge
GSC locality no.	: C-101008	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Upper <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-8	82-MJO-BBR-8	Black Bear Ridge
GSC locality no.	: C-101009	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Upper <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
BBR-12	82-MJO-BBR-12	Black Bear Ridge
GSC locality no.	: C-101013	
Formation	: Pardonet	
Series/Stage	: Middle Norian	



- Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II/I  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (3)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- BBR-13            82-MJO-BBR-13            Black Bear Ridge  
 GSC locality no. : C-101014  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- BBR-14            82-MJO-BBR-14            Black Bear Ridge  
 GSC locality no. : C-101015  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (2)  
     *Fragilicorona labritricuspis* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- BBR-15            82-MJO-BBR-15            Black Bear Ridge  
 GSC locality no. : C-101016  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- BBR-16            82-MJO-BBR-16            Black Bear Ridge  
 GSC locality no. : C-101017  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- BBR-18            82-MJO-BBR-18            Black Bear Ridge  
 GSC locality no. : C-101019  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella serrulata*/*Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* III/II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1982

BBR-19	82-MJO-BBR-19	Black Bear Ridge
GSC locality no.	: C-101020	
Formation	: Pardonet	
Series/Stage	: Middle Norian	
Conodont Zone	: <i>Epigondolella serrulata/Epigondolella postera</i>	
Ammonoid Zone	: <i>Mesohimavatites columbianus</i> III/II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-20	82-MJO-BBR-20	Black Bear Ridge
GSC locality no.	: C-101021	
Formation	: Pardonet	
Series/Stage	: Middle Norian	
Conodont Zone	: <i>Epigondolella serrulata/Epigondolella postera</i>	
Ammonoid Zone	: <i>Mesohimavatites columbianus</i> III/II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-21	82-MJO-BBR-21	Black Bear Ridge
GSC locality no.	: C-101022	
Formation	: Pardonet	
Series/Stage	: Middle Norian	
Conodont Zone	: Lower <i>Epigondolella bidentata/Epigondolella serrulata</i>	
Ammonoid Zone	: <i>Mesohimavatites columbianus</i> IV	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-22	82-MJO-BBR-22	Black Bear Ridge
GSC locality no.	: C-101027	
Formation	: Bocock/Pardonet	
Series/Stage	: Upper Norian	
Conodont Zone	: Lower <i>Epigondolella bidentata</i>	
Ammonoid Zone	: <i>Gnomohalorites cordilleranus</i> I	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian tooth fragment	
Collector	: M.J. Orchard, 1982	
BBR-23	82-MJO-BBR-23	Black Bear Ridge
GSC locality no.	: C-101023	
Formation	: Bocock/Pardonet	
Series/Stage	: Upper Norian	
Conodont Zone	: Lower <i>Epigondolella bidentata/Epigondolella serrulata</i>	
Ammonoid Zone	: <i>Mesohimavatites columbianus</i> IV	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: rare actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
BBR-24	82-MJO-BBR-24	Black Bear Ridge
GSC locality no.	: C-101024	
Formation	: Bocock/Pardonet	
Series/Stage	: Upper Norian	
Conodont Zone	: Lower <i>Epigondolella bidentata</i>	
Ammonoid Zone	: <i>Gnomohalorites cordilleranus</i> I	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	

- BBR-26                    82-MJO-BBR-26                    Black Bear Ridge  
 GSC locality no.            : C-101026  
 Formation                    : Bocoek/Pardonet  
 Series/Stage                : Upper Norian  
 Conodont Zone              : Lower *Epigondolella bidentata*  
 Ammonoid Zone             : *Gnomohalorites cordilleranus* I  
 Ichthyolith Zone            : undetermined  
 Ichthyoliths                : actinopterygian teeth  
 Collector                    : M.J. Orchard, 1982
- BBR-33                    82-MJO-BBR-33                    Black Bear Ridge  
 GSC locality no.            : C-101033  
 Formation                    : Pardonet  
 Series/Stage                : Lower Norian  
 Conodont Zone              : Middle *Epigondolella triangularis*  
 Ammonoid Zone             : *Malayites dawsoni*  
 Ichthyolith Zone            : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (5)  
     actinopterygian teeth  
 Collector                    : M.J. Orchard, 1982
- BH-1                      80-MJO-BH-1                      Brown Hill  
 GSC locality no.            : C-087926  
 Formation                    : Pardonet  
 Series/Stage                : Middle Norian  
 Conodont Zone              : *Epigondolella elongata*  
 Ammonoid Zone             : *Mesohimavatites columbianus* Ic  
 Ichthyolith Zone            : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (3)  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (5)  
     *Fragilicorona unicuspis* n. gen. et sp. s.f. (2)  
     *Suaviloquentia longilingua* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector                    : M.J. Orchard, 1980
- BH-2                      80-MJO-BH-2                      Brown Hill  
 GSC locality no.            : C-089725  
 Formation                    : Pardonet  
 Series/Stage                : Middle Norian  
 Conodont Zone              : *Epigondolella spiculata*  
 Ammonoid Zone             : *Mesohimavatites columbianus* I  
 Ichthyolith Zone            : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (3)  
     actinopterygian teeth  
 Collector                    : M.J. Orchard, 1980
- BH-4                      80-MJO-BH-4                      Brown Hill  
 GSC locality no.            : C-302380  
 Formation                    : Pardonet  
 Series/Stage                : Middle Norian  
 Conodont Zone              : *Epigondolella spiculata*  
 Ammonoid Zone             : *Mesohimavatites columbianus* I  
 Ichthyolith Zone            : undetermined  
 Ichthyoliths                : rare actinopterygian teeth  
 Collector                    : M.J. Orchard, 1980
- BH-5/6                    80-MJO-BH-5/6                    Brown Hill  
 GSC locality no.            : C-302389  
 Formation                    : Pardonet  
 Series/Stage                : Middle Norian

Conodont Zone	:	<i>Epigondolella spiculata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ia/ <i>Drepanites rutherfordi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	
BH-8	80-MJO-BH-8		Brown Hill
GSC locality no.	:	C-087924	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella spiculata</i>	
Ammonoid Zone	:	<i>Drepanites rutherfordi</i>	
Ichthyolith Zone	:	<i>Synechodus incrementum</i>	
Ichthyoliths:			
		<i>Carinasubcorona subradiciplana</i> n. gen. et sp. s.f. (6)	
		<i>Complanicorona subrugosa</i> n. gen. et sp. s.f. (6)	
		<i>Fragilicorona labribrevirostrum</i> n. gen. et sp. s.f. (63)	
		<i>Fragilicorona labricuspis</i> n. gen. et sp. s.f. (200+)	
		<i>Fragilicorona labritricuspis</i> n. gen. et sp. s.f. (6)	
		<i>Fragilicorona unicuspis</i> n. gen. et sp. s.f. (49)	
		<i>Glabrisubcorona arduidevexa</i> n. gen. et sp. s.f. (38)	
		<i>Glabrisubcorona tendibasis</i> n. gen. et sp. s.f. (5)	
		<i>Glabrisubcorona vadosidevexa</i> n. gen. et sp. s.f. (82)	
		<i>Lobaticorona floriditurris</i> n. gen. et sp. s.f. (5)	
		<i>Ornatilabrilancea solicarina</i> n. gen. et sp. s.f. (11)	
		<i>Rugosicorona devexa</i> n. gen. et sp. s.f. (11)	
		<i>Suaviloquentia longilingua</i> n. gen. et sp. s.f. (9)	
		<i>Synechodus incrementum</i> n. sp. (4)	
		actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	
BH-14	80-MJO-BH-14		Brown Hill
GSC locality no.	:	C-302381	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	Lower <i>Epigondolella multidentata</i>	
Ammonoid Zone	:	<i>Drepanites rutherfordi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	
BH-15	80-MJO-BH-15		Brown Hill
GSC locality no.	:	C-087921	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	Lower <i>Epigondolella multidentata</i>	
Ammonoid Zone	:	<i>Drepanites rutherfordi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	
BH-17	80-MJO-BH-17		Brown Hill
GSC locality no.	:	C-087920	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	Lower <i>Epigondolella multidentata</i>	
Ammonoid Zone	:	<i>Drepanites rutherfordi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	

- BH-20                    80-MJO-BH-20                    Brown Hill  
 GSC locality no.                    : C-302382  
 Formation                            : Pardonet  
 Series/Stage                        : Middle Norian  
 Conodont Zone                      : Lower *Epigondolella multidentata*  
 Ammonoid Zone                      : *Drepanites rutherfordi*  
 Ichthyolith Zone                    : *Synechodus incrementum*  
 Ichthyoliths:  
   *Carinasubcorona subradiciplana* n. gen. et sp. s.f. (4)  
   *Complanicorona subrugosa* n. gen. et sp. s.f. (5)  
   *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (74)  
   *Fragilicorona labricuspis* n. gen. et sp. s.f. (49)  
   *Fragilicorona unicuspis* n. gen. et sp. s.f. (7)  
   *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (13)  
   *Glabrisubcorona tendibasis* n. gen. et sp. s.f. (2)  
   *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (104)  
   *Lobaticorona floriditurris* n. gen. et sp. s.f. (3)  
   *Lobaticorona floridibasis* n. gen. et sp. s.f. (1)  
   *Suaviloquentia longilingua* n. gen. et sp. s.f. (17)  
   *Synechodus incrementum* n. sp. (7)  
 actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980
- BH-24                    80-MJO-BH-24                    Brown Hill  
 GSC locality no.                    : C-302383  
 Formation                            : Pardonet  
 Series/Stage                        : Lower Norian  
 Conodont Zone                      : Upper *Epigondolella triangularis*  
 Ammonoid Zone                      : *Juvavites magnus* II  
 Ichthyolith Zone                    : *Synechodus incrementum*  
 Ichthyoliths:  
   *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (1)  
 actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980
- BH-26                    80-MJO-BH-26                    Brown Hill  
 GSC locality no.                    : C-087919  
 Formation                            : Pardonet  
 Series/Stage                        : Lower Norian  
 Conodont Zone                      : Upper *Epigondolella triangularis*  
 Ammonoid Zone                      : *Juvavites magnus* I/II  
 Ichthyolith Zone                    : *Synechodus incrementum*  
 Ichthyoliths:  
   *Fragilicorona labricuspis* n. gen. et sp. s.f. (3)  
 actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980
- BH-27 TOP                80-MJO-BH-27 top                Brown Hill  
 GSC locality no.                    : C-087918  
 Formation                            : Pardonet  
 Series/Stage                        : Lower Norian  
 Conodont Zone                      : Upper *Epigondolella triangularis*  
 Ammonoid Zone                      : *Juvavites magnus* I  
 Ichthyolith Zone                    : *Synechodus incrementum*  
 Ichthyoliths:  
   *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (2)  
   *Fragilicorona labricuspis* n. gen. et sp. s.f. (2)  
   *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
 actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980

BH-27	80-MJO-BH-27	Brown Hill
GSC locality no.	: C-177684	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Upper <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Juvavites magnus</i> I/ <i>Malayites dawsoni</i> III	
Ichthyolith Zone	: <i>Synechodus incrementum</i>	
Ichthyoliths:		
	<i>Fragilicorona labribrevirostrum</i> n. gen. et sp. s.f. (19)	
	<i>Fragilicorona labricuspis</i> n. gen. et sp. s.f. (8)	
	<i>Glbrisubcorona vadosidevexa</i> n. gen. et sp. s.f. (28)	
	<i>Rugosicorona devexa</i> n. gen. et sp. s.f. (2)	
	actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
BH-27 BASE	80-MJO-BH-27 base	Brown Hill
GSC locality no.	: C-302384	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Middle <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> III	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
BH-28U	80-MJO-BH-28U	Brown Hill
GSC locality no.	: C-087973	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Middle <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Juvavites magnus</i> / <i>Malayites dawsoni</i> III	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
BH-29U	80-MJO-BH-29U	Brown Hill
GSC locality no.	: C-087917	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Middle <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Juvavites magnus</i> / <i>Malayites dawsoni</i> III	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
BH-30 TOP	80-MJO-BH-30 top	Brown Hill
GSC locality no.	: C-087916	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Middle <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> III	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
BH-30/31	80-MJO-BH-30/31	Brown Hill
GSC locality no.	: C-087915	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: Middle <i>Epigondolella triangularis</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> II/III	



- Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1980
- BH-41                    80-MJO-BH-41                    Brown Hill  
 GSC locality no. : C-087911  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Lower *Epigondolella triangularis*  
 Ammonoid Zone : *Malayites dawsoni*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1980
- BH-46/47B                80-MJO-BH-46/47B                Brown Hill  
 GSC locality no. : C-302385  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*  
 Ammonoid Zone : *Malayites dawsoni* I  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1980
- BH-47/48                80-MJO-BH-47/48                Brown Hill  
 GSC locality no. : C-087910  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*  
 Ammonoid Zone : *Malayites dawsoni* I/*Stikinoceras kerri* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (1)  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1980
- BH-48                    80-MJO-BH-48                    Brown Hill  
 GSC locality no. : C-087909  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*  
 Ammonoid Zone : *Stikinoceras kerri* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths:  
     *Lobaticorona tumiditurris* n. gen. et sp. s.f. (1)  
     actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1980
- BH-51                    80-MJO-BH-51                    Brown Hill  
 GSC locality no. : C-087908  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*/Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1980

- BH-51A                    80-MJO-BH-51A                    Brown Hill  
 GSC locality no.                    : C-302386  
 Formation                            : Pardonet  
 Series/Stage                        : Lower Norian  
 Conodont Zone                      : Upper *Metapolygnathus primitius*  
 Ammonoid Zone                     : *Stikinoceras kerri* II  
 Ichthyolith Zone                  : *Synechodus incrementum*  
 Ichthyoliths:  
     *Sacrisubcorona submedicarina* n. gen. et sp. s.f. (2)  
     *Synechodus incrementum* n. sp. (2)  
     actinopterygian teeth and scales  
 Collector                            : M.J. Orchard, 1980
- BH-58 BASE                80-MJO-BH-58 base                    Brown Hill  
 GSC locality no.                    : C-087904  
 Formation                            : Pardonet/Baldonnel  
 Series/Stage                        : Upper Carnian  
 Conodont Zone                      : *Metapolygnathus communisti/Upper Metapolygnathus nodosus*  
 Ammonoid Zone                     : *Klamathites macrolobatus/Tropites welleri* II  
 Ichthyolith Zone                  : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Gracilisuggestus triapices* n. gen. et sp. s.f. (1)  
     *Synechodus volaticus* n. sp. (1)  
     actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980
- BH-59                      80-MJO-BH-59                    Brown Hill  
 GSC locality no.                    : C-087903  
 Formation                            : Pardonet/Baldonnel  
 Series/Stage                        : Upper Carnian  
 Conodont Zone                      : *Metapolygnathus nodosus*  
 Ammonoid Zone                     : *Tropites welleri*  
 Ichthyolith Zone                  : undetermined  
 Ichthyoliths                        : actinopterygian teeth  
 Collector                            : M.J. Orchard, 1980
- BH-60                      80-MJO-BH-60                    Brown Hill  
 GSC locality no.                    : C-086792  
 Formation                            : Baldonnel  
 Series/Stage                        : Upper Carnian  
 Conodont Zone                      : *Metapolygnathus nodosus*  
 Ammonoid Zone                     : *Tropites welleri*  
 Ichthyolith Zone                  : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Acrodus?* sp. 1 (2)  
     *Labascicorona longifossae* n. gen. et sp. s.f. (2)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (3)  
     *Synechodus volaticus* n. sp. (1)  
     actinopterygian teeth and scales  
 Collector                            : M.J. Orchard, 1980
- BH-61                      80-MJO-BH-61                    Brown Hill  
 GSC locality no.                    : C-177683  
 Formation                            : Baldonnel  
 Series/Stage                        : Upper Carnian  
 Conodont Zone                      : *Metapolygnathus nodosus*  
 Ammonoid Zone                     : *Tropites welleri*  
 Ichthyolith Zone                  : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (1)  
 Collector                            : M.J. Orchard, 1980

- BH-61B                      80-MJO-BH-61B                      Brown Hill  
 GSC locality no.                      : C-177682  
 Formation                      : Baldonnel  
 Series/Stage                      : Upper Carnian  
 Conodont Zone                      : *Metapolygnathus nodosus*  
 Ammonoid Zone                      : *Tropites welleri*  
 Ichthyolith Zone                      : *Synechodus multinodosus*  
 Ichthyoliths:  
     *Acrodus?* sp. 1 (14)  
     *Complanicorona glabra* n. gen. et sp. s.f. (4)  
     *Complanicorona rugosimargines* n. gen. et sp. s.f. (1)  
     *Labascicorona longifossae* n. gen. et sp. s.f. (1)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (10)  
     *Sacrisubcorona circabasis* n. gen. et sp. s.f. (1)  
     *Sacrisubcorona submedicarina* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector                      : M.J. Orchard, 1980
- BH-62                      80-MJO-BH-62                      Brown Hill  
 GSC locality no.                      : C-087901  
 Formation                      : Baldonnel  
 Series/Stage                      : Upper Carnian  
 Conodont Zone                      : Lower *Metapolygnathus nodosus*  
 Ammonoid Zone                      : *Tropites welleri* I  
 Ichthyolith Zone                      : *Synechodus multinodosus* or *Coniunctio aequirugosa*  
 Ichthyoliths:  
     *Complanicorona glabra* n. gen. et sp. s.f. (2)  
     *Complanicorona rugosimargines* n. gen. et sp. s.f. (1)  
     *Gracilisuggestus triapices* n. gen. et sp. s.f. (2)  
     *Gracilisuggestus uniapex* n. gen. et sp. s.f. (5)  
     *Labascicorona alata* n. gen. et sp. s.f. (7)  
     *Labascicorona longifossae* n. gen. et sp. s.f. (2)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (38)  
     *Lobaticorona floriditabella* n. gen. et sp. s.f. (1)  
     *Sacrisubcorona circabasis* n. gen. et sp. s.f. (3)  
     *Sacrisubcorona submedicarina* n. gen. et sp. s.f. (3)  
     actinopterygian teeth and scales  
 Collector                      : M.J. Orchard, 1980
- GK-1-19                      87-(OF)-GK-1-19                      Brown Hill  
 GSC locality no.                      : C-153069  
 Formation                      : Liard  
 Series/Stage                      : upper? Ladinian  
 Conodont Zone                      : undetermined  
 Ammonoid Zone                      : undetermined  
 Ichthyolith Zone                      : *Coniunctio aequirugosa*  
 Ichthyoliths:  
     *Coniunctio aequirugosa* n. gen. et sp. s.f. (4)  
     *Labascicorona alata* n. gen. et sp. s.f. (5)  
     *Labascicorona longifossae* n. gen. et sp. s.f. (4)  
     *Labrilancea glabrisubtricuspis* n. gen. et sp. s.f. (3)  
     *Lobaticorona floriditabella* n. gen. et sp. s.f. (1)  
     *Parvidiabolus acutus* n. gen. et sp. s.f. (1)  
     *Polyacrodus contrarius* n. sp. (2)  
     *Sacrisubcorona submedicarina* n. gen. et sp. s.f. (2)  
     *Suaviloquentia obliquilingua* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector                      : D.W. Gibson, 1987
- GK-1-20                      87-(OF)-GK-1-20                      Brown Hill  
 GSC locality no.                      : C-153070  
 Formation                      : Liard

- Series/Stage : upper? Ladinian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : *Coniunctio aequirugosa* or *Synechodus multinodosus*  
 Ichthyoliths:  
*Polyacrodus contrarius* n. sp. (1)  
 rare actinopterygian teeth  
 Collector : D.W. Gibson, 1987
- GK-1-38 87-(OF)-GK-1-38 Brown Hill  
 GSC locality no. : C-153071  
 Formation : Liard  
 Series/Stage : upper? Ladinian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : D.W. Gibson, 1987
- GK-1-48 87-(OF)-GK-1-48 Brown Hill  
 GSC locality no. : C-153072  
 Formation : Liard  
 Series/Stage : upper? Ladinian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : *Coniunctio aequirugosa* or *Synechodus multinodosus*  
 Ichthyoliths:  
*Parvidiabolus acutus* n. gen. et sp. s.f. (3)  
*Polyacrodus contrarius* n. sp. (1)  
 actinopterygian teeth  
 Collector : D.W. Gibson, 1987
- Sutherland Zone 80-MJO-Suth. Zone Brown Hill  
 GSC locality no. : C-087972  
 Formation : Liard  
 Series/Stage : upper Ladinian  
 Conodont Zone : *Budurovignathus mungoensis*  
 Ammonoid Zone : *Frankites sutherlandi*  
 Ichthyolith Zone : *Coniunctio aequirugosa*  
 Ichthyoliths:  
*Complanicorona glabra* n. gen. et sp. s.f. (21)  
*Coniunctio aequirugosa* n. gen. et sp. s.f. (5)  
*Coniunctio multirugosa* n. gen. et sp. s.f. (2)  
*Duplisuggestus duplirugosus* n. gen. et sp. s.f. (10)  
*Glabrisubcorona?* sp. 1 s.f. (86)  
 ?*Gracilisuggestus* sp. s.f. (1)  
*Gracilisuggestus triapices* n. gen. et sp. s.f. (3)  
*Gracilisuggestus uniapex* n. gen. et sp. s.f. (4)  
*Labascicorona alata* n. gen. et sp. s.f. (28)  
*Labascicorona longifossae* n. gen. et sp. s.f. (1)  
*Labrilancea glabrisubcuspis* n. gen. et sp. s.f. (51)  
*Labrilancea glabrisubtricuspis* n. gen. et sp. s.f. (43)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (4)  
*Lobaticorona tumidibasis* n. gen. et sp. s.f. (3)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (14)  
*Parvidiabolus acutus* n. gen. et sp. s.f. (1)  
*Parvidiabolus longisulcus* n. gen. et sp. s.f. (1)  
*Parvidiabolus obliquus* n. gen. et sp. s.f. (7)  
*Parviscappha univelum* n. gen. et sp. s.f. (1)  
*Polyacrodus contrarius* n. sp. (5)  
*Prcrisubcorona circabasis* n. gen. et sp. s.f. (16)  
*Sacroprigalea medirugosa* n. gen. et sp. s.f. (2)  
*Saisubcorona submedicarina* n. gen. et sp. s.f. (9)

- Suaviloquentia obliquilingua* n. gen. et sp. s.f. (2)  
*Synechodus volaticus* n. sp. (1)  
*Synechodus* sp. 2 (2)  
*Undulaticorona propensa* n. gen. et sp. s.f. (1)  
actinopterygian teeth and scales  
Collector : M.J. Orchard, 1980
- MJO-119A            83-MJO-(TE)-119A            near Carbon Creek  
GSC locality no.        : C-302392  
Formation                : Pardonet  
Series/Stage            : Middle Norian  
Conodont Zone         : *Epigondolella spiculata*  
Ammonoid Zone         : *Mesohimavatites columbianus* I  
Ichthyolith Zone       : undetermined  
Ichthyoliths            : actinopterygian teeth  
Collector                : M.J. Orchard, 1983
- MJO-119B            83-MJO-(TE)-119B            Carbon Creek  
GSC locality no.        : C-302393  
Formation                : Pardonet  
Series/Stage            : Middle Norian  
Conodont Zone         : *Epigondolella elongata*  
Ammonoid Zone         : *Mesohimavatites columbianus*  
Ichthyolith Zone       : undetermined  
Ichthyoliths            : actinopterygian teeth  
Collector                : M.J. Orchard, 1983
- MJO-119D            83-MJO-(TE)-119D (datum)        Carbon Creek  
GSC locality no.        : C-103869  
Formation                : Pardonet  
Series/Stage            : Middle Norian  
Conodont Zone         : Upper *Epigondolella multidentata*  
Ammonoid Zone         : *Drepanites rutherfordi*  
Ichthyolith Zone       : undetermined  
Ichthyoliths            : rare actinopterygian teeth  
Collector                : M.J. Orchard, 1983
- TE-217D            80-MJO-(TE)-217D            Crying Girl  
GSC locality no.        : C-302387  
Formation                : Pardonet  
Series/Stage            : Middle Norian  
Conodont Zone         : *Epigondolella serrulata*  
Ammonoid Zone         : *Mesohimavatites columbianus* III  
Ichthyolith Zone       : *Synechodus incrementum*  
Ichthyoliths:  
*Fragilicorona brevirostrum* n. gen. et sp. s.f. (22)  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (5)  
*Fragilicorona unicuspis* n. gen. et sp. s.f. (22)  
*Fragilicorona tricuspis* n. gen. et sp. s.f. (17)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (8)  
actinopterygian teeth  
Collector                : M.J. Orchard, 1980
- TE-217E            80-MJO-(TE)-217E            Crying Girl  
GSC locality no.        : C-302388  
Formation                : Pardonet  
Series/Stage            : Middle Norian  
Conodont Zone         : *Epigondolella postera*  
Ammonoid Zone         : *Mesohimavatites columbianus* II  
Ichthyolith Zone       : undetermined  
Ichthyoliths            : actinopterygian teeth  
Collector                : M.J. Orchard, 1980

- TE-220A                      80-MJO-(TE)-220A                      Crying Girl  
 GSC locality no.                      : C-302390  
 Formation                                : Pardonet  
 Series/Stage                            : Middle Norian  
 Conodont Zone                         : Upper *Epigondolella multidentata*  
 Ammonoid Zone                        : *Drepanites rutherfordi*  
 Ichthyolith Zone                      : *Synechodus incrementum*  
 Ichthyoliths:  
     *Carinasubcorona subradiciplana* n. gen. et sp. s.f. (17)  
     *Complanicorona subrugosa* n. gen. et sp. s.f. (6)  
     *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (97)  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (108)  
     *Fragilicorona labritricuspis* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (18)  
     *Glabrisubcorona tendibasis* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (41)  
     *Lobaticorona floriditurris* n. gen. et sp. s.f. (1)  
     *Ornatilabrilancea solicarina* n. gen. et sp. s.f. (11)  
     *Rugosicorona devexa* n. gen. et sp. s.f. (1)  
     *Suaviloquentia longilingua* n. gen. et sp. s.f. (4)  
     *Synechodus incrementum* n. sp. (5)  
 actinopterygian teeth  
 Collector                                : M.J. Orchard, 1980
- EDC-315B                      81-MJO-EDC-315B                      East of Ducette Creek  
 GSC locality no.                      : C-101138  
 Formation                                : Bocock  
 Series/Stage                            : Upper Norian  
 Conodont Zone                         : ?Upper *Epigondolella bidentata*  
 Ammonoid Zone                        : ?*Paracochloceras amoenum*/*Gnomohalorites cordilleranus*  
 Ichthyolith Zone                      : undetermined  
 Ichthyoliths                            : actinopterygian teeth  
 Collector                                : M.J. Orchard, 1981
- MS-243B                      81-MJO-(TE)-MS-243B                      McLay Spur  
 GSC locality no.                      : C-101147  
 Formation                                : Pardonet  
 Series/Stage                            : Middle Norian  
 Conodont Zone                         : Upper *Epigondolella multidentata*  
 Ammonoid Zone                        : *Drepanites rutherfordi*  
 Ichthyolith Zone                      : *Synechodus incrementum*  
 Ichthyoliths:  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
 actinopterygian teeth  
 Collector                                : M.J. Orchard, 1981
- MS-243C                      81-MJO-(TE)-MS-243C                      McLay Spur  
 GSC locality no.                      : C-101148  
 Formation                                : Pardonet  
 Series/Stage                            : Lower Norian  
 Conodont Zone                         : Upper *Epigondolella triangularis*  
 Ammonoid Zone                        : *Juvavites magnus* II  
 Ichthyolith Zone                      : *Synechodus incrementum*  
 Ichthyoliths:  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (2)  
     *Suaviloquentia longilingua* n. gen. et sp. s.f. (fragment)  
 actinopterygian teeth  
 Collector                                : M.J. Orchard, 1981
- MS-244A                      81-MJO-(TE)-MS-244A                      McLay Spur  
 GSC locality no.                      : C-101149  
 Formation                                : Pardonet



- Series/Stage : Lower Norian  
 Conodont Zone : Middle *Epigondolella triangularis*  
 Ammonoid Zone : *Malayites dawsoni* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
*Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (1)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
 actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- MS-247A            81-MJO-(TE)-MS-247A            McLay Spur  
 GSC locality no. : C-101150  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus*  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (159)  
*Fragilicorona labritricuspis* n. gen. et sp. s.f. (103)  
*Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (27)  
*Glabrisubcorona tendibasis* n. gen. et sp. s.f. (1)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (9)  
*Lobaticorona floriditabella* n. gen. et sp. s.f. (1)  
*Ornatilabrilancea solicarina* n. gen. et sp. s.f. (2)  
*Rugosicorona devexa* n. gen. et sp. s.f. (2)  
 actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- MS-247B            81-MJO-(TE)-MS-247B            McLay Spur  
 GSC locality no. : C-101751  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella elongata*  
 Ammonoid Zone : *Mesohimavatites columbianus* Ic  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (1)  
 actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1981
- MS-248A            81-MJO-(TE)-MS-248A            McLay Spur  
 GSC locality no. : C-101752  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*  
 Ammonoid Zone : *Stikinoceras kerri*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : rare actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- MS-GB            81-MJO-MS-GB            McLay Spur  
 GSC locality no. : C-101753  
 Formation : ?Baldonnel  
 Series/Stage : Upper Carnian  
 Conodont Zone : *Metapolygnathus nodosus*/*Metapolygnathus polygnathiformis*  
 Ammonoid Zone : *Tropites welleri*/*Tropites dilleri*  
 Ichthyolith Zone : *Synechodus multinodosus*  
 Ichthyoliths:  
*Acrodus?* sp. 1 (17)  
*Complanicorona glabra* n. gen. et sp. s.f. (7)  
*Complanicorona rugosimargines* n. gen. et sp. s.f. (4)

*Labascicorona alata* n. gen. et sp. s.f. (2)  
*Labascicorona longifossae* n. gen. et sp. s.f. (3)  
*Labascicorona mediflexura* n. gen. et sp. s.f. (32)  
*Ornatilabrilancea circacarina* n. gen. et sp. s.f. (3)  
*Polyacrodus contrarius* n. sp. (6)  
*Proprigalea mediglabra* n. gen. et sp. s.f. (1)  
*Sacrisubcorona circabasis* n. gen. et sp. s.f. (14)  
actinopterygian teeth and scales

Collector : M.J. Orchard, 1981

MS-1                      82-MJO-MS-1                      McLay Spur

GSC locality no. : C-101034  
Formation : Pardonet  
Series/Stage : Lower Norian  
Conodont Zone : Upper *Epigondolella triangularis*  
Ammonoid Zone : *Juvavites magnus* II  
Ichthyolith Zone : *Synechodus incrementum*

Ichthyoliths:

*Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (8)  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (6)  
*Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (3)  
*Glabrisubcorona tendibasis* n. gen. et sp. s.f. (1)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (10)  
actinopterygian teeth

Collector : M.J. Orchard, 1982

MS-2                      82-MJO-MS-2                      McLay Spur

GSC locality no. : C-101035  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Lower *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : *Synechodus incrementum*

Ichthyoliths:

*Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (4)  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (10)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (7)  
actinopterygian teeth

Collector : M.J. Orchard, 1982

MS-3                      82-MJO-MS-3                      McLay Spur

GSC locality no. : C-101036  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Lower *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : *Synechodus incrementum*

Ichthyoliths:

*Carinasubcorona subradiciplana* n. gen. et sp. s.f. (9)  
*Complanicorona subrugosa* n. gen. et sp. s.f. (9)  
*Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (130)  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (200+)  
*Fragilicorona labritricuspis* n. gen. et sp. s.f. (14)  
*Fragilicorona unicuspis* n. gen. et sp. s.f. (13)  
*Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (158)  
*Glabrisubcorona tendibasis* n. gen. et sp. s.f. (48)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (200+)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (29)  
*Lobaticorona floriditurris* n. gen. et sp. s.f. (7)  
*Ornatilabrilancea solicarina* n. gen. et sp. s.f. (3)  
*Rugosicorona devexa* n. gen. et sp. s.f. (33)  
*Suaviloquentia longilingua* n. gen. et sp. s.f. (55)

- Synechodus incrementum* n. sp. (105)  
actinopterygian teeth and scales
- Collector : M.J. Orchard, 1982
- MS-4                    82-MJO-MS-4                    McLay Spur
- GSC locality no. : C-101037  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Lower *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : *Synechodus incrementum*  
Ichthyoliths:  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (1)  
actinopterygian teeth
- Collector : M.J. Orchard, 1982
- MS-5                    82-MJO-MS-5                    McLay Spur
- GSC locality no. : C-101038  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Upper *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : *Synechodus incrementum*  
Ichthyoliths:  
*Complanicorona subrugosa* n. gen. et sp. s.f. (1)  
*Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (20)  
*Fragilicorona labricuspis* n. gen. et sp. s.f. (43)  
*Glabrisubcorona tendibasis* n. gen. et sp. s.f. (4)  
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (32)  
*Lobaticorona floridibasis* n. gen. et sp. s.f. (3)  
*Ornatilabrilancea solicarina* n. gen. et sp. s.f. (1)  
*Rugosicorona devexa* n. gen. et sp. s.f. (3)  
*Suaviloquentia longilingua* n. gen. et sp. s.f. (8)  
*Synechodus incrementum* n. sp. (15)  
actinopterygian teeth and scales
- Collector : M.J. Orchard, 1982
- MS-6                    82-MJO-MS-6                    McLay Spur
- GSC locality no. : C-101039  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Upper *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : *Synechodus incrementum*  
Ichthyoliths:  
*Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (1)  
actinopterygian teeth
- Collector : M.J. Orchard, 1982
- MS-7                    82-MJO-MS-7                    McLay Spur
- GSC locality no. : C-101040  
Formation : Pardonet  
Series/Stage : Middle Norian  
Conodont Zone : Upper *Epigondolella multidentata*  
Ammonoid Zone : *Drepanites rutherfordi*  
Ichthyolith Zone : undetermined  
Ichthyoliths : abundant skeletal debris  
Collector : M.J. Orchard, 1982
- MS-8                    82-MJO-MS-8                    McLay Spur
- GSC locality no. : C-101041  
Formation : Pardonet  
Series/Stage : Middle Norian

Conodont Zone	:	<i>Epigondolella spiculata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ib	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
MS-9	82-MJO-MS-9		McLay Spur
GSC locality no.	:	C-101042	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella spiculata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ib	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
MS-10	82-MJO-MS-10		McLay Spur
GSC locality no.	:	C-101043	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella elongata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ic	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
MS-11	82-MJO-MS-11		McLay Spur
GSC locality no.	:	C-101044	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella elongata/Epigondolella postera</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ic/II	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
MS-12	82-MJO-MS-12		McLay Spur
GSC locality no.	:	C-101046	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella postera</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> II	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
MS-12A	82-MJO-MS-12A		McLay Spur
GSC locality no.	:	C-101045	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella serrulata/Epigondolella postera</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> II	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
TE-313A	82-MJO-(TE)-313A		McLay Spur
GSC locality no.	:	C-101047	
Formation	:	Pardonet	
Series/Stage	:	Middle Norian	
Conodont Zone	:	<i>Epigondolella spiculata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> Ia	

- Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- NPP-206-C2      81-MJO-(TE)-NPP-206-C-2      Ne Parle Pas Rapids  
 GSC locality no. : C-101765  
 Formation : Bocock/Pardonet  
 Series/Stage : Upper Norian  
 Conodont Zone : Lower *Epigondolella bidentata*  
 Ammonoid Zone : *Gnomohalorites cordilleranus*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : rare actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- NPP-LOW      81-MJO-NPP-Low      Ne Parle Pas Rapids  
 GSC locality no. : C-101754  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : Upper *Epigondolella multidentata*  
 Ammonoid Zone : *Drepanites rutherfordi*  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Complanicorona subrugosa* n. gen. et sp. s.f. (2)  
     *Fragilicorona labribrevirostrum* n. gen. et sp. s.f. (5)  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (4)  
     *Fragilicorona unicuspis* n. gen. et sp. s.f. (1)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (3)  
     *Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (6)  
     *Lobaticorona floriditurris* n. gen. et sp. s.f. (1)  
     *Suaviloquentia longilingua* n. gen. et sp. s.f. (4)  
     *Synechodus incrementum* n. sp. (98)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- TE-314B      82-OF-(TE)-314B      near Bocock Peak  
 GSC locality no. : C-302391  
 Formation : Bocock/Pardonet  
 Series/Stage : Upper Norian  
 Conodont Zone : Lower *Epigondolella bidentata*  
 Ammonoid Zone : *Gnomohalorites cordilleranus* I  
 Ichthyolith Zone : undetermined  
 Ichthyoliths:  
     *Suaviloquentia longilingua* n. gen. et sp. s.f. (1)  
     actinopterygian teeth  
 Collector : M.J. Orchard, 1982
- PH-210B      81-MJO-(TE)-PH-210B      Pardonet Hill  
 GSC locality no. : C-101767  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Lower *Epigondolella triangularis*  
 Ammonoid Zone : *Malayites dawsoni*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-213B      81-MJO-(TE)-PH-213B      Pardonet Hill  
 GSC locality no. : C-101768  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : *Epigondolella quadrata*  
 Ammonoid Zone : above *Stikinoceras kerri* II

- Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1981
- PH-218A            81-MJO-(TE)-PH-218A            Pardonet Hill  
 GSC locality no. : C-101770  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Lower *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri* I  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1981
- PH-219B            81-MJO-(TE)-PH-219B            Pardonet Hill  
 GSC locality no. : C-101773  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : few poor actinopterygian tooth fragments  
 Collector : M.J. Orchard, 1981
- PH-219C            81-MJO-(TE)-PH-219C            Pardonet Hill  
 GSC locality no. : C-101774  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : rare actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-221A            81-MJO-(TE)-PH-221A            Pardonet Hill  
 GSC locality no. : C-101775  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella elongata*  
 Ammonoid Zone : *Mesohimavatites columbianus* I  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-225A            81-MJO-(TE)-PH-225A            Pardonet Hill  
 GSC locality no. : C-101776  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella serrulata*  
 Ammonoid Zone : *Mesohimavatites columbianus* III  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-227A            81-MJO-(TE)-PH-227A            Pardonet Hill  
 GSC locality no. : C-101778  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : *Epigondolella postera*  
 Ammonoid Zone : *Mesohimavatites columbianus* II  
 Ichthyolith Zone : *Synechodus incrementum*  
 Ichthyoliths:  
     *Fragilicorona labricuspis* n. gen. et sp. s.f. (22)  
     *Glabrisubcorona arduidevexa* n. gen. et sp. s.f. (1)



*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f. (22)  
actinopterygian teeth

- Collector : M.J. Orchard, 1981
- PH-227C            81-MJO-(TE)-PH-227C            Pardonet Hill  
 GSC locality no. : C-101779  
 Formation : Pardonet  
 Series/Stage : Middle Norian  
 Conodont Zone : Lower *Epigondolella bidentata*/*Epigondolella serrulata*  
 Ammonoid Zone : *Mesohimavatites columbianus* IV  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : rare actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-230A            81-MJO-(TE)-PH-230A            Pardonet Hill  
 GSC locality no. : C-101780  
 Formation : Bocock/Pardonet  
 Series/Stage : Upper Norian  
 Conodont Zone : Lower *Epigondolella bidentata*  
 Ammonoid Zone : *Gnomohalorites cordilleranus*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-237A            81-MJO-(TE)-PH-237A            Pardonet Hill  
 GSC locality no. : C-101781  
 Formation : Bocock  
 Series/Stage : Upper Norian  
 Conodont Zone : ?Upper *Epigondolella bidentata*  
 Ammonoid Zone : ?*Paracochloceras amoenum*/*Gnomohalorites cordilleranus*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-316B            81-MJO-(TE)-PH-316B            Pardonet Hill  
 GSC locality no. : C-101782  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri*  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1981
- PH-317A            81-MJO-(TE)-PH-317A            Pardonet Hill  
 GSC locality no. : C-101783  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth and scales  
 Collector : M.J. Orchard, 1981
- PH-1                82-MJO-PH-1                        Pardonet Hill  
 GSC locality no. : C-101048  
 Formation : Pardonet  
 Series/Stage : Lower Norian  
 Conodont Zone : Upper *Metapolygnathus primitius*  
 Ammonoid Zone : *Stikinoceras kerri* II  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : M.J. Orchard, 1982

PH-2	82-MJO-PH-2	Pardonet Hill
GSC locality no.	: C-101049	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i> II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
PH-3	82-MJO-PH-3	Pardonet Hill
GSC locality no.	: C-101050, 98898	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: above <i>Stikinoceras kerri</i> II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
PH-4	82-MJO-PH-4	Pardonet Hill
GSC locality no.	: C-101051, 98897	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: above <i>Stikinoceras kerri</i> II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
PH-5	82-MJO-PH-5	Pardonet Hill
GSC locality no.	: C-101052	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> I/ <i>Stikinoceras kerri</i> II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
PH-6	82-MJO-PH-6	Pardonet Hill
GSC locality no.	: C-101053	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> I/ <i>Stikinoceras kerri</i> II	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1982	
PH-7	82-MJO-PH-7	Pardonet Hill
GSC locality number	: C-101054, 98896	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> I	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
PH-9	82-MJO-PH-9	Pardonet Hill
GSC locality no.	: C-101056	
Formation	: Pardonet	
Series/Stage	: Lower Norian	

Conodont Zone	:	Lower <i>Epigondolella triangularis</i>	
Ammonoid Zone	:	<i>Malayites dawsoni</i>	
Ichthyolith Zone	:	<i>Synechodus incrementum</i>	
Ichthyoliths:			
		<i>Carinasubcorona subradiciplana</i> n. gen. et sp. s.f. (2)	
		<i>Fragilicorona labribrevirostrum</i> n. gen. et sp. s.f. (10)	
		<i>Fragilicorona labricuspis</i> n. gen. et sp. s.f. (6)	
		<i>Glabrisubcorona arduidevexa</i> n. gen. et sp. s.f. (3)	
		<i>Glabrisubcorona vadosidevexa</i> n. gen. et sp. s.f. (7)	
		<i>Suaviloquentia longilingua</i> n. gen. et sp. s.f. (1)	
		actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
PH-10	82-MJO-PH-10		Pardonet Hill
GSC locality no.	:	C-101057	
Formation	:	Pardonet	
Series/Stage	:	Lower Norian	
Conodont Zone	:	Lower <i>Epigondolella triangularis</i>	
Ammonoid Zone	:	<i>Malayites dawsoni</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare skeletal fragment	
Collector	:	M.J. Orchard, 1982	
UPH-1	82-MJO-UPH-1		Pardonet Hill
GSC locality no.	:	C-101058	
Formation	:	Pardonet/Baldonnel	
Series/Stage	:	Lower Norian/Upper Carnian	
Conodont Zone	:	Upper/Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	:	<i>Stikinoceras kerri/Klamathites macrolobatus</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
UPH-3	82-MJO-UPH-3		Pardonet Hill
GSC locality no.	:	C-101060	
Formation	:	Pardonet/Baldonnel	
Series/Stage	:	Lower Norian/Upper Carnian	
Conodont Zone	:	Upper/Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	:	<i>Stikinoceras kerri/Klamathites macrolobatus</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
UPH-4	82-MJO-UPH-4		Pardonet Hill
GSC locality no.	:	C-101061	
Formation	:	Pardonet/Baldonnel	
Series/Stage	:	Lower Norian/Upper Carnian	
Conodont Zone	:	Upper/Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	:	<i>Stikinoceras kerri/Klamathites macrolobatus</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	
UPH-5	82-MJO-UPH-5		Pardonet Hill
GSC locality no.	:	C-101062	
Formation	:	Pardonet/Baldonnel	
Series/Stage	:	Lower Norian/Upper Carnian	
Conodont Zone	:	Upper/Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	:	<i>Stikinoceras kerri/Klamathites macrolobatus</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1982	

UPH-6	82-MJO-UPH-6	Pardonet Hill (high)
GSC locality no.	: C-101063	
Formation	: Pardonet/Baldonnel	
Series/Stage	: Lower Norian/Upper Carnian	
Conodont Zone	: Upper/Lower <i>Metapolygnathus primitius</i>	
Ammonoid Zone	: <i>Stikinoceras kerri</i> I	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1982	
GK-1-26	89-(OF)-GK-1-26	Pardonet Hill
GSC locality no.	: C-172264	
Formation	: Charlie Lake	
Series/Stage	: Carnian	
Conodont Zone	: undetermined	
Ammonoid Zone	: undetermined	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: rare actinopterygian teeth	
Collector	: D.W. Gibson, 1989	
GK-2-12	89-(OF)-GK-2-12	Pardonet Hill
GSC locality no.	: C-172263	
Formation	: Charlie Lake	
Series/Stage	: Lower Norian/Upper Carnian	
Conodont Zone	: probably Lower <i>Metapolygnathus nodosus</i>	
Ammonoid Zone	: <i>?Tropites welleri</i>	
Ichthyolith Zone	: probably <i>Synechodus multinodosus</i>	
Ichthyoliths:		
<i>Acrodus?</i> sp. 1 (fragment)		
Collector	: D.W. Gibson, 1989	
GK-2-26	89-(OF)-GK-2-26	Pardonet Hill
GSC locality no.	: C-172266	
Formation	: Charlie Lake	
Series/Stage	: ?Carnian	
Conodont Zone	: undetermined	
Ammonoid Zone	: undetermined	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: rare actinopterygian teeth	
Collector	: D.W. Gibson, 1989	
PP-1	80-MJO-PP-1	Pine Pass
GSC locality no.	: C-102782	
Formation	: Pardonet	
Series/Stage	: Lower Norian	
Conodont Zone	: <i>Epigondolella quadrata</i>	
Ammonoid Zone	: <i>Malayites dawsoni</i> I	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth and scales	
Collector	: M.J. Orchard, 1980	
PP-2	80-MJO-PP-2	Pine Pass
GSC locality no.	: C-101788	
Formation	: Bocock/Pardonet	
Series/Stage	: Upper Norian	
Conodont Zone	: Lower <i>Epigondolella bidentata</i>	
Ammonoid Zone	: <i>Gnomohalorites cordilleranus</i>	
Ichthyolith Zone	: undetermined	
Ichthyoliths	: actinopterygian teeth	
Collector	: M.J. Orchard, 1980	
PP-3	80-MJO-PP-3	Pine Pass
GSC locality no.	: C-101135	
Formation	: Bocock/Pardonet	

Series/Stage	:	Middle Norian	
Conodont Zone	:	Lower <i>Epigondolella bidentata</i> / <i>Epigondolella serrulata</i>	
Ammonoid Zone	:	<i>Mesohimavatites columbianus</i> IV/III	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1980	
P82-48F	82-(MJO)-P-82-48F		Toad River
GSC locality no.	:	C-090874	
Formation	:	Liard	
Series/Stage	:	upper? Ladinian	
Conodont Zone	:	unzoned	
Ammonoid Zone	:	? <i>Maclearnoceras maclearni</i>	
Ichthyolith Zone	:	<i>Coniunctio aequirugosa</i> or <i>Synechodus multinodosus</i>	
Ichthyoliths:			
		<i>Polyacrodus contrarius</i> n. sp. (2)	
		actinopterygian teeth	
Collector	:	Paul Psutka/Peter Read, 1982	
SZ-1	83-MJO-SZ-1		Toad River
GSC locality no.	:	C-103858	
Formation	:	Liard	
Series/Stage	:	upper Ladinian	
Conodont Zone	:	<i>Budurovignathus mungoensis</i>	
Ammonoid Zone	:	<i>Frankites sutherlandi</i>	
Ichthyolith Zone	:	<i>Coniunctio aequirugosa</i>	
Ichthyoliths:			
		<i>Synechodus</i> sp. 1 (1)	
		actinopterygian teeth	
Collector	:	M.J. Orchard, 1983	
SZ-2	83-MJO-SZ-2		Toad River
GSC locality no.	:	C-103859	
Formation	:	Liard	
Series/Stage	:	upper Ladinian	
Conodont Zone	:	<i>Budurovignathus mungoensis</i>	
Ammonoid Zone	:	<i>Frankites sutherlandi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1983	
SZ-3	83-MJO-SZ-3		Toad River
GSC locality no.	:	C-103860	
Formation	:	Liard	
Series/Stage	:	upper Ladinian	
Conodont Zone	:	<i>Budurovignathus mungoensis</i>	
Ammonoid Zone	:	<i>Frankites sutherlandi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian tooth fragment	
Collector	:	M.J. Orchard, 1983	
SZ-4	83-MJO-SZ-4		Toad River
GSC locality no.	:	C-103861	
Formation	:	Liard	
Series/Stage	:	upper Ladinian	
Conodont Zone	:	<i>Budurovignathus mungoensis</i>	
Ammonoid Zone	:	<i>Frankites sutherlandi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	few unidentified elasmobranch teeth and scales	
Collector	:	M.J. Orchard, 1983	
SZ-5	83-MJO-SZ-5		Toad River
GSC locality no.	:	C-103862	
Formation	:	Liard	

Series/Stage	:	upper Ladinian	
Conodont Zone	:	<i>Budurovignathus mungoensis</i>	
Ammonoid Zone	:	<i>Frankites sutherlandi</i>	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1983	
MJO-WGS	81-MJO-WGS		West Glacier Spur
GSC locality no.	:	C-101814	
Formation	:	?Baldonnel	
Series/Stage	:	Carnian	
Conodont Zone	:	undetermined	
Ammonoid Zone	:	undetermined	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	actinopterygian teeth	
Collector	:	M.J. Orchard, 1981	
GK-68-8-27	88-(OF)-GK-68-8-27		Chowade South
GSC locality no.	:	C-145780	
Formation	:	Ludington	
Series/Stage	:	Carnian	
Conodont Zone	:	undetermined	
Ammonoid Zone	:	undetermined	
Ichthyolith Zone	:	<i>Synechodus multinodosus</i>	
Ichthyoliths:			
		<i>Acrodus?</i> sp. 1 (fragment)	
		<i>Complanicorona glabra</i> n. gen. et sp. s.f. (4)	
		<i>Labascicorona alata</i> n. gen. et sp. s.f. (4)	
		<i>Labascicorona mediflexura</i> n. gen. et sp. s.f. (1)	
		<i>Sacrisubcorona circabasis</i> n. gen. et sp. s.f. (3)	
		<i>Synechodus multinodosus</i> n. sp. (1)	
		<i>Synechodus</i> cf. <i>multinodosus</i> n. sp. (1)	
		actinopterygian teeth	
Collector	:	D.W. Gibson, 1988	
GK-68-8-3	88-(OF)-GK-68-8-3		Chowade South
GSC locality no.	:	C-145779	
Formation	:	Ludington	
Series/Stage	:	upper Ladinian/Lower Carnian	
Conodont Zone	:	undetermined	
Ammonoid Zone	:	undetermined	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	D.W. Gibson, 1988	
GK-68-16-25	88-(OF)-GK-68-16-25		Eleven Mile Creek
GSC locality no.	:	C-145788	
Formation	:	Baldonnel	
Series/Stage	:	Upper Carnian	
Conodont Zone	:	undetermined	
Ammonoid Zone	:	undetermined	
Ichthyolith Zone	:	undetermined	
Ichthyoliths	:	rare actinopterygian teeth	
Collector	:	D.W. Gibson, 1988	
GK-B	87-(OF)-GK-B		Laurier Pass
GSC locality no.	:	C-153083	
Formation	:	Ludington	
Series/Stage	:	Carnian	
Conodont Zone	:	undetermined	
Ammonoid Zone	:	undetermined	



- Ichthyolith Zone : undetermined  
 Ichthyoliths : rare unidentified elasmobranch scales  
 Collector : D.W. Gibson, 1987
- GK-LPA 87-(OF)-GK-LPA Laurier Pass  
 GSC locality no. : C-153080  
 Formation : Pardonet  
 Series/Stage : Norian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : D.W. Gibson, 1987
- GK-2-19 88-(OF)-GK-2-19 Laurier Pass  
 GSC locality no. : C-145771  
 Formation : Ludington  
 Series/Stage : Carnian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : actinopterygian teeth  
 Collector : D.W. Gibson, 1988
- GK-88-1-11 88-(OF)-GK-88-1-11 Laurier Pass  
 GSC locality no. : C-145768  
 Formation : Ludington  
 Series/Stage : Upper Carnian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : *Coniunctio aequirugosa* or *Synechodus multinodosus*  
 Ichthyoliths:  
     *Gracilisuggestus triapices* n. gen. et sp. s.f. (2)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (5)  
     *Synechodus volaticus* n. sp. (1)  
     actinopterygian teeth  
 Collector : D.W. Gibson, 1988
- GK-88-1-25 88-(OF)-GK-88-1-25 Laurier Pass  
 GSC locality no. : C-145769  
 Formation : Ludington  
 Series/Stage : Upper Carnian  
 Conodont Zone : undetermined  
 Ammonoid Zone : undetermined  
 Ichthyolith Zone : undetermined  
 Ichthyoliths : rare actinopterygian teeth  
 Collector : D.W. Gibson, 1988
- GK-88-3-20C 88-(OF)-GK-88-3-20C Laurier Pass  
 GSC locality no. : C-145774  
 Formation : Ludington  
 Series/Stage : Upper Carnian  
 Conodont Zone : ?*Metapolygnathus nodosus*  
 Ammonoid Zone : ?*Tropites welleri*  
 Ichthyolith Zone : probably *Synechodus multinodosus*  
 Ichthyoliths:  
     *Acrodus?* sp. 1 (1)  
     actinopterygian teeth and scales  
 Collector : D.W. Gibson, 1988

- GK-1-5                    89-(OF)-GK-1-5                    McLay Spur  
 GSC locality no.            : C-172262  
 Formation                    : Charlie Lake  
 Series/Stage                : Carnian  
 Conodont Zone              : undetermined  
 Ammonoid Zone             : undetermined  
 Ichthyolith Zone          : undetermined  
 Ichthyoliths                : actinopterygian teeth  
 Collector                    : D.W. Gibson, 1989
- GK-68-10-16            88-(OF)-GK-68-10-16            Mount Ludington  
 GSC locality no.            : C-145777  
 Formation                    : Ludington  
 Series/Stage                : Ladinian/Carnian  
 Conodont Zone              : undetermined  
 Ammonoid Zone             : undetermined  
 Ichthyolith Zone          : undetermined  
 Ichthyoliths                : rare actinopterygian teeth  
 Collector                    : D.W. Gibson, 1988
- GK-68-10-18            88-(OF)-GK-68-10-18            Mount Ludington  
 GSC locality no.            : C-145778  
 Formation                    : Ludington  
 Series/Stage                : Upper Carnian  
 Conodont Zone              : undetermined  
 Ammonoid Zone             : undetermined  
 Ichthyolith Zone          : undetermined  
 Ichthyoliths                : rare actinopterygian teeth  
 Collector                    : D.W. Gibson, 1988
- GK-69-15-18            88-(OF)-GK-69-15-18            Pink Mountain  
 GSC locality no.            : C-145789  
 Formation                    : Pardonet  
 Series/Stage                : Lower Norian  
 Conodont Zone              : *Epigondolella quadrata*, "Abneptis A"  
 Ammonoid Zone             : *Malayites dawsoni* I/*Stikinoceras kerri* II  
 Ichthyolith Zone          : undetermined  
 Ichthyoliths                : actinopterygian teeth and scales  
 Collector                    : D.W. Gibson, 1988
- GK-3-20                    87-(OF)-GK-3-20                    Ursula Creek  
 GSC locality no.            : C-153073  
 Formation                    : Ludington  
 Series/Stage                : Carnian  
 Conodont Zone              : ?*Metapolygnathus communisti*/*Metapolygnathus nodosus*  
 Ammonoid Zone             : *Klamathites macrolobatus*/*Tropites welleri*  
 Ichthyolith Zone          : *Synechodus multinodosus* or *Coniunctio aequirugosa*  
 Ichthyoliths:  
     *Duplisuggestus duplirugosus* n. gen. et sp. s.f. (1)  
     *Labascicorona mediflexura* n. gen. et sp. s.f. (2)  
     actinopterygian teeth  
 Collector                    : D.W. Gibson, 1987
- GK-87-3-14              88-(OF)-GK-87-3-14              Ursula Creek  
 GSC locality no.            : C-145785  
 Formation                    : Ludington  
 Series/Stage                : Upper Carnian  
 Conodont Zone              : undetermined  
 Ammonoid Zone             : undetermined  
 Ichthyolith Zone          : undetermined  
 Ichthyoliths                : none found  
 Collector                    : D.W. Gibson, 1988

GK-87-3-16B      88-(OF)-GK-87-3-16 base      Ursula Creek  
GSC locality no.      : C-145786b  
Formation      : Ludington  
Series/Stage      : Upper Carnian  
Conodont Zone      : ?Upper *Metapolygnathus nodosus*  
Ammonoid Zone      : ?*Tropites welleri*  
Ichthyolith Zone      : undetermined  
Ichthyoliths      : actinopterygian teeth  
Collector      : D.W. Gibson, 1988

GK-87-3-16T      88-(OF)-GK-87-3-16 top      Ursula Creek  
GSC locality no.      : C-145786a  
Formation      : Ludington  
Series/Stage      : Upper Carnian  
Conodont Zone      : ?Upper *Metapolygnathus nodosus*  
Ammonoid Zone      : ?*Tropites welleri*  
Ichthyolith Zone      : undetermined  
Ichthyoliths      : actinopterygian teeth  
Collector      : D.W. Gibson, 1988

## APPENDIX 3

### A coded utilitarian system for identifying Triassic elasmobranch ichthyoliths from the Peace River area, northeastern British Columbia

A revised identification system from “A coded utilitarian system for identifying Paleozoic ichthyoliths” (Tway, 1984; Doyle et al., 1974) is used and included below. The original system consists of letters and numbers that are used to describe ichthyolith morphology. The system was designed to be computer compatible and provide an immediate alternative method to identify ichthyoliths for geological and stratigraphical purposes. Linnaean binomial names can be assigned as soon as morphological variation and biological relationships of ichthyoliths are more clearly understood and recognized.

At the highest level of the utilitarian system, the letter “a” refers to the general outline of an ichthyolith and is followed by a number that refers to a description of the outline. A slash “/” separates letter categories. The letter “b” and a number refer to a description of prominent features on the ichthyolith (particularly the upper crown or blade surface). The first two letters “a” and “b” describe major ichthyolith groups called types (e.g. Type a4/b2, a lanceolate ichthyolith with lines, ridges, or keels). A type is further subdivided into a subtype with subsequent letter and number descriptors. An example of another type is: Type a13/b±2+6.

An example of a subtype of the above type is: Subtype a13/b±2+6/c3/d2+5+7/e2/f1/g2+4+5/h2,3/i1,2.

Each letter must have at least one number but may have more than one. A variety of symbols with different meanings may be used to separate numbers as follows:

A comma [e.g. h2,3] is used to indicate that either feature 2 or 3 may be present, but not both.

A hyphen [e.g. f1-6] indicates variability in this feature such as having 1 to 6 lines on a surface.

A plus [e.g. d2+5] indicates that both features are present.

A ± [e.g. b ± 2+6] means that the ichthyolith may or may not have character b2, and has character b6.

A ≥ [e.g. i ≥ 5] is used where numbers of a feature are counted, and in this case 5 or more are present.

Brackets around numbers [e.g. b(3,4)+6] are used to group numbers separated by a comma and to distinguish those separated by a + or ±. In this example, the ichthyolith has character b3 or b4 and character b6.

New additions or revisions to the Tway (1984) utilitarian system included below are highlighted in bold. Only types and subtypes used to identify elasmobranch ichthyoliths from the Triassic Peace River area are included (please refer to Tway, 1984 for the remaining types and subtypes).

Some of the more global terminology changes are as follows:

1. Platform is changed to pedicle (platform will be used instead to represent a mesial structure on the upper crown or element surface).
2. Element is changed to crown (to differentiate an ichthyolith pedicle and crown from an element. An element is the whole ichthyolith structure [pedicle and crown]).
3. “Reverse (posterior) side of blade” is changed to subcrown (to represent the surface below the crown where the pedicle is attached).

### CODED IDENTIFICATION SYSTEM

#### a. General outline:

1. none of the following
2. elliptical or lanceolate, one edge acutely dentate
3. polygonal without a **pedicle**
4. lanceolate or somewhat polygonal with a **pedicle**
5. circular to elliptical with a **pedicle**; if elliptical, width greater than length
6. elliptical with a **pedicle**; length greater than width
7. approximately triangular with two or three lateral projections
8. approximately triangular with straight or curved axis, and with a prominent angular flexure of one or both margins

9. approximately triangular or conical with straight or curved axis, and without a prominent flexure of either margin
  10. multicuspid with cusps of equal size
  11. multicuspid with cusps of unequal size
  12. dome-shaped
  13. mushroom-shaped with rounded or flattened surface **and a pedicle**
  14. pyramid-shaped
  15. bar-shaped
  16. circular to subcircular without a **pedicle**
  17. **sail-shaped crown (triangular, taller than wide, and with a curved diagonal); on a flaring pedicle that is broader at its basal edges than the crown**
- b. Features on **upper crown** surface:
1. none of the following
  2. parallel or subparallel lines, **ridges, and** (or) keels; if parallel lines radiate, they do so from a single edge or from a point on the margin
  3. lines radiate from the centre of **crown**
  4. in elliptical or subcircular forms, one single or double, straight or arcuate line across the greatest dimension
  5. in triangular or conical forms, transverse line
  6. a distinct **curved or** undulating line **or ridge** approximately parallel to **curved**, undulating or dentate edge
  7. in triangular forms with rounded apex, median line
  8. element entirely translucent
  9. concentric lines
  10. stippled surface
  11. **granular surface**

**Type a2/b(1,2)±6**

- c. Number of peaks on **posterior** (dentate) **margin** (edge):
0. indeterminate
  1. one
  2. two
  3. three
  - etc.
- d. Length/width ratio of **crown**:
0. **indeterminate**
  1. length greater than width
  2. length approximately equal to width
  3. length less than width
- e. **Crown** symmetry:
0. indeterminate
  1. **crown** symmetrical on both sides of median plane
  2. **crown** asymmetrical
- f. Peak size; median peak in relation to lateral peaks:
0. indeterminate
  1. median peak less than twice length of lateral peaks
  2. median peak twice to three times length of lateral peaks
  3. median peak more than three times length of lateral peaks
  4. median peak shorter than lateral peaks

- g. Depressions between peaks:
  - 0. indeterminate
  - 1. U-shaped
  - 2. V-shaped
  - 3. slit-like
  
- h. **Anterior crown** margin opposite peaks:
  - 0. indeterminate
  - 1. rounded
  - 2. approximately V-shaped
  - 3. irregular, uneven, or undulating (**may have mesial protrusion**)
  - 4. flared into an irregular structure
  
- i. Features present on **upper crown surface**:
  - 0. indeterminate or absent
  - 1. tridentate feature at **crown anterior margin**
  - 2. parallel or subparallel lines, **ridges**, or keels that do not converge
  - 3. subparallel lines, **ridges**, or keels converging at **anterior margin** (end opposite peaks)
  - 4. subparallel lines, **ridges**, or keels converging at **posterior** margin with peaks
  - 5. narrow differentiated area along **all** margins
  - 6. network of fine, transverse secondary lines
  - 7. dendritic pattern of secondary lines
  - 8. scalloped pattern of secondary lines
  - 9. toothed keels
  - 10. **faint and often discontinuous line parallel to anterior crown margins**
  - 11. **prominent and continuous line, ridge, or keel parallel to anterior crown margins**
  - 12. **lines, ridges, or keels that curve over crown anterior and posterior margins**
  - 13. **median keel or platform that is more raised and broader than lateral lines, ridges, keels, or platforms**
  
- j. Number of lines, **ridges**, or keels on **upper crown surface** (includes those forming the mesial platform):
  - 0. indeterminate or absent
  - Recorded as numbers
  
- k. Outline of **subpedicle surface**:
  - 0. indeterminate
  - 1. circular to subcircular
  - 2. triangular with apex pointing anteriorly
  - 3. triangular with apex pointing posteriorly
  - 4. very elongated below **crown**
  - 5. square to cruciform
  - 6. ovoid to cruciform
  - 7. irregular
  - 8. crescentic
  - 9. lobed
  - 10. **tetrapetaloid**
  - 11. **multipetaloid**
  
- l. Size of **pedicle** (at anterior and sides):
  - 0. **indeterminate**
  - 1. **pedicle** wider than **crown**
  - 2. **pedicle** same width as **crown**
  - 3. **pedicle** narrower than **crown**



- m. Features on subcrown:**
0. indeterminate
  1. absent (smooth)
  2. median line, ridge, keel, or platform
  3. two lines, ridges, keels, or platforms
  4. three or more short parallel to subparallel lines, ridges, or keels that commonly do not exceed  $\frac{1}{2}$  crown length
  5. three or more long parallel to subparallel lines, ridges, or keels that commonly exceed  $\frac{1}{2}$  crown length and often extend from posterior pedicle margin to posterior crown margin or apex
  6. curved line, ridge, or keel near subcrown centre posterior region around pedicle
  7. curved depression surrounding junction of crown and pedicle
- n. Upper crown mesial platform (or differentiated structure):**
0. indeterminate
  1. absent or considerably reduced
  2. line, ridge, or keel
  3. narrow and elongate lanceolate (rounded anterior margin, pointed posterior margin), (greater than five times longer than wide)
  4. elongate lanceolate (three to five times longer than wide)
  5. lanceolate (greater than one to less than three times longer than wide)
  6. broad lanceolate (equally as long as wide, or wider than long)
  7. narrow and elongate rhomboid (greater than five times longer than wide)
  8. elongate rhomboid (three to five times longer than wide)
  9. rhomboid (two to three times longer than wide)
  10. broad rhomboid (equally as long as wide, or wider than long)
  11. long, extends anterior to posterior (greater than  $\frac{1}{2}$  crown length)
  12. short, (less than or equal to  $\frac{1}{2}$  crown length)
  13. with internal lines, ridges, or keels (that are not closely paired)
  14. with closely paired lines, ridges, or keels
- p. Anterior crown overhang of pedicle/crown junction:**
0. indeterminate
  1. absent (crown drops obliquely or vertically to pedicle)
  2. minor (crown slightly curves under to pedicle)
  3. prominent (crown significantly under to pedicle)
- q. Pedicle type:**
0. indeterminate
  1. tetrahedroid
  2. keeled tetrahedroid
  3. expanded tetrahedroid
  4. keeled expanded tetrahedroid
  5. fluted truncate
  6. keeled fluted truncate
  7. plain truncate
  8. keeled plain truncate
- r. Subpedicle surface:**
0. indeterminate
  1. flat
  2. concave
  3. convex
  4. convex with bulge to one side

s. **Crown curvature from side edge to side edge:**

0. indeterminate
1. **approximately flat (may be equally undulating)**
2. **convex (may be undulating, but mesially highest)**
3. **concave (may be undulating, but mesially lowest)**

**Type a3,4/b(1,2)±6**

c. **Shape of crown:**

0. indeterminate
1. lanceolate, larger than 1.0 mm (refer to c2 below for *d, e, f, g, h, i, j, l, m, and n*)
2. lanceolate, smaller than 1.0 mm

d. **Features on upper crown surface:**

0. indeterminate
1. absent (**smooth**)
2. one median line, **ridge, keel, or platform**
3. two lines, **ridges, or keels**
4. three or more parallel to subparallel lines, **ridges, or keels** that do not converge centrally
5. three or more parallel to subparallel lines, **ridges, or keels** that converge centrally
6. irregular network of lines
7. **faint and often discontinuous line parallel to anterior crown margins**
8. **prominent and continuous line, ridge, or keel parallel to anterior crown margins**
9. **lines, ridges, or keels that curve over crown anterior and posterior margins**
10. **median keel or platform that is more raised and broader than lateral lines, ridges, keels, or platforms without closely paired lines, ridges or keels**
11. **platform with interior paired lines, ridges, or keels; furrows on each side of platform do not undercut**
12. **high platforms with interior paired lines, ridges, or keels; deep furrows on each side of platform that undercut**

e. **Anterior crown margin opposite peak:**

0. indeterminate or none of the following
1. rounded
2. approximately V-shaped, angular
3. irregular, uneven, or undulating (**may have mesial protrusion**)
4. flared into an irregular structure

f. **Outline of subpedicle surface:**

0. indeterminate
1. equilateral triangle
2. isosceles triangle
3. circular to subcircular, smooth margins
4. square to diamond (**rhomboid**) shaped
5. **circular to subcircular, crenulated margins**
6. cruciform
7. ovoid
8. **tetrapetaloid**
9. **multipetaloid**

g. **Size of pedicle (at anterior and sides):**

0. indeterminate
1. **pedicle wider than crown**
2. **pedicle same width as crown**
3. **pedicle narrower than crown**

- h. Development of lateral peaks on **posterior crown**:
  - 0. indeterminate
  - 1. no development, smooth margins
  - 2. some development, irregular margins
  
- i. Length/width ratio of **crown**:
  - 0. indeterminate
  - 1. length greater than width, but less than three times width
  - 2. length approximately equal to width
  - 3. length less than width
  - 4. length greater than three times width
  
- j. **Upper crown mesial platform (or differentiated structure)**:
  - 0. indeterminate
  - 1. absent or considerably reduced
  - 2. line, ridge, or keel
  - 3. narrow and elongate lanceolate (rounded anterior margin, pointed posterior margin), (greater than five times longer than wide)
  - 4. elongate lanceolate (three to five times longer than wide)
  - 5. lanceolate (greater than one to less than three times longer than wide)
  - 6. broad lanceolate (equally as long as wide, or wider than long)
  - 7. narrow and elongate rhomboid (greater than five times longer than wide)
  - 8. elongate rhomboid (three to five times longer than wide)
  - 9. rhomboid (two to three times longer than wide)
  - 10. broad rhomboid (equally as long as wide, or wider than long)
  - 11. long, extends anterior to posterior (greater than 1/2 crown length)
  - 12. short, (less than or equal to 1/2 crown length)
  - 13. with internal lines, ridges, or keels (that are not closely paired)
  - 14. with closely paired lines, ridges, or keels
  
- k. **Features on subcrown**:
  - 0. indeterminate
  - 1. absent (smooth)
  - 2. median line, ridge, keel, or platform
  - 3. two lines, ridges, keels, or platforms
  - 4. three or more short parallel to subparallel lines, ridges, or keels that commonly do not exceed 1/2 longer crown length
  - 5. three or more long parallel to subparallel lines, ridges, or keels that commonly extend from posterior pedicle margin to posterior crown margin or apex
  - 6. curved line, ridge, or keel near subcrown centre posterior region around pedicle
  - 7. curved depression surrounding junction of crown and pedicle
  
- l. **Anterior crown overhang of pedicle/crown junction**:
  - 0. indeterminate
  - 1. absent (crown drops obliquely or vertically to pedicle)
  - 2. minor (crown slightly curves under to pedicle)
  - 3. prominent (crown significantly under to pedicle)
  
- m. **Pedicle type**:
  - 0. indeterminate
  - 1. tetrahedroid
  - 2. keeled tetrahedroid
  - 3. expanded tetrahedroid
  - 4. keeled expanded tetrahedroid
  - 5. fluted truncate
  - 6. keeled fluted truncate

- 7. **plain truncate**
  - 8. **keeled plain truncate**
- n. **Subpedicle surface:**
- 0. **indeterminate**
  - 1. **flat**
  - 2. **concave**
  - 3. **convex**
  - 4. **convex with bulge to one side**
3. kite-shaped, with longer sides concave
4. rhombic
- d. **Pattern of lines, ridges, or keels on upper crown surface:**
- 0. indeterminate
  - 1. absent
  - 2. one line, **ridge, or keel**
  - 3. **two** or more parallel to subparallel lines, **ridges, or keels** that do not converge centrally
  - 4. three or more parallel to subparallel lines that converge at or near one corner
  - 5. irregular network of lines, **ridges, or keels**
  - 6. concentric chevrons, with centre at one corner of **crown**
  - 7. concentric rhombs with centre at middle of **crown**
  - 8. many parallel or subparallel lines arising predominantly from one or two edges of crown
  - 9. concentric rhombs with centre at one corner of **crown**
- e. **Length/width ratio of crown:**
- 0. indeterminate
  - 1. length greater than width
  - 2. length approximately same as width
  - 3. **length less than width**
- f. **Other features present:**
- 0. indeterminate
  - 1. no other significant features
  - 2. one **line, ridge, or keel** on **subcrown**
  - 3. **pedicle** present
  - 4. more than one **line, ridge, or keel** on **subcrown**
  - 5. extension of crown into a peg-like structure
  - 6. **subcrown smooth and unornamented**
  - 7. **one or two crown edges serrated**
  - 8. **upper crown surface with stippled region(s)**
  - 9. **canal opening(s) or hooded foramina on upper crown surface**
- g. **Thickness of element:**
- 0. indeterminate
  - 1. very flattened (thickness **less than** 1/4 width)
  - 2. moderately flattened (thickness = 1/4 **to** 1/2 width)
  - 3. moderately thick (thickness = 1/2 **to** 1 times width)
  - 4. very thick (thickness greater than width)

**Type a5/b(1,2)±6**

- c. Length/width ratio of crown:
0. indeterminate
  1. length same as width
  2. length less than width
- d. Features on upper crown surface:
0. indeterminate
  1. absent (smooth)
  2. one median line, ridge, keel, or platform
  3. two lines, ridges, or keels
  4. three or more parallel to subparallel lines, ridges, or keels that do not converge centrally
  5. three or more parallel to subparallel lines, ridges, or keels that converge centrally
  6. irregular network of lines
  7. faint and often discontinuous line parallel to anterior crown margins
  8. prominent and continuous line, ridge, or keel parallel to anterior crown margins
  9. lines, ridges, or keels that curve over crown anterior and posterior margins
  10. median keel or platform that is more raised and broader than lateral lines, ridges, keels, or platforms without closely paired lines, ridges or keels
- e. Outline of pedicle:
0. indeterminate
  1. circular to subcircular
  2. triangular
  3. elliptical with smooth margins
  4. elliptical with crenulated margins
  5. square to cruciform
  6. multipetaloid
- f. Size of pedicle:
0. indeterminate
  1. pedicle wider than crown
  2. pedicle approximately same width as crown
  3. pedicle narrower than crown
- g. Features on subcrown:
0. indeterminate
  1. absent (smooth)
  2. median line, ridge, keel, or platform
  3. two lines, ridges, keels, or platforms
  4. three or more short parallel to subparallel lines, ridges, or keels that commonly do not exceed  $\frac{1}{2}$  longer crown length
  5. three or more long parallel to subparallel lines, ridges, or keels that commonly extend from posterior pedicle margin to posterior crown margin or apex
  6. curved line, ridge, or keel near subcrown centre posterior region around pedicle
  7. curved depression surrounding junction of crown and pedicle
- h. Anterior crown overhang of pedicle/crown junction:
0. indeterminate
  1. absent (crown drops obliquely or vertically to pedicle)
  2. minor (crown slightly curves under to pedicle)
  3. prominent (crown significantly under to pedicle)

- i. **Pedicle type:**
0. indeterminate
  1. tetrahedroid
  2. keeled tetrahedroid
  3. expanded tetrahedroid
  4. keeled expanded tetrahedroid
  5. fluted truncate
  6. keeled fluted truncate
  7. plain truncate
  8. keeled plain truncate

- j. **Subpedicle surface:**
0. indeterminate
  1. flat
  2. concave
  3. convex
  4. convex with bulge to one side

**Type a6/b1,2**

- c. Pattern of lines, **ridges**, or keels:
0. indeterminate
  1. absent
  2. faint line parallel to edge of **crown**
  3. one median line, **ridge**, or keel on **upper crown surface**
  4. two lines, **ridges**, or keels on **upper crown surface**
  5. three or more parallel or subparallel lines, **ridges**, or keels on **upper crown surface**
  6. single broad median depression on **upper crown surface**
  7. one or more keels on **subcrown**
  8. curved **line**, **ridge**, or keel on **subcrown** approximately parallel to edge of **crown**
- d. Outline of **pedicle**:
0. indeterminate
  1. circular to subcircular
  2. triangular
  3. elliptical with smooth margins
  4. elliptical with crenulated margins
  5. square to cruciform
  6. diamond-shaped
- e. Size of **pedicle** (at anterior and sides):
0. indeterminate
  1. **pedicle** wider than **crown**
  2. **pedicle** approximately same width as **crown**
  3. **pedicle** narrower than **crown**

**Type a11/b(1,2,3)±6**

- c. Arrangement of projections (**cusps**):
0. indeterminate
  1. widely spaced
  2. close together

- d. Shape of **base (root)** from which **cusps** arise:
0. indeterminate
  1. none of the following
  2. elongate and bar-shaped
  3. flat and plate-like
  4. circular to subcircular in outline, but not flattened
  5. thick and polygonal
  6. curved
  7. circular to subcircular and flat with a button-like process
  8. circular to subcircular and thick with a button-like process
  9. flat and star-shaped
- e. Shape of projections (**cusps**):
0. indeterminate
  1. triangular, not curved
  2. triangular, curved lingually
  3. triangular, curved **laterally (mesially or distally)**
  4. broad and blunt
  5. none of the above
- f. Number of projections (**cusps**):
- Recorded as numbers
- g. Position of projections (**cusps**):
0. indeterminate
  1. linearly arranged
  2. not linearly arranged
- h. **Geometry of cusps:**
0. **indeterminate**
  1. cusps of different sizes with no order to their distribution
  2. medial cusp with lateral cusps decreasing in size from medial cusp to edge of element; symmetrical
  3. medial cusp with smaller lateral cusps, one of lateral cusps larger than lateral cusp nearest medial cusp; symmetrical
  4. posterior cusp largest, succeeding anterior cusps decreasing in size; asymmetrical
  5. medial cusp smaller than lateral cusps; symmetrical
- i. **Crown labial surface features:**
0. **indeterminate**
  1. **absent (smooth)**
  2. **lines or ridges multiple (greater than the number of cusps), long (greater than ½ height of crown), and approximately vertical**
  3. **lines or ridges multiple (greater than the number of cusps), short (less than ½ height of crown), and approximately vertical**
  4. **lines or ridges few (same as or less than the number of cusps), long (greater than ½ height of crown), and approximately vertical**
  5. **lines or ridges few (same as or less than the number of cusps), short (shorter than ½ height of crown), and approximately vertical**
  6. **one node below each cusp on crown shoulder**
  7. **more than one node below each cusp on crown shoulder**
  8. **prominent peg (protrusion) on crown shoulder below principal cusp**
  9. **rounded (not prominent) protrusion on crown shoulder below principal cusp**
  10. **Longitudinal line(s) or ridge(s) on and traversing lower crown shoulder, may be networked, may be discontinuous**



**j. Crown lingual surface features:**

Refer to characteristics: i. 0 to 10 above

**Type a13/b±(1,2,3)±6**

**c. Crown shape when viewed from above:**

0. indeterminate
1. triangular
2. five-sided to rectangular
3. circular to subcircular
4. square
5. irregular
6. **shallowly lobed (not deeply cut into centre of crown)**
7. **deeply lobed (deeply cut into centre of crown)**

**d. Nature of crown margins:**

0. indeterminate
1. smooth
2. crenulated
3. concave between projections but smooth throughout
4. distinct **lines, ridges, or keels** on one edge
5. distinct **lines, ridges, or keels** on all edges
6. distinct **lines, ridges, or keels** on more than one edge but not on all edges
7. **Line, ridge, or keel parallel to one or more margins (perpendicular to other lines, ridges, or keels when they are present)**
8. **lobed with bifurcating lines, ridges, or keels**

**e. Nature of pedicle:**

0. indeterminate
1. short and flattened (less than or equal **height of crown**)
2. long (longer than thickness of **crown**)

**f. Width of pedicle:**

0. indeterminate
1. **pedicle base wider than crown**
2. **pedicle base approximately same width as crown**
3. **pedicle base narrower than crown**

**g. Features on subcrown surface:**

0. indeterminate
1. **smooth or unornamented**
2. **with lines, ridges, or keels extending from upper crown surface to (or near) pedicle**
3. **with broadly rounded undulations perpendicular to pedicle and approximately at subcrown corners**
4. **curved line, ridge, or keel near subcrown centre posterior region around pedicle**
5. **curved depression surrounding junction of crown and pedicle**
6. **prominent (often mesial) ridge or keel**

**h. Outline of subpedicle surface:**

0. indeterminate
1. **circular to subcircular with smooth margins**
2. **circular to subcircular with crenulated margins**
3. **square to rhomboid**
4. **cruciform**
5. **tetrapetaloid**
6. **multipetaloid**

7. irregular
8. polygonal

**i. Subpedicle surface:**

0. indeterminate
1. flat
2. concave
3. convex
4. convex with bulge to one side

**Type a15/b(1,2)±6**

**c. Crown ornamentation:**

0. indeterminate or none
1. lines or ridges parallel
2. lines or ridges radiate from margin
3. lines or ridges extend longitudinally along shoulders, may be networked

**Type a17/b11**

**c. Crown wings at base of “sail” near pedicle:**

0. indeterminate
1. absent
2. one on each side and perpendicular to crown “sail”

## **PLATES 1-38**

### **Middle and Late Triassic elasmobranch ichthyoliths from northeastern British Columbia**

In the following plate captions, Geological Survey of Canada (GSC) numbers are provided. All ichthyolith samples are registered in the GSC Calgary office and given a GSC locality number (e.g. GSC loc. C-101069). Samples may be cross-referenced in Figure 2 (which shows sample stratigraphic position). Additional sample information may be found in Appendices 1 or 2 and Table A2-1. Several microfossils may be recovered from a single sample.

All illustrated and type ichthyolith specimens (e.g. GSC 105093) are catalogued and located at The National Type Collection of Invertebrate and Plant Fossils, Geological Survey of Canada, Ottawa. Illustrations are scanning electron microscope images from a Cambridge S-100 Stereo-scan.



# **PART IA**

**ELASMOBRANCH TEETH**

**PLATES 1-12**

## PLATE 1

**All illustrations are figured specimens, Upper Carnian; in figures 1-5 and 11-13 from the Baldonnel Formation, in figures 6-10 and 14-16 from the Baldonnel? Formation.**

### *Acrodus?* sp. 1

Figures 1-2. Specimen 1, figured specimen GSC 105098, GSC loc. C-177682, (BH-61B), showing an intact, approximately horizontal and elongate crown with some shallow and parallel ridges and an irregular shallow occlusal crest. Scale bar = 500  $\mu$ m.

1. Occlusal view of crown.
2. Lingual or labial view of crown.

Figures 3-5. Specimen 2, figured specimen GSC 105099, GSC loc. C-177682, (BH-61B). Showing a crown fragment with a mesh-like network of ridges on the shoulders. Scale bar = 500  $\mu$ m.

3. Occlusal view of crown.
4. Lingual or labial view of crown.
5. View of subcrown surface with root missing.

Figures 6-7. Specimen 3, figured specimen GSC 105100, GSC loc. C-101753 (MS-GB). Showing a tooth fragment with shallow and parallel crown ridges that are perpendicular to the lingual or labial faces. A prominent crown shoulder that overhangs a furrow and the crown/root junction.

6. Occlusal view of crown. Scale bar = 800  $\mu$ m.
7. Lingual or labial view of crown and root showing a furrow under crown shoulder near crown/root junction. Scale bar = 850  $\mu$ m.

Figures 8-9. Specimen 4, figured specimen GSC 105101, GSC loc. C-101753 (MS-GB). A broken specimen with crown ridges that are wavy but approximately centrally parallel, and networked at the shoulders.

8. Occlusal view of crown. Scale bar = 800  $\mu$ m.
9. Lingual or labial view of crown and root. Scale bar = 850  $\mu$ m.

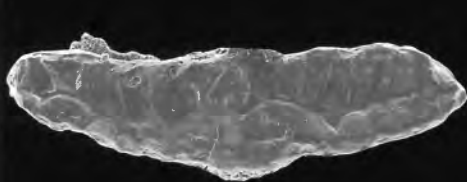
Figure 10. Specimen 5, figured specimen GSC 105102, GSC loc. C-101753 (MS-GB). A specimen fragment showing a lingual or labial view of the crown, occlusal crest, and root. Scale bar = 900  $\mu$ m.

Figures 11-13. Specimen 2, figured specimen GSC 105099, GSC loc. C-177682, (BH-61B). Enlargements of the subcrown surface (location marked by arrow in fig. 5).

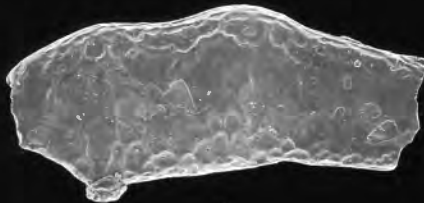
11. Showing a mesh-like texture near the crown right edge that might be remnants of osteodentine. Scale bar = 75  $\mu$ m.
- 12-13. Two different locations and magnifications of underneath the upper crown unit (top of images). Scale bar = 75  $\mu$ m (fig. 12) and 18  $\mu$ m (fig. 13).

Figures 14-16. Specimen 6, figured specimen GSC 105103, GSC loc. C-101753, (MS-GB). Views and enlargements of a section through a tooth specimen etched in 1-5% HCl.

14. Showing thin upper crown unit (approximately 40  $\mu$ m thick). Scale bar = 150  $\mu$ m.
15. Enlargements of upper crown unit (fig. 14, left) showing vertically oriented fibre bundles and thin outer surface layer of single crystallite enameloid. Scale bar = 18  $\mu$ m (fig. 15).
16. Enlargement of upper crown unit (fig. 14, top right) showing an irregular mesh or network of fibre bundles topped by single crystallite enameloid. Scale bar = 24  $\mu$ m.



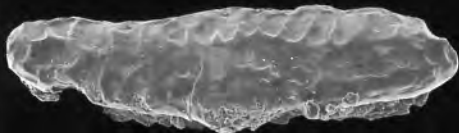
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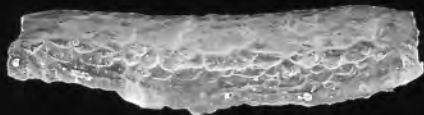
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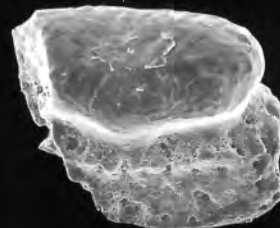
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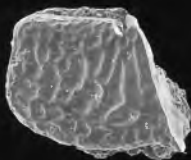
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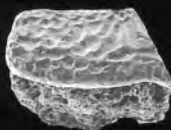
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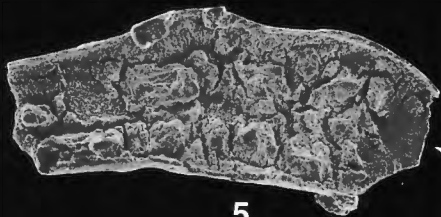
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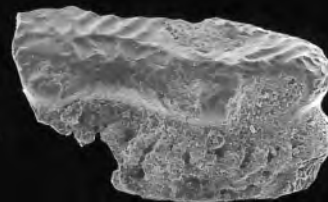
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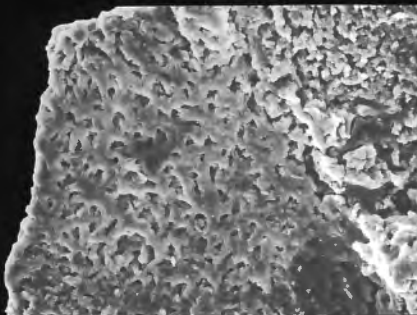
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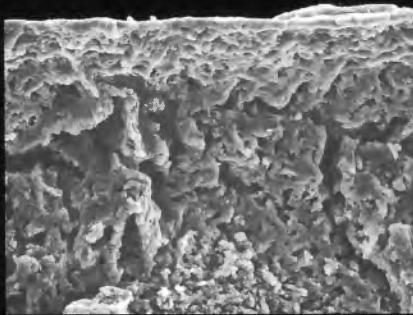
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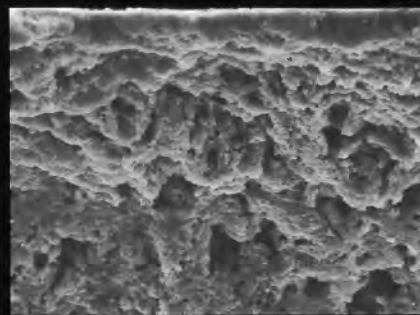
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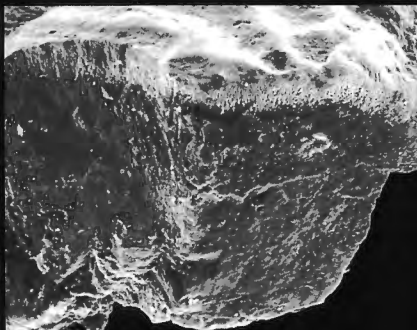
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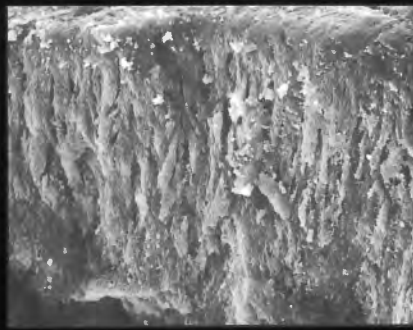
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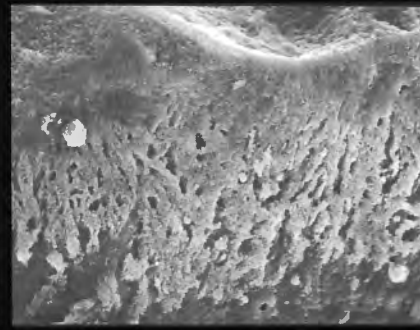
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14



15



16



## PLATE 2

All illustrated specimens are Ladinian and from the Liard Formation.

*Polyacrodus contrarius* n. sp.

### Type A

Three specimens of Type A at various views. The lingual protrusion below the principal cusp is best seen in figures 4, 5, 9, and 14. Note that the occlusal crest is displaced lingually and the surface area of the crown labial face is greater than the lingual. On specimens 1 and 3, the crown heels are displaced lingually whereas on specimen 2, labially.

Figures 1-5. Specimen 1, paratype GSC 105092, GSC loc. C-101064 (ACE-1). Note the reduced ornamentation on the crown labial face. Scale bar = 500  $\mu$ m.

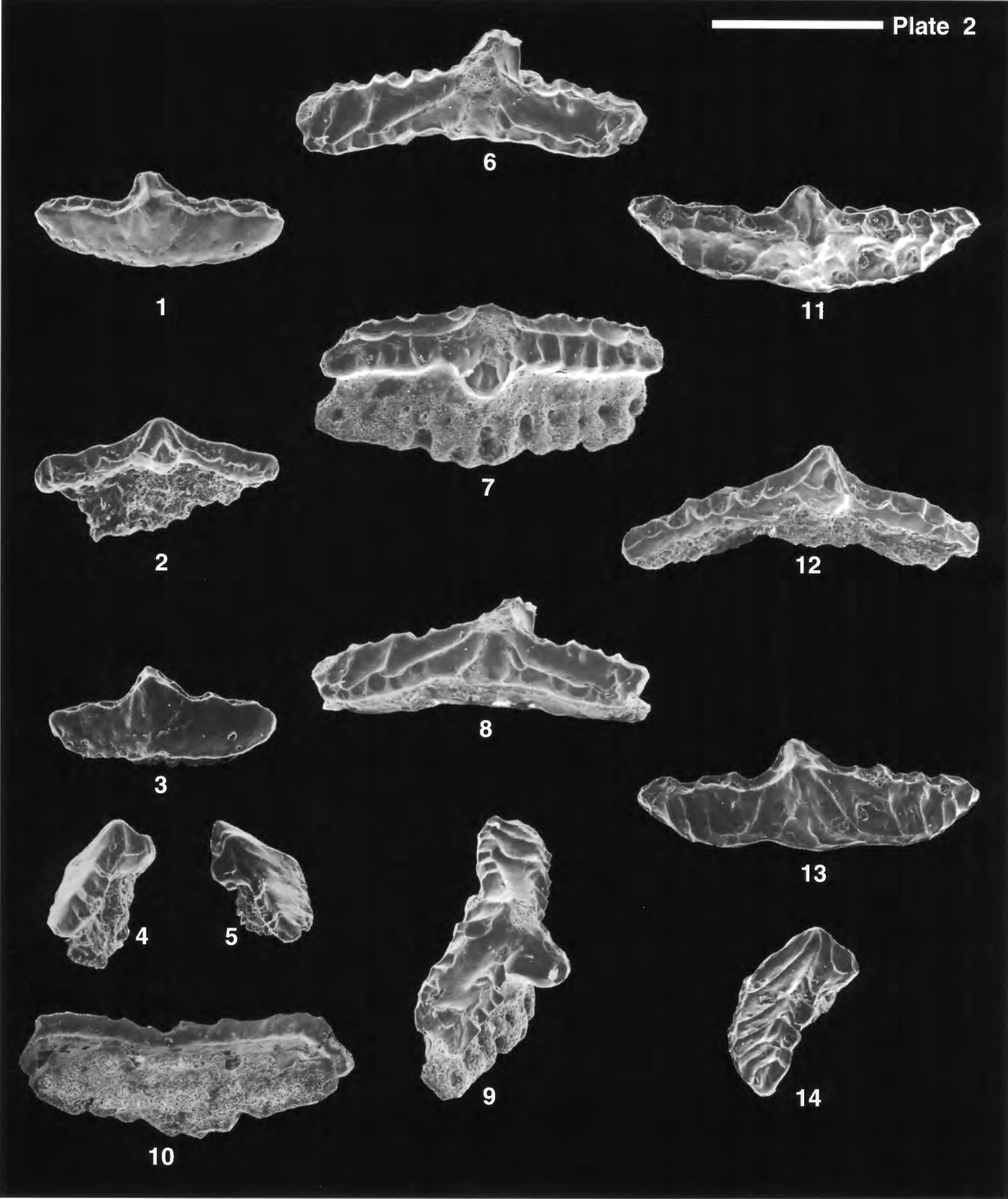
1. Occlusal view of crown.
2. Lingual view.
3. Labial view.
- 4-5. Profile views showing lingual protrusion.

Figures 6-10. Specimen 2, holotype GSC 105093, GSC loc. C-101069 (BEH-3). Specimen with a well preserved root, concave hollows located centrally on the crown labial face, increased number of ridges on the crown, and nodes developed at the crown labial shoulder. Scale bar = 500  $\mu$ m.

6. Occlusal view of crown.
7. Lingual view of crown and root.
8. Labial view of crown and root.
9. Profile view showing lingual protrusion.
10. Basal view of root and labial face of root and crown.

Figures 11-14. Specimen 3, paratype GSC 105094, GSC loc C-101064 (ACE-1). Showing a variant of the crown ornamentation with an increased number of vertical and diagonal ridges on the crown labial face. Scale bar = 500  $\mu$ m.

11. Occlusal view.
12. Lingual view.
13. Labial view.
14. Profile view of crown showing lingual protrusion.



### PLATE 3

All illustrated specimens are Ladinian and from the Liard Formation.

*Polyacrodus contrarius* n. sp.

Types B and C

Figures 1-5. Type B, specimen 4, paratype GSC 105095, GSC loc. C-101068 (BEH-2). The surface area of the crown labial face is reduced when compared to specimens 1-3. Scale bar = 500  $\mu$ m.

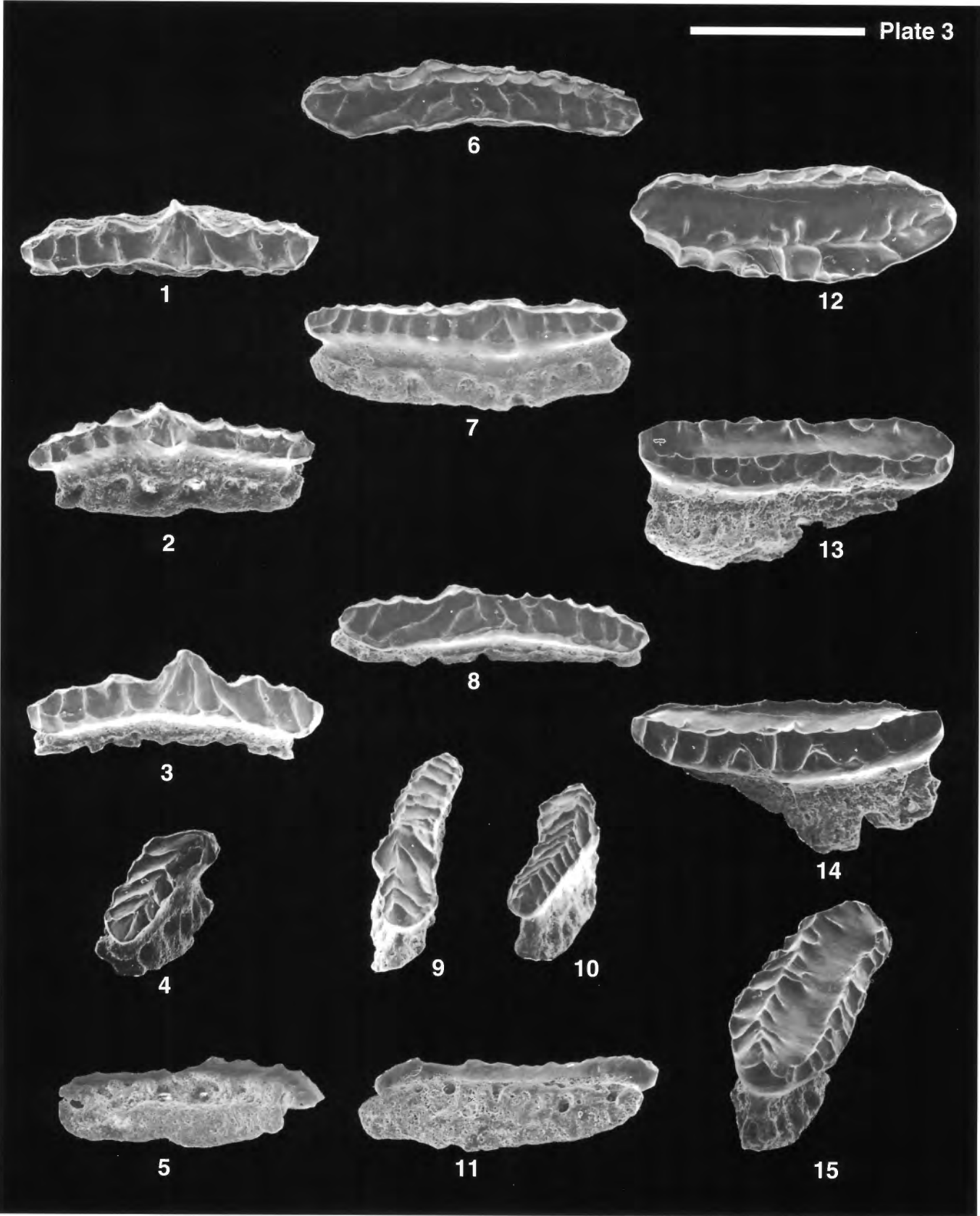
1. Occlusal view of crown.
2. Lingual view of crown and root.
3. Labial view of crown and root.
4. Profile view showing lingual protrusion.
5. Basal view of root and labial face of root and crown.

Figures 6-11. Type B, specimen 5, paratype GSC 105096, GSC loc. C-101068 (BEH-2). Crown extended laterally with a reduced labial face surface area, prominent vertical ridges, low principal cusp, and well preserved root. Lingual protrusion is less prominent. Scale bar = 500  $\mu$ m.

6. Occlusal view of crown.
7. Lingual view of crown and root.
8. Labial view of crown and root.
- 9-10. Profile views showing reduced lingual protrusion.
11. Basal view of root and labial face of root and crown.

Figures 12-15. Type C, specimen 6, paratype GSC 105097, GSC loc. C-153069 (GK-1-19). Crown with principal and lateral cusps extremely reduced (at image left), large central concavity or hollow, prominent nodes along the margin longitudinal ridge (at image right), and absent lingual protrusion. Scale bar = 500  $\mu$ m.

12. Occlusal view of crown.
13. Lingual view of crown and root.
14. Labial view of crown and root.
15. Profile view of crown and root.



## PLATE 4

All illustrated specimens are Middle Norian and from the Pardonet Formation at GSC loc. C-101036 (MS-3).

*Synechodus incrementum* n. sp.

Types A, B, and C

Figures 1-6. Type A, paratype GSC 105104. Specimen with a high principal cusp that is lingually inclined. Root with a high labial arch, deeply concave lower labial face, and lingual face torus or bulge.

1. Occlusal view. Scale bar = 1000  $\mu\text{m}$ .
2. Lingual view of crown and root showing high lingual root face. Scale bar = 950  $\mu\text{m}$ .
3. Labial view of crown and root showing high crown/root arch. Scale bar = 1100  $\mu\text{m}$ .
- 4-5. Profile views showing crown lingual inclination and lingual root bulge. Scale bar = 1100  $\mu\text{m}$  (fig. 4) and 1000  $\mu\text{m}$  (fig. 5).
6. Basal view of root and deeply concave lower labial root face. Scale bar = 1000  $\mu\text{m}$ .

Figures 7-12. Type B, paratype GSC 105105. Specimen with a moderately high principal cusp that is laterally inclined. Root with a slight labial arch and concave lower labial face.

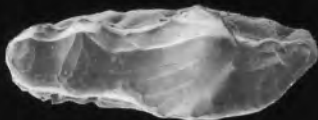
7. Occlusal view. Scale bar = 1025  $\mu\text{m}$ .
8. Lingual view of crown and root showing lateral inclination of crown. Scale bar = 1050  $\mu\text{m}$ .
9. Labial view of crown and root showing slight crown/root arch. Scale bar = 1050  $\mu\text{m}$ .
- 10-11. Profile views. Scale bar = 950  $\mu\text{m}$ .
12. Basal view of root and concave lower labial root face. Scale bar = 1000  $\mu\text{m}$ .

Figures 13-18. Type C, holotype GSC 105106. Specimen with a moderately high principal cusp that is slightly lingually and laterally inclined to almost vertical. Root with a labial arch, moderately high lingual face, and concave lower labial face.

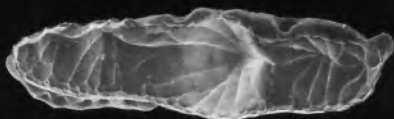
13. Occlusal view showing elongate fusiform crown outline. Scale bar = 950  $\mu\text{m}$ .
14. Lingual view of crown and root showing moderately high principal cusp and reduced lateral cusps. Scale bar = 950  $\mu\text{m}$ .
15. Labial view of crown and root showing crown/root arch and large canal openings on lower labial root face. Scale bar = 1050  $\mu\text{m}$ .
- 16-17. Profile views. Scale bar = 950  $\mu\text{m}$ .
18. Basal view of root and concave lower labial root face. Scale bar = 1025  $\mu\text{m}$ .



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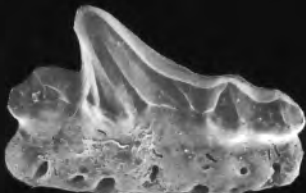
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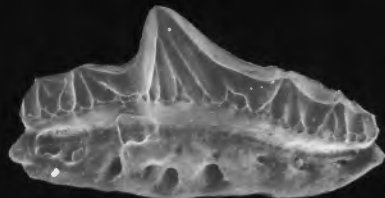
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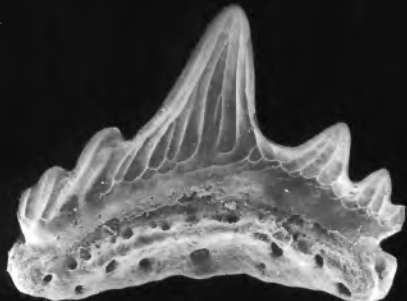
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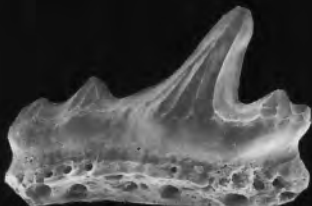
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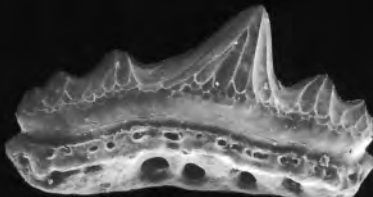
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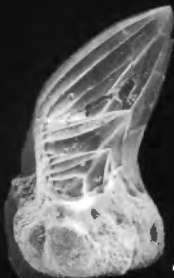
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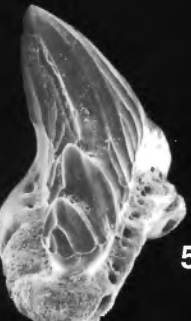
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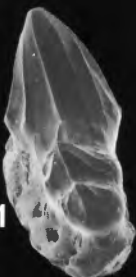
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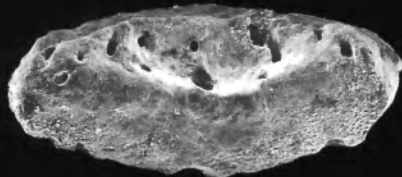
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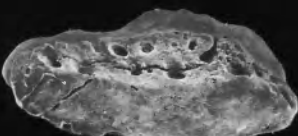
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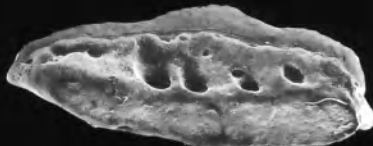
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6



12



18

## PLATE 5

All illustrated specimens are Middle Norian and from the Pardonet Formation at GSC loc. C-101036 (MS-3).

*Synechodus incrementum* n. sp.

Types D and E

Figures 1-6. Type D, paratype GSC 105107. Specimen with a lower principal cusp that is slightly lingually inclined to almost vertical. Root with a slight labial arch and concave lower labial face with channelling on upper/lower rim.

1. Occlusal view showing fusiform crown outline. Scale bar = 1000  $\mu$ m.
2. Lingual view of crown and root showing reduced height of principal cusp. Scale bar = 1025  $\mu$ m.
3. Labial view of crown and root showing slight crown/root arch. Scale bar = 1050  $\mu$ m.
- 4-5. Profile views. Scale bar = 950  $\mu$ m (fig. 4) and 1025  $\mu$ m (fig. 5).
6. Basal view of root and concave lower labial root face with channels on upper/lower lingual face rim. Scale bar = 1050  $\mu$ m.

Figures 7-12. Type E, paratype GSC 105108. Specimen with a moderately low principal cusp that is slightly lingually inclined to almost vertical. Some lateral cusps are regularly inclined towards the principal cusp. Root with a labial arch and concave lower labial face with channelling on the upper/lower rim.

7. Occlusal view showing fusiform crown outline. Scale bar = 1350  $\mu$ m.
8. Lingual view of crown and root showing reduced height of principal cusp. Scale bar = 1300  $\mu$ m.
9. Labial view of crown and root showing crown/root arch and regularly inclined lateral cusps (image left) towards principal cusp. Scale bar = 1325  $\mu$ m.
- 10-11. Profile views. Scale bar = 1250  $\mu$ m (fig. 10) and 1150  $\mu$ m (fig. 11).
12. Basal view of root and concave lower labial root face with channels on upper/lower lingual face rim. Scale bar = 1250  $\mu$ m.

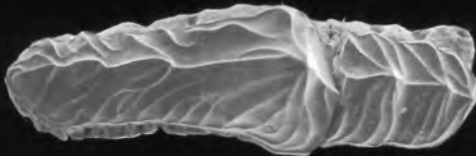
Figures 13-17. Type E, paratype GSC 105109. A broken specimen with regularly inclined lateral cusps towards principal cusp. Root with a labial arch and reduced and shallow concave lower labial face.

13. Occlusal view. Scale bar = 1200  $\mu$ m.
14. Lingual view of crown and root showing regularly inclined lateral cusps. Scale bar = 1200  $\mu$ m.
15. Labial view of crown showing regularly inclined lateral cusps and root with a reduced and shallow lower labial face. Scale bar = 1200  $\mu$ m.
16. Profile view. Scale bar = 1125  $\mu$ m.
17. Basal view of flat root and reduced lower labial root face. Scale bar = 1200  $\mu$ m.

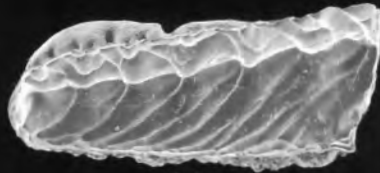




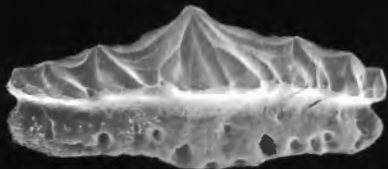
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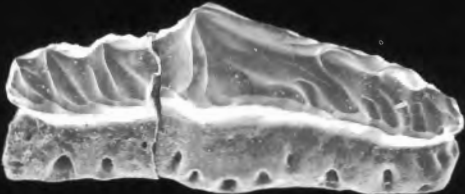
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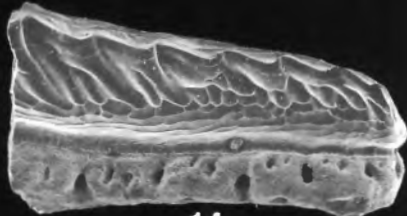
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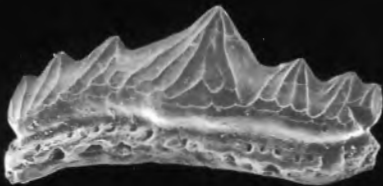
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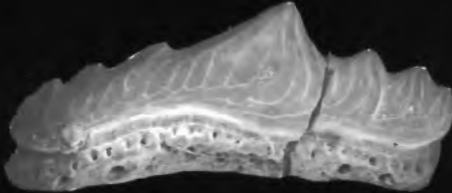
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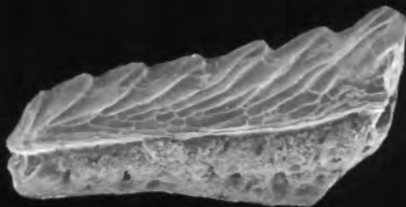
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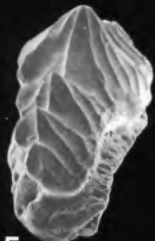
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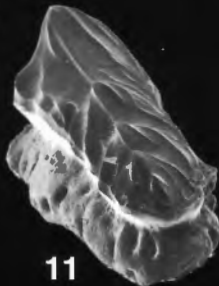
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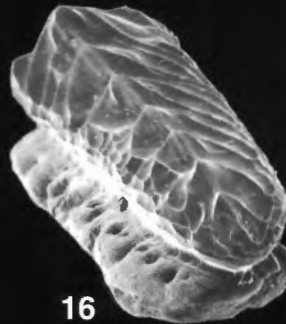
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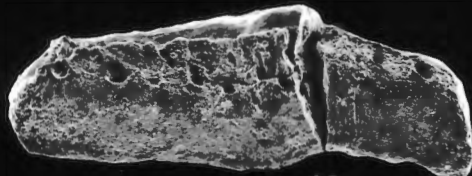
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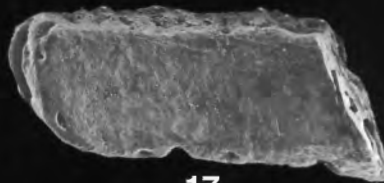
16



6



12



17

## PLATE 6

All illustrated specimens are Middle Norian and from the Pardonet Formation at GSC loc. C-101754 (NPP-Low).

*Synechodus incrementum* n. sp.

Types F, G, and H

Figures 1-6. Type F, paratype GSC 105110. Specimen with a low principal cusp that is slightly lingually inclined to almost vertical. Root with a slight labial arch and concave lower labial face with channelling.

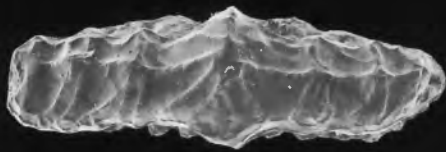
1. Occlusal view showing elongate fusiform crown outline with a rounded and moderately protruding central region at shoulders, and primary transverse ridge extending over principal cusp labially-lingually. Scale bar = 950  $\mu\text{m}$ .
2. Lingual view of crown and root showing reduced height of principal cusp, and lingual root face about same height as crown. Scale bar = 1000  $\mu\text{m}$ .
3. Labial view of crown and root showing slight crown/root arch. Scale bar = 950  $\mu\text{m}$ .
- 4-5. Profile views showing expanded shoulder regions below principal cusp. Scale bar = 950  $\mu\text{m}$  (fig. 4) and 900  $\mu\text{m}$  (fig. 5).
6. Basal view of root and concave lower labial root face with well developed channels. Scale bar = 950  $\mu\text{m}$ .

Figures 7-12. Type G, paratype GSC 105111. Specimen with a low principal cusp that is slightly lingually inclined to almost vertical. Crown with prominent lingual and labial shoulder bulges below principal cusp. Root with a shallow concave lower labial face and channelling on upper/lower rim.

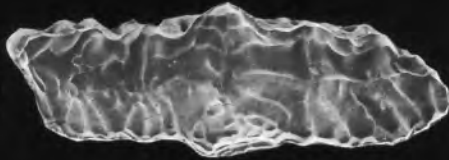
7. Occlusal view showing elongate fusiform crown outline with a moderate protruding central region at shoulders, and a primary transverse ridge extending over principal cusp labially-lingually. Scale bar = 950  $\mu\text{m}$ .
8. Lingual view of crown and root showing reduced height of principal cusp, and lingual root face about same height as crown. Scale bar = 1000  $\mu\text{m}$ .
9. Labial view of crown and root showing a slight crown/root arch and protruding bulge below principal cusp. Scale bar = 1000  $\mu\text{m}$ .
- 10-11. Profile views showing expanded shoulder regions (especially lingually) below principal cusp. Scale bar = 950  $\mu\text{m}$ .
12. Basal view of root and shallow concave lower labial root face with channels. Scale bar = 1000  $\mu\text{m}$ .

Figures 13-18. Type H, paratype GSC 105112. Specimen with very reduced crown cusps. Crown with a prominent labial shoulder bulge below principal cusp. Root with an expanded shallow concave lower labial face and channelling.

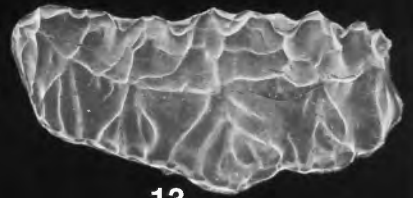
13. Occlusal view of crown showing prominent central labial bulge and primary transverse ridge extending over principal cusp labially-lingually. Scale bar = 1000  $\mu\text{m}$ .
14. Lingual view of crown and root showing reduced height of principal cusp. Scale bar = 1025  $\mu\text{m}$ .
15. Labial view of crown and narrow root face. Scale bar = 1050  $\mu\text{m}$ .
- 16-17. Profile views showing expanded labial shoulder region below principal cusp. Scale bar = 1025  $\mu\text{m}$  (fig. 16) and 980  $\mu\text{m}$  (fig. 17).
18. Basal view of root and expanded shallow concave lower labial root face with channels. Scale bar = 1025  $\mu\text{m}$ .



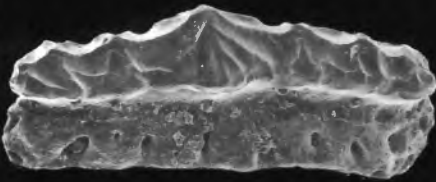
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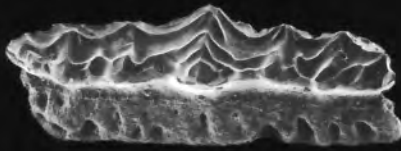
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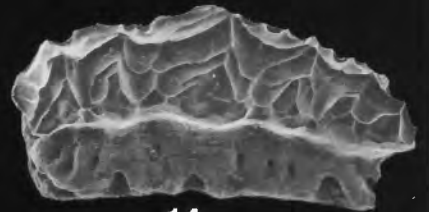
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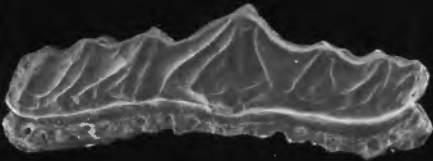
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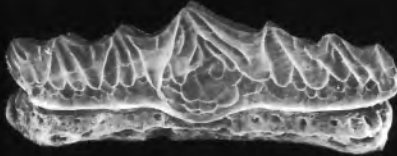
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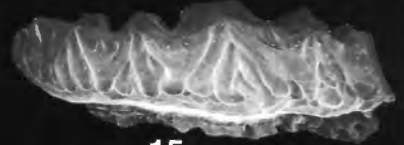
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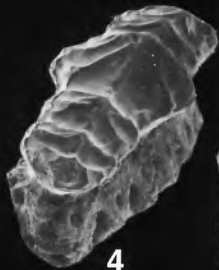
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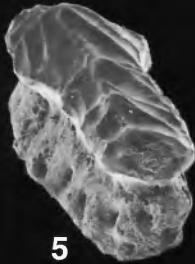
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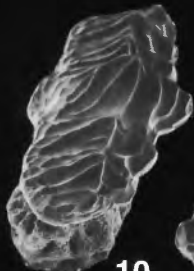
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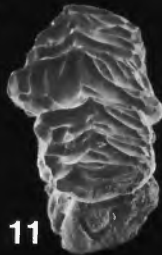
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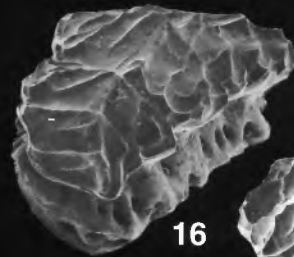
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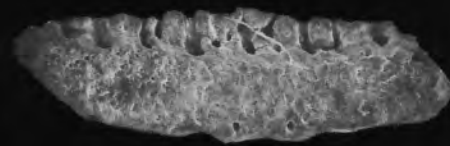
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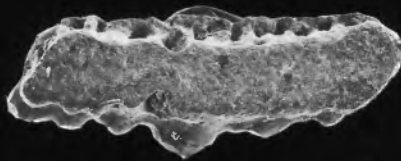
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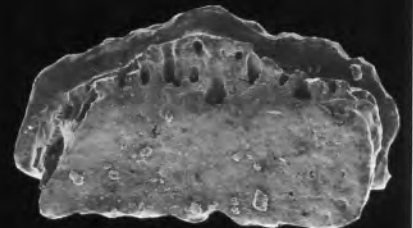
17



6



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18

## PLATE 7

**All illustrated specimens are sections of the crown etched in HCl, Middle Norian, and from the Par-donet Formation.**

*Synechodus incrementum* n. sp.

Figures 1-4. Specimen 1, paratype GSC 105113, GSC locality C-101754 (NPP-Low). A specimen with a high principal cusp sectioned longitudinally.

1. Close-up of bundles of parallel fibres near crown surface. Close-up area marked by arrow in figure 3. Scale bar = 90  $\mu\text{m}$ .
2. Close-up of crown apex region showing parallel fibres oriented vertically. Outer dentine and enameloid layer along crown right edge. Scale bar = 150  $\mu\text{m}$ .
3. Overview of sectioned and etched crown. Scale bar = 425  $\mu\text{m}$ .
4. Enlargement of outer enameloid layer showing single crystallites oriented perpendicular to outer surface. Scale bar = 12  $\mu\text{m}$ .

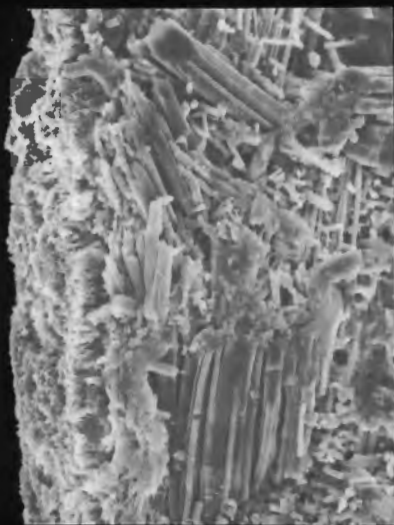
Figure 5. Specimen 2, higher principal cusp type, paratype GSC 105114, GSC loc. C-101754 (NPP-Low). Shows enameloid with crystallites, and fibres that are woven to haphazard. Scale bar = 28  $\mu\text{m}$ .

Figures 6, 9. Specimen 3, lower principal cusp type, paratype GSC 105115, GSC loc. C-101036 (MS-3).

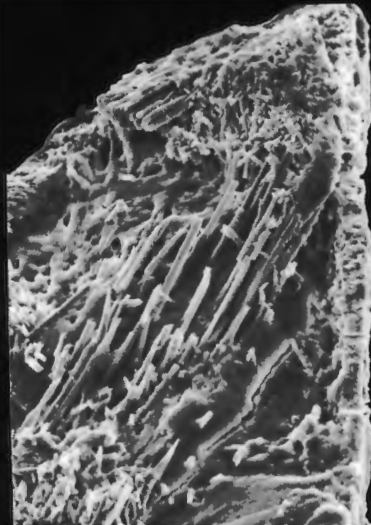
6. Near crown ridge, enameloid with uppermost single crystallites above fibres oriented perpendicular to outer surface. Below, fibres are more haphazardly arranged. Scale bar = 24  $\mu\text{m}$ .
9. Near occlusal crest, single crystallites above irregular fibre bundles. Scale bar = 40  $\mu\text{m}$ .

Figure 7. Specimen 4, lower principal cusp type, near crown shoulder with cross-section of ridges at left and right, paratype GSC 105116, GSC loc. C-101036 (MS-3). Enameloid layer with crystallites on top of parallel fibre bundles perpendicular to the outer surface (left) and a woven pattern with haphazard bundles below. Scale bar = 105  $\mu\text{m}$ .

Figure 8. Specimen 6, lower principal cusp type, paratype GSC 105118, GSC loc. C-101754 (NPP-Low). Surface of crown section was not etched in HCl and shows upper enameloid layer. Scale bar = 75  $\mu\text{m}$ .



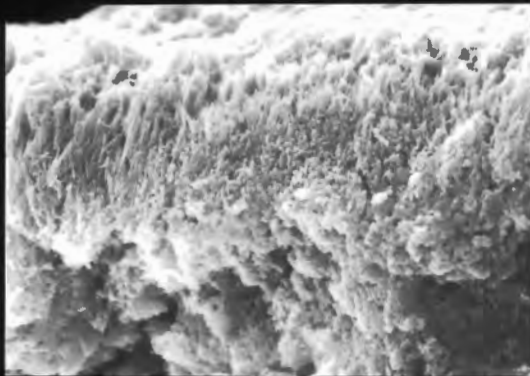
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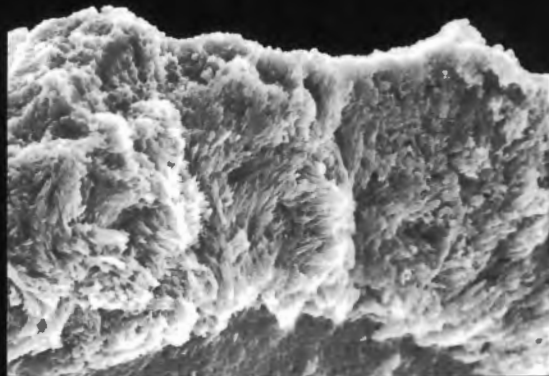
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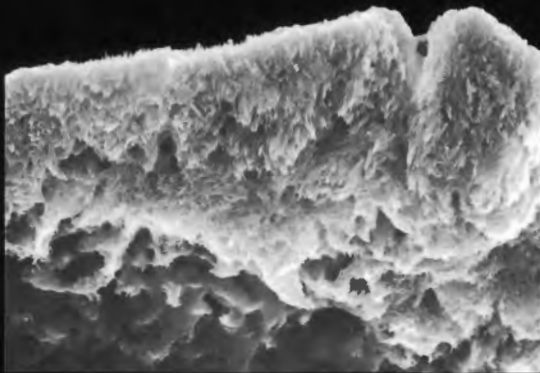
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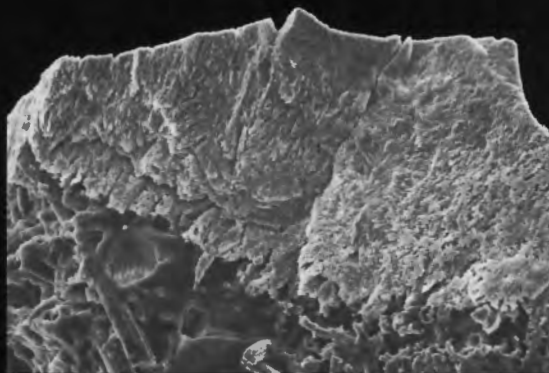
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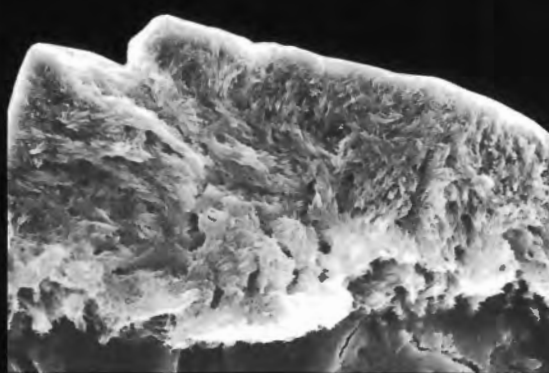
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9

## PLATE 8

All illustrated specimens are Upper Carnian and from the Baldonnel? Formation at GSC loc. C-101002 (BBR-1).

### *Synechodus multinodosus* n. sp.

Figures 1-24. Type A, specimens 1-4. Illustrations show variations of tooth form and ornamentation. Type A has a high principal cusp that is inclined lingually, crown heels are displaced labially, labial and lingual crown shoulder nodes are common, lingual root face has a bulge or torus, root base is arcuate with rounded peak of arch directed lingually, and lower labial root face is channelled showing pseudo-polyaulacorhize vascularization.

Figures 1-6. Specimen 1, holotype GSC 105119. Moderately small specimen with lateral cusps, and principal cusp vertical line or ridge that extends to a shoulder peg.

1. Occlusal view showing crown heel labial displacement, principal cusp line or ridge, and central peg. Scale bar = 950  $\mu$ m.
2. Lingual view showing high root face and central bulge or torus. Scale bar = 1000  $\mu$ m.
3. Labial view showing lateral cusps, high principal cusp and its line or ridge, shoulder nodes, central shoulder peg, and thin and arched labial root face broken by canal openings. Scale = 900  $\mu$ m.
- 4-5. Profile views showing crown lingual inclination and bulging lingual root face. Scale bar = 1000  $\mu$ m (fig. 4) and 950  $\mu$ m (fig. 5).
6. Basal view of arcuate root with a labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 900  $\mu$ m.

Figures 7-12. Specimen 2, paratype GSC 105120. Moderately small specimen with reduced lateral cusps. Shoulder nodes are common but central peg is absent.

7. Occlusal view showing crown heel labial displacement and shoulder nodes. Scale bar = 1000  $\mu$ m.
8. Lingual view showing high root face and central bulge or torus. Scale bar = 1000  $\mu$ m.
9. Labial view showing reduced lateral cusps, high principal cusp, shoulder nodes, and thin and arched labial root face. Scale = 1000  $\mu$ m.
- 10-11. Profile views showing crown lingual inclination and bulging lingual root face. Scale bar = 1000  $\mu$ m.
12. Basal view of arcuate root with a labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 1000  $\mu$ m.

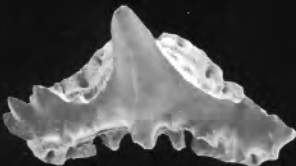
Figures 13-18. Specimen 3, paratype GSC 105121. Moderately large specimen with no (or abraded) lateral cusps. Shoulder nodes are common (but less prominent) and central peg is absent.

13. Occlusal view showing crown heel labial displacement and shoulder nodes. Scale bar = 950  $\mu$ m.
14. Lingual view showing high root face and central bulge. Scale bar = 1000  $\mu$ m.
15. Labial view showing absent lateral cusps, and presence of high principal cusp, shoulder nodes, arched basal crown, and labial root face. Scale = 950  $\mu$ m.
- 16-17. Profile views showing crown lingual inclination and bulging lingual root face. Scale bar = 1000  $\mu$ m.
18. Basal view of arcuate root with a labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 1000  $\mu$ m.

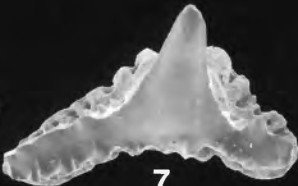
Figures 19-24. Specimen 4, paratype GSC 105122. Moderately large specimen with no (or abraded) lateral cusps. Shoulder nodes are common (but less prominent). Crown is expanded laterally and has large principal cusp.

19. Occlusal view showing a large crown expanded laterally, large principal cusp, heels labially displaced, and less prominent shoulder nodes. Scale bar = 1100  $\mu$ m.
20. Lingual view showing high root face and central bulge. Scale bar = 1000  $\mu$ m.
21. Labial view showing absence of lateral cusps and presence of high principal cusp, shoulder nodes, arched basal crown, and labial root face. Scale = 1000  $\mu$ m.
- 22-23. Profile views showing crown lingual inclination and bulging lingual root face. Scale bar = 1000  $\mu$ m.
24. Basal view of arcuate root with a labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 1000  $\mu$ m.

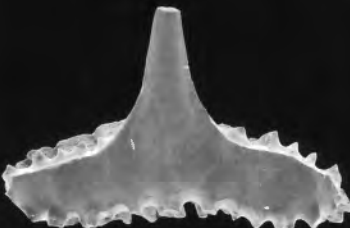




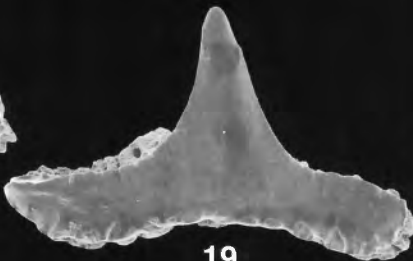
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13



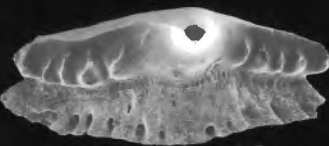
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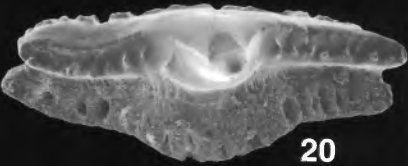
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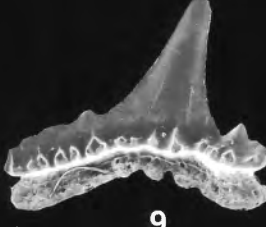
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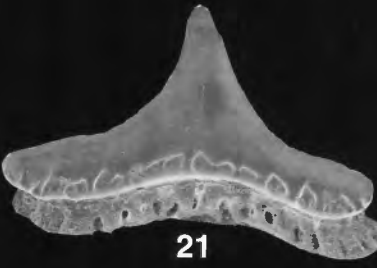
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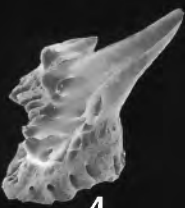
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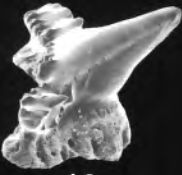
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21



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16



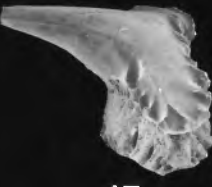
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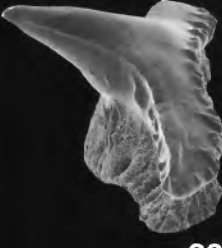
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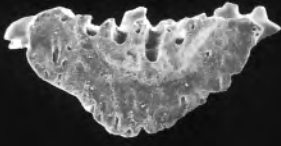
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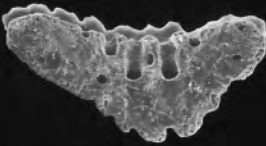
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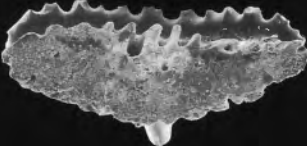
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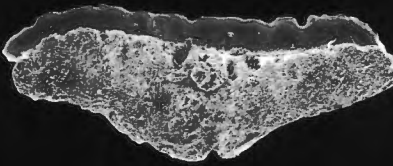
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12



18



24



## PLATE 9

All illustrated specimens are Upper Carnian and from the Baldonnel? Formation. The specimens in figures 1-12 are from GSC loc. C-101002 (BBR-1) and figures 13-17 from GSC loc. C-101119 (BBR-311A).

### *Synechodus multinodosus* n. sp.

Figures 1-12. Type B, specimens 5-6. Illustrations show variations of tooth form and ornamentation. Type B has a low principal cusp that is inclined lingually or is approximately vertical, crown is greatly expanded laterally, crown shoulder nodes are common, lingual root face may have a bulge or torus, and root base is flat and elongate. Canal channels are common on root lower labial face (showing pseudo-polyaulacorhize vascularization) and notched rim separating upper and lower labial faces.

Figures 1-6. Specimen 5, paratype GSC 105123. Tooth is expanded laterally. Principal cusp is moderately low with a vertical labially-lingual transverse ridge and a labial shoulder peg. Lateral cusps are abraded or absent. Labial root face is shallowly arched and channelled.

1. Occlusal view showing laterally expanded crown, principal cusp line or ridge, and central peg and shoulder nodes. Scale bar = 1050  $\mu$ m.
2. Lingual view showing high root face and crown principal cusp vertical ridge. Scale bar = 1050  $\mu$ m.
3. Labial view showing moderately low principal cusp and its ridge, shoulder nodes, central shoulder peg, and thin and shallowly arched labial root face broken by canal openings. Scale bar = 1000  $\mu$ m.
- 4-5. Profile views showing crown shoulder nodes and labial peg. Scale bar = 1000  $\mu$ m (fig. 4) and 950  $\mu$ m (fig. 5).
6. Basal view of elongate root with a shallow labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 1050  $\mu$ m.

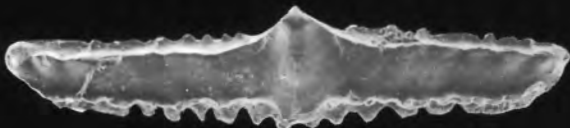
Figures 7-12. Specimen 6, paratype GSC 105124. Tooth is expanded laterally. Principal cusp is low with a vertical labially-lingual transverse ridge, and labial and lingual shoulder pegs. Lateral cusps are low, abraded, or absent. Labial root face is channelled.

7. Occlusal view showing laterally expanded crown, principal cusp line or ridge, shoulder pegs and nodes, and lateral cusp. Scale bar = 1000  $\mu$ m.
8. Lingual view showing high root face and crown principal cusp vertical ridge and lateral cusp. Scale bar = 1050  $\mu$ m.
9. Labial view showing low principal cusp and its ridge, and crown shoulder nodes and pegs. Scale = 1000  $\mu$ m.
- 10-11. Profile views showing crown shoulder nodes and pegs. Scale bar = 1000  $\mu$ m (fig. 10) and 950  $\mu$ m (fig. 11).
12. Basal view of elongate root with a shallow labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization). Scale bar = 1000  $\mu$ m.

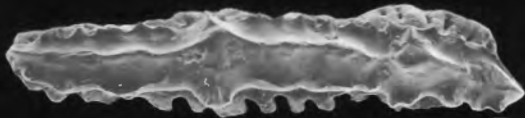
### *Synechodus cf. multinodosus* n. sp.

Figures 13-17. Figured specimen GSC 105125 showing prominent crown nodular vertical ridges. Cusps are lingually inclined and crown heels are labially displaced. Canal channels are common on root lower labial face (pseudo-polyaulacorhize vascularization) and notch rim separating upper and lower labial faces. Scale bar = 500  $\mu$ m.

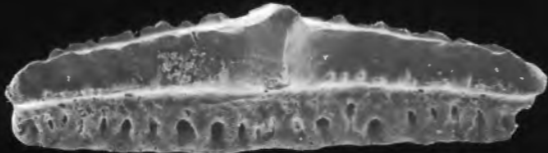
13. Occlusal view showing crown ridges, nodes, and labial displacement of heels.
14. Lingual view.
15. Labial view showing crown principal and lateral cusps, ridges, and nodes. Labial root face is narrow and arched.
16. Profile view showing crown lingual inclination, ridges and nodes.
17. Basal view of root with a shallow labial concave hollow broken by canal channels (pseudo-polyaulacorhize vascularization).



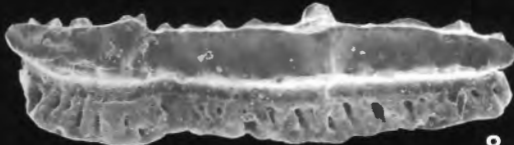
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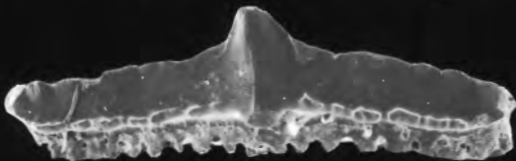
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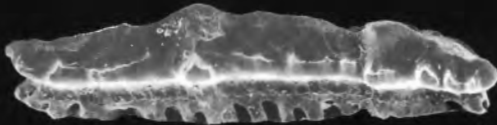
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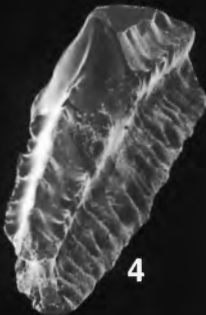
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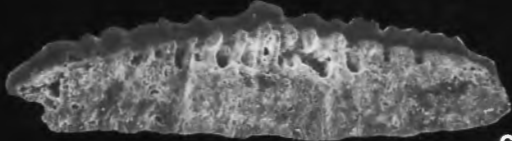
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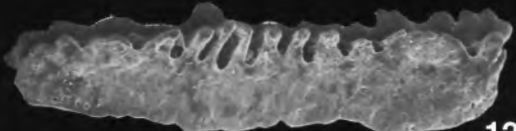
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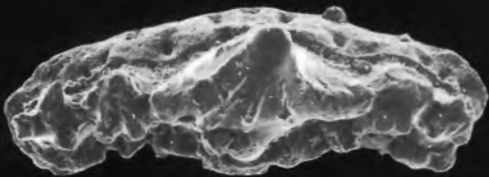
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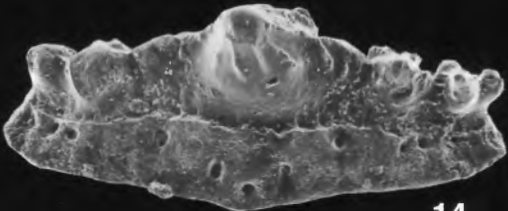
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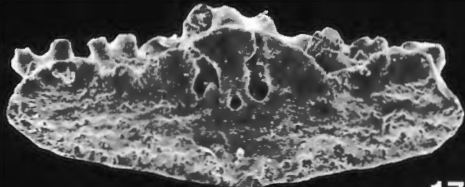
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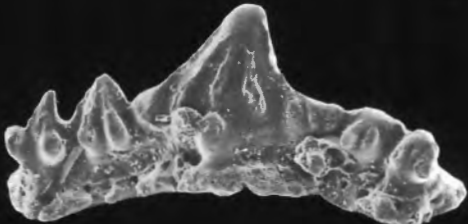
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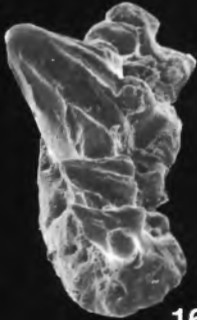
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16

## PLATE 10

All illustrated specimens are sections of the crown etched in HCl, Upper Carnian, and from the Bal-donnel? Formation at GSC loc. C-101002 (BBR-1).

*Synechodus multinodosus* n. sp.

Types A and B

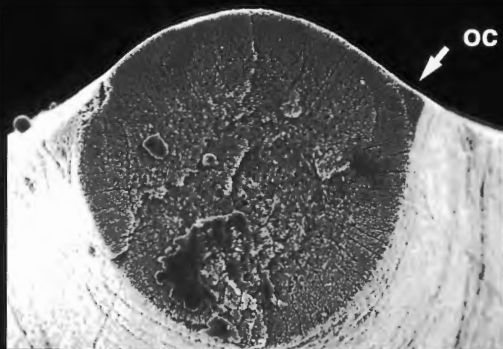
Figures 1-2. Type A, specimen 1, paratype GSC 105126. Figure 1 shows a cross-section through upper tooth crown near apex. Occlusal crest (oc) is seen on each side. Figure 2 is an enlargement showing many thin fibres parallel to crown outer surface (perpendicular to viewing; labelled pf). These fibres are dense near outer surface. Towards central region there is more open space and fibre orientation is more irregular or tangled (tf). Scale bar = 95  $\mu\text{m}$  (fig. 1) and 40  $\mu\text{m}$  (fig. 2).

Figures 3-4. Type A, specimen 2, paratype GSC 105127. Figure 3 shows parallel fibre bundles as seen from lingual face near sectioned surface. Figure 4 further illustrates parallel and tangled fibre layers. Scale bar = 30  $\mu\text{m}$  (fig. 3) and 20  $\mu\text{m}$  (fig. 4).

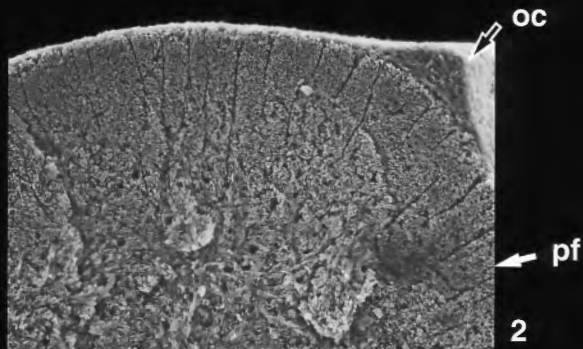
Figure 5. Type B, specimen 5, paratype GSC 105130. Illustration of a cross-section through occlusal crest showing fibres that are bent. Scale bar = 40  $\mu\text{m}$ .

Figure 6. Type B, specimen 3, paratype GSC 105128. Shows damaged region of crown apex and occlusal crest where parallel fibres are seen running basally-apically. Scale bar = 80  $\mu\text{m}$ .

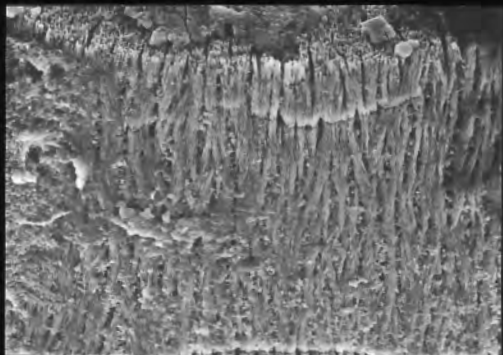
Figures 7-8. Type B, specimen 4, paratype GSC 105129. Figure 7 is a cross-section through crown showing a single crystallite layer (sc) with crystals perpendicular to outer surface. Below this layer, best seen near occlusal crest (oc) and in figure 8, are parallel fibre bundles. Scale bar = 50  $\mu\text{m}$  (fig. 7) and 20  $\mu\text{m}$  (fig. 8).



1



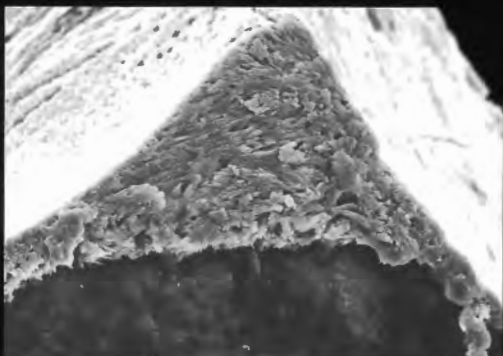
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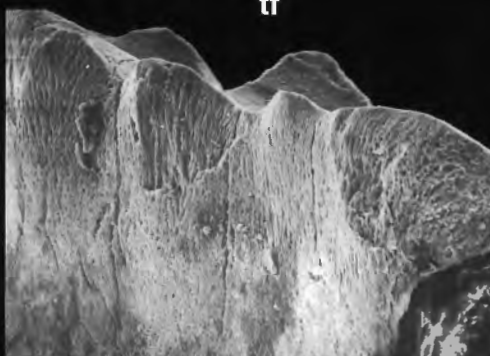
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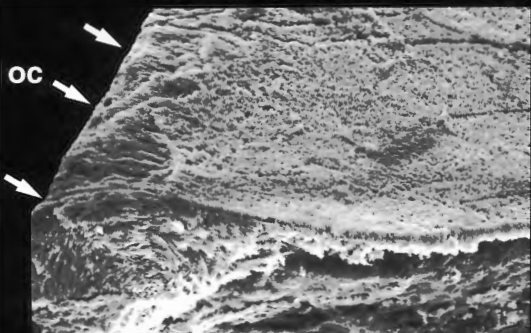
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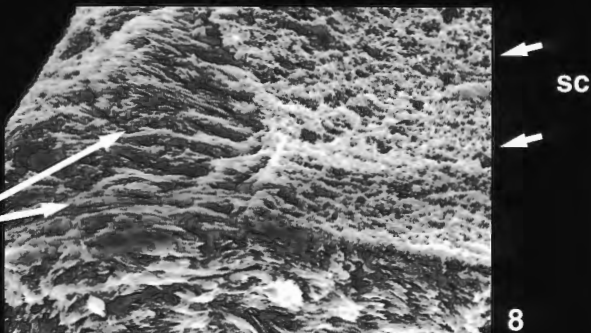
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## PLATE 11

**The illustrated specimen in figures 1-5 is Ladinian and from the Liard Formation.**

*Synechodus* sp. 1

Figures 1-5. Figured specimen GSC 105132, GSC loc. C-153075 (GK-4-11). A crown with a moderately high principal cusp, reduced lateral cusps, and heels displaced labially. Main ornamentation is occlusal crest traversing cusps mesiodistally. Scale bar = 500  $\mu$ m.

1. Basal view of root showing arcuate base and concave labial face with canal openings.
2. Occlusal view showing labially displaced crown heels.
3. Lingual view showing high lingual root face and a central bulge.
4. Labial view showing principal cusp, reduced lateral cusps, and arched crown base and root under principal cusp.
5. Profile view showing cusp lingual inclination.

**The illustrated specimen in figures 6-8 is Upper Carnian and from the Baldonnel Formation.**

*Synechodus* sp. 2

Figures 6-8. Figured specimen GSC 105131, GSC loc. C-101119, (BBR-311A). A crown with a high principal cusp, occlusal crest, heels displaced labially, inflated labial lower crown face, no lateral cusps, and with no (or minor) other surface ornamentation. Scale bar = 500  $\mu$ m.

6. Occlusal view showing high principal cusp, labially displaced crown heels, slight central bulge or uvula below principal cusp, and absent lateral cusps.
7. Lingual view showing high lingual root face and a central bulge. Broken apex is approximately circular in cross-section.
8. Profile view showing crown lingual inclination and lower labial inflated face. Lingual root face has a prominent bulge.

## PLATE 11 (cont.)

The illustrated specimens in figures 9-17 are Ladinian and from the Liard Formation.

*Synechodus volaticus* n. sp.

### Type A

Figures 9-17. Specimens 1-3, GSC loc. C-101065 (ACE-2). A crown with a moderately high principal cusp and two lateral cusps. Labial shoulder has a continuous longitudinal rim (lip) and short ridges that intersect it perpendicularly where each forms an acute node. Root lingual face is high with a central bulge and large basal canal openings. Root upper labial face is broken by large canal openings on lower concave labial face. Basal root surface is arcuate.

Figures 9-12. Specimen 1, paratype GSC 105133. Labial crown face has a continuous longitudinal shoulder rim with two ridges that intersect it perpendicularly and form nodes at the rim.

9. Basal view of arcuate root and canal channelling of lower labial root face. Scale bar = 325  $\mu\text{m}$ .
10. Lingual view of crown and high root face with a central bulge and canal openings near the base. Scale bar = 350  $\mu\text{m}$ .
11. Labial view of crown and root showing crown cusp arrangement and canal channelling of upper labial root face. Scale bar = 350  $\mu\text{m}$ .
12. Profile view showing crown inclination and labial face ridges, nodes, and rim. Scale bar = 350  $\mu\text{m}$ .

Figure 13. Specimen 3, paratype GSC 105134. View of subcrown labial face surface, root lower labial face, and basal root surface. Three large canal openings are seen on lower labial root face. Scale bar = 325  $\mu\text{m}$ .

Figures 14-17. Specimen 2, holotype GSC 105135. Labial crown face has an undulating longitudinal shoulder rim that is intersected perpendicularly by several ridges that form nodes at the rim.

14. Basal view of arcuate root and canal channelling of lower labial root face. Scale bar = 300  $\mu\text{m}$ .
15. Lingual view of crown and high root face with a central bulge and canal openings near the base. Scale bar = 350  $\mu\text{m}$ .
16. Labial view of crown and root showing crown cusp arrangement and canal channelling of upper labial root face. Scale bar = 350  $\mu\text{m}$ .
17. Profile view showing crown inclination and labial face ridges, nodes, and rim. Scale bar = 350  $\mu\text{m}$ .

## PLATE 11 (cont.)

The illustrated specimen in figures 18-22 is Upper Carnian and from the Baldonnel? Formation.

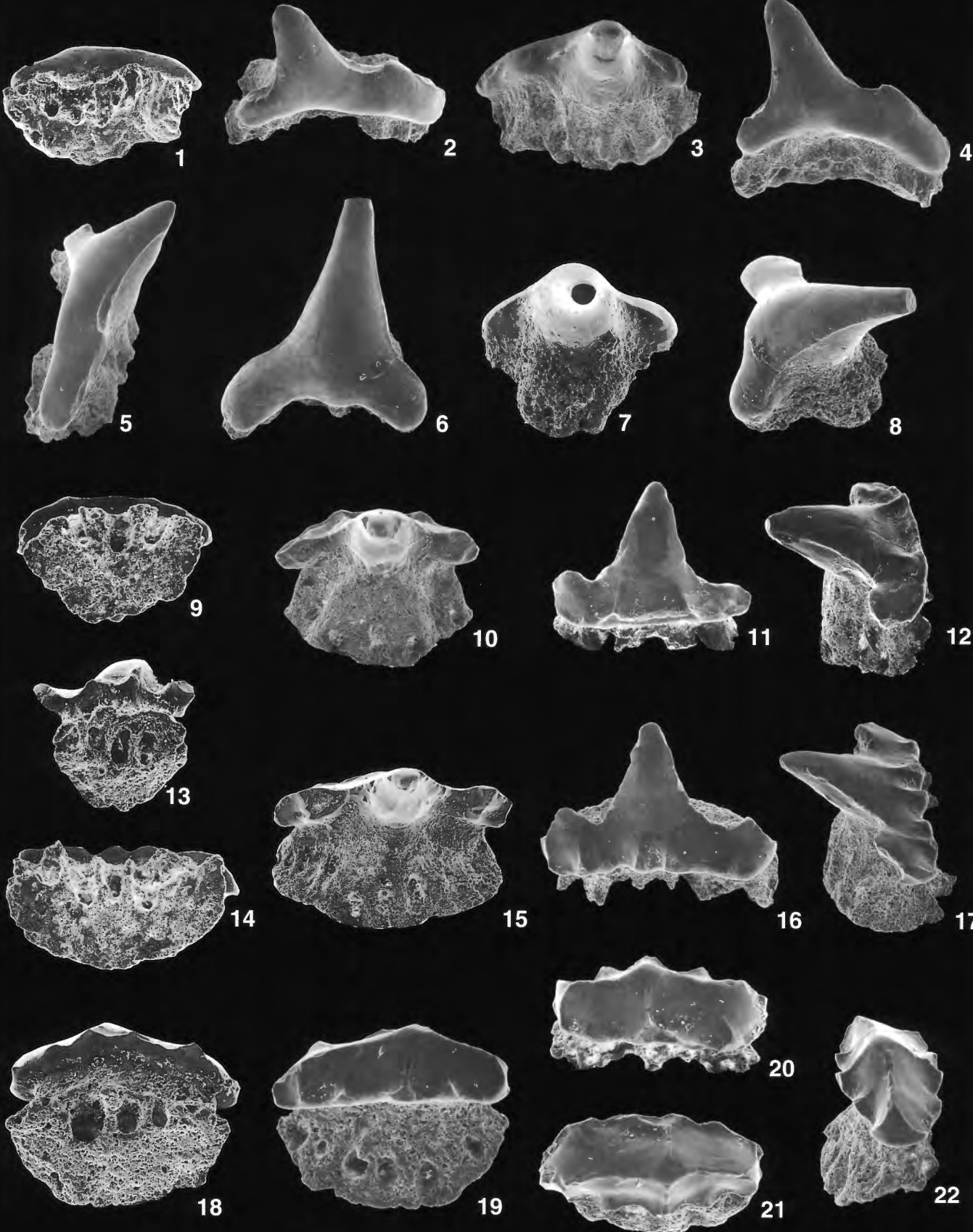
*Synechodus volaticus* n. sp.

### Type B

Figures 18-22. Paratype, GSC 105137, GSC loc. C-101003 (BBR-2). A crown with a low principal cusp and reduced lateral cusps. Crown shoulders have an undulating longitudinal ridge and short lines or ridges that intersect the shoulder ridge perpendicularly where each forms an acute and commonly prominent node. Root lingual face is high with a central bulge and large basal canal openings. Root upper labial face is broken by large canal openings found on lower concave labial face. Basal root surface is arcuate. Scale bar = 250  $\mu$ m.

18. View of labial subcrown surface, large canal openings on lower labial root face, and arcuate basal root surface.
19. Lingual view of crown and a high root face with a central bulge and large canal openings near the base.
20. Labial view of crown and root showing crown cusp arrangement and canal channelling of upper labial root face.
21. Occlusal view showing a lingually inclined cusp.
22. Profile view showing prominent acute shoulder nodes of both crown faces.





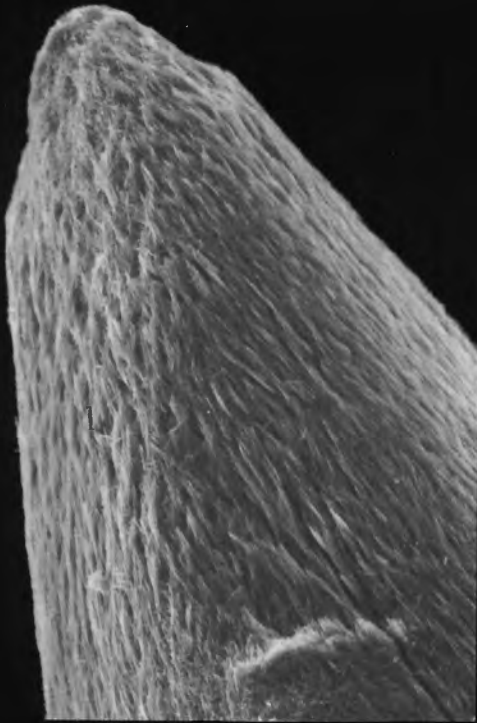
## PLATE 12

**The illustrated specimen is Ladinian and from the Liard Formation at GSC loc. C-101069 (BEH-3).**

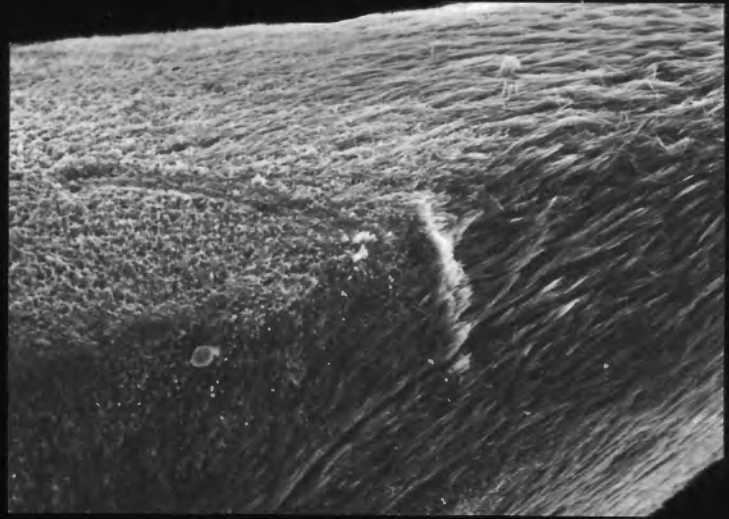
*Synechodus volaticus* n. sp.

Figures 1-4. Paratype GSC 105136. Illustrations of a principal cusp etched in HCl showing two layers (shiny single crystallite and parallel fibres) of the three layers described by Reif (1973, 1974b) as characteristic of neoselachian sharks.

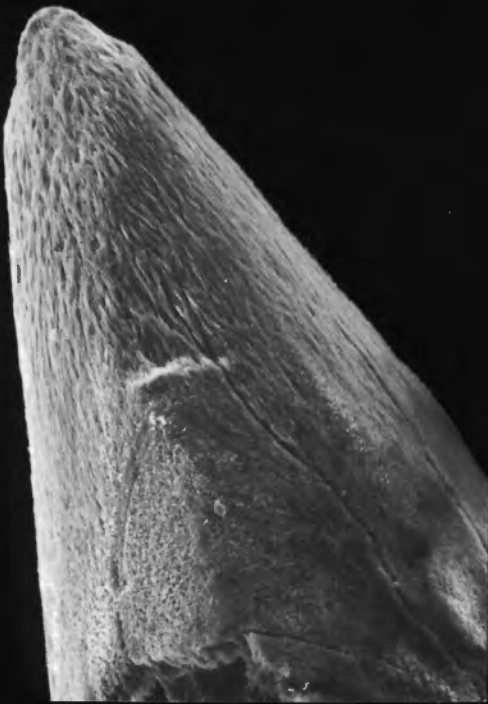
1. View of apex region showing parallel fibre bundles that run basally to apex. Scale bar = 50  $\mu\text{m}$ .
2. Enlargement of basal cusp region showing tiny crystallites perpendicular to outer surface on top of parallel fibre bundles (at right). Scale bar = 50  $\mu\text{m}$ .
3. View of cusp showing apex and basal regions in enlargements of figures 1 and 2. Scale bar = 90  $\mu\text{m}$ .
4. Partial section through cusp basal region showing single crystallites on top with parallel fibre bundles positioned below. Scale bar = 25  $\mu\text{m}$ .



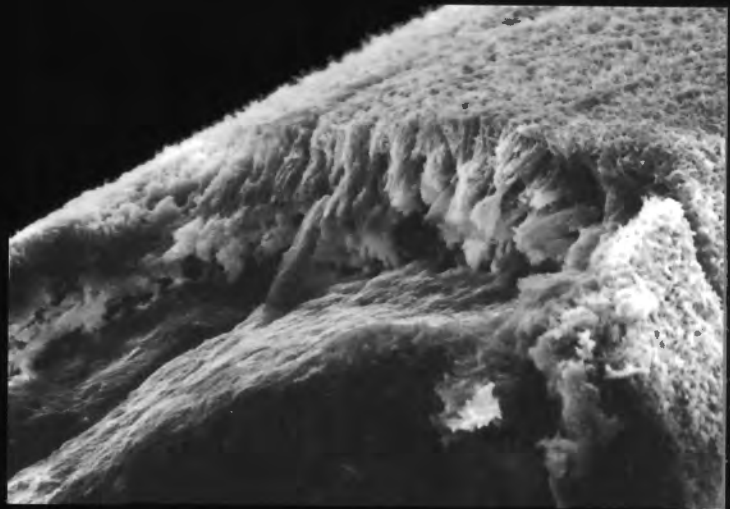
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4



# **PART IB**

## **ELASMOBRANCH SCALES (DERMAL DENTICLES)**

### **PLATES 13-38**

## PLATE 13

**The illustrated specimen in figures 1-5 is Ladinian and from the Liard Formation.**

*Parviscapha trivela* n. gen. et sp. s.f.

Figures 1-5 Holotype GSC 105294, GSC loc. C-101065 (ACE-2). Basal, posterior, anterior, upper, and profile views. Crown with prominent central sail-like keel with lateral wing on each side. Surface texture granular. Subpedicle surface concave with large central canal opening. Scale bar = 150  $\mu$ m.

**The illustrated specimen in figures 6-10 is Upper Carnian and from the Baldonnel? Formation and; figures 11-16 is Ladinian and from the Liard Formation.**

*Parviscapha univelum* n. gen. et sp. s.f.

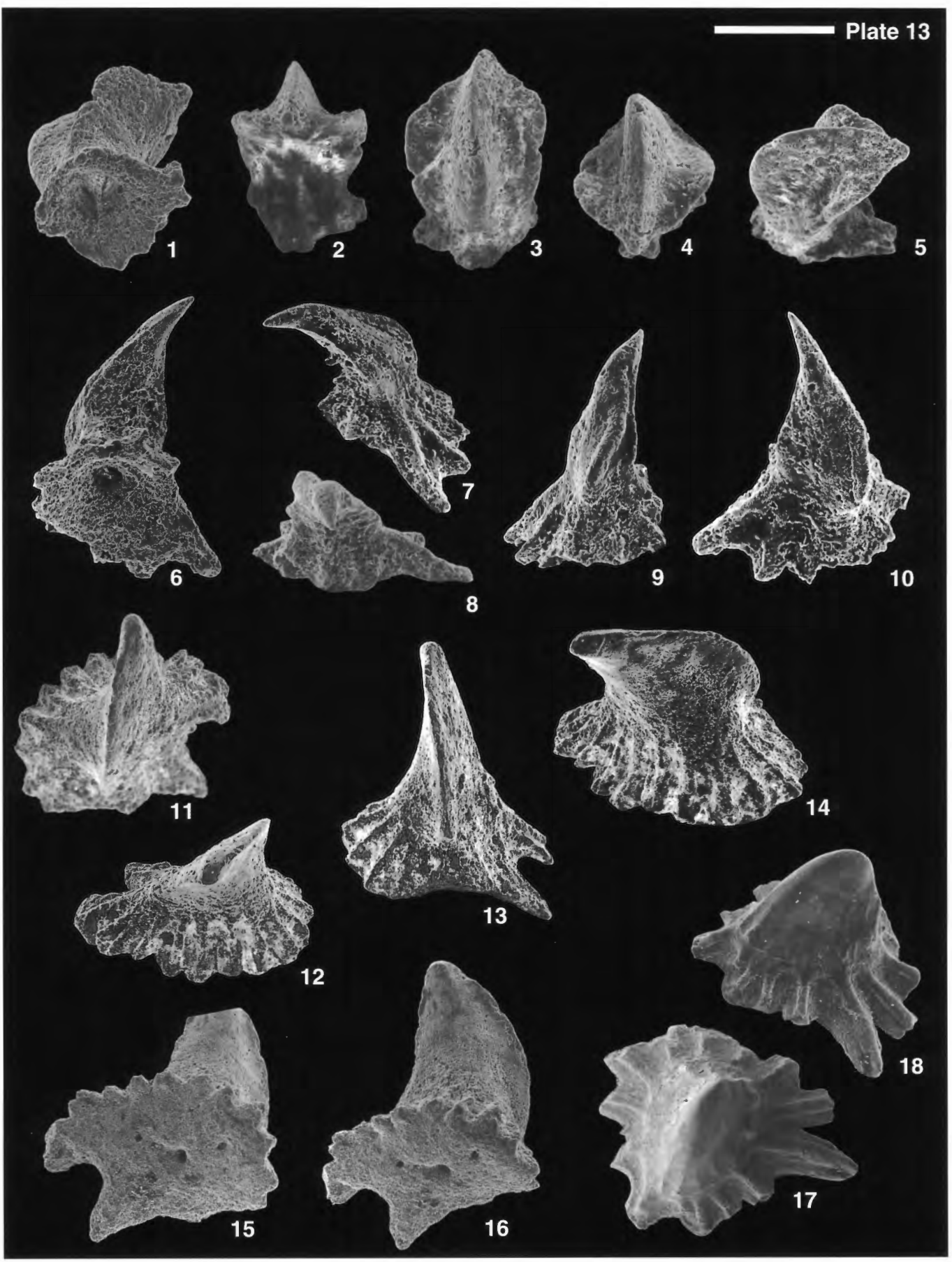
Figures 6-10. Paratype GSC 105295, GSC loc. C-101003 (BBR-2). Basal, posterior-profile, posterior, anterior, and anterior-profile views. Crown with prominent central keel and acute posterior apex. Surface texture granular. Subpedicle surface concave with central canal opening. Scale bar = 200  $\mu$ m.

Figures 11-16. Holotype GSC 105296, GSC loc. C-101069 (BEH-3). Upper, posterior, anterior, profile, subpedicle, and subcrown views. Showing crown with prominent central keel rising to posterior apex. Surface texture granular. Pedicle well preserved and fluted truncate. Subpedicle surface multipetaloid with small central canal opening. Scale bar = 400  $\mu$ m (fig. 11, 15, 16), 375  $\mu$ m (fig. 12), 350  $\mu$ m (fig. 13), and 300  $\mu$ m (fig. 14).

**The illustrated specimen in figures 17-18 is Upper Carnian and from the Baldonnel Formation.**

?*Parviscapha univelum* n. gen. et sp. s.f.

Figures 17-18. Figured specimen GSC 105297, GSC loc. C-101118 (BBR-310B). Upper and profile views. Crown shorter and less keeled than holotype; with smooth and lustrous texture that may be an outer enameloid layer. Scale bar = 450  $\mu$ m (fig. 17) and 425  $\mu$ m (fig. 18).





## PLATE 14

**The illustrated specimens in figures 1-6 are Middle Norian and from the Pardonet Formation.**

*Lobaticorona floriditurris* n. gen. et sp. s.f.

Figures 1-4. Holotype GSC 105283, GSC loc. C-101754 (NPP-Low). Basal, upper, and profile views. Primary ridge traverses central crown and splits into secondary and tertiary ridges or lines on crown lobes. Furrows penetrate deeply into crown centre. Subpedicle surface outline multipetaloid. Scale bar = 400 µm.

Figures 5-6. Paratype GSC 105284, GSC loc. C-101003 (BBR-2). Upper and profile views. Crown with fewer ridges and different arrangement of lobes than holotype. Scale bar = 200 µm.

**The illustrated specimens in figures 7-11 are Upper Carnian and from the Baldonnel Formation.**

*Lobaticorona floriditabella* n. gen. et sp. s.f.

Figures 7-8. Paratype GSC 105285, GSC loc. C-101119 (BBR-311A). Basal views showing flat and multipetaloid subpedicle with irregular central canal opening (fig. 7). Subcrown with irregular lobate and furrowed outline (fig. 8). Scale bar = 400 µm.

Figures 9-11. Holotype GSC 105286, GSC loc. C-101119 (BBR-311A). Basal, upper, and profile views. Crown with short bifurcating ridges on lobes; not deeply penetrated by furrows. Subpedicle surface outline multipetaloid and surface with many small canal openings. Scale bar = 450 µm (fig. 9, 11), and 400 µm (fig. 10).

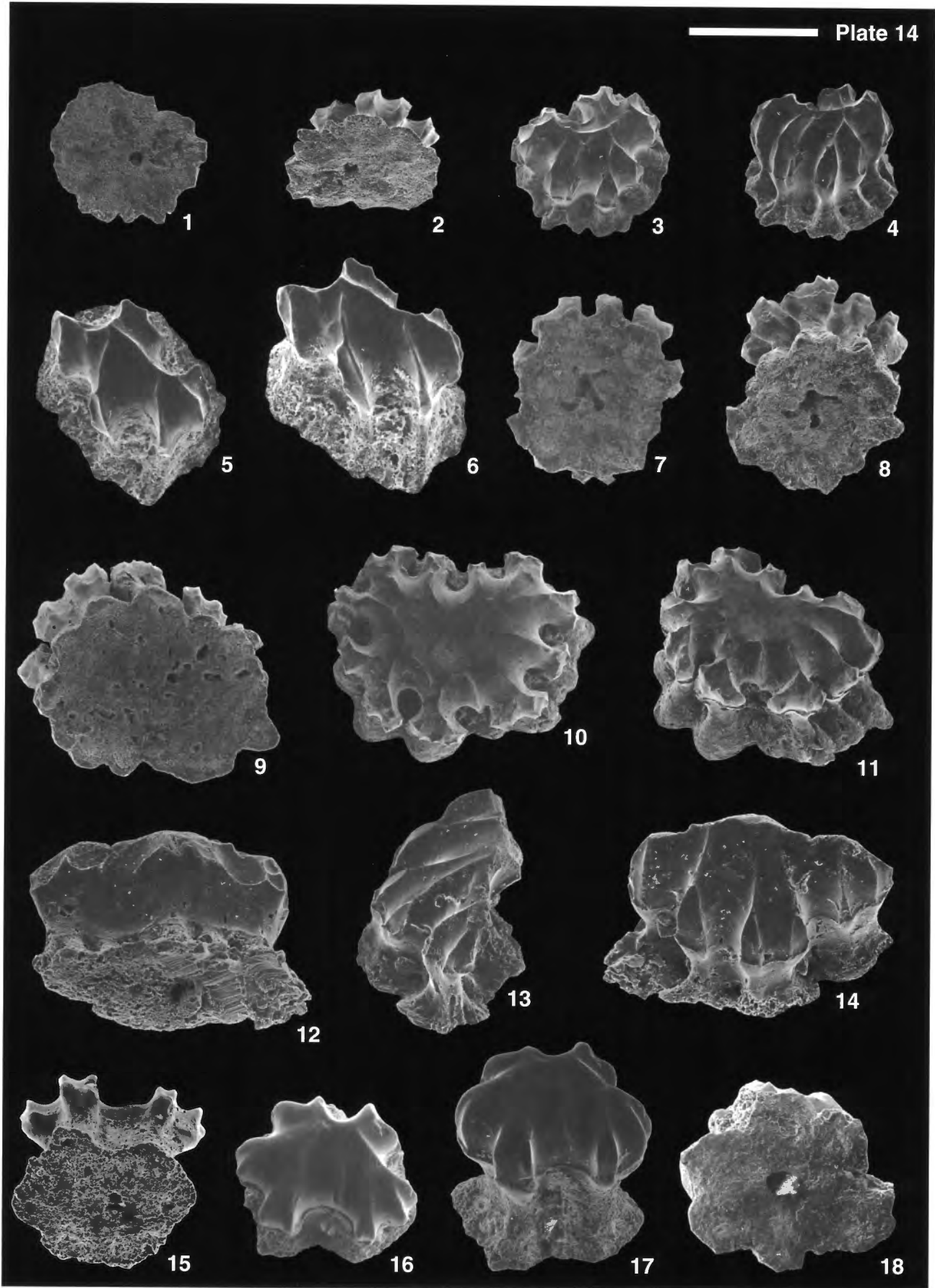
**The illustrated specimens in figures 12-14 and 18 are Middle Norian and from the Pardonet Formation and; figures 15-17 are Ladinian and from the Liard Formation.**

*Lobaticorona floridibasis* n. gen. et sp. s.f.

Figures 12-14. Paratype GSC 105287, GSC loc. C-101036 (MS-3). Subposterior, profile, and anterior views. Crown inclined and ridges converge near broad posterior margin. Scale bar = 200 µm.

Figures 15-17. Holotype GSC 105288, GSC loc. C-101064 (ACE-1). Basal, upper, and anterior views. Crown slightly inclined; ridges converge posteriorly near slightly developed posterior apex. Scale bar = 200 µm.

Figure 18. Paratype GSC 105289, GSC loc. C-101036 (MS-3). Subpedicle surface showing typical multipetaloid nature of margins and central canal opening. Scale bar = 200 µm.



## PLATE 15

**The illustrated specimen in figures 1-3 is Lower Norian and from the Pardonet Formation.**

*Lobaticorona tumiditurris* n. gen. et sp. s.f.

Figures 1-3 Holotype GSC 105290, GSC loc. C-087909 (BH-48). Basal, upper, and profile views. Primary ridge traverses central crown and splits into secondary ridges or lines on crown lobes. Furrows penetrate deeply into crown centre. Scale bar = 200 µm.

**The illustrated specimen in figures 4-6 is Ladinian and from the Liard Formation; figures 7-9 is Upper Carnian and from the Baldonnel? Formation.**

*Lobaticorona tumiditabella* n. gen. et sp. s.f.

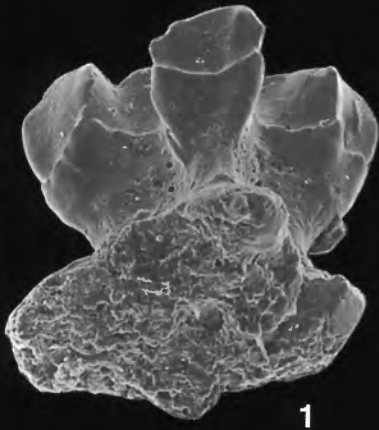
Figures 4-6. Holotype GSC 105291, GSC loc. C-101069 (BEH-3). Basal, upper, and profile views. Crown with moderately short bifurcating ridges on lobes; not deeply penetrated by furrows. Subpedicle surface convex and with many small canal openings. Scale bar = 400 µm.

Figures 7-9. Paratype GSC 105292, GSC loc. C-101003 (BBR-2). Basal, upper, and profile views. Crown with long bifurcating ridges that extend to lobes; not deeply penetrated by furrows. Subpedicle surface with large central canal opening. Scale bar = 400 µm.

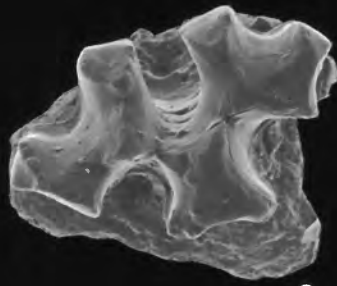
**The illustrated specimen in figures 10-13 is from the Liard Formation and Ladinian.**

*Lobaticorona tumidibasis* n. gen. et sp. s.f.

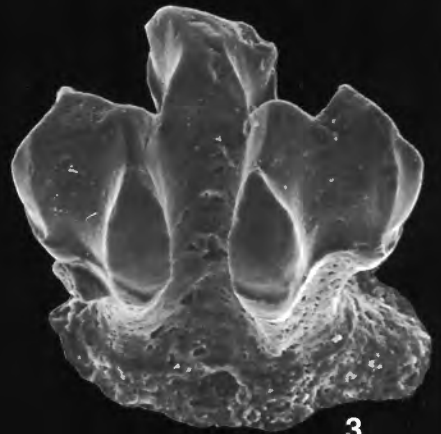
Figures 10-13. Holotype GSC 105293, GSC loc. C-153075 (GK-4-11). Basal, upper, anterior, and profile views. Crown slightly inclined and ridges converge near posterior margin. Scale bar = 400 µm.



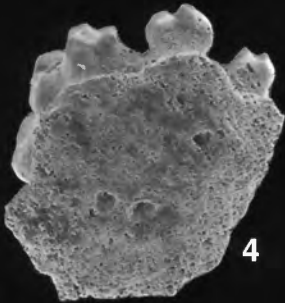
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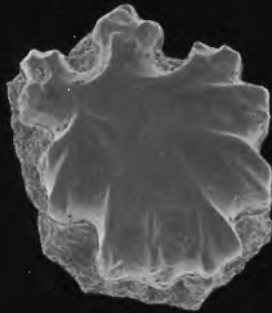
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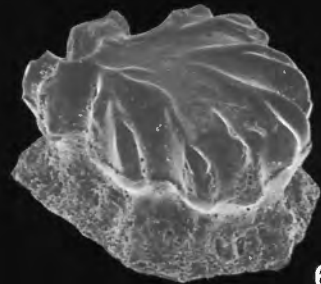
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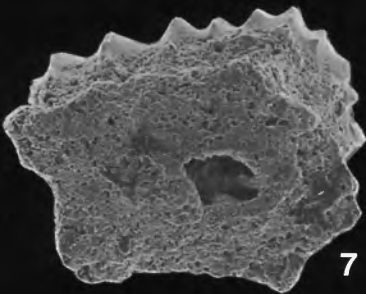
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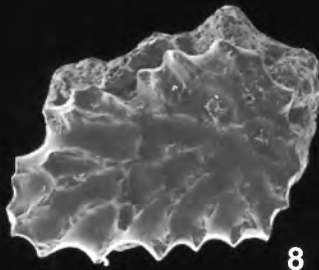
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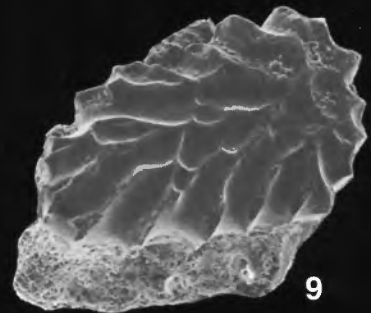
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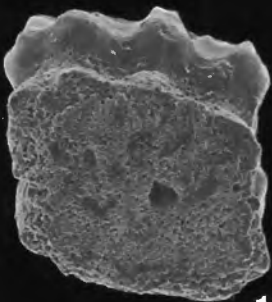
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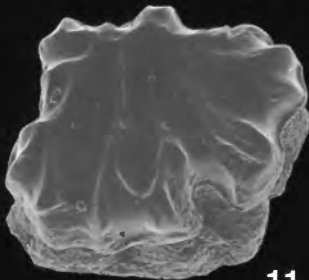
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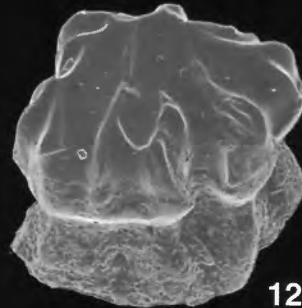
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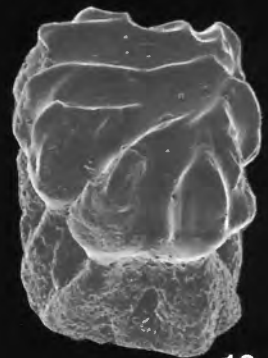
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13

## PLATE 16

All illustrated specimens are Ladinian and from the Liard Formation.

*Proprigalea mediglabra* n. gen. et sp. s.f.

Figures 1-3. Holotype GSC 105280, GSC loc. C-101065 (ACE-2). Basal, upper, and profile views. Crown dome-shaped and circular with short ridges on margins perpendicular to longitudinal ridge. Pedicle subcentral and fluted truncate. Subpedicle surface with large canal opening (fig. 1). Scale bar = 475  $\mu\text{m}$ .

*Proprigalea languidula* n. gen. et sp. s.f.

Upper crown surface with moderately short ridges near anterior margins; posterior and central crown generally smooth and unornamented. Pedicle fluted truncate (may be keeled), and positioned anteriorly under crown.

Figures 4-6. Type A, Paratype GSC 105281, GSC loc. C-101068 (BEH-2). Basal, profile, and anterior views. Crown slightly extended to posterior (fig. 5); subcrown surface concave and unornamented (fig. 4). Scale bar = 500  $\mu\text{m}$ .

Figures 7-10. Type B, holotype GSC 105282, GSC loc. C-101065 (ACE-2). Basal, profile, upper, and anterior views. Crown extended to posterior (fig. 8); subcrown surface with mesial ridge or keel and concavity on each side (fig. 7). Scale bar = 500  $\mu\text{m}$ .



## PLATE 17

All illustrated specimens are Ladinian and from the Liard Formation.

*Undulaticorona propensa* n. gen. et sp. s.f.

Figure 1. Paratype GSC 105276, GSC loc. C-101068 (BEH-2). View showing keeled and ridged subcrown. Subpedicle surface concave; outline multipetaloid. Scale bar = 450  $\mu$ m.

Figures 2-4. Holotype GSC 105275, GSC loc. C-101066 (ACE-3). Upper, anterior, and profile views. Crown circular to lanceolate with ridges that curve over crown margins to subcrown surface; anterior margin with overhang and longitudinal line or ridge. Scale bar = 450  $\mu$ m.

*Undulaticorona profundifossae* n. gen. et sp. s.f.

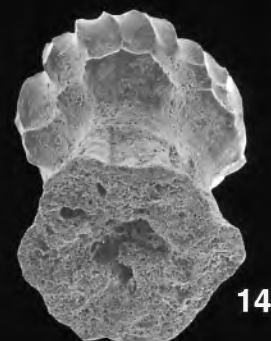
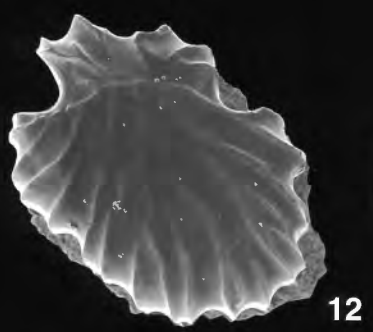
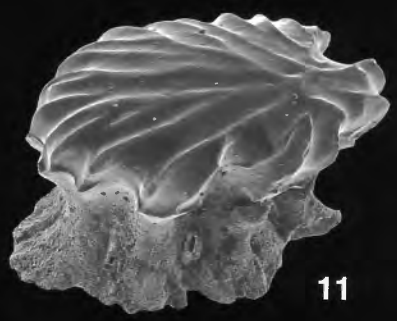
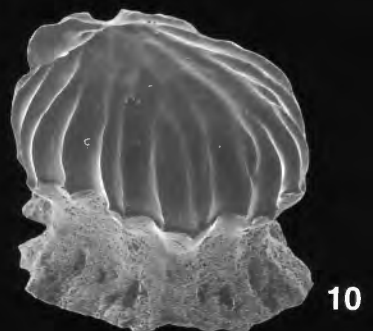
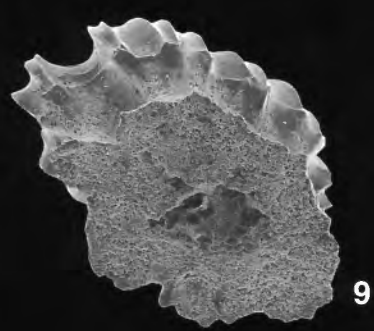
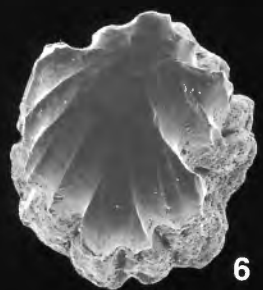
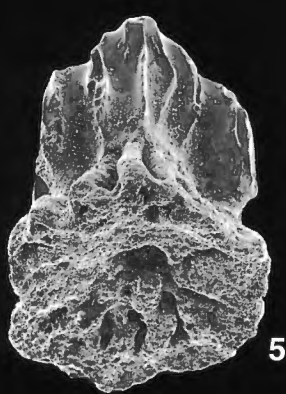
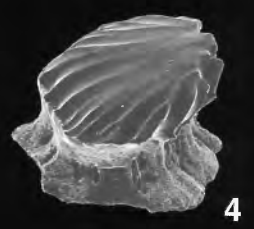
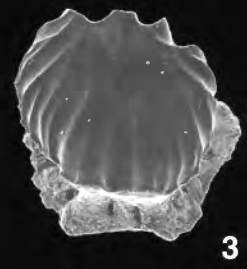
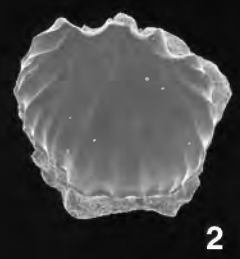
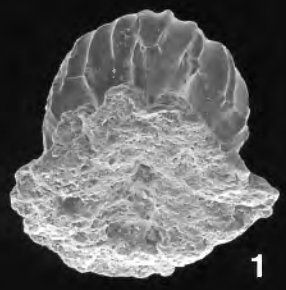
Figures 5-8. Holotype GSC 105277, GSC loc. C-101069 (BEH-3). Basal, upper, anterior, and profile views. Crown with deep furrows and prominent ridges that curve over margins to subcrown surface. Subcrown with keels and ridges. Pedicle keeled fluted truncate. Subpedicle surface concave and with large central canal opening; outline multipetaloid. Scale bar = 475  $\mu$ m (fig. 5), and 500  $\mu$ m (fig. 6-8).

*Proprigalea medirugosa* n. gen. et sp. s.f.

Figures 9-12. Paratype GSC 105278, GSC loc. C-101066 (ACE-3). Basal, anterior, profile, and upper views. Crown dome-shaped but not symmetrical; ridges long and converge posteriorly; anterior longitudinal ridge prominent. Subcrown with halo and ridges. Pedicle subcentral and fluted truncate. Subpedicle surface flat and with large central canal opening. Scale bar = 350  $\mu$ m.

Figures 13-15. Holotype GSC 105279, GSC loc. C-101069 (BEH-3). Upper, basal, and profile views. Crown dome-shaped and approximately symmetrical; ridges long and converge centrally; shoulder longitudinal ridge prominent. Subcrown with halo and ridges. Pedicle subcentral and fluted truncate. Subpedicle surface flat and with large central canal opening. Scale bar = 350  $\mu$ m.





## PLATE 18

**The illustrated specimens in figures 1-3 are Ladinian and from the Liard Formation.**

*Parvidiabolus obliquus* n. gen. et sp. s.f.

Figure 1. Paratype GSC 105267, GSC loc. C-101069 (BEH-3). Subcrown with deep furrows and long ridges (commonly more centrally raised). Subpedicle surface concave and with moderately large central canal opening; outline circular with an irregular margin. Scale bar = 350  $\mu$ m.

Figures 2-3. Holotype GSC 105268, GSC loc. C-101069 (BEH-3). Anterior and profile views. Crown with three posterior apices, and long and similarly raised ridges; furrows moderately deep. Pedicle fluted truncate. Scale bar = 350  $\mu$ m.

**The illustrated specimens in figures 4-7 are Ladinian and from the Liard Formation.**

*Parvidiabolus convexus* n. gen. et sp. s.f.

Figures 4-5. Paratype GSC 105269, GSC loc. C-101065 (ACE-2). Basal views showing several long subcrown ridges and multipetaloid subpedicle with large central canal opening. Scale bar = 600  $\mu$ m (fig. 4) and 500  $\mu$ m (fig. 5).

Figures 6-7. Holotype GSC 105270, GSC loc. C-101069 (BEH-3). Anterior and profile views, showing convex crown from side edge to side edge. Crown with three posterior apices; several ridges similarly raised and long. Scale bar = 550  $\mu$ m.

**The illustrated specimen in figures 8-10 is Upper Carnian and from the Baldonnel? Formation.**

*Parvidiabolus longisulcus* n. gen. et sp. s.f.

Figures 8-10. Holotype GSC 105274, GSC loc. C-101003 (BBR-2). Basal, anterior, and profile views. Crown with three posterior apices and mesial platform with prominent furrows on each side; ridges long. Subcrown with long and well raised ridges. Subpedicle surface concave and with central canal opening; outline multipetaloid. Scale bar = 500  $\mu$ m (fig. 8) and 475  $\mu$ m (fig. 9-10).

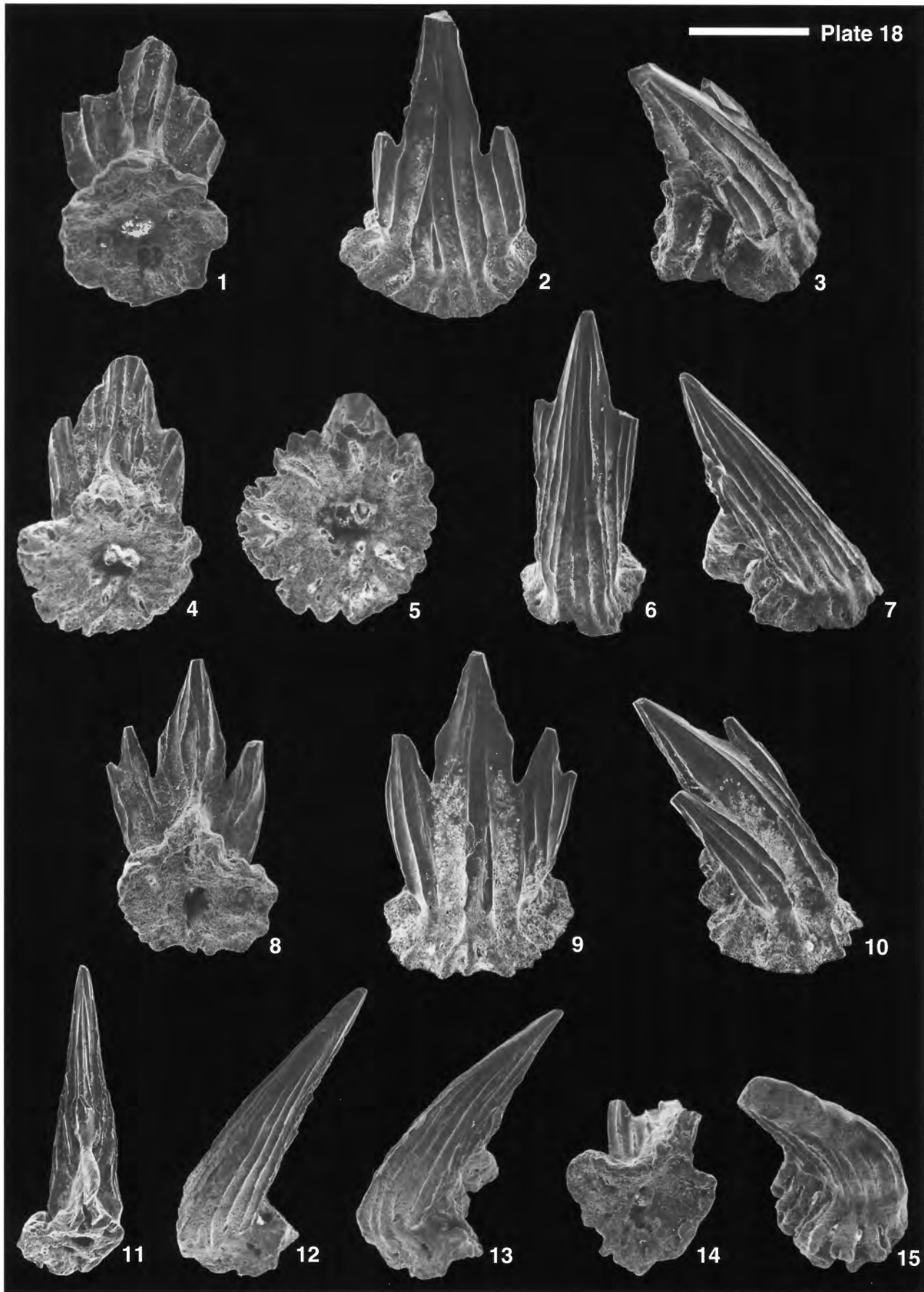
**The illustrated specimens in figures 11-15 are Ladinian and from the Liard Formation.**

*Parvidiabolus acutus* n. gen. et sp. s.f.

Figures 11-13. Holotype GSC 105271, GSC loc. C-101069 (BEH-3). Basal, anterior, and profile views. Crown convex from side to side, narrow and elongate; with long ridges and single posterior apex. Subcrown with long ridges and prominent mesial keel. Scale bar = 700  $\mu$ m (fig. 11) and 650  $\mu$ m (figs. 12-13).

Figure 14. Paratype GSC 105272, GSC loc. C-101069 (BEH-3), showing concave subpedicle surface with central canal opening. Scale bar = 650  $\mu$ m.

Figure 15. Paratype GSC 105273, GSC loc. C-153072 (GK-1-48). Profile view of damaged specimen showing intact fluted truncate pedicle. Scale bar = 550  $\mu$ m.



## PLATE 19

All illustrated specimens are Ladinian and from the Liard Formation.

*Duplisuggestus duplirugosus* n. gen. et sp. s.f.

Figures 1-4. Paratype (fig. 1-2) GSC 105262 and holotype GSC 105263 (fig. 3-4), GSC loc. C-101069 (BEH-3). Basal, anterior, and profile views. Crown mesial platform with closely paired ridges that converge posteriorly. Subcrown with mesial ridge and other lines or ridges. Pedicle keeled fluted truncate. Subpedicle surface flat and with moderately large central canal opening; outline rhomboid. Scale bar = 600  $\mu$ m.

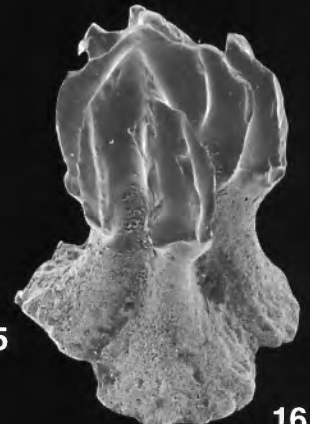
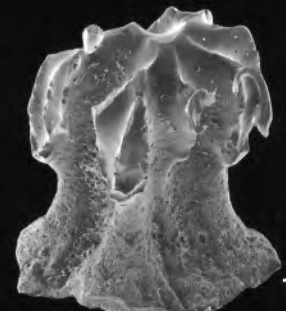
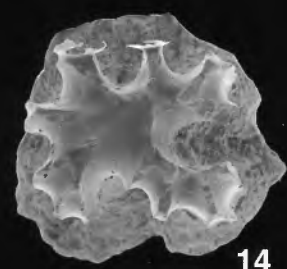
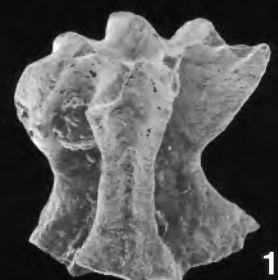
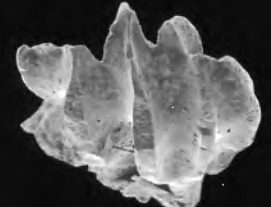
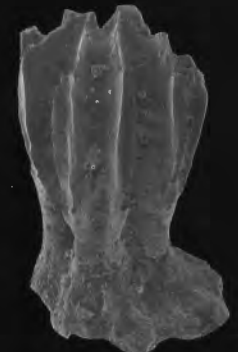
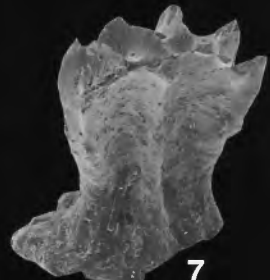
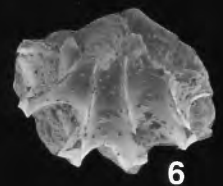
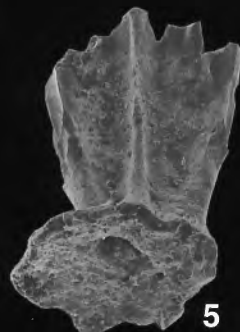
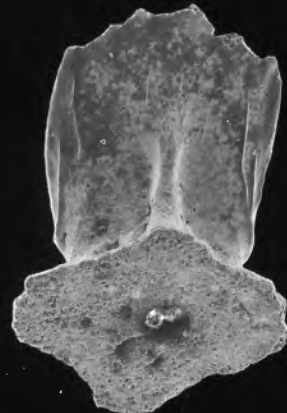
*Duplisuggestus profundisulcus* n. gen. et sp. s.f.

The illustrations show variation in form of three specimens. In figures 5-8, the crown is steeply oblique and the posterior subcrown is more open. In figures 13-16, an almost erect crown is convex from side to side and has similar ornamentation on all faces. Figures 9-12 show an intermediate type.

Figures 5-8. Holotype GSC 105264, GSC loc. C-101065 (ACE-2). Basal, upper, subposterior, and anterior views. Crown steeply oblique. Upper crown surface with three narrow and long platforms each formed of two close ridges; furrows long and deep (fig. 8). Subcrown with mesial ridge or keel (fig. 5, 7). Subpedicle surface concave with large canal opening. Scale bar = 400  $\mu$ m.

Figures 9-12. Paratype GSC 105265, GSC loc. C-101065 (ACE-2). Basal, upper, subposterior, and anterior views. Crown steeply oblique. Upper crown surface similar to holotype. Subcrown with double mesial keels (fig. 9, 11). Scale bar = 400  $\mu$ m.

Figures 13-16. Paratype GSC 105266, GSC loc. C-153075 (GK-4-11). Basal, upper, subposterior, and anterior views. Crown erect with similar faces on all sides. Platforms long, narrow, prominent, and commonly with two ridges. Furrows deep and long. Pedicle keeled fluted truncate. Subpedicle surface concave. Scale bar = 450  $\mu$ m (fig. 13), and 400  $\mu$ m (fig. 14-16).



## PLATE 20

All illustrated specimens are Ladinian and from the Liard Formation.

*Coniunctio aequirugosa* n. gen. et sp. s.f.

Figures 1-3. Holotype GSC 105257, GSC loc. C-101065 (ACE-2). Upper, anterior, and profile. Crown with many long and similarly raised ridges perpendicular to anterior longitudinal ridge. Pedicle keeled fluted truncate. Scale bar = 450  $\mu\text{m}$  (fig. 1, 3) and 475  $\mu\text{m}$  (fig. 2).

Figure 4. Paratype GSC 105379, GSC loc. C-101065 (ACE-2). Showing subcrown with ridges and halo. Subpedicle surface flat with large central canal opening; outline rhomboid. Scale bar = 500  $\mu\text{m}$ .

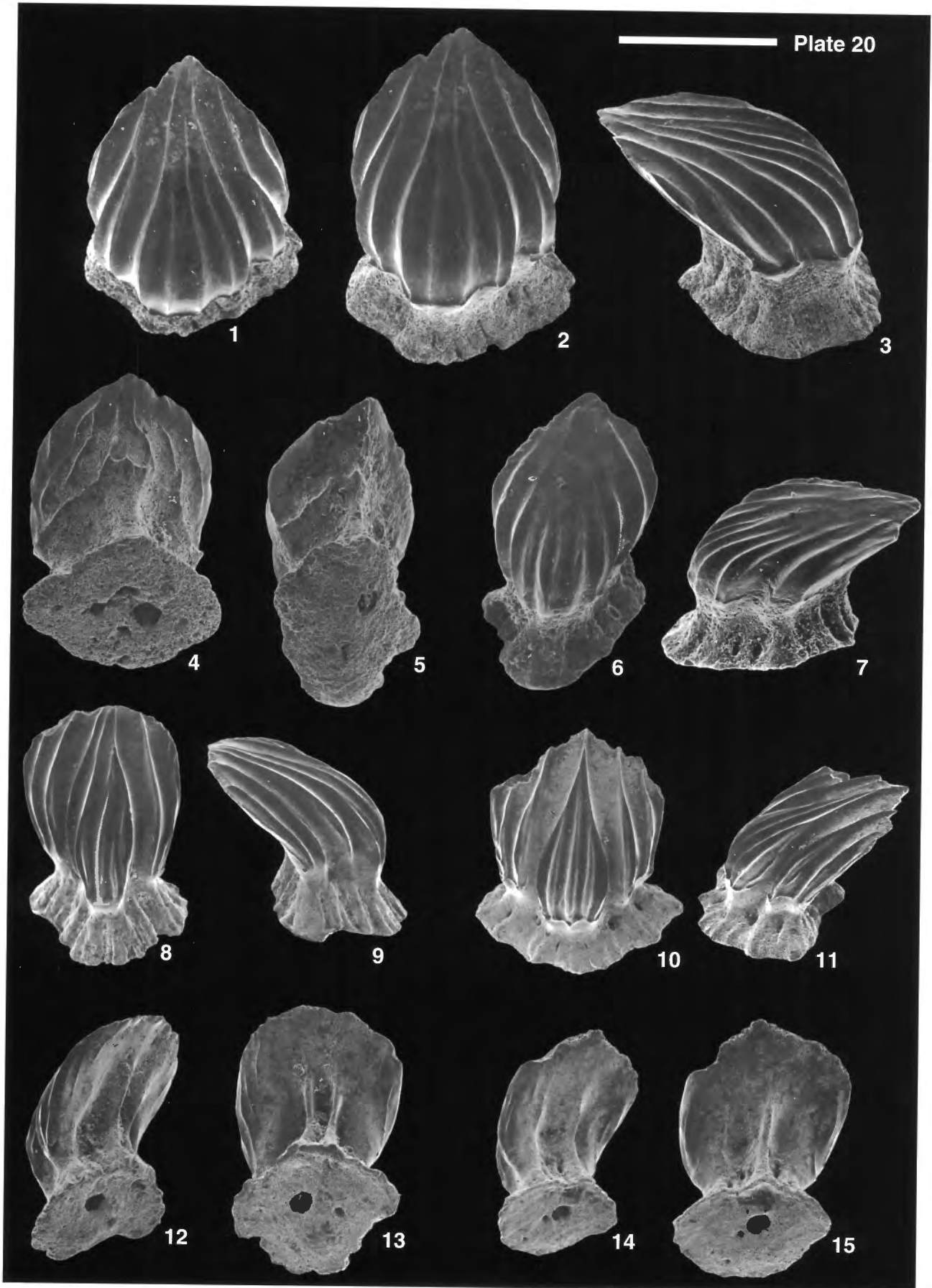
Figures 5-7. Paratype GSC 105258, GSC loc. C-101065 (ACE-2). Basal, anterior, and profile views. Upper crown surface similar to holotype. Subcrown with rounded mesial ridge and halo; additional ridges absent. Pedicle keeled fluted truncate. Subpedicle surface convex with anterior bulge and small canal opening; outline rhomboid. Scale bar = 500  $\mu\text{m}$ .

*Coniunctio multirugosa* n. gen. et sp. s.f.

Figures 8-9, 12-13. Holotype GSC 105259, GSC loc. C-101065 (ACE-2). Anterior, profile, and basal views. Crown with long mesial platform, long lateral ridges, moderately deep and long furrows, and anterior longitudinal ridge. Subcrown with two mesial ridges and additional short lines or ridges (fig. 12-13). Pedicle keeled fluted truncate. Scale bar = 950  $\mu\text{m}$ .

Figures 10-11. Paratype GSC 105260, GSC loc. C-101066 (ACE-3). Anterior and profile views. Upper crown surface similar to holotype but with prominent anterior longitudinal ridge. Scale bar = 950  $\mu\text{m}$  (fig. 10) and 900  $\mu\text{m}$  (fig. 11).

Figures 14-15. Paratype GSC 105261, GSC loc. C-101065 (ACE-2). Two views showing subcrown with one mesial ridge and other with short lines or ridges. Scale bar = 1000  $\mu\text{m}$  (fig. 14) and 875  $\mu\text{m}$  (fig. 15).





## PLATE 21

**The illustrated specimens in figures 1-8 and 13-15 are Ladinian and from the Liard Formation.**

*Labascicorona alata* n. gen. et sp. s.f.

Figures 1, 5. Type A, paratype GSC 105246, GSC loc. C-101065 (ACE-2). Anterior and profile views. Crown with a narrow and elongate rhomboid mesial platform with no lines or ridges. Profile view showing broad and deep furrow on each side of mesial platform typical of this species. Scale bar = 500  $\mu\text{m}$ .

Figures 2, 6. Type B, holotype GSC 105247, GSC loc. C-101065 (ACE-2). Anterior and profile views. Crown with a narrow and elongate lanceolate mesial platform with one line or ridge. Scale bar = 500  $\mu\text{m}$  (fig. 2) and 475  $\mu\text{m}$  (fig. 6).

Figures 3, 7. Type C, paratype GSC 105248, GSC loc. C-153075 (GK-4-11). Anterior and profile views. Crown with elongate lanceolate mesial platform with two lines or ridges. Scale bar = 700  $\mu\text{m}$ .

Figures 4, 8. Type D, paratype GSC 105249, GSC loc. C-101065 (ACE-2). Anterior and profile views. Crown with lanceolate mesial platform with three lines or ridges. Scale bar = 500  $\mu\text{m}$ .

Figures 13-14. Type C, paratype GSC 105250, GSC loc. C-153075 (GK-4-11). Views of subcrown showing mesial ridge, and subpedicle rhomboid outline and anterior convex bulge. Scale bar = 700  $\mu\text{m}$ .

Figure 15. Type B, paratype GSC 105251, GSC loc. C-101065 (ACE-2). Basal view showing well raised subcrown mesial ridge, and subpedicle large canal opening and anterior convex bulge. Scale bar = 500  $\mu\text{m}$ .

**The illustrated specimens in figures 9-10 and 16 are Upper Carnian from the Baldonnell Formation.**

*Labascicorona mediflexura* n. gen. et sp. s.f.

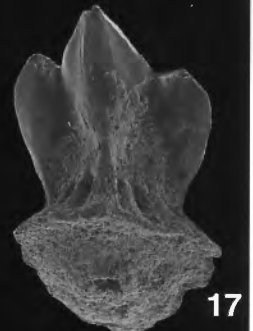
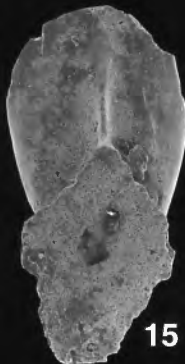
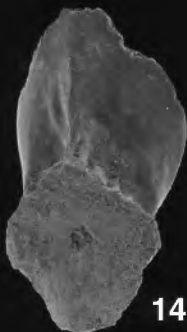
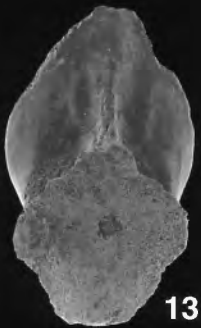
Figures 9-10. Holotype GSC 105252, GSC loc. C-101119 (BBR-311A). Profile and anterior views. Crown with several moderately long ridges that shallow posteriorly. Scale bar = 500  $\mu\text{m}$ .

Figure 16. Paratype GSC 105253, GSC loc. C-101119 (BBR-311A). View showing subcrown mesial ridge, and rhomboid subpedicle outline with surface convex anterior bulge. Scale bar = 500  $\mu\text{m}$ .

**The illustrated specimen in figures 11-12 and 17 is Ladinian and from the Liard Formation.**

*Labascicorona nitidifastigia* n. gen. et sp. s.f.

Figures 11-12, 17. Holotype GSC 105254, GSC loc. C-153075 (GK-4-11). Profile, anterior, and basal views. Crown convex anterior to posterior with short ridges and prominent and long mesial platform. Posterior crown commonly smooth; margin with three apices. Subcrown with prominent and rounded mesial ridge that extends to central apex. Subpedicle surface with convex anterior bulge. Scale bar = 500  $\mu\text{m}$ .



## PLATE 22

**The illustrated specimen in figures 1-3 is Upper Carnian and from the Baldonnell Formation.**

*Labascicorona longifossae* n. gen. et sp. s.f.

Figures 1-3. Holotype GSC 105255, GSC loc. C-101003 (BBR-2). Basal, anterior, and profile views. Crown with long mesial platform and lateral ridges; deep furrows on each side of mesial platform and between ridges (fig. 2-3). Subcrown with broadly rounded mesial ridge. Subpedicle surface convex at anterior and with small canal opening; outline rhomboid. Scale bar = 500  $\mu$ m.

**The illustrated specimen in figures 4-7 is Ladinian and from the Liard Formation.**

*Labascicorona trifastigia* n. gen. et sp. s.f.

Figures 4-7. Holotype GSC 105256, GSC loc. C-101069 (BEH-3). Subcrown, profile, anterior, and subpedicle views. Crown with three posterior apices and long and broad mesial platform (fig. 5-6). Subcrown with several short ridges originating at posterior apex regions and extending towards pedicle; mesial ridge very broad and rounded (fig. 4). Subpedicle surface large, and with one or more small canal openings and a convex anterior bulge (fig. 7). Scale bar = 500  $\mu$ m.

**The illustrated specimens in figures 8-13 are Ladinian from the Liard Formation.**

*Gracilisuggestus triapices* n. gen. et sp. s.f.

Figures 9-10. Holotype GSC 105165, GSC loc. C-101065 (ACE-2). Profile and anterior views. Crown with three posterior apices, long and narrow mesial platform, and one or more pairs of long lateral ridges. Pedicle tetrahedroid. Scale bar = 250  $\mu$ m.

Figures 12-13. Paratype GSC 105166, GSC loc. C-101069 (BEH-3). Profile and anterior views. Similar to holotype but also with an anterior longitudinal line. Scale bar = 350  $\mu$ m.

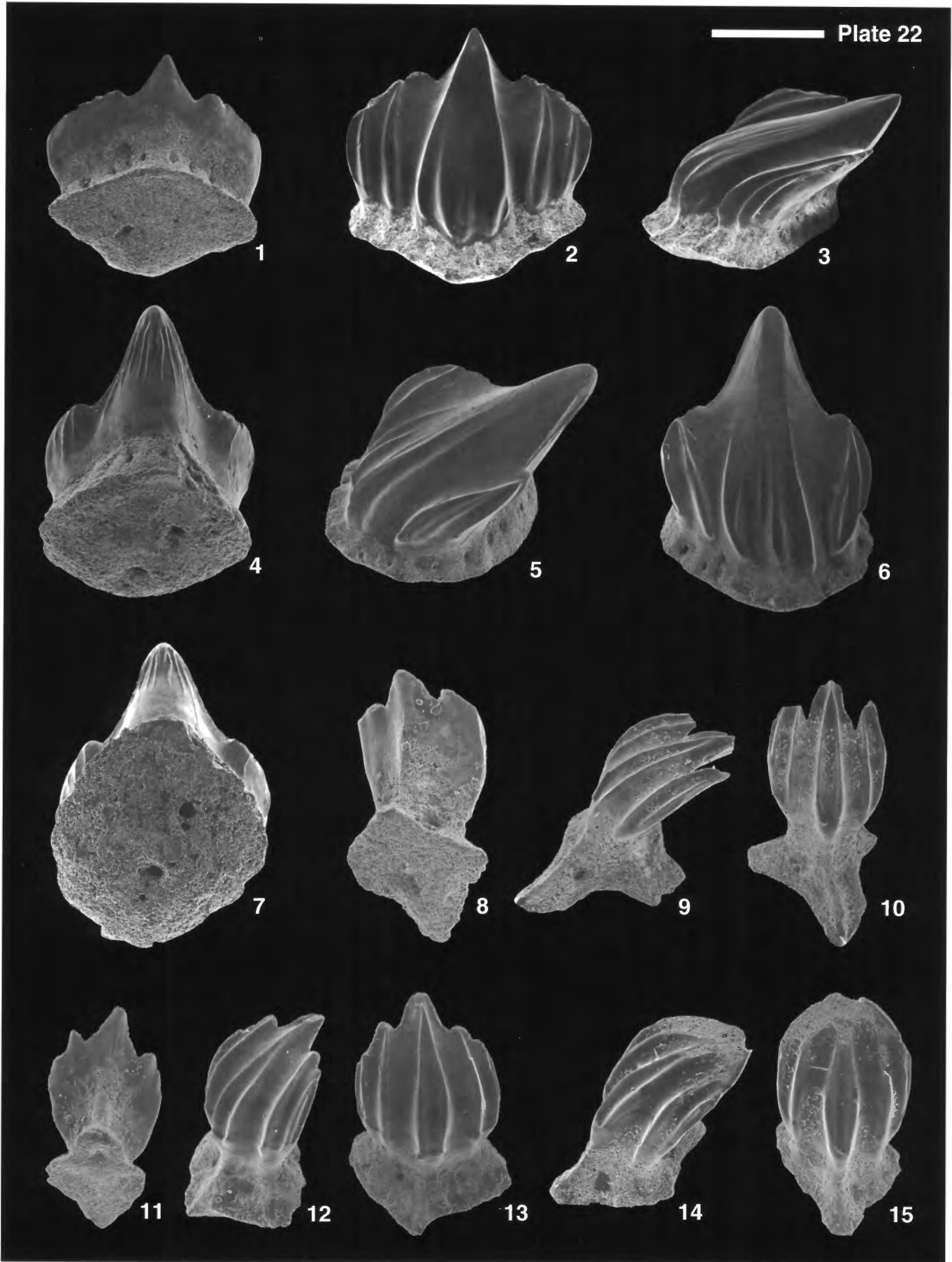
Figure 8. Paratype GSC 105167, GSC loc. C-101065 (ACE-2). Showing prominent subcrown mesial ridge. Subpedicle surface concave and with small canal opening; outline rhomboid. Scale bar = 250  $\mu$ m.

Figure 11. Paratype GSC 105168, GSC loc. C-101065 (ACE-2). Showing shallow and broadly rounded subcrown mesial ridge. Subpedicle surface concave; outline rhomboid. Scale bar = 250  $\mu$ m.

**The illustrated specimen in figures 14-15 is Upper Carnian and from the Baldonnell? Formation.**

*Gracilisuggestus uniapex* n. gen. et sp. s.f.

Figures 14-15. Holotype GSC 105169, GSC loc. C-101003 (BBR-2). Profile and anterior views. Crown with one posterior apex; otherwise similar to *G. triapices*. Scale bar = 250  $\mu$ m.



## PLATE 23

All illustrated specimens are Middle Norian and from the Pardonet Formation.

*Fragilicorona unicuspis* n. gen. et sp. s.f.

Figures 1-2. Holotype GSC 105138, GSC loc. C-087924 (BH-8). Profile view (fig. 1) showing simple tetrahedroid pedicle and minor or absent anterior crown overhang. Anterior view (fig. 2) showing one posterior apex, long and narrow mesial platform, and absent anterior shoulder longitudinal line. Scale bar = 200  $\mu$ m.

Figures 9, 12. Paratype GSC 105139, GSC loc. C-087924 (BH-8), showing views of subcrown and subpedicle surfaces. Cracking on subcrown (fig. 9) is artifact of preservation, otherwise surface smooth and unornamented. Subpedicle outline tetrapetaloid to rhomboid; surface with small central canal opening. Scale bar = 200  $\mu$ m.

Figure 10. Type A, paratype GSC 105140, GSC loc. C-302387 (TE-217D). View of subcrown. Scale bar = 200  $\mu$ m.

*Fragilicorona labricuspis* n. gen. et sp. s.f.

Figures 3-8. Crown with one posterior apex, anterior longitudinal shoulder line, minor anterior crown overhang, and various numbers of lines or ridges on various widths of mesial platforms. Scale bar = 250  $\mu$ m.

- 3-4. Type A, holotype GSC 105141, GSC loc. C-302390 (TE-220A). Anterior and profile views; mesial platform moderately narrow with no lines or ridges.
- 5-6. Type B, paratype GSC 105142, GSC loc. C-302390 (TE-220A). Anterior and profile views; mesial platform moderately narrow with one line.
7. Type C, paratype GSC 105143, GSC loc. C-101150 (MS-247A). Anterior view; mesial platform with two long ridges.
8. Type D, paratype GSC 105144, GSC loc. C-101036 (MS-3). Anterior view; mesial platform moderately broad with three short lines.

Figure 11. Type B, paratype GSC 105145, GSC loc. C-101150 (MS-247A). Showing views of subcrown and subpedicle surfaces. Cracking on subcrown is artifact of preservation, otherwise surface smooth and unornamented. Subpedicle outline tetrapetaloid to rhomboid. Scale bar = 250  $\mu$ m.

Figures 13-14. Paratype GSC 105147, GSC loc. C-087924 (BH-8). Two views of subpedicle surface showing tetrapetaloid pattern with petal-like bases slightly overlapping and concave centrally. Scale bar = 150  $\mu$ m.



## PLATE 24

All illustrated specimens are Middle Norian and from the Pardonet Formation.

*Fragilicorona tricuspis* n. gen. et sp. s.f.

Figures 1-2. Holotype GSC 105148, GSC loc. C-302387 (TE-217D). Anterior view (fig. 1) showing three posterior apices, long and narrow mesial platform and absent anterior shoulder longitudinal line. Profile view (fig. 2) showing minor or absent anterior crown overhang, crown/pedicle junction marked by a line, and simple tetrahedroid pedicle. Scale bar = 200  $\mu$ m.

Figures 12-13. Holotype (fig. 1-2) GSC 105148, GSC loc. C-302387 (TE-217D). Views of subcrown and subpedicle surfaces. Cracking on subcrown (fig. 12) is artifact of preservation, otherwise surface smooth and unornamented. Subpedicle outline tetrapetaloid. Scale bar = 200  $\mu$ m.

*Fragilicorona labritricuspis* n. gen. et sp. s.f.

Figures 3-8. Crown with three posterior apices, anterior longitudinal shoulder line, minor anterior crown overhang, and various numbers of lines or ridges on various widths of mesial platforms.

- 3-4. Type A, paratype GSC 105150, GSC loc. C-101150 (MS-247A). Profile and anterior views; mesial platform moderately narrow with no lines or ridges. Scale bar = 200  $\mu$ m.
- 5-6. Type B, paratype GSC 105151, GSC loc. C-101150 (MS-247A). Profile and anterior views; mesial platform moderately narrow with one ridge. Anterior longitudinal line restricted to base of mesial platform. Scale bar = 200  $\mu$ m.
- 7-8. Type B, holotype GSC 105152, GSC loc. C-101150 (MS-247A). Profile and anterior views; mesial platform with one short line. Scale bar = 250  $\mu$ m.
- 9. Type C, paratype GSC 105153, GSC loc. C-101114 (BBR-305B). Anterior view; mesial platform moderately broad with two long ridges. Scale bar = 250  $\mu$ m.
- 10-11. Type D, paratype GSC 105154, GSC loc. C-101150 (MS-247A). Anterior and profile views; mesial platform moderately broad with three lines or ridges. Scale bar = 200  $\mu$ m.

Figures 14-15. Paratype GSC 105155, GSC loc. C-101150 (MS-247A). Views of subpedicle and subcrown surfaces. Subpedicle outline tetrapetaloid. Cracking on subcrown is an artifact of preservation, otherwise surface smooth and unornamented. Scale bar = 200  $\mu$ m.

Figure 16. Paratype GSC 105156, GSC loc. C-101150 (MS-247A). View of subcrown surface that is better preserved (less cracking) showing general lack of ornamentation. Scale bar = 200  $\mu$ m.





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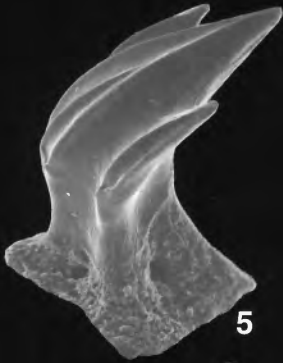
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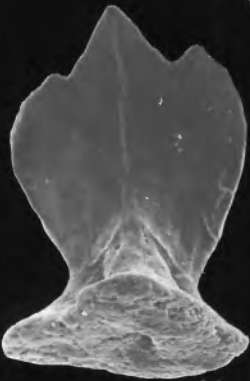
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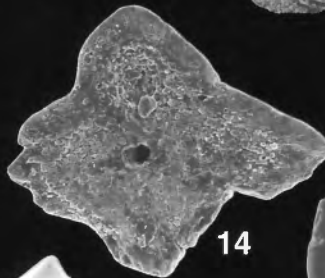
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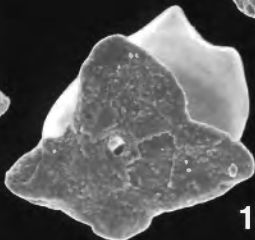
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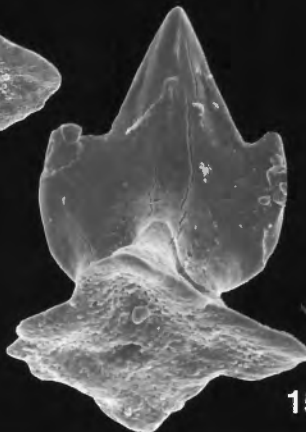
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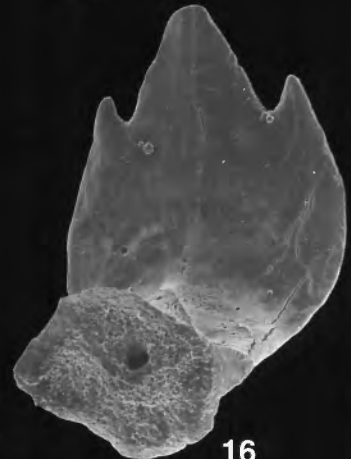
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## PLATE 25

All illustrated specimens are Middle Norian and from the Pardonet Formation.

*Fragilicorona brevirostrum* n. gen. et sp. s.f.

Figures 1-2. Holotype GSC 105157, GSC loc. C-302387 (TE-217D). Profile view (fig. 1) showing minor or absent anterior crown overhang and simple tetrahedroid pedicle. Anterior view (fig. 2) showing one posterior apex, broad and shallow mesial platform, and absent anterior shoulder longitudinal line. Scale bar = 200  $\mu$ m.

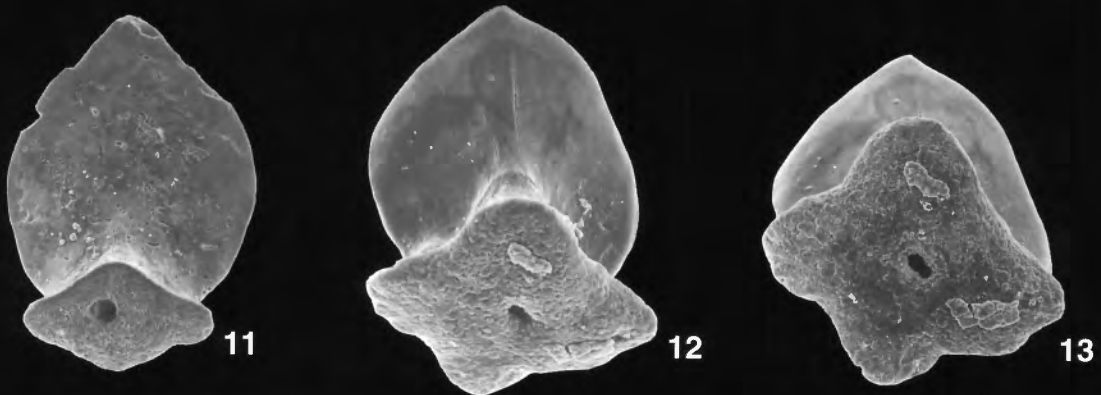
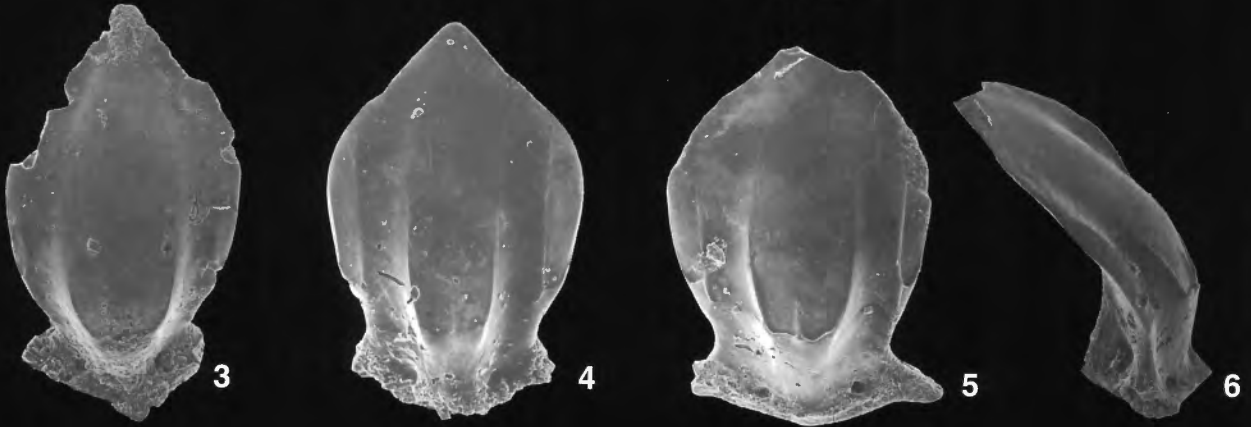
Figures 12-13. Paratype GSC 105158, GSC loc. C-302387 (TE-217D). Views of subcrown and subpedicle surfaces. Cracking on subcrown (fig. 12) is an artifact of preservation, otherwise the surface is smooth and unornamented. Subpedicle outline tetrapetaloid to rhomboid. Scale bar = 200  $\mu$ m.

*Fragilicorona labribrevirostrum* n. gen. et sp. s.f.

Figures 3-10. Crown with one posterior apex, anterior longitudinal shoulder line (especially at base of mesial platform), minor anterior crown overhang, broad and shallow mesial platform (length best seen in profile), and various numbers of lines or ridges on mesial platform.

3. Type A, paratype GSC 105159, GSC loc. C-101036 (MS-3). Anterior view; mesial platform without lines or ridges. Scale bar = 300  $\mu$ m.
4. Type B, paratype GSC 105160, GSC loc. C-101036 (MS-3). Anterior view; mesial platform with one short line. Anterior longitudinal line faint and restricted to base of mesial platform. Scale bar = 250  $\mu$ m.
- 5-6. Type B, paratype GSC 105161, GSC loc. C-101036 (MS-3). Anterior and profile views; mesial platform with one short line; anterior longitudinal line moderately prominent. Scale bar = 250  $\mu$ m.
- 7-8. Type C, paratype GSC 105162, GSC loc. C-101036 (MS-3). Anterior and profile views; mesial platform with two short lines, anterior longitudinal line prominent. Scale bar = 300  $\mu$ m (fig. 7) and 250  $\mu$ m (fig. 8).
- 9-10. Type D, holotype GSC 105163, GSC loc. C-101036 (MS-3). Profile and anterior views; mesial platform moderately broad with three short lines; anterior longitudinal line prominent. Scale bar = 300  $\mu$ m (fig. 9) and 250  $\mu$ m (fig. 10).

Figure 11. Type B, paratype GSC 105164, GSC loc. C-101036 (MS-3). Views of subpedicle and subcrown surfaces. Subpedicle outline tetrapetaloid to rhomboid. Cracking on subcrown is an artifact of preservation, otherwise surface unornamented. Scale bar = 300  $\mu$ m.



## PLATE 26

All illustrated specimens are Ladinian and from the Liard Formation.

*Labrilancea glabrisubcuspis* n. gen. et sp. s.f.

Figure 1. Paratype GSC 105174, GSC loc. C-087972 (Sutherland Zone). Showing unornamented sub-crown surface. Scale bar = 200  $\mu$ m.

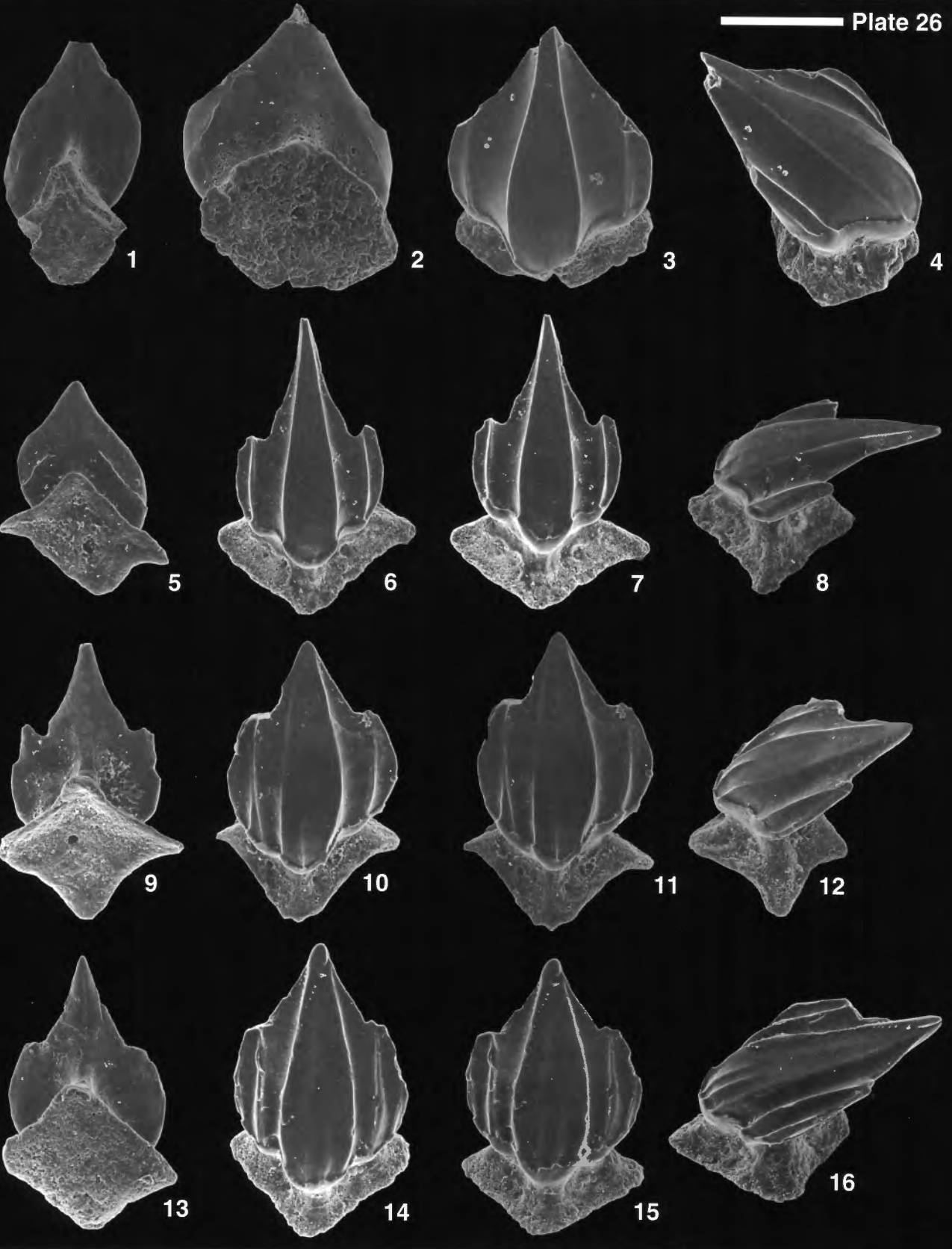
Figures 2-4. Holotype GSC 105173, GSC loc. C-101068 (BEH-2). Anterior and profile crown views showing one posterior apex, long mesial platform, wing (lateral) ridges, and prominent anterior overhang with longitudinal line or ridge. Subcrown surface with two short lines (discontinuous thin halo) near crown edges. Scale bar = 200  $\mu$ m.

Figure 5. Paratype GSC 105176, GSC loc. C-087972 (Sutherland Zone). Subcrown surface with discontinuous thin halo. Subpedicle outline rhomboid; surface concave. Scale bar = 200  $\mu$ m.

*Labrilancea glabrisubtricuspis* n. gen. et sp. s.f.

Figures 6-16. GSC loc. C-087972 (Sutherland Zone). Crown shallowly oblique with a prominent anterior overhang and long longitudinal line or ridge, long mesial platform and wing (lateral) ridges, and a posterior margin with three apices. Pedicle simple tetrahedroid. Different types are recognized by the number of mesial platform lines or ridges. Scale bar = 200  $\mu$ m.

- 6-8. Type A, holotype GSC 105177. Upper, anterior, and profile views. Mesial platform absent of lines or ridges.
- 10-12. Type B, paratype GSC 105178. Upper, anterior, and profile views. Mesial platform with one short line.
- 14-16. Type C, paratype GSC 105179. Upper, anterior, and profile views. Mesial platform with two short lines.
- 9. Paratype GSC 105180. View of subcrown and subpedicle surfaces. Subcrown unornamented. Subpedicle surface concave; outline rhomboid.
- 13. Paratype GSC 105181. View of subcrown and subpedicle surface. Subcrown unornamented. Subpedicle surface approximately flat; outline rhomboid.



## PLATE 27

**The illustrated specimens in figures 1-12 are Ladinian and from the Liard Formation.**

*Ornatilabrilancea circacarina* n. gen. et sp. s.f.

Subcrown and subpedicle surfaces, and upper, anterior, and profile views of crown. Subcrown surface with halo and rounded mesial ridge. Crown anterior margin overhang prominent with longitudinal line.

Figures 1-4. Type B, paratype GSC 105182, GSC loc. C-101065 (ACE-2). Subpedicle surface flat to convex; outline rhomboid. Mesial platform shallow and long with short line. Scale bar = 200  $\mu$ m.

Figures 5-8. Type B, holotype GSC 105183, GSC loc. C-153075 (GK-4-11). Subpedicle surface convex; outline rhomboid. Mesial platform long with short ridge. Scale bar = 200  $\mu$ m.

Figures 9-12. Type C, paratype GSC 105184, GSC loc. C-101065 (ACE-2). Subpedicle surface convex; outline rhomboid. Mesial platform long with central short ridge. Scale bar = 200  $\mu$ m (fig. 9), and 300  $\mu$ m (fig. 10-12).

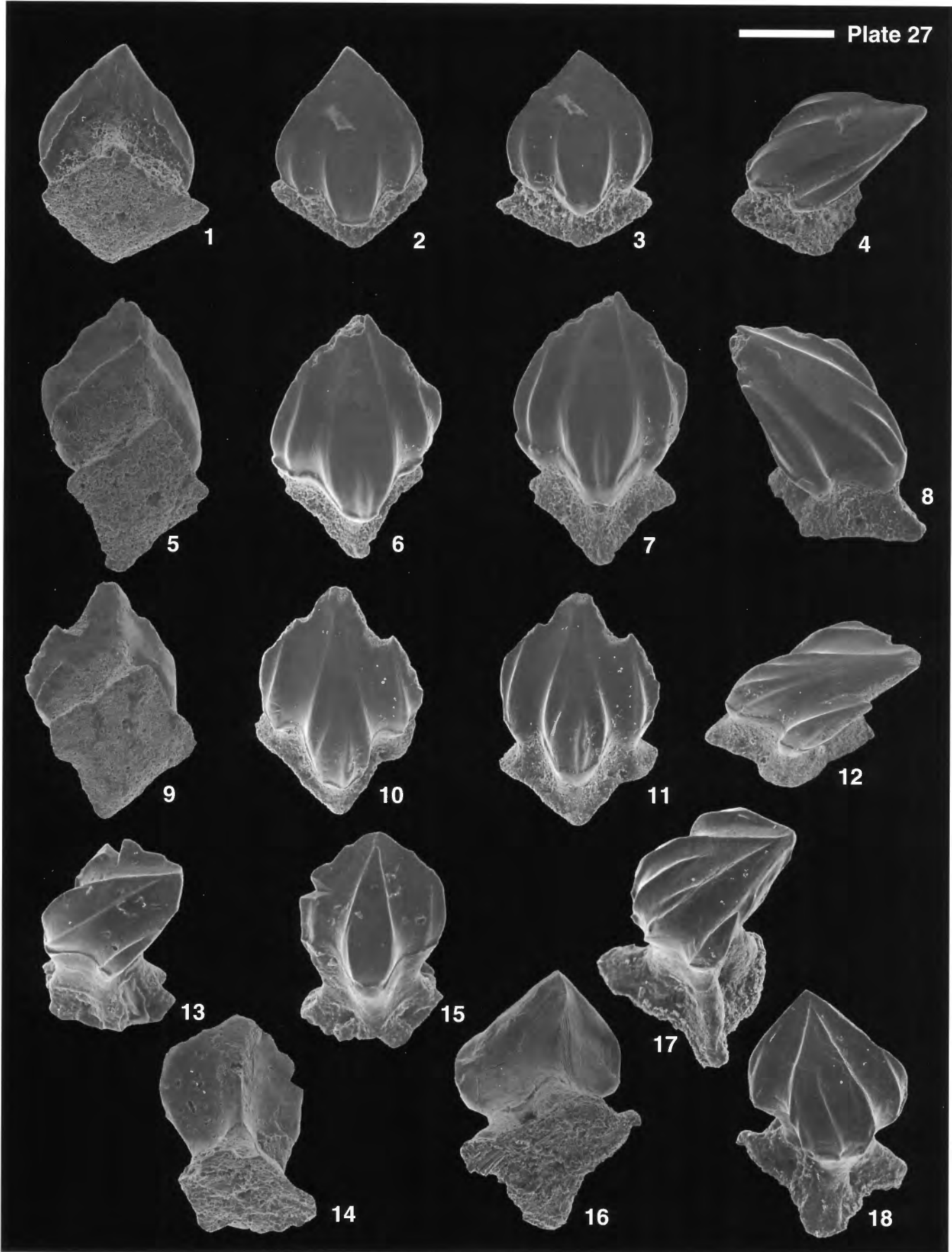
**The illustrated specimens in figures 13-18 are Middle Norian and from the Pardonet Formation.**

*Ornatilabrilancea solicarina* n. gen. et sp. s.f.

Subcrown and subpedicle surfaces, and anterior and profile views of crown. Subcrown with rounded mesial ridge; halo absent. Crown anterior margin overhang prominent with longitudinal line. Subpedicle surface concave to flat; outline tetrapetaloid or rhomboid.

Figures 13-15. Type A, paratype GSC 105185, GSC loc. C-101038 (MS-5). Crown mesial platform long and without lines or ridges. Scale bar = 150  $\mu$ m.

Figures 16-18. Type B, holotype GSC 105186, GSC loc. C-101150 (MS-247A). Crown mesial platform long and with one central line or ridge. Scale bar = 150  $\mu$ m.





## PLATE 28

**The illustrated specimens in figures 1-8 are Upper Carnian and from the Baldonnel? Formation at GSC loc. C-101002 (BBR-1).**

*Minuticorona triculmina* n. gen. et sp. s.f.

Figures 1-3. Holotype GSC 105187. Upper, anterior, and profile views showing three posterior apices, and long mesial platform and ridges similarly raised. Scale bar = 150  $\mu$ m.

Figure 7. Paratype GSC 105188. Showing unornamented subcrown surface. Scale bar = 150  $\mu$ m.

*Minuticorona uniculmen* n. gen. et sp. s.f.

Figures 4-6. Holotype GSC 105189. Upper, anterior, and profile views showing one posterior apex, and shallow mesial platform and moderately short ridges similarly raised. Scale bar = 150  $\mu$ m.

Figure 8. Paratype GSC 105190. Showing unornamented subcrown surface and rhomboid to tetrahedroid subpedicle outline. Scale bar = 150  $\mu$ m.

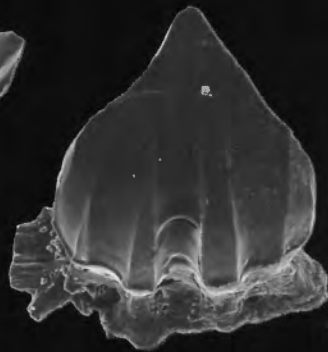
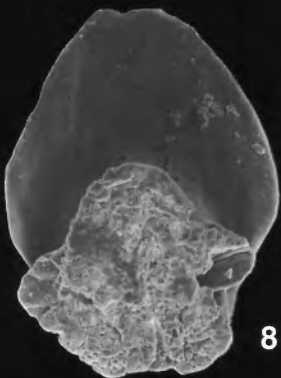
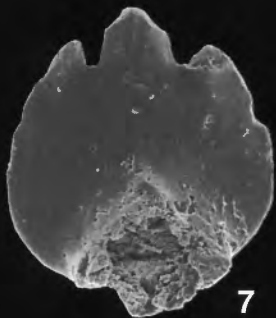
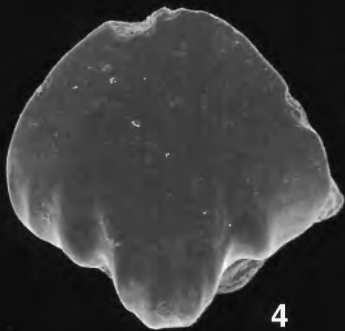
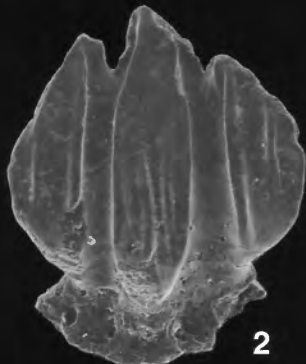
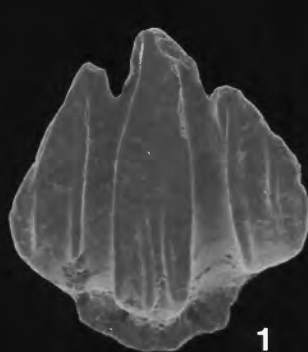
**The illustrated specimens in figures 9-13 are Middle Norian and from the Pardonet Formation at GSC loc. C-101036 (MS-3).**

*Rugosicorona devexa* n. gen. et sp. s.f.

Figure 9. Paratype GSC 105170. View of subcrown and subpedicle surfaces. Several ridges centrally prominent and extend from posterior apex to near pedicle. Subpedicle surface outline rhomboid. Scale bar = 200  $\mu$ m.

Figures 10-11. Paratype GSC 105171. Profile and anterior views showing long crown ridges and minor to almost absent anterior longitudinal line. Scale bar = 200  $\mu$ m.

Figures 12-13. Holotype GSC 105172. Profile and anterior views showing long crown ridges and prominent anterior longitudinal line. Scale bar = 200  $\mu$ m.



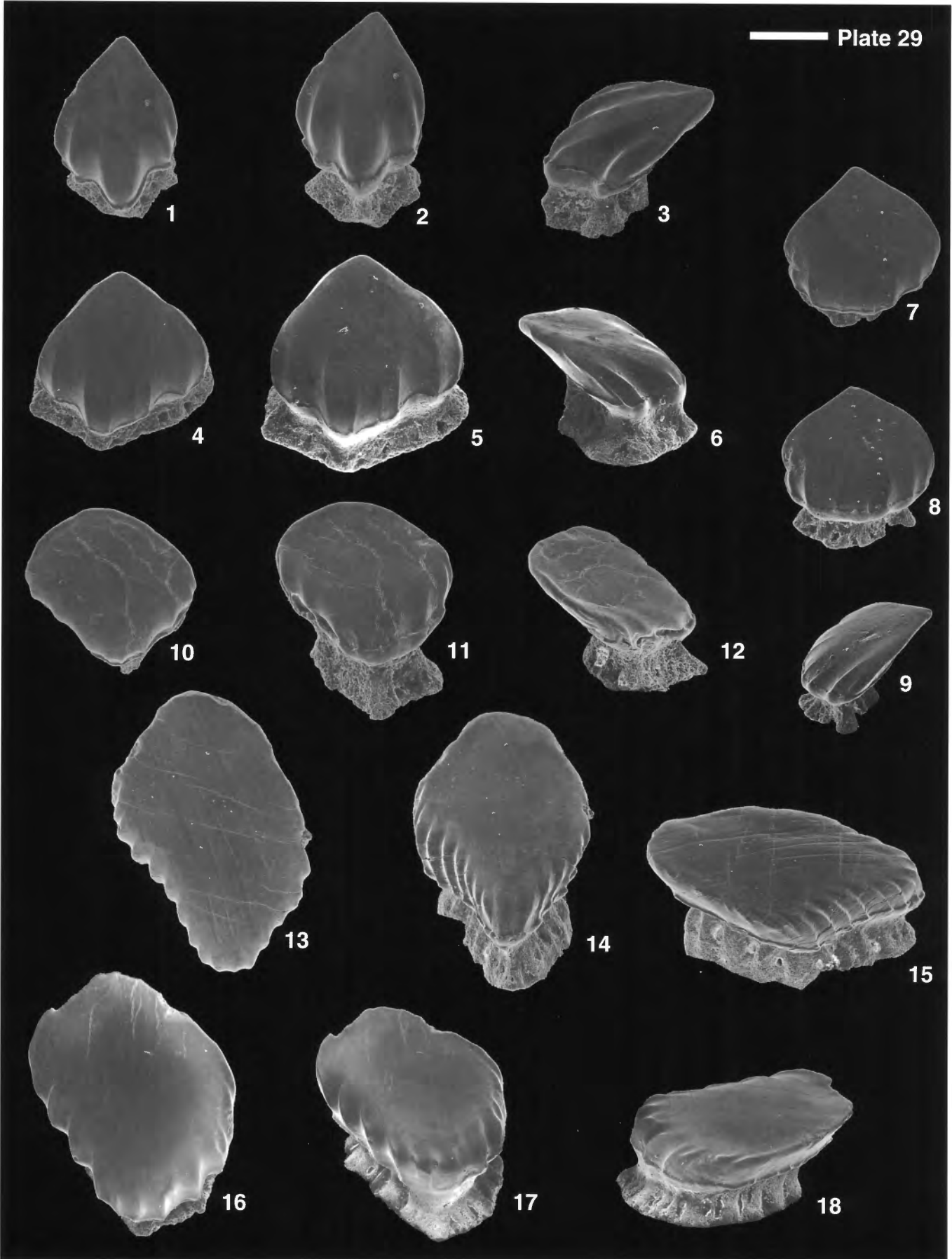
## PLATE 29

All illustrated specimens are Ladinian and from the Liard Formation.

*Sacrisubcorona circabasis* n. gen. et sp. s.f.

Figures 1-18. Variation in crown outline, anterior margin, mesial platform, and lines or ridges.

- 1-3. Type A, paratype GSC 105217, GSC loc. C-101069 (BEH-3). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion well extended. Scale bar = 200  $\mu$ m.
- 4-6. Type B, paratype GSC 105218, GSC loc. C-101065 (ACE-2). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion moderately extended. Scale bar = 200  $\mu$ m.
- 7-9. Type C, paratype GSC 105219, GSC loc. C-101065 (ACE-2). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion broad and slightly extended. Scale bar = 200  $\mu$ m.
- 10-12. Type D, paratype GSC 105220, GSC loc. C-101067 (BEH-1). Upper, anterior, and profile views. Crown rounded rhomboid; anterior margin mesial protrusion rounded rhomboid vertex. Scale bar = 200  $\mu$ m.
- 13-15. Type E, paratype GSC 105221, GSC loc. C-101069 (BEH-3). Upper, anterior, and profile views. Crown rounded rhomboid; longer anterior to posterior than wide; anterior margin mesial protrusion rounded rhomboid vertex and may be slightly undulating. Scale bar = 300  $\mu$ m.
- 16-18. Type F, holotype GSC 105222, GSC loc. C-101069 (BEH-3). Upper, anterior, and profile views. Crown lanceolate; anterior margin undulating; mesial platform and anterior protrusion reduced or absent. Scale bar = 250  $\mu$ m (fig. 16), and 300  $\mu$ m (fig. 17, 18).



## PLATE 30

**All illustrated specimens are Ladinian and from the Liard Formation.**

*Sacrisubcorona circabasis* n. gen. et sp. s.f.

Figures 1-3. Type G, paratype GSC 105223, GSC loc. C-101069 (BEH-3). Upper, anterior, and profile views. Crown lanceolate; anterior margin undulating; with mesial platform and broad anterior protrusion. Scale bar = 350  $\mu$ m.

Figure 4. Type A, paratype (Pl. 29, fig. 1-3) GSC 105217, GSC loc. C-101069 (BEH-3). Subcrown with halo. Subpedicle surface flat; outline rhomboid. Scale bar = 200  $\mu$ m.

Figure 5. Type B, holotype (Pl. 23, fig. 4-6) GSC 105218, GSC loc. C-101065 (ACE-2). Subcrown with halo. Subpedicle surface convex with anterior bulge; outline rhomboid. Scale bar = 200  $\mu$ m.

Figure 6. Type E, paratype (Pl. 23, fig. 13-15) GSC 105221, GSC loc. C-101069 (BEH-3). Subcrown with halo. Subpedicle surface posteriorly expanded, flat, and with large central canal opening. Scale bar = 300  $\mu$ m.

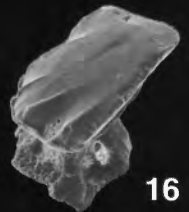
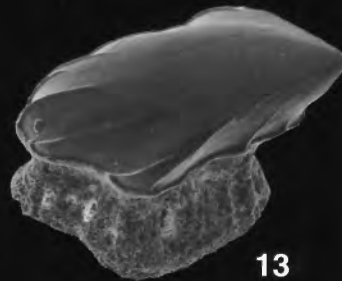
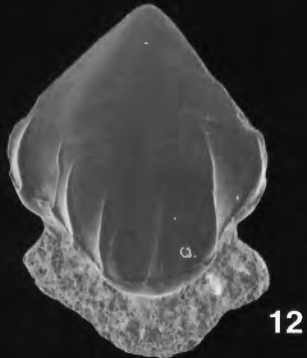
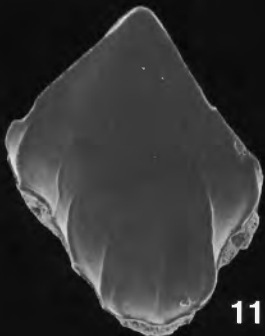
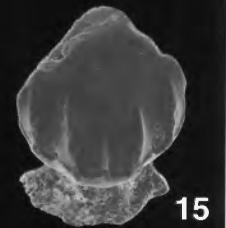
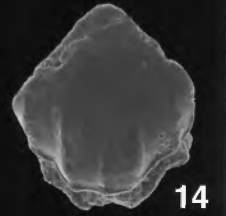
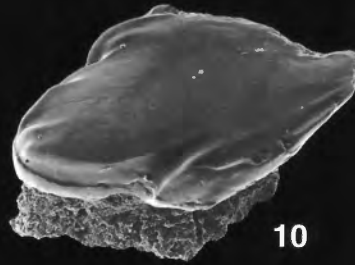
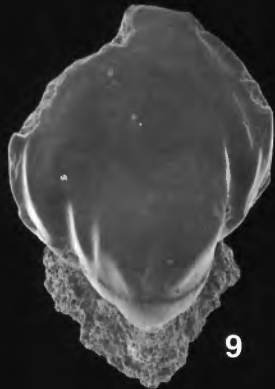
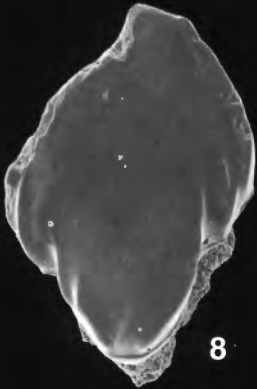
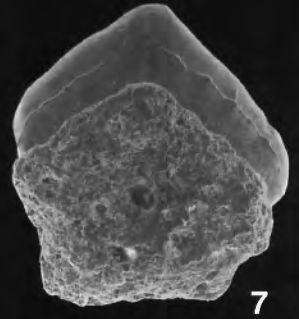
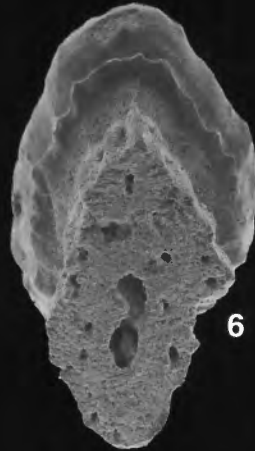
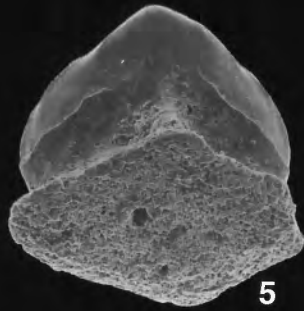
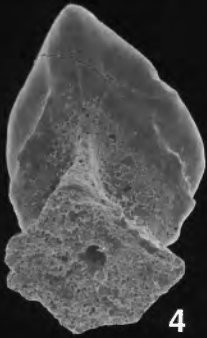
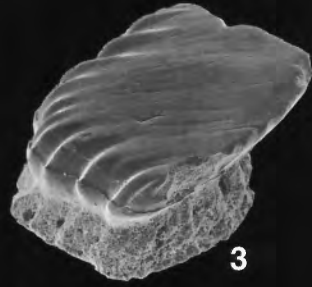
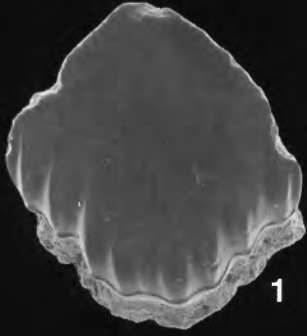
Figure 7. Type F, paratype GSC 105224, GSC loc. C-101068 (BEH-2). Subcrown with halo. Subpedicle surface convex with anterior bulge. Scale bar = 350  $\mu$ m.

*Sacrisubcorona submedicarina* n. gen. et sp. s.f.

Figures 8-10. Type A, paratype GSC 105225, GSC loc. C-101064 (ACE-1). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion well extended. Scale bar = 200  $\mu$ m.

Figures 11-13. Type B, holotype GSC 105226, GSC loc. C-101068 (BEH-2). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion moderately extended. Scale bar = 200  $\mu$ m.

Figures 14-16. Type C, paratype GSC 105227, GSC loc. C-101068 (BEH-2). Upper, anterior, and profile views. Crown lanceolate; anterior margin mesial protrusion short and broad. Scale bar = 200  $\mu$ m.



## PLATE 31

All illustrated specimens are Ladinian and from the Liard Formation.

*Sacrisubcorona submedicarina* n. gen. et sp. s.f.

Figures 1-3. Type D, paratype GSC 105228, GSC loc. C-153069 (GK-1-19). Upper, anterior, and profile views. Crown rounded rhomboid; anterior margin mesial protrusion rounded rhomboid vertex. Scale bar = 500  $\mu\text{m}$  (fig. 1) and 475  $\mu\text{m}$  (fig. 2-3).

Figures 4, 8, 12. Type E, paratype GSC 105229, GSC loc. C-153075 (GK-4-11). Upper, anterior, and profile views. Crown rounded rhomboid; longer anterior to posterior than wide; anterior margin mesial protrusion rounded rhomboid vertex and may be slightly undulating. Scale bar = 400  $\mu\text{m}$  (fig. 4 & 12), and 450  $\mu\text{m}$  (fig. 8).

Figures 5-7. Type F, paratype GSC 105230, GSC loc. C-153075 (GK-4-11). Upper, anterior, and profile views. Crown lanceolate; anterior margin undulating; mesial platform and anterior protrusion reduced or absent. Scale bar = 500  $\mu\text{m}$ .

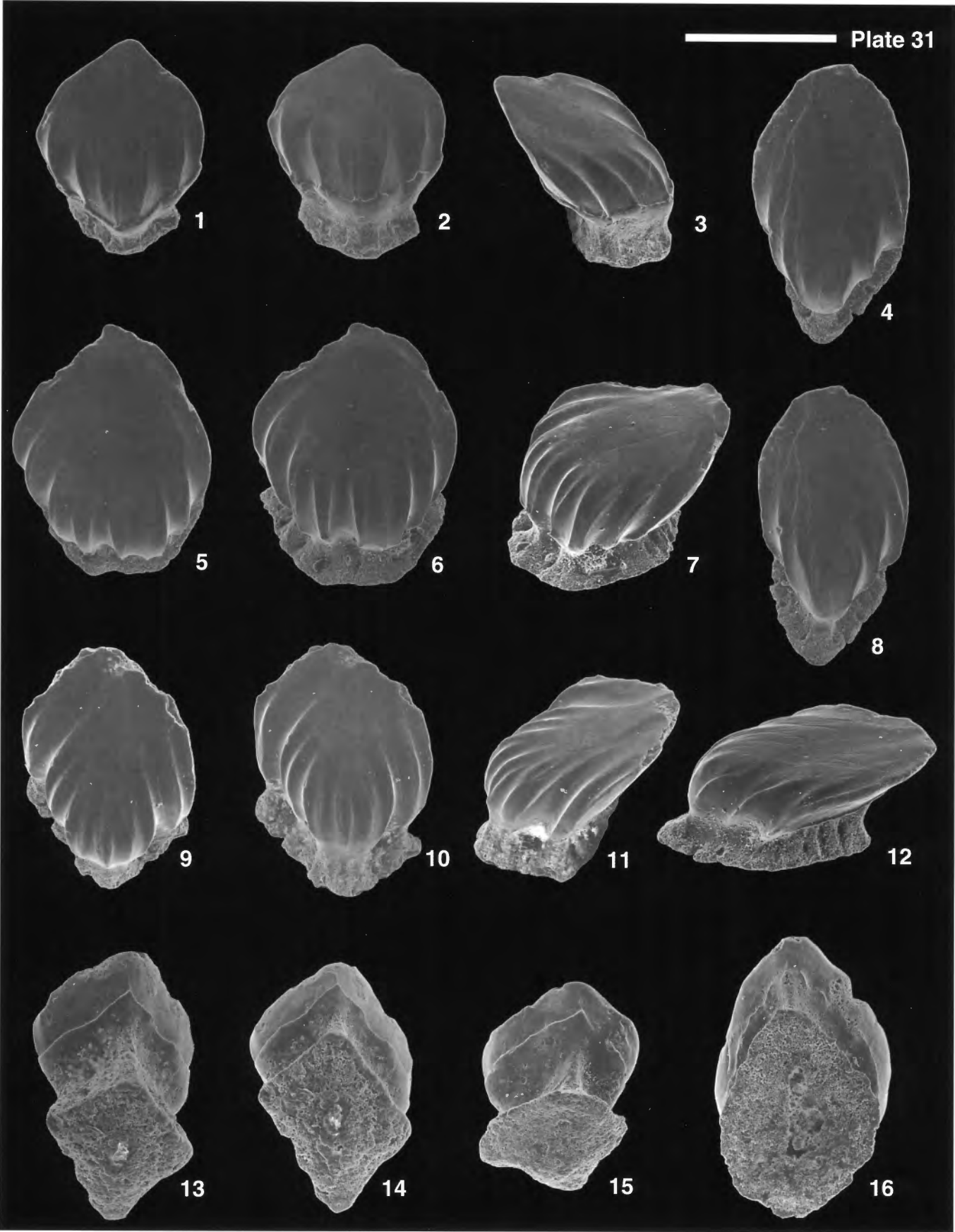
Figures 9-11. Type G, paratype GSC 105231, GSC loc. C-101065 (ACE-2). Upper, anterior, and profile views. Crown lanceolate; anterior margin undulating; with mesial platform and broad anterior protrusion. Scale bar = 475  $\mu\text{m}$ .

Figures 13-14. Type A, paratype GSC 105232, GSC loc. C-101069 (BEH-3). Subcrown with halo and mesial rounded ridge. Subpedicle surface convex with anterior bulge; outline rhomboid. Scale bar = 400  $\mu\text{m}$ .

Figure 15. Type D, paratype GSC 105233, GSC loc. C-153069 (GK-1-19). Subcrown with halo and mesial ridge. Subpedicle surface convex with anterior bulge; outline rhomboid. Scale bar = 500  $\mu\text{m}$ .

Figure 16. Type F, paratype GSC 105234, GSC loc. C-101069 (BEH-3). Subcrown with halo and rounded mesial ridge. Subpedicle surface flat with large central canal opening. Scale bar = 500  $\mu\text{m}$ .





## PLATE 32

All illustrated specimens are Middle Norian and from the Pardonet Formation.

*Carinasubcorona subradiciplana* n. gen. et sp. s.f.

Figures 1-4. Type A, holotype GSC 105212, GSC loc. C-302390 (TE-220A). Scale bar = 200  $\mu$ m.

1. Subcrown surface with broadly rounded mesial ridge; halo absent. Subpedicle surface flat; outline rhomboid.
- 2-4. Upper, anterior, and profile views. Anterior margin mesial protrusion rounded and moderately extended.

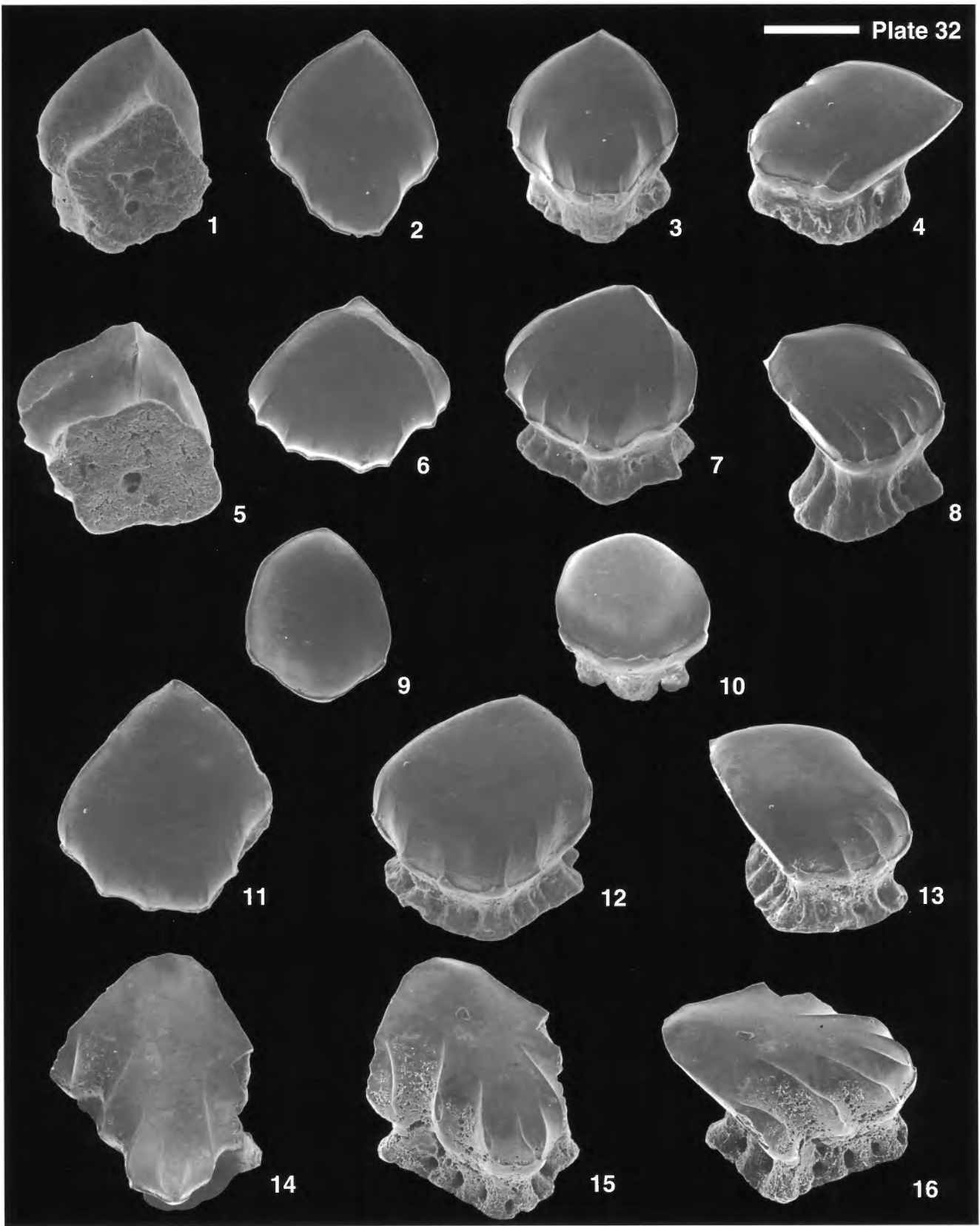
Figures 5-8. Type B, paratype GSC 105213, GSC loc. C-302390 (TE-220A). Scale bar = 200  $\mu$ m.

5. Subcrown surface with mesial ridge; halo thin and discontinuous. Subpedicle surface flat; outline approximately rhomboid.
- 6-8. Upper, anterior, and profile views. Anterior margin mesial protrusion broadly rounded and slightly extended.

Figures 9-10. Type C, paratype GSC 105214, GSC loc. C-302390 (TE-220A). Upper and anterior views. Crown anterior margin rounded; mesial platform and protrusion absent. Scale bar = 200  $\mu$ m.

Figures 11-13. Type D, paratype GSC 105215, GSC loc. C-101036 (MS-3). Upper, anterior, and profile views. Crown anterior margin broadly rounded with moderately deep and rounded undulations; mesial platform and protrusion absent. Scale bar = 200  $\mu$ m.

Figures 14-16. Type E, paratype GSC 105216, GSC loc. C-302390 (TE-220A). Upper, anterior, and profile views. Crown with mesial platform and undulating anterior margin with mesial protrusion. Scale bar = 200  $\mu$ m.



## PLATE 33

All illustrated specimens are Middle Norian and from the Pardonet Formation.

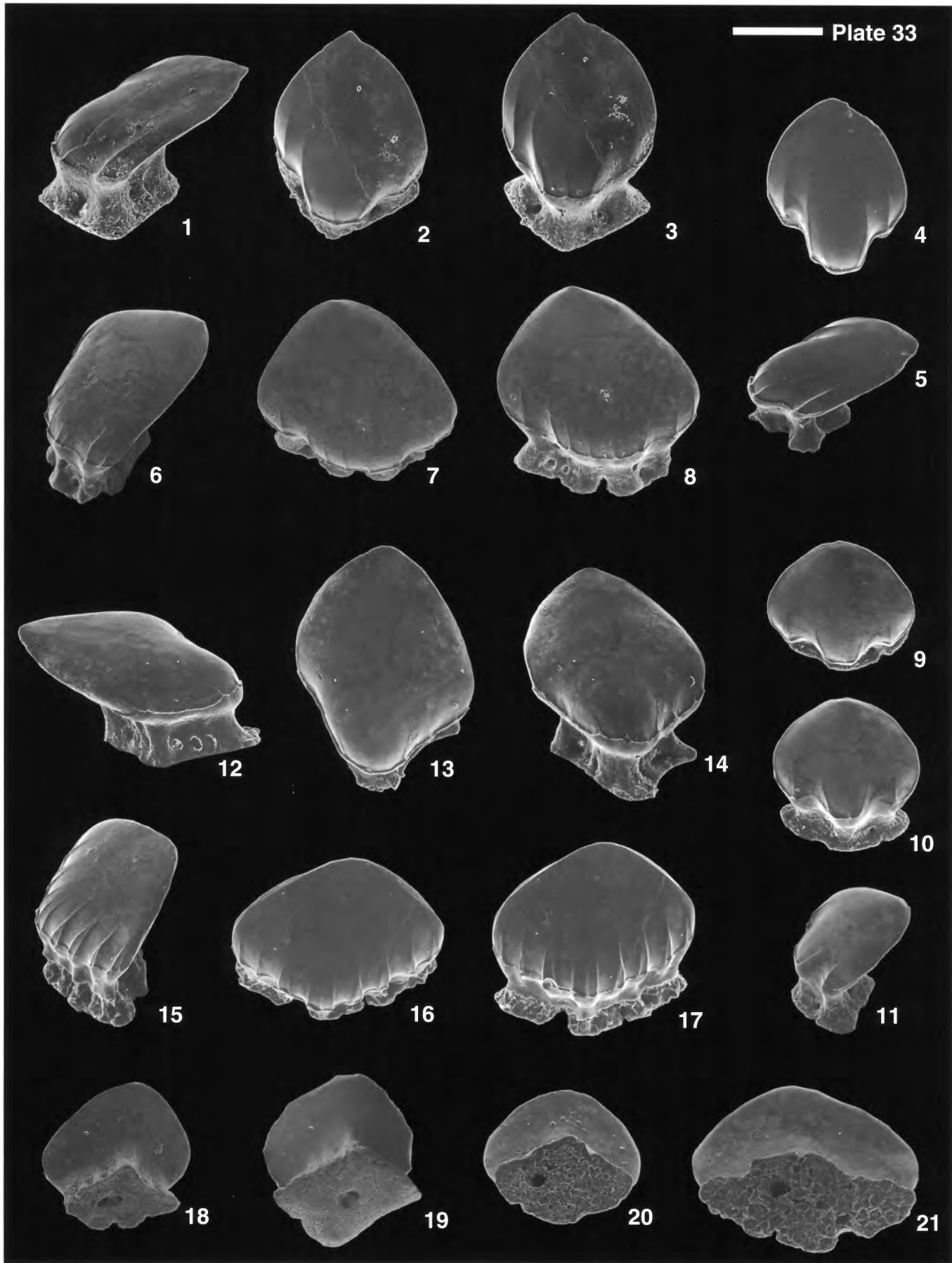
*Glabrisubcorona vadosidevexa* n. gen. et sp. s.f.

Figures 1-17. Variation in crown shape and protrusion of anterior margin. Scale bar = 200  $\mu$ m.

- 1-3. Type A, paratype GSC 105191, GSC loc. C-101036 (MS-3). Profile, upper, and anterior views. Anterior margin mesial protrusion broad and moderately extended.
- 4-5. Type A, paratype GSC 105192, GSC loc. C-302390 (TE-220A). Upper and profile views. Anterior margin mesial protrusion broad and moderate to well extended.
- 6-8. Type B, holotype GSC 105193, GSC loc. C-302390 (TE-220A). Profile, upper and anterior views. Anterior margin mesial protrusion broad with minor extension.
- 9-11. Type C, paratype GSC 105194, GSC loc. C-302390 (TE-220A). Upper, anterior, and profile views. Similar to Type B except crown as wide or wider than long.
- 12-14. Type D, paratype GSC 105195, GSC loc. C-101036 (MS-3). Profile, upper, and anterior views. Crown rounded rhomboid and anterior margin rounded.
- 15-17. Type E, paratype GSC 105196, GSC loc. C-302390 (TE-220A). Profile, upper, and anterior views. Crown anterior margin shallowly undulating with furrows and lines or ridges perpendicular to anterior longitudinal shoulder ridge.

Figures 18-21. All GSC loc. C-302390 (TE-220A), showing unornamented subcrown and variations of subpedicle surface.

18. Type B, paratype (fig. 6-8 above) GSC 105193. Flat subpedicle surface with rhomboid almost tetrapetaloid outline. Scale bar = 300  $\mu$ m.
19. Type B, paratype GSC 105197. Flat subpedicle surface with central canal opening and rhomboid pedicle outline. Scale bar = 300  $\mu$ m.
20. Type C, paratype (fig. 9-11 above) GSC 105194. Flat subpedicle surface with rhomboid to slightly stretched (wider from side to side than anterior to posterior) outline. Scale bar = 200  $\mu$ m.
21. Type E, paratype (fig. 15-17 above) GSC 105196. Flat subpedicle surface with rhomboid outline that is stretched or wider from side to side rather than anterior to posterior. Scale bar = 200  $\mu$ m.



## PLATE 34

All illustrated specimens are Middle Norian and from the Pardonet Formation at GSC loc. C-101036 (MS-3).

### *Glabrisubcorona arduidevexa* n. gen. et sp. s.f.

Figures 1-9. Variation in shape and protrusion of crown anterior margin. Scale bar = 200  $\mu$ m.

- 1-3. Type A, paratype GSC 105198. Profile, anterior, and upper views. Crown commonly broader than long with broad anterior mesial protrusion.
- 4-6. Type B, holotype GSC 105199. Profile, anterior, and upper views. Crown about equally broad as long. Mesial protrusion less prominent.
- 7-9. Type C, paratype GSC 105200. Profile, anterior, and upper views. Anterior margin undulating or crenulated without prominent mesial protrusion.

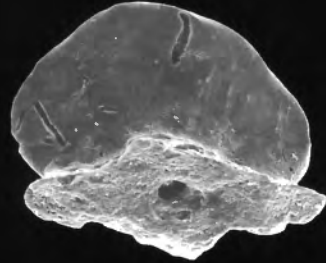
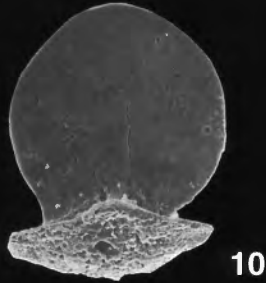
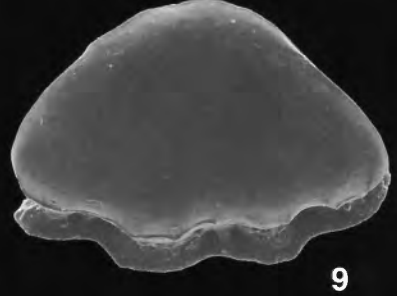
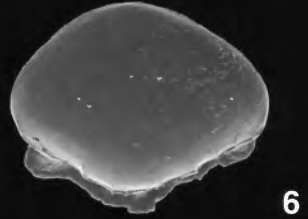
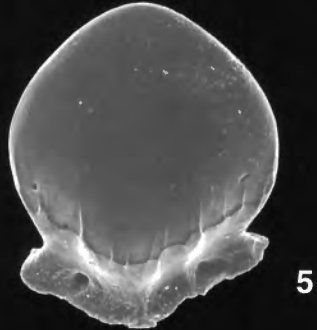
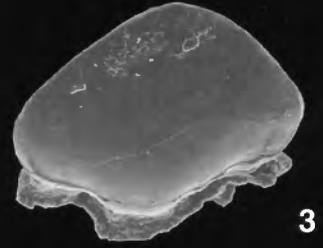
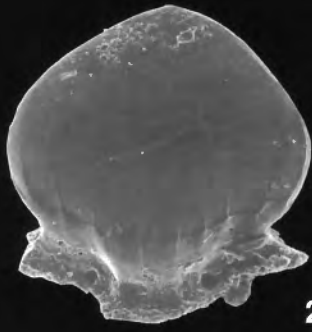
Figures 10-11. Unornamented subcrown surface (unless altered after deposition; e.g. cracking). Subpedicle surface flat; outline rhomboid. Two different specimens show broadening of subpedicle surface laterally (from side to side) rather than anterior to posterior. Scale bar = 200  $\mu$ m.

10. Type B, paratype GSC 105201.
11. Type C, paratype GSC 105202.

### *Glabrisubcorona tendibasis* n. gen. et sp. s.f.

Figure 12. Paratype GSC 105203. Subcrown, laterally expanded (from side to side instead of anterior to posterior) subpedicle outline, and flat subpedicle surface. Scale bar = 200  $\mu$ m.

Figures 13-15. Holotype GSC 105204. Upper, anterior, and profile views, showing crown considerably wider than long and without mesial platform. Scale bar = 200  $\mu$ m.





## PLATE 35

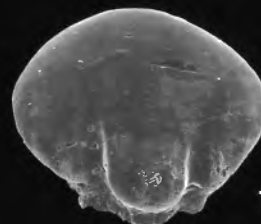
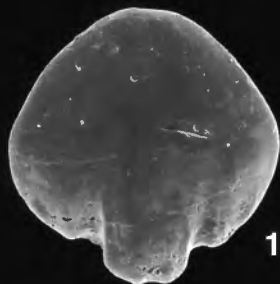
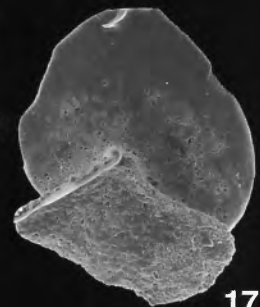
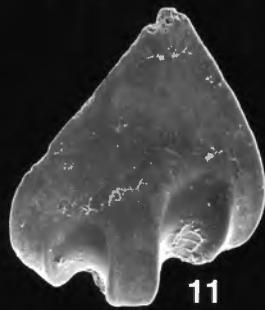
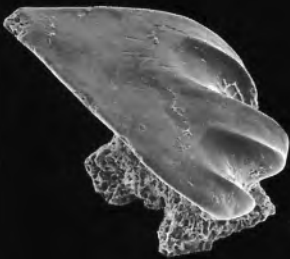
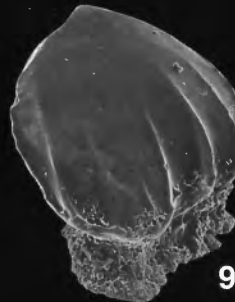
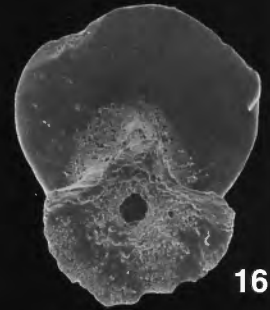
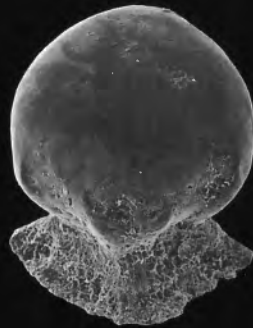
**Illustrations are all figured specimens. Figures 1-12 and 16-17 are Ladinian and from the Liard Formation; figures 13-15 are Upper Carnian and from the Baldonnel? Formation.**

*Glabrisubcorona?* sp. 1 s.f.

Figures 1-15. Showing variation in crown anterior margin, mesial platform, and lines or ridges.

- 1-3. Type A, figured specimen GSC 105205, GSC loc. C-087972 (Sutherland Zone). Profile, upper, and anterior views. Anterior crown margin rounded without (or with minor) mesial protrusion. Scale bar = 200  $\mu$ m.
- 4-6. Type B, figured specimen GSC 105206, GSC loc. C-101065 (ACE-2). Profile, upper, and anterior views. Anterior crown margin with short and broadly rounded mesial protrusion. Scale bar = 200  $\mu$ m.
- 7-9. Type C, figured specimen GSC 105207, GSC loc. C-101065 (ACE-2). Profile, upper, and anterior views. Anterior crown margin undulating with several shallow rounded protrusions and prominent ridges perpendicular to anterior shoulder longitudinal line. Scale bar = 200  $\mu$ m.
- 10-12. Type D, figured specimen GSC 105208, GSC loc. C-101065 (ACE-2). Profile, upper, and anterior views. Anterior crown margin with short and narrow mesial protrusion. Furrows rounded and moderately deep at anterior. Scale bar = 250  $\mu$ m.
- 13-15. Type D, figured specimen GSC 105209, GSC loc. C-101002 (BBR-1). Profile, upper, and anterior views. Crown similar to GSC 105208 (fig. 10-12 above) but with broader mesial protrusion, shallower furrows, and less prominent ridges. Scale bar = 200  $\mu$ m.

Figures 16-17. Type A, figured specimens GSC 105210 (fig. 16) and GSC 105211 (fig. 17), GSC loc. C-087972 (Sutherland Zone). Showing posterior subcrown and rhomboid subpedicle outline (fig. 17). Subpedicle surface concave (fig. 16) or flat (fig. 17). Scale bar = 200  $\mu$ m.



## PLATE 36

**The illustrated specimens in figures 1-5 are Upper Carnian and from the Baldonnel? Formation.**

*Complanicorona glabra* n. gen. et sp. s.f.

Figures 1-3. Holotype GSC 105241, GSC loc. C-101002 (BBR-1). Basal, upper, and profile views. Subpedicle surface with large canal opening, and subcrown unornamented (fig. 1). Crown rounded and without lines or ridges (fig. 2-3). Scale bar = 300  $\mu$ m.

Figures 4-5. Paratype GSC 105242, GSC loc. C-101002 (BBR-1). View of subcrown surface with lip and cavity where pedicle was positioned (fig. 4). Upper view of unornamented crown (fig. 5). Scale bar = 300  $\mu$ m.

**The illustrated specimens in figures 6-11 are Ladinian and from the Liard Formation.**

*Complanicorona rugosimargines* n. gen. et sp. s.f.

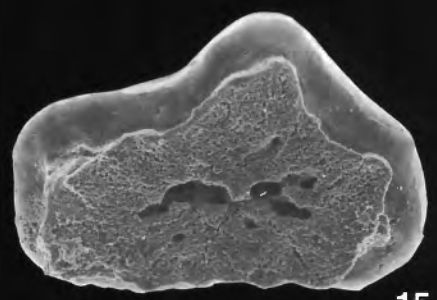
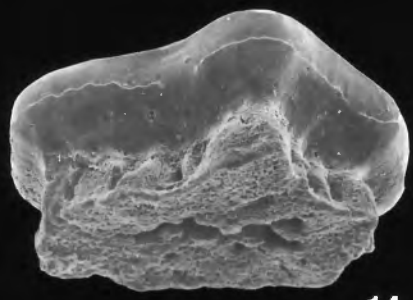
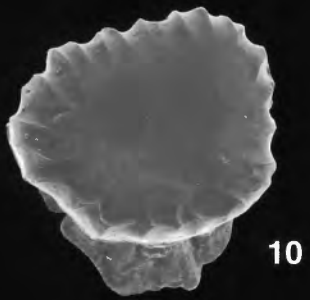
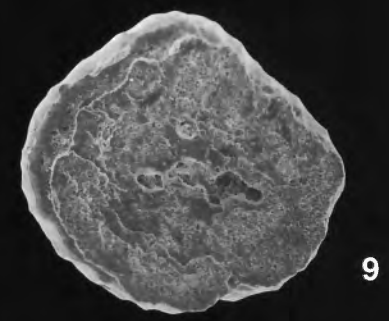
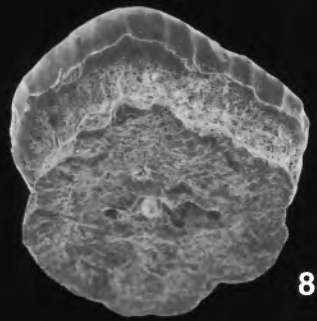
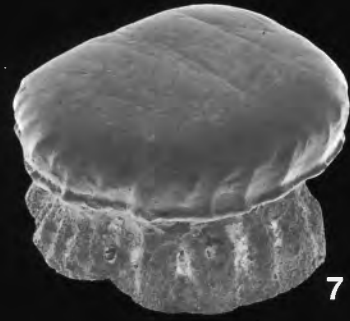
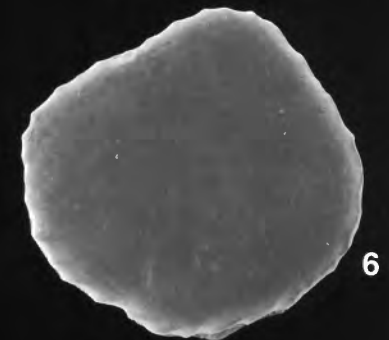
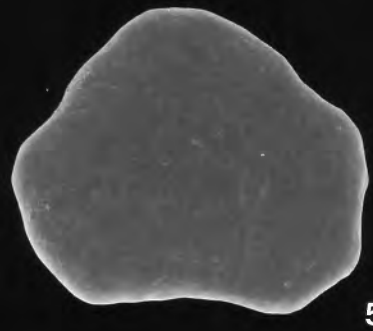
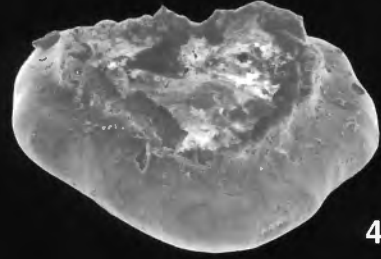
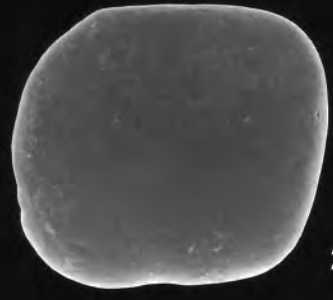
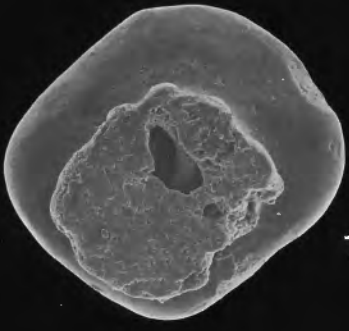
Figures 6-9. Holotype GSC 105243, GSC loc. C-101065 (ACE-2). Upper, profile, subcrown, and subpedicle views. Crown with short ridges along all crown shoulders that are perpendicular to longitudinal line or subcrown halo. Subpedicle surface with large, irregular, and central canal opening (fig. 9). Scale bar = 400  $\mu$ m (fig. 6), and 450  $\mu$ m (fig. 7-9)

Figures 10-11. Paratype GSC 105244, GSC loc. C-101069 (BEH-3). Upper and profile views. Crown with longer ridges but they do not reach centre. Pedicle expanded tetrahedroid. Scale bar = 400  $\mu$ m.

**The illustrated specimen in figures 12-15 is Middle Norian and from the Pardonet Formation.**

*Complanicorona subrugosa* n. gen. et sp. s.f.

Figures 12-15. Holotype GSC 105245, GSC loc. C-302390 (TE-220A). Upper, anterior, subcrown, and subpedicle views. Crown smooth with longitudinal line around shoulder margins or as subcrown halo. Subcrown with rounded and broad corner ridges (fig. 14). Pedicle expanded tetrahedroid. Subpedicle surface with large and irregular central canal opening. Scale bar = 450  $\mu$ m (fig. 12-14) and 400  $\mu$ m (fig. 15).



## PLATE 37

**The illustrated specimen in figures 1, 6, 9 is Ladinian and from the Liard Formation.**

*Suaviloquentia obliquilingua* n. gen. et sp. s.f.

Figures 1, 6, 9. Holotype GSC 105235, GSC loc. C-101068 (BEH-2). Anterior, profile, and basal views, showing long and narrow oblique crown with no anterior margin overhang (fig. 1, 6). Subcrown ornamented with long ridges (fig. 9). Scale bar = 500  $\mu$ m.

**The illustrated specimens in figures 2, 7, 10, and 11 are Upper Carnian and from the Baldonnel? Formation.**

*Suaviloquentia brevilingua* n. gen. et sp. s.f.

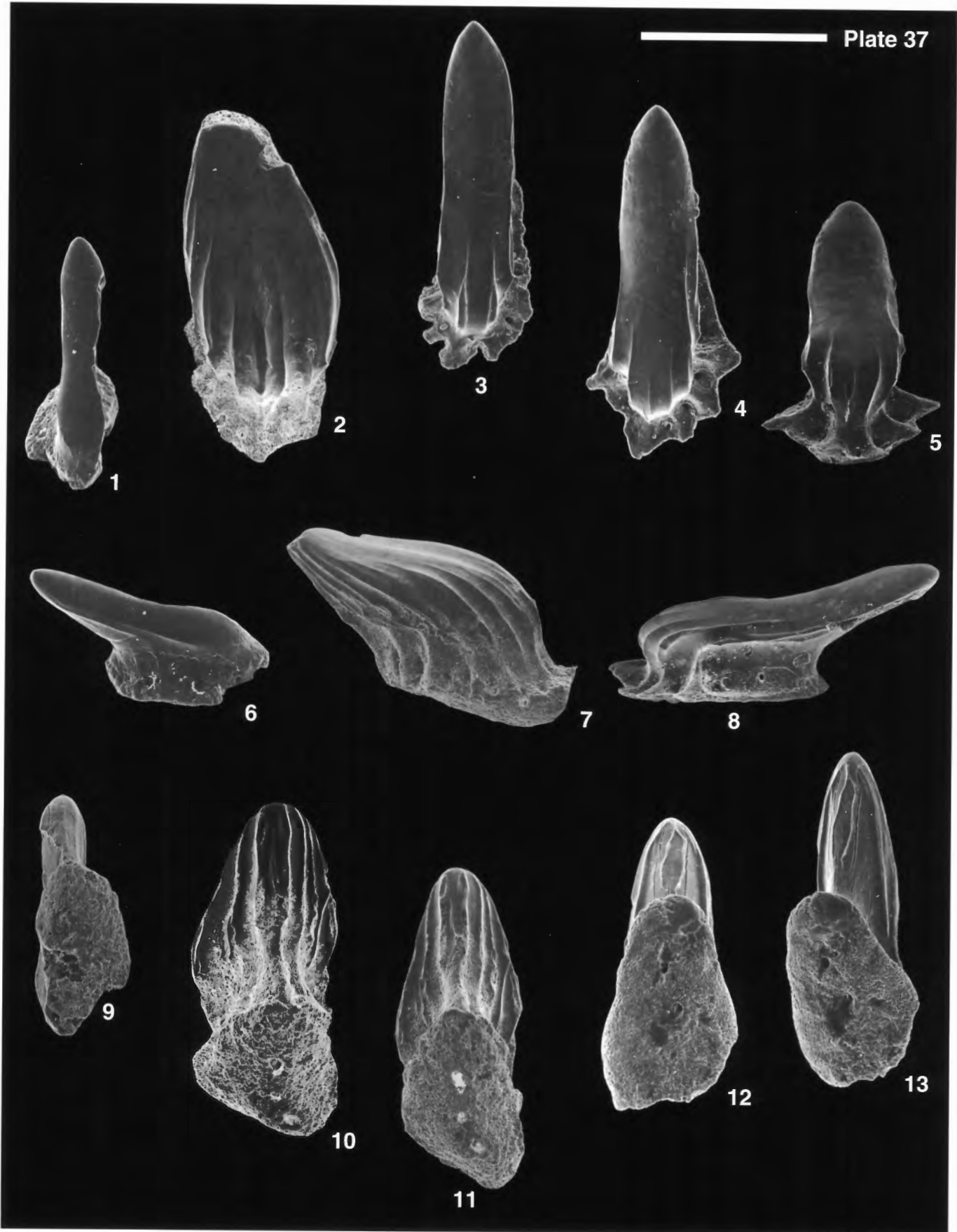
Figures 2, 7, 10, 11. Holotype GSC 105236 (fig. 2, 7) and paratype GSC 105237 (fig. 10-11), all from GSC loc. C-101003 (BBR-2), Baldonnel? Formation, Upper Carnian. Anterior, profile, and basal views. Crown broader with intermediate length ridges. Subcrown ornamented with several long ridges (fig. 10-11). Pedicle keeled, expanded, posteriorly stretched, and tetrahedroid. Subpedicle surface convex with anterior bulge (fig. 7). Scale bar = 700  $\mu$ m.

**The illustrated specimens in figures 3-5, 8, and 10-12 are Middle Norian and from the Pardonet Formation.**

*Suaviloquentia longilingua* n. gen. et sp. s.f.

Figures 3-5, 8, 12-13. GSC loc. C-101036 (MS-3). Crown long and narrow with short mesial platform and ridges. Pedicle keeled, expanded, posteriorly stretched, and tetrahedroid.

3. Paratype GSC 105238. Moderately narrow anterior mesial platform with anteriorly bifurcating ridges. Scale bar = 550  $\mu$ m.
- 4-5, 8. Holotype GSC 105239. Upper, anterior, and profile views, showing broad anterior mesial platform with short ridges (fig. 4-5). Pedicle keeled expanded tetrahedroid and posteriorly stretched. Scale bar = 500  $\mu$ m.
- 12-13. Paratype GSC 105240. Views of long subcrown ridges. Subpedicle surface commonly with large and irregular shaped central canal opening. Scale bar = 500  $\mu$ m.



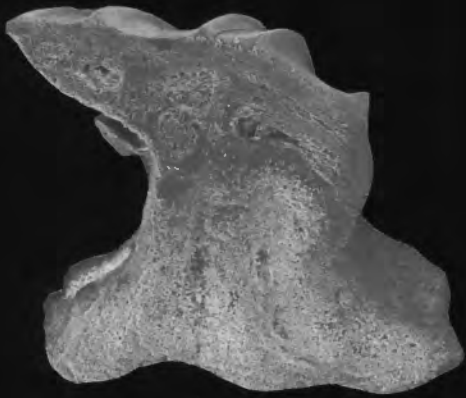
## PLATE 38

### HCl etched cross-sections through dermal denticles.

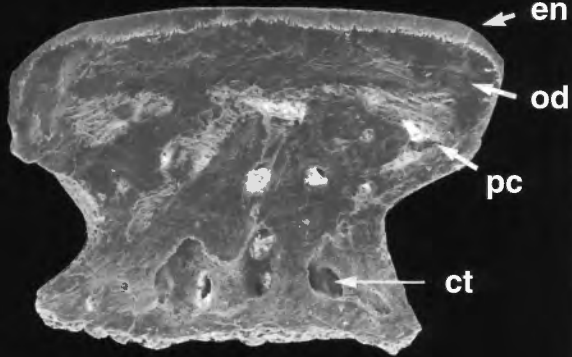
Figures 1-3. Figured specimen GSC 105298, GSC loc. C-087972 (Sutherland Zone), Liard Formation, Ladinian. A fragment that is probably *Gracilisuggestus* n. gen. s.f. Overview of whole section (fig. 1) and enlargements of cusp and upper surface layers (fig. 2-3). Outer most layer of enameloid crystallites (en) (fig. 3) are above orthodentine (od) and cavities for pulp chambers (pc). Scale bar = 400  $\mu\text{m}$  (fig. 1), 200  $\mu\text{m}$  (fig. 2), and 100  $\mu\text{m}$  (fig. 3).

Figures 4-6. Figured specimen GSC 105299, GSC loc. C-101065 (ACE-2), Liard Formation, Ladinian. A fragment of *Complanicorona rugosimargines* n. sp. s.f. Overview of whole section (fig. 4) and enlargements of upper surface regions (fig. 5-6). Base of pedicle penetrated by vascular canal tubules (ct) (fig. 4) and above is orthodentine (od) (fig. 4-5) and pulp cavities (pc). Outer most layer (fig. 6) comprised of enameloid crystallites (en) perpendicular to outer surface. Scale bar = 400  $\mu\text{m}$  (fig. 4), 42  $\mu\text{m}$  (fig. 5), and 11  $\mu\text{m}$  (fig. 6).

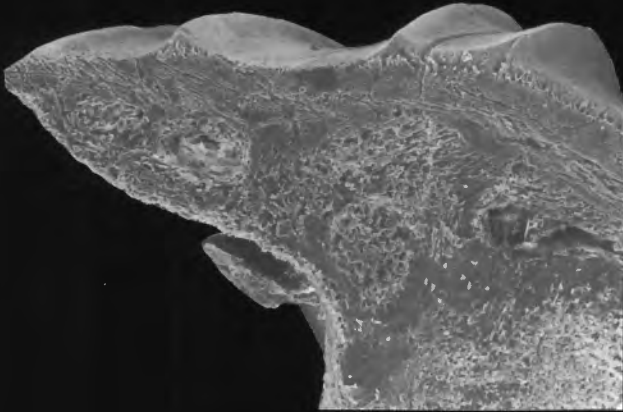




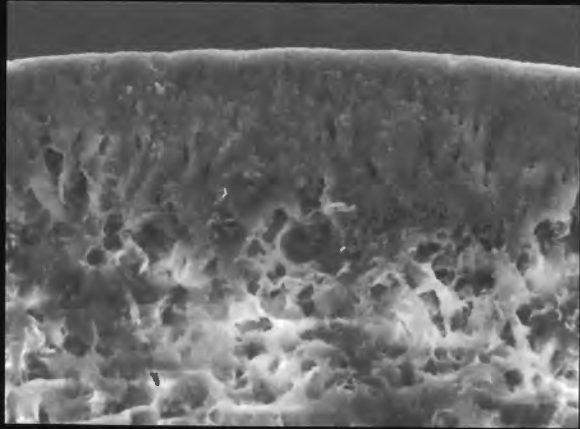
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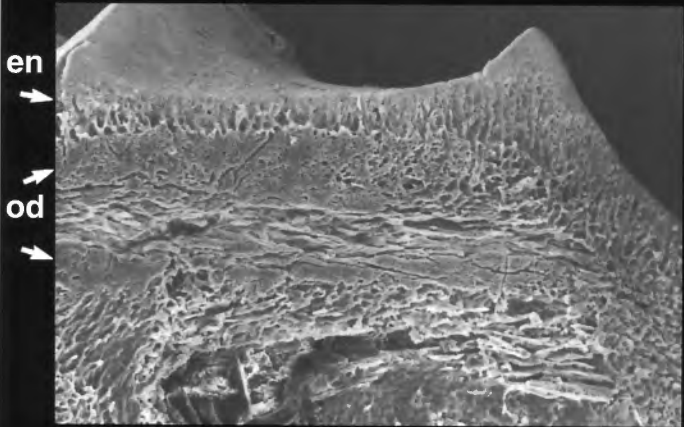
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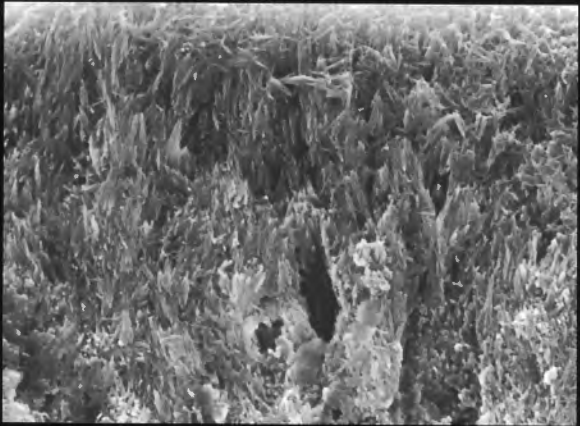
2



5



3



6

