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BULLETIN 169

LATE UPPER DEVONIAN (FAMENNIAN) RHYNCHONELLID BRACHIOPODS FROM WESTERN CANADA

Paul Sartenaer

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By
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PREFACE

The need for precise palaeontological zonation as a key to the stratigraphic problems of the Devonian rocks of western Canada has long been recognized. Fossils continue to provide information basic to stratigraphic studies as indices of relative age within the framework of Devonian time, but as the emphasis passes from reconnaissance geology to detailed studies it becomes important to distinguish and correlate increasingly finer stratigraphic units. This requires precise palaeontological information based on sound principles of systematic taxonomy.

Such information is provided in this report, which presents the results of a number of years' work in the field and laboratory by a leading international authority on Devonian brachiopods. There is little doubt that the report will be a lasting contribution to our knowledge of the Devonian rocks of western Canada, whose importance as oil reservoirs needs hardly to be stressed.

Y. O. FORTIER,
Director, Geological Survey of Canada

OTTAWA, October 27, 1967

BULLETIN 169 — Rhynchonelliden (Brachiopoden) aus dem oberen Ober-Devon (Famennien) von West-Kanada

Von Paul Sartenaer

БЮЛЛЕТЕНЬ 169 — Поздне-верхнедевонские (фаменские) ринхонеллиды (Brachiopoda) Запада Канады.

П. Сартенер

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Abstract

Forty-one species and subspecies of Famennian rhynchonellid brachiopods have been studied in detail from material collected in Canada. Collections were made in the U.S.A. for species and subspecies either exclusive to that country or in common with those from Canada.

Thirty-eight species and subspecies from nine genera are described: six in *Trifidorostellum* Sartenaer, of which two subspecies are new, *T. cascadense mugodjaricum* and *T. uralicum fontis*; three in *Rugaltarostrum* Sartenaer; two in *Gastrodetoechia* Sartenaer, of which one subspecies is new, *G. utahensis rugosa*; one in *Megalopterorhynchus* Sartenaer; three in *Eoparaphorhynchus* Sartenaer; ten in *Sinotectirostrum* Sartenaer, of which six are new, *S. medicinale deceptum, S. mackenziei, S. saxirubrum, S. avellana, S. montosum, S. paucirugosum;* two in *Evanescirostrum* Sartenaer, of which one is new, *E.* sp. A; five in *Basilicorhynchus* Crickmay, of which three are new, *B. basilicus interpositus, B. basilicus regalis, B.* sp. A; six, all new, in *Ptychomaletoechia* Sartenaer, *P. contractiformis, P. sulculifera, P. serva, P. septentrionalis, P. summa, P. finitima.* Three new species have a provisional generic assignment: *"Pugnax" rara, "P."* sp., *"Plectorhynchella" montifelicitatis.*

External and internal characters are illustrated. The stratigraphic extension and geographic distribution of the described forms are indicated.

A new zonal scheme is proposed for the Famennian of the Rocky Mountains and the Northwest Territories.

Résumé

L'auteur a étudié en détail quarante et une espèces et sous-espèces de Brachiopodes Rhynchonellides du Famennien en se basant sur du matériel recueilli au Canada. Dans la mesure où certaines de ces espèces et sous-espèces se trouvent aussi, ou exclusivement, aux États-Unis, des récoltes ont été faites dans ce pays.

Trente-huit des espèces et sous-espèces décrites sont distribuées dans neuf genres: six dans *Trifidorostellum* Sartenaer, dont deux sous-espèces nouvelles, *T. cascadense mugodjaricum* et *T. uralicum fontis;* trois dans *Rugaltarostrum* Sartenaer; deux dans *Gastrodetoechia* Sartenaer, dont une sous-espèce nouvelle, *G. utahensis rugosa;* une dans *Megalopterorhynchus* Sartenaer; trois dans *Eoparaphorhynchus* Sartenaer; dix dans *Sinotectirostrum* Sartenaer, dont six nouvelles, *S. medicinale deceptum, S. mackenziei, S. saxirubrum, S. avellana, S. montosum, S. paucirugosum;* deux dans *Evanescirostrum* Sartenaer, dont une nouvelle, *E.* sp. A; cinq dans *Basilicorhynchus* Crickmay, dont trois nouvelles, *B. basilicus interpositus, B. basilicus regalis,*

B. sp. A; six, toutes nouvelles, dans *Ptychomaletoechia* Sartenaer, *P. contractiformis, P. sulculifera, P. serva, P. septentrionalis, P. summa, P. finitima.* Trois nouvelles espèces ont reçu une attribution générique provisoire: *"Pugnax" rara, "P."* sp., *"Plectorhynchella" montifelicitatis.*

Les caractères externes et internes des formes décrites sont illustrés, tandis que leur extension stratigraphique et leur répartition géographique sont indiquées.

Une zonation nouvelle est proposée pour le Famennien des Montagnes Rocheuses et des Territoires du Nord-Ouest.

INTRODUCTION

Representatives of the Rhynchonellida are the commonest fossils in most Famennian taphocoenoses. They are indispensable tools in stratigraphy because they are preserved in a large variety of rocks, evolve rapidly, thus having a short biochron, and have a restricted number of species with numerous specimens for most. Genera as well as species appear in restricted biozones. The importance of the Rhynchonellida in subdividing marine Upper Devonian sequences has already been recognized (e.g., in Belgium and France, by Gosselet, 1877, etc.). Since then, many workers have taken advantage of the order to establish biostratigraphic subdivisions of various stages. In Canada, this has been done recently for the Middle and early Upper Devonian by McLaren (1962). In various publications (1956, etc.), the writer has drawn attention to the importance of the group and has suggested that a large stated time-range for a rhynchonellid genus commonly means that it is poorly known and is in need of revision. However, Grant (1965) gave a considerable stratigraphic range to some revised and some new genera of the superfamily Stenoscismatacea. The limited life-span of the Famennian genera described in this paper is coupled with a wide geographic distribution (e.g., the *Basilicorhynchus basilicus* Group).

One of the major goals of this contribution is to suggest that benthonic organisms are at least as valuable as plankton or nekton in correlation. This view has already been developed by Sartenaer (1961b, 1961c, 1961e, 1963, 1964, 1965a, 1965b) and Sartenaer and Rozman (1965), and is gaining increased acceptance following detailed collecting and study of particular groups, e.g., Struve (1956, 1961, 1963a, 1963b, 1964). In the area concerned, brachiopods are the only macro-organisms that have allowed whatever progress and refinement achieved so far in the Famennian Stage, and which provide an effective tool in the field. Cephalopods are extremely rare (*see* House and Pedder, 1963).

The forty-one species and subspecies that were studied represent at least eleven genera. Among the genera accepted without restriction, only *Basilicorhynchus* has been previously described. All the genera are exclusively of Famennian age.

All the primary types of the species described in this paper have been examined as well as those of species cited in the literature. The type localities of all these species have been visited. Finally, primary types of species previously considered as Famennian have also been studied. The collections considered in this work cover an immense territory, but represent only a small part of the potential information.

From this paper has resulted the first correlation of strata between the Canadian Rocky Mountains and the Northwest Territories, notwithstanding distance and facies change.

This work is complementary to a similar study by McLaren (1962) on Middle and early Upper Devonian rhynchonelloid brachiopods from western Canada.

Acknowledgments

This report presents the results of a research project commenced during the tenure of a post-doctorate fellowship of the National Research Council at the Geological Survey of Canada between 1958 and 1960, and continued over succeeding years at the Institut

MS. received December 1966.

Royal des Sciences naturelles de Belgique in Brussels and also during a further period in Ottawa. Field work in the Mackenzie River area, the Canadian Rocky Mountains, and in western United States was arranged and sponsored by the Geological Survey.

Although this work was done on behalf of the Survey, I feel obliged to express my appreciation to the Director, Dr. Y. O. Fortier, to Dr. J. M. Harrison, past-Director, to the many members for their assistance and encouragement, and for all the facilities that were placed at my disposal. Dr. D. J. McLaren contributed generously of his time and knowledge at all stages of the research and placed his extensive collections at my disposal; he also undertook the critical reading of the manuscript.

Of the many geologists who assisted with their knowledge and field experience I must thank Dr. H. R. Belyea, Dr. G. O. Raasch, and Mr. P. F. Moore (Canadian Rocky Mountains), Dr. W. Sadlick (Utah and Idaho), Dr. M. R. Mudge and Dr. C. A. Sandberg (Montana). I was also able to examine some of the classic localities in New York State under the guidance of Dr. G. A. Cooper and Dr. J. W. Wells.

I would like to acknowledge the following scientists who received me in their institutions and allowed me to examine their collections: Dr. O. D. Blake (Oil and Gas Conservation Bureau, Billings, Montana), Dr. C. H. Crickmay (Imperial Oil Limited, Calgary), Dr. J. T. Dutro, Jr. (United States Geological Survey, Washington), Dr. W. P. Haynes (Museum of Comparative Zoölogy, Harvard University), Mrs. K. V. W. Palmer (Paleontological Research Institution, Ithaca, New York), Dr. G. O. Raasch (Shell Oil Company, Calgary), Dr. W. Sadlick (Idaho State College; University of Houston), Dr. C. R. Stelck (University of Alberta), Dr. W. L. Stokes (University of Utah, Salt Lake City), Dr. P. S. Warren (University of Alberta), Dr. J. M. Weller (University of Chicago), Dr. J. W. Wells (Cornell University).

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Collections from western Canada were given to me by Dr. C. H. Crickmay. Plaster casts of Dr. Crickmay's primary types considered in this paper are deposited in the Geological Survey of Canada.

Dr. E. M. Baldwin and Dr. J. T. Dutro, Jr., allowed me to designate primary types in their collections.

Dr. J. S. Williams (Utah State Agricultural College, Logan, Utah) helped in locating some outcrops near Logan, Utah.

During the course of a visit to the U.S.S.R. I was able to examine a number of important collections at various institutions, notably at the Geological Faculty of Moscow University, Geological Institute and Paleontological Institute of the Academy of Science of the U.S.S.R., V.N.I.G.N.I., Central Geological Museum, V.S.E.G.E.I. I would particularly mention the following Soviet scientists for their many courtesies: M. S. Abramian, R. E. Alekseeva, M. V. Martynova, D. V. Nalivkin, O. I. Nikiforova, M. A. Rjonsnitzkaia, Kh. S. Rozman, T. G. Sarytcheva, A. N. Sokolskaia, S. V. Tcherkesova.

STRATIGRAPHIC PALAEONTOLOGY

Zonal Concepts

The total range of any morphologically established species or genus is, by definition, a biozone (range-zone). In choosing the zonal scheme proposed in this report, I have tried to take advantage of existing zones and to keep those that have already proved useful. Four zones have been chosen which allow as close correlation as possible between the Famennian rocks of the Northwest Territories and the Rocky Mountains. These zones are range-zones and, as a consequence, their extension depends on the range in time of the species or the genus on which they are based.

The system of standard zones proposed by Callomon (1965) for the Jurassic System cannot usefully be applied at present to the Devonian of western Canada, nor, perhaps, to any zonation based on shelly benthos.

A genus is selected as the zonal index in three out of the four range-zones proposed. The teilzones of these genera are recognized outside Canada and thus their range-zones may prove of wide significance. Certain range-zones which are not considered useful in western Canada may be formalized in other parts of the world, and thus gain importance locally.

Earlier zonal schemes are shown on Figure 1, and are adjusted stratigraphically to show how they are here considered to tie in with the proposed zonal classification. The commonly accepted formation terminology for both the Northwest Territories and the Rocky Mountains, and Western Plains areas is shown.

Eoparaphorhynchus Zone

Representatives of the genus *Eoparaphorhynchus* are present in Belgium, Canada (Rocky Mountains, N.W.T.), France, Germany, U.S.A. (Alaska, Nevada, Utah), and the U.S.S.R. (Kazakhstan, Mugodjary, Pamir). Whenever exact information is available, the zone is restricted to the lower part of the lower Famennian, but is not present in the lowermost beds. For species of the U.S.S.R. *see* comments under the description of the genus *Eoparaphorhynchus*.

The *Eoparaphorhynchus* Zone is represented by *E. maclareni* in the Northwest Territories (Upper and Central Mackenzie River valley). The following fauna occurs in the zone: *Athyris angelica* Hall, *Cleiothyridina* sp., *Cyrtiopsis nahanniensis* Crickmay, *C.* sp., *Cyrtospirifer disjunctus* (Sowerby), *C. whitneyi* (Hall), *Productella* sp., *Schizophoria iowensis* (Hall), *S. mcfarlanei* (Meek) var., *Orbiculoidea* sp., *Aulopora* sp., crinoids, gastropods, ostracods, and pelecypods. *Athyris* is particularly abundant in the lowest part of the zone. Associated rhynchonellids are *Ptychomaletoechia contractiformis, P. septentrionalis, P. serva, "Pugnax" rara, Rugaltarostrum madisonense, Sinotectirostrum mackenziei.*

Eoparaphorhynchus maclareni is present in Alaska. It has been cited in Iran (Elburz Mountains) by Gaetani (1965), but it may be *E. lentiformis* or rather *Gastrodetoechia iranica;* the problem is discussed under the description of *Eoparaphorhynchus lentiformis.*

The *Eoparaphorhynchus* Zone is represented by *E. walcotti* in a restricted area around Mountain Park in the Rocky Mountains. The species was first described in Nevada and

is also found in Utah. The following fauna occurs in the zone: *Athyris angelicoides* Merriam, *Cyrtospirifer portae* Merriam, *C.* sp., *Orbiculoidea* sp., *Productella* sp., *Schuchertella* sp., and *"Conularia"* sp. Associated rhynchonellids are *Sinotectirostrum medicinale deceptum, S. medicinale medicinale, S. paucirugosum,* and perhaps *Evanescirostrum seversoni.*

The *Eoparaphorhynchus* Zone is represented by *E. lentiformis* in a restricted area east and north of Jasper in the Rocky Mountains. The zone has been described in Belgium by Sartenaer (1957a, 1957b). The species is known from the U.S.S.R. (Kazakhstan, Pamir), and doubtfully from Iran. The following fauna occurs in the zone: *Athyris* cf. *A. angelicoides* Merriam, *A.* sp., *Chonetes* sp., *Cyrtiopsis mimetes* Crickmay, *C. prepta* Crickmay, *Cyrtospirifer* cf. *C. portae* Merriam, *C.* sp., *Lingula* sp., *Orbiculoidea* sp., *Productella* sp., *Schuchertella* sp., pelecypods (including *Leptodesma* sp.), *"Conularia"* sp., *"Styliolina", Echinocaris* sp., placoderm fish fragments. Associated rhynchonellid is *Sinotectirostrum medicinale medicinale.*

Basilicorhynchus Zone

The genus *Basilicorhynchus* is present in Belgium, Canada (Rocky Mountains, N.W.T., Arctic Archipelago), France, and perhaps the U.S.S.R. (Siberia). Whenever precise information is available, the zone is restricted to the upper part of the lower Famennian. The zone lies above the *Eoparaphorhynchus* Zone and no overlapping is known.

The *Basilicorhynchus* Zone is represented by *B. basilicus* in the Northwest Territories (Upper and Central Mackenzie River valley). It is characterized by three subspecies: *B. basilicus basilicus, B. basilicus interpositus, B. basilicus regalis.* Such a zone has not been formally recognized previously.

A *Pugnoides gerardimontis* Zone, now *Basilicorhynchus basilicus gerardimontis* Zone, was recognized in Belgium by Sartenaer (1956, 1957b). The *Pugnoides basilicum* Zone proposed by Sartenaer (1956, 1957b) becomes the *Evanescirostrum alblinii* Zone.

The species has been mentioned in the U.S.S.R. (Siberia) under the name *Leiorhynchus* aff. *L. basilicum* by Alekseeva (1965, pp. 184, 185) and is discussed under the description of *Basilicorhynchus basilicus basilicus.*

The following fauna occurs in the zone: *Athyris angelica* Hall, *A.* sp., *Cleiothyridina* sp., *Chonopectus horaeus* Crickmay, *Cyrtiopsis mimetes* Crickmay, *C. nahanniensis* Crickmay, *C. prepta* Crickmay, *C.* sp., *C. normandvillana* Crickmay, *Cyrtospirifer disjunctus* (Sowerby), *C.* sp., *C. whitneyi* (Hall), *Leioproductus* sp., *Productella* sp., *Schizophoria iowensis* (Hall), pelecypods, and gastropods including *Bellerophon* cf. *B. maera* (Hall) and *Euomphalus* sp. Associated rhynchonellids are *Ptychomaletoechia contractiformis, P. septentrionalis, P. serva, P. sulculifera, "Pugnax" rara, Rugaltarostrum madisonense, Sinotectirostrum mackenziei, S. medicinale medicinale.*

B. basilicus basilicus Subzone is known from the Northwest Territories (Upper and Central Mackenzie River valley) and the Alberta and British Columbia Rocky Mountains. It lies immediately above the *Eoparaphorhynchus maclareni* Zone wherever they occur in the same outcrop.

B. basilicus regalis Subzone is known from the Northwest Territories (Upper Mackenzie River valley, North Nahanni River and Root River valleys only). It lies above the *B. basilicus basilicus* Subzone but is separated from it by rocks containing *B. basilicus interpositus.*

The *Basilicorhynchus* Zone is represented by *B.* sp. A in the Alberta and British Columbia Rocky Mountains.

Gastrodetoechia Zone

The genus *Gastrodetoechia* is present in Canada (Rocky Mountains, N.W.T.), Iran (Elburz Mountains), U.S.A. (Idaho, Montana, Utah), and the U.S.S.R. (Armenia). The zone extends from the middle Famennian to the lower part of the upper Famennian. In Armenia the genus ranges from upper Famennian to Strunian.

In the Northwest Territories, the zone starts well above the *Basilicorhynchus* Zone and does not reach the base of the *Athyris angelica* Zone as defined originally in the Yohin syncline. In the Rocky Mountains, the zone starts also well above a poorly represented *Basilicorhynchus* Zone, but its upper limit cannot be defined on account of the disconformity at the top of the Palliser Formation.

The *Gastrodetoechia* Zone is represented by *G. utahensis* in the Alberta Rocky Mountains, and in the Northwest Territories (Upper and Central Mackenzie River valley). The zonal index was described in Utah and is also found in Idaho and Montana.

The following fauna occurs in the zone: *Athyris angelica* Hall, *A.* sp., *Avonia* sp., *Choristites glennfoxi* Crickmay, *C. protistus* Crickmay, *Cleiothyridina* sp., *Crurithyris* cf. *C. unionensis* Weller, *C. youngtownensis* Crickmay, *Cyrtiopsis hiraethlynae* Crickmay, *C.* sp., *Cyrtospirifer animasensis* (Girty), *C. disjunctus* (Sowerby), *C. gallatinensis* (Haynes), *C. kindlei* Stainbrook, *C. monticola* (Haynes), *C.* sp., *C. whitneyi* (Hall), *Leioproductus coloradoensis* (Kindle), *L. plicatus* (Kindle), *Planoproductus* cf. *P. hillsboroensis* (Kindle), *Productella lata* Warren, *Reticularia* cf. *R. spinigera* (Kindle), *Schellwienella* sp., *Schizophoria* aff. *S. australis* Kindle, *S.* sp., *S. striatula* (von Schlotheim), *Schuchertella girtyi* Shimer, *S.* sp., *Strophopleura notabilis* (Kindle), *S.* sp., *Tenticospirifer* cf. *T. conoideus* (Roemer). Gastropods (including *Diaphorostoma* sp., and *Euomphalus eurekensis* Walcott), and fish fragments are also found. The following ammonoids have been described by House and Pedder (1963): *Cheiloceras* (*C.*) *sacculum* (Sandberger), *Imitoceras* sp., *Lobotornoceras* aff. *L. bilobatum* (Wedekind), ?*Platyclymenia* sp., *Sporadoceras* cf. *S. primaevum* Schindewolf, *Tornoceras* (*T.*) cf. *crebriseptum* (Raymond).

Associated rhynchonellids are *Evanescirostrum seversoni, Megalopterorhynchus haynesi, Ptychomaletoechia finitima, P. sulculifera, P. summa, "Plectorhynchella" montifelicitatis, Rugaltarostrum madisonense, Sinotectirostrum banffense banffense, S. banffense shimeri, S. montosum, S. nordeggi, S. saxirubrum, Trifidorostellum cascadense cascadense.*

The *G. utahensis* Zone is represented by *G. utahensis utahensis* in the Alberta Rocky Mountains where it is restricted to the upper part of the Palliser Formation, and by *G. utahensis rugosa* in the Northwest Territories (Upper and Central Mackenzie River valley) where it is known in Hume's (1922) "Shale Zone No. 2" except the lowest and highest beds.

Sinotectirostrum avellana Zone

The zone is known in the Northwest Territories (upper Mackenzie River valley: North Nahanni and Root Rivers only), and in two wells in northeastern British Columbia. The zonal index is a characteristic species and the only representative of the genus *Sinotectirostrum* in the zone.

The zone corresponds almost exactly with Hume's (1922) *Athyris angelica* Zone, although *Sinotectirostrum avellana* has not been found in the highest beds of the latter zone.

In one of the wells in northeastern British Columbia a specimen has been collected at 74 feet below the top of the Wabamun Group.

The following fauna occurs in the zone: *Ambocoelia* sp., *Athyris angelica* Hall, *Cyrtospirifer disjunctus* (Sowerby), *C. whitneyi* (Hall), *Productella lachrymosa* var. *P. lima.* Pelecypods are also present. Associated rhynchonellid is *Rugaltarostrum madisonense.*

Other Rhynchonellid Genera

Evanescirostrum. Representatives of the genus are present in Belgium, France, Canada (Rocky Mountains), and the U.S.A. (Idaho). The genus extends from the upper part of the lower Famennian to the lower part of the upper Famennian. In Belgium, an *E. alblinii* Zone was proposed by Sartenaer (1956, 1957b) under the name *Pugnoides basilicum* Zone.

In Canada, the earliest appearance of the genus is not yet clearly established. The upper limit probably coincides with the top of the Palliser, but this is not certain because of the disconformity at the top of that formation. An *Evanescirostrum seversoni* Zone is known, which in Canada is restricted to the Alberta and British Columbia Rocky Mountains, and is also known from the U.S.A. (Idaho).

Megalopterorhynchus. Representatives of the genus are present in Canada (Rocky Mountains) and the U.S.A. (Idaho, Montana). The genus is restricted to the lower part of the upper Famennian. In Canada, the upper limit of the genus cannot be firmly established because of disconformity at the top of the Palliser Formation.

"Plectorhynchella". For reasons given under the description of the genus, only Famennian forms (plus some lower Tournaisian forms, the validity of which has not been checked) are attributed to a genus presently referred to as *"Plectorhynchella".* The genus *"Plectorhynchella"* has been mentioned in Belgium, Canada (Rocky Mountains), Germany, Morocco, U.S.S.R. (Kazakhstan, Mugodjary, Ural). In Canada it is known from the lower part of the upper Famennian; the upper limit of the genus cannot be established because of disconformity at the top of the Palliser Formation. In Belgium it is known from a single collection made at the end of the last century and reported to be of lower Famennian age. In Germany a species called *Rhynchonella inversilla* found by Wulff (1923) in the lower Famennian of the Aachen region is here referred to *"Plectorhynchella".* In Morocco the genus has been mentioned by Drot (1964, p. 175) in the lower (zone II) and upper (zone IV) Famennian. In the U.S.S.R., Rozman (1960c, 1962) has reported the genus from the *Cheiloceras, Laevigites* and *Prolobites* Zones of southern Ural and Mugodjary Mountains.

Ptychomaletoechia. The genus is present in Belgium, Canada (Rocky Mountains, N.W.T., Arctic), France, Iran, Spain, U.S.A., and U.S.S.R. It extends from the lower part of the lower Famennian (with the exception of the lowermost beds) to the lower part of the upper Famennian. In Canada, the upper limit is not firmly established owing to disconformity at the top of the Palliser Formation in the Rocky Mountains, and the genus has not been found in the *Athyris angelica* Zone of the Northwest Territories. Material not yet described indicates the presence of the genus in the middle Famennian ("niveau de Souverain-Pré") and in the lower part of the upper Famennian of Belgium. The presence of the genus in the upper Frasnian is disregarded, as the species *Ptychomaletoechia elburzensis* is attributed by the writer to the genus *Ripidiorhynchus.*

"Pugnax". The genus is present in Belgium, Canada (N.W.T.), France, Germany, U.S.S.R., and probably some other countries. It is restricted to the lower Famennian and is found, in Canada, in the *Eoparaphorhynchus* Zone and throughout most, if not all, the *Basilicorhynchus* Zone.

Rugaltarostrum. The genus is present in Canada (Rocky Mountains, N.W.T.), U.S.A. (Idaho, Montana), and the U.S.S.R. In the U.S.A., it is found in Haynes' (1916a, b) Members No. 4 and No. 5 (middle and upper parts) of the Three Forks Formation, or in the upper part of Sandberg's (1965) Trident Member of that formation; it is also found in the lower part of Sandberg's (1965) Sappington Member. In the British Columbia Rocky Mountains, the genus is known in the highest beds of the Palliser Formation. In the Northwest Territories it is present in the upper part of the *Eoparaphorhynchus* Zone, in the *Basilicorhynchus* Zone, and in the *Athyris angelica* Zone (as defined in the Northwest Territories). Thus, the genus extends from the lower part (highest horizons) of the lower Famennian to the middle (and perhaps the upper) part of the upper Famennian.

Sinotectirostrum. The genus is present in Canada (Rocky Mountains, N.W.T.), U.S.A. (Idaho, Montana?, Nevada, Utah), and the U.S.S.R. (Arctic). In the U.S.A., it is restricted to the Three Forks Formation in Idaho, and to the "Contact Ledge" of Utah. *Sinotectirostrum*?

sp. has been mentioned by Reso and by Johnson and Reso (1966), in a bed approximately 240 feet below the top of the Pilot Formation at Bactrian Mountain (southeastern Nevada), where the formation is 341 feet thick. They estimate that the associated fauna indicates a late Famennian age. No precise information is available for the Russian material. In the Canadian Rocky Mountains the genus extends from the lower Famennian to the lower part of the upper Famennian, but its upper limit cannot be firmly established because of disconformity at the top of the Palliser Formation. In the Northwest Territories the genus is found in the *Athyris angelica* Zone as defined in that region, and may therefore extend to the upper part of the upper Famennian.

Trifidorostellum. The genus is present in Canada (Rocky Mountains), U.S.A. (Idaho, Montana), and the U.S.S.R. (Mugodjary, North-East, Ural). In Canada and the U.S.A., the genus is restricted to the lower part of the upper Famennian. In Canada, the upper limit of the genus cannot be firmly established because of disconformity at the top of the Palliser Formation. In the U.S.S.R., Rozman (1960b, 1962) has found *T. posturalicum* in the upper part of the upper Famennian, and *T. uralicum* in the lower part of the upper Famennian; the latter species was considered by Nalivkin (1947) as derived from the lower horizons of the Famennian[1]. The mention of the genus *Trifidorostellum* in the Lower Carboniferous by Schmidt *in* Schmidt and McLaren (1965, p. H578) may be in reference to species rejected from the genus by the writer.

Correlation with Ammonoid Zones

The stratigraphic significance of ammonoid zones in the Devonian of the world is well known. It seems useful, therefore, to attempt correlation between the ammonoid and rhynchonellid zonal schemes. Unfortunately, the ammonoid zones are poorly represented in western Canada as only little and poorly preserved material is available. For this reason only the location of the known faunas is indicated (Figs. 1 and 2, *in pocket*).

Cheiloceras Zone (toII)

Northwest Territories—House and Pedder (1963) state that the lower part of Hume's (1922) Shale Zone No. 2 (= map-unit D 5) in the Yohin syncline (North Nahanni River valley) has yielded a suite of goniatites indicative of the upper *Cheiloceras* major Zone including *Lobotornoceras* aff. *L. bilobatum* (Wedekind), *Cheiloceras* (*C.*) *sacculum* (G. and F. Sandberger), *Sporadoceras* cf. *S. primaevum* Schindewolf, and *Imitoceras* sp. These species, represented by one, two, one, and three specimens respectively, were collected from talus about 150 feet above the base or within the lower 355 feet of map-unit D 5 (1,178 feet thick in Yohin syncline); one specimen identified as *Cheiloceras* (*C.*) cf. *sacculum* comes from the same map-unit in an isolated outcrop 5 miles SSW of the confluence of Battlement Creek and the North Nahanni River.

In considering House and Pedder's (1963) Table 1, three points must be borne in mind: "*Nudirostra*" *gibbosa seversoni* has never been reported from the Shale Zone No. 2, and is absent in the Northwest Territories; "*N.*" *gibbosa walcotti* is unknown in the Northwest Territories.

Platyclymenia Zone (toIII)

Rocky Mountains—Warren (1927, p. 20) lists ?*Platyclymenia americana* Raymond in the Minnewanka Limestone (upper part) of the Banff area; he mentions that the "specimen, which is doubtfully referred to this species, is fragmentary, preserving only the living

[1] *T. aldanicum* and *T. verchojanicum*, which have not been studied yet by the writer, are reported in the lower half of the Famennian.

chamber and, therefore, cannot be identified definitely." As Warren mentions later that no specimen of *Platyclymenia* has been found in Canada, this means that he rejects his identification. This specimen is lost, however, as noted by House and Pedder (1963). Miller (1938, p. 198) noted that "its general physionomy suggests that it is a nautiloid, and there seems no good reason to believe that it is related to *Platyclymenia*."

Taylor (1958, p. 15) mentions cf. *Platyclymenia* sp. in the Upper Alexo Formation or Lower Palliser Formation; this fossil is lost as noted by House and Pedder (1963).

House and Pedder (1963, p. 506), on the basis of a "clymenid tentatively identified as *Platyclymenia*" found within the *ventricosa* brachiopod zone, consider that the zone "can now be tentatively directly correlated with the *Platyclymenia* major Zone." This unique specimen is identified as *?Platyclymenia* sp. and was collected from 0–16 feet below the top of Palliser Formation of Mount Lorette.

Northwest Territories—House and Pedder (1963, p. 497) state that "higher in the unit (Hume's Shale Zone No. 2), the presence of a *Tornoceras* comparable with *T. crebriseptum* (Raymond) of the Three Forks Formation of Montana, probably indicates that the upper part of the unit is to be assigned to the *Platyclymenia* major Zone." House (pp. 527-528) identifies the two available specimens as *Tornoceras* (*T.*) cf. *crebriseptum* and indicates that they have been collected in Yohin syncline in Hume's map-unit D 5 from 564 to 574 feet below the top and from 604 to 614 feet above the base.

In conclusion, the Famennian rocks of western Canada contain the *Cheiloceras* major Zone (*to*II) (in the Northwest Territories only), and part of the *Platyclymenia* major Zone (*to*III). The association, in the type locality of the Three Forks Formation (southwestern Montana), of the *Gastrodetoechia utahensis utahensis* Zone and the *Prolobites delphinus* Zone (*to*III) makes it highly probable that the equivalent of this latter zone is represented in Canada. The position of the *Sinotectirostrum avellana* Zone in terms of ammonoid zones is still unknown. Clark and Ethington (1965, p. 387, fig. 2) infer that the upper two thirds of the Mount Hawk Formation lie within the *to*II Zone and that the Alexo Formation is equivalent to the *to*III, *to*IV, and *to*V (lower part) Zones. This is in opposition with the conclusions based on Frasnian and Famennian rhynchonellid and ammonoid zones.

Famennian of the Type Area

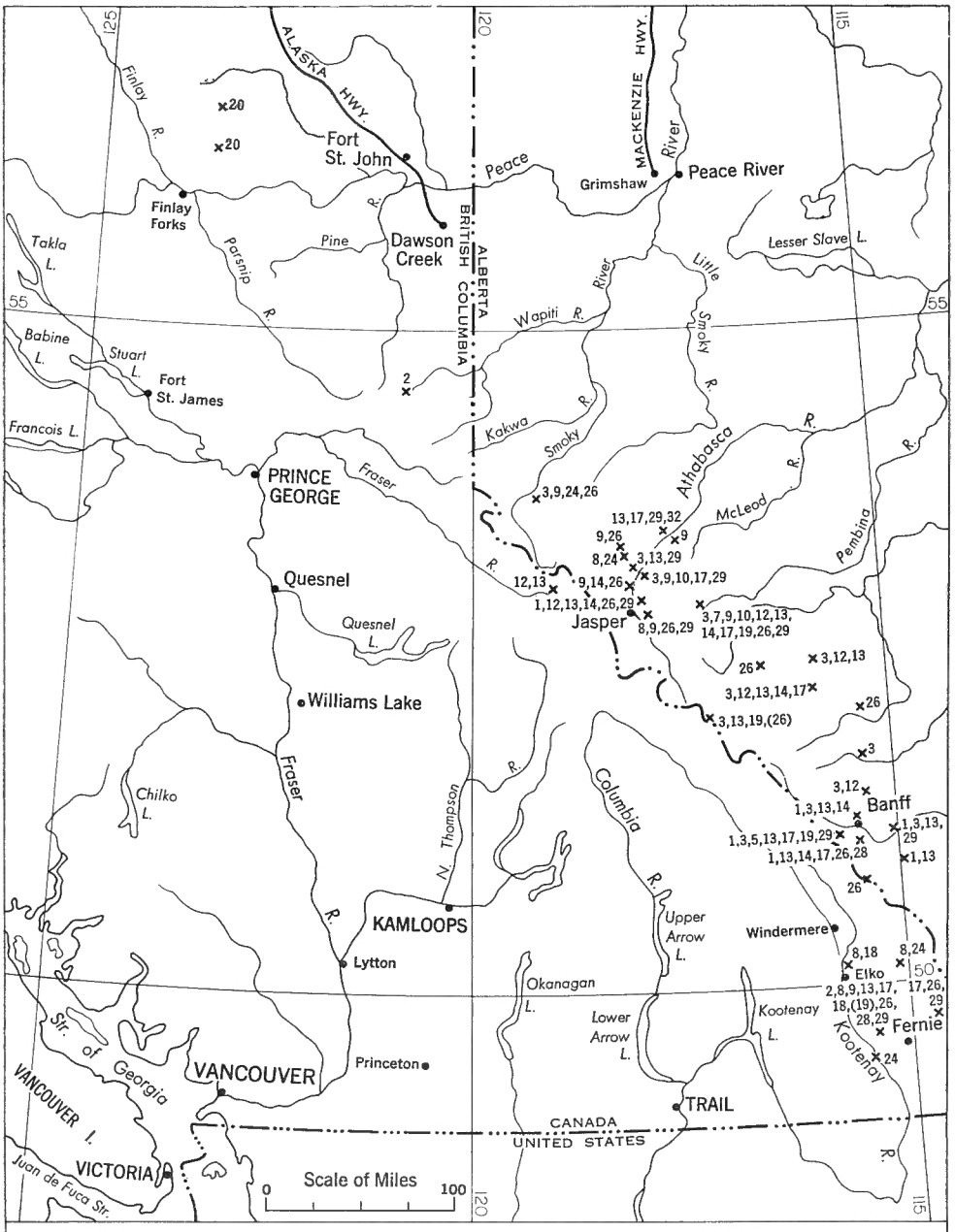
The terms lower, middle, and upper Famennian have been used loosely in the past, even though such subdivisions have received more formal recognition (Gosselet, 1880; Mourlon, 1882; Dupont, 1886). The matter has been fully discussed by Sartenaer (1957b, 1957d, 1958b). More recently conodont studies have confirmed the subdivisions of these previous workers (Bouckaert and Ziegler, 1965). The three subdivisions of the Famennian accepted here are shown on Figure 2 in relation to standard ammonoid zones and to the Canadian rhynchonellid zones.

Correlation between Western Canada and Western U.S.A.

Although the problem of correlation between western American outcrops is most important, little progress has been achieved since the original definition of many of the formations in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. These formations encompass a considerable thickness of rock in which the precise location of the various species of the included fauna is often not known. Furthermore, the systematic position of many of these species has not been thoroughly investigated or revised. Thus it is not surprising that the Trident Member of the Three Forks Formation of southwestern Montana remains, after half a century, the best known unit, because of Haynes' (1916a, 1916b) work on the stratigraphy and brachiopod fauna.

Some of the Rhynchonellida of the Three Forks Formation are revised in this paper, because of their close affinity with Canadian forms.

Figure 3, *in pocket* suggests correlation of Famennian rocks and beds straddling the Frasnian–Famennian and Famennian–Mississippian boundaries between certain areas in western North America. Shortcomings and approximations may be ascribed to lack of information. Nevertheless, the importance in correlation of rhynchonellid genera, considered either separately or in association with other fossils emerges clearly. Thus the upper beds of the Devils Gate Formation are certainly older than the upper part of the Trident Member of the Three Forks Formation. The close similarities between the genera *Paurorhyncha* and *Gastrodetoechia* suggest that the lower part of the Box Member of the Percha Formation is of the same age as the upper part of the Trident Member, and that the upper part of the Box Member is slightly younger.



INDEX TO FOSSILS

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4. *Gastrodetoechia utahensis rugosa*
5. *Megalopterorhynchus haynesi*
6. *Eoparaphorhynchus maclareni*
7. *Eoparaphorhynchus walcotti*
8. *Eoparaphorhynchus lentiformis*
9. *Sinotectirostrum medicinale medicinale*
10. *Sinotectirostrum medicinale deceptum*
11. *Sinotectirostrum mackenziei*
12. *Sinotectirostrum nordeggi*
13. *Sinotectirostrum banffense banffense*
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15. *Sinotectirostrum saxirubrum*
16. *Sinotectirostrum avellana*
17. *Sinotectirostrum montosum*
18. *Sinotectirostrum paucirugosum*
19. *Evanescirostrum seversoni*
20. *Evanescirostrum* sp. A
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22. *Basilicorhynchus basilicus interpositus*
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28. *Ptychomaletoechia septentrionalis*
29. *Ptychomaletoechia summa*
30. *Ptychomaletoechia finitima*
31. *"Pugnax" rara*
32. *"Plectorhynchella" montifelicitatis*

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FIGURE 4. Index map of southern region.

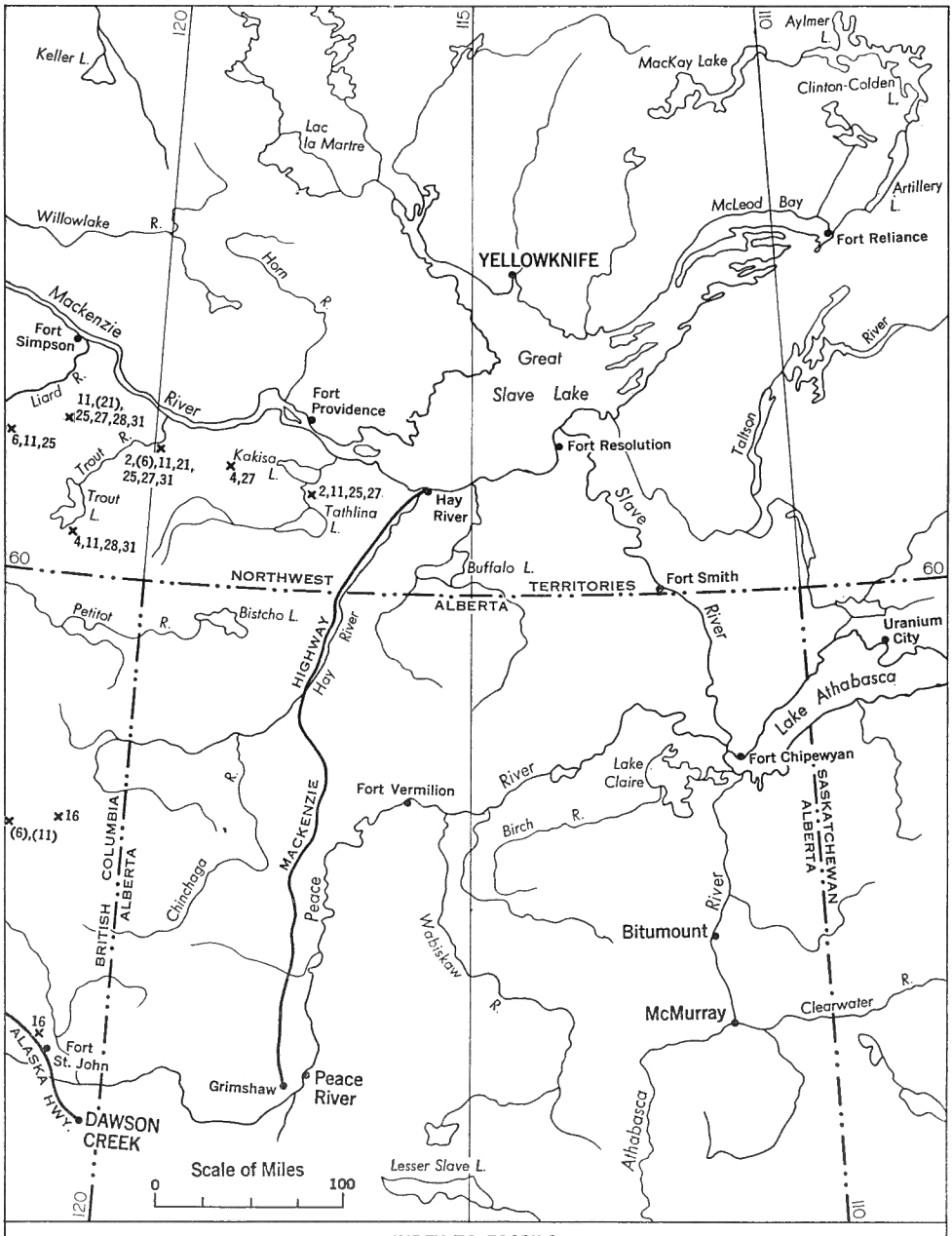

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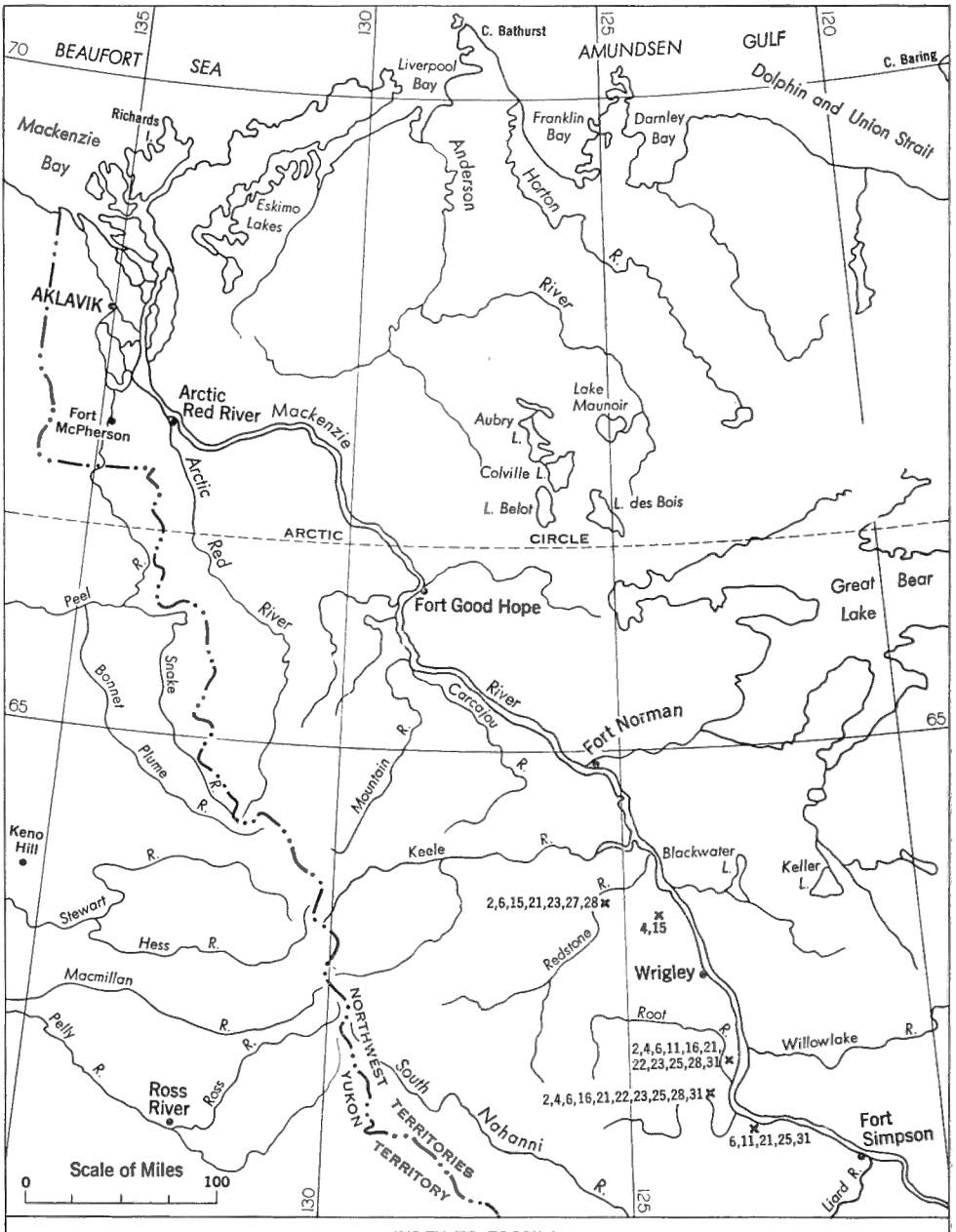
FIGURE 5. Index map of central region.



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31. *"Pugnax" rara*
32. *"Plectorhynchella" montifelicitatis*

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FIGURE 6. Index map of northern region.

DESCRIPTIVE PALAEONTOLOGY

This work is a beginning in solving major problems of evolution, correlation, and palaeoecological, and palaeogeographical distribution. As there are no natural divisions in an evolving plexus, limits assigned to populations, i.e., a species or subspecies name, are artificial. Names and their taxonomic status are chosen in accord with the needs of stratigraphy and restrictions imposed by the Code, but tend as closely as possible to approximate natural units.

In descriptive palaeontology, species and subspecies are only first approximations. More precise stratigraphy requires more detailed descriptions based on more rigorous, comprehensive, and abundant collecting. By means of intra- and inter-continental correlation, a world-wide stratigraphic standard will take shape. Then, palaeoecological and palaeogeographical hypotheses may become constructive. The assignment of a species or a subspecies to one genus after another represents successive approximations and means progress in our knowledge. Comparison of species from different continents is necessary to avoid duplication, but must not be attempted where information is inadequate.

We have scarcely begun to understand the internal structures of the Rhynchonellida. Thus, the variability, functions, and systematic significance of these structures have not yet been determined. In this connection, genera such as *Basilicorhynchus, Evanescirostrum,* and *Gastrodetoechia* are similar in more than one character, and identification based on isolated specimens may prove difficult. Some genera have similar internal structures, for instance: *Gastrodetoechia, Megalopterorhynchus, Paurorhyncha* (and even *Rugaltarostrum*), or the group *Ptychomaletoechia, Ripidiorhynchus,* and *Sinotectirostrum.* Either basic internal differences have not yet been recognized, or certain new genera may be differentiated only by means of external characters.

The number of species is surprisingly low, and the stratigraphic extension is restricted.

When localities have not been visited by the writer, the locality and stratigraphic information given by the original author or collector are cited unless an evident correction could be made. The present evaluation of such information is found on Figures 1 to 6. The field notebooks of all the geologists whose collections were studied have been examined, but no responsibility is accepted for stratigraphic data concerning localities not visited by the writer.

Types. Deposited in the Geological Survey of Canada type collection are primary types of new and old Canadian species (and subspecies) and hypotypes of existing Canadian species (and subspecies) together with plaster casts of primary types from the U.S.A. and, with few exceptions, of hypotypes of species (and subspecies) collected in the U.S.A. Plaster casts of the primary types of all the species (and subspecies) are deposited in the "Institut royal des Sciences naturelles" of Belgium under the number I.G. 23535.

Specimens of all species (and subspecies) are present in collections of both the Geological Survey of Canada and the "Institut royal des Sciences naturelles" of Belgium.

Terminology

The definition of specific or generic characters is one of the most important and difficult tasks of descriptive palaeontology. It is not yet possible to define specific, generic, or ontogenetic variability, nor to place fossils in their functional, ecological, and evolutionary

framework. Furthermore, it is not yet useful to restrict the meaning of known terms to functional significance, although such refinement may eventually be necessary.

Most of the terms used in this paper to describe internal and external features of the Rhynchonellida are widely known and accepted. Moreover, the illustrations accompanying the descriptions should preclude any misinterpretation of the terms. In the list below are terms that (1) are new or not widely used, (2) have more than one meaning, (3) tend to be more than descriptive.

Convergence or divergence of dental plates is relative to the median line of transverse serial sections.

Costae are always counted at the commissures and include those resulting from divisions. When the numbers on both flanks differ, the higher is recorded. The ridges bordering the sulcus are not considered as lateral costae when they are not separated from the flanks by a furrow. Specimens with 2/2, or 3/3, etc., . . ., lateral costae are included with specimens with 2/3, or 3/4, etc. . . ., lateral costae.

Adventitious costa—a costa on the fold or in the sulcus, that reaches neither from the beak nor to the frontal commissure; not necessarily a parietal costa.

Bifurcated costa (*see* A)—a costa branching from another, oriented in any direction.

Biparted costa (*see* B)—a branching costa that gives rise to two subequal costae separated only by a furrow.

Dichotomized costa (*see* C)—a branching costa that gives rise to two subequal costae oriented symmetrically relative to the original.

Intercalated costa—a costa starting between two others; not resulting from division of another.

Parietal costa—a costa on the flank(s) of the sulcus or fold; need not necessarily indent the frontal commissure. Adventitious costae are counted with the parietal costae.

Regular costae—costae similar in width and/or elevation.

Irregular costae—costae different in width and/or elevation.

Secondary costa (*see* D)—costa resulting from secondary lateral outgrowth from another costa.

General costal formula—is a grouping of at least 75% of the specimens in the categories: median, parietal, and lateral.

Foramen is a hole in the ventral beak which is rarely observed. It is open anteriorly and communicates with the opening between the deltidial plates. The foramen was probably functional after the juvenile stages, but in the absence of sufficient information, the term is considered as descriptive without functional connotation.

Hinge plate is used in a general sense, as are the terms inner and outer plates.

Interarea always refers to the ventral interarea.

Measurements and orientation of specimens. Measurements are in millimetres. The abbreviations used are l=length; t=thickness; w=width; pv=pedicle valve; bv=brachial valve.

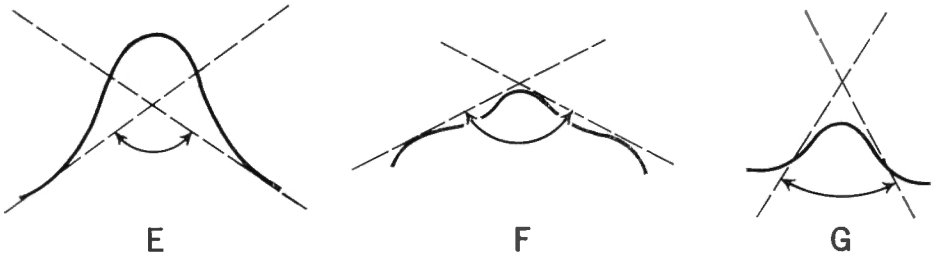
Length is the anterior-posterior distance measured parallel to the plane of commissure, and tangential to the most exterior points of the specimen. Width is measured in the same plane at right angles to the length. Thickness is measured at right angles to both length and

width between the highest and lowest points of the specimen. Transverse serial sections are in a plane perpendicular to the plane of commissure.

Some slight discrepancies exist at times between the measurements given in the tables and those taken from photographs; this is due to difficulty in orientating specimens.

Measurements shown in parentheses indicate a reasonable estimate on a damaged specimen.

Septalium. As used by Sartenaer (1961a, p. 6, infrapaginal note 4).



Shoulder angle. In ventral views, three different angles may be considered in the umbonal region:

E—the angle formed by the prolongation of the cardinal commissure. This is the *angle of the cardinal commissure.* It has been used when no other angle could be measured, e.g., in representatives of the genus *Trifidorostellum;*

F—the angle formed between vertical planes tangential to the cardinal commissure and to the borders of the umbonal region near the beak. This is the *apical angle* as commonly used in the literature;

G—the angle formed between vertical planes tangential only to the borders of the umbonal region near the beak. This is the *shoulder angle* as defined by the writer and used in preference to the apical angle, because it can be measured even when the apical angle cannot.

Striation. In some places, clearly indicated in the text, the term has been used to designate striae, the nature of which and the position on or below the shell could not be established because of the state of preservation of the material. The important problem of the systematic significance of the fine radial striation, already evocated by Sartenaer (1956, pp. 23-24), is considered in this paper under the description of the genus *Eoparaphorhynchus.*

Serial sections. Only transverse serial sections are figured. Sectioning was continued until the crura disappeared, and is used to evaluate the taxonomic significance of the variability of these structures and to investigate the shape of the muscle scars.

Trifidorostellum Sartenaer, 1961
(=*Pseudoleiorhynchus* Rozman, 1962)

1961d. *Trifidorostellum* n. gen.—SARTENAER, p. 5.

Type species. Leiorhynchus dunbarense Haynes, 1916.

Diagnosis. Transverse; few wide costae; no parietal costae; median costae generally starting at the beaks and commonly divided; external lateral costae confined to the anterior part of the shell; angle of the cardinal commissure at the beak very wide; dorsal umbo inflated and usually projected posteriorly beyond the pedicle valve; tongue recurved posteriorly; sulcus beginning a very short distance from the beak; ventral beak almost in contact with the brachial valve. Slender internal structures; narrow ventral umbonal cavities; ventral muscle field poorly marked; no septum; no septalium; hinge plate divided; delicate crura with characteristic shape.

Species and subspecies attributed to the genus. Type species, *T. cascadense cascadense* (Warren, 1927), *T. cascadense mugodjaricum* nov. subsp., *T. uralicum uralicum* (Nalivkin, 1947), *T. uralicum fontis* nov. subsp., *T. posturalicum* (Rozman, 1962). *T. aldanicum* Alekseeva, 1967 and *T. verchojanicum* Alekseeva, 1967, which were published when this paper was in press, have not yet been studied.

Description

The genus is represented by species and subspecies of small to medium, medium, and medium to large size. They are uniplicate to parasulcate. They are transverse and subelliptic to suboval in dorsal view. The greatest thickness of the shell is sometimes at the frontal commissure, but usually it is posterior to it. The number of median and lateral costae varies from one species to another, but is usually low. There are no parietal costae. The median costae start at the beaks (except the middle dorsal costa of *T. dunbarense*) or very near to it. In *T. dunbarense* median costae are never divided; in the other species and subspecies divisions are either rare or common. The lateral costae are always simple and the external ones are confined to the anterior part of the shell; the others start from the umbo. The costae are wide, rounded, or with rounded tops. Width is the greatest dimension. Length and thickness have similar values, the thickness being sometimes less, sometimes greater, than the length. The angle of the cardinal commissure at the beak varies between 145 and 175 degrees. Postero-lateral margins are concave near the commissure. Radiating striae sometimes occur on the anterior part of the dorsal flanks of the North American species and subspecies; they may be vascular impressions.

The internal structures are very slender. Despite the inflated aspect of the shell due chiefly to the inflated dorsal umbo, there is no thickening of the shell in the umbonal area, even in the largest specimens.

Pedicle valve. The flat-bottomed sulcus is deep and begins at a very short distance from the beak; it widens and deepens abruptly forwards. The beak is small, acute, clearly defined, and slightly incurved; owing to the inflation of the dorsal umbo, it is commonly almost in contact with the brachial valve. The foramen, which is very rarely seen, is small and round. The top of the tongue is usually recurved. The delthyrium also is very rarely observed. Deltidial plates may be observed in transverse serial sections (Text-figs. 3A, B, C). The interarea is narrow and low.

In the posterior part of the shell, the dental plates are divergent and very close to the walls of the valve, leaving narrow umbonal cavities; anteriorly their shape is variable. They are slender, very short, and are attached to the floor of the valve only in their posterior part. The teeth are short, simple, and robust. The teeth enter late (in transverse serial sections) into the dental sockets, in a dorso-lateral direction, when the dental plates have almost disappeared. As the margins are concave near the postero-lateral commissures, these commissures stick out sharply outward; thus denticula are strongly developed and parallel to the outer socket ridges of the brachial valve along the plane of commissure, and the teeth are at some distance from the cardinal commissure.

Ventral muscle scars, although commonly seen, are very difficult to distinguish within the muscle field; the specimen on which they are best preserved shows the diductor scars enclosing the very faint reniform adductor scars. A small myophragm separates the adductor scars. The muscle field is not well marked, longer than wide, rhomboidal, and with vague limits.

Brachial valve. The umbo is inflated and usually projected posteriorly beyond the pedicle valve. The fold is high and begins a very short distance from the beak. The top of the fold is slightly rounded to rounded and sometimes almost flat depending on the species.

There is neither a dorsal septum nor a septalium. On internal moulds, commonly, a narrow median groove may be observed (Pl. I, fig. 1a) in the posterior part of the valve of

the North American forms. This groove starts from the beak and may reach one third of the unrolled length of the valve; it is 0.2 to 0.3 mm deep. This groove does not correspond to a true septum, although it may be residual. Nothing suggests it corresponds to a myophragm.

The hinge plate is divided. The outer plates of the hinge plate are narrow, slender, and inclined towards each other. In successive sections the diverging crural bases develop before the outer plates; they are strong and pass forward into delicate crura that diverge from one another dorsally. Farther into the shell they lengthen and converge again; a low ridge develops on the exterior at the point of recurvature (Text-figs. 1A, 2A). A further ridge may appear externally at the junction of the outer plates and crural bases (Text-figs. 3A, B, C, D). The crura are short and commonly remain completely in the brachial valve. Exceptionally they may be curved at their distal end and pass the plane of commissure in a ventral direction (Text-fig. 2B).

The dental sockets are simple, shallow, and directed ventro-laterally to laterally (Text-figs. 1B, 2A).

Dorsal muscle scars have not been observed despite the abundant material at hand.

Comparisons. Differences from the genus *Leiorhynchus* Hall, 1860 have been given by Sartenaer (1961d, p. 5). *Trifidorostellum* can readily be distinguished from all other genera.

Discussion. The genus *Pseudoleiorhynchus* Rozman, 1962, with *Liorhynchus uralicus* Nalivkin, 1947 as type species, falls into synonymy with *Trifidorostellum* as explained by Sartenaer and Rozman (1965).

The following species attributed by Rozman (1960b, pp. 43, 47, 48, fig. 2, p.50; 1962, pp. 123, 127-8) to the genus are rejected: *Liorhynchus depressus* Rjonsnitzkaia, 1953, *Pseudoleiorhynchus* (*Pugnax*?) *plana* (=*nomen nudum*), and *Liorhynchus plano-ovalis* Nalivkin, 1937. As a consequence the stratigraphic extension of the genus (Frasnian to lower Tournaisian) as given by Rozman (1962, p. 123) is limited to the Famennian (Sartenaer and Rozman 1965, p. 149). *Trifidorostellum posturalicum* has been found in the Kurgandjar beds representing the upper part of the upper Famennian and *T. uralicum uralicum* in the Murzakaevo beds representing the lower part of the upper Famennian. Nalivkin (1947) calls the beds where *T. uralicum uralicum* has been collected lower horizons of the Famennian. It must not be forgotten that divisions such as lower and upper Famennian as now used may vary from one region to another. The North American species of the genus are confined to the lower part of the upper Famennian.

Calvinaria? *undulata* Termier, 1950 and *Pseudoleiorhynchus*(?) *zemoulensis* Drot, 1964, Famennian species considered to belong to the genus *Trifidorostellum* by Drot (1964, pp. 168-173), are rejected.

The geographic distribution of the genus is limited so far to the States of Montana and Idaho, U.S.A., to the Canadian Rocky Mountains, Alberta, and to the Ural (and Mugodjary) Mountains, and probably the North-East, U.S.S.R.

It is interesting to note that a Mugodjary species, *Trifidorostellum posturalicum,* is closely similar to *T. dunbarense,* and might be a subspecies; that a Mugodjary subspecies, *T. cascadense mugodjaricum* resembles *T. cascadense cascadense;* and that *T. uralicum uralicum* of Mugodjary and Eastern Urals appears to correspond to *T. uralicum fontis.*

In order to make this correspondence acceptable a few words will have to be written on Russian material. Similar correspondence of other forms will be discussed under the description of the genus *Sinotectirostrum.*

Stratigraphic position and geographic distribution. The species and subspecies referred to this genus are restricted, in Canada and the U.S.A., to the lower part of the upper Famennian. They are reported in the U.S.S.R. from the lower and upper part of the upper Famennian, and, recently, by Alekseeva (1967), in the lower half of the Famennian (*see* comment above).

Trifidorostellum dunbarense (Haynes)

Plate I, figure 1; Text-figures 1A, B

[e.p.] 1907. *Leiorhynchus* sp.—HOLZAPFEL *in* RAYMOND, p. 118;
1916b. *Leiorhynchus dunbarense* sp. nov.—HAYNES, pp. 38, 39, pl. VIII, fig. 8;
[e.p.] 1924b. *Leiorhynchus dunbarense*—KINDLE, p. 217;
[non] 1943. *Leiorhynchus* cf. *dunbarense* Haynes—BALDWIN, pp. 146, 151, pl. 1, figs. 3–5;
[non] 1952. *Nudirostra dunbarense* (Haynes)—HOLLAND, p. 1705;
1952a. *Leiorhynchus dunbarense* Haynes—CRICKMAY, p. 588;
[non] 1952a. *Leiorhynchus* cf. *L. dunbarense* Haynes—CRICKMAY, p. 594;
1961d. *Trifidorostellum dunbarense* (Haynes)—SARTENAER, pp. 5, 6, pl. I, figs. 4a–e, pl. II, fig. C;
1963. *Nudirostra* cf. *dunbarense* (Haynes)—DUTRO *in* ROBINSON, fig. 3, p. 36, table 2 (Mil–6) (*coet. excl.*);
[non] 1963. *Nudirostra* cf. *dunbarense* (Haynes)—DUTRO *in* ROBINSON, table 2 (288, 435 T6) (*coet. excl.*).

Types

Holotype (Pl. I, figs. 1a–e=pl. VIII, fig. 8 *in* Haynes, 1916b=pl. I, figs. 4a–e *in* Sartenaer, 1961d). CM No. 2704. Near Dunbar's mine, north of Three Forks, Montana, U.S.A. "Limestone layers at top of member number 5," Three Forks Shale. Collector: P. E. Raymond.

Hypotype A. USNM No. 154968. T5N, R1 + 2W (Devils Fence 15′ Quad.), Montana, U.S.A. Three Forks Formation. Collector: O.D. Blake.

Hypotype B. USNM No. 154969. T2N, R2W, Sec. 22 (Jefferson Island 15′ Quad.), Nose of anticline NE of Doherty Mountain, Montana, U.S.A. Same formation and collector.

Hypotype C. USNM No. 154970. T3N, R2W, Sec. 10 (Devils Fence 15′ Quad.), North Boulder valley, approximately centre of south half, 20–25 feet below the base of Haynes' (1916a,b) unit 4 in Three Forks Shale. Collector: J. T. Dutro, Jr., 1956.

Hypotypes D, USNM No. 154971; E, USNM No. 154972; F, USNM No. 154973; G, USNM No. 154974. Same locality, formation, and collector as for hypotype C.

Hypotype H. GSC No. 15523 (Text-fig. 1A=pl. II, fig. C *in* Sartenaer, 1961d). Same locality, formation, and collector as for hypotype A.

Hypotype I. USNM No. 154975 (Text-fig. 1B). Milligan Creek (Three Forks 15′ Quad.), Montana, U.S.A. Three Forks Formation. Collector: O.D. Blake.

Material

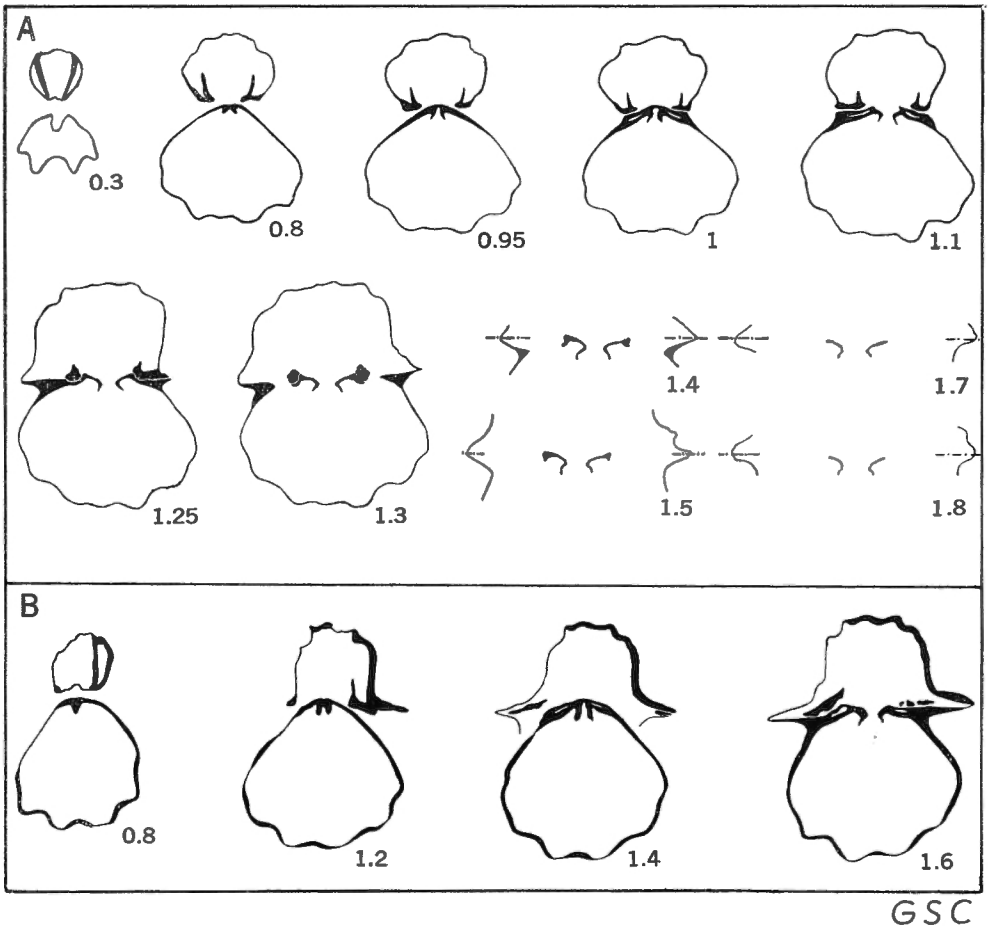
Holotype; six specimens identified as *Leiorhynchus dunbarense* by Dr. W. P. Haynes, at the Museum of Comparative Zoölogy, Harvard College; six specimens received from Dr. O. D. Blake in Billings, and nine specimens on loan from Dr. J. T. Dutro, Jr. of the U.S. Geological Survey, assigned to this species; three specimens collected by Dr. C. A. Sandberg and the writer in 1959; one specimen identified as *Nudirostra* cf. *dunbarense* by Dutro *in* Robinson (1963). Thus twenty-six specimens from Montana have been available for study; most of them are in good state of preservation.

Six specimens were collected by Dr. W. Sadlick and the writer in 1960 in Idaho.

Description

The species is small-to-medium-sized (*see* Table below). The greatest width of the shell is situated around $^{9}/_{10}$ of the length measured from the beak.

From the borders of sulcus and fold, flanks curve progressively towards the margins, gently in the pedicle valve, more steeply in the brachial valve, the steepness being related to the thickness of the shell. The flanks are concave near the postero-lateral margins. The maximum thickness is sometimes at the front, but usually it is posterior to it.



TEXT-FIGURE 1. *Trifidorostellum dunbarense* (Haynes)

Camera lucida drawings of serial transverse sections (x4); distances are in mm forward from the crest of the umbo.

A = Hypotype H, GSC No. 15523 (l:(11.7)mm; w:15.5mm; t:12.2mm);

B = Hypotype I, USNM No. 154975 (l:13.9mm; w:19.5mm; t:14.0mm).

Pedicle valve. The sulcus begins at a very short distance from the beak. It widens and deepens rapidly; its greatest depth—where it passes into the high tongue—is four to eight times the height of the median costae; its greatest width, at the front, varies from 45 to 65 per cent of the width of the shell. The flat-bottomed sulcus is sharply limited by the first lateral costae. Commonly the tongue is recurved posteriorly. Exceptionally the borders of the tongue may be nearly parallel.

The beak is small, acute, clearly defined, and slightly incurved; it does not overhang the hinge line, but owing to inflation of the brachial umbo, it is commonly almost in contact with the brachial valve. The foramen is small and round, resulting from resorption of the beak; it is rarely observed. The interarea is well delimited with a maximum height of one millimetre and a length of one third, or slightly more, of the width of the shell. In the holotype, the delthyrium can be seen; at its base, it occupies half the length of the interarea.

Brachial valve. The fold begins at a very short distance from the beak. It is well marked and generally high with a very slightly rounded and sometimes almost flat top. In the holotype, which is also the largest specimen, the top of the fold is particularly rounded. The maximum height of the valve is at or forward of the mid-length and, exceptionally, at the front.

The umbo is inflated and commonly projects posteriorly beyond the pedicle beak.

Ornament. The general costal formula is ½; 0; ½ to ⅔. Costae are simple in the nineteen specimens on which observations have been possible.

All specimens have three costae on the fold and two in the sulcus. The middle costa on the fold can hardly be observed on the holotype due to poor preservation. These costae start at the beak or very near to it, with the exception of the middle dorsal one. Thus, near to the beak, there is a sulcus between the external costae of the fold. In this sulcus and in the posterior part of the middle dorsal costa there is a median groove very clearly indicated on internal moulds (*see* description of the genus).

Lateral costae start from the umbonal regions; when there are three costae, the external costa is commonly restricted to the anterior part of the shell. The ratios of lateral costae, counted on sixteen specimens, are distributed as follows: ½: 5 sp.; ⅔: 7 sp.; ⅓: 3 sp.; ¾: 1 sp.

Costae are obtuse, rounded or with rounded tops, and average 3 mm wide at the front margin. The costae bordering the sulcus and the dorsal median costae (in their posterior part) are more angular than the others.

The surface is covered by distinct growth lamellae, 3 to 4 per mm at mid-length. Very rarely, fine radiating striae are observed; they can be seen on the holotype on the anterior margin of the dorsal flanks and in the median portion of the sinus (only in fig. 1d of Pl. I are they vaguely visible on the left side).

Dimensions. Hypotypes F and G are the smallest specimens among the collections. Thicknesses and lengths have similar values (*see* ratios t/l in table below), but specimens are usually thicker than long. Width being proportionally greatest (*see* ratios l/w and t/w), ventral and dorsal views show a characteristic elliptical shape.

in mm	Holotype	Hypotype C	Hypotype E	Hypotype D	Hypotype A	Hypotype B	Hypotype G	Hypotype F
l	19.2	17.0	15.9	14.7	14.0	14.0	13.8	11.4
w	26.9	22.6	22.6	(20.5)	20.1	17.1	17.0	17.4
lpv unrolled	32.0	27.5	29.0	25.0	26.0	25.5	20.0	19.0
t	18.0	18.3	16.0	15.2	15.5	15.1	11.7	12.2
tpv	5.0	4.8	4.5	2.7	5.2	3.7	3.9	3.7
tbv	13.0	13.5	11.5	12.5	10.3	11.4	7.8	8.5
l/w	0.71	0.75	0.70	(0.72)	0.70	0.82	0.81	0.66
t/w	0.67	0.81	0.71	(0.74)	0.77	0.88	0.69	0.70
t/l	0.94	1.08	1.00	1.03	1.11	1.08	0.85	1.06

The angle of the cardinal commissure at the beak varies from 145 to 170 degrees. The cardinal commissure as well as the posterior part of the lateral commissures is sharp as the valves are convexo-concave in this region.

Internal characters. The species being the type species of the genus, the internal characters are given under the description of the genus.

Growth. The two smallest specimens (hypotypes F and G) are similar to the large ones.

Discussion

Synonymy. Haynes (1916b) chose as holotype a specimen from Raymond's collection (*see* his explanation of pl. VIII) and three out of six specimens came from the same collection. They were collected, according to Haynes, from the top of his member 5 of the Three Forks Shale; [e.p.] is written because other specimens of Raymond's collections are included by Haynes in *L. madisonense* and *L. madisonense* var. *gibbosum.*

The specimens only from Montana, cited by Kindle (1924b), are put into synonymy.

The specimen figured by Baldwin (1943) does not belong here. Owing to the presence of a median dorsal septum, the notably less obtuse angle of the cardinal commissure at the beak, no deep sulcus, variable number of costae, etc., . . ., it has been put into synonymy with *Evanescirostrum seversoni.*

Crickmay's (1952a) specimen of *Leiorhynchus* cf. *L. dunbarense* is a fragment with only the frontal part showing well; it has three costae in the sinus. It could belong to *Evanescirostrum seversoni.*

Holland's (1952) *Nudirostra dunbarense* (two specimens) belong to *Rugaltarostrum jeffersonense.*

Fourteen specimens identified as *Nudirostra* cf. *dunbarense* (Haynes) by Dutro *in* Robinson (1963) have been put into synonymy with *Rugaltarostrum gibbosum.*

Comparisons. The species is distinguished by small-to-medium size, few costae, and constant number of undivided median costae.

Haynes (1916b) suggested resemblance to *Liorhynchus ashtabulense* Prosser, 1912. Examination of the syntypes of *L. ashtabulense* shows it to differ in the following characters: l/w ratio different (as already pointed out by Haynes), shoulder angle, and ornament. Moreover, the syntypes are four "ventral" valves, but in three of them a median septum can be seen through the shell and are therefore, most probably, brachial valves; more material should be available for fuller investigation.

Comparisons with *Trifidorostellum cascadense cascadense* and *T. uralicum fontis* will be found under the description of those subspecies.

Stratigraphic position. The species, under the name *Leiorhynchus* sp., was found by Raymond (1907) in the Red Shale Zone. Five of Haynes' specimens were collected from "the limestone layers at the top of member 5," one from "the base of gray limestone number 4," i.e., in a thickness of about 20 feet. The specimen collected by Ross and identified by Dutro *in* Robinson was collected 28 feet below the base of the upper siltstone unit in the Milligan Creek sector.

Thus, according to the literature, the species has been derived from a maximum thickness of only 40 feet in Montana; this is also where the writer made his collections.

The specimens from Idaho derive from the lower part of the 75 feet of "shaly limestone with interbedded thin limestone beds" of the section measured by Baldwin (1943, p. 145) in the Three Forks Formation.

Geographic distribution. T. dunbarense is a rare species, which has been found in a restricted area of southwestern Montana within the limits of the following 15 minute quadrangles: Devils Fence, Jefferson Island, Manhattan, Radersburg, Three Forks, Toston. The species has been found also a mile east of Freighter Spring, near Dickey, Idaho. Contrary to Kindle's (1924b, p. 217) statement, the species does not occur in the Banff section, Alberta.

Trifidorostellum cascadense cascadense (Warren)

Plate I, figures 2–7; Text-figures 2A–D

[e.p.?]	1924b.	*Leiorhynchus dunbarense*—KINDLE, p. 217;
	1927.	*Leiorhynchus cascadensis* sp. nov.—WARREN, p. 19;
	1927.	*Leiorhynchus cascadense* sp. nov.—WARREN, pp. 53–54, pl. IV, figs. 10–12;
	1940.	*Leiorhynchus cascadensis*—MERRIAM, p. 72;
[non]	1950.	*Leiorhynchus cascadensis* Warren—ERDMAN, p. 75;
[?]	1950.	*Leiorhynchus* cf. *cascadense* Warren—de WIT and McLAREN, p. 15;
	1950.	*Leiorhynchus cascadensis* Warren—WARREN and STELCK, p. 64;
	1952a.	*Leiorhynchus cascadensis* Warren—CRICKMAY, p. 590;
	1954.	*Paurorhyncha cascadensis* (Warren)—McLAREN, p. 175;
	1956.	*Paurorhyncha cascadensis* (Warren)—BELYEA and McLAREN, p. 89;
	1958.	*Paurorhyncha cascadensis* (Warren)—HARKER and McLAREN, p. 251;
	1964.	"*Leiorhynchus*" *cascadensis* Warren—PEDDER *in* BELYEA and McLAREN, p. 792.

Types

Lectotype (Pl. I, figs. 7a–e). GSC No. 8905 (= pl. IV, fig. 12 *in* Warren, 1927). Cascade Mountain, Banff, Banff National Park, Alberta. Upper beds of Lower Banff Limestone (=uppermost beds of Minnewanka Limestone). Collector: P. S. Warren. Syntype (paralectotype) (Pl. I, figs. 6a,b). GSC No. 8905a (=pl. IV, figs. 10, 11 *in* Warren, 1927); syntypes (paralectotypes) GSC No. 8905b, c, d. Same locality, formation, and collector.

Hypotypes A, GSC No. 15525 (Pl. I, figs. 2a–e); B, GSC No. 15526 (Pl. I, figs. 3a–c); C, GSC No. 15527 (Pl. I, fig. 4); D, GSC No. 15528 (Pl. I, figs. 5a–e); E, GSC No. 15529; F, GSC No. 15530; G, GSC No. 15531 (Text–fig. 2A). GSC loc. 17050. Collector: E. W. Peyto, 1925.

Hypotypes H, GSC No. 15532; I, GSC No. 15533; J, GSC No. 15534. Near Banff, Alberta. Upper Devonian. No other information available.

Hypotype K. GSC No. 15535 (Text–fig. 2D). GSC loc. 38815. Collectors: H. Belyea and P. Sartenaer, 1959.

Hypotypes L, GSC No. 15536 (Text–fig. 2C); M, GSC No. 15537 (Text–fig. 2B). Same locality, formation, and collector as for hypotypes A–G.

Material

Five syntypes of *Leiorhynchus cascadense,* and specimens from the following GSC localities: 8768 (22), 16958 (1), 17050 (26), 18235 (2), 38815 (11), 38823 (2), 38879 (1), 38885 (11), 38888 (1), 38901 (1); three specimens with "near Banff" as only information. Less than half the material is in satisfactory state of preservation.

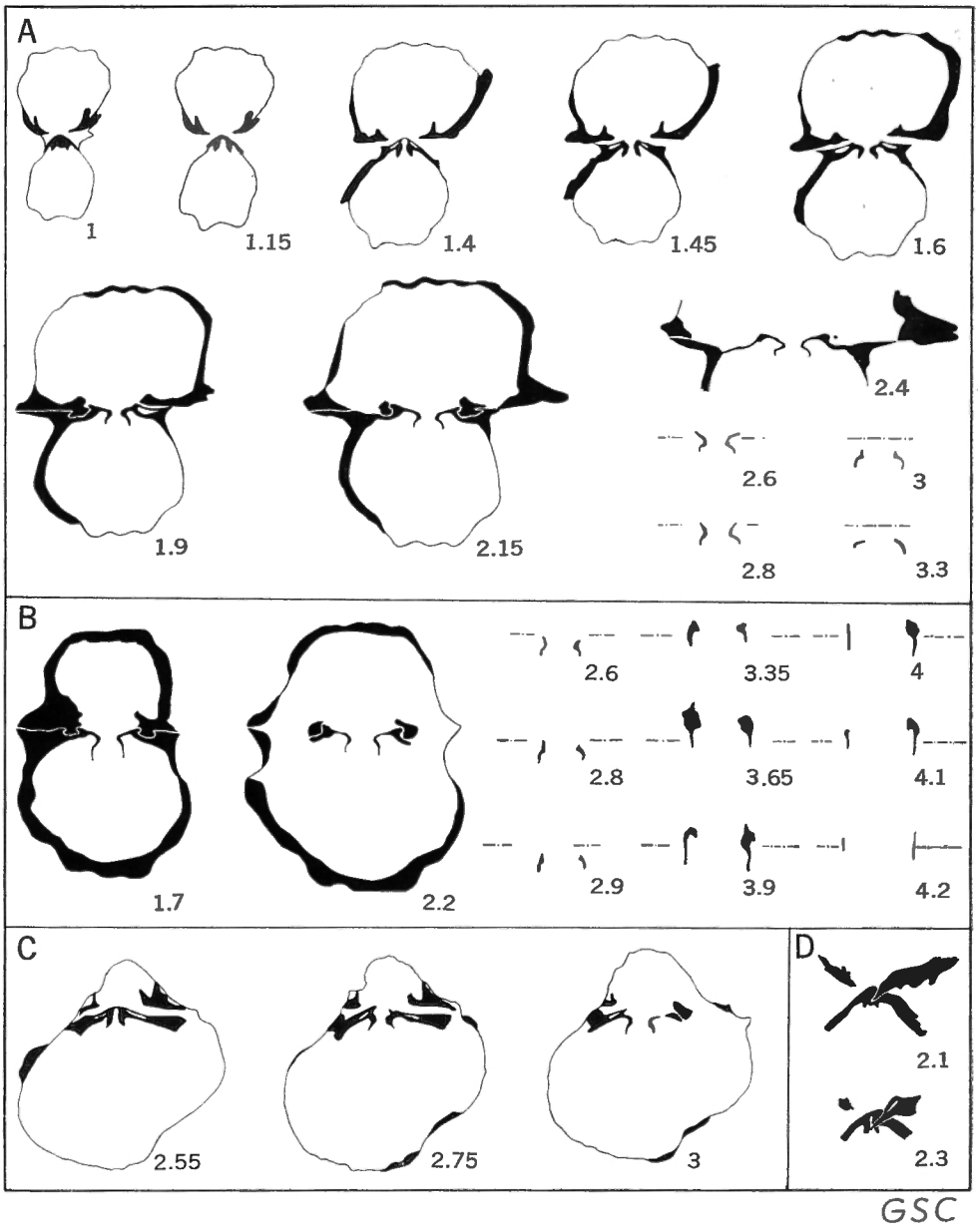
Description

Many of the characters of *T. dunbarense* and *T. cascadense cascadense* being similar, only the differences between the species and subspecies are given here. The subspecies is medium-to-large-sized, the smallest specimen being almost as large as the largest one of *T. dunbarense.*

In the paralectotype GSC No. 8905a (Pl. I, figs. 6a, b=pl. IV, figs. 10, 11 *in* Warren, 1927) the margins of the flanks look abrupt, but this is due to secondary shell growth secreted at a gerontic stage.

As the first lateral costae are rounded, the limits of the sulcus are vague. The costae becoming rounder with increasing size or the poorer state of preservation, or both, may account for this difference from *T. dunbarense.* The top of the fold and of the tongue are always rounded. The frontal commissure is often weakly crenulated.

Ornament. The general costal formula is 3/2 to 5/4; 0; 3/3 to 5/5. Ratios of median costae in the best preserved specimens are distributed as follows: 3/2: 9 sp. (24%); 4/3: 10 sp. (27%); 5/4: 11 sp. (30%); 6/5: 5 sp. (13.5%); 7/6: 2 sp. (5.5%).



TEXT-FIGURE 2. *Trifidorostellum cascadense cascadense* (Warren)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

A = Hypotype G, GSC No. 15531 (l:18.1mm; w: 26.9mm; t:19.3mm);

B = Hypotype M, GSC No. 15537 (l:16.6mm; w:24.3mm; t:20.3mm);

C = Hypotype L, GSC No. 15536 (l:(17.4)mm; w:22.3mm; t:(14.2)mm);

D = Hypotype K, GSC No. 15535 (l:27.3mm; w:32.2mm; t:28.2mm); a fragment of the pedicle valve is crushed into the brachial valve.

In almost half of the specimens with more than 3½ costae, there is, on each side in the sulcus and fold, an adventitious costa that is lower and narrower than the other costae (Pl. I, figs. 2c,d, 5b, 6a). Sometimes, in specimens with more than 3½ costae, one bifurcation starting at about the posterior third of the length can be seen; more specimens (Pl. I, figs. 2a–d) seem to have such a bifurcation, but the state of preservation forbids any definite conclusion. Intercalated (one or two) costae are not rare. All the adventitious costae have been counted as median ones as few can definitely be recognized as parietal.

Owing to the state of preservation and a tendency towards obsolescence, lateral costae are difficult to study. Satisfactory observations could only be made on nine specimens. Of these, four have 3⅜ costae; two have 4¼; two have 5⅛; one has 6⅛. As far as could be seen, one or two of the external lateral costae are confined to the anterior part of the shell. Costae may reach a width of 4 mm at the front. There is no relation between the size of the shell and the number of costae.

Growth lamellae are seldom preserved.

In three specimens, radiating striae have been observed. In the lectotype (Pl. I, figs. 7c,e), these striae are definitely under the shell; they may be vascular impressions although they look more or less regular.

Dimensions.

in mm	Lectotype	Hypotype K	Hypotype F	Hypotype D	Hypotype H	Hypotype A	Hypotype E	Hypotype I	Hypotype G	Hypotype J	Hypotype B
l	28.3	27.3	21.5	20.5	19.7	19.5	18.7	18.2	18.1	17.4	15.8
w	38.8	32.2	31.2	26.5	26.3	26.7	26.7	27.0	26.9	26.1	22.8
lpv unrolled	(50.0)	50.0	(35.0)	41.0	37.0	(34.0)	32.5	31.5	32.0	32.0	30.5
t	28.7	28.2	21.0	23.4	22.4	17.0	19.7	17.8	19.3	17.0	16.9
tpv	11.8	9.2	7.2	8.5	6.5	5.8	6.7	6.1	6.0	5.9	6.7
tbv	16.9	19.0	13.8	14.5	15.9	11.2	13.0	11.7	13.3	11.1	10.2
l/w	0.73	0.85	0.69	0.77	0.75	0.73	0.70	0.67	0.67	0.67	0.69
t/w	0.74	0.88	0.67	0.88	0.85	0.64	0.74	0.66	0.72	0.69	0.74
t/l	1.01	1.03	0.98	1.14	1.14	0.87	1.05	0.98	1.07	0.98	1.07

Discussion

Synonymy. As the Montana specimens mentioned by Kindle (1924b) have been put into synonymy with *T. dunbarense,* the only specimens included here are those from the Banff sections. It is probable that Kindle had this subspecies in mind as no other Upper Devonian forms are known in the Canadian Rocky Mountains that look similar to *T. dunbarense.* Erdman's (1950) specimens are considered to belong to *Gastrodetoechia utahensis utahensis.*

Comparisons. The subspecies is distinguished by medium to large size, number of costae, and occasional development of bifurcated, intercalated, and adventitious median costae. The holotype of *T. dunbarense* most closely resembles *T. cascadense cascadense.*

Warren (1927) has pointed out some resemblance between *T. cascadense cascadense* and both *Leiorhynchus jeffersonense* Haynes, 1916 and small forms of *Camarotoechia endlichi* (Meek, 1875). *Rugaltarostrum jeffersonense* is easily distinguishable by its internal characters; externally, they are very similar. External differences are given under the description of *R. jeffersonense.* There is no similarity between Meek's species and *T. cascadense cascadense.* Similarities and differences between *T. cascadense cascadense* and *Megalopterorhynchus*

haynesi are given under the description of that species. Differences between *Trifidorostellum cascadense cascadense* and *T. uralicum fontis* are given under the description of that subspecies.

Stratigraphic position. Warren (1927) found his new species in the "uppermost beds of Minnewanka limestone on Cascade Mountain." Pedder *in* Belyea and McLaren (1964) cited the species in the lower part of a 110-foot unit located between 44.3 and 153.3 feet below the top of the Palliser Formation. In the remainder of the literature, the subspecies is cited, without further precision, in the upper beds of the Palliser Formation, *Athyris angelica* Zone, *Nudirostra utahensis ventricosa* Zone, Costigan Member. Crickmay (1952a) speaks of the "upper 50 feet" of the Palliser Formation.

The writer's collections were made 1 foot to 11 feet (Sulphur Mountain), 30 to 34 feet (Mount Rundle), 0 to 5 feet (The Wedge), 5 feet (Jura Creek), and 58 feet (Bourgeau Range, Healy Creek) below the top of the Palliser Formation.

McLaren collected three specimens referred to this subspecies: one in the upper few feet of the Palliser Formation on Sulphur Mountain; two from the upper part of the same formation on Mount Norquay. Peyto did not leave enough information to permit locating his collection stratigraphically, but after study of the same outcrops (Bourgeau Range, Healy Creek) it is almost certain that it came from a bed somewhere in the 55 upper feet of the Palliser Formation. After a study of the Upper Palliser of Maligne Canyon, it is considered that the "Upper limestone beds" (the only information found in Kindle's notebook about his collection) refer to the upper 50 feet of the Palliser Formation.

Thus the subspecies has only been found, with one exception, in the upper 55 feet of the Palliser Formation in the Canadian Rocky Mountains.

Geographic distribution. T. cascadense cascadense is neither abundant nor rare. Although it has been found mostly in the vicinity of Banff, it has been collected as far south as The Wedge and as far north as Maligne Canyon. The subspecies is unknown outside the Canadian Rocky Mountains.

Trifidorostellum cascadense mugodjaricum nov. subsp.

1962. *Pseudoleiorhynchus uralicus* (Nalivkin), 1947—ROZMAN, pp. 123–5, pl. XI, figs. 1–7, pl. XII, figs. 1–12, fig. 31 *in textu* p. 124.

The name is derived from the Mugodjary Mountains, U.S.S.R.

Type Locality

Upper Kurgandjar River, 3 km south-southwest of the by-pass road to Tashkent, edge of escarpment of a left bank tributary. Bertchogursk depression, South Mugodjary Mountains, U.S.S.R.

Type Horizon

Murzakaevo beds (lower part of the upper Famennian). No further details available.

Types

Holotype. Pl. XI, figs. 1a,b,v,g *in* Rozman, 1962. No. 3552/4. Costal formula: ½; 0; ⅙.

Paratypes A-J are *in* Rozman, 1962: A, Pl. XI, figs. 2a,b,v,g. No. 3552/5. Costal formula ⅓; 0; ¾; B, Pl. XI, figs. 3a,b,v,g. No. 3552/2. Costal formula ½; 0; ¾ and ⅙; C, Pl. XI, figs. 4a,b,g,v,d, No. 3552/3. Costal formula ½; 0; ⅙; D, Pl. XII, figs. 6a,b,g,v,d. No. 3552/6. Costal formula ⅔; 0; ⅙; E, Pl. XII, figs. 7a,b,g. No. 3552/67. Costal formula ½; 0; ⅔; F, Pl. XII, figs. 8a,b,g,v,d. No. 3552/66. Costal formula ⅔; 0; ⅔; G, Pl. XII, figs. 9a,b,g. No. 3552/68. Costal formula ½; 0; ¾ and ¼; H, Pl. XII, figs. 10a,b,g. No. 3552/69. Costal formula ⅜; 0; ⅜; I, Pl. XII, figs. 11a,b,g,v. No. 3552/70. Costal formula ½; 0; ⅔; J, Pl. XII, figs. 12a,b,g. No. 3552/71. Costal formula ½; 0; ½.

Discussion

Of the figured specimens described by Rozman (1962) under the name *Pseudoleiorhynchus uralicus,* none is close to the lectotype of *Trifidorostellum uralicum* (Nalivkin, 1947). The latter is discussed elsewhere. Rozman's specimens are, therefore, separated under a new geographic subspecies *T. cascadense mugodjaricum*. Stratigraphic information is not precise enough to consider erecting a stratigraphic subspecies.

The ratios of median costae in the nineteen figured specimens, including some juvenile forms, are distributed as follows: 2/1: 3sp.; 3/2: 12 sp.; 3/4: 1 sp.; 4/3: 3 sp., while the ratios of the lateral costae are 0: 2 sp.; 1/2: 1 sp.; 2/2: 1 sp.; 2/3: 4 sp.; 3/3: 1 sp.; 3/4: 3 sp.; 4/5: 7 sp.

An adventitious costa has been found on one specimen. There is a divided costa on the fold in only one specimen (pl. XI, figs. 2a,b,v,g). In two specimens there are intercalated costae in the sulcus, one in the specimen just mentioned (pl. XI, figs. 2a,b,v,g), two almost worn out in another (pl. XII, figs. 1a,b,v,g).

The size of the specimens corresponds to the largest specimens of *T. dunbarense* or small specimens of *T. cascadense cascadense.*

Although near to *T. dunbarense* in many features, including size and number of median costae, *T. cascadense mugodjaricum* differs by a higher number of lateral costae; variation in the number of median costae; some division of the median costae; the less crenulated frontal commissure; and especially by the low and rounded lateral costae bordering the sulcus. *T. cascadense mugodjaricum* resembles *T. cascadense cascadense* in most characters, but is separated from it by smaller size, commonly fewer median costae, the almost general absence of adventitious costae, and rarer division of the median costae.

The constancy of these differences should be corroborated by observations on more than nineteen specimens.

Trifidorostellum uralicum uralicum (Nalivkin)

1947. *Liorhynchus uralicus* Nalivkin, in litt.—NALIVKIN, pp. 90–1, pl. XX, figs. 8a–c;

[non] 1962. *Pseudoleiorhynchus uralicus* (Nalivkin), 1947—ROZMAN, pp. 123–5, pl. XI, figs. 1–7, pl. XII, figs. 1–12, fig. 31 *in textu* p. 124;

1965. *Trifidorostellum uralicum* (Nalivkin)—SARTENAER and ROZMAN, p. 149, figs. 2a,b,v,g,d.

Discussion

The lectotype of *T. uralicum uralicum* (designated by Sartenaer and Rozman, 1965, p. 149) has the costal formula 6/6; 0; 2/3; and 3/4. The six median costae on the fold result from the division of three costae; two of the five median costae in the sulcus are intercalated, two others result from the division of one costa. This is the only specimen described or figured so far; this does not exclude the possibility that some have been included in other species described in the U.S.S.R.

Of 103 specimens of a form from Idaho, several are identical with the lectotype of *T. uralicum uralicum.* Most, however, are larger and wider than the Russian specimen. In order to draw attention to this similarity, the Idaho forms are described as a new subspecies of *T. uralicum,* although this conclusion may have to be modified when the Russian species is better known.

Stratigraphic and geographic information on this species is given under the description of the genus.

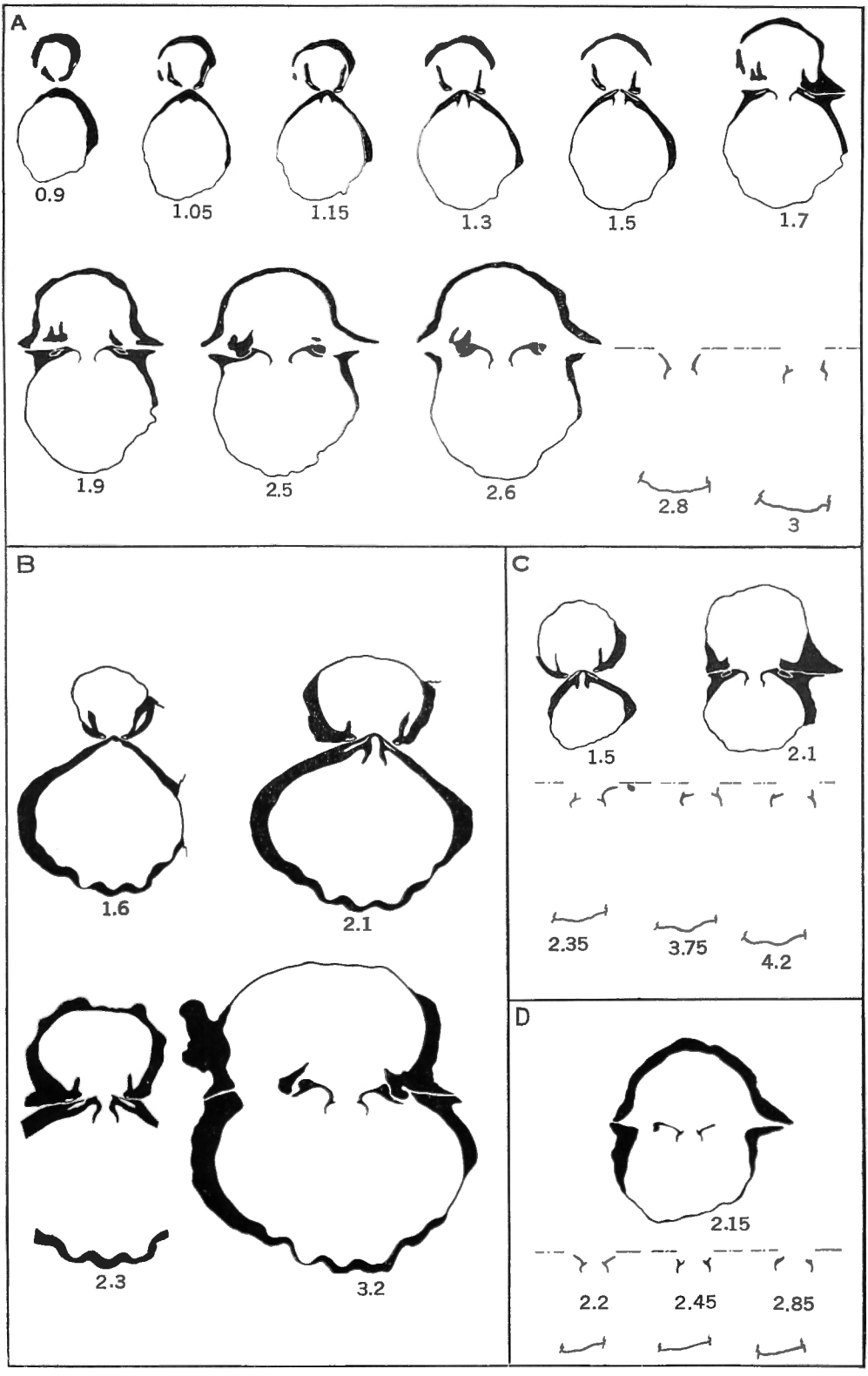
Trifidorostellum uralicum fontis nov. subsp.

Plate II, figures 1–7; Text-figures 3A–D

1943. *Leiorhynchus madisonense* var. *gibbosum* Haynes—BALDWIN, pp. 146, 151, pl. 1, fig. 13, *non synonymia;*

1943. *Leiorhynchus* cf. *L. jeffersonsense* Haynes—BALDWIN, p. 146.

Fons, fontis (Latin, masc.)=spring; to indicate that the holotype was collected near Freighter Spring, Idaho, U.S.A.



TEXT-FIGURE 3. *Trifidorostellum uralicum fontis* nov. subsp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
A=Paratype E, USNM No. 154980 (l:18.7mm; w: 24.7mm; t:16.3mm);
B=Paratype H, USNM No. 154983 (l:22.7mm; w:36.7mm; t:25.7mm);
C=Paratype F, USNM No. 154981 (l:(21.0)mm; w:32.1mm; t:(15.6)mm);
D=Paratype G, USNM No. 154982 (l:(16.4) mm; w:23.5 mm; t:12.6 mm).

Types

Holotype (Pl. II, figs. 1a–e). PRI No. 6042 (=pl. 1, fig. 13 *in* Baldwin, 1943). In the upper 115 feet of the measured section, Three Forks Formation. One mile east of Freighter Spring near Dickey, Lost River Range, Idaho, U.S.A. (=locality No. 4 *in* Baldwin, 1943) (Borah Peak Quad.). Collector: E. M. Baldwin, 1941.

Paratype A. USNM No. 154976 (Pl. II, figs. 2a-e). Same locality and formation. Collectors: W. Sadlick and P. Sartenaer, 1960.

Paratypes B, USNM No. 154977 (Pl. II, figs. 3a-e); C, USNM No. 154978 (Pl. II, figs. 4a-c); D, USNM No. 154979 (Pl. II, figs. 5a-c); E, USNM No. 154980 (Text-fig. 3A); F, USNM No. 154981 (Text-fig. 3C); G, USNM No. 154982 (Text-fig. 3D); H, USNM No. 154983 (Text-fig. 3B); I, USNM No. 154984 (Pl. II, fig. 7); J, USNM No. 154985 (Pl. II, figs. 6a–d). Same locality, formation, and collectors.

Material

From the same locality in Idaho, 103 specimens: holotype; three specimens received from Dr. E. M. Baldwin; 99 specimens (including the paratypes) collected by Dr. W. Sadlick and the writer in 1960. Less than half of the specimens are in satisfactory state of preservation.

Description

T. uralicum fontis is similar to *T. cascadense cascadense* except in differences in number, distribution, and division of costae. The general costal formula is 5/6 to 7/8; 0; 2/3 to 4/5.

Ratios of median costae are distributed in the best preserved specimens as follows: 5/4: 2 sp. (5%); 5/6: 21 sp. (49%); 7/6: 14 sp. (32%); 9/7: 5 sp. (12%); 9/8: 1 sp. (2%).

Bifurcated costae on the fold and intercalated costae in the sulcus are seen on most specimens.

Ratios of lateral costae are distributed as follows in 35 specimens: 0/1 : 1 sp. (3%); 1/2 : 1 sp. (3%); 2/3 : 6 sp. (17%); 3/4 : 15 sp. (42%); 4/5 : 7 sp. (20%); 5/6 : 3 sp. (9%); 6/7: 1 sp. (3%); 7/8: 1 sp. (3%).

Dimensions.

in mm	Paratype C	Paratype B	Paratype A	Holotype	Paratype D
l	25.6	21.5	20.0	16.5	15.8
w	38.5	31.4	26.2	23.1	22.7
lpv unrolled	49.0	43.0	39.0	34.5	29.5
t	27.7	24.7	22.6	20.2	18.2
tpv	8.6	8.2	7.0	6.2	5.1
tbv	19.1	16.5	15.6	14.0	13.1
l/w	0.67	0.68	0.76	0.71	0.70
t/w	0.72	0.79	0.86	0.87	0.80
t/l	1.08	1.15	1.13	1.22	1.15

Discussion

Comparisons. Similarities and differences from *T. dunbarense* are the same as for *T. cascadense cascadense.*

Trifidorostellum posturalicum (Rozman)

1962. *Pseudoleiorhynchus posturalicus* sp. nov.—ROZMAN, pp. 125–7, pl. XIII, figs. 1–10, pl. XIV, figs. 1–9, pl. XV, figs. 1–7, pl. XVI, figs. 1–8, pl. XXXI, figs. 8–10, fig. 32 *in textu* p. 126.

Discussion

This species has been abundantly illustrated by Rozman (1962). For comparisons with North American forms, the following information is given.

The ratios of median costae in thirty-three out of the thirty-four specimens figured, including some juvenile forms, are distributed as follows: 2/1: 2 sp.; 3/2: 25 sp.; 4/3: 5 sp.; 5/4: 1 sp., while the ratios of the lateral costae in thirty-two specimens are: 0: 18 sp.; 1/2: 3 sp.; 2/2: 2 sp.; 2/3: 2 sp.; 3/3: 1 sp.; 3/4: 2 sp.; 4/4: 1 sp.; 4/3: 3 sp. In only one specimen (Pl. XIV, figs. 4a,b,g,v) are there two intercalated costae in the sulcus and three costae on the fold which seem to result from the division of one costa.

The Russian species is thus readily distinguished from *T. cascadense* and *T. uralicum* by the costal formula and by the extremely rare divisions of the median costae. On the other hand, *T. posturalicum* is very close to *T. dunbarense* in the number of median costae, the extremely rare divisions of the median costae, the generally clearly crenulated frontal commissure, the well marked first lateral costa bordering the sulcus, the slightly rounded and sometimes almost flat top of the fold. *T. posturalicum* differs from *T. dunbarense* by a larger size, a greater variability in the number of median costae, the number of lateral costae, the occurrence of very rare divisions in the median costae. It is questionable if these differences are of specific value. The Russian species may be only a subspecies of *T. dunbarense*.

Stratigraphic and geographic information on this species is given under the description of the genus.

Rugaltarostrum Sartenaer, 1961

1961d. *Rugaltarostrum* n.gen.—SARTENAER, p. 6.

Type species. Leiorhynchus madisonense Haynes, 1916.

Diagnosis. Transverse; few wide, rounded, variably developed costae; median costae start generally at the beaks and commonly divide; simple lateral costae; parietal costae present; costellae commonly present; angle of the cardinal commissure large; dorsal umbonal region moderately inflated; deep and wide sulcus starting at or forward of the beak; postero-lateral commissures protrude sharply; high tongue and fold. Slender internal structures; wide ventral umbonal cavities; deep and wide septalium supported by a short septum; hinge plate divided.

Species attributed to the genus. Type species; *R. gibbosum* (Haynes, 1916); *R. jeffersonense* (Haynes, 1916); with doubt and thus not included in the description: *Camarotoechia Partridgiae* Nalivkin, 1930 (*non* Whidborne, 1897).

Description

The genus is represented by uniplicate to parasulcate species of small, medium, and large size. They are transverse and subelliptic to suboval in dorsal view. The commissure is sharp and deeply crenulated by the costae.

The number of median and lateral costae varies from one species to another, but is usually low. Costae are wide, rounded or obtuse with rounded top. Dorsal median costae may become high anteriorly. The development of costae is extremely variable between species. Median costae (excluding those resulting from divisions) generally start at the beak. Lateral costae are simple and often low. Costellae are commonly observed on the flanks of the type species and of *R. gibbosum*. Width is by far the greatest dimension. The angle of the cardinal commissure at the beak varies between 125 and 162 degrees. Postero-lateral margins are concave near the commissure.

The internal structures are slender. A thickening of the shell in the ventral umbonal area has been observed only in some specimens of *R. jeffersonense*.

Pedicle valve. The umbonal region is moderately inflated. The bottom of the deep sulcus is flat or slightly convex. The sulcus widens rapidly and may reach three quarters of total width at anterior border of shell; it starts at or forward of the beak depending on the species; it is bordered by wide, rounded (or with rounded top), and well marked ridges. The upper part of the trapezoidal tongue may or may not be recurved posteriorly depending on the species. The beak is small, acute, well defined; it overhangs rarely the hinge line and, in some species, is sometimes closely incurved over the dorsal umbo. The foramen was not seen. The interarea is short and ill-defined latero-ventrally.

The delthyrium is partly covered by deltidial plates, which are best seen in transverse serial sections (Text-figs. 4–6,9).

The slender dental plates are short and concave anteriorly; they are divergent to parallel in the very posterior part of the shell and become progressively parallel (but slightly curved outwards) then converge anteriorly. The dental plates limit wide umbonal cavities. The teeth are short, stout, and simple. They enter the dental sockets (in transverse serial sections) when the dental plates have almost disappeared; this is not true of *R. jeffersonense* as the position of the dental sockets is influenced by the greater gibbosity of the dorsal umbonal region. Owing to the concavity of the margins of the valves near the postero-lateral commissures, these commissures stick out sharply and there are wide surfaces of contact between the valves.

The ventral muscle field is very vaguely limited anteriorly and antero-laterally; posteriorly and postero-laterally it is in relief. Nothing but longitudinal ribs and furrows could be distinguished in the suboval muscle field, the width of which may reach a quarter of the width of the shell, and the length $^4/_{10}$ of the length.

Brachial valve. The valve, tongue, and fold are high. The greatest thickness of the valve—and so of the shell—is generally located at the frontal margin. The fold starts at the beak or at a variable distance from it, depending on the species. The top of the fold is flat or slightly convex.

The short and slender septum supports a deep and wide septalium; the junction of the outer plates with the borders of the septalium is sometimes (Text–fig. 9B) marked by a ridge.

The hinge plate is divided. The outer plates are slender and inclined towards each other. The crura are short and slender cusp-crescent or triangular, generally incurved at their distal end; they become progressively more apart anteriorly.

The dental sockets are simple, shallow, and generally narrow.

Dorsal muscle scars have not been observed.

Comparisons. Differences from the genus *Leiorhynchus* Hall, 1860 have been given by Sartenaer (1961d, p. 6). When comparing *Megalopterorhynchus* with *Rugaltarostrum,* Sartenaer (1965c, p. 6) showed the difference between *Megalopterorhynchus* and large specimens of *Rugaltarostrum.*

Despite general external similarities, such as the transverse outline and the broad fold and sulcus, between *Rugaltarostrum* and *Calvinaria* Stainbrook, 1945, they can be differentiated without difficulty. In *Calvinaria* the umbonal regions are smooth, the sulcus and fold start at some distance from the beaks, the ventral valve is more inflated, the fold carries generally two strong and broad costae that commonly bifurcate in weaker costae and to which corresponds a broad costa in the sulcus, the median costae are more irregular. Internally *Calvinaria* differs in the strong ventral muscle field, the small crural trough, thickening of the shell not found in the largest specimens of *Rugaltarostrum jeffersonense,* residual umbonal cavities and, thus, by the absence of distinct dental lamellae; it should be noted that these two last characters are considered by McLaren (1962, pp. 23, 24) as due to secondary shell growth in large shells and are not included in the extended definition of the genus (for transverse serial sections in *Calvinaria ambigua* see Stainbrook, 1945, fig. 2 (15) p. 58; Sartenaer, 1955, pl. I, figs. 1–9; McLaren, 1962, fig. 8A, p. 37).

Analogies and differences between some representatives of the genera *Trifidorostellum* and *Rugaltarostrum* are discussed under the description of *R. jeffersonense.*

Camarotoechia Partridgiae Nalivkin, 1930 (*non* Whidborne, 1897) from the Famennian beds of the Tchil-mairam range of Eastern Ferghana, has external characters that make it highly probable that it belongs to the genus. Lack of information about the internal structures forbids a final conclusion. The species has been mentioned very often, following Nalivkin (1930), in the Famennian beds of the U.S.S.R., e.g., Nalivkin (1937a, p. 108) in the lower Famennian, Domratchev (1952, pp. 91, 94) in the lower Famennian (D$_3^3$mak.=Makarovo beds) and at the base of the upper Famennian (D$_3^3$ mour.=Murzakaevo beds), Novojilova (1955, pp. 71, 72, 78), Batanova (1963, p. 366) in the lower Famennian (*see* further discussion under *Rugaltarostrum madisonense*). Thus if this species should really belong to *Rugaltarostrum* its distribution would be increased.

Stratigraphic position and geographic distribution. The species referred to this genus extend in Canada and the U.S.A. from the lower part (highest horizons) of the lower Famennian to the middle part, and perhaps the upper part, of the upper Famennian. If the Russian form is proved to belong to the genus, it would be found in the U.S.S.R. in the lower Famennian and the lower part of the upper Famennian (but *see* comments on these subdivisions under the description of the genus *Trifidorostellum*).

Rugaltarostrum madisonense (Haynes)

Plate III, figures 1–13; Text-figures 4–6

[e.p.]	1907.	*Leiorhynchus* sp.—HOLZAPFEL *in* RAYMOND, p. 118;
	1916b.	*Leiorhynchus madisonense* sp. nov.—HAYNES, p. 39, pl. VII, figs. 11–13;
[e.p.]	1922.	*Leiorhynchus*—WHITTAKER, pp. 52 B, 53 B;
	1922.	*Leiorhynchus* sp.—HUME, p. 72 B, line 44 (*coet. excl.*);
	1943.	*Leiorhynchus madisonense* Haynes—BALDWIN, p. 146;
	1943.	*Pugnax*, sp.—BALDWIN, p. 152, pl. 1, figs. 18–20;
	1945.	*Leiorhynchus*—HUME and LINK, p. 38, line 49 (*coet. excl.*);
	1949.	*Leiorhynchus*—LAUDON *et al.*, p. 1519;
	1952a.	*Leiorhynchus madisonense* Haynes—CRICKMAY, p. 588;
[non]	1952.	*Nudirostra madisonense*? (Haynes)—HOLLAND, p. 1706;
	1954.	*Leiorhynchus*—HUME, p. 46, line 9 (*coet. excl.*);
	1955.	*Leiorhynchus madisonense* Haynes—ALEXANDER, p. 46;
	1956.	*Nudirostra madisonensis* (Haynes)—WARREN and STELCK, pl. XXV, figs. 8–10 (=figs. 11–13, pl. VII *in* HAYNES, 1916b);
[non]	1957.	*Leiorhynchus madisonense* Haynes—CLOUD *in* KLEPPER, WEEKS and RUPPEL, p. 15;
	1961d.	*Rugaltarostrum madisonense* (Haynes)—SARTENAER, p. 6, pl. I, figs. 5a-e, pl. II, fig. D.

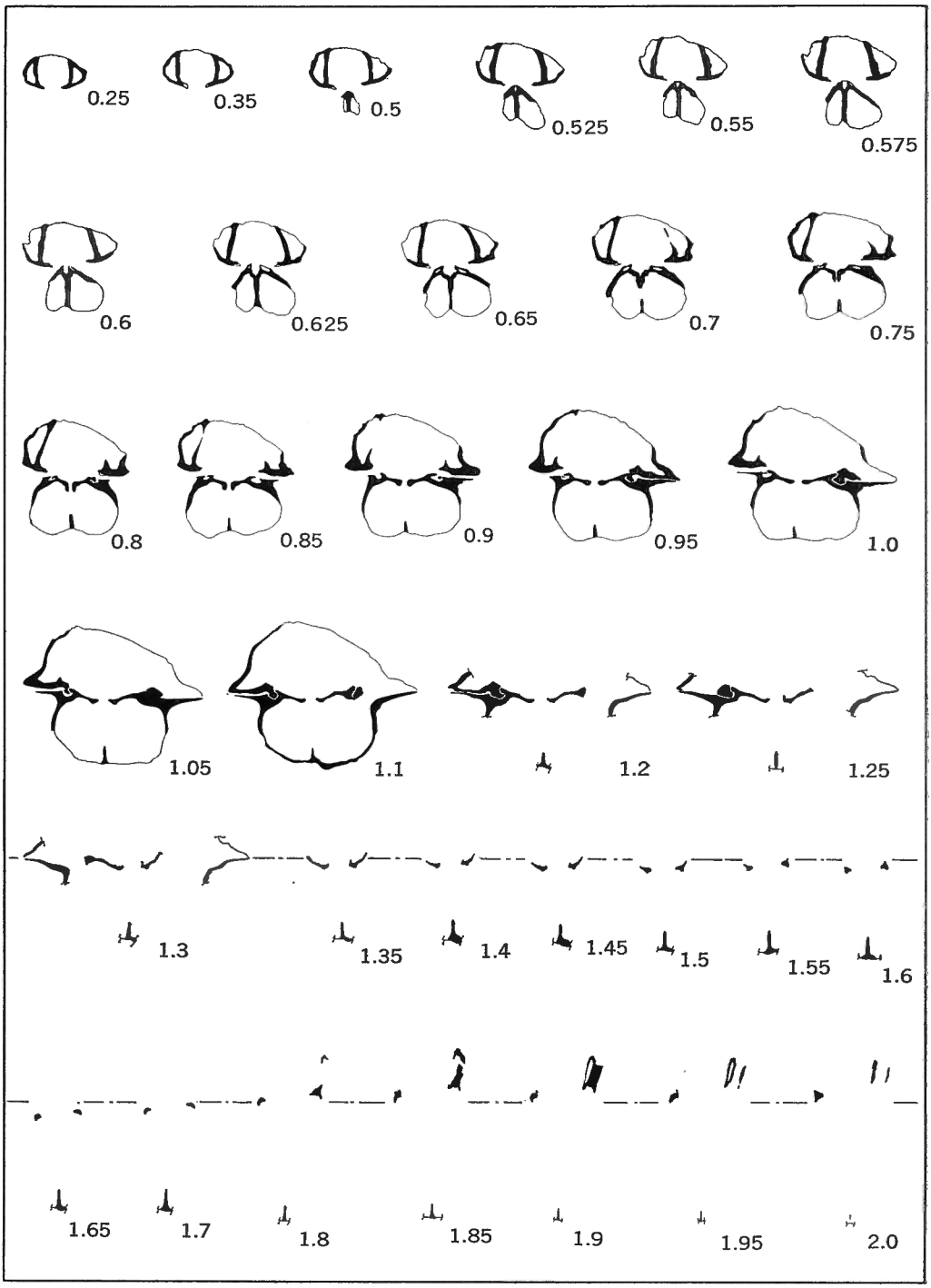
Types

Holotype (Pl. III, figs. 1a–e=pl. VII, figs. 11, 12 *in* Haynes, 1916b=pl. I, figs. 5a–e *in* Sartenaer, 1961d). CM No. 2701. Three Forks, Montana, U.S.A. "Green shale and associated limestone layers of member number 5," Three Forks Shale. Collector: P. E. Raymond. Haynes (1916b, p. 39) has written "The type is in the Carnegie Museum." Unfortunately there are two specimens (CM Nos. 2701, 2702) in the Carnegie Museum, each one in a box with no other indication on the label but "Type." These two specimens are figured (CM No. 2701=figs. 11, 12, pl. VII; CM No. 2702=fig. 13, pl. VII). As figure 13 refers to a "smooth-sided form," and as the "sides of the shell" are "usually marked by one or two faint, low, rounded plications," it may be assumed that the other specimen, CM No. 2701, is the holotype.

Paratype (Pl. III, figs. 2a–d). CM No. 2702 (=pl. VII, fig. 13 *in* Haynes, 1916b). Same locality, formation, and collector.

Hypotype A (Pl. III, fig. 5). PRI No. 6043 (=pl. I, figs. 18–20 *in* Baldwin, 1943, as *Pugnax*, sp). One mile east of Freighter Spring near Dickey, Idaho, U.S.A. (Borah Peak Quad.). "Upper 115 feet of the measured section," Three Forks Formation. Collector: E. W. Baldwin, 1941.

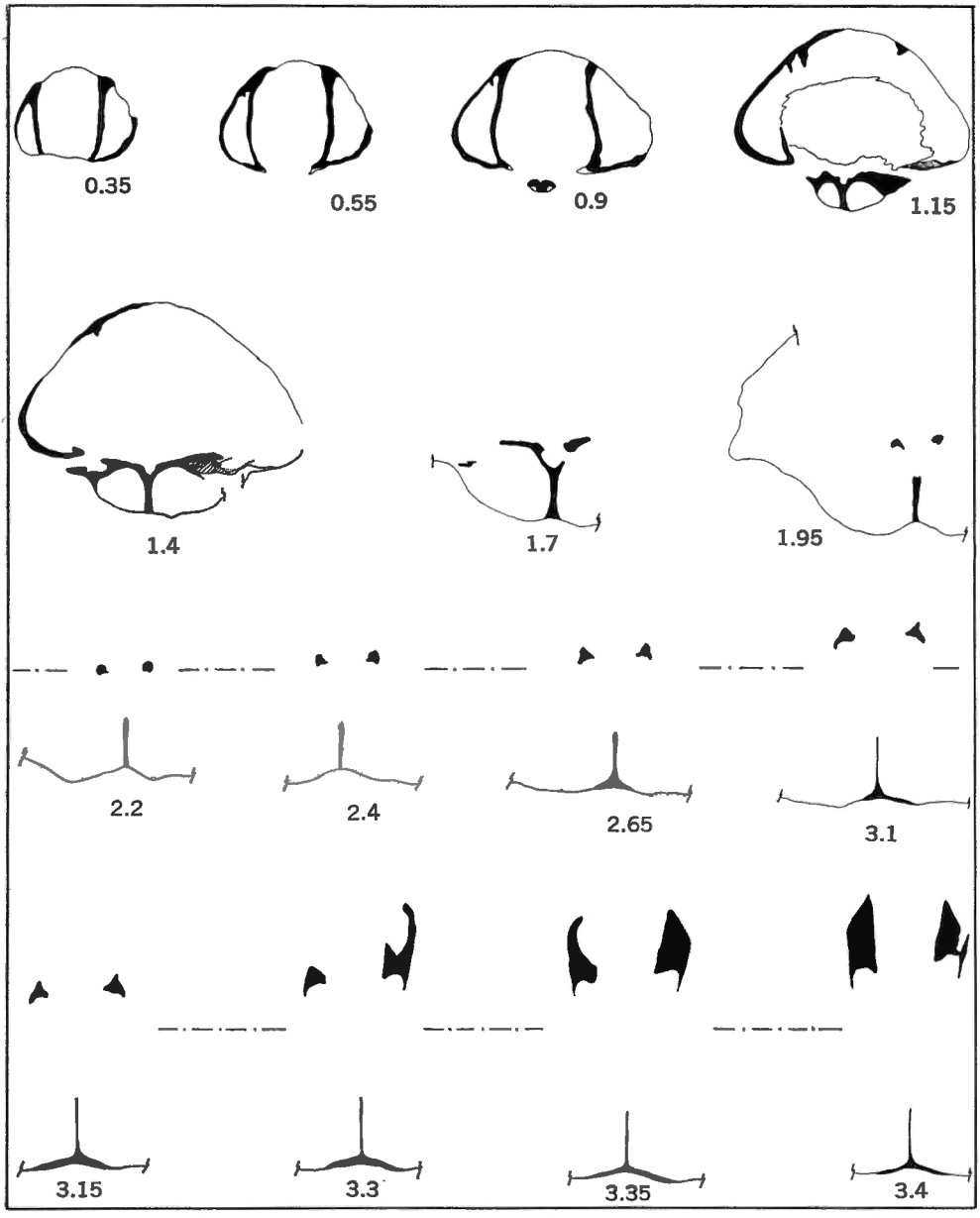
Hypotypes B, GSC No. 15666 (Pl. III, figs. 6a–d); C, GSC No. 15667 (Pl. III, figs. 7a, b); D, GSC No. 15668 (Pl. III, figs. 8a–e); E, GSC No. 15669 (Pl. III, figs. 4a, b); F, GSC No. 15670 (Pl. III, figs. 9a, b); G, GSC No. 15671; H, GSC No. 15672 (Pl. III, figs. 10a, b); I, GSC No. 15673 (Pl. III, figs. 11a, b); J, GSC No. 15674 (Pl. III, figs. 12a–c); K, GSC No. 15675 (Pl. III, figs. 13a, b). GSC loc. 7163. Collector: G. S. Hume, 1921.



TEXT-FIGURE 4. *Rugaltarostrum madisonense* (Haynes)

Camera lucida drawings of serial transverse sections (x6); distances are in mm forward from the crest of the umbo.

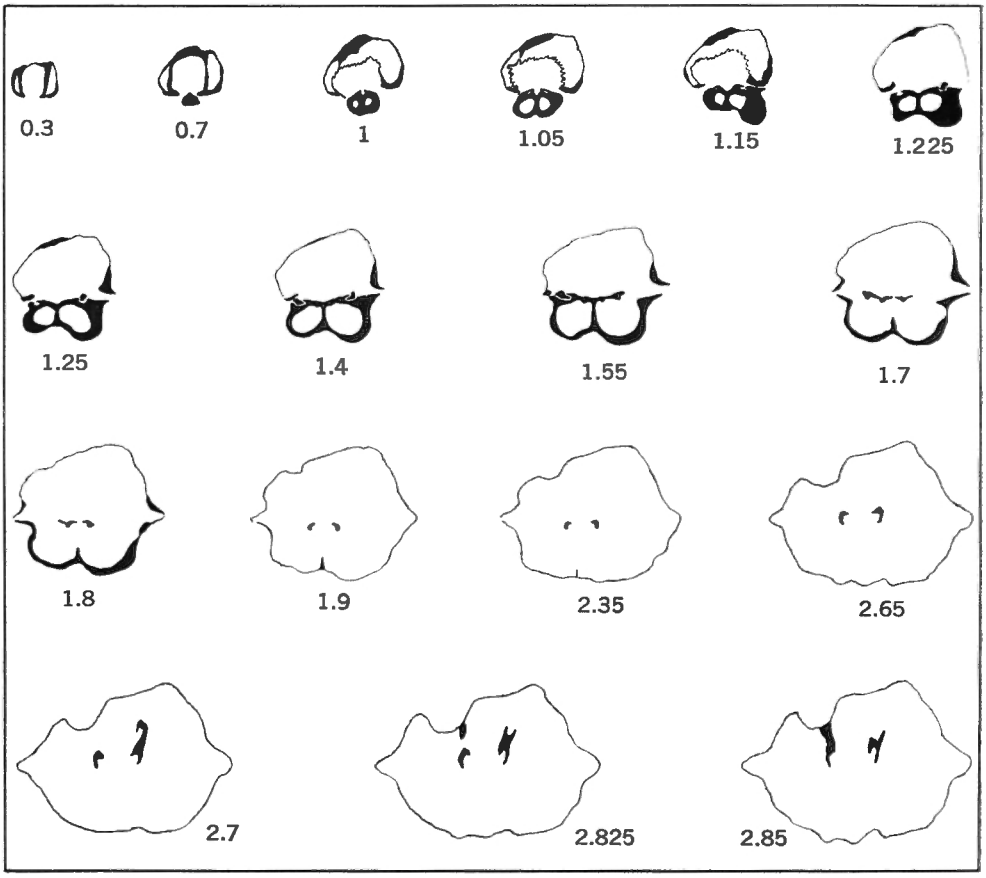
Hypotype M, GSC No. 15677 (l:12.8 mm; w:15.9 mm; t:8.2 mm).



TEXT-FIGURE 5. *Rugaltarostrum madisonense* (Haynes)

Camera lucida drawings of serial transverse sections (x9); distances are in mm forward from the crest of the umbo.

Hypotype N, USNM No. 155001a (l:14.0 mm; w:(16.1) mm; t:9.0 mm).



TEXT-FIGURE 6. *Rugaltarostrum madisonense* (Haynes)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype O, USNM No. 155001b (l:10.3 mm; w:(14.7) mm; t:10.0 mm).

Hypotype L. GSC No. 15676 (Pl. III, figs. 3a–d). GSC loc. 7172. Same collector.

Hypotype M. GSC No. 15677 (Text-fig. 4=pl. II, fig. D *in* Sartenaer, 1961d). Same locality, formation, and collector.

Hypotype N. USNM No. 155001a (Text-fig. 5). East half, Sec. 36, T2N, R1W, 9 miles west of Three Forks, Montana, U.S.A. Three Forks Formation. Collector: G. B. Maxey, 1941.

Hypotype O. USNM No. 155001b (Text-fig. 6). Same locality and formation as for hypotype A. Collectors: W. Sadlick and P. Sartenaer, 1960.

Material

Montana. Holotype; paratype; three specimens identified as *Leiorhynchus madisonense* by Dr. W. P. Haynes in the collections of the Museum of Comparative Zoölogy, Harvard College, Cambridge, U.S.A.

Idaho. One specimen figured and identified by Baldwin (1943) as a *Pugnax* sp.; three specimens received from Dr. E. M. Baldwin; 120 specimens collected by Dr. W. Sadlick and the writer in 1960.

Canadian Rocky Mountains. GSC localities (12): 40736 (11), 40743 (1).

Northwest Territories. GSC localities (214): 6959 (8), 7161C (1), 7163 (60), 7164 (1), 7172 (132), 7174 (2), 7175 (5), 30546 (1), 30727 (1), 32889 (1), 33318 (1), 38711(1).

Most of the material is in good state of preservation.

Description

The species is small and transverse. The contour, in dorsal view, is subelliptic to suboval. The commissure is very sharp and deeply crenulated by the costae.

Pedicle valve. The umbonal region is moderately inflated. The slope of the flanks decreases posteriorly and laterally towards the commissure and the curvature often becomes reversed giving a distinctive convexo-concave aspect in transverse sections.

The sulcus begins at a distance varying between 10 and 13 per cent (usually between 20 and 35) of the length of the shell or between 12 and 35 per cent (usually between 15 and 30) of the unrolled length of the pedicle valve forward of the beak. The sulcus widens rapidly and reaches at the front between 54 and 75 per cent of the width of the shell. The sulcus is deep—two to seven times the height of the costae—and bordered by wide, rounded and well marked ridges. The bottom of the sulcus is flat or slightly convex.

The sulcus passes progressively into the tongue. The tongue is one of the characteristic features by reason of its proportionally great height, sharp borders, and variable shape. The tongue is generally trapezoidal but very often, as for example hypotypes D (Pl. III, fig. 8c) and L (Pl. III, fig. 3c), the borders tend to be parallel. The upper part of the tongue is rarely tangential to a vertical plane and even more rarely recurved posteriorly. Sometimes the summit of the ventral median costae protrudes beyond the borders of the tongue as seen in lateral view.

The beak is suberect to erect, small, acute and well defined; it rarely overhangs the hinge line. The interarea is short, 25 to 35 per cent of the width of the shell, and ill-defined ventro-laterally. The base of the delthyrium occupies more than half the length of the interarea. The delthyrium is partly closed by deltidial plates that leave an oval opening in the middle. This opening encroaches sometimes on the beak where a minute opening can then be seen.

Brachial valve. The flanks slope gently in all directions and become sometimes concave near the postero-lateral margins.

The fold is high and greatest thickness is at the front. Like the sulcus, the fold starts at some distance from the beak. On each side of the fold there is a depression corresponding to the ridges limiting the sulcus. The top of the fold is flat or slightly convex.

Ornament. The general costal formula is 2/1 to 4/3; 0; 0.

The ratios of median costae are distributed as follows in 214 specimens: 0: 2 sp. (1.–%); 2/1: 49 sp. (23.–%); 3/2: 109 sp. (51.–%); 4/3: 43 sp. (20.–%); 5/4: 9 sp. (4.–%); 6/5: 2 sp. (1.–%).

Median costae are rounded to obtuse with rounded top anteriorly. Especially dorsally, they are high in the anterior part of the shell and tend to become obsolescent towards the beaks. Their average width at the front is 2 to 2½ mm with a maximum of 3½ mm. The one or two dorsal costae on the median line start forward of the beak (Pl. III, figs. 1a, 3a, 4a, 6a, 7a, 8a, 9a, 11a, 13a) and may pass posteriorly into a shallow groove (Pl. III, figs. 7a, 9a, 13a). Some costae are irregular (45%), some divided and intercalated (10%).

In eighteen specimens one parietal costa has been observed (1/1–9/0 or 9/0–1/1) (Pl. III, figs. 2a,b, 9a,b), and in five specimens two (1/1–1/1) (Pl. III, figs. 4a,b).

The ratios of lateral costae are distributed as follows in 211 specimens: 0/1: 172 sp. (81.5%); 1/2: 21 sp. (10.–%); 2/3: 11 sp. (5.–%); 3/4: 6 sp. (3.–%); 4/5: 1 sp. (0.5%).

Lateral costae are simple and rounded or obtuse. The sulcus and fold are bordered by a strong costal ridge and groove respectively extending from near the beak and which may be the only lateral ornament (0/1). Other costae may develop laterally from about mid-shell length (Pl. III, fig. 8a), the outermost being merely an indentation of the commissure. The number of costae may be unequal on either side. There is no relation between number of costae and size of specimen, or between number of median and parietal costae.

Costellae (three to five per mm near the commissure) are often visible (Pl. III, figs. 3d, 5, 6a, 8a).

Dimensions.

in mm	Holotype	Paratype	Hypotype L	Hypotype C	Hypotype D	Hypotype B	Hypotype A	Hypotype E	Hypotype G	Hypotype H	Hypotype F
l	(14.4)	(12.7)	12.0	11.9	11.6	11.2	11.1	10.5	9.3	8.8	8.5
w	20.4	17.7	16.4	14.8	13.7	13.8	16.6	14.2	10.3	10.5	11.7
lpv unrolled	(21.0)	(16.0)	17.0	17.0	16.0	17.0	20.0	15.0	11.5	13.0	14.0
t	13.0	7.9	10.8	8.7	7.8	8.0	11.9	8.0	3.9	5.2	8.3
tpv	3.0	2.2	1.6	2.5	2.1	3.0	2.2	2.6	1.4	2.0	2.0
tbv	10.0	5.7	9.2	6.2	5.7	5.0	9.7	5.4	2.5	3.2	6.3
l/w	(0.71)	(0.72)	0.73	0.80	0.85	0.81	0.67	0.74	0.90	0.84	0.73
t/w	0.64	0.45	0.66	0.59	0.57	0.58	0.72	0.56	0.38	0.50	0.71
t/l	(0.90)	(0.62)	0.90	0.73	0.67	0.71	1.07	0.76	0.42	0.59	0.98
shoulder angle	?	?	105°	105°	100°	105°	?	105°	105°	105°	105°
angle of the cardinal commissure	(130°)	(135°)	135°	130°	125°	135°	(140°)	130°	?	130°	130°

The width is the greatest dimension. The holotype is one of the largest specimens.

The shoulder angle varies between 100 and 110 degrees, but, as it sometimes cannot be measured, the angle of the cardinal commissure is given.

The greatest width of the shell is at about 9/10 of the length. The greatest length of the shell is usually at the top of the tongue, but it is located somewhat lower when the ventral median costae protrude beyond the borders of the tongue.

Internal characters. The species being the type species of the genus, internal characters are given under the description of the genus.

Growth. Measurements of three young specimens:

in mm	Hypotype I	Hypotype K	Hypotype J
l	7.7	7.5	7.0
w	8.5	7.3	6.7
lpv unrolled	9.0	8.7	8.0
t	4.5	3.3	3.0
tpv	1.3	1.8	1.4
tbv	3.2	1.5	1.6
l/w	0.91	1.03	1.04
t/w	0.53	0.45	0.45
t/l	0.58	0.44	0.43
shoulder angle	100°	96°	100°

The species has a monocyclic and non-constant curvature growth; thus, thickness is relatively small in the juvenile stages. On even the smallest specimens examined, sulcus and fold are already marked.

Discussion

Specimens of the size of the holotype are not found in Canada, but may occur in Idaho. This character is the only observed difference between specimens from Montana, Idaho, and Canada; it is not considered sufficient for separating the Canadian specimens from the species. Moreover, many specimens of the size of the Canadian ones are found in Montana and Idaho.

Synonymy. Raymond's (1907) *Leiorhynchus* sp. was collected from the same beds as Haynes' material; the holotype and paratype of *L. madisonense* were selected by Haynes from Raymond's collections; this indication has been found on the label with the holotype. As three specimens of *L. dunbarense* (including the holotype) and some specimens of *L. madisonense* var. *gibbosum* were also selected by Haynes from Raymond's collections, [e.p.] must be written.

Whittaker's (1922) and Hume's (1922) original material has been studied. As Whittaker's (1922) collection (GSC loc. 6959) contains also *Basilicorhynchus basilicus basilicus,* and perhaps *Eoparaphorhynchus maclareni,* [e.p.] has been indicated.

The specimen of *Pugnax* sp. figured by Baldwin (1943) is an exceptional specimen with very deep sulcus and very high fold.

Laudon, *et al.* (1949) have mentioned one specimen of *Leiorhynchus* in the upper beds of the Palliser Formation. Dr. L. R. Laudon kindly put this specimen at the writer's disposal.

Holland's (1952) identification is discussed under *Rugaltarostrum gibbosum.*

The three specimens identified by Cloud *in* Klepper, Weeks, and Ruppel (1957) have been put into synonymy with *Gastrodetoechia utahensis utahensis.*

Comparisons. The species is distinguished by small size, sulcus and fold starting at some distance from the beaks, number and distribution of costae, rare division of median costae, and middle median costa(e) not starting at the beak on the fold.

Four specimens from Nevada, identified as *Rhynchonella (Leiorhynchus) sinuatus* Hall by Walcott (1884, pp. 158-9), have been examined at the United States National Museum. They include the figured specimen, which is unusual by its well marked lateral costae. These specimens bear some resemblance to *Rugaltarostrum madisonense,* but differ by the absence of costellae, the systematically divided median costae, the number and nature of lateral costae, the smaller height of the pedicle valve at the front, and internal structures. The Nevada specimens are different from the New York species, the validity of which has been discussed by Hall (1867, p. 362) who states that it is "probably a small variety" of *Leiorhynchus mesacostale,* and by Kindle (1896, p. 37) who considers that "it may be found that this form is only a variety of *L. limitaris.*"

Rhynchonella (Leiorhynchus) sinuatus is very close, externally and internally, to the *Calvinaria variabilis* (Whiteaves) group recently described by McLaren (1962), which differs from *R. madisonense* by the same characters as the Nevada form. Generic differences have been discussed under the description of the genus *Rugaltarostrum.*

R. madisonense is easily distinguished by its shape, contour, depth of sulcus, height of fold, size and number of median costae from *Leiorhynchus mesacostale,* as already pointed by Haynes (1916b).

Some similarities may be found between *R. madisonense* and small specimens of *Eoparaphorhynchus lentiformis,* but the proportionally greater width, the wider angle of the cardinal commissure, the shape and elevation of the tongue, as well as the aspect of the median costae, separate *R. madisonense.*

Nalivkin's (1930) figures (pl. V, figs. 14a,b,c,d) of *Camarotoechia Partridgiae* Nalivkin, 1930 (*non* Whidborne, 1897) resemble *Rugaltarostrum madisonense* by most of the given characters, but Nalivkin mentions that dichotomised costae are the rule (although figures do not show any) and that the sulcus and fold reach the beak (in fact they start very close to the beaks); by these features as well as by the number of lateral costae, the species is nearer to *R. gibbosum,* but has not the gibbosity of that species. As only ten specimens

have been available to Nalivkin for study, it is difficult to grasp the variability of the Russian form, to establish if it is a separate species, and to compare it with the American species. Nalivkin's material (pl. V, figs. 20a,b,c,d) is considered here with reservation, although it may be a juvenile form of the species with exceptionally wide sulcus.

Stratigraphic position. In Montana, according to Haynes (1916b), the species is abundant in the green shale and associated limestone layers of member 5 (the middle and upper part of that member) and it is mentioned in his faunal list (p. 25) in member 4. Member 5 lies immediately below member 4. Thus, the species derives from a thickness of 40 feet.

Whittaker's (1922) collection (GSC loc. 6959) derives from the upper 25 feet (zones q to t) of the exposed Trout River section.

Baldwin's (1943) *Pugnax* sp., as well as the writer's specimens, were collected in the upper 115 feet of the Three Forks Formation in Idaho.

Laudon, *et al.* (1949) collected their specimen in the highest beds of the Palliser Formation on Rigby Peak (Wapiti Lake area), B.C. The specimens identified by Cloud (1957) derive from the highest beds of the Devonian in the southern Elkhorn Mountains, Montana. In the District of Mackenzie the species has been found chiefly at two different stratigraphic levels: Hume's *Athyris angelica* Zone=D 6 (GSC locs. 7163, 7174, 7175, 38711); *Basilicorhynchus basilicus* Zone and upper part of the *Eoparaphorhynchus maclareni* Zone (GSC locs. 6959, 7161C, 7164, 7172, 30546, 30727, 33318); on Redstone River (GSC loc. 32889) it occurs with *Basilicorhynchus basilicus interpositus*.

The information for the specimens collected in the Fernie map-area (west half) (GSC locs. 40736, 40743) is "high in the Palliser Formation."

Geographic distribution. The species is known from Montana and Idaho in the U.S.A.; in the Canadian Rocky Mountains it has been found at two localities in B.C.: Fernie map-area (west half) and Wapiti Lake area; in the Northwest Territories, it has been collected in the valleys of Redstone, Root, North Nahanni, Trout, and Kakisa Rivers.

Rugaltarostrum gibbosum (Haynes)

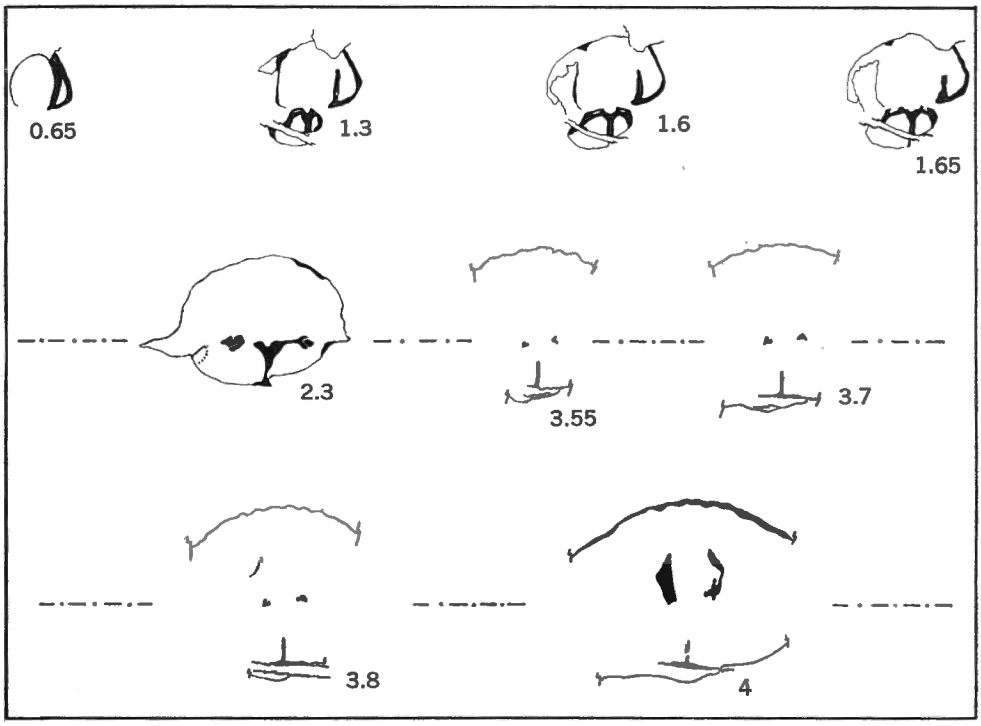
Plate III, figure 14; Text-figure 7

[e.p.]	1907.	*Leiorhynchus* sp.—HOLZAPFEL *in* RAYMOND, p. 118;
[e.p.]	1907.	*Leiorhynchus* sp.—RAYMOND, p. 121;
	1916b.	*Leiorhynchus madisonense* var. *gibbosum* var. nov.—HAYNES, pp. 39–40, pl. VII, figs. 14–16;
[non]	1943.	*Leiorhynchus madisonense* var. *gibbosum* Haynes—BALDWIN, pp. 146, 151, pl. 1, fig. 13;
	1952a.	*Leiorhynchus gibbosum* Haynes—CRICKMAY, p. 588;
[?]	1952.	*Nudirostra madisonense*? (Haynes)—HOLLAND, p. 1706;
[non]	1954.	*Nudirostra gibbosa* (Haynes) species group—McLAREN, pp. 179–180;
	1955.	*Leiorhynchus madisonense* var. *gibbosum* Haynes—ALEXANDER, p. 46, fig. 64, pl. XXIV;
	1956.	*Nudirostra madisonensis* var. *gibbosa* (Haynes)—WARREN and STELCK, pl. XXV, figs. 11, 12 (=figs. 14–16, pl. VII *in* HAYNES, 1916b);
[e.p.]	1957.	*Leiorhynchus* n. sp. 1—CLOUD *in* KLEPPER, WEEKS, and RUPPEL, p. 15;
	1963.	*Nudirostra gibbosa* (Haynes)—DUTRO *in* ROBINSON, table 2;
	1963.	*Nudirostra* cf. *dunbarense* (Haynes)—DUTRO *in* ROBINSON, table 2 (288, 435T6) (*coet. excl.*);
	1963.	*Nudirostra* cf. *jeffersonense* (Haynes)—DUTRO *in* ROBINSON, table 2.

Types

Holotype (Pl. III, figs. 14a–e=pl. VII, figs. 14–16 *in* Haynes, 1916b). CM No. 2703. Three Forks, Montana, U.S.A. "Gray limestone, number 4" or "green shales, number 5," Three Forks Shale. Collector: P. E. Raymond. This indication has been found on the label with the holotype.

Hypotype. USNM No. 155002 (Text-fig. 7). East half, Sec. 36, T2N, R1W, nine miles west of Three Forks, Montana, U.S.A. Three Forks Formation. Collector: G. B. Maxey, 1941.



TEXT-FIGURE 7. *Rugaltarostrum gibbosum* (Haynes)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype, USNM No. 155002 (l:17.4 mm; w:(23.0) mm; t:(14.2) mm).

Material

Holotype; seven specimens identified as *Leiorhynchus madisonense* var. *gibbosum* by Dr. W. P. Haynes in the collections of the Museum of Comparative Zoölogy, Harvard College, Cambridge; two specimens received from Dr. O. D. Blake assigned to this species by the writer; one specimen identified as *Leiorhynchus* n. sp. 1 by Cloud *in* Klepper, Weeks, and Ruppel (1957); seventeen specimens identified as *Nudirostra* cf. *dunbarense, N. gibbosa, N.* cf. *jeffersonense* by Dutro *in* Robinson (1963).

Eighteen specimens are in satisfactory state of preservation.

Discussion

Although the species has not been found in Canada, it is examined here in order to stress the differences from *R. madisonense* and to illustrate the genus by another species.

Haynes' description may be accepted with the following comments: four to five simple lateral costae on some specimens (five on holotype); divided costae are common on the fold (Pl. III, fig. 14e); intercalated and parietal costae are common in the sulcus (Pl. III, fig. 14c); costae are regular, and median costae tend often to become obsolescent towards the beaks; the l/w ratios of *R. madisonense* and *R. gibbosum* are similar; generally fold and sulcus start closer to the beaks than in *R. madisonense*.

The larger size, the gibbous appearance, the usually higher number and extension of the lateral costae, and the number of median costae are considered as characteristic, and Haynes' variety is elevated to specific rank, as has been done already by Crickmay (1952a) and McLaren (1954).

Measurements of the holotype (in mm):

l : 17.1	w : 22.9	lpv unrolled : 31.0	t : 15.8	tpv : 5.8	tbv : 10.0
l/w : 0.75	t/w : 0.69	t/l : 0.92	shoulder angle : 115°		
angle of the cardinal commissure : 140°					

Synonymy. [e.p.] is written before Raymond's (1907) *Leiorhynchus* sp. (p. 118) for the reason given under the discussion of *Rugaltarostrum madisonense.*

[e.p.] is written before Raymond's (1907) *Leiorhynchus* sp. (p. 121) because this author may have included under this identification more than the twenty-four specimens (including the holotype) identified by Haynes (1916b) as *L. madisonense* var. *gibbosum.*

The specimen of *L. madisonense* var. *gibbosum* figured by Baldwin (1943) has been chosen as the holotype of *Trifidorostellum uralicum fontis.*

The specimen which Holland (1952) assigned with doubt to *Nudirostra madisonense* is a partly preserved brachial valve showing as many as seven lateral costae but cannot be definitely identified.

McLaren's (1954) "*Nudirostra gibbosa* species group" is discussed under the description of *Eoparaphorhynchus walcotti* and *Evanescirostrum seversoni.*

Four of the five specimens identified as *Leiorhynchus* n.sp. 1 by Cloud *in* Klepper, Weeks and Ruppel (1957) are put into synonymy with *Gastrodetoechia utahensis utahensis.*

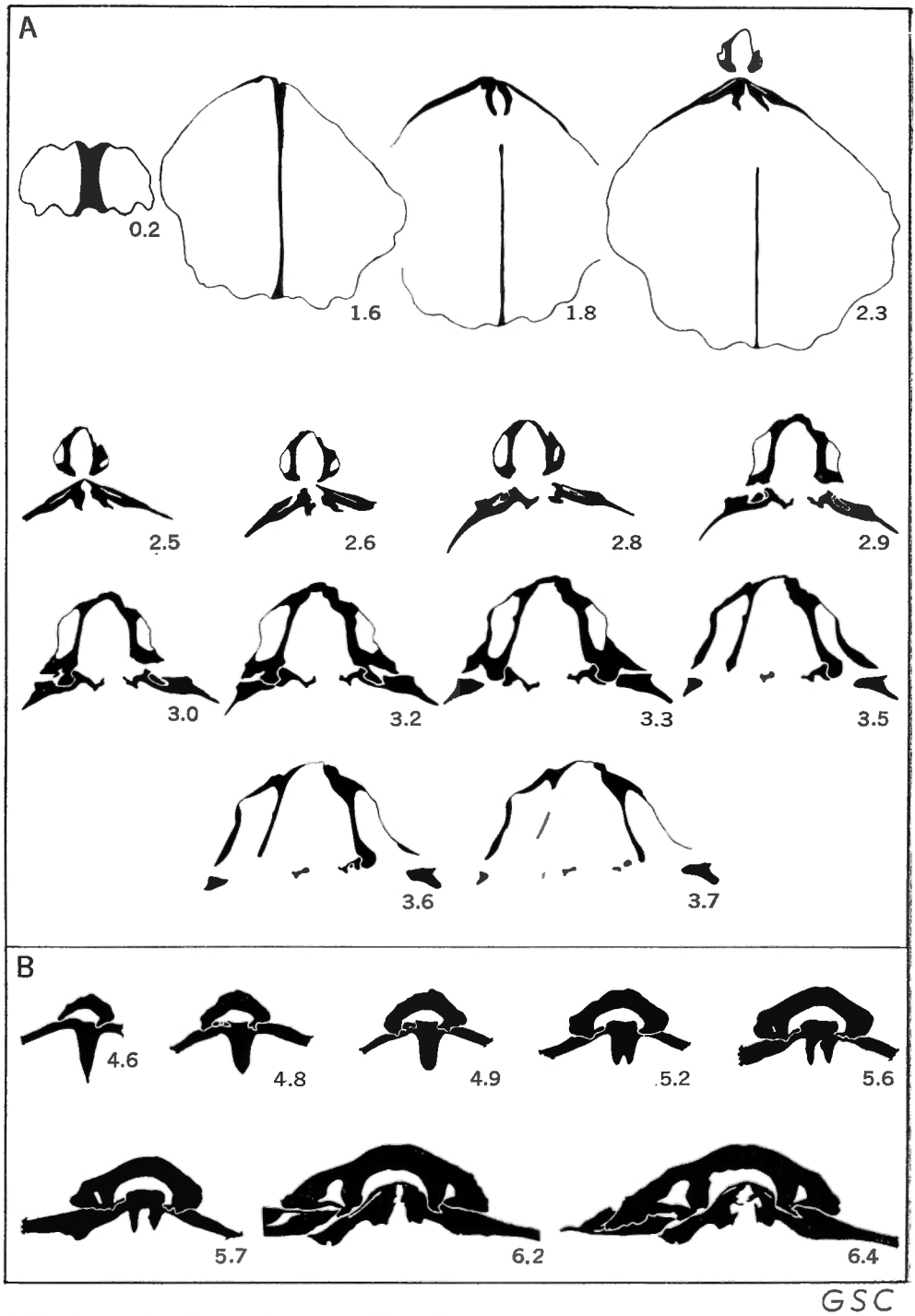
Comparisons. The species is distinguished by medium size, sulcus and fold starting close to the beaks, number and distribution of costae, common division of median costae, and lateral costae starting at the umbones. The species closely resembles *Rugaltarostrum madisonense,* but differs by the characters mentioned above. Some remarks on *Camarotoechia Partridgiae* Nalivkin, 1930 (*non* Whidborne, 1897) are made under the description of *Rugaltarostum madisonense.*

Stratigraphic position and geographic distribution. Specimens have been found only in Montana. According to Haynes (1916b) they "are numerous in the gray limestone, number 4, and also in the green shales (in the middle and upper part as indicated in the faunal list (p. 25)), number 5" of the Three Forks Formation, this means in a thickness of 40 feet. Holland's (1952) specimen was collected in green shales of the same age at the Sappington Sandstone type locality. The specimen collected by Klepper, Weeks, and Ruppel (1957) is from the "medial limestone" of the Three Forks Formation. Robinson's (1963) three collections were from the Willow Creek sector: 287, between 30 and 35 (?) feet above the base of the upper siltstone unit of the Three Forks Formation, 288 and 435 T6 between 95 and 105 feet below the base of the Lodgepole Limestone.

Rugaltarostrum jeffersonense (Haynes)

Plate II, figure 8; Plate IV, figure 3; Text-figures 8A, B, 9A, B

1907. *Leiorhynchus*, large form—RAYMOND, p. 121;
1916b. *Leiorhynchus jeffersonense* sp. nov.—HAYNES, pp. 41–42, pl. VIII, fig. 9;
[non] 1943. *Leiorhynchus* cf. *L. jeffersonense* Haynes—BALDWIN, p. 146;
1952a. *Leiorhynchus jeffersonense* Haynes—CRICKMAY, p. 588;
1952. *Nudirostra dunbarense* (Haynes)—HOLLAND, p. 1705;
1955. *Leiorhynchus jeffersonense* Haynes—ALEXANDER, p. 46;
[non] 1956. *Nudirostra* cf. *N. jeffersonensis* (Haynes)—BELYEA and McLAREN, p. 89;
1963. *Nudirostra jeffersonense* (Haynes)—DUTRO *in* ROBINSON, fig. 3, p. 36, table 2;
[non] 1963. *Nudirostra* cf. *jeffersonense* (Haynes)—DUTRO *in* ROBINSON, table 2;
1963. *Nudirostra* aff. *ventricosa* (Haynes)—DUTRO *in* ROBINSON, fig. 3, p. 36, table 2.

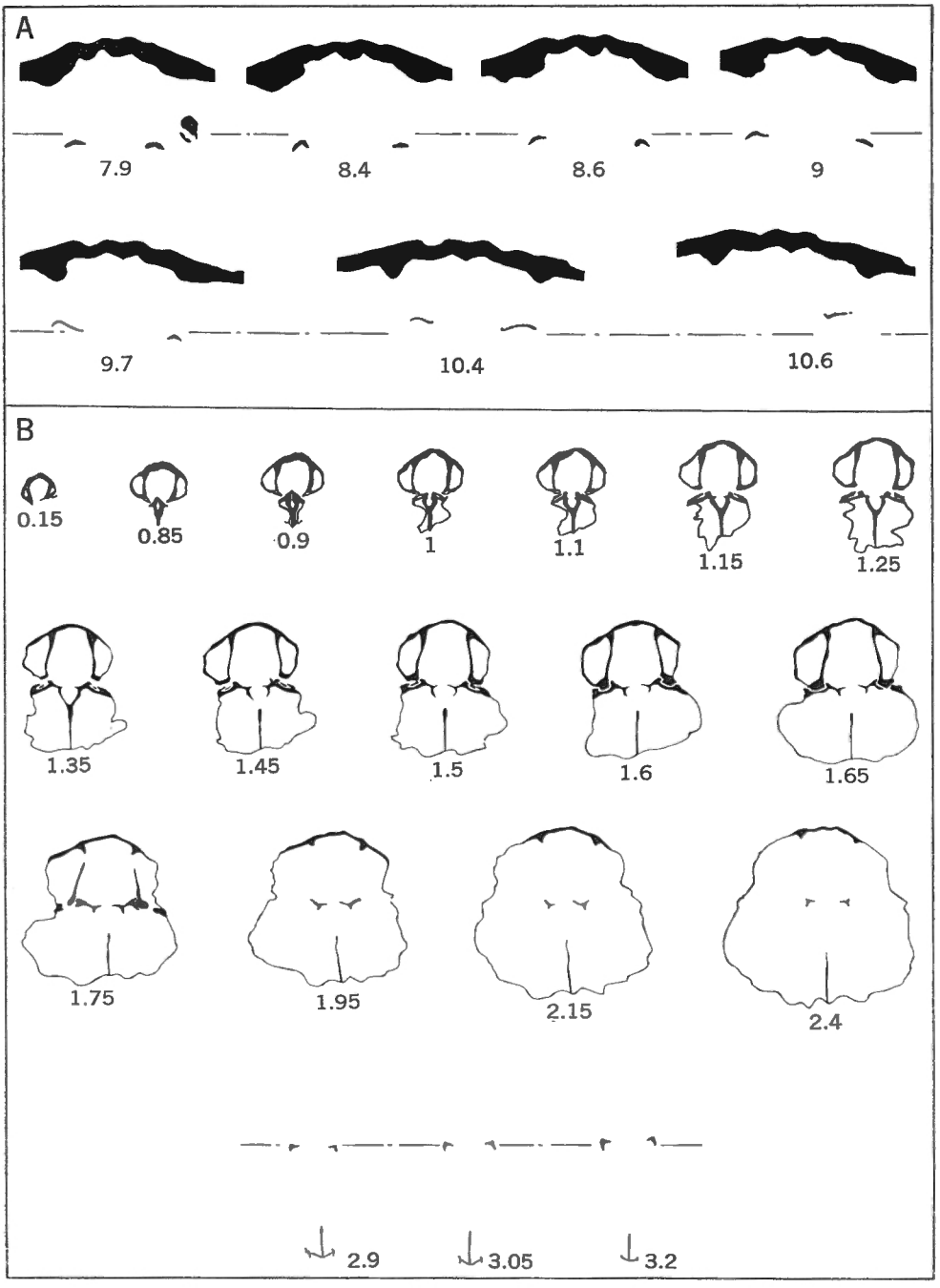


TEXT-FIGURE 8. *Rugaltarostrum jeffersonense* (Haynes)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

A = Hypotype B, USNM No. 154987 (l:24.0 mm; w:29.7 mm; t:22.5 mm). Deformed specimen;

B = Hypotype C, USNM No. 154988 (l:32.1 mm; w:41.1; t:? mm). Deformed specimen (continued on Text-fig. 9A).



TEXT-FIGURE 9. *Rugaltarostrum jeffersonense* (Haynes)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

A=Hypotype C, USNM No. 154988 (l:32.1 mm; w:41.1 mm; t:? mm). Deformed specimen (continued from Text-fig. 8B);

B=Hypotype D, USNM No. 154989 (l:16.2 mm; w:23.7 mm; t:12.4 mm).

Types

Holotype (Pl. IV, figs. 3a–e=pl. VIII, fig. 9 *in* Haynes, 1916b). MCZ No. 8762. South of Sappington, Montana, U.S.A. "Upper limestone in green shale number 5," Three Forks Formation. Collector: W. P. Haynes. Indications found on the label with the holotype.

Hypotype A. USNM No. 154986 (Pl. II, figs. 8a–c). T2N, R2W, Sec. 22 (Jefferson Island 15′ Quad.), nose of anticline NE of Doherty Mountain, Montana, U.S.A. Three Forks Formation. Collector: O. D. Blake.

Hypotype B. USNM No. 154987 (Text-fig. 8A). Milligan Canyon (=type locality of the Sappington Sandstone) (Three Forks 15′ Quad.), Montana, U.S.A. Three Forks Formation. Collector: O. D. Blake.

Hypotype C. USNM No. 154988 (Text-figs. 8B, 9A). Same locality, formation, and collector.

Hypotype D. USNM No. 154989 (Text-fig. 9B). Milligan Canyon (=type locality of the Sappington Sandstone) (Three Forks 15′ Quad.), Montana, U.S.A. Three Forks Formation, between 100 and 110 feet below the base of the Sappington Sandstone. GSC loc. 38841. Collectors: C. A. Sandberg and P. Sartenaer, 1959.

Material

Holotype; two specimens identified as *Leiorhynchus jeffersonense* by Dr. W. P. Haynes in the collections of the Museum of Comparative Zoölogy; six specimens received from Dr. O. D. Blake, assigned to this species by the writer; two specimens identified as *Nudirostra dunbarense* by Holland (1952); thirteen specimens collected by Dr. C. A. Sandberg and the writer in 1959; two specimens identified as *N. jeffersonense* and *N.* aff. *ventricosa* by Dutro *in* Robinson (1963).

Thus twenty-six specimens from Montana are available for study; none of them is well preserved.

Discussion

This species is not known from Canada. It is briefly examined here as another representative of the genus and to draw attention to differences from other forms (*see* Comparisons). Haynes' description may be referred to, but with the following modifications.

A few specimens of small size are valuable for the study of the growth; the dimensions of two such specimens are given below. As in *Rugaltarostrum gibbosum*, the sulcus and fold start closer to the beak than in *R. madisonense* and may even reach it (Pl. IV, fig. 3c). The sulcus is deep. Costae on the fold are divided (Pl. IV, fig. 3c), and in the sulcus intercalated (Pl. IV, fig. 3e). Median costae start at the beaks and do not tend to become obsolescent; parietal costae are common in the sulcus; lateral costae are simple and do not reach the umbones.

Dimensions of the holotype and two smaller specimens:

in mm	Holotype	Hypotype A	Hypotype D
l	31.7	22.3	16.2
w	41.1	(28.5)	23.7
lpv unrolled	(41.0)	25.0	24.0
t	22.5	11.0	12.4
tpv	8.0	3.8	5.2
tbv	(14.5)	7.2	7.2
l/w	0.77	(0.78)	0.68
t/w	0.55	(0.39)	0.52
t/l	(0.71)	0.49	0.77
shoulder angle	?	116°	115°
angle of the cardinal commissure	162°	140°	?

Synonymy. The specimen described by Raymond (1907) under the name: *Leiorhynchus,* large form, was included by Haynes (1916b) in the description of his new species.

The two large specimens identified as *Nudirostra dunbarense* by Holland (1952) belong to this species.

The specimens identified by McLaren *in* Belyea and McLaren (1956) as *Nudirostra* cf. *N. jeffersonensis* do not belong to the species, but are not identified; those identified by Baldwin (1943) as *Leiorhynchus* cf. *L. jeffersonense* are here considered as *Trifidorostellum uralicum fontis.*

The two specimens identified as *Nudirostra* cf. *jeffersonense* by Dutro *in* Robinson (1963) are put into synonymy with *Rugaltarostrum gibbosum.*

Comparisons. The species is distinguished by large size, number and distribution of costae, and median costae not becoming obsolescent towards the beaks. Sulcus and fold may start at or near the beaks.

Trifidorostellum uralicum fontis bears close external resemblance to *Rugaltarostrum jeffersonense:* proportional great width; same size; similar number of median costae; divided and intercalated median costae; wide costae; postero-lateral margins concave near the commissure; deep and wide sulcus; the top of the tongue recurved posteriorly; ventral beak almost in contact with the brachial valve; similar angles of the cardinal commissure. But *Trifidorostellum uralicum fontis* has more lateral costae, smoother costae bordering the sulcus, and the top of the fold and tongue is always rounded.

T. cascadense cascadense is also very similar in most of the characters mentioned for *Trifidorostellum uralicum fontis,* and may be separated by the same external differences and also by its generally smaller size, its smaller number of median costae that are only sometimes bifurcated and intercalated, its approximately equal thickness and length. Warren (1927, p. 54) has already given some differences between the two forms.

The important differences of the internal structures between the two genera further avoid confusion.

Differences from *Gastrodetoechia utahensis utahensis* (Kindle) are given under the description of that species.

Stratigraphic position. Raymond's (1907) specimen was found in "zone B: 10 feet of gray limestone", which he also named Zone 4. This zone is considered equivalent to Haynes' member 4.

Haynes (1916b) collected the species from the base of the same grey limestone (member 4) and from the upper limestone in green shale (member 5); this means in a thickness of 20 feet.

Holland's (1952) material was collected in the uppermost 8 feet 7 inches from what he considered to be the Three Forks Formation at the Madison type section.

Robinson's (1963) specimen (55) was collected from 10 to 30 feet below the base of the upper siltstone unit of the Three Forks Formation in the Milligan Creek sector. Dutro's (1963) specimen (57 MDu 35) was collected from 39 to 42 feet above the base of the same unit in the same sector.

Geographic distribution. The species is known only from Montana, where it has been collected within the limits of the following 15 minute quadrangles: Devils Fence, Jefferson Island, Manhattan, Radersburg, Three Forks, Toston.

Gastrodetoechia Sartenaer, 1965

1965c. *Gastrodetoechia* n.gen.—SARTENAER, pp. 2–4.

Type species. Leiorhynchus utahensis Kindle, 1908. As differences between *Gastrodetoechia utahensis utahensis* and *G. utahensis rugosa* are considered only of subspecific value, the Utah species has been selected as type despite the scarcity of its representatives and the fragmental state of the primary types opposed to the abundance and satisfactory state of preservation of *G. utahensis rugosa.*

Diagnosis. Bulky appearance; variable contour; strongly inequivalve; few wide, rounded, and low costae; median costae commonly start at the beaks but not always; considerable variation in division of costae; external lateral costae confined to the anterior part of the shell; shoulder angle between 95 and 120 degrees; ventral umbonal region marked; ventral beak ridges; moderately deep to shallow sulcus beginning a variable distance from the beak; fold moderately high. Strong ventral muscle field; long septum supporting a more or less deep, covered, septalium.

Species and subspecies attributed to the genus. Type species, *G. utahensis rugosa* nov. subsp., *G. dichotomians* (Abramian, 1954), *G. dichotomians assimulata* (Abramian, 1954), *G. iranica* Gaetani, 1965. *Leiorhynchus dichotomians kasakhstanicus* Rozman, 1962 does not belong to the genus.

Description

The genus includes uniplicate to parasulcate small to large species. The general aspect is more or less globular. The contour is variable (transversally elongated to rounded, rounded-pentagonal or elongated) in dorsal view and dome-shaped in cardinal view. All species are strongly inequivalve. The commissure is sharp and, depending on the species, more or less deeply crenulated by the costae. The greatest thickness of the shell is either at the frontal commissure or posterior to it. The cardinal line is undulated. Parietal costae are extremely rare. The well marked wide costae are obtuse with rounded top and low except those on the anterior parts of the fold and ventral flanks. The angle of the costae on the fold in cross-section may be close to 90 degrees at the front.

Median and lateral costae are few, but show considerable variation. Median costae are either simple or divided, and start either at the beaks or some distance in front. Generally the bounding costae are lower than the rest of the costae on the fold. Lateral costae, when present, are either simple or divided, the external ones being confined to the anterior part of the shell. The shoulder angle varies between 95 and 120 degrees. Postero-lateral margins are concave near the commissure.

The shell is commonly thickened in the extreme-apical region.

Pedicle valve. The umbonal region is marked. Beak ridges are present. The flanks are flat to convex and become steep near the commissure. In longitudinal median sections, the curvature of the valve is weak but increases noticeably at the start of the tongue. In transverse median sections, the curvature is a flattened half ellipse invaginated by the wide sulcus. The sulcus, moderately deep to shallow, begins at a variable distance from the beak (17 to 50 per cent of the length of the shell, generally 30 to 50 per cent); it is wide at the front (60 to 79 per cent of the width of the shell), and its bottom is generally flat to slightly convex. The sulcus is clearly delimited with lateral costae. The small beak is erect and ends with a small circular foramen. The interarea is limited by blunt borders; its length varies between 35 to 50 per cent of the width of the shell. The trapezoidal tongue has sharp borders and tends to become vertical at its crest.

Posteriorly, the dental plates are concave and divergent, but become convergent anteriorly. At mid-height, in transverse serial sections, the dental plates approximate ventrally where they border the muscle field. The umbonal cavities are more or less open depending on secondary calcite growth. The teeth are stout, wide, more or less crenulated.

The muscle field varies from 48 to 56 per cent of the length and from 31 to 41 per cent of the width of the shell. The posterior parts of the diductor and adductor scars may be seen in transverse serial sections; individualized scars have not been recognized on specimens. The muscle field is strongly marked, e.g., hypotype L of *G. utahensis utahensis* (Pl. V, fig. 2a), but its antero-lateral limits are vague.

Brachial valve. The valve is high. The flanks are steep and become abrupt towards the commissure. In longitudinal median sections, the curve of the valve in the posterior half is quarter of a circle. The fold is moderately high with a flat to slightly convex top; it begins at a variable distance from the beak and is clearly delimited.

The septum is long, and for a short distance supports a more or less deep septalium a little deeper than wide. The junction of the outer plates of the hinge plate with the borders of the septalium is marked in the type species by lamellar outgrowths, which may be remainders of a fragile connectivum (Sartenaer, 1965c), this supposition is substantiated by transverse serial sections made by Gaetani (1965) of *G. iranica.* The outer plates are narrow, flat to convex, oblique (inclined towards each other). The inner socket ridges are high. The crura are dorsally concave and crescent-shaped anteriorly in transverse serial sections; they widen and flatten at their distal end.

The muscle scars have only been observed in one specimen of *G. iranica.* Both pair of adductor scars are separated medially by the septum; the anterior pair are tear-shaped scars and the posterior pair kidney-shaped and enclose the anterior pair postero-laterally. The muscle field is 33 per cent of the width and 33 per cent of the length of the shell.

Comparisons. Gastrodetoechia has nothing in common with *Leiorhynchus* Hall, 1860, to which the type species was originally attributed.

Some characters, such as a deep septalium and ventral beak ridges, suggest the closely related genus *Paurorhyncha* Cooper, 1942, but that genus is distinctive in many features, including more inequivalve; different ratios of dimension; non-globular; sulcus occupying most of the pedicle valve and leaving only reduced ventral flanks; high fold; numerous costae; divided costae on the whole surface; lateral costae reaching the umbonal region.

From *Eoparaphorhynchus,* with which it might be confused, *Gastrodetoechia* differs by generally a more elongated contour and globular aspect; relatively higher brachial valve; often lower and less angular costae, especially in the posterior part of the shell; divided lateral costae in some species; shorter lateral costae; vaguely limited interarea ventrally; presence of beak ridges; narrower hinge plate; wider septalium; covered septalium; differently shaped crura; high inner socket ridges. *Eoparaphorhynchus* and *Gastrodetoechia* resemble each other by few wide costae; sulcus and fold not starting at the beaks; wide sulcus; many internal characters.

Gastrodetoechia and *Basilicorhynchus* have the following features in common: globular and inequivalve aspect; sulcus and fold not starting at the beaks; flat-bottomed sulcus shallow, and wide at front; shape of ventral beak; few wide, low costae; value of shoulder angle; deep septalium. *Basilicorhynchus* may be separated by inflated ventral umbonal region; simple median costae, starting some distance from the beaks; internal lateral costae restricted to the anterior part of the shell; less pronounced or faint beak ridges; generally smaller size; thicker dorsal septum; ventral umbonal cavities reduced by secondary growth; longer ventral muscle field; divided hinge plate.

Discussion. Abramian (1954) described a new species, *Liorhynchus dichotomians,* from the upper Famennian and the Etroeungt, based on twenty-nine specimens (thirteen in excellent state of preservation) and a new variety, *L. dichotomians assimulatus,* based on nineteen specimens (eight fragments).[1] The writer has collected 200 specimens in Iran (half of them in satisfactory state of preservation) from the same and other outcrops as those visited by Gaetani, and identical to *Gastrodetoechia iranica* Gaetani. Most of the features of the Armenian and Iranian forms are similar: size, absence of inflation, characters of sulcus and fold, general costal formula ½ to ¼; 0; ⅔ to ⅘, divisions and aspect of costae, location of the greatest thickness of the shell. The transversally elongated contour of the shell described by Abramian is not general as can be deducted from her table of measurements; in the Iranian material one quarter of the specimens are transversally elongated to rounded. It must be noted that the figures of the species are not natural size *in* Abramian (1954) but are natural size *in* Abramian (1957). Nevertheless some constant differences seem to exist. *G. dichotomians* is often wider, has better marked costae, and more systematically divided costae; in the Iranian specimens lateral costae are rarely divided. Precise stratigraphic information is lacking

[1] Two specimens of the species and a plaster cast of the holotype as well as the plaster cast of a specimen of the variety were sent to the writer by Abramian; this is gratefully acknowledged.

for the Armenian species. The given range—upper Famennian to Strunian—needs closer scrutiny. The Iranian species may be present in Armenia; the writer had the privilege of studying ten juvenile specimens from the Armenian collections of Rjonsnitzkaia in the V.S.E.G.E.I. in Leningrad which cannot be separated from Iranian specimens. Conversely the writer has collected specimens in Iran indicating that the Armenian species might be present in that country.

Stratigraphic position and geographic distribution. The west American species extends from the middle Famennian to the lower part of the upper Famennian. The Iranian species is confined to the upper part of the *Ptychomaletoechia? deltidialis* Zone of the lower Famennian; as divisions such as lower, middle, and upper Famennian are still not precise in the Elburz Mountains, the range of the species may prove to be similar to the one of the American species. The Armenian species has been reported from the upper Famennian and the Strunian. *Leiorhynchus* aff. *utahensis* has been identified from the Famennian of Siberia.

Gastrodetoechia utahensis utahensis (Kindle)

Plate V, figures 1–11; Text-figure 10

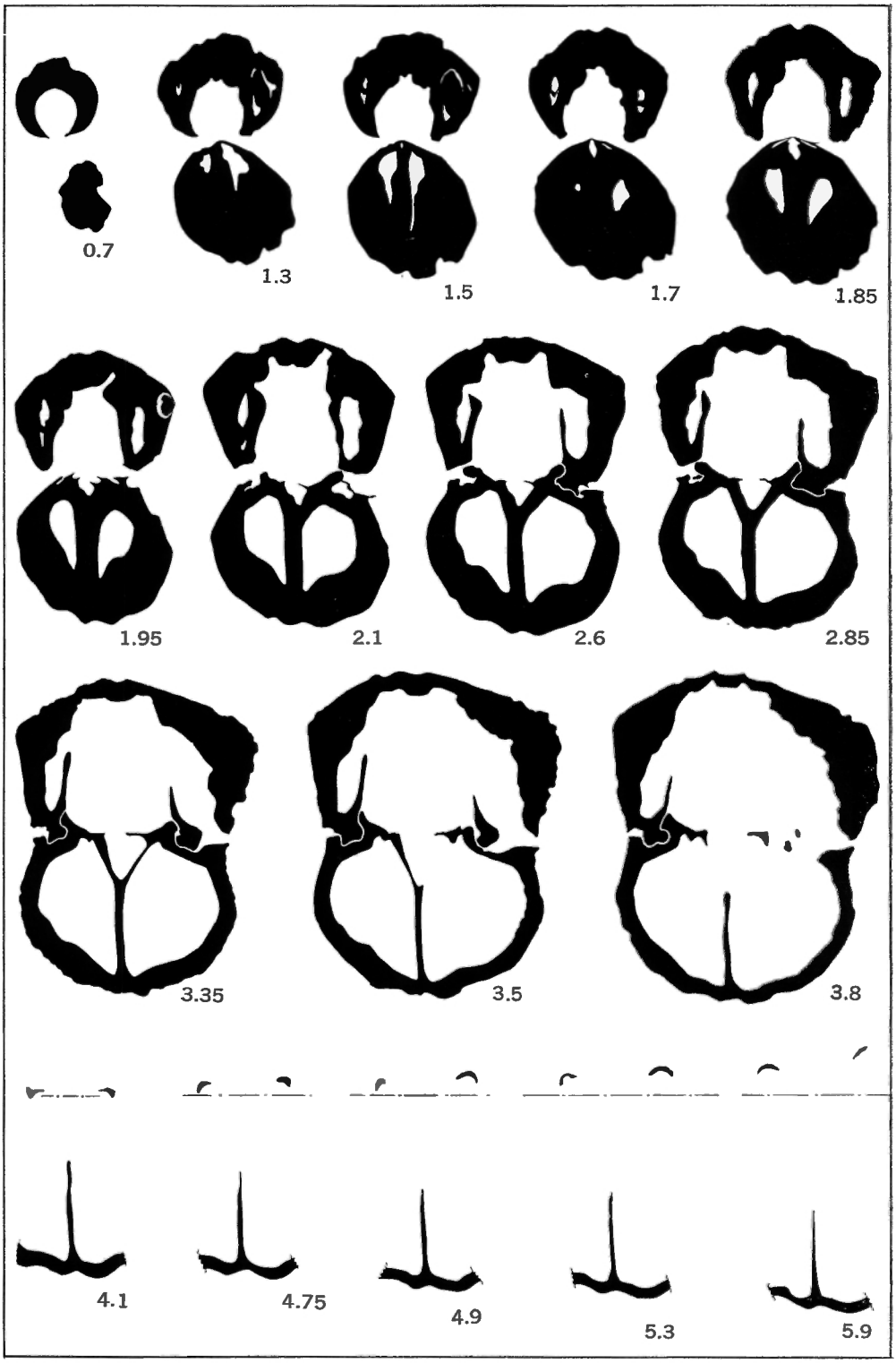
1908. *Leiorhynchus utahensis* n.sp.—KINDLE, pp. 17, 27, pl. 3, figs. 1, 1a–c;
1913. *Leiorhynchus utahensis* sp. nov.—KINDLE *in* HINTZE, p. 110;
[?] 1913. *Leiorhynchus utahensis*—KINDLE *in* BUTLER, p. 35;
1916b. *Leiorhynchus utahense* var. *ventricosum* var. nov.—HAYNES, pp. 40–41, pl. VIII, figs. 10–11;
1924b. *Leiorhynchus utahense*—KINDLE, p. 217;
1943. *Leiorhynchus utahense* var. *ventricosum* Haynes—BALDWIN, p. 146;
1950. *Leiorhynchus cascadensis* Warren—ERDMAN, p. 75;
1950. *Leiorhynchus* n.sp. B—ERDMAN, p. 75;
1951. *Leiorhynchus utahensis* Kindle—FOX, p. 842;
1952a. *Leiorhynchus ventricosum* Haynes—CRICKMAY, p. 588;
1954. *Nudirostra utahensis ventricosa* (Haynes)—McLAREN, pp. 160, 174, 175, 180, pl. I, figs. 1–3;
1954. *Leiorhynchus utahensis* Kindle—FOX, p. 130;
1955. *Nudirostra utahensis ventricosa* (Haynes)—McLAREN p. 46;
1955. *Leiorhynchus utahense* var. *ventricosum* Haynes—ALEXANDER, p. 46;
1956. *Nudirostra utahensis ventricosa* (Haynes)—BELYEA and McLAREN, pp. 78, 89;
1956. *Nudirostra utahensis* (Kindle) var. *ventricosa* (Haynes)—WARREN and STELCK, pl. XXV, fig. 13 (=fig. 10, pl. VIII *in* HAYNES, 1916b); pl. XXIX, figs. 4–9;
1957. *Leiorhynchus madisonense* Haynes—CLOUD *in* KLEPPER, WEEKS, and RUPPEL, p. 15;
[e.p.] 1957. *Leiorhynchus* n.sp. 1—CLOUD *in* KLEPPER, WEEKS, and RUPPEL, p. 15;
1957. *Leiorhynchus* n.sp. 2—CLOUD *in* KLEPPER, WEEKS, and RUPPEL, p. 15;
1958. *Nudirostra utahensis ventricosa* (Haynes)—McLAREN, p. 194, pl. V, figs. 1–3 (fig. 3=fig. 3, pl. I *in* McLAREN, 1954);
1962. *Paurorhyncha utahensis* (Kindle)—McLAREN *in* McLAREN, NORRIS, and McGREGOR, p. 32, pl. XV, figs. 1–3 (=pl. V, figs. 1–3 *in* McLAREN, 1958);
[?] 1963. *Nudirostra ventricosa* (Haynes)—DUTRO *in* ROBINSON, fig. 3, p. 36, table 2;
[non] 1963. *Nudirostra* aff. *ventricosa* (Haynes)—DUTRO *in* ROBINSON, fig. 3, p. 36, table 2;
1963. "*Nudirostra*" *ventricosa* (Haynes)—PEDDER *in* HOUSE and PEDDER, p. 506;
1964. "*Leiorhynchus*" *utahensis* Kindle—PEDDER *in* BELYEA and McLAREN, p. 792;
1965c. *Gastrodetoechia utahensis* (Kindle, E.M., 1908)—SARTENAER, pp. 4, 5, pl. I, figs. 1–3, pl. II, fig. A;
[?] 1965. *Leiorhynchus* aff. *utahensis* (Kindle)—ALEKSEEVA, pp. 184, 185.

Types

Holotype (Pl. V, figs. 1a, b=pl. 3, figs. 1, 1a *in* Kindle, 1908=pl. I, figs. 1a, b *in* Sartenaer, 1965c). USNM No. 62235a. Green Canyon, nearly east of Paradise Post Office (Paradise 7½' Quad.), Utah, U.S.A. Jefferson Limestone, but *see* remarks under Stratigraphic Position. Collector: E. M. Kindle.

Paratype A (Pl. V, fig. 9=pl. 3, fig. 1b *in* Kindle, 1908=pl. I, fig. 2 *in* Sartenaer, 1965c). USNM No. 62235b. Same locality, formation, and collector.

Paratype B (Pl. V, fig. 3=pl. 3, fig. 1c *in* Kindle, 1908). USNM No. 62235c. Same locality, formation, and collector.



TEXT-FIGURE 10. *Gastrodetoechia utahensis utahensis* (Kindle)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype Q, GSC No. 15549 (l:25.0 mm; w:(31.7) mm; t:28.8 mm).

Hypotype A (Pl. V, figs. 7a–c=pl. VIII, figs. 10, 11 *in* Haynes, 1916b=pl. XXV, fig. 13 *in* Warren and Stelck, 1956=pl. I, figs. 3a–c *in* Sartenaer, 1965c)=holotype of *Leiorhynchus utahense* var. *ventricosum*. CM No. 2705. Three Forks (Three Forks 15′ Quad.), Montana, U.S.A., "Top of green shale number 5" of the Three Forks Formation. Collector: W. P. Haynes.

Hypotype B=paratype of *L. utahense* var. *ventricosum*. MCZ No. 8770a. Logan (Manhattan 15′ Quad.), near river, Montana, U.S.A. Base of Limestone No. 4 or top of Green Shale No. 5 of the Three Forks Formation. Same collector.

Hypotypes C=paratype of *L. utahense* var. *ventricosum*. MCZ No. 8770b; D=paratype of *L. utahense* var. *ventricosum*. MCZ No. 8770c. Same locality, formation, and collector,

Hypotype E. GSC No. 15538. GSC loc. 11275. Collector: O. A. Erdman, 1943.

Hypotype F. GSC No. 11210 (Pl. V, figs. 10a–c=pl. I, figs. 1–3 *in* McLaren, 1954=pl. V, figs. 1–3 *in* McLaren, 1958=pl. XV, figs. 1–3 *in* McLaren, Norris, and McGregor, 1962). GSC loc. 19430. Collector: J. L. Severson, 1949.

Hypotypes G, USNM No. 154990 (Pl. V, figs. 11a–d); H, USNM No. 154991. Three miles NE Golden Sunlight Mine, Montana, U.S.A. Three Forks Formation. Collector: W. M. Mitchell.

Hypotypes I, GSC No. 15541; J, GSC No. 15542. GSC loc. 19960. Collector: D. J. McLaren, 1951.

Hypotype K. USNM No. 154992 (Pl. V, fig. 5). T2N, R2W, Sec. 22 (Jefferson Island 15′ Quad.), nose of anticline NE of Doherty Mountain, Montana, U.S.A. Three Forks Formation. Collector: O. D. Blake.

Hypotypes L, GSC No. 15544 (Pl. V, figs. 2a–b); M, GSC No. 15545 (Pl. V, fig. 4). GSC loc. 18081. Collector: D. J. McLaren, 1949.

Hypotype N. GSC No. 15546. GSC loc. 18085. Same collector.

Hypotype O. GSC No. 15547 (Pl. V, figs. 8a–d). Same locality, formation, and collector.

Hypotype P. GSC No. 15548. GSC loc. 11220. Collector: O. A. Erdman, 1943.

Hypotype Q. GSC No. 15549 (Text-fig. 10). Same locality, formation, and collector as for hypotype F.

Hypotype R. GSC No. 15563 (Pl. V, fig. 6). GSC loc. 18074. Collector: D. J. McLaren, 1949.

Hypotype S. GSC No. 15862 (=pl. II, fig. A *in* Sartenaer, 1965c). South-facing slope opposite Spring Creek, Logan Cañon, 24-12N-2E, 1/125,000th topographic sheet of Logan, Utah, U.S.A. "Contact Ledge," Three Forks Formation. Collectors: W. Sadlick and P. Sartenaer, 1960.

Material

Utah. Holotype; two paratypes; two specimens on loan from Dr. W. Sadlick; one specimen collected by Dr. W. Sadlick and the writer in 1960.

Idaho. Two specimens collected by Dr. W. Sadlick and the writer in 1960.

Montana. Holotype and three paratypes of *Leiorhynchus utahense* var. *ventricosum;* four specimens received from Dr. O. D. Blake; four specimens collected by Dr. C. A. Sandberg and the writer in 1959 (GSC loc. 38838 (1); GSC loc. 38854 (3)); ten specimens identified as *L. madisonense* (3), *L.* n. sp. 1 (4), and *L.* n. sp. 2 (3) by Cloud *in* Klepper, Weeks, and Ruppel (1957).

Canadian Rocky Mountains. The following GSC localities: 11189 (1), 11193 (2), 11214 (3), 11218 (1), 11220 (1), 11275 (2), 16887 (1), 16889 (1), 16987 (1), 17051 (3), 18074 (4), 18077 (1), 18080 (4), 18081 (3), 18082 (1), 18085 (4), 18119 (3), 19430 (3), 19960 (4), 20011 (1), 25474 (2), 38857 (2), 38865 (1), 38871 (1), 38902 (4), 42121 (1), 69278 (1).

Twenty-five per cent of the specimens are in satisfactory state of preservation, but as the species is easily recognizable, use can be made of most of the poorly preserved specimens and fragments.

Description

The species is large, inflated, with bulky appearance and characteristically dome-shaped in cardinal views. The lateral margins of the valves meet in an obtuse angle which increases to 180 degrees in thick shells. Postero-laterally margins are concave near the commissure. Commissure is sharp. The greatest thickness of the shell is very often at the summit of the tongue. In some shells the greatest thickness is posterior to the front, and the anterior part of the fold falls towards the commissure. The triangular contour in Kindle's (1908) figure 1c, plate 3 is incorrect (*see* Pl. V, fig. 3) and has led to consider the triangular outline of the posterior part of the shell as a distinguishing character of the form of Utah.

Pedicle valve. In ventral view, the posterior and lateral parts of the valve form a flat or slightly curved crescent-shaped area, reaching sometimes as far as half the length of the shell, bordered postero-laterally by beak ridges. From these ridges to the cardinal commissure the flanks are steep.

The wide sulcus starts at some distance from the beak, and reaches at the front 64 to 79 per cent of the width of the shell. In some specimens, e.g., holotype of *L. utahense* var. *ventricosum*, two ridges start from the beak (Pl. V, fig. 7c); if prolonged, they would mark the limits of the sulcus but they disappear shortly after its beginning. When these ridges are present, they indicate the limits of the sulcus, which are usually vague. The junction of the frontal and lateral commissures is marked by strong spurs. The bottom of the sulcus is flat, rarely slightly concave or convex. It is moderately deep: two to six times the thickness of a costa at the front.

The upper part of the tongue is either vertical or recurved posteriorly; the borders are sharp.

The small erect beak overhangs the hinge line exceptionally, and is close to or touches the inflated dorsal umbo. A minute rounded foramen was observed in only one specimen, at the extremity of the beak. The interarea is rarely clearly defined ventrally; its length is equivalent to about one third to one half the width of the shell; its height may reach 3 mm as the cardinal line is strongly deflected dorsally.

Brachial valve. The umbonal region is gibbous and commonly projects posteriorly. Like the sulcus, the fold starts indistinctly at an indefinite distance from the beak up to half the length of the shell. The height of the fold is highly variable: two to eight times the thickness of the costae. The summit of the fold is flat or more often slightly rounded. There is usually a depression at the bottom of the slopes of the fold. In very high specimens, the slopes of the flanks are sometimes in prolongation of those of the fold.

Ornament. The general coastal formula is $^3/_2$ to $^4/_3$; 0; 0. Fifty-three specimens from the U.S.A. and the Canadian Rocky Mountains, on which such observations were possible, have shown the following numbers of median costae: $^3/_2$ or $^3/?$ or $?/_2$: 39 sp. (73.6%); $^4/_3$ or $^4/?$ or $?/_3$: 11 sp. (20.75%); $^5/_4$ and $^5/?$: 3 sp. (5.65%).

Median costae are well marked, generally simple, and start from the umbo; in only two specimens is there a biparted costa on the fold (one specimen has four costae, the other five (Pl. V, fig. 11b)), the division taking place at about one third of the length of the shell from the beak. Intercalated costae (Pl. V, fig. 1a) are rare. Median costae on the fold are higher than those in the sulcus and, although generally obtuse with rounded top in transverse section they may form angles as low as 90 degrees. Costae in the sulcus are always obtuse in section. Although usually of equal width on the same specimen, one or two costae may sometimes differ from the others. They may be up to 8 mm wide at the front, but are commonly 4 to 5 mm. Furrows have the same depth and width as the costae. In two specimens with $^5/_4$ costae, the bounding costae of the fold are lower than the three others (Pl. V, fig. 11d) and are matched by similar costae in the sulcus; in one specimen they could be called parietal.

In one specimen, a ridge limits the depression bordering the fold and could be considered a lateral costa; it indents the lateral commissure.

The ridges (*see* above) sometimes bordering the sulcus are not considered true lateral costae (Pl. V, figs. 1a, 3, 7c).

All specimens show concentric growth lines, three to six per millimetre at mid-length. Vascular impressions are rare and may be confused with a radial "striation." Some shells show faint costellae (two per mm). Plate V, figure 7b shows branching vascular impressions on the anterior part of the dorsal flank and striae in the middle part of the same flank.

Dimensions. The primary types are in such poor state of preservation that no measurement is possible on them. Hypotype C is the largest specimen in the collections.

in mm	Hypotype C	Hypotype B	Hypotype E	Hypotype D	Hypotype A	Hypotype G	Hypotype H	Hypotype J	Hypotype F	Hypotype I
l	46.9	38.5	37.7	35.9	34.5	34.3	32.2	(32.1)	28.2	27.8
w	42.0	38.3	(33.7)	38.7	36.6	40.5	32.4	36.3	31.7	32.8
lpv unrolled	85.0	66.0	68.0	?	57.0	47.5	(43.0)	?	50.0	48.0
t	48.3	38.2	38.8	?	30.1	23.9	22.5	21.2	27.5	27.1
tpv	17.1	9.5	10.8	8.0	10.1	6.0	6.2	6.0	7.3	5.5
tbv	31.2	28.7	28.0	?	20.0	17.9	17.4	15.2	20.3	21.6
l/w	1.10	1.00	(1.12)	(0.93)	0.94	0.85	0.99	(0.88)	0.89	0.85
t/w	1.15	1.00	(1.15)	?	0.82	0.59	0.69	0.58	0.87	0.83
t/l	1.03	0.99	1.03	?	0.87	0.70	0.70	(0.66)	0.98	0.97
shoulder angle	(120°)	(135°)	120°	?	120°	120°	?	115°	120°	115°

There is great variability in the measurements. Hypotypes G and J are exceptionally flat specimens and hypotypes C and E are exceptionally high ones.

The shoulder angle varies between 100 and 120 degrees (generally between 110 and 120) with the exception of the doubtful 135 degrees measurement; one badly preserved specimen has yielded a measurement of 95 degrees.

Internal characters. Internal characters are those given under the original description of the genus.

Growth. The species has a non-constant and monocyclic curvature growth. Juvenile t/w and t/l ratios are sometimes maintained in adult forms, e.g., hypotypes G and J. Conversely, adult characters may be reached in early stages, e.g., hypotype K (Pl. V, fig. 5) which has already an appreciable height.

Measurements of the six smallest specimens are:

in mm	Hypotype O	Hypotype L	Hypotype M	Hypotype K	Hypotype P	Hypotype N
l	25.4	25.2	24.3	23.7	23.6	21.6
w	22.4	30.5	28.5	(24.6)	27.6	25.0
lpv unrolled	34.0	?	?	(36.0)	42.0	(33.0)
t	15.4	(24.5)	?	22.1	23.2	17.5
tpv	5.3	8.0	6.7	5.5	6.5	3.9
tbv	10.1	(16.5)	?	16.6	16.7	13.6
l/w	11.3	0.83	0.85	(0.96)	0.86	0.86
t/w	0.68	(0.80)	?	(0.90)	0.84	0.70
t/l	0.61	(0.97)	?	0.93	0.98	0.81
shoulder angle	(95°)	115°	110°	?	?	?

In the smallest specimens the upper part of the tongue is directed forwards.

Discussion

Synonymy. Gastrodetoechia utahensis is a poorly known species. The only description given so far is the original one (*see* comments on the primary types under the explanation of Pl. V).

Leiorhynchus utahense var. *ventricosum,* considered as a subspecies by McLaren (1954, 1955, 1956, 1958) and as a species by Crickmay (1952a), cannot be separated from *Gastrodetoechia utahensis utahensis* on the basis of the presently available material. With few exceptions, specimens from Utah, Montana, and the Canadian Rocky Mountains have the same size and similar number of costae. Still, collections from Utah are too small for evaluating if the absence of large specimens and the presence of four costae in the sulcus of most specimens have a systematic meaning. Kindle (1908) knew already the "undescribed form" of Montana "closely related" to his species; he thought the differences were "probably not much more than varietal."

One of the five specimens identified as *Leiorhynchus* n.sp. 1 by Cloud *in* Klepper, Weeks, and Ruppel (1957) is put into synonymy with *Rugaltarostrum gibbosum.*

Nudirostra ventricosa identified by Dutro *in* Robinson (1963) has not been examined by the writer. The specimen identified as *N.* aff. *ventricosa* by Dutro *in* Robinson (1963) has been put into synonymy with *Rugaltarostrum jeffersonense.*

Alekseeva's (1965) material has not been available for study.

Comparisons. Apart from the important internal differences, *Rugaltarostrum jeffersonense* differs from *Gastrodetoechia utahensis utahensis* by many external characters. The latter has a smaller width relative to length, a wider sulcus and thus more reduced ventral flanks, marked beak ridges, rare divided or intercalated median costae, usually less median costae, no lateral costae, ridges bordering the sulcus restricted to the posterior part of the shell.

Similarities with and differences from *Megalopterorhynchus haynesi* are given under the description of that species.

Externally, there are affinities with such species as *Paurorhyncha cooperi* Stainbrook, 1947 from the Percha Formation of New Mexico and Arizona, and *P. endlichi* (Meek, 1875) from the Upper Devonian of Colorado, but the species is easily separable by the nature of its costae and the shape of the brachial valve.

Stratigraphic position. Sartenaer (1965c, pp. 4, 5) has discussed the problem connected with the location of the Green Canyon "nearly east of Paradise Post Office" mentioned by Kindle (1908, pp. 16, 17).

Dr. W. Sadlick and the writer found three specimens associated with many specimens of *Sinotectirostrum banffense shimeri* and of *Productella* sp. in the upper 6 feet of the "Contact Ledge" in the Spring Hollow, Logan Canyon, Cache County; the "Contact Ledge" is here 24 feet thick.

Kindle (*in* Butler, 1913, p. 35) identified the species from the Mowitza Shale of northeastern Utah. The collection has not been examined by the present author.

Haynes (1916b) collected his variety *ventricosum* from the base of his Limestone No. 4 and the top of his Green Shale No. 5, this means that the variety has been found in a thickness of about 26 feet. The other specimens from Montana mentioned in the available material were collected within the same beds.

The specimens collected by Klepper, Weeks, and Ruppel (1957) are from the "medial limestone" of the Three Forks Formation.

Robinson's (1963) collection from the Milligan Creek sector derives from 50 to 60 feet above the base of the upper siltstone unit of the Three Forks Formation.

Alekseeva's (1965) *Leiorhynchus* aff. *utahensis* is reported from the Famennian.

Baldwin's (1943) material, as well as the writer's were collected from the upper 115 feet of the Three Forks Formation in Idaho. A precise study of this section should provide more detailed stratigraphic information.

Erdman's (1950) specimens were collected within the upper 200 feet of the Devonian, and Fox's (1951, 1954) material from the upper part of the Palliser Formation.

Hypotype F figured by McLaren (1954 and 1958) was collected from the upper 15 feet of the Palliser Formation at Mount Coleman, Banff National Park, with two other specimens. *Nudirostra utahensis ventricosa* mentioned by McLaren (1955) comes from the upper 3 feet of the Palliser Formation of the Medicine Lake section. Belyea and McLaren (1956) cite the same variety in the Costigan Member of the Palliser Formation of Bow Valley and adjacent areas.

The two specimens figured by Warren and Stelck (1956) were collected by J. Campbell in a quarry 2 miles east of Nordegg in the "Upper ? beds of Palliser formation."

E. W. Peyto did not leave enough information to locate his collection stratigraphically, but after study of the same outcrops (Bourgeau Range, Healy Creek), it is almost certain that it comes from within the 25 upper feet of the Palliser Formation.

All specimens collected by McLaren in the Canadian Rocky Mountains fall within the upper 20 feet of the Palliser Formation, and the specimens collected by H. Belyea and the writer were in the upper 10 feet of this formation.

Pedder's (House and Pedder, 1963) collection derives from the Costigan Member of the Palliser Formation.

Pedder *in* Belyea and McLaren (1964) cites *"Leiorhynchus" utahensis* in the lower part of a 110 feet unit located between 44.3 and 153.3 feet below the top of the Palliser Formation.

Geographic distribution. The species does not seem to be abundant in Utah, where it has been reported only near Logan in the northeast and near Shauntie in the southwest. It occurs in southwestern Montana where it has been found in the following 15 minute quadrangles: Devils Fence, Jefferson Island, Manhattan, Radersburg, Three Forks, and Toston. It is known from a single locality in Idaho: a mile east of Freighter Spring near Dickey.

In the Canadian Rocky Mountains it is known between Winnifred Pass in the North and Bow Valley in the South, at: Mount de Smet, Mount Greenock, Mount Hawk, Cadomin, Alexo map-area, Nigel Peak, Sunwapta Pass, Mount Coleman, North Saskatchewan River Gap, Idlewilde Mountain, mountain between Limestone Creek and Clearwater River, James Pass, Burnt Timber area, Lake Minnewanka, Bourgeau Range, Jura Creek.

Alekseeva's (1965) *Leiorhynchus* aff. *utahensis* has been collected in Siberia.

Gastrodetoechia utahensis rugosa nov. subsp.

Plate VII, figures 1–4; Text-figure 11

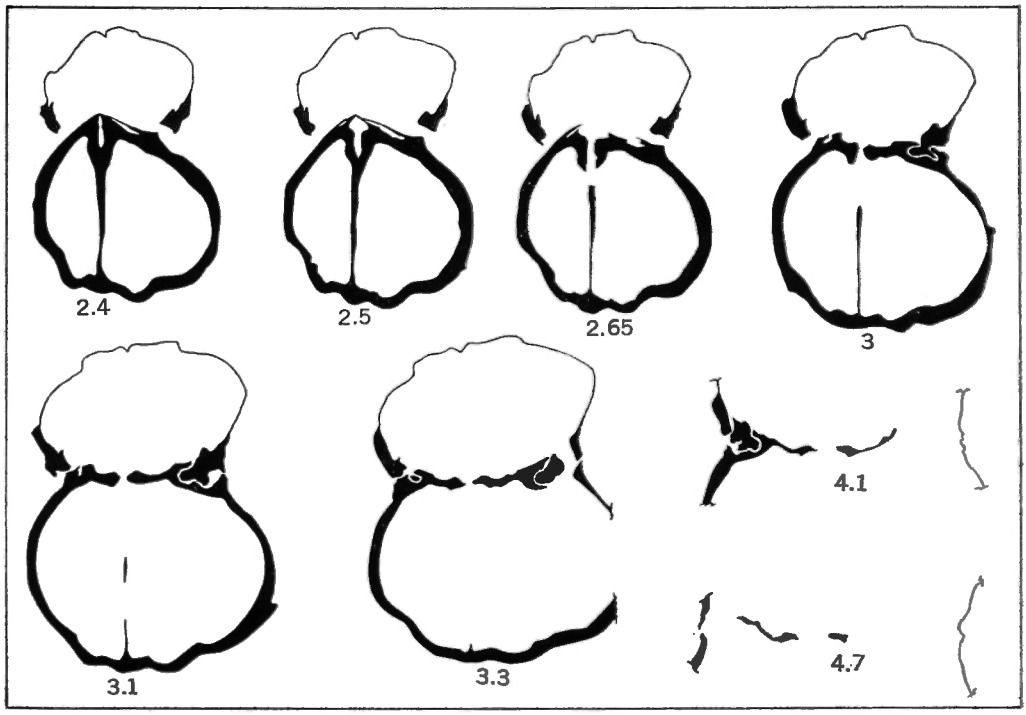
1922. *Leiorhynchus* sp.—HUME, p. 72B *in* "Shale Zone No. 2";
1945. *Leiorhynchus*—HUME and LINK, p. 38, line 55 (*coet. excl.*);
1954. *Leiorhynchus*—HUME, p. 46, line 15 (*coet. excl.*);
[e.p.] 1954. *Nudirostra gibbosa walcotti*—McLAREN, p. 173, line 17 (*coet. excl.*);
[e.p.] 1954. *Nudirostra gibbosa* (Haynes) species group—McLAREN, p. 179;
1962. "*Leiorhynchus*" cf. "*L*" *seversoni* (McLaren)—BELYEA and McLAREN, p. 11;
1965c. Sous-espèce géographique de *Gastrodetoechia utahensis*—SARTENAER, p. 3, pl. I, fig. 4.

Rugosus, a, um (Latin)=plicated; to draw the attention on the lateral costae.

Types

Holotype. GSC No. 15857 (Pl. VII, figs. 1a–e). GSC loc. 38701. Collector: P. Sartenaer, 1959.

Paratypes A, GSC No. 15858 (Pl. VII, fig. 3=pl. I, fig. 4 *in* Sartenaer, 1965c); B, GSC No. 15859 (Pl. VII, fig. 2). Same locality, zone, and collector.



TEXT-FIGURE 11. *Gastrodetoechia utahensis rugosa* nov. subsp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype D, GSC No. 15861 (l:(30.8) mm; w:28.4 mm; t:24.6 mm).

Paratype C. GSC No. 15860 (Pl. VII, fig. 4). GSC loc. 7180. Collector: G. S. Hume, 1921.

Paratype D. GSC No. 15861 (Text-fig. 11). GSC loc. 7165. Collector: G. S. Hume, 1921.

Material

All the material is from the District of Mackenzie (GSC locs.). In the Root River valley: 7176 (3), 7180 (23); in the North Nahanni River valley: 7165 (45), 7165A (1), 26763 (6), 32109 (2), 32110 (4), 32113 (3), 33430 (38), 38700 (43), 38701 (237), 38705 (4), 38713 (14), 38719 (11), 43835 (15), 73020 (3), 73021 (5); in the Johnson River valley: 44608 (2); in the Island River valley: 28380 (6), 28386 (4); in the Rabbit Lake area: 31531 (179).

More than four fifths of the material is in satisfactory state of preservation.

Description

The only important difference between *G. utahensis utahensis* and *G. utahensis rugosa* is the presence of lateral costae in the latter subspecies. Although constant, this difference is not considered of specific value and *G. utahensis rugosa* is separated as a geographic subspecies.

Minor differences for *G. utahensis rugosa* include: a generally proportionately lower height due to its commonly lesser bulk; costae bordering the sulcus which is thus clearly delimited; the greatest thickness of the shell less generally at the front; dorsal umbonal region commonly not projecting posteriorly.

A minute rounded foramen was observed in only one specimen.

Ornament. The general costal formula is ½; 0; ⅜ to ¾. From the same outcrop (GSC loc. 38701) 204 specimens have shown the following numbers of median costae:

	Adults		Juveniles		Totals	
Number of costae	spec.	%	Number of specimens	%	Number of specimens	%
2/1	14	7.80	3	12.–	17	8.35
3/2	145	81.–	22	88.–	167	81.85
4/3	19	10.60			19	9.30
5/4	1	0.60			1	0.50
	179	100.–	25	100.–	204	100.–

Only one specimen has a biparted costa on the fold. Irregular median costae have been observed in 5 per cent of the specimens. The bounding costae on the fold are commonly lower than the others; sometimes they could be called parietal, but actual parietal costae have been seen on only two specimens.

The numbers of lateral costae in the same outcrop are:

	Adults		Juveniles		Totals	
Number of costae	spec.	%	Number of specimens	%	Number of specimens	%
0	1	0.70	1	7.70	2	1.30
1/2	14	10.–	3	23.05	17	11.10
2/3	72	51.45	8	61.55	80	52.30
3/4	44	31.45	1	7.70	45	29.40
4/5	7	5.–			7	4.60
5/6	2	1.40			2	1.30
	140	100.–	13	100.–	153	100.–

Costellae were observed on one specimen.

Dimensions.

in mm	Paratype A	Holotype
l	34.5	28.5
w	41.1	26.4
lpv unrolled	49.0	40.0
t	23.3	18.8
tpv	8.0	4.3
tbv	15.3	14.5
l/w	0.84	1.08
t/w	0.57	0.71
t/l	0.68	0.66
shoulder angle	120°	112°

Discussion

Synonymy. Specimens of the *Nudirostra gibbosa* (Haynes) species group and the *N. gibbosa walcotti of* McLaren (1954) excluded from the synonymy are included in *Eoparaphorhynchus maclareni* and *E. walcotti.*

Stratigraphic position. The subspecies has been collected in the Yohin syncline, N.W.T., between 1,170 and 1,455 feet from the base of the Famennian. It is recognized in various other outcrops in the Northwest Territories, but sections are usually too incomplete to indicate the stratigraphic range. All the specimens from the North Nahanni and Root Rivers area are included in Hume's (1922, p. 72B) Shale Zone No. 2. Hume commented on the larger size of the specimens in Zone No. 2.

Geographic distribution. The subspecies has been found in the valley of the following rivers in the Northwest Territories: Island, Johnson, North Nahanni, Root, and in the Rabbit Lake area.

Megalopterorhynchus Sartenaer, 1965

1965c. *Megalopterorhynchus* n. gen.—SARTENAER, pp. 5–7.

Type species. Megalopterorhynchus haynesi Sartenaer, 1965.

Diagnosis. Transverse; strongly inequivalve; costae few, strong, wide, angular with rounded top; median costae start at the beaks and may divide either rarely or commonly; simple lateral costae; parietal costae may be present; costellae present; shoulder angle wide; cardinal line undulated; dorsal umbonal region inflated; deep and wide sulcus starting a short distance from the beak; shell bordering the sulcus flat to slightly convex; high tongue and fold; faint beak ridges. Shape of dental plates influenced by the strong relief of the muscle field; deep and wide septalium supported by a long septum; lamellar outgrowths covering part of the septalium; wide umbonal cavities.

Species attributed to the genus. Type species, *M.* nov. sp. from Idaho (not yet described).

Description

The type species is large, and the species from Idaho of medium size. They are uniplicate to parasulcate, strongly inequivalve, and transverse. The number of median and lateral costae is low. The median costae start at the beaks; divisions are either common or rare. The lateral costae are simple; only the internal ones reach the umbonal regions. Parietal costae may be present. The costae are wide, well marked, high on the fold, and angular with rounded top. Costellae are sometimes present. Width is the greatest dimension. The shoulder angle varies between 120 and 135 degrees. Postero-lateral margins are concave near the commissure. The cardinal line is undulated.

Pedicle valve. Sulcus is flat to slightly concave, deep, and wide at front. It starts a short distance from the beak, widens rapidly, and is well marked anteriorly. The shell bordering the sulcus is flat to slightly convex. The tongue is high. The beak is small and erect. The interarea is only vaguely limited ventrally. Faint beak ridges are present.

The dental plates are concave and divergent posteriorly and become generally parallel to convergent anteriorly; anteriorly, in transverse serial sections, they approximate ventrally where they border the muscle field. The umbonal cavities are wide. The teeth are simple, robust, and wide. The denticula are wide and strongly developed. Deltidial plates may sometimes be observed in transverse serial sections. The muscle field has a strong relief.

Brachial valve. The valve is very high. The umbonal region is inflated and commonly projects posteriorly. The fold is high and starts close to the beak; it is well marked anteriorly. The top of the fold is either flat or slightly to strongly convex.

A long septum supports a large septalium that is deeper than wide. The outer plates of the hinge plate become concave anteriorly. The junction with the borders of the septalium is marked (Text-fig. 12) by lamellar outgrowths that sometimes cover the greater part of the septalium. The internal socket ridges are high. The crura are concave dorsally and shaped like Phrygian cap in transverse serial sections; they are slightly incurved at their distal end

Comparisons. There are few differences in the internal structures of *Megalopterorhynchus* and *Paurorhyncha* Cooper, 1942. Externally, both genera have a deep sulcus, a high fold, a dorsal umbonal region protruding posteriorly, and inequivalve and roughly similar aspects. *Paurorhyncha* differs from *Megalopterorhynchus* by the following characters: shape more variable; costae more numerous, less high, and divided both on the flanks and in the fold and sulcus; parietal costae more numerous and always present; lateral costae reaching the umbonal regions; ventral beak ridges more clearly marked; smaller shoulder angle; no costellae; sulcus occupying more of the pedicle valve and leaving only reduced ventral flanks.

The genus *Gastrodetoechia* bears some resemblance to *Megalopterorhynchus* in size, inequivalve aspect, presence of beak ridges, small ventral interarea, presence of only a few costae all wide, and some internal structures. However many characters make *Gastrodetoechia* distinct from *Megalopterorhynchus:* sulcus less deep and wider at front; tongue and fold less high; shape more globular; costae less high; parietal costae extremely rare; width relatively smaller; ventral lateral flanks longitudinally more convex; dorsal umbonal region not protruding posteriorly; denticula narrower; umbonal cavities narrower and higher; ventral muscle field differently shaped. A covered septalium has been observed in *Gastrodetoechia* but not in *Megalopterorhynchus;* however, lamellar outgrowths are present in the latter genus and a complete covering could have been present.

Differences and similarities between the largest species of the genus *Rugaltarostrum, R. jeffersonense,* and *Megalopterorhynchus haynesi* are given under the discussion of the latter species.

Stratigraphic position and geographic distribution. The two species referred to this genus occur in Canada and the U.S.A. in the lower part of the upper Famennian.

Megalopterorhynchus haynesi Sartenaer

Plate IV, figures 1, 2; Text-figure 12

1957. *Paurorhyncha endlichi* (Meek)—CLOUD *in* KLEPPER, WEEKS, and RUPPEL, p. 15;
1965c. *Megalopterorhynchus haynesi* n.sp.—SARTENAER, p. 7, pl. 1, figs. 5, 6, pl. II, fig. B.

Types

Holotype. GSC No. 15692 (Pl. IV, figs. 1a–e=pl. I, fig. 5 *in* Sartenaer, 1965c). GSC loc. 17051. Collector: E. W. Peyto, 1925.

Paratype A. GSC No. 15693. T2N, R2W, Sec. 22 (Jefferson Island 15′ Quad.), nose of anticline NE of Doherty Mountain, Montana, U.S.A. Three Forks Formation. Collector: O. D. Blake.

Paratype B. GSC No. 15694. Same locality, formation, and collector as for the holotype.

Paratype C. GSC No. 15695 (Text-fig. 12=pl. II, fig. B *in* Sartenaer, 1965c). GSC loc. 38874. Collectors: H. R. Belyea and P. Sartenaer, 1959.

Paratype D. GSC No. 15709 (Pl. IV, figs. 2a-e=pl. I, figs. 6a–c *in* Sartenaer, 1965c). Three miles northeast of Golden Sunlight Mine, SW Montana, U.S.A. Three Forks Formation. Collector: W. M. Mitchell.

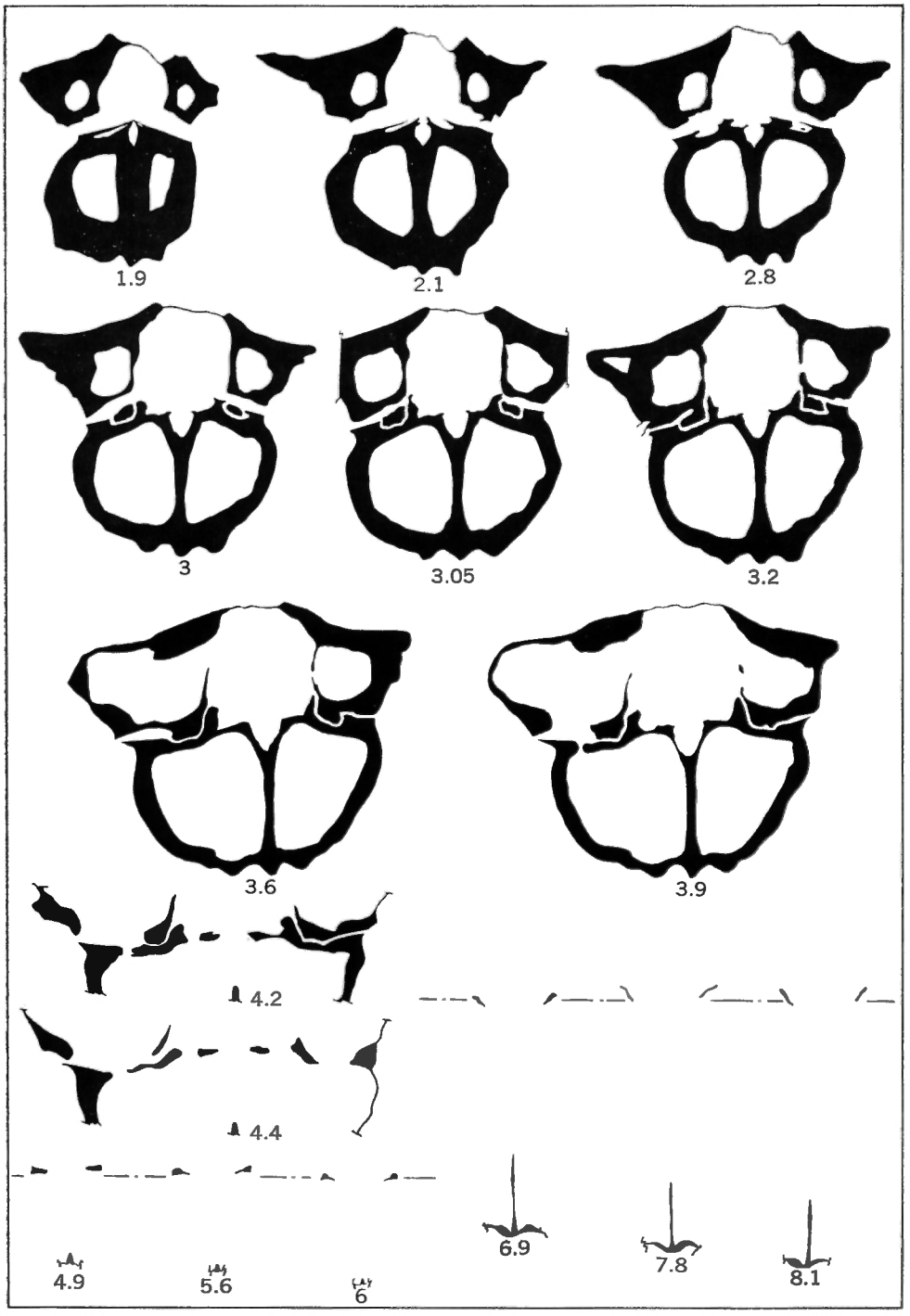
Material

Canadian Rocky Mountains. GSC localities: 17051 (4), 38874 (1).

Montana. Two specimens received from Dr. O. D. Blake in Billings; two specimens collected by Dr. C. A. Sandberg and the writer in 1959; one specimen identified as *Paurorhyncha endlichi* by Cloud *in* Klepper, Weeks, and Ruppel (1957).

Description

The species is large, strongly inequivalve, and transversely elongated. The commissure is sharp and strongly indented by the costae.



TEXT-FIGURE 12. *Megalopterorhynchus haynesi* Sartenaer

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Paratype C, GSC No. 15695 (l:34.0 mm; w:(42.0) mm; t:31.7 mm).

Pedicle valve. The flanks are flat to slightly convex in the area bordering the sulcus, then slope rather sharply towards the commissure and become concave near the postero-lateral commissure; this inversion of the curvature may extend as far as mid-length. On each side of the beak there is a faint and short beak ridge.

The well defined sulcus starts at a short distance from the beak and widens rapidly. It is deep—four to six times the height of the median costae—and wide: 58 to 69 per cent of the width of the shell at the front. The bottom is usually flat but may be slightly concave.

The sulcus passes progressively to a high tongue with sharp borders. The upper part of the tongue is either vertical or recurved posteriorly. Sometimes, near the top, the median costae protrude beyond the borders of the tongue. The frontal commissure is influenced by the curvature of the fold and may, therefore, have a sub-ogival aspect (Pl. IV, fig. 2d).

The small beak has been clearly observed only on paratype D, where it is erect and overhangs the hinge line slightly; because of the inflated dorsal umbonal area, it touches the brachial valve. The interarea is poorly delimited ventrally. As the cardinal line is strongly deflected dorsally, the interarea may reach a height of 3 to 4 mm. Its length corresponds to about half the width of the shell. No foramen has been observed.

Brachial valve. The flanks of the valve slope progressively and steeply towards the commissure and become concave postero-laterally; this inversion of the curvature may extend as far as mid-length. The umbonal region is inflated and commonly projects posteriorly. The high and well defined fold starts close to the beak. Its top may be flat, but more commonly it is slightly or even strongly convex. The greatest thickness of the valve—and thus of the shell—may be either at the front or somewhat posterior to it; in the latter the fold falls from this summit to the commissure.

Ornament. The general costal formula is 3/2 to 7/6; 0 or 1/1–2/0 or 1/1–1/1; 1/2 to 3/3.

The costae are distributed as follows for the eight specimens at our disposal:

Median + parietal		Median		Parietal		Lateral	
Number of costae	spec.	Number of costae	spec.	Number of costae	spec.	Number of costae	spec.
3/2	1	3/2	3	0	2	1/2	3
4/3	1	4/3	2	1/0—1/0	2	2/3	4
5/4	3	5/4	3	1/1—1/1	4	3/3	1
6/5	1	—	—	—	—	—	—
7/6	2	—	—	—	—	—	—

The well marked median costae start at the beaks. In four specimens, one or two are divided (Pl. IV, figs. 2b, c) or intercalated (Pl. IV, fig. 2e) in the posterior third of the shell. The median costae are regular or irregular; they are high in the anterior half of the shell and higher on the fold than in the sulcus. The costae are rounded in the posterior part of the shell and become gradually angular with rounded top towards the front; their angle in cross-section is usually obtuse, but exceptionally, on dorsal costae, it may be acute. The width of the costae at the front varies between 3 and 6 mm. When there are more than three costae on the fold, the bounding costae are lower than the others. The parietal costae never reach the frontal commissure; when they do not reach the beak either, they might be called adventitious (Pl. IV, fig. 1e). Only the internal lateral costae reach the umbo and the most external ones are restricted to the margins of the flanks. The lateral costae are obtuse with rounded top.

Costellae—two to three per millimetre—cover the surface of the shell (Pl. IV, figs. 2a, d).

Fine concentric growth lines are common on well preserved specimens.

Dimensions.

in mm	Holotype	Paratype C	Paratype A	Paratype D	Paratype B
l	35.8	34.0	(27.8)	27.7	(23.8)
w	44.2	(42.0)	38.6	38.7	30.8
lpv unrolled	57.0	(52.0)	(43.5)	45.0	?
t	34.3	31.7	25.6	26.2	(20.02)
tpv	8.2	5.7	6.9	8.5	(4.2)
tbv	26.1	26.0	18.7	17.7	15.82
l/w	0.81	(0.81)	(0.72)	0.72	(0.77)
t/w	0.78	(0.76)	0.66	0.68	(0.65)
t/l	0.96	0.93	(0.92)	0.95	(0.84)
shoulder angle	125°	?	?	(125°)	?

Paratype B is the smallest specimen in the collections. The shoulder angle could only be measured accurately in two specimens, but in none of the nine specimens was it less than 125 degrees. The umbonal region protrudes posteriorly. The greatest width of the shell fluctuates between 9/10 and 2/3 of the length of the shell from the beak.

Internal characters. The internal characters are those given under the description of the genus.

Discussion

The possibility of distinguishing two species, one with few costae and another with more, is not dismissed, but the small number of specimens available does not allow further investigation.

Comparisons. The species is distinguished by large size, general costal formula, and divided median costae in about half of the specimens.

R. jeffersonense is similar in size, width and depth of sulcus, height of tongue and fold, sulcus and fold starting near the beaks, costae few, wide and high, divided median costae, and many internal characters. Figures 2 and 3 of Plate IV illustrate some of these similarities. Both species occur in the same beds in Montana and some specimens may have the same number of median and lateral costae. Nevertheless, *R. jeffersonense* differs by more inflated ventral flanks, less inequivalve character, wider angle of the cardinal commissure, transversally oval contour in dorsal view, absence of flat shell bordering the sulcus, absence of pronounced beak ridges, non-undulated cardinal line, more constant number of median costae (5/4 to 6/5), number of lateral costae more constantly low, umbonal region usually moderately inflated, shorter septum, narrower and higher umbonal cavities, less pronounced lamellar outgrowths, lower inner socket ridges, and shape of dental plates. More material of both species will have to be collected and studied to ascertain the value of the differences seen in the costae.

Some specimens of *Trifidorostellum cascadense cascadense,* such as the lectotype, may reach a size similar to the one of *Megalopterorhynchus haynesi.* The sulcus and fold are similar in both species, in depth, width, and point of starting. In *Trifidorostellum cascadense cascadense,* there are also occasionally divided median costae, and adventitious costae. The two species can be separated by their internal characters. Externally, *T. cascadense cascadense* differs by a generally smaller size, a wider angle of the cardinal commissure that produces a more ovate contour in dorsal view, by the absence of a flat area bordering the sulcus, by usually more lateral costae and by the absence of beak ridges.

Gastrodetoechia utahensis utahensis and *Megalopterorhynchus haynesi,* may be found in the same beds, and have many similar features, some being common to both genera: large size, gibbose and inequivalve aspect, flat to slightly convex area bordering the sulcus, beak ridges on each side of the ventral beak, wide sulcus, dorsally deflected cardinal line, wide

costae. *M. haynesi* differs by a usually higher fold and tongue, a deeper and narrower sulcus, a dorsal umbonal region commonly projected posteriorly, a higher number of median costae, commonly divided median costae, the usual presence of parietal costae, as well as interiors.

Stratigraphic position. The five Canadian specimens have been collected from the same outcrop from the upper 25 feet of the Palliser Formation.

The five Montana specimens have been collected from the Three Forks Formation: four in Haynes' (1916b) "green shale=member No. 5," one in Klepper, Weeks, and Ruppel's (1957) "medial limestone."

Geographic distribution. Canada. Bourgeau Range near Banff, Alberta. *U.S.A.* Southwestern Montana.

Eoparaphorhynchus Sartenaer, 1961

1961d. *Eoparaphorhynchus* n.gen.—SARTENAER, p. 2.

Type species. Eoparaphorhynchus maclareni Sartenaer, 1961.

Diagnosis. Contour variable, generally transverse; few wide costae; parietal costae rare; median costae start at the beaks and sometimes divide; external lateral costae confined to the anterior part of the shell; shoulder angle wide; costellae present; shallow and wide sulcus beginning a variable distance from the beak. Narrow and deep to moderately deep septalium supported by a long septum; hinge plate divided.

Species and subspecies attributed to the genus. Type species, *E. lentiformis* (Nalivkin, 1930) (*non* Gürich, 1903), *Rhynchonella triaequalis* Gosselet, 1877, *Camarotoechia triaequalis praetriaequalis* Sartenaer, 1957, *Eoparaphorhynchus walcotti* (Merriam, 1940), Russian species (*see* below).

Description

This genus includes uniplicate to parasulcate species of small to medium, medium, and medium to large size. Although variable, the contour in dorsal view is very often transversally oval. The commissure is sharp and deeply crenulated by the costae. The number of costae is low and not very variable from one species to another. Parietal costae are rare. The median costae start at the beaks. They may be divided and irregular, but the number of specimens affected varies from one species to another. The lateral costae are simple and start at the umbones, except the external ones, which are sometimes reduced to mere indentations of the lateral commissure. The costae are wide and angular, becoming more rounded to rounded—flattish towards the beaks. Shoulder angle varies between 100 and 130 degrees. Postero-lateral margins are concave near the commissure. Costellae have been observed extremely rarely in *E. triaequalis* and *E. walcotti,* frequently in *E. lentiformis,* in one specimen out of ten of *E. maclareni.*

The shell is thickened in the umbonal region.

Pedicle valve. The umbonal region is slightly to strongly inflated. The sulcus begins at a variable distance from the beak; it is wide at the front with flat or slightly convex bottom. The depth of the sulcus varies from one species to another. The beak is erect to slightly incurved, exceptionally strongly incurved and terminated by a small circular foramen. The top of the trapezoidal tongue is usually recurved posteriorly, except in the smallest species, *E. lentiformis.* The interarea, limited by low ridges, is narrow; its length varies between 40 and 66 per cent of the width of the shell. The deltidial plates are seen in transverse serial sections.

In the posterior part of the shell, the dental plates are divergent and somewhat concave, but they become parallel and then slightly convergent anteriorly. The dental plates are short (2.3 to 3.6 mm) and concave anteriorly. The umbonal cavities are much reduced posteriorly. The teeth are short, stout with a few dorsal crenulations. The denticula are strong and clearly marked.

The length of the muscle field varies from 40 to 62 per cent of the length and from 35 to 42 per cent of the width of the shell. It is variable in shape, well marked, with vague antero-lateral limits. The flabellate diductor scars enclose the small cordiform or reniform adductor scars, which are divided posteriorly by a low median myophragm. The muscle scars are well seen in transverse serial sections.

Brachial valve. The fold is well marked and does not start at the beak. Its top is flat or slightly convex. Except for *E. lentiformis*, the smallest species, the valve usually recurves from the summit towards the frontal commissure.

The septum is long (3.5 to 6.5 mm) and thick, and thins anteriorly. It supports a narrow septalium, moderately deep to deep. The junction of the outer plates of the hinge plate with the borders of the septalium is sometimes marked by a ridge. In one specimen, these ridges develop into plates, which almost touch each other and partly cover the septalium as inner plates.

The hinge plate is divided. The outer plates are thick, usually flat or slightly concave, exceptionally strongly concave; they are wider against the crural bases, which are distinctly marked. The short crura become progressively concave dorsally and separate anteriorly. The crura are slightly incurved at their distal end. Transverse serial sections in the anterior part of the crura are lanciform or crescent-shaped. The dental sockets are not deep and rather narrow; the bottom of the sockets is marked by a few crenulations.

The adductor scars cannot be delimited, and are transverse ellipsoidally shaped, divided medially by the septum.

Comparisons. The name *Eoparaphorhynchus* was chosen to indicate that it is older than *Paraphorhynchus* Weller, 1905 and bears some resemblance to it by the costellae. The two genera are not necessarily related; this problem is open to further investigation. Species of *Paraphorhynchus* always have well marked costellae; species of *Eoparaphorhynchus* may have faint costellae, which are rare or extremely rare in most of the species. *Paraphorhynchus* differs also in its deeper and wider septalium, more slender internal structures, longer dental plates, larger umbonal cavities, differently shaped crura, different ventral muscle field, and other characters.

The genus *Yunnanella* Grabau, 1923 has constant and well marked costellae. In the type species, *Y. hanburii* (Davidson, 1853), the costae are restricted to the anterior part of the shell. These two characters are sufficient to separate *Yunnanella* and *Eoparaphorhynchus,* although there are other external and internal differences. It was presumably the presence of costellae in *Leiorhynchus walcotti* (=*Eoparaphorhynchus maclareni*) that led Warren and Stelck (1950, p. 64) to suggest that the species belonged to the subgenus *Yunnanellina*[1].

Yunnanella[2] cf. *Y. mesoplicata* Grabau, cited by Crickmay (1952a, p. 593), is here attributed, with doubt, to *Sinotectirostrum medicinale* (q.v.). Thus neither the genus *Yunnanella* nor the genus *Nayunella* have yet been found in North America.

It must be stressed that costellae have proved to be of value in the definition of a genus only as one character amongst others. When their presence has been given generic value in itself, then the door has been open to far-reaching mistakes. Thus the attribution of the lower Givetian *Terebratula Schnurii* de Verneuil, 1840 to the genus *Nayunnella,* has been corrected by Schmidt (1964, pp. 505, 506; 1965, pp. 16, 17) by erecting the genus *Schnurella.* This has resulted in the removal of some species from the genus *Yunnanella*[2] and in the modification of the scheme of stratigraphic distribution as proposed by Rozman (1959, 1962). Rozman's suggested evolutionary lineage is not taken into consideration. Rozman (1959, 1960a,b, 1962) also mentions the genera *Yunnanella*[2] and *Yunnanellina*[1] in Kazakhstan and the Mugodjary Mountains in beds of lower and upper Famennian age and includes in the genus *Yunnanellina*[1] some species referred to the genus *Paraphorhynchus* by Nalivkin (1937), Simorin (1956), Martynova (1956, 1961), Sass (1960), and others.

[1] This must be read as *Yunnanella. See* Sartenaer (1961a, 1962).

[2] This must be read as *Nayunnella* Sartenaer, 1961. *See* Sartenaer (1961a, 1962).

The group of Russian forms concerned includes *Paraphorhynchus badura* Nalivkin, 1937, *P. čelak* Nalivkin, 1937, *P. fatima* Nalivkin, 1937, *P. gonthieri* Nalivkin, 1937 (*non* Gosselet, 1887), *Yunnanellina karatauensis* Rozman, 1960, *Y. kasakhstanica* Rozman, 1960, *Y. kurgandjarica* Rozman, 1960, *Y. mugodjarica* Rozman, 1960, *Paraphorhynchus triaequalis* Nalivkin, 1937 (*non* Gosselet, 1877), *P. zobeida* Nalivkin, 1937, *P. zuleika* Nalivkin, 1937. The writer agrees to rejecting from *Paraphorhynchus* the species included in it, but not to attributing them to *Yunnanella* (=Rozman's *Yunnanellina*). It is believed that some of the species may belong to *Eoparaphorhynchus*. Better knowledge of Chinese material and outcrops, and larger Russian collections are needed before drawing definite systematic and stratigraphic conclusions.

Further discussion on costellae may be found *in* Sartenaer (1956, pp. 23, 24).

In summary, the genus *Eoparaphorhynchus* was erected by considering many characters, presence of costellae being one of them, and separation from other genera is also established on the basis of various features.

Resemblances with and differences from the genera *Gastrodetoechia* Sartenaer, 1965 and *Evanescirostrum* Sartenaer, 1965 are given under the description of those genera.

Stratigraphic position and geographic distribution. The species and subspecies referred to this genus are restricted in Belgium, Canada, France, Germany, the U.S.A., and the U.S.S.R. to the lower part of the lower Famennian. For species of the U.S.S.R. *see* also comments above.

Eoparaphorhynchus maclareni Sartenaer

Plate VI, figures 1–12; Plate VII, figures 5–9; Text-figures 13–15

[e.p.?]	1922.	*Leiorhynchus* sp., *Leiorhynchus*—WHITTAKER, pp. 52B, 53B;
[e.p.]	1922.	*Leiorhynchus* cf. *clarkei* Prosser—WILLIAMS, p. 64B;
[e.p.]	1922.	*Leiorhynchus* sp.—HUME, p. 71B, line 33 (*coet. excl.*);
	1922.	*Rhynchonella duplicata*—HUME, p. 71B;
	1944.	*Leiorhynchus walcotti* Merriam—WARREN, pp. 112, 113, pl. II, figs. 7–10 (*non synonymia*);
[e.p.]	1945.	*Leiorhynchus*—HUME and LINK, p. 38, line 60 (*coet. excl.*);
	1945.	*Rhynchonella*—HUME and LINK, p. 38, line 61;
	1950.	*Leiorhynchus walcotti*—WARREN and STELCK, pp. 64, 65;
[e.p.]	1950.	*Leiorhynchus* sp. (=*L. walcotti* Merriam)—WARREN and STELCK, p. 64;
[e.p.]	1954.	*Leiorhynchus*—HUME, p. 46, line 19 (*coet. excl.*);
	1954.	*Rhynchonella*—HUME, p. 46, line 21;
[e.p.]	1954.	*Nudirostra gibbosa* (Haynes) species group—McLAREN, p. 179;
[e.p.]	1954.	*Nudirostra gibbosa walcotti*—McLAREN, p. 173, line 17 (*coet. excl.*);
	1956.	*Nudirostra walcotti* (Merriam) var. *seversoni* McLaren—WARREN and STELCK, pl. XXVI, figs. 35–46;
	1961.	*Leiorhynchus* cf. *L. seversoni* McLaren—DUTRO *in* SABLE and DUTRO, p. 590;
	1961.	*Leiorhynchus* sp.—DUTRO *in* SABLE and DUTRO, p. 590;
	1961d.	*Eoparaphorhynchus maclareni* n. sp.—SARTENAER, pp. 2, 3, pl. I, figs. 1a–e, 2, pl. II, fig. A;
[?]	1965.	*Eoparaphorhynchus maclareni* Sartenaer, 1961—GAETANI, pp. 686, 687, 694, 696, 697, 730–732, pl. 71, figs. 7a–e.

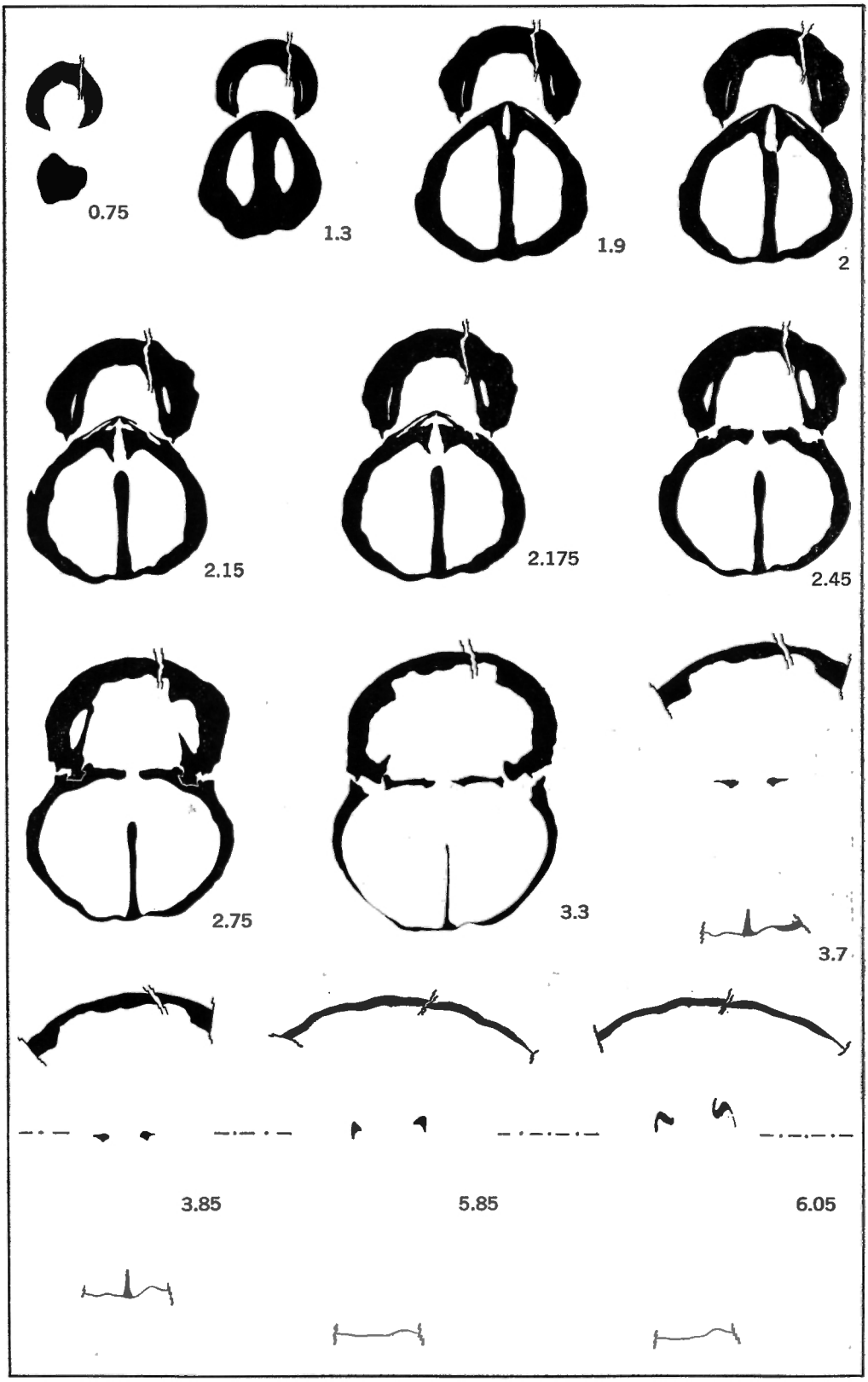
Types

Holotype. GSC No. 15578 (Pl. VI, figs. 1a–e=pl. I, figs. 1a–e *in* Sartenaer, 1961d). GSC loc. 33384. Collector: D. J. McLaren, 1957.

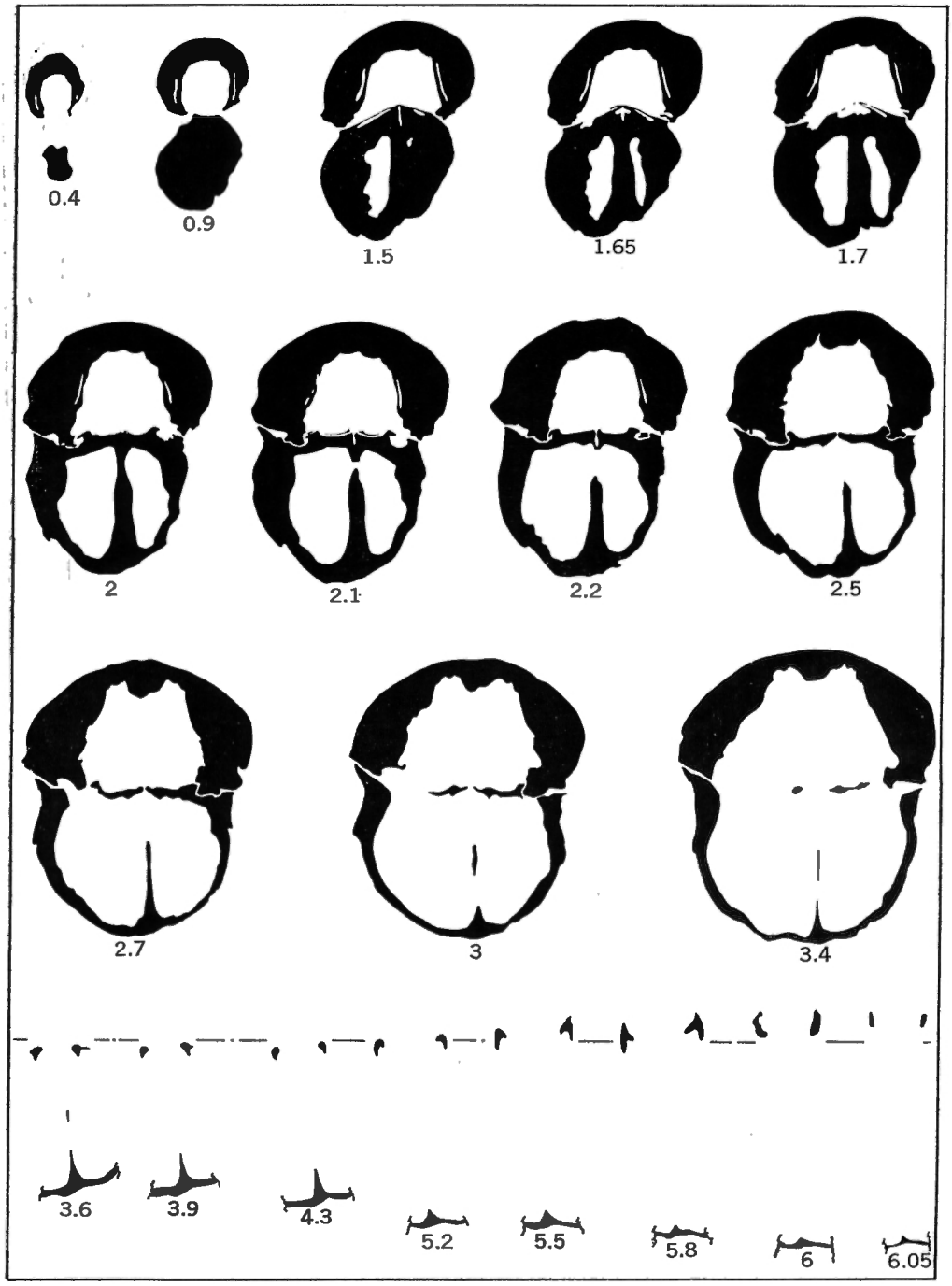
Paratype A. GSC No. 15579 (Pl. VII, figs. 8a–c). GSC loc. 5721. Collector: E. M. Kindle, 1917.

Paratype B. GSC No. 15580 (Pl. VI, figs. 11a–c). GSC loc. 5724. Same collector.

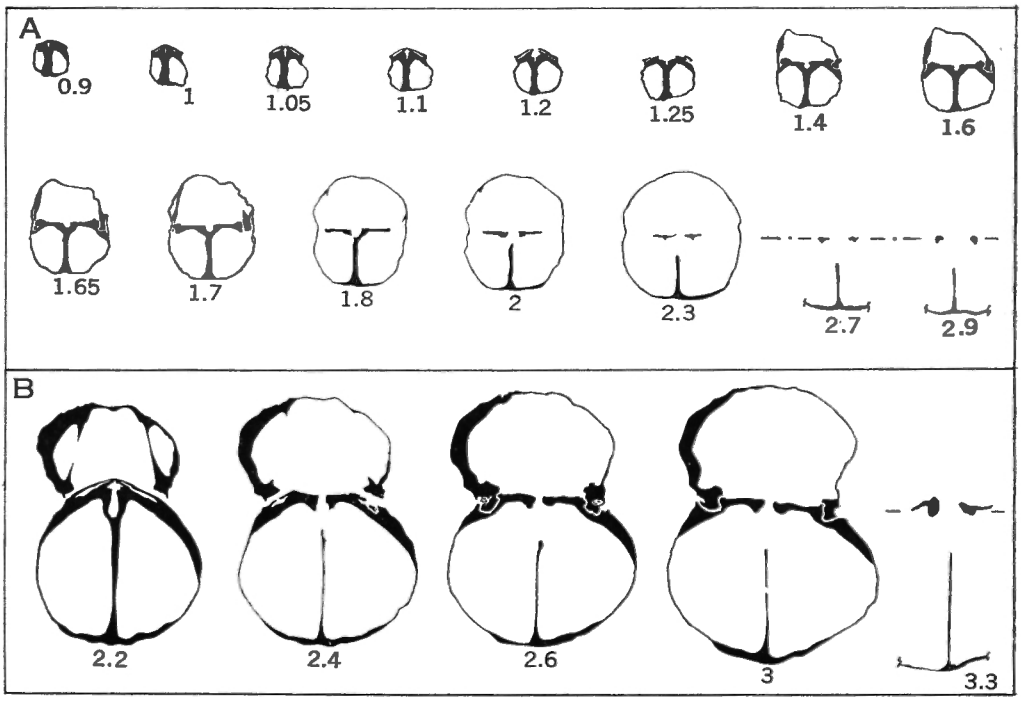
Paratypes C, GSC No. 15581 (Pl. VI, figs. 2a–e); D, GSC No. 15582 (Pl. VI, figs. 10a,b); E, GSC No. 15583 (Pl. VI, figs. 9a–c); F, GSC No. 15584; G, GSC No. 15585 (Pl. VI, figs. 3a–e); H, GSC No. 15586 (Pl. VI, figs. 6a, b); I, GSC No. 15587; J, GSC No. 15588; K, GSC No. 15589 (Pl. VI, figs. 5a–c); L, GSC No. 15590; M, GSC No. 15591 (Pl. VI, fig. 4). GSC loc. 6493. Collector: E. M. Kindle, 1919.



TEXT-FIGURE 13. *Eoparaphorhynchus maclareni* Sartenaer
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype DD, GSC No. 15608 (l:21.0 mm; w:22.7 mm; t:17.8 mm).



TEXT-FIGURE 14. *Eoparaphorhynchus maclareni* Sartenaer
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype AA, GSC No. 15605 (l:20.5 mm; w:24.1 mm; t:23.3 mm).



TEXT-FIGURE 15. *Eoparaphorhynchus maclareni* Sartenaer
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
A = Paratype BB, GSC No. 15606 (l:14.4 mm; w:15.2 mm; t:10.3 mm);
B = Paratype CC, GSC No. 15607 (l:19.4 mm; w:23.0 mm; t:17.2 mm).

Paratype N. GSC No. 15592 (Pl. VII, figs. 7a, b=pl. I, fig. 2 *in* Sartenaer, 1961d). GSC loc. 7149C. Collector: G. S. Hume, 1921.

Paratypes O, GSC No. 15593; P, GSC No. 15594. GSC loc. 7169. Same collector.

Paratypes Q, GSC No. 15595 (Pl. VI, figs. 12a,b); R, GSC No. 15596 (Pl. VII, figs. 5a, b; S, GSC No. 15597 (Pl. VI, fig. 7). GSC loc. 7184. Collector: G. S. Hume, 1921.

Paratypes T, GSC No. 15598 (Pl. VII, figs. 9a,b); U, GSC No. 15599 (Pl. VII, fig. 6). GSC loc. 38691. Collector: P. Sartenaer, 1959.

Paratypes V, GSC No. 15600; W, GSC No. 15601; X, GSC No. 15602; Y, GSC No. 15603. GSC loc. 38693. Collector: P. Sartenaer, 1959.

Paratype Z. GSC No. 15604 (Pl. VI, figs. 8a, b). GSC loc. 38716. Same collector.

Paratypes AA, GSC No. 15605 (Text-fig. 14=pl. II, fig. A *in* Sartenaer 1961d); BB, GSC No. 15606 (Text-fig. 15A). Same locality, formation and collector as for paratypes C to M.

Paratypes CC, GSC No. 15607 (Text-fig. 15B); DD, GSC No. 15608 (Text-fig. 13). GSC loc. 7184. Collector: G. S. Hume, 1921.

Material

GSC localities on the Mackenzie River, N.W.T.: 5721 (270), 5722 (3), 5723 (11), 5724 (30), 7149A (95), 7149B (27), 7149C (6), 7149F (177), 11375 (11), 11426 (1), 26756 (8), 38692 (70), 38693 (81), 38694 (2), 38695 (3), 38697 (26), 38703 (12), 43328 (8).

GSC localities in the Root River valley, N.W.T.: 6493 (598), 7169 (203), 7178 (1), 7179 (1), 7180 (120), 7183 (6), 7184 (212), 7186 (2), 7189 (15), 7190 (1), 12837 (3), 12838 (16), 22484 (12), 22493 (7), 22534 (10), 22538 (7), 22547 (11), 26759 (10), 28633 (6), 28638 (4), 33384 (50), 33385 (19), 38691 (181), 38707 (20), 38716 (132), 38722 (10), 38725 (50).

GSC localities in the North Nahanni River valley, N.W.T.: 7158A (1), 7158B (3), 7158C (35), 7159 (3), 7161B (1), 7161C (5), 33332 (5), 33341 (3), 33412 (4), 33418 (2), 33457 (14), 36043 (4), 36045 (4), 38699 (10), 38704 (5), 38709 (11), 38714 (4), 38717 (38), 38718 (7), 38720 (9).

GSC localities in the Redstone River valley, N.W.T.: 32989 (4), 32993 (147), 33001 (17).

GSC localities in the Blackstone River valley, N.W.T.: 21965 (77), 36061 (36).

Three specimens collected by E. J. Whittaker on the Trout River, N.W.T., but the locality is doubtful.

The species may be present in the Imperial Sikanni Chief No. 1 well, British Columbia, but the available material is very poorly preserved: GSC locs. 41898 (1), 41899 (1), 41902 (3), 41903 (1), 41905 (1).

Forty-two specimens have been studied, all from De Long Mountains, Alaska.

More than four fifths of these 3,049 specimens are in satisfactory state of preservation.

Description

The species is medium to large sized. The contour in dorsal view is variable. Transversally most of the specimens are slightly oval or circular. Commissure is sharp and strongly crenulated by the costae. The top of the tongue rarely represents the greatest thickness of the shell, which is usually located in the anterior part of the brachial valve at a variable distance from the front.

Pedicle valve. Flanks are gently curved, except in the postero-lateral part where they are steep to vertical and very often concave near the commissure. The umbonal region is commonly inflated, sometimes very strongly.

The sulcus starts at a variable distance from the beak, depending on the inflation of the umbonal region, rarely close to the beak and sometimes at mid-length of valve. The sulcus is usually shallow—one to two times the height of median costae—and may be very shallow (paratype B, Pl. VI, fig. 11; paratype R, Pl. VII, fig. 5a) or even medially inflated to the same level as the flanks (paratype N, Pl. VII, fig. 7a) when the median part of the sulcus is swollen. The well marked sulcus has its greatest width varying for most of the specimens between 61 and 78 per cent of the width of the shell; two thirds of the specimens show values between 65 and 78 per cent. The bottom of the sulcus is flat or slightly convex. The form of the tongue depends on the height of the valve. The upper part tends to become vertical and is sometimes recurved posteriorly. Median costae often protrude anteriorly beyond the sharp borders of the trapezoidal tongue.

The beak is erect to slightly incurved, rarely strongly incurved; at its apex is a minute circular foramen. The beak does not commonly overhang the hinge line. When strongly incurved or when umbonal regions are inflated, the beak may touch the brachial valve. The interarea is limited ventrally by a low ridge which tends to disappear or disappears away from the beak. The interarea is low, the height depending on the size; its length corresponds to 40 to 56 per cent of the width of the shell. The delthyrium occupies, at its base, half the length of the interarea. Deltidial plates appear in transverse serial sections of some specimens.

Brachial valve. Dorsal flanks are very seldom abrupt, except in the postero-lateral part where they are often recurved at the commissure.

The well marked fold starts forward of the beak and its top is flat or slightly convex. The height of the fold is variable. From the highest point, located in the anterior part of the shell, the valve falls towards the frontal commissure.

Ornament. The general costal formula is 3½; 0; ½ to 2/3.

Median costae, observed in 2,015 specimens, have shown the following ratios (number of specimens is between brackets):

	Totals %	Adults %	Juveniles %
0	0.40 (8)		2.50 (8)
2/1	10.30 (208)	8.90 (150)	17.95 (58)
3/2	78.60 (1583)	79.60 (1347)	73.05 (236)
4/3	10.10 (204)	10.80 (183)	6.50 (21)
5/4	0.60 (12)	0.70 (12)	
	100 (2015)	100 (1692)	100 (323)

The proportions vary little from one outcrop to another as can be seen in the table below.

	GSC loc. 6493 Root River			GSC loc. 5721 Mackenzie River			GSC loc. 21965 Blackstone River			GSC loc. 38716 Root River		
	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %
0		5.20 (3)	1.– (3)									
2/1	8.45 (20)	20.70 (12)	10.90 (32)	4.85 (5)	13.80 (4)	6.80 (9)	15.65 (10)	10.– (1)	14.85 (11)	13.95 (12)	26.65 (4)	15.85 (16)
3/2	78.40 (185)	67.40 (39)	76.20 (224)	82.50 (85)	69.– (20)	79.55 (105)	79.70 (51)	90.– (9)	81.10 (60)	75.60 (65)	73.35 (11)	75.25 (76)
4/3	11.85 (28)	6.75 (4)	10.90 (32)	12.65 (13)	17.20 (5)	13.65 (18)	3.10 (2)		2.70 (2)	10.45 (9)		8.90 (9)
5/4	1.30 (3)		1.– (3)				1.– (1)		1.35 (1)			
	100 (236)	100 (58)	100 (294)	100 (103)	100 (29)	100 (132)	100 (64)	100 (10)	100 (74)	100 (86)	100 (15)	100 (101)

Median costae are generally simple and start at the beaks or very near to them. They are angular, but their top is rounded to round-flattish near the beaks. Their average width at the front is 4 to 5 mm with a minimum of 2½ mm and a maximum of 7 to 8 mm. In one specimen out of a hundred, divisions occur either as one or two biparted costae on the fold (paratype I) with corresponding intercalated costa(e) in the sulcus, or as a secondary costa, or as an adventitious costa (paratype R, Pl. VII, fig. 5b). Irregular costae are present in 5 per cent of the specimens (paratype A, Pl. VII, fig. 8; paratype B, Pl. VI, fig. 11; paratype D, Pl. VI, fig. 10; paratype S, Pl. VI, fig. 7; paratype V). In many more specimens, this irregularity is very slight—the bounding costae of the fold are lower than the other(s).

Parietal costae, on one side only, are present in 1 to 3.5 per cent of the specimens, depending on the locality. Most of them start at the beaks (paratype T, Pl. VII, fig. 9b), but

some do not (paratype D, Pl. VI, fig. 10). Parietal costae could be considered either as median costae (i.e., an accentuation of the difference of level between middle and bounding costae on the fold), or as lateral costae (i.e., an internal costa located particularly high or low).

Lateral costae, observed in 1,583 specimens, have shown the following ratios:

	Totals %	Adults %	Juveniles %
0	7.10 (112)	2.45 (32)	29.85 (80)
1/2	25.0 (396)	21.20 (279)	43.65 (117)
2/3	52.05 (824)	57.40 (755)	25.75 (69)
3/4	13.35 (211)	15.90 (209)	0.75 (2)
4/5	2.20 (35)	2.65 (35)	
5/6	0.30 (5)	0.40 (5)	
	100 (1,583)	100 (1,315)	100 (268)

The ratios, in the same outcrops as above, are as follows:

	GSC loc. 6493 Root River			GSC loc. 5721 Mackenzie River			GSC loc. 21965 Blackstone River			GSC loc. 38716 Root River		
	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %	Adults %	Juveniles %	Totals %
0	0.95 (2)	35.10 (20)	8.35 (22)	1.15 (1)	25.– (5)	5.70 (6)		60.– (6)	8.– (6)	2.35 (2)		2.05 (2)
1/2	30.10 (62)	43.85 (25)	33.10 (87)	10.60 (9)	45.– (9)	17.15 (18)	16.90 (11)	40.– (4)	20.– (15)	27.05 (23)	50.– (7)	30.30 (30)
2/3	50.– (103)	21.05 (12)	43.70 (115)	56.45 (48)	30.– (6)	51.40 (54)	66.20 (43)		57.35 (43)	49.40 (42)	50.– (7)	49.50 (49)
3/4	16.50 (34)		12.95 (34)	25.90 (22)		20.95 (22)	16.90 (11)		14.65 (11)	20.– (17)		17.15 (17)
4/5	2.45 (5)		1.90 (5)	5.90 (5)		4.80 (5)				1.20 (1)		1.– (1)
	100 (206)	100 (57)	100 (263)	100 (85)	100 (20)	100 (105)	100 (65)	100 (10)	100 (75)	100 (85)	100 (14)	100 (99)

One or two of the internal lateral costae start from the umbonal regions; the other(s) are restricted to the anterior part of the shell and, sometimes, are mere indentations of the commissure. In almost 20 per cent of the specimens, the number of costae is different on each flank. This is not uncommon for the genus, but it is exceptionally frequent in this species (paratype D, Pl. VI, fig. 10a; paratype R, Pl. VII, fig. 5a). Lateral costae are simple and similar to the median ones. Two per cent of the specimens show an internal ventral costa narrower and lower than the others (paratype E, Pl. VI, figs. 9a,b), which is sometimes the result of the bipartition. There may be a corresponding costa in the brachial valve.

Costellae occur in almost 10 per cent of the specimens (holotype; paratype A, Pl. VII, figs. 8a,c; paratype F; paratype N, Pl. VII, fig. 7b).

Growth lines are common.

Dimensions. Measurements of thirteen specimens:

	Paratype F	Paratype T	Paratype P	Paratype W	Paratype R	Paratype D	Holotype	Paratype C	Paratype V	Paratype X	Paratype E	Paratype Q	Paratype Y
l	26.3	(23.3)	23.0	22.2	21.8	21.6	(20.7)	20.7	20.5	20.1	18.2	17.5	17.5
w	27.8	29.1	23.8	28.8	22.3	22.6	24.3	22.9	21.1	22.9	20.7	23.0	20.7
lpv unrolled	37.0	38.0	34.0	33.5	37.5	33.0	32.0	34.0	32.3	34.0	31.5	28.0	26.5
t	18.8	20.5	17.7	16.6	22.3	18.4	16.6	18.9	17.4	18.7	17.3	15.7	13.9
tpv	6.9	6.1	6.9	6.8	6.3	5.9	4.8	5.9	5.9	6.1	5.4	4.6	4.5
tbv	11.9	14.4	10.8	9.8	16.0	12.5	11.8	13.0	11.5	12.6	11.9	11.1	9.4
l/w	0.95	(0.80)	(0.97)	0.76	0.98	0.96	(0.85)	0.90	0.97	0.88	0.88	0.76	0.85
t/w	0.68	0.70	0.74	0.58	1.00	0.81	0.68	0.83	0.82	0.82	0.84	0.68	0.67
t/l	0.71	(0.80)	0.77	0.75	1.02	0.85	(0.80)	0.91	0.85	0.93	0.95	0.90	0.79
shoulder angle	(100°)	125°	120°	125°	116°	(120°)	115°	115°	105°	111°	110°	120°	110°

The holotype and paratypes C,D,E,P,V,X refer to specimens having the typical shape of the species; the holotype and paratypes C,D,P refer to specimens having the usual size of adult specimens.

Most specimens have shoulder angles between 110 and 125 degrees, but values as low as 100 degrees have been measured.

Internal characters. The internal characters are given under the description of the genus.

Growth. Measurements of eight juvenile specimens:

	Paratype G	Paratype O	Paratype H	Paratype I	Paratype K	Paratype J	Paratype L	Paratype M
l	13.8	11.8	11.5	11.0	10.1	10.0	8.8	8.4
w	13.0	13.4	12.8	12.7	10.1	10.7	8.7	8.0
lpv unrolled	17.0	13.2	14.5	12.0	11.0	12.0	10.0	9.0
t	7.7	5.7	6.8	4.7	4.2	4.9	3.7	3.9
tpv	3.6	2.7	2.5	2.1	2.2	2.4	2.0	1.8
tbv	4.1	3.0	4.3	2.6	2.0	2.5	1.7	2.2
l/w	1.06	0.88	0.90	0.87	1.00	0.93	1.01	1.05
t/w	0.59	0.43	0.53	0.37	0.42	0.46	0.43	0.49
t/l	0.56	0.48	0.59	0.42	0.42	0.49	0.42	0.46
shoulder angle	94°	115°	100°	110°	98°	115°	105°	95°

The shoulder angle of juvenile specimens, although variable, has a lower mean value.

Juvenile characters are the same as in any species or subspecies of the superfamily Rhynchonellacea.

Discussion

Synonymy. The *Leiorhynchus* mentioned by Whittaker (1922), Hume (1922, 1954), and Hume and Link (1945) have been assigned to this species following study of their collections; some of Hume's specimens have been chosen as paratypes and a few have been figured. Included in their collections are specimens of the *Basilicorhynchus basilicus* Group and *Rugaltarostrum madisonense* (this species only in Whittaker's collections). Whittaker's specimens from Trout River may not be from that locality.

Williams' (1922) original material includes *Eoparaphorhynchus maclareni* and *Basilicorhynchus basilicus basilicus.*

Among the collections, some specimens have been labelled *Camarotoechia* cf. *duplicata, Pugnax* sp., and *Leiorhynchus* n.sp. near *L. madisonense* by Kindle (GSC loc. 5721), and *Rhynchonella duplicata* (GSC locs. 7158B, 7161C), and *Hypothyris* (GSC loc. 7149C) by Hume.

Warren and Stelck's (1950) *Leiorhynchus* sp. (=*L. walcotti*) refers to Hume's (1922) *Leiorhynchus* sp.

The *Nudirostra gibbosa* species group from Root River and the *N. gibbosa walcotti* from the Mackenzie River region, particularly from Hume's Shale Zone No. 2 on North Nahanni and Root Rivers, cited by McLaren (1954), include specimens of *Eoparaphorhynchus maclareni* and *Gastrodetoechia utahensis rugosa*. The specimens identified as *N. walcotti* var. *seversoni* by Warren and Stelck (1956) belong to the new species.

The forty-two specimens identified by Dutro *in* Sable and Dutro, 1961 as *Leiorhynchus* cf. *L. seversoni* and *L.* sp. are considered to belong to *Eoparaphorhynchus maclareni*. This Alaskan population differs somewhat from the type material by having a larger proportion of individuals with 2/1 median costae. These median costae are strongly elevated. If further material from other localities in Alaska should corroborate such difference, the possibility of a geographic subspecies may have to be considered. Ratios of median costae are: 2/1, twenty-nine specimens; 3/2, eleven specimens; 4/3, one specimen; the ratios of lateral costae are: 1/2, four specimens; 2/3, ten specimens; 3/4, nine specimens; 4/5, four specimens.

The specimen figured by Gaetani (1965) is very similar to small specimens of *Eoparaphorhynchus maclareni,* but it is closer to adult specimens of *E. lentiformis;* however, the possibility that the specimen might be a juvenile form of *Gastrodetoechia iranica* is not dismissed.

Comparisons. The species is distinguished by medium to large size, variable contour, sulcus shallow and wide at front, general costal formula, rare divisions of the median costae, median costae of the sulcus often protruding beyond the borders of the tongue.

Costal formulae, measurement ratios, and shoulder angles of *Pugnoides chanakchiensis* Abramian, 1954 are similar; the Armenian species is usually bigger than average specimens of *E. maclareni*. More details about *Pugnoides chanakchiensis* are given under the description of *Evanescirostrum seversoni.*

There are some external resemblances with *Camarotoechia deprati* var. *raricosta* Nalivkin, 1930 but, on account of the lack of information, drawing attention on this point is the most that can be done.

E. maclareni and *E. triaequalis triaequalis* (Gosselet, 1877) are closely related; similar specimens can be picked out in both species (paratype B, Pl. VI, fig. 11). The most striking resemblances lie in the pattern of costal development. Both species have costae of the same nature (height, width, angularity), the same number of lateral costae, similar number of median costae, rare parietal costae, and rare divisions in the median costae. Measurement ratios are also similar in both adult and juvenile forms. The external aspect of the two species is different; *E. triaequalis triaequalis* is commonly inflated in the umbonal regions. This inflation is expressed by the wider shoulder angles; apical angles, on the other hand, are similar. Furthermore, *E. triaequalis triaequalis* differs by a shallower sulcus, larger at the front, more abrupt flanks, smaller size, and less variability. Costellae occur in only two specimens out of 371, but here the state of preservation might play a role and the specific or generic significance of this type of costellation is still not clear.

E. triaequalis praetriaequalis (Sartenaer, 1957) is not as inflated as *E. triaequalis triaequalis* and is closer to *E. maclareni* in its external shape (paratype U, Pl. VII, fig. 6), width of sulcus at the front, the depth of sulcus, and the slope of the flanks. It differs from *E. maclareni* in the general costal formula and size; divisions of median costae are more frequent. Costellae occur in one specimen out of 245.

Some specimens of *E. maclareni* are almost identical to specimens of *E. walcotti* (paratype S, Pl. VI, fig. 7; paratype T, Pl. VII, fig. 9), but such similarities are limited to shape or to median costae (when the number is low) and more rarely to lateral costae; similarities in shape and costae together are not found. Differences on the other hand are numerous. *E. maclareni* has a shallower sulcus, wider at the front, the median part of which is commonly slightly inflated, so that the sulcus begins farther from the beak; median costae protrude beyond the borders of the tongue. *E. maclareni* has wider costae and a different general costal formula, less parietal costae, but divisions in median costae are similar in both species; a depressed ventral internal lateral costa is extremely rare in *E. maclareni*. Costellae occur only in one specimen of *E. walcotti*.

Similarities and differences between *E. maclareni* and *E. lentiformis*, and *Evanescirostrum seversoni* are given under those species.

Stratigraphic position. In Yohin syncline, where the section is complete, the species is present between 129 and 310 feet above the base of the Famennian; specimens increase in size and number upwards. In other outcrops sections are usually not thick enough to show its stratigraphic range.

Hume's (1922b, p. 71B) *Leiorhynchus* Zone includes all occurrences of this species.

Although reported to occur together at such places as Camsell Bend, N.W.T., and in Nevada by Warren and Stelck (1956, p.6), *Nudirostra walcotti seversoni* and *N. walcotti walcotti* do not occur in the N.W.T., and *Evanescirostrum seversoni* is unknown in Nevada.

Dutro *in* Sable and Dutro (1961) considers the Alaskan material to be middle Famennian. The genus *Eoparaphorhynchus* suggests lower Famennian.

Geographic distribution. See under Material. Also present in Alaska.

Eoparaphorhynchus walcotti (Merriam)

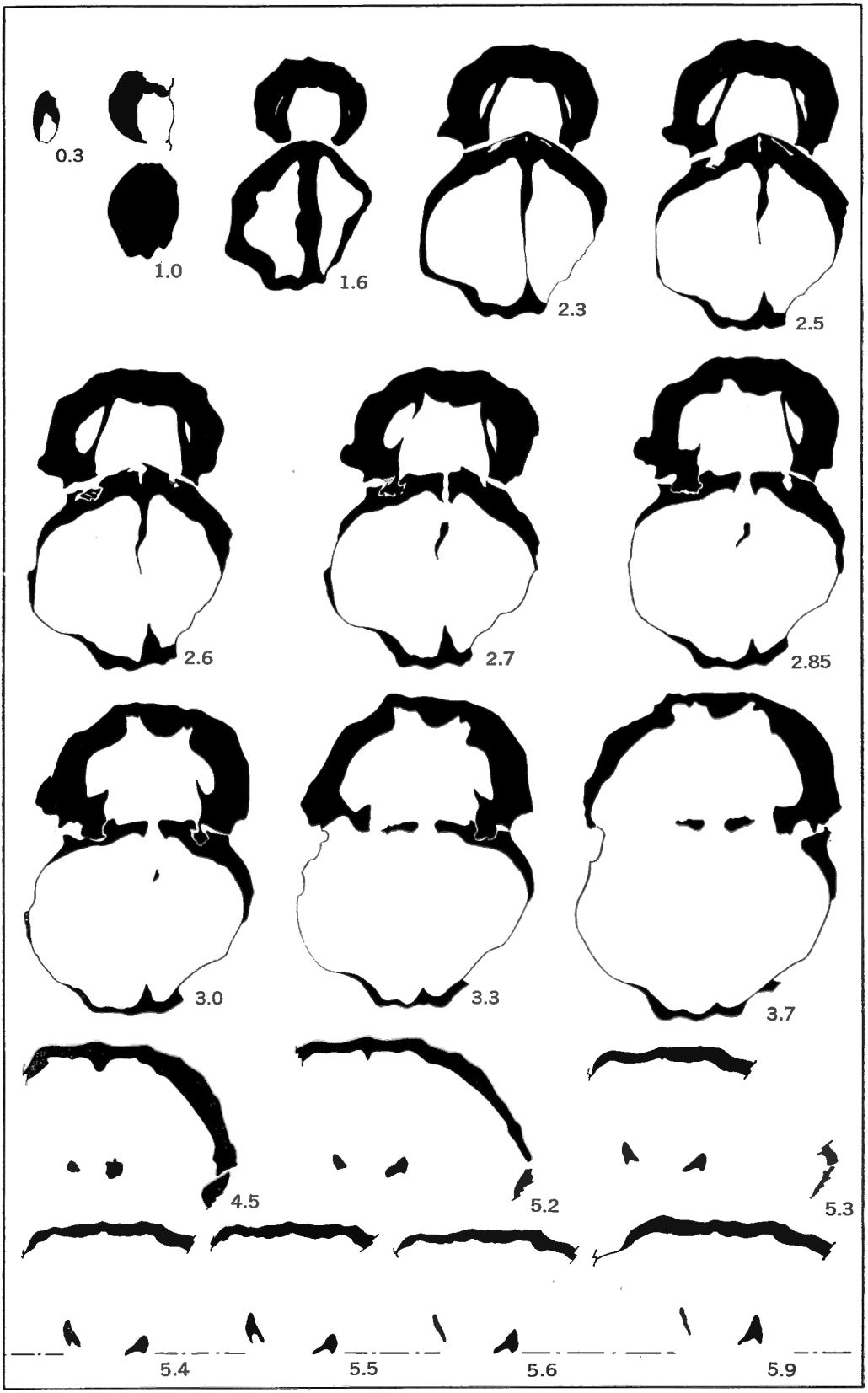
Plate VIII, figures 1–11; Text-figures 16, 17

[e.p.]	1884.	*Rhynchonella pugnus* Martin—WALCOTT, pp. 155–157 (*non synonymia*; *non* figs. 7, 7a);
[e.p.]	1884.	*Rhynchonella* (*Leiorhynchus*) *Laura* Billings—WALCOTT, p. 159 (*non synonymia*);
	1940.	*Leiorhynchus walcotti* n.sp.—MERRIAM, p. 82, pl. 9, figs. 4–8 (*synonymia* e.p.);
[non]	1944.	*Leiorhynchus walcotti* Merriam—WARREN, pp. 112–113, pl. II, figs. 7–10;
[non]	1950.	*Leiorhynchus walcotti* Merriam—WARREN and STELCK, pp. 64, 65;
[non]	1950.	*Leiorhynchus* sp. (=*L. walcotti* Merriam)—WARREN and STELCK, p. 64;
[e.p.]	1954.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, pp. 160, 173, 180, pl. I, figs. 9–11 (*coet. excl.*);
[e.p.]	1955.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 29;
[non]	1955.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 48;
[e.p.]	1956.	*Nudirostra gibbosa walcotti* (Haynes)—BELYEA and McLAREN, p. 89;
	1958.	*Nudirostra walcotti* (Merriam)—McLAREN, p. 194, pl. V, figs. 24–26;
	1962.	"*Leiorhynchus*" *walcotti* Merriam—McLAREN *in* McLAREN and MOUNTJOY, p. 14;
	1962.	"*Leiorhynchus*" *walcotti* Merriam—McLAREN *in* McLAREN, NORRIS, and McGREGOR, p. 32, pl. XV, figs. 24–26 (=pl. V, figs. 24–26 *in* McLAREN, 1958);
	1965.	"*Leiorhynchus*" *walcotti* Merriam—McLAREN *in* MacKENZIE, pp. 9, 83;
	1965.	"*Leiorhynchus*" *walcotti* Merriam—McLAREN *in* MOUNTJOY, p. 30.

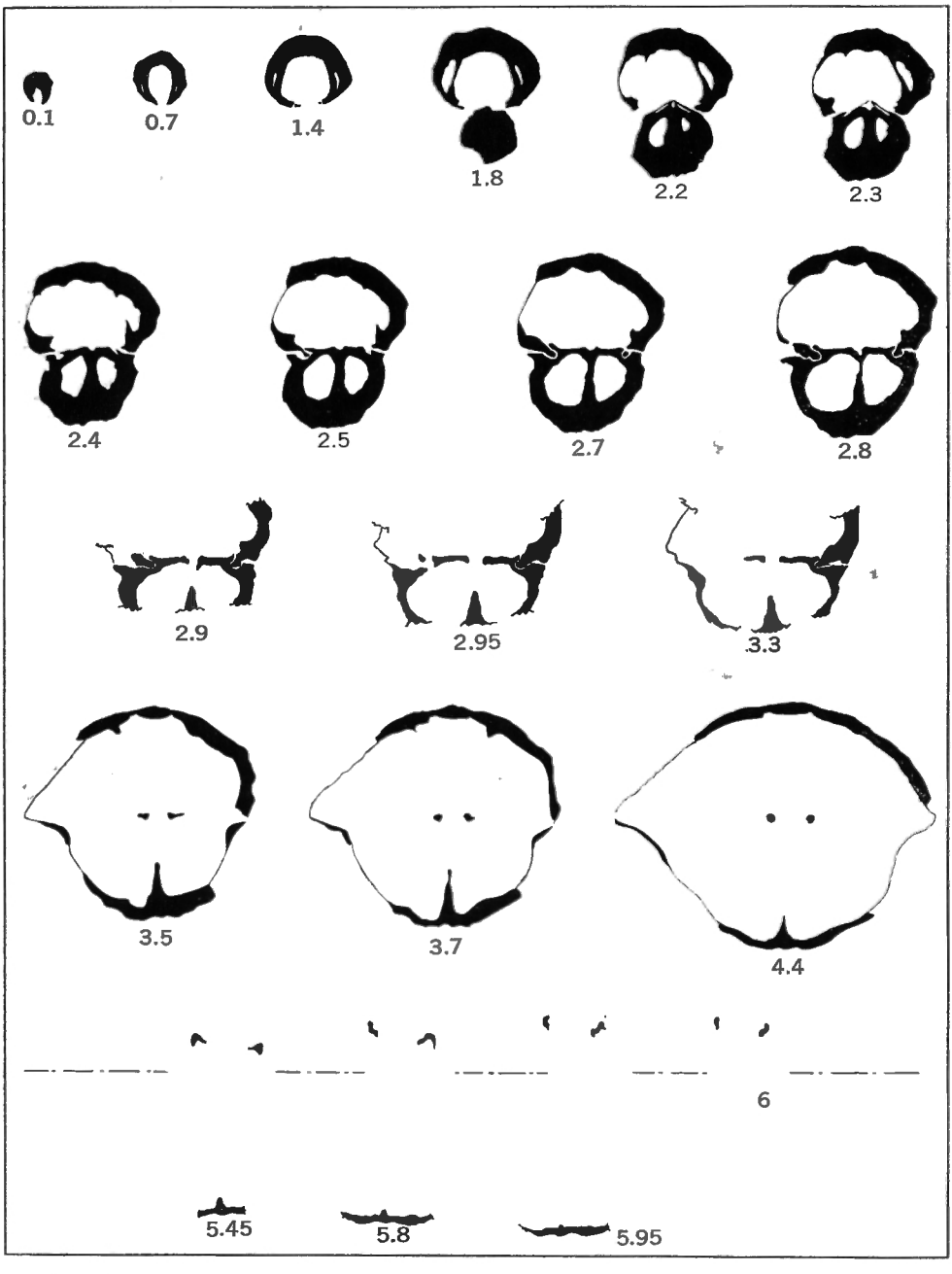
Types

Holotype (Pl. VIII, fig. 10=pl. 9, fig. 5 *in* Merriam, 1940). USNM No. 96381. North side of Devils Gate Pass, Roberts Mountains 15′ Quad., Nevada, U.S.A. Devils Gate Formation, *Cyrtospirifer* Zone, edgewise member. Collector: C. W. Merriam.

Paratypes A (Pl. VIII, 9=pl. 9, fig. 4 *in* Merriam, 1940), USNM No. 96382a; B (pl. 9, fig. 6 *in* Merriam, 1940), USNM No. 96382b; C (Pl. VIII, figs. 3a, b=pl. 9, fig. 8 *in* Merriam, 1940), USNM No. 96382c; D (pl. 9, fig. 7 *in* Merriam, 1940), USNM No. 96382d. Same locality, formation, and collector as holotype.



TEXT-FIGURE 16. *Eoparaphorhynchus walcotti* (Merriam)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype O, USNM No. 154997 (l:(23.3) mm; w:(28.8) mm; t:23.5 mm).



TEXT-FIGURE 17. *Eoparaphorhynchus walcotti* (Merriam)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype N, GSC No. 15561 (l:? mm; w:(26.4) mm; t:? mm). Broken specimen.

Hypotype A. GSC No. 10012 (Pl. VIII, figs. 2a–e=pl. I, figs. 9–11 *in* McLaren, 1954). GSC loc. 18262. Collector: R. de Wit, 1949.

Hypotype B. GSC No. 13800 (Pl. VIII, figs. 5a–d=pl. V, figs. 24–26 *in* McLaren, 1958 =pl. XV, figs. 24–26 *in* McLaren, Norris, and McGregor, 1962). Same locality, formation and collector.

Hypotypes C, USNM No. 154993 (Pl. VIII, figs. 1a–e); D, USNM No. 154994. Eureka District, Nevada, U.S.A. USNM loc. 564. Devils Gate Formation. Collector: C. D. Walcott.

Hypotypes E, GSC No. 15552; F, GSC No. 15553. GSC loc. 18262. Collector: R. de Wit, 1949.

Hypotypes G, GSC No. 15554; H, GSC No. 15555 (Pl. VIII, figs. 4a–d). GSC loc. 24541. Collector: D. J. McLaren, 1953.

Hypotype I. GSC No. 154995 (Pl. VIII, figs. 7a–e). Same locality, formation, and collector as for hypotypes C and D.

Hypotypes J, GSC No. 15557 (Pl. VIII, fig. 11); K, GSC No. 15558 (Pl. VIII, fig. 8); L, GSC No. 15559 (Pl. VIII, figs. 6a–e). Same locality, formation, and collector as for hypotypes A, B, E, and F.

Hypotype M. GSC No. 15560. Same locality, formation, and collector as for hypotypes G and H.

Hypotype N (Text-fig. 17). GSC No. 15561. Same locality, formation, and collector as for hypotypes A, B, E, F, J, K and L.

Hypotype O (Text-fig. 16). USNM No. 154997. Devils Gate area, Nevada, U.S.A. Devils Gate Formation, *Cyrtospirifer* Zone. Collector: C. W. Merriam.

Material

Nevada. Eighteen specimens from the Eureka District: five primary types; seven specimens in the collections of the Geological Survey of Canada; six specimens presented to the writer, in 1953, by Dr. C. W. Merriam. 133 specimens, under various identifications, have been studied at the United States National Museum in Washington in the collections of C. D. Walcott and E. Kirk.

Utah. Ten specimens from the top of the Guilmette Formation in the Newfoundland Range have been studied at the Idaho State College.

Canadian Rocky Mountains. GSC localities: 18262 (65); 18263 (3); 24528 (3); 24529 (6); 24539 (9); 24541 (113); 24542 (1); 48370 (8).

Of these 200 specimens, only one tenth may be considered in satisfactory state of preservation.

Description

The species is medium to large sized with variable contour. Wide specimens have an oval contour; others are subcircular. In narrow specimens, the fold falls less strongly, if at all, and its highest point is close to the front. The commissure is sharp and strongly indented by the costae. The postero-lateral margins are concave, near the commissure. Width is the greatest dimension.

Pedicle valve. The flanks slope gently towards the commissure, more steeply in the posterior part.

The sulcus begins usually a short distance from the beak but sometimes as far from it as four tenths of the length; it is well defined, deepens slowly and widens quickly forward. The bottom of the sulcus is flat or slightly convex; its greatest width varies between 53 and 65 per cent of the width of the shell.

The upper part of the tongue tends to be vertical or even recurved.

The small, erect to suberect beak does not overhang the hinge line. The minute foramen, rarely observed, encroaches on the beak. Only fragments of deltidial plates have been seen. The interarea is well defined; its length varies between 46 and 60 per cent of the width of the shell, with an average height of one millimetre.

Brachial valve. The flanks curve progressively towards the commissure. With increasing height, the flanks become steeper and even sometimes vertical near the commissure.

The well marked fold starts a short distance from the beak and increases quickly in height. Its greatest height lies at a variable distance back from the commissure and corresponds to two to four times the height of the median costae. Its top is slightly convex transversely.

Ornament. The general costal formula is 3/2 to 5/4; 0; 4/5 to 7/8.

Median costae, observed in 82 specimens, show the following ratios:

2/1 : 1.20% (1 sp.); 3/2 : 14.65% (12 sp.); 4/3 : 52.45% (43 sp.); 5/4 : 25.60% (21 sp.); 6/5 : 6.10% (5 sp.).

Median costae are generally simple and start at the beaks. A few specimens show one or two divided or intercalated median costae in either fold or sulcus, including the holotype which has a biparted costa on the fold (Pl. VIII, fig. 10) and, paratype C with two intercalated costae in the sulcus (Pl. VIII, figs. 3a, b) and corresponding biparted costae on the fold. Three out of these specimens have 6/5 median costae and two have 5/4. Median costae are flattened and rounded in the posterior part of the shell, and become angular anteriorly. Posteriorly the furrows have only a fraction of the width of the costae, but have a similar width anteriorly. Median costae vary in width from 2.5 to 5 mm at the front, 3 to 4 mm being a common measurement. In more than half of the specimens, median costae are irregular. When there are more than three costae on the fold, the two external ones are usually narrower and lower than the median ones.

Parietal costae occur in one out of five specimens.

Lateral costae, observed in 37 specimens, show the following ratios:

3/4 : 10.80% (4 sp.);
4/5 : 18.95% (7 sp.);
5/6 : 37.85% (14 sp.);
6/7 : 16.20% (6 sp.);
7/8 : 16.20% (6 sp.).

The ratios in the primary types (virtual costae excluded) are: holotype: 6/7; paratype A: 4/5; paratype B: 7/8; paratype C: (4/5); paratype D: 3/4.

Lateral costae, like median costae, are flattened and rounded in the posterior part of the shell, and become angular anteriorly. They start at the umbonal regions, except the one or two most external ones, which may be mere indentations of the commissure. In a few specimens including the holotype and paratypes A and C, there are external virtual costae, which have not been included in the ratios given above: these costae are faint and do not indent the commissure (paratype C, Pl. VIII, fig. 3b on left side). Commonly, on one flank of the pedicle valve—more rarely on both flanks—the internal lateral costa is narrower and depressed (paratype C, Pl. VIII, fig. 3a; hypotype B, Pl. VIII, fig. 5d; hypotype C, Pl. VIII, fig. 1c). This costa may be the result of a bipartition (hypotype K, Pl. VIII, fig. 8 on left side). A corresponding costa in the brachial valve may occur (hypotype B, Pl. VIII, fig. 5a). Such a depressed costa might be considered parietal (hypotype J, Pl. VIII, fig. 11 on left side), but, because of the developmental pattern of such costae, they are considered as lateral.

Growth lines are common. Costellae occur in one specimen.

Dimensions. Measurements of thirteen specimens.

The holotype, paratypes A, B, C, D, and hypotypes C and D are specimens from Nevada, the others are specimens from the Canadian Rocky Mountains.

	Paratype C	Paratype D	Hypotype B	Hypotype E	Paratype B	Holotype	Hypotype D	Hypotype C	Hypotype A	Hypotype F	Hypotype G	Hypotype M	Paratype A
l	(24.0)	(23.0)	(22.5)	(22.5)	(22.3)	(21.6)	21.2	21.1	20.7	20.2	19.6	19.1	18.2
w	(31.9)	29.6	28.8	27.9	26.2	26.6	(25.0)	25.2	25.1	(23.0)	22.3	(22.0)	21.6
lpv unrolled	?	?	?	(32.0)	(36.0)	?	37.0	33.0	31.0	34.0	?	30.0	(32.0)
t	(21.8)	21.4	20.0	17.0	21.4	17.1	21.1	19.0	16.0	19.6	(16.2)	(17.2)	(16.0)
tpv	(8.6)	7.5	6.4	5.8	5.9	7.4	5.0	7.0	6.0	5.5	4.5	(4.3)	6.0
tbv	13.2	13.9	13.6	11.2	15.5	9.7	16.1	12.0	10.0	14.1	11.7	(12.9)	(10.0)
l/w	(0.75)	(0.78)	(0.78)	(0.81)	0.85	(0.81)	(0.85)	0.84	0.82	(0.88)	0.88	(0.87)	0.84
t/w	(0.68)	0.72	0.69	0.61	0.82	0.64	(0.86)	0.75	0.64	(0.85)	(0.73)	(0.78)	(0.74)
t/l	(0.91)	(0.93)	0.89	(0.76)	(0.96)	(0.79)	1.0	0.90	0.77	(0.97)	(0.83)	(0.90)	(0.88)
shoulder angle	?	?	?	(130°)	125°	?	111°	120°	110°	110°	110°	(110°)	110°

The extremes of the shoulder angle are 107° and 125°; despite the fact that transition values exist, specimens are mostly concentrated around low values (paratype A, hypotypes D, F, G) and high values (paratype B, hypotypes C, E), in other words around narrow and wide forms. Thickness is variable (*see* ratios t/w and t/l).

Growth. As the species has a monocyclic non-constant curvature growth, juvenile characters (in juvenile stages or maintained in later stages) are associated with thin forms (*see* table below).

Juvenile forms are poorly preserved. The two specimens on the following table are at a more advanced stage, but retain juvenile characters (measurements in mm):

Hypotype	l	w	lpv unrolled	t	tpv	tbv	l/w	t/w	t/l	shoulder angle
I	18.4	23.0	24.5	11.3	5.2	6.1	0.80	0.49	0.61	118°
H	16.1	(18.2)	21.0	7.7	3.6	4.1	(0.88)	(0.42)	0.48	109°

Discussion

Synonymy. Walcott's (1884) *Rhynchonella pugnus* and *Rhynchonella* (*Leiorhynchus*) *Laura* are put into partial synonymy, as more than ¾ of his specimens in the U.S. National Museum belong to *E. walcotti.*

Merriam's (1940) synonymy is accepted only *e parte* because Walcott's *Rhynchonella* (*Leiorhynchus*) *sinuatus* seems to be a distinct species.

Mention subsequent to the original description of *Eoparaphorhynchus walcotti* in the United States of America has been left out of the synonymy.

Forms described as *Leiorhynchus walcotti* by Warren (1944), and Warren and Stelck (1950) belong to *Eoparaphorhynchus maclareni* (differences between the 2 species are discussed under the description of that species), but forms listed by them as *Leiorhynchus* sp. (=*L. walcotti* Merriam) belong to *Eoparaphorhynchus maclareni* and the *Basilicorhynchus basilicus* Group.

Since 1954, McLaren has recognized the identity between the Nevada form and specimens from the Canadian Rocky Mountains. As the writer separates the collections from Medicine Lake under a separate species, *Eoparaphorhynchus lentiformis,* and as the species is unknown in the Mackenzie River region, only part of McLaren's *Nudirostra gibbosa walcotti* is brought into synonymy. Some of McLaren's (1955) *N. gibbosa walcotti* may be *Evanescirostrum seversoni.*

Remarks. As noted above, and in the table of measurements, the contour of *Eoparaphorhynchus walcotti* is variable. Further collecting should indicate if wide and narrow forms of *E. walcotti* belong to separate subspecies (geographic, stratigraphic, or related with facies). The presence of intermediate forms suggests that we are dealing with a single species, but the scarcity of the available collections and the lack of information on the variability and exact stratigraphic position of the species does not allow a definite conclusion. The problem is similar in the Canadian Rocky Mountains and, here too, more collecting and accurate information is needed, as most of the specimens (GSC locs. 18262, 18263, 24528, 24541, 24542) have been collected without detailed stratigraphic data or from talus.

Because of the poor preservation of the material (*see* above) it is not possible to state definitely that the Nevada and Canadian forms are identical or that they are separate subspecies. Specimens from Nevada commonly have more irregular median costae or more virtual lateral costae or lateral costae than specimens from Canada.

The following possibilities are open: extreme variability of one species; existence of two or more subspecies either in Nevada, or in Canada, or in both. Specimens like those from GSC loc. 24539 would represent an extreme departure from the mean or the subspecies.

Comparisons. The species is distinguished by medium to large size, variable contour, sulcus and fold starting a short distance from the beaks, fold commonly falling from top of brachial valve to front, general costal formula, rare divisions of the irregular median costae, internal lateral costa very often narrower and depressed in relation to the others.

McLaren (1954) elevated the variety *Leiorhynchus madisonense* var. *gibbosum* to specific rank and recognized in this new species 2 subspecies: *Nudirostra gibbosa walcotti,* and *N. gibbosa seversoni,* but later restored *walcotti* to specific status (McLaren, 1958, 1962 *in* McLaren, Norris and McGregor). There are close resemblances between *Eoparaphorhynchus walcotti* and some specimens of *Rugaltarostrum gibbosum,* as for example the type of Haynes' variety. These resemblances, of which Merriam (1940) and Baldwin (1943) were well aware, may be seen in the descriptions and figures, but there are many differences. *R. gibbosum* has a different shape; its tongue grows higher and thus, the greatest thickness of the shell is at the frontal commissure; its length is smaller in relation to the width; its shoulder angle is different; the usual number of lateral costae is different and it does not possess any depressed ventral internal lateral costa; its median costae are not irregular and do not reach the high numbers possible in *Eoparaphorhynchus walcotti;* the middle dorsal costae reach the beak and are never replaced by a groove near to the beak.

The many differences between *E. walcotti* and specimens of *Pugnoides chanakchiensis* Abramian, 1954, from the uppermost upper Famennian and the lower Strunian of the S.S.R. of Armenia, include the general costal formula; more details about the Armenian species are given under the description of *Evanescirostrum seversoni.*

The figured specimens of *Camarotoechia deprati* Mansuy of Nalivkin, 1930 (non *C. deprati* Mansuy 1912) resemble wide specimens of *Eoparaphorhynchus walcotti* in the costae (number, aspect, eventual divisions), shape, shoulder angle; the formula of costae according to the text is higher than in the figures.

The inflated aspect of *Eoparaphorhynchus triaequalis triaequalis,* its general costal formula, and its smaller size make this subspecies easily separable from *E. walcotti. E. triaequalis praetriaequalis* also is smaller, but is similar to *E. walcotti* in its shape (measurement ratios, shoulder angles), the number of median costae, and the occurrence of a depressed ventral internal lateral costa (although rare), but *E. walcotti* has more lateral costae, rarely divided median costae, generally a deeper sulcus and higher fold, both of which start nearer to the beaks.

Resemblances and differences from *E. lentiformis* and *Evanescirostrum seversoni* are discussed under the description of those species.

Stratigraphic position. The species is abundant in the "*Cyrtospirifer* zone" of the Devils Gate Formation of Nevada introduced by Merriam (1940), and present in the Guilmette (upper part) and West Range Formations.

In the Canadian Rocky Mountains, the species has been found only in the lowest beds (the lower member) of the Sassenach Formation. On the east side of Deception Creek, it has been found by McLaren (1955, p. 29) in unit 30, between 90 and 126 feet from the base of the Lower Member of the Sassenach Formation, and on the ridge northwest of Rocky River Forks, at 131 feet from the base of the same formation. In the Brazeau map-area it has been collected at 200 feet above the base of the Sassenach Formation.

Geographic distribution. Outside Nevada and Utah, the species is known from a limited area in the Canadian Rocky Mountains: top of Prospect Mountain and base of Climax Mountain near Mountain Park; northeast and northwest side of Deception Creek; ridge northwest of Rocky Forks; Brazeau map-area.

Eoparaphorhynchus lentiformis (Nalivkin, 1930) (*non* Gürich, 1903)

Plate IX, figures 1–8; Text-figure 18

For full consideration of this species *see* Sartenaer (1957a). A short synonymy referring to Canadian specimens and more recent publications is given here.

	1954.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 173, line 7 (*coet. excl.*);
[e.p.]	1954.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 180, pl. I, figs. 12, 13 (*coet. excl.*);
	1955.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 48;
	1955.	*Nudirostra* sp.—McLAREN, p. 48;
[e.p.]	1956.	*Nudirostra gibbosa walcotti* (Haynes)—BELYEA and McLAREN, p. 89;
	1962.	"*Leiorhynchus*" *lentiformis* Nalivkin—SARTENAER *in* McLAREN and MOUNTJOY, p. 27;
[?]	1963.	*Eoparaphorhynchus lentiformis* (Nalivkin)—GAETANI *in* ASSERETO, pp. 526, 528;
[?]	1965.	*Eoparaphorhynchus maclareni* Sartenaer, 1961—GAETANI, pp. 686, 687, 694, 696, 697, 730–2, pl. 71, figs. 7a–e.

Types

Hypotypes A, GSC No. 15564 (Pl. IX, figs. 1a–e); B, GSC No. 15565 (Pl. IX, figs. 5a–d). GSC loc. 19606. Collector: D. J. McLaren, 1951.

Hypotype C. GSC No. 15566. GSC loc. 19660. Collector: D. J. McLaren, 1951.

Hypotype D. GSC No. 15567. GSC loc. 19661. Collector: D. J. McLaren, 1951.

Hypotypes E, GSC No. 15568; F, GSC No. 15569 (Pl. IX, figs. 4a–d); G, GSC No. 15570 (Pl. IX, figs. 3a–e); H, GSC No. 15571; I, GSC No. 15572; J, GSC No. 15573 (Pl. IX, figs. 6a–e); K, GSC No. 15574. GSC loc. 19630. Collector: D. J. McLaren, 1951.

Hypotypes L, GSC No. 10014 (Pl. IX, figs. 2a–e=pl. I, figs. 12, 13 *in* McLaren, 1954, as *Nudirostra gibbosa walcotti*); M, GSC No. 15575 (Pl. IX, figs. 7a–d); N, GSC No. 15576. GSC loc. 18227. Collector: D. J. McLaren, 1949.

Hypotype O. GSC No. 15577 (Pl. IX, figs. 8a–e). Same locality, formation, and collector as for hypotypes A and B.

Hypotype P. GSC No. 15696 (Text-fig. 18). Same locality, formation, and collector as for hypotypes E to K.

Material

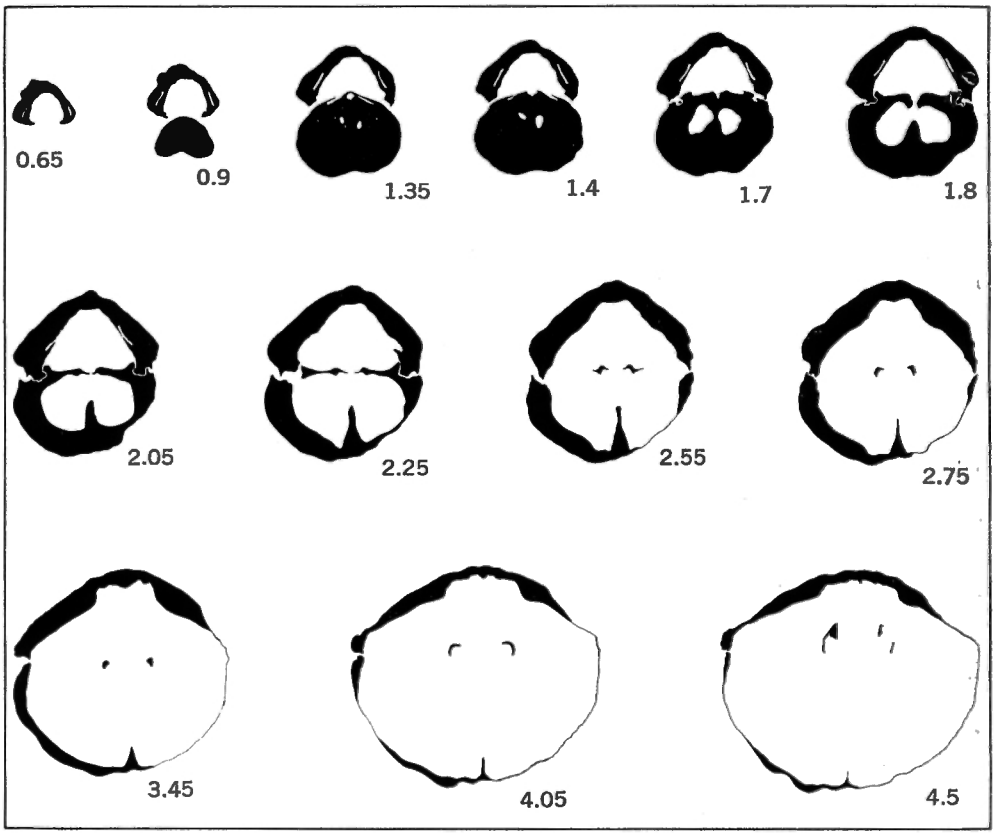
GSC localities: 18227 (32), 18233 (2), 18240 (3), 18243 (1), 19598 (4), 19605 (1), 19606 + 19629 + 19630 + 19638 + 19656 + 19660 + 19661 (281), 38864 (95), 38884 (62), 38968 (5), 45867 (12), 45868 (1), 45919 (5), 56161 (3), 57476 (1).

Most of the specimens are in satisfactory state of preservation.

Description

Only a brief description of Canadian specimens is given. The general costal formula is ⅜ to ⅘; 0; ⅔ to ⅘.

Eighteen specimens out of 321 show irregularities in the median costae. In juvenile forms, the interior dorsal median costa(e) is (are) often depressed in relation to the external ones.



TEXT-FIGURE 18. *Eoparaphorhynchus lentiformis* (Nalivkin) (*non* Gürich)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype P, GSC No. 15696 (l:14.9 mm; w:(15.9) mm; t:(12.2) mm).

Costellae can be observed on many specimens, usually on the flanks, rarely in the sulcus and on the fold.

Measurements of fifteen specimens:

	Hypotype L	Hypotype A	Hypotype B	Hypotype N	Hypotype E	Hypotype O	Hypotype D	Hypotype C	Hypotype M	Hypotype F	Hypotype G	Hypotype H	Hypotype I	Hypotype K	Hypotype J
l	(17.8)	16.9	(16.5)	(15.5)	15.2	15.1	(14.9)	14.2	14.1	11.7	(9.9)	(9.7)	8.8	8.8	8.7
w	21.5	22.0	19.0	20.8	16.1	15.5	16.5	15.8	(15.8)	11.6	9.9	10.2	9.3	8.2	8.0
lpv unrolled	?	28.5	21.0	28.5	21.5	22.0	21.5	20.0	19.0	13.0	13.0	(12.0)	10.5	10.3	9.5
t	16.8	16.9	15.8	17.1	11.4	12.0	10.5	9.2	9.3	4.7	5.6	(5.6)	3.7	4.5	3.5
tpv	4.1	4.3	3.9	4.5	3.6	3.2	3.3	3.2	3.0	2.0	2.5	2.0	1.8	2.0	1.79
tbv	12.7	12.6	11.9	12.6	7.8	8.8	7.2	6.0	6.3	2.7	3.1	(3.6)	1.9	2.5	1.8
l/w	(0.83)	0.77	0.87	(0.75)	0.94	0.97	(0.90)	0.90	(0.89)	1.00	(1.00)	(0.95)	0.95	1.07	1.0
t/w	0.78	0.77	0.83	0.82	0.71	0.77	0.64	0.58	(0.59)	0.41	0.57	(0.55)	0.40	0.55	0.44
t/l	(0.94)	1.00	0.96	(1.10)	0.75	0.79	(0.70)	0.65	0.66	0.40	(0.57)	(0.58)	0.42	0.51	0.40
shoulder angle	?	115°	110°	(117°)	(100°)	106°	(104°)	(110°)	110°	100°	97°	101°	91°	91°	95°

Few specimens are larger than hypotype L; the two largest measurable are 25.1 mm and 24.2 mm wide. Many specimens are smaller than hypotype J; in them, the pedicle valve is higher than the brachial valve. Shoulder angles are less in juvenile forms.

The l/w ratio decreases with growth.

Discussion

Synonymy. The writer has already (1957a, pp. 13–15) drawn attention to the analogies between specimens from Belgium and France and those from Medicine Lake. Now that Canadian material has been studied as well as *Eoparaphorhynchus walcotti* described in connection with it, this tentative conclusion can be confirmed. As only the specimens from the vicinity of Medicine Lake are included in the species [e.p.] is written in the synonymy.

Comments on the possible presence of the species in Iran have been made under the discussion of the synonymy of *E. maclareni.*

Remarks. Since the original citation by Nalivkin (1930) from the Famennian of Turkestan and Pamir, the species has only once been recognized in Russia as *Leiorhynchus* aff. *lentiformis* and *L.* cf. *lentiformis* in beds of the same age (the Goubakha beds) by Tchotchia and Adrianova (1952). But it has often been reported in the Frasnian: Mendym beds (late middle Frasnian) by Batanova (1955), Novojilova (1955), Liachenko (1959), Tchernov (1961); Askyn beds (upper Frasnian) by Tchotchia and Adrianova (1952), Adrianova (1955); Zolotikha beds (upper Frasnian) by Tchotchia and Adrianova (1952); Barma beds (upper Frasnian) by Adrianova (1955).

All the Russian collections consist of few specimens of small size—this character being considered as specific. More abundant Russian material must be studied in order to reach more reliable conclusions on their systematic significance and stratigraphic range.

Comparisons. The species is distinguished by small size, non-variable contour, deep sulcus and high fold starting a short distance from the beaks, greatest thickness commonly at front, general costal formula, irregular and commonly divided median costae, costellae commonly observed.

A few specimens of *Eoparaphorhynchus walcotti* show some similarity with *E. lentiformis,* but differences are numerous. Adult specimens of *E. lentiformis* do not reach the average size or the typical oval contour of wide specimens of *E. walcotti.* The greatest height of the fold in *E. lentiformis* often occurs at the frontal commissure, or the curvature from the summit of the brachial valve to the commissure is shorter and less pronounced; the same feature is present in narrow specimens of *E. walcotti.* In *E. lentiformis* the sulcus is usually deeper, the fold higher, the general costal formula different (but irregularities in the median costae are similar), and costellae are often observed; juvenile forms are also of different shape. It should be noted also that *E. lentiformis* and *E. walcotti* do not occur together.

In Belgian specimens of *E. lentiformis,* divisions in the median costae are more common.

Differences between *E. lentiformis* and *E. maclareni* are numerous. *E. lentiformis* is a smaller species, less variable in shape, has a deeper sulcus that is generally less wide at the front, not swollen medially and thus starts nearer to the beak. The general costal formula is different and divisions in median costae are more frequent. Both species have similar juvenile forms, although more variable in *E. maclareni.*

Differences and similarities between *E. lentiformis* and *Rugaltarostrum madisonense* and *Evanescirostrum seversoni* are discussed under the description of those species. Differences and similarities between *E. lentiformis* and *E. triaequalis triaequalis* and *E. triaequalis praetriaequalis* have been examined in a previous publication (Sartenaer, 1957c).

Similarities to specimens of *Pugnoides chanakchiensis* Abramian, 1954 are great, notably in the general costal formula and the ratios of measurements (e.g., 1/w ratios); the Armenian species never has more than three lateral costae, but only thirty-one specimens have been described so far. The size and shoulder angle of *P. chanakchiensis* are greater. More details about the Armenian species are given under the description of *Evanescirostrum seversoni.*

Stratigraphic position. Most specimens have been collected between 80 feet and 298 feet from the base of Member A of the Sassenach Formation (*see* McLaren, 1955, pp. 47, 48) but are concentrated between 243 feet and 298 feet. The species has also been collected elsewhere at 61 feet (GSC loc. 45868), between 80 and 85 feet (GSC loc. 45919), between 175 and 200 feet (GSC loc. 45867) above the base of the Sassenach Formation, and between 222 and 234 feet below the top of the Sassenach Formation (GSC loc. 56161).

Geographic distribution. The species has been found in a very restricted area in the vicinity of Medicine Lake (western flank of Proposal Mountain to the east of the southeast end of Medicine Lake; Beaver ridge, between Medicine Lake and Beaver Lake; the mountain to the north of Beaver Lake), and also at Thornton Creek, Elko, and the Fernie map-area. west half.

Sinotectirostrum Sartenaer, 1961

1961d. *Sinotectirostrum* n.gen.—SARTENAER, pp. 3–4.

Type species. Sinotectirostrum medicinale Sartenaer, 1961.

Diagnosis. Variable contour; high number of wide costae starting at beaks; parietal costae always present, usually numerous; number of median costae highly variable; costae simple, rarely divided; shoulder angle between 93 and 120 degrees; sulcus and fold begin a variable distance from the beaks. Usually large umbonal cavities; ventral muscle field with low relief; short septum supports a deep, narrow septalium covered anteriorly by a fragile connectivum; strongly marked crural bases; teeth and dental sockets crenulated.

Species and subspecies attributed to the genus. Type species, *S. avellana* nov. sp., *S. banffense banffense* (Warren, 1927), *S. banffense shimeri* (Warren, 1927), *S. mackenziei* nov. sp., *S. medicinale deceptum* nov. subsp., *S. montosum* nov. sp., *S. nordeggi* (Kindle, 1924), *S. paucirugosum* nov. sp., *S. saxirubrum* nov. sp. *S.?* sp. has been mentioned by Johnson and Reso (1966, pp. 125, 128) in the lower part of the Pilot Formation.

Description

This genus includes uniplicate species of small to medium, medium, and medium to large size. The contour varies, depending on the species, from transversely oval, rarely subrounded, to longitudinally oval. The commissure is sharp and deeply crenulated by the costae in most of the species, with the exception of the borders of the tongue. Postero-lateral margins are concave near the commissure and more or less steep depending on the species. The number of the well marked costae is high, and variable. Parietal costae are always present and usually numerous; they disappear near to the borders of the tongue which are rarely crenulated. Median costae are of variable width. Sometimes the median costae are fan-shaped near the frontal commissure. The number of lateral costae is high and less variable than the number of median costae. The internal ventral lateral costae may become concave anteriorly towards the sulcus. Occasionally, the internal ventral lateral costae are lower than the others. The costae are flat or flat-rounded posteriorly to angular-rounded or angular with flat top or angular anteriorly; they are ordinarily wide. Costae are usually low but may be high. Costae start at the beaks and are simple; exceptionally the lateral and median costae may divide. Roof-shaped costae are the rule in the type species, and may occur in other species. Shoulder angle varies between 93 and 120 degrees.

The shell may be slightly thickened in the apical region.

Pedicle valve. The umbonal region is slightly to strongly inflated. The sulcus starts imperceptibly at a distance from the beak varying between 27 and 81 per cent of the length of the shell; it commonly widens slowly but sometimes rapidly. The well marked sulcus is wide when it starts and is 57 to 83 per cent of the width of the shell at the front. The depth of the sulcus is variable but usually low. The bottom of the sulcus may be

flat but is usually slightly convex. The beak is erect to suberect, small, detached and well marked. The small foramen is rarely seen and results from the resorption of the beak. The interarea is 1 to 2 mm high and its length varies between 36 and 62 per cent of the width of the shell. The trapezoidal tongue has sharp borders; its upper part is vertical or recurved posteriorly depending on the species; its median part may protrude beyond the borders. The deltidial plates, as seen in transverse serial sections, are large, stout, and strongly attached.

The slender and short dental plates are wide apart; they diverge posteriorly and become parallel or convergent anteriorly. Anteriorly, in transverse serial sections, the dental plates approximate ventrally where they border the muscle field. The umbonal cavities are usually large. The teeth are short (0.5 to 1.4 mm), stout, with a few dorsal crenulations. The denticula are clearly marked.

The ventral muscle field has low relief, especially anteriorly where it is not sharply limited. The width of the muscle field is about 30 per cent of the width of the shell, and the length between 50 and 60 per cent of the length. The adductor scars are lens-shaped and diverge posteriorly. The flabellate diductor scars enclose entirely the adductor scars and are marked by longitudinal ribs and furrows.

Brachial valve. The fold is well marked, wide, generally higher than the sulcus is deep and starts imperceptibly at a variable distance from the beak. It is sometimes flat-topped, but usually slightly to strongly convex. There may be a median depression in the anterior part of the fold. In some specimens the costae on the fold are sharply bent towards the frontal commissure. The greatest thickness of the valve may be at the frontal commissure, but is commonly somewhat posterior to it.

The septum is short (one third to one quarter the length of the shell) and supports the septalium for a short distance. The septalium is deep and narrow, amphora-shaped, V-shaped or U-shaped in transverse serial sections. The fragile connectivum covering the anterior part of the septalium is only sometimes preserved. Thus, the hinge plate is undivided. The outer plates are flat to slightly concave posteriorly, commonly with a median swelling, and become slightly to strongly concave anteriorly; in transverse serial sections, they extend anteriorly to the septalium.

The crural bases, as seen in transverse serial sections, develop as characteristic swellings of the inner ends of the outer hinge plates. The crura are short, bordered for some distance forwards by the outer hinge plates, and with pronounced divergence anteriorly. They are dorsally concave and have the shape of a Phrygian cap in transverse serial sections; they are slightly bent at their distal end.

The bottoms of the deep dental sockets are marked by a few crenulations.

The adductor scars are formed by two pair of large ellipses, that are often difficult to separate on account of their low relief. The width of the dorsal muscle field is about 30 per cent of the width of the shell.

Comparisons. As revised by Sartenaer (1961c), the genus *Camarotoechia* has nothing in common with the genus *Sinotectirostrum*. The genus *Cupularostrum* Sartenaer, 1961 is easily distinguishable by the following characters: smaller size; subrounded contour; very different general costal formula; parietal costae absent or rare; less median and lateral costae; ventral muscular field with strong relief; different shape of the dental plates; shallow, cup-shaped septalium; strong connectivum.

The group of species belonging to the genera *Sinotectirostrum* and *Ptychomaletoechia* is very difficult to deal with, despite abundant specimens in some species. The two genera have many features in common: sharp and deeply crenulated commissure; concave postero-lateral margins near the commissure; similar shoulder angles; appreciable differences in the number of costae from one species to another; nature of costae; costae starting from the umbones; well marked sulcus and fold not starting at the beaks; depth of the sulcus; height of the fold;

the top of the fold more or less convex; the top of the tongue usually recurved posteriorly; prominent and detached erect to suberect ventral beak; aspect of ventral interarea; shape and nature of the deltidial plates, dental sockets, outer plates of the hinge plate, crural bases, septum, teeth and crura; connectivum often not preserved; outer plates of the hinge plate extending anteriorly to the septalium in transverse serial sections. On account of these similarities, the writer has hesitated a long time before separating the two genera, but some constant differences have proven significant. The genus *Ptychomaletoechia* differs from the genus *Sinotectirostrum* by the following characters, considered as a group: usually smaller size; proportionally greater thickness as can be easily seen in the t/w and t/l ratios; sulcus and fold starting nearer to the beaks, less wide where they start, widening rapidly towards the front (these three characters are closely connected); sulcus and fold are narrower at the front (43 to 59 per cent of the width of the shell); bottom of the sulcus generally flat to slightly concave rather than slightly convex to flat; higher tongue (this character coupled with the narrowness of the sulcus at the front results in quite different proportions of the tongue, the borders of which tend to be more parallel); flanks of the sulcus commonly steeper and usually pass more sharply into the tongue; greatest thickness of the shell more generally at the frontal commissure; less variability in the number of lateral and median costae within a species; median costae never disposed in fan order near the frontal commissure; parietal costae scarce; fewer lateral costae in most species; septalium more invariably cupule- or amphora-shaped in transverse serial sections, commonly shallower; thicker structures in the apical region; dental plates more often convergent anteriorly and less often wide apart. The following differences allow a quick differentiation: greater thickness, sulcus and fold narrower at the front, higher and differently proportionated tongue, median costae never disposed in fan order near the frontal commissure. Cases of homoeomorphy are not rare in *Rhynchonellida,* but they are particularly striking in some species of the two genera just discussed, in which isolated specimens may almost be matched, e.g., *Sinotectirostrum avellana* and *Ptychomaletoechia dumonti.* In *Ptychomaletoechia dumonti* the sulcus and fold start farther from the beaks with an appreciable width and widen slowly towards the front. Parietal costae are present and rarely indent the borders of the tongue, while the internal ventral lateral costae tend to become concave anteriorly towards the sulcus. All these characters are found in the genus *Sinotectirostrum;* nevertheless the above-mentioned features concerning costae of *Ptychomaletoechia dumonti* are attributable to the fact that it is a species of *P.* with an unusually high number of costae.

The systematic and stratigraphic importance of a group of Russian forms has brought the writer to erect a new genus: *Ripidiorhynchus* Sartenaer, 1966. This genus has many characters common to both *Sinotectirostrum* and *Ptychomaletoechia* or present in one or the other, e.g., *Sinotectirostrum*—parietal costae always present and not indenting the borders of the tongue; *Ptychomaletoechia*—thickness, narrowness of fold and sulcus, high tongue, size. In addition the genus *Ripidiorhynchus* has characters of its own (*see* Sartenaer, 1966).

Stratigraphic position and geographic distribution. The species and subspecies referred to this genus are found in Canada, the U.S.A., and the U.S.S.R. It is present throughout the whole Famennian, but some uncertainty remains for the highest beds of the upper Famennian.

Sinotectirostrum medicinale medicinale Sartenaer

Plate X, figures 1–11; Plate XIII, figures 9–14; Text-figures 19, 20

[?] 1952a. *Yunnanella* cf. *Y. mesoplicata* Grabau—CRICKMAY, p. 593;
1954. *Camarotoechia* spp.—McLAREN, p. 173;
1955. *Camarotoechia banffensis* Warren subsp. nov.—McLAREN, p. 47;
1958. *Camarotoechia* sp. E (n.sp.)—McLAREN, p. 194, pl. V, figs. 16–18;
1958. *Camarotoechia* sp. E—McLAREN *in* LEECH, pp. 24, 26;
1961d. *Sinotectirostrum medicinale* n.sp.—SARTENAER, pp. 3, 4, pl. I, figs. 3a, b (=pl. V, figs. 16–18 *in* McLAREN, 1958), pl. II, fig. B;

1962. *Sinotectirostrum medicinale* Sartenaer—McLAREN *in* McLAREN and MOUNTJOY, p. 14;
1962. *Sinotectirostrum medicinale* Sartenaer—McLAREN *in* McLAREN, NORRIS, and McGREGOR, p. 32, pl. XV, figs. 16–18 (=pl. V, figs. 16–18 *in* McLAREN, 1958);
1962. *Sinotectirostrum* (?) sp.—McLAREN *in* McLAREN and MOUNTJOY, p. 20;
1962. "*Camarotoechia*" *nordeggi banffensis* Warren—SARTENAER *in* McLAREN and MOUNTJOY, p. 21;
1965. *Sinotectirostrum medicinale* Sartenaer—McLAREN *in* MOUNTJOY, p. 30;
1965. *Camarotoechia nordeggi* Kindle?—McLAREN *in* MOUNTJOY, p. 100, fig. 6;
1965. *Sinotectirostrum* sp.—McLAREN *in* MACKENZIE, p. 9.

Types

Holotype (Pl. X, figs. 1a–e=pl. V, figs. 16–18 *in* McLaren, 1958, as *Camarotoechia* sp. E (n. sp.)=pl. I, figs. 3a, b *in* Sartenaer, 1961d=pl. XV, figs. 16–18 *in* McLaren, Norris and McGregor, 1962). GSC No. 13797. GSC loc. 18241. Collector: D. J. McLaren, 1949.

Paratype A. GSC No. 15648 (Pl. X, figs. 2a–e). GSC loc. 18236. Collector: D. J. McLaren, 1949.

Paratype B. GSC No. 15649 (Pl. X, figs. 3a–e). GSC loc. 18231. Collector: D. J. McLaren, 1949.

Paratype C. GSC No. 15650 (Pl. X, figs. 4a–e). GSC loc. 18234. Collector: D. J. McLaren, 1949.

Paratype D. GSC No. 15651 (Pl. X, figs. 5a–e). Same locality, formation, and collector as for the holotype.

Paratype E. GSC No. 15652 (Pl. XIII, figs. 9a–c). GSC loc. 19597. Collector: D. J. McLaren, 1951.

Paratypes F, GSC No. 15653 (Pl. XIII, figs. 14a–c); G, GSC No. 15654 (Pl. XIII, figs. 13a–d); H, GSC No. 15655 (Pl. XIII, figs. 12a–d). GSC loc. 19651. Collector: D. J. McLaren, 1951.

Paratypes I, GSC No. 15656 (Pl. X, figs. 6a–d); J, GSC No. 15657 (Pl. X, figs. 7a–d). Same locality, formation, and collector as for paratype B.

Paratypes K, GSC No. 15658 (Pl. X, figs. 10a–e); L, GSC No. 15659 (Pl. X, figs. 9a–e); M, GSC No. 15660 (Pl. X, figs. 8a–c). GSC loc. 18233. Collector: D. J. McLaren, 1949.

Paratype N. GSC No. 15661 (Pl. X, figs. 11a–c). Same locality, formation, and collector as paratype A.

Paratype O. GSC No. 15662 (Pl. XIII, figs. 10a–e). GSC loc. 18238. Collector: D. J. McLaren, 1949.

Paratype P. GSC No. 15663 (Pl. XIII, figs. 11a,b). Same locality, formation and collector as for paratypes F to H.

Paratype Q. GSC No. 15664 (Text-fig. 19). GSC loc. 42187. Collector: D. J. McLaren, 1951.

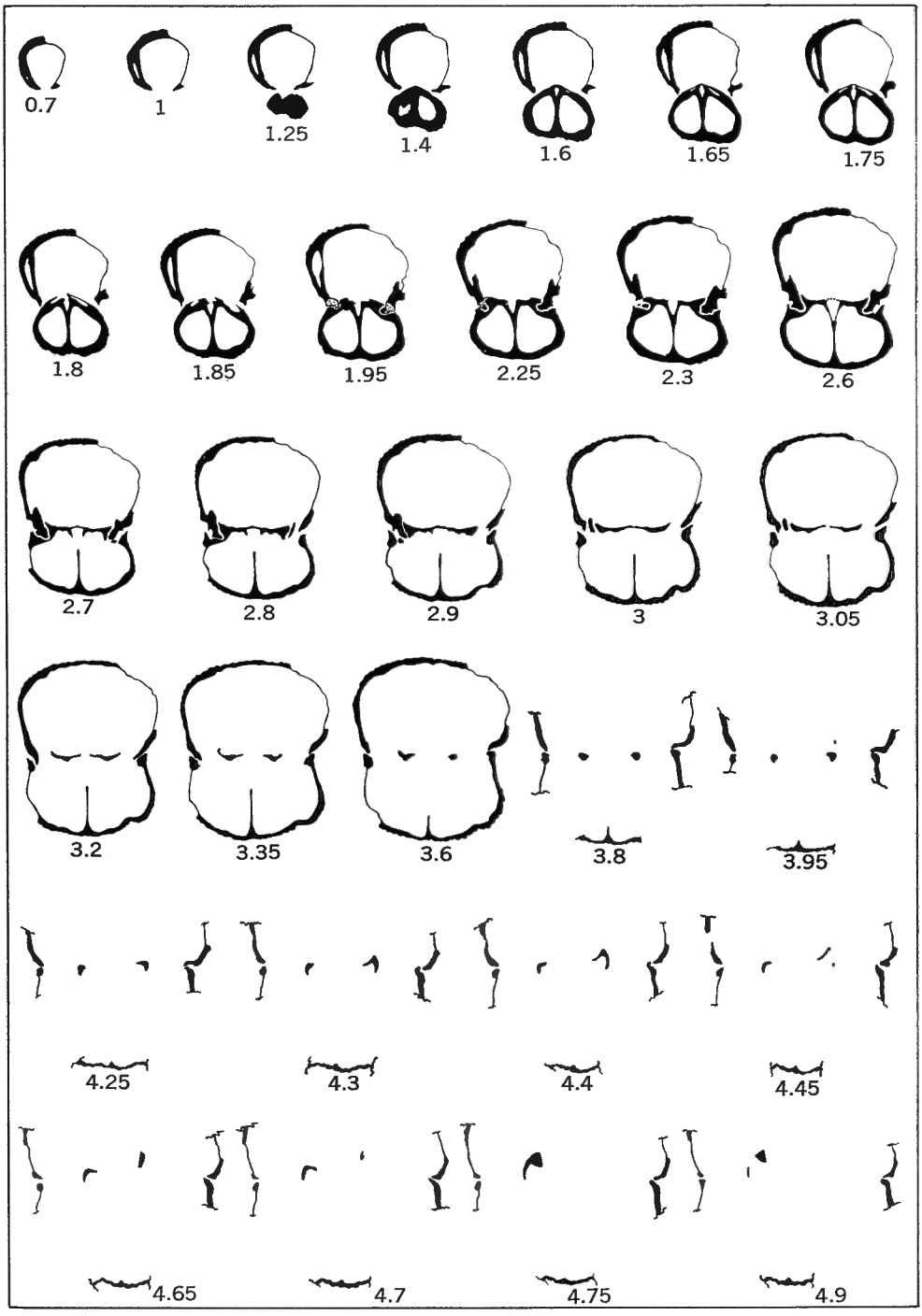
Paratype R. GSC No. 15665 (Text-fig. 20=pl. II, fig. B *in* Sartenaer, 1961d). Same locality, formation and collector as for paratype E.

Material

The following GSC localities in the Canadian Rocky Mountains: 18136 (1), 18222 (1), 18225 (1), 18228 (1), 18229 (1), 18230 (1), 18231 (9), 18232 (2), 18233 (7), 18234 (7), 18236 (5), 18237 (15), 18238 (2), 18239 (2), 18241 (7), 19597 (48), 19606 (3), 19622 (2), 19626 (2), 19628 (4), 19629 (1), 19651 (29), 19656 (1), 19975 (21), 32276 (2), 36904 (3), 42187 (27), 45915 (4), 45927 (1), 45935 (3), 45941 (1), 48370 (3).

Description

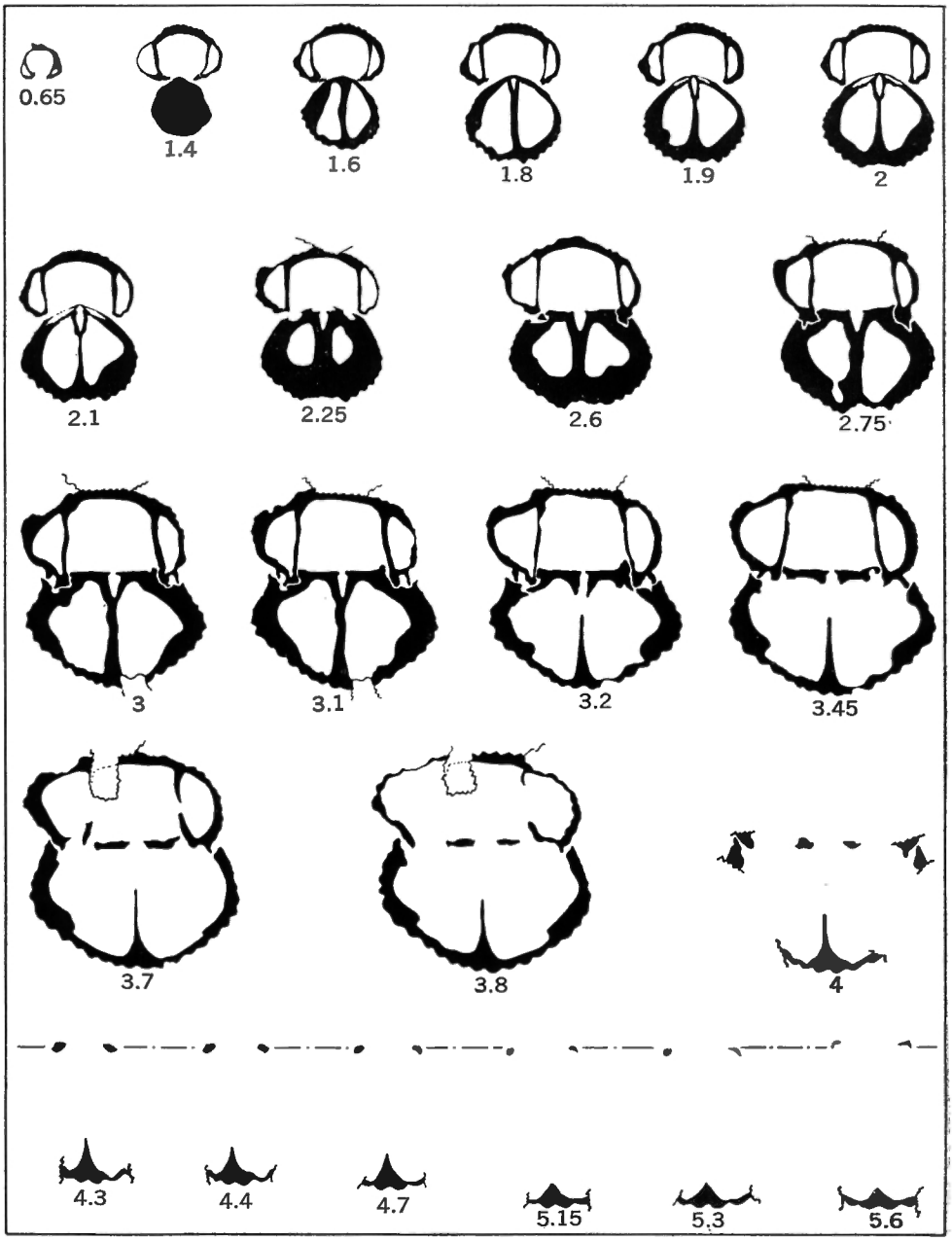
The species is medium to large sized. The small shoulder angle and the form of the postero-lateral margins give a characteristically angular aspect to the posterior part of the shell. With the exception of the borders of the tongue, the commissure is strongly indented by the costae.



TEXT-FIGURE 19. *Sinotectirostrum medicinale medicinale* Sartenaer

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Paratype Q, GSC No. 15664 (l:16.5 mm; w:17.4 mm; t:12.8 mm).



TEXT-FIGURE 20. *Sinotectirostrum medicinale medicinale* Sartenaer

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Paratype R, GSC No. 15665 (l:20.2 mm; w:23.0 mm; t:17.8 mm).

Pedicle valve. The flanks slope evenly towards the commissure, more sharply at the margins; postero-lateral margins are vertical or slightly concave near the commissure.

The well marked sulcus starts imperceptibly between 43 and 58 per cent of the shell length forward of the beak, or between 36 and 52 per cent of the unrolled length of the valve. Its width posteriorly is 45 to 70 per cent of its width at the front where it is 62 to 83 per cent the width of the shell. The depth of the sulcus is variable—two to five times (usually two to three) the height of the median costae. Its bottom is flat or very slightly convex, and occupies 51 to 68 per cent of its width; this means that the sides of the sulcus are often not very steep, and thus show an appreciable width in ventral view. The sides of the sulcus are characterized by the special aspect of the parietal costae (*see* under Ornament). The sulcus passes progressively into a trapezoidal tongue, bordered by sharp borders and becoming vertical towards the very top.

The beak is erect to suberect, small and clearly detached; it rarely overhangs the hinge line. No foramen could be observed. The deltidial plates may be seen in transverse serial sections (Text-figs. 19, 20). The delthyrium is very wide at its base. The interarea is clearly defined and elongated, but on account of the small shoulder angle of the species, the length of the interarea represents only 36 to 50 per cent of the width of the shell.

Brachial valve. The well marked fold starts imperceptibly, like the sulcus, forward of the beak, but usually somewhat closer to it. It is high and moderately to strongly convex, rarely flat. The greatest thickness of the valve is posterior to the frontal commissure, and from here the fold falls gently or, exceptionally, abruptly towards the commissure.

Ornament. The general costal formula is $\frac{6}{5}$ to $\frac{9}{8}$; $\frac{1}{1}$–$\frac{1}{1}$ to $\frac{3}{3}$–$\frac{3}{3}$; $\frac{10}{11}$ to $\frac{15}{16}$. The ratios of the median and parietal costae are distributed as follows:

Median + Parietal			Median			Parietal		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
4/3	1	0.85	4/3	2	1.95	0	1	0.95
8/7	12	10.15	5/4	2	1.95	1-0/1-0	1	0.95
9/8	14	11.75	6/5	23	22.55	1-1/1-1	19	18.10
10/9	13	10.90	7/6	20	19.60	1-2/1-2	9	8.60
11/10	13	10.90	8/7	19	18.65	or 2-1/2-1		
12/11	18	15.10	9/8	19	18.65	2-2/2-2	48	45.70
13/12	15	12.60	10/9	8	7.85	3-2/3-2	10	9.50
14/13	13	10.90	11/10	6	5.90	or 2-3/2-3		
15/14	11	9.25	12/11	2	1.95	3-3/3-3	16	15.25
16/15	6	5.05	14/13	1	0.95	4-3/4-3	1	0.95
17/16	1	0.85						
18/17	1	0.85						
21/20	1	0.85						
	119	100.–		102	100.–		105	100.–

The median costae are simple, regular, and start at the beaks; in two specimens only, a division has been observed in the anterior part of the fold, and in one of the specimens the sulcus has a corresponding division. Posteriorly the costae are low and rounded to flat, but become more and more angular and high towards the front where they commonly reach a width of 1.5 to 2 mm. The costae are obtuse, but may be sometimes acute on the fold at the front. Roof-shaped costae with a well marked ridge are characteristic (Pl. X, figs. 2, 4), although blunt costae are not uncommon. The number of costae varies widely. The only specimen with $\frac{14}{13}$ costae is a small one: paratype K (Pl. X, fig. 10).

Parietal costae rarely indent the commissure. Their number is generally the same on each side of both sulcus and fold. When the fold is very convex, or when the ventral internal lateral costae are lower than the others, the limits of sulcus and fold can easily be established by the indentation or non-indentation of the commissure.

Lateral costae are distributed as follows:

costae	Number of spec.	%
6/7	1	1.20
7/8	3	3.60
8/9	2	2.40
9/10	5	6.05
10/11	13	15.65
11/12	7	8.45
12/13	18	21.70
13/14	8	9.60
14/15	12	14.50
15/16	6	7.25
16/17	3	3.60
17/18	4	4.80
19/20	1	1.20
	83	100.–

The lateral costae are simple, regular, start at the umbones, and are rarely divided. The number of lateral costae are minimal because many specimens are poorly preserved. The costae have similar shape to median costae but are asymmetrical on the slopes of the flanks. Occasionally, the internal ventral costa is lower than the others.

All costae are strongly marked. There is no relation between their number and size of the specimen. Very fine growth-lines may occur.

Dimensions. Measurements of seven specimens:

in mm	Paratype A	Paratype E	Paratype B	Paratype C	Holotype	Paratype D	Paratype F
l	(22.5)	22.4	19.7	17.5	15.6	(15.1)	14.8
w	23.2	25.4	(18.7)	20.7	(17.7)	16.3	(14.2)
lpv unrolled	?	30.5	28.0	19.0	25.0	23.5	22.5
t	16.6	16.5	13.8	11.7	13.1	12.2	13.1
tpv	5.5	5.2	6.0	4.7	4.5	3.1	3.5
tbv	11.1	11.3	7.8	7.0	8.6	9.1	9.9
l/w	(0.97)	0.88	(1.05)	0.85	(0.88)	(0.93)	(1.04)
t/w	(0.72)	0.65	(0.74)	0.57	(0.74)	0.75	(0.92)
t/l	(0.74)	0.78	0.70	0.67	0.84	(0.81)	0.88
shoulder angle	95°	(95°)	98°	96°	93°	?	95°

The low shoulder angle is characteristic. For most specimens it varies between 95 and 100 degrees, but may be as wide as 110 degrees.

Internal characters. The internal characters are given under the description of the genus. A few details are added. Deltidial plates have not been observed. Structures are slightly thickened in the apical region. The septalium is not so deep and narrow as in most species of

the genus. Three specimens out of the eight sectioned have a connectivum preserved. The septum is somewhat longer than in the other species and supports the septalium further forward.

Growth. As the species has a non-constant and monocyclic curvature growth, the thickness increases noticeably in later stages when width and length increase relatively little.

Juvenile characters are: proportionally smaller thickness; pedicle valve thicker than the brachial valve; sulcus, tongue, and fold not marked; parietal costae indent the commissure.

in mm	Paratype J	Paratype I	Paratype K	Paratype H	Paratype L	Paratype N	Paratype G	Paratype O	Paratype P	Paratype M
l	13.5	(13.3)	13.1	11.4	10.0	10.0	9.8	9.8	8.6	7.8
w	14.8	14.6	12.7	11.6	10.9	10.9	12.3	9.7	8.9	8.7
lpv unrolled	18.5	20.0	17.5	13.0	13.0	13.0	15.0	13.0	10.0	10.0
t	8.8	10.1	9.6	5.8	6.4	6.4	8.5	6.6	4.0	4.8
tpv	3.1	4.2	3.0	2.2	2.5	2.0	2.6	2.2	2.1	2.2
tbv	5.7	5.9	6.6	3.6	3.9	4.4	5.9	4.4	1.9	2.6
l/w	0.91	(0.91)	1.03	0.98	0.92	0.92	0.80	1.01	0.97	0.90
t/w	0.59	0.69	0.76	0.50	0.59	0.59	0.69	0.68	0.45	0.55
t/l	0.65	(0.76)	0.73	0.51	0.64	0.64	0.87	0.67	0.47	0.62
shoulder angle	98°	99°	94°	100°	94°	90°	97°	90°	91°	93°

The shoulder angle in juvenile forms varies generally between 90 and 100 degrees, but angles of 85 degrees have been measured.

Discussion

Synonymy. The specimen described as *Yunnanella* cf. *Y. mesoplicata* by Crickmay (1952a) is a fragment; however twelve costae may be counted on the fold and twenty-three on each flank; there is a median depression in the anterior part of the fold.

Camarotoechia spp. of McLaren (1954) are considered here as one single species for reasons that are discussed below in relation with the variability of the species.

McLaren (1958) was the first to point out the specific status of this form.

Comparisons. The subspecies is distinguished by a very wide sulcus with wide flanks at the front, roof-shaped costae, considerable variation in the number of median costae, narrow shoulder angle and abrupt postero-lateral margins giving a characteristically angular aspect to the posterior part of the shell.

Comparison with *Sinotectirostrum banffense banffense* is given under the description of that subspecies.

Remarks. The wide range of variability in the number of costae makes it necessary to consider whether two subspecies or even species may be present. Paratype K (Pl. X, fig. 10) differs from a specimen such as paratype B (Pl. X, fig. 3), in the number of median (+ parietal) costae and in size. Paratype K is the only specimen in the collections with so many costae. But there are large specimens, with many median (+ parietal) costae, e.g., paratype E (⅝; ⅜-⅜; ?) and small specimens with few, e.g., paratype O (⅝; ½-½; 15/16). Furthermore specimens from the same bed as paratype K show great variation. Paratype F has intermediate characters between paratypes K and B.

The possibility of more than one pattern of growth seems unlikely when collections of the same bed are examined. Paratype L (Pl. X, fig. 9) is an intermediate form between speci-

mens such as paratype H (Pl. XIII, fig. 12) and paratype O (Pl. XIII, fig. 10). Paratype O is a juvenile form having already adult height. More material is needed to check the validity of this conclusion.

A comparable range of variation is found in *Eoparaphorhynchus walcotti,* and *Sinotectirostrum banffense banffense.*

It is not clear whether the significance of specimens with blunt costae is due to variability or preservation. Finally, more information is still needed about geographic variation.

Stratigraphic position. 825 feet (GSC loc. 18136) below the top of the Palliser Formation; 16 feet (GSC loc. 18222), 57 feet (GSC loc. 18229), 90 feet (GSC loc. 18230), 127 feet (GSC loc. 18231), 130 feet (GSC loc. 18232), 141.5 feet to 155.5 feet (GSC loc. 32276), 160 feet (GSC loc. 18233), 165 feet to 168 feet (GSC loc. 18234), 175 feet to 200 feet (GSC loc. 18236), 194 feet (GSC loc. 18225), 250 feet (GSC loc. 18238), 325 feet (GSC loc. 18239) below the top of the Sassenach Formation; circa 500 feet up from the base of the Sassenach Formation (GSC loc. 19651); *"Camarotoechia* Zone" *in* unit 42, middle part of Member B of Sassenach Formation (*in* McLaren, 1955, p. 47) (GSC loc. 19597); upper beds of the Sassenach Formation (GSC locs. 19626, 19628); Upper Sassenach Formation (GSC loc. 45915); basal 8 feet of the Sassenach Formation (the formation is only 40 feet thick; pers. com. D. J. McLaren) (GSC loc. 19975); 200 feet above the base of the Sassenach Formation (GSC loc. 48370); lower 30 feet of the Palliser Formation (GSC loc. 36904). *Sinotectirostrum* (?) sp. and *"Camarotoechia" nordeggi banffensis in* McLaren and Mountjoy (1962, pp. 20-21) derive from a 23 foot thick Sassenach Formation.

The remaining specimens derive from talus or undefined horizons from the Sassenach Formation (GSC locs. 18228, 18237, 18241, 19606, 19622, 19629, 19656, 42187).

Crickmay's (1952a) *Yunnanella* cf. *Y. mesoplicata* has been collected at about 530 feet below the top of the Palliser Formation.

Thus this subspecies has been collected from the base of the Palliser Formation and from the Sassenach Formation. Most of the specimens derive from the middle part (chiefly) and upper part of the Sassenach Formation.

Geographic distribution. The subspecies has been found at the following localities in the Canadian Rocky Mountains: Devonian Mountain, The Ancient Wall, Mount Rajah, Fiddle River, Morro Peak, The Palisade, Medicine Lake (Proposal Mountain, Beaver Ridge), Brazeau map-area, Fernie map-area (west half).

Crickmay's (1952a) *Yunnanella* cf. *Y. mesoplicata* derives from Imperial Normandville well No. 1, about 220 miles northwest of Edmonton, Alberta.

Sinotectirostrum medicinale deceptum nov. subsp.

Plate XI, figures 7–9; Text-figure 21

1955. *Camarotoechia banffensis* Warren subsp. nov.—McLAREN, p. 29.

Deceptus, a, um (Latin) = deceived; most of the material derives from Deception Creek.

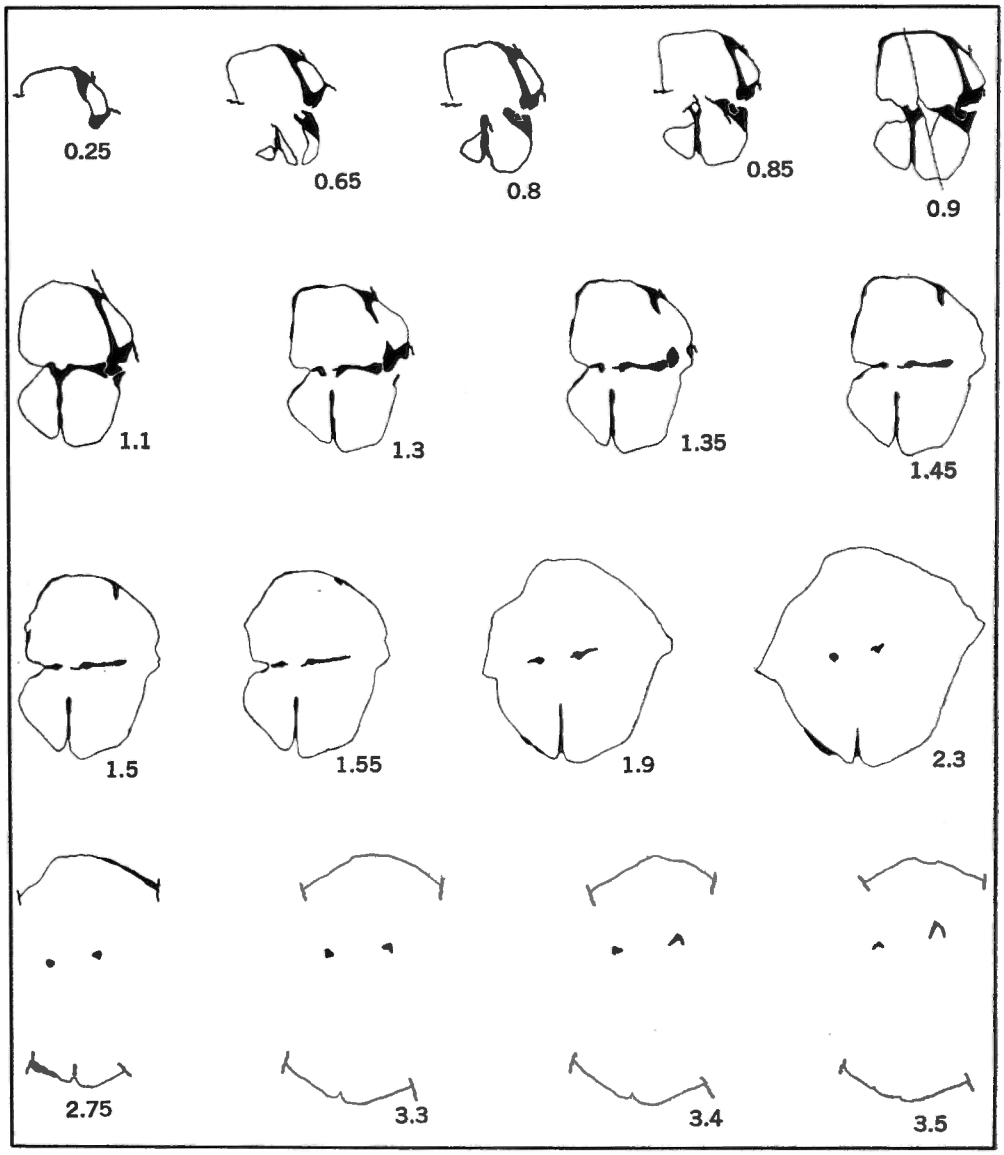
Types

Holotype. GSC No. 15892 (Pl. XI, figs. 7a–e). GSC loc. 24555. Collector: D. J. McLaren, 1953.

Paratypes A, GSC No. 15893 (Pl. XI, figs. 9a–e); B, GSC No. 15895; C, GSC No. 15896; D, GSC No. 15897; E, GSC No. 15900 (Pl. XI, figs. 8a–e); H, GSC 15894 (Text-fig. 21). GSC loc. 24541. Collector: D. J. McLaren, 1953.

Paratype F. GSC No. 15898. GSC loc. 18138. Collector: D. J. McLaren, 1949.

Paratype G. GSC No. 15899. GSC loc. 24540. Collector: D. J. McLaren, 1953.



TEXT-FIGURE 21. *Sinotectirostrum medicinale deceptum* nov. subsp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype H, GSC No. 15894 (l:(18.5) mm; w:19.6 mm; t:13.0 mm).

Material

The following GSC localities in the Canadian Rocky Mountains: 18138 (1), 24528 (1), 24540 (3), 24541 (8), 24555 (1).

Ten specimens are in satisfactory state of preservation.

Description

Only differences between *S. medicinale medicinale* and *S. medicinale deceptum* are given. In *S. medicinale deceptum* the shoulder angle is wider, the postero-lateral margins of the flanks are not abrupt but concave, the ventral umbonal region more inflated, thus the posterior part of the shell is not characteristically angular. The sulcus of *S. medicinale deceptum* starts nearer to the beak and less imperceptibly; it is narrower where it starts, widens rapidly but is narrower (53 to 64% of the width of the shell, with one exception (73%)) at the front. The fold starts nearer to the beak and its top is usually strongly convex.

Ornament. The general costal formula is 4/3 to 5/4; 2/2–1/1, 2/2–2/2, 2/2–3/3; 10/11 to 19/20; thus the number of median costae is smaller. The costae are more rounded, less elevated and not roof-shaped. Divisions of lateral costae have been observed in three out of fourteen specimens. The new subspecies tends to be proportionally wider.

Dimensions. Measurements of nine specimens:

in mm	Holotype	Paratype H	Paratype C	Paratype F	Paratype B	Paratype E	Paratype D	Paratype A	Paratype G
l	(20.2)	(18.5)	(15.3)	(15.3)	15.0	14.7	13.9	13.3	12.0
w	25.1	19.6	19.8	19.3	19.2	19.4	13.8	15.0	12.3
lpv unrolled	(33.0)	(20.5)	(18.0)	(23.5)	(25.5)	25.5	11.5	17.5	15.0
t	17.8	13.0	9.5	16.4	15.4	15.4	8.0	7.2	6.4
tpv	4.0	5.0	3.4	(6.0)	5.0	4.5	3.0	2.5	2.7
tbv	13.8	8.0	6.1	(10.4)	10.4	10.9	5.0	4.7	3.7
l/w	(0.80)	(0.94)	(0.77)	(0.79)	0.78	0.76	1.00	0.89	0.97
t/w	0.71	0.66	0.48	0.85	0.80	0.79	0.58	0.48	0.52
t/l	(0.88)	0.70	(0.62)	(1.07)	1.03	1.05	0.58	0.54	0.53
shoulder angle	(95°)	?	?	?	120°	112°	(95°)	98°	102°

Internal characters. The internal characters are those mentioned under the description of the genus. Only a few details are added: the deltidial plates have not been observed; the structures are thickened in the apical region; the only specimen sectioned has no connectivum preserved.

Discussion

Remarks. The small number of specimens makes comparison with other species and subspecies more difficult. Larger collections would be desirable in deciding about a possible species rank.

Comparisons. S. mackenziei, which is near to *S. medicinale medicinale,* differs from the new subspecies by: sulcus and fold start farther from the beaks; greater width of the sulcus at the front and where it starts; top of the fold flat to slightly convex; a smaller shoulder angle; ventral umbonal region not inflated; different formula of costae; more median costae; proportionally narrower.

From *S. banffense banffense, S. medicinale deceptum* differs by: inflated ventral umbonal region; sulcus starts less imperceptibly, nearer to the beak and narrower, widens rapidly,

deeper with a flat bottom which represents a smaller proportion of the sulcus; fold starts nearer to the beak, widens rapidly with a strongly curved top; a different costal formula, notably less median and parietal costae.

Stratigraphic position. The subspecies has been found at the base of the Sassenach Formation: between 39.5 and 60 feet (GSC loc. 18138) and between 28 and 34 feet (GSC loc. 24555) above the base of the formation.

In the only section (Morro Peak) where both *S. medicinale medicinale* and *S. medicinale deceptum* have been collected, the former subspecies occurs 600 feet higher than the latter.

Geographic distribution. The subspecies is derived from a restricted area in the Canadian Rocky Mountains: Deception Creek and Morro Peak.

Sinotectirostrum mackenziei nov. sp.

Plate XI, figures 1–6; Text-figure 22

1957. *Camarotoechia* aff. *nordeggi*—CRICKMAY, p. 2;
[e.p.] 1962. "*Camarotoechia*"—BELYEA and McLAREN, p. 10.

A. Mackenzie, explorer, whose name has been given to the Mackenzie River, N.W.T.

Types

Holotype. GSC No. 15698 (Pl. XI, figs. 1a–e). GSC loc. 38691. Collector: P. Sartenaer, 1959.

Paratype A. GSC No. 15699 (Pl. XI, figs. 2a–e). GSC loc. 21965. Collector: Socony Vacuum Exploration Co., 1952.

Paratype B. GSC No. 15700 (Pl. XI, figs. 3a–e). GSC loc. 7149F. Collector: G. S. Hume, 1921.

Paratype C. GSC No. 15701. GSC loc. 5721. Collector: E. M. Kindle, 1917.

Paratypes D, GSC No. 15702; J, GSC No. 15708 (Text-fig. 22). GSC loc. 6493. Collector: E. M. Kindle, 1919.

Paratypes E, GSC No. 15703; G, GSC No. 15705 (Pl. XI, figs. 4a–d); H, GSC No. 15706 (Pl. XI, figs. 6a–c); I, GSC No. 15707 (Pl. XI, figs. 5a–d). GSC loc. 7169. Collector: G. S. Hume, 1921.

Paratype F. GSC No. 15704. GSC loc. 7186. Collector: G. S. Hume, 1921.

Material

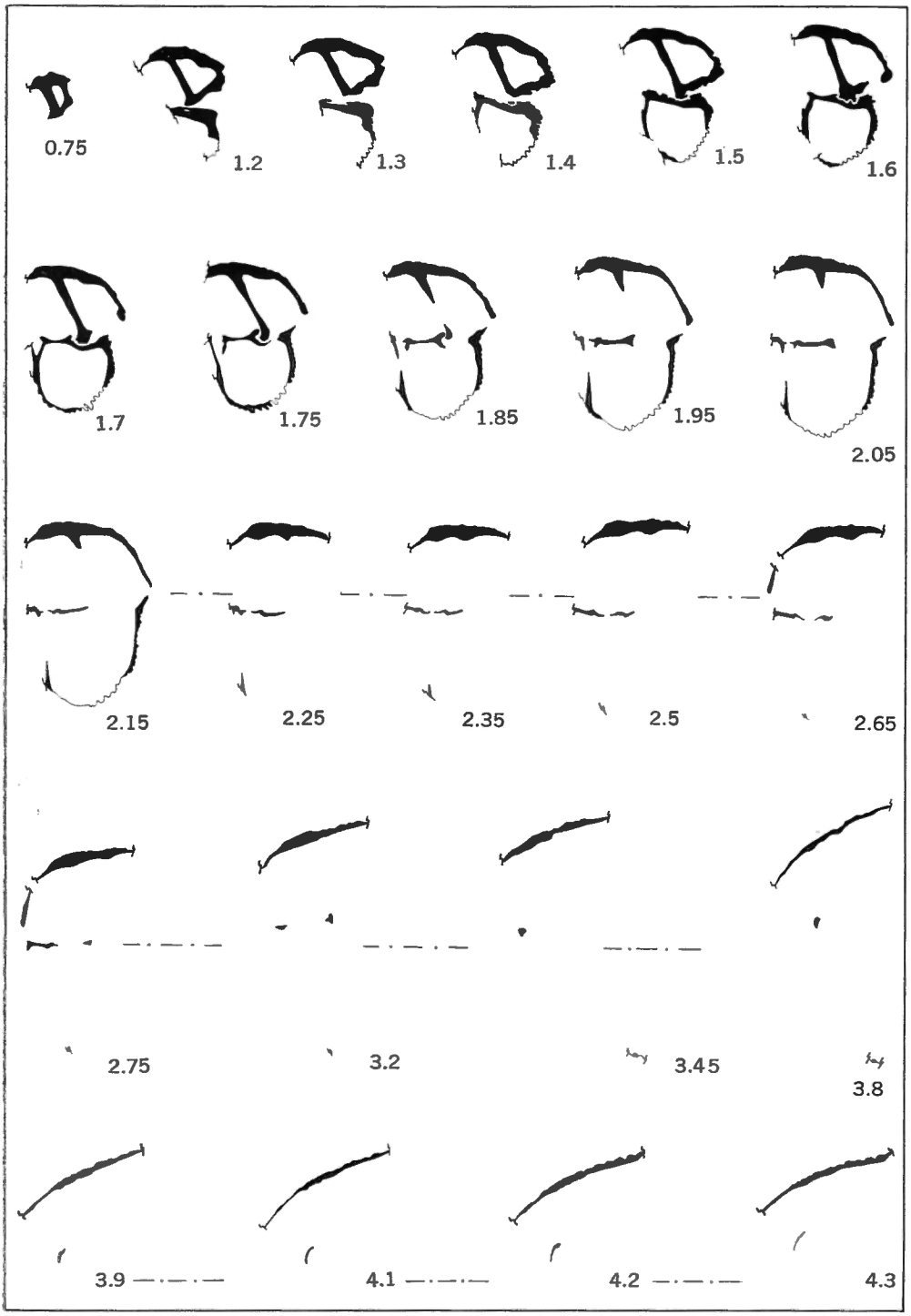
GSC localities in the Northwest Territories: Kakisa River: 17486 (1), 30546 (1), 30727 (1); Redknife River: 7284 (6), 7286 (1); Trout River: 30586 (2), 30610 (1); Imperial Island River well: 28389 (1); Jean-Marie River: 7312 (2), 7315 (7); Blackstone River: 21965 (1); Root River: 6493 (4), 7169 (4), 7186 (1), 38691 (1); Mackenzie River: 5721 (2), 7149A (2), 7149F (1).

The species may be represented by a single juvenile specimen in the Imperial Sikanni Chief No. 1 well, British Columbia (GSC loc. 41905).

Only one third of the material is in satisfactory state of preservation.

Description

As there are many similarities between *Sinotectirostrum mackenziei* and *S. medicinale*, only the differences between the two species are given. The new species might be a geographic subspecies of *S. medicinale*, but as the collections of *S. mackenziei* are limited and as its stratigraphic range is not fully known, it is considered preferable at present to accept the two forms derived from widely separated regions as distinct species.



TEXT-FIGURE 22. *Sinotectirostrum mackenziei* nov. sp.

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Paratype J, GSC No. 15708 (l:15.5 mm; w:(13.5) mm; t:14.6 mm). The specimen is laterally compressed.

The species is of medium size; it never reaches the size of some specimens of *S. medicinale*. The width of the sulcus at the front varies between 63 and 71 per cent of the width of the shell, but is never as wide as in some specimens of *S. medicinale;* the flanks of the sulcus are commonly steeper.

The postero-lateral margins of the valves are concave, but do not have the steep aspect of those of *S. medicinale.*

The general costal formula is 5/4 to 9/8; 1/1-1/1 to 2/2-2/2; 13/14 to 18/19.

The distribution of the costae is as follows:

Median + Parietal			Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
7/6	1	4.35	5/4	2	11.10	1-1/1-1	1	5.90	9/10	1	7.15
8/7	1	4.35	6/5	4	22.20	2-2/2-2	12	70.60	12/13	1	7.15
9/8	3	13.05	7/6	3	16.70	3-3/3-3	4	23.50	13/14	1	7.15
10/9	3	13.05	8/7	5	27.75				14/15	2	14.30
11/10	3	13.05	9/8	3	16.70				15/16	2	14.30
12/11	3	13.05	10/9	1	5.55				16/17	2	14.30
13/12	3	13.05							17/18	3	21.35
14/13	2	8.675							18/19	1	7.15
15/14	2	8.675							21/22	1	7.15
16/15	1	4.35									
17/16	1	4.35									
	23	100.–		18	100.–		17	100.–		14	100.–

Most specimens do not have roof-shaped costae, but exceptions occur, e.g., paratype A. The absence of this character gives a more homogeneous aspect to the species than to *S. medicinale* where some specimens with less angular costae occur amongst those with distinctly roof-shaped costae. The width of the median costae varies between 1 and 1.5 mm at the front.

Measurements of seven specimens:

in mm	Paratype C	Paratype E	Paratype D	Paratype A	Paratype F	Holotype	Paratype B
l	16.1	15.9	15.9	15.7	15.0	14.5	(12.3)
w	(18.8)	17.1	16.2	19.4	19.1	17.0	14.7
lpv unrolled	23.5	19.0	23.5	28.0	23.5	21.7	(18.0)
t	11.9	9.4	12.3	15.5	12.0	10.0	10.2
tpv	3.9	3.6	4.4	4.8	4.5	4.0	3.2
tbv	8.0	5.8	7.9	10.7	7.5	6.0	7.0
l/w	(0.86)	0.93	0.98	0.81	0.79	0.85	(0.84)
t/w	(0.63)	0.55	0.76	0.80	0.63	0.60	0.70
t/l	0.74	0.59	0.77	0.99	0.80	0.69	(0.83)
shoulder angle	100°	105°	103°	(105°)	105°	103°	?

The shoulder angle varies between 100 and 105 degrees and is, thus, usually wider than in *S. medicinale.*

Measurements of three juvenile forms:

in mm	Paratype G	Paratype H	Paratype I
l	11.2	9.8	8.9
w	13.5	11.7	10.8
tpv unrolled	15.0	14.0	13.0
t	7.3	6.5	6.3
tpv	3.4	2.9	2.7
tbv	3.9	3.6	3.6
l/w	0.83	0.84	0.82
t/w	0.54	0.56	0.58
t/l	0.65	0.66	0.71
shoulder angle	100°	104°	105°

The shoulder angle of juvenile forms is somewhat wider than in *S. medicinale.*

The dental plates converge anteriorly. The only specimen sectioned has a connectivum preserved.

Discussion

Synonymy. Crickmay's (1957) specimen has been studied in Calgary. Part of Belyea and McLaren's (1962) specimens of *"Camarotoechia"* are put into synonymy with *Ptychomaletoechia contractiformis.*

Comparisons. Individual specimens may be very difficult to separate from specimens of *S. banffense banffense,* owing to the absence of well marked roof-shaped costae and a tendency towards higher shoulder angles. When several specimens are considered, the smaller size and lower value of the shoulder angle in *S. mackenziei* are distinctive.

Stratigraphic position. The most precise information comes from outcrops on Trout River. Crickmay's (1957, p. 2) specimen was collected between 55 and 77 feet above the base of the Trout River Formation. Other specimens derive from between 64 and 69 feet (GSC loc. 30610) and 81.5 feet up (GSC loc. 30586) from the base of the Trout River Formation.

On Kakisa River, specimens have been found near the base of (GSC locs. 30546, 30727) and within the Trout River Formation (GSC loc. 17486).

On Redknife and Jean-Marie Rivers, specimens derive from the base of the Trout River Formation (GSC locs. 7286, 7315) and from the top of the same formation or the base of the Tetcho Formation (GSC locs. 7284, 7312).

A specimen from the Imperial Island River well No. 1 (GSC loc. 28389) has been found at 4,278 feet with ten specimens of *Ptychomaletoechia septentrionalis* and one specimen of *"Pugnax" rara.*

Specimens from Blackstone (GSC loc. 21965), Root (GSC locs. 6493, 7169, 7186, 38691), and Mackenzie Rivers (GSC locs. 5721, 7149A, 7149F) are from the *Eoparaphorhynchus maclareni* Zone.

Thus, the species is known from the base of the Trout River Formation to the base of the Tetcho Formation.

Geographic distribution. The species is known in the Northwest Territories, in the valleys of the following rivers: Blackstone, Island, Jean-Marie, Kakisa, Mackenzie, Redknife, Root, Trout. It may be present in northeastern British Columbia.

The *Sinotectirostrum nordeggi–banffense–shimeri* Group

The *nordeggi–banffense–shimeri* Group occurs at the same stratigraphical level—the highest beds of the Palliser Formation, although the writer has never collected more than one species or subspecies from the same bed.

The taxa are:

1. *S. nordeggi,* which is tied to a lectotype chosen from two syntypes. The species is represented by few specimens and no juvenile forms;
2. *S. banffense banffense,* which was originally described from a single specimen. One of the two syntypes of *S. nordeggi* is included in this subspecies. The subspecies is represented by many specimens including only one juvenile form;
3. *Camarotoechia shimeri,* which was described on the basis of four syntypes. A lectotype is chosen in this paper. It was not possible to consider either of the two undamaged syntypes definitely as a juvenile form of *Sinotectirostrum nordeggi* or *S. banffense banffense;* on the other hand they could be matched with specimens from a large collection from Idaho showing all growth stages. This form, which is rare in the Canadian Rocky Mountains, is close to *S. banffense banffense* and is distinguished as *S. banffense shimeri.*

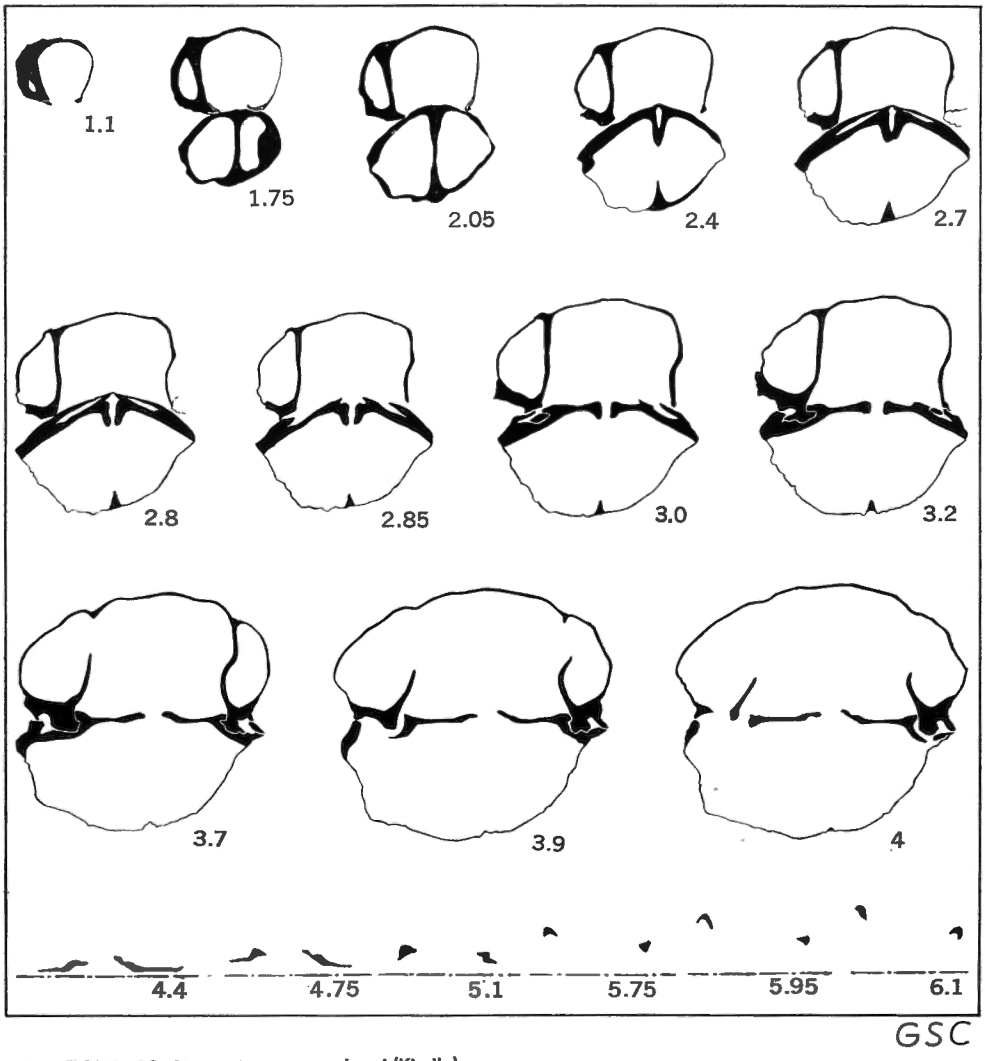
Some of the above-mentioned difficulties, combined with insufficiently precise stratigraphic control, make it difficult to assess variability and relationship with facies in the group.

Hence the taxonomic scheme proposed is tentative and, to some extent, opposed to an alternative solution in which the various forms are united in a single species with a wide range of variability (Kindle, 1924b; Warren, 1937, 1942, 1949; Warren and Stelck, 1950, 1956). A comparable situation may be recognized in the U.S.S.R. where Nalivkin (1960) assigns various forms to *Camarotoechia radiata* Nalivkin, 1960.

Sinotectirostrum nordeggi (Kindle)

Plate XII, figures 1–4; Text-figure 23

	1924b.	*Camarotoechia nordeggi* n.sp.—KINDLE, p. 218, pl. XIV, figs. 8, 9 (*coet. excl.*);
	1929.	*Camarotoechia nordeggi* Kindle—KINDLE, p. 187;
[?]	1937.	*Camarotoechia nordeggi* Kindle—WARREN, p. 455;
[?]	1942.	*Camarotoechia nordeggi* Kindle—WARREN, p. 132;
[non]	1942.	*Camarotoechia* cf. *C. nordeggi* Kindle—COOPER *in* COOPER *et al.*, p. 1771;
	1943.	*Camarotoechia nordeggi* Kindle—BALDWIN, pp. 146, 150, pl. 1, fig. 22 (*coet. excl.*);
	1943.	*Camarotoechia* cf. *shimeri* Warren—BALDWIN, pp. 146, 150–1, pl. 1, fig. 10;
[?]	1949.	*Camarotoechia nordeggi* Kindle—WARREN, p. 568;
	1950.	*Camarotoechia nordeggi* Kindle—ERDMAN, p. 75, collection numbers 11275, 11276 (*coet. excl.*);
	1950.	*C.* cf. *nordeggi* Kindle—ERDMAN, p. 75, collection numbers 11194, 11197, 11213, 11214, 11218 (*coet. excl.*);
[?]	1950.	*Camarotoechia nordeggi* Kindle—de WIT and McLAREN, p. 11;
[?] [e.p.]	1950.	*Camarotoechia* cf. *nordeggi* Kindle—de WIT and McLAREN, p. 15;
[?]	1950.	*Camarotoechia nordeggi* Kindle—WARREN and STELCK, p. 64;
[non]	1951.	*Camarotoechia nordeggi* Kindle—HOLLAND, p. 128;
[non]	1951.	*Camarotoechia* n.sp. cf. *C. nordeggi* Kindle—HOLLAND, p. 128;
	1951.	*Camarotoechia nordeggi* Kindle—FOX, p. 842;
[non]	1952a.	*Camarotoechia* cf. *C. nordeggi* Kindle—CRICKMAY, p. 594;
[non]	1952.	*Camarotoechia nordeggi* Kindle—HOLLAND, p. 1718;
[non]	1952.	*C.* n.sp. cf. *C. nordeggi* Kindle—HOLLAND, p. 1718;
	1954.	*Camarotoechia nordeggi* Kindle—FOX, p. 129;
[non]	1954.	*Camarotoechia nordeggi* Kindle—McLAREN, pp. 160, 173;
[non]	1955.	*Camarotoechia nordeggi* Kindle—McLAREN, pp. 27, 46;
	1956.	*Camarotoechia nordeggi* Kindle—WARREN and STELCK, pl. XXVII, figs. 15–17;
[non]	1956.	*Camarotoechia nordeggi*—BELYEA and McLAREN, p. 78;
[e.p.]	1956.	*Camarotoechia nordeggi* Kindle—BELYEA and McLAREN, p. 89;
[?]	1956.	*Paurorhyncha*? sp. (not specifically identifiable)—RAASCH, p. 117;
[?]	1956a.	*Camarotoechia nordeggi*—CRICKMAY, p. 188;
[non]	1956.	*Camarotoechia nordeggi*—SADLICK, p. 66;
[non]	1957.	*Camarotoechia* aff. *nordeggi*—CRICKMAY, p. 2;
[non]	1962.	*Camarotoechia nordeggi* Kindle—McLAREN *in* PRICE, p. 19;
	1962.	*C. nordeggi* Kindle—McLAREN *in* MOUNTJOY, p. 28, line 27 (*coet. excl.*);
	1963.	"*Camarotoechia*" *nordeggi* Kindle—PEDDER *in* HOUSE and PEDDER, p. 506;
[non]	1964.	"*Camarotoechia*" sp. cf. *C. nordeggi* Kindle—McLAREN *in* BELYEA and McLAREN, p. 803.



TEXT-FIGURE 23. ***Sinotectirostrum nordeggi*** **(Kindle)**
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype I, GSC No. 15632 (l:26.0 mm; w:28.5 mm; t:16.6 mm).
The right dorsal flank and the fold are crushed.

Types

Lectotype (Pl. XII, figs. 1a–e=pl. XIV, figs. 8, 9 *in* Kindle, 1924). GSC No. 5821. 4½ miles northwest of Nordegg, Alberta. Upper part of the Banff Limestone. Collector: E. M. Kindle.

Hypotype A. GSC No. 15626 (Pl. XII, figs. 3a–e). GSC loc. 11218, nearly same locality as GSC loc. 11198. Collector: O. A. Erdman, 1943.

Hypotype B. GSC No. 15627 (Pl. XII, figs. 2a, b). GSC loc. 11275. Same collector.

Hypotype C (=pl. 1, fig. 22 *in* Baldwin, 1943). PRI No. 6039. One mile east of Freighter Spring near Dickey, Lost River Range, Idaho, U.S.A. Borah Peak Quad. Within the upper 115 feet of the Three Forks Formation. Collector: E. M. Baldwin.

Hypotype D. GSC No. 15628. GSC loc. 11213. Collector: O. A. Erdman, 1943.

Hypotype E. GSC No. 15629. GSC loc. 11187. Collector: J. F. Henderson, 1943.

Hypotype F. GSC No. 15630. GSC loc. 11220. Collector: O. A. Erdman, 1943.

Hypotype G. GSC No. 15631. GSC loc. 38871. Collectors: H. R. Belyea and P. Sartenaer, 1959.

Hypotype H (Pl. XII, figs. 4a, b=pl. 1, fig. 10 *in* Baldwin, 1943, under *Camarotoechia* cf. *shimeri*). PRI No. 6040. Same locality, formation, and collector as for hypotype C.

Hypotype I. GSC No. 15632 (Text-fig. 23). Same locality, formation and collector as for hypotype E.

Material

The following GSC localities in the Canadian Rocky Mountains: lectotype, 11187 (4), 11194 (1), 11197 (1), 11213 (1), 11214 (4), 11217 (1), 11218 (2), 11220 (2), 11275 (1), 11276 (1), 18085 (1), 18086 (1), 21718 (3) but uncertain; 25205 (2), 26717 (1), 38871 (1), 69277 (1).

Seven specimens from Idaho: PRI Nos. 6039 and 6040; two specimens received from Dr. E. M. Baldwin; three specimens collected by Dr. W. Sadlick and the writer in 1960.

Fifty per cent of the material is in satisfactory state of preservation.

Description

The species is large. The contour is transversally oval to circular in a few specimens (Pl. XII, fig. 2a). The flanks slope progressively towards the commissure and, for the brachial valve, gently or steeply depending on the thickness of the shell; postero-lateral margins are concave near the commissure. Commissure is sharp and, with the exception of the borders of the tongue, indented by the costae.

Pedicle valve. The sulcus starts imperceptibly between 42 and 59 per cent of the length of the shell forward of the beak, or between 37 and 50 per cent of the unrolled length of the valve. It widens slowly; its width, where it starts, is usually more than half its maximum width at the front, which varies between 60 and 66 per cent of the width of the shell. The sulcus is shallow—two to four times the height of the costae, and deepens slowly towards the frontal commissure. The floor of the sulcus is commonly slightly convex medially, rarely flat. The floor occupies almost three quarters of its total width. The sides are characterized by distinctive parietal costae (*see* Ornament).

The sulcus passes progressively into the trapezoidal tongue, which is often recurved posteriorly. The borders of the tongue are sharp and not indented by the costae. Its median part may project anteriorly.

The beak is suberect to erect and well marked. The interarea may reach a height of 2 mm and its length varies between 40 and 50 per cent of the width of the shell.

Brachial valve. The fold starts imperceptibly between 34 and 40 per cent of the length of the shell forward of the beak. Like the sulcus, it starts with an appreciable width and widens slowly. It is well marked and commonly higher than the sulcus is deep; its top is more or less slightly arched. The greatest thickness of the valve is posterior to the frontal commissure, at a variable distance from it.

Ornament. The general costal formula is 8/7 to 14/13; 8/8–8/8 to 4/4–4/4; 11/12 to 19/20. Costae are simple, usually low, and start at the umbones.

The ratios of median + parietal and median costae are distributed in the following way:

Median + parietal			Median		
Number of costae	spec.	%	Number of costae	spec.	%
14/13	2	7.70	8/7	3	11.55
15/14	3	11.55	9/8	3	11.55
16/15	5	19.20	10/9	7	26.90
17/16	4	15.40	11/10	6	23.10
18/17	3	11.55	13/12	2	7.70
19/18	4	15.40	14/13	5	19.20
20/19	2	7.70			
21/20	1	3.80			
22/21	2	7.70			
	26	100.–		26	100.–

The median costae usually reach a width of 1 to 1½ mm at the front, and may reach 2½ mm when costae are less numerous. In some specimens the middle costae of the sulcus and fold tend to become fan-shaped at the front.

Parietal costae are characteristic as they do not indent the borders of the tongue; they fail very near the frontal margin (Pl. XII, figs. 1a, d, e, 3b, c). The number of parietal costae is commonly equal on each side.

Lateral costae are known only on eighteen specimens and their distribution is given below. The low ratios are minimal as most external costae are faint and often worn. $^{11}/_{12}$: 2 sp; $^{12}/_{13}$: 1 sp; $^{13}/_{14}$: 1 sp; $^{14}/_{15}$: 1 sp; $^{15}/_{16}$: 2 sp; $^{16}/_{17}$: 4 sp; $^{17}/_{18}$: 2 sp; $^{18}/_{19}$: 3 sp; $^{19}/_{20}$: 1 sp; $^{22}/_{23}$: 1 sp.

The internal ventral costae tend to curve axially towards the front. All costae are flat-rounded posteriorly and become progressively angular-rounded anteriorly. Growth lines are mostly absent.

Dimensions. Measurements of eight specimens:

in mm	Hypotype G	Hypotype I	Lectotype	Hypotype E	Hypotype D	Hypotype C	Hypotype F	Hypotype A
l	(27.3)	26.0	(25.2)	24.7	(23.3)	(22.5)	20.9	19.2
w	31.5	28.5	30.7	32.8	27.0	(29.8)	29.6	24.2
lpv unrolled	?	37.0	?	?	?	?	37.0	30.0
t	22.1	16.6	17.9	22.2	(15.3)	20.7	20.3	17.8
tpv	6.7	5.6	6.2	8.5	5.3	7.2	5.3	5.8
tbv	15.4	11.0	11.7	13.7	(10.0)	13.5	15.0	12.0
l/w	(0.87)	0.91	(0.82)	0.75	(0.86)	(0.76)	0.71	0.79
t/w	0.70	0.58	0.58	0.68	(0.57)	(0.69)	0.69	0.74
t/l	(0.82)	0.64	(0.71)	0.90	(0.66)	(0.92)	0.97	0.93
shoulder angle	?	110°	?	(120°)	?	?	120°	?

Width is the greatest dimension. The greatest width of the shell is between 56 and 66 per cent of the length from the beak.

Internal characters. The internal characters are as described for the genus. A few details are added.

No connectivum is preserved in the only specimen sectioned, and the ridge or thickening at the junction of the outer plates of the hinge plate with the borders of the septalium is very faint.

Growth. The species has a non-constant and monocyclic curvature growth: thickness increases noticeably in later stages when width and length increase relatively little.

Sulcus and fold are ill-defined.

Other juvenile characters are: thickness of the pedicle valve greater than that of the brachial; greatest thickness of the brachial valve is located posteriorly.

Dimensions of the only specimen with juvenile characters:

in mm	Hypotype H
l	17.8
w	22.1
lpv unrolled	23.5
t	10.6
tpv	3.8
tbv	6.8
l/w	0.81
t/w	0.48
t/l	0.60
shoulder angle	120°

Discussion

Synonymy. The species was originally illustrated by two specimens (Kindle, 1924b, pl. XIV, figs. 8, 9, 10); the specimen in figures 8 and 9 has been chosen as the lectotype. The specimen on figure 10 from near Banff, Alberta at Mount Hole-in-the-Wall belongs to a subspecies, *S. banffense banffense,* which is represented by more abundant and better preserved material.

Warren and Stelck (1956) did not figure *Camarotoechia banffensis* but only *C. nordeggi.* This suggests that they have dropped *C. banffensis* and given a broader meaning to *C. nordeggi.* This is, furthermore, substantiated by the fact that Warren (1937, 1942, 1949), and Warren and Stelck (1950) do not mention *C. banffensis.*

De Wit and McLaren's (1950) identifications could refer to *Sinotectirostrum nordeggi* or to *S. banffense banffense* or to both; [e.p.] accounts for the fact that neither species has been found below the Costigan Member of the Palliser Formation.

Holland's (1951, 1952) *Camarotoechia nordeggi* and *C.* n. sp. cf. *C. nordeggi,* and Cooper's (1942) *C.* cf. *C. nordeggi* are considered as *Sinotectirostrum banffense shimeri.*

Crickmay's (1952a) specimens of *Camarotoechia* cf. C. *nordeggi,* which the writer has examined in Calgary, are distributed amongst *Sinotectirostrum banffense banffense* and *S. banffense shimeri.*

McLaren's (1954) *Camarotoechia nordeggi* is excluded from synonymy because the species has not been found in the Morro Member of the Palliser Formation. Hence the *C. nordeggi* cited by Belyea and McLaren (1956, p. 78) has also been excluded and [e.p.] written in front of the *C. nordeggi* cited by the same authors (p. 89) in order to exclude specimens from the Morro Member.

McLaren's (1955) specimens of *Camarotoechia nordeggi* are considered as *Sinotectirostrum banffense banffense.*

Crickmay (1956a) identified the specimen called *Paurorhyncha*? sp. by Raasch (1956) as *Camarotoechia nordeggi*. This identification must be considered doubtful as the specimen is incomplete.

Sadlick's (1956) *Camarotoechia nordeggi* specimens are considered to be *Sinotectirostrum banffense shimeri.*

Crickmay's (1957) *Camarotoechia* aff. *nordeggi* are considered to belong to *Sinotectirostrum mackenziei.*

The specimens (GSC loc. 40205) identified by McLaren *in* Mountjoy (1962) at the base of the Palliser Formation belong to *Ptychomaletoechia sulculifera.* Specimens identified as *Camarotoechia nordeggi* by McLaren *in* Price (1962) are *Sinotectirostrum banffense banffense.* Specimens identified by McLaren *in* Belyea and McLaren (1964) as "*Camarotoechia*" sp. cf. *C. nordeggi* are put in *Sinotectirostrum banffense banffense.*

Comparisons. The species is distinguished by large size and large number of costae. Similarities to and differences from *S. banffense banffense* are given under the description of that subspecies.

Stratigraphic position. The lectotype occurs in "the upper part of the Banff limestone" [= upper part of the Palliser Formation], and the species is mentioned by Kindle (1929) in the "upper division of the Minnewanka limestone" [= Palliser Formation]. Erdman's specimens fall "within the upper 200 feet of the Upper Devonian." Warren's collections derive from the "uppermost bed of the Minnewanka Formation." The specimens from Idaho have been collected in the upper 115 feet of the Three Forks Formation. This is the most precise information found in the literature.

The remainder of the material at hand, for which more information is available, occurs in the top of the Palliser Formation near the top (GSC loc. 11187), in the upper 15 feet (GSC loc. 18085), at 28 feet below the top (GSC loc. 18086), at the top (GSC locs. 21718, 26717), somewhere between 14 and 44 feet below the top (GSC loc. 25205), in the upper 10 feet (GSC loc. 38871), uppermost beds.

The species is thus confined in the upper part of the Palliser Formation and is probably restricted to the upper 50 feet.

Geographic distribution. In the Canadian Rocky Mountains, specimens derive from Cadomin, Maligne Canyon, Mount Robson (southeast) map-area, Nordegg, Shankland Creek, Alexo map-area, Gap of North Saskatchewan River, Burnt Timber area. The species is known in Idaho.

Sinotectirostrum banffense banffense (Warren)

Plate XII, figures 5–8; Plate XIII, figures 1–3, 6, 7; Text-figures 24, 25

	1924b.	*Camarotoechia nordeggi*, n.sp.—KINDLE, p. 218, pl. XIV, fig. 10 (*coet. excl.*);
	1926.	*Camarotoechia* sp.—SHIMER, p. 45;
	1927.	*Camarotoechia banffensis* sp. nov.—WARREN, pp. 19, 51–2, pl. IV, figs. 7–9;
[?]	1937.	*Camarotoechia nordeggi* Kindle—WARREN, p. 455;
[?]	1942.	*Camarotoechia nordeggi* Kindle—WARREN, p. 132;
[?]	1947.	*Camarotoechia omaliusi* Gosselet, 1877—NALIVKIN, p. 88, pl. XIX, figs. 11a, b;
[?]	1949.	*Camarotoechia nordeggi* Kindle—WARREN, p. 568;
	1950.	*Camarotoechia nordeggi* Kindle—ERDMAN, p. 75, collection number 11273 (*coet. excl.*);
	1950.	*C.* cf. *nordeggi* Kindle—ERDMAN, p. 75, collection number 11200 (*coet. excl.*);
	1950.	*C.* cf. *banffensis* Warren—ERDMAN, p. 75;
[?]	1950.	*Camarotoechia nordeggi* Kindle—de WIT and McLAREN, p. 11;
[?][e.p.]	1950.	*Camarotoechia* cf. *nordeggi* Kindle—de WIT and McLAREN, p. 15;
[e.p.]	1950.	*Camarotoechia* cf. *shimeri* Warren—de WIT and McLAREN, p. 15;
[?]	1950.	*Camarotoechia nordeggi* Kindle—WARREN and STELCK, p. 64;
	1951.	*Camarotoechia banffensis* Warren—FOX, p. 842;

	1952a.	*Camarotoechia banffensis* Warren—CRICKMAY, p. 590;
	1952a.	*Camarotoechia* cf. *C. sobrina* Stainbrook—CRICKMAY, p. 590;
[e.p.]	1952a.	*Camarotoechia* cf. *C. nordeggi* Kindle—CRICKMAY, p. 594;
	1954.	*Camarotoechia banffensis* Warren—FOX, p. 129;
[non]	1954.	*Camarotoechia banffensis* Warren—McLAREN, pp. 160, 173;
	1955.	*Camarotoechia nordeggi* Kindle—McLAREN, pp. 27, 46;
[?]	1956.	*Paurorhyncha endlichi* (Kindle)—RAASCH, p. 116;
[?]	1956.	*Paurorhyncha*? sp. (not specifically identifiable)—RAASCH, p. 117;
[?]	1956a.	*Camarotoechia nordeggi*—CRICKMAY, p. 188;
[non]	1956.	*Camarotoechia banffensis* Warren—BELYEA and McLAREN, p. 89;
[non]	1958.	*Camarotoechia banffensis* Warren—McLAREN, pl. V, figs. 13–15;
[?]	1960.	*Camarotoechia radiata* Nalivkin sp. nov.—NALIVKIN, p. 351, pl. 82, figs. 3a, b, v, g, 4a, b, 5a, b (= pl. XIX, figs. 11a, b *in* NALIVKIN, 1947, under *Camarotoechia omaliusi*) (*coet. excl.*);
	1962.	*Camarotoechia* cf. *C. banffensis* Warren—McLAREN *in* PRICE, p. 19;
	1962	*Camarotoechia nordeggi* Kindle—McLAREN *in* PRICE, p. 19;
	1962.	*Camarotoechia banffensis* Warren—McLAREN *in* MOUNTJOY, p. 28;
[non]	1962.	"*Camarotoechia*" *nordeggi banffensis* Warren—SARTENAER *in* McLAREN and MOUNTJOY, p. 21;
[?]	1964.	"*Camarotoechia*" sp. cf. *C. nordeggi* Kindle—McLAREN *in* BELYEA and McLAREN, p. 803;
	1965.	"*Camarotoechia*" *nordeggi* Kindle—McLAREN *in* MOUNTJOY, p. 32.

Types

Holotype (Pl. XII, figs. 6a–e=pl. IV, figs. 7–9 *in* Warren, 1927). GSC No. 8903. Sulphur Mountain, Banff National Park, Alberta. Upper Devonian, upper beds of Minnewanka Limestone. Collector: P. S. Warren.

Hypotype A (Pl. XII, figs. 7a–e=syntype of *Camarotoechia nordeggi*, Pl. XIV, fig. 10 *in* Kindle, 1924b). GSC No. 5821a. Mount Hole-in-the-Wall, near Banff, Banff National Park, Alberta. Upper part of the Banff Limestone. Collector: E. M. Kindle.

Hypotype B (Pl. XII, figs. 8a–c=*Camarotoechia* sp. *in* Shimer, 1926). GSC No. 4570. North shore of Lake Minnewanka, Banff National Park, Alberta. Upper 30 feet of the Upper Minnewanka Limestone. Collector: H. W. Shimer.

Hypotypes C, GSC No. 15634; D, GSC No. 15635. GSC loc. 18242. Collector: D. J. McLaren, 1949.

Hypotypes E, GSC No. 15636 (Pl. XIII, figs. 6a–d); F, GSC No. 15637. GSC loc. 38855. Collectors: H. R. Belyea and P. Sartenaer, 1959.

Hypotypes G, GSC No. 15638 (Pl. XIII, figs. 1a–c); H, GSC No. 15639 (Pl. XIII, figs. 2a–c); I, GSC No. 15640 (Pl. XIII, figs. 3a–c); K, GSC No. 15642 (Text-fig. 24). GSC loc. 36914. Collector: E. Mountjoy, 1958.

Hypotype J. GSC No. 15641 (Pl. XIII, figs. 7a–d). Mountain Park area, Alberta. No other information available. Collector: W. A. Kelly, 1924.

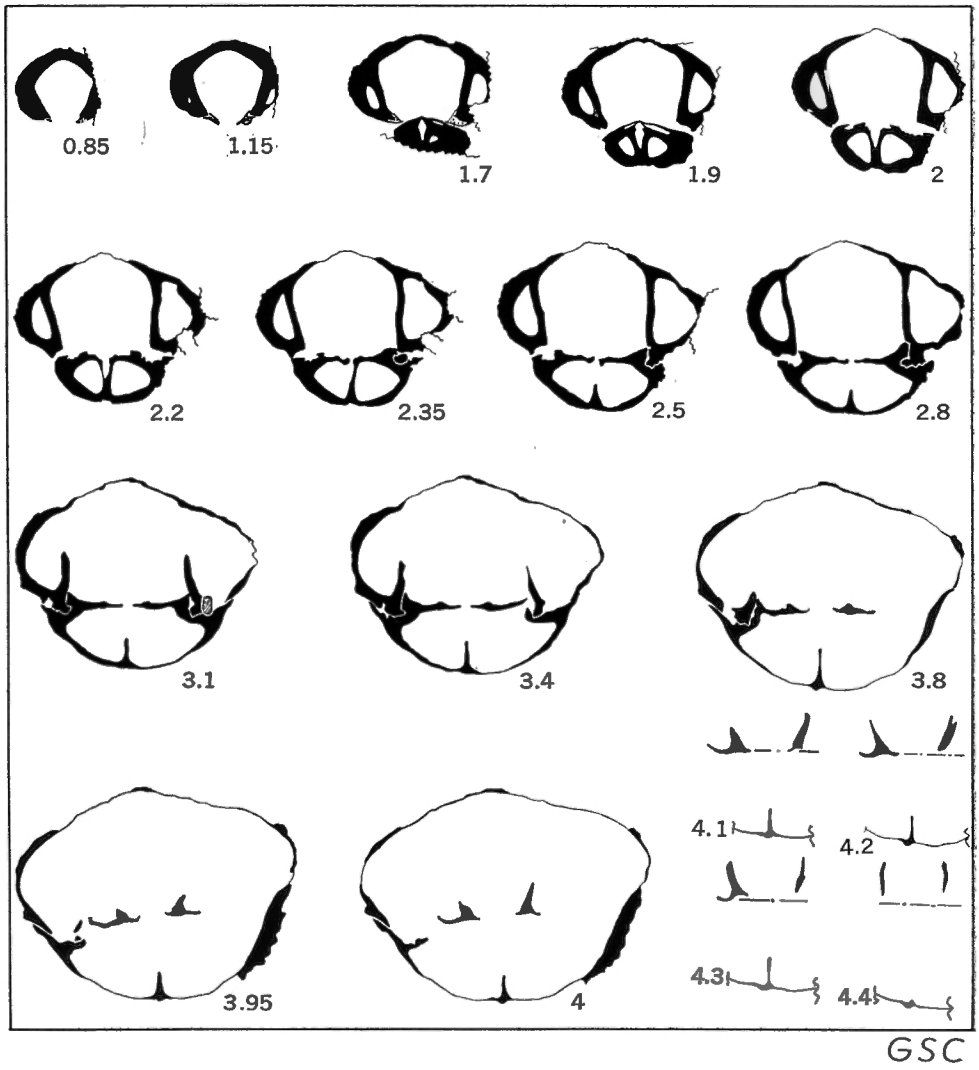
Hypotype L. GSC No. 15643 (Text-fig. 25). GSC loc. 18088. Collector: D. J. McLaren, 1949.

Hypotype M. GSC No. 15633 (Pl. XII, fig. 5). GSC loc. 38866. Collectors: H. R. Belyea and P. Sartenaer, 1959.

Material

GSC localities in the Canadian Rocky Mountains: holotype; two specimens with the following type numbers: GSC No. 4570, 5821a; 8768 (7), 11200 (2), 11225 (7), 11241 (17), 11245 (1), 11273 (1), 17044 (2), 17045 (6), 17052 (2), 18086 (1), 18088 (1), 18242 (23), 21718 (9), 24441 (1), 24549 (3), 36856 (6), 36914 (45), 36936 (8), 38823 (2), 38855 (23), 38866 (18), 38876 (1), 38885 (3), 38887 (1), 38892 (1), 40677 (1), 40682 (8), 42125 (2), 42139 (3), 45879 (10), 48396 (15), 49559 (1), no number (20).

More than half the material is in satisfactory state of preservation. Crickmay's material has been studied in Calgary.



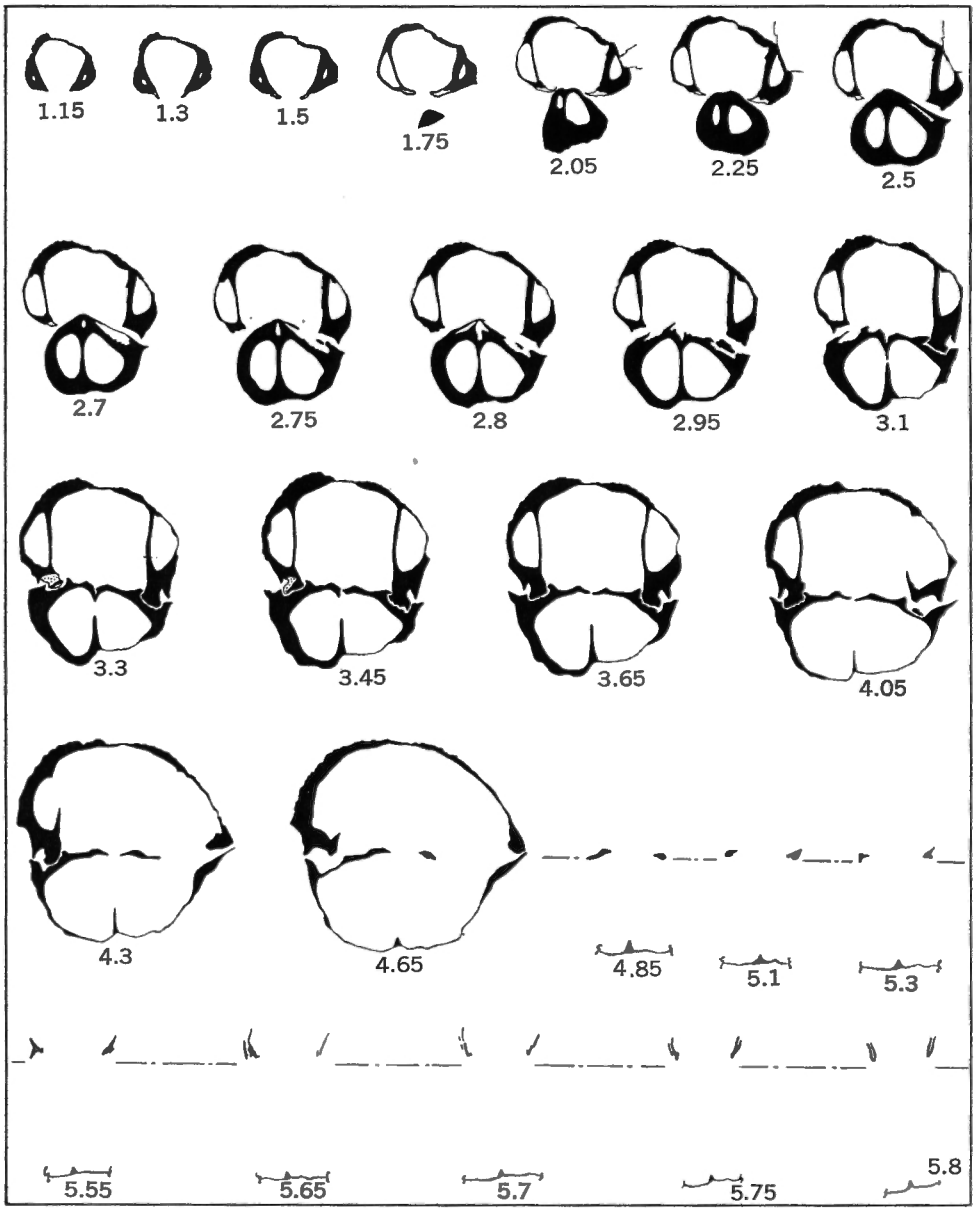
TEXT-FIGURE 24. *Sinotectirostrum banffense banffense* (Warren)
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Hypotype K, GSC No. 15642 (l:18.5 mm; w:(21.5) mm; t:14.6 mm).

Description

Remarks. Only differences from *S. nordeggi* are given. The subspecies is small to medium sized.

The width of the sulcus at the front varies for most of the specimens between 60 and 66 per cent of the width of the shell, but exceptionally it can be as low as 55 per cent and not uncommonly it is higher than 66 per cent and may reach 75 per cent (72 per cent is the value for the holotype).

The length of the ventral interarea varies between 45 and 57 per cent of the width of the shell. The round foramen is minute and results from the resorption of the beak.



TEXT-FIGURE 25. *Sinotectirostrum banffense banffense* (Warren)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Hypotype I, GSC No. 15643. Broken specimen.

Sometimes, especially in high specimens, the costae on the fold are recurved abruptly towards the frontal commissure.

Ornament. The general costal formula is 6/6 to 8/7; 3/3-3/3 to 4/4-4/4; 10/11 to 16/17.

The ratios of median and parietal costae are distributed as follows:

Median + parietal			Median			Parietal		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
9/8	1	0.75	5/4	2	3.05	2-2/2-2	8	11.40
10/9	10	7.35	6/5	26	39.35	2-3/2-3	1	1.45
11/10	15	11.05	7/6	16	24.20	3-3/3-3	36	51.40
12/11	29	21.30	8/7	12	18.20	3-4/3-4, 4-3/4-3	5	7.15
13/12	27	19.85	9/8	6	9.10	4-4/4-4	13	18.55
14/13	26	19.10	10/9	2	3.05	4-5/4-5	1	1.45
15/14	15	11.05	11/10	2	3.05	3-5/3-5	1	1.45
16/15	9	6.60				5-5/4-4	1	1.45
17/16	4	2.95				5-5/5-5	3	4.25
						5-6/5-6	1	1.45
	136	100.–		66	100.–		70	100.–

Often, the state of preservation does not allow to count separately the median and parietal costae, although their total number can be counted (*see* column 1).

The width of the median costae at the front is the same as for *S. nordeggi*, the smaller size being matched by fewer costae. The fan arrangement of the median costae may be very pronounced.

Distribution of lateral costae (84 sp.): 6/6: 3 sp; 9/10: 5 sp; 10/11: 6 sp; 11/12: 11 sp; 12/13: 6 sp; 13/14: 11 sp; 14/15: 12 sp; 15/16: 14 sp; 16/17: 6 sp; 17/18: 3 sp; 19/20: 5 sp; 20/21: 2 sp.

Dimensions. Measurements of nine specimens:

in mm	Hypotype A	Holotype	Hypotype G	Hypotype D	Hypotype H	Hypotype I	Hypotype E	Hypotype C	Hypotype F
l	(19.6)	19.3	19.2	(18.0)	18.0	17.8	(17.3)	16.1	13.8
w	23.2	22.6	23.3	22.0	21.4	20.8	20.2	19.9	17.8
lpv unrolled	(31.0)	28.0	28.0	(29.0)	27.0	28.0	?	25.0	21.5
t	17.0	(12.7)	13.6	17.0	14.0	16.2	13.5	15.0	11.5
tpv	4.8	4.3	4.0	5.0	5.1	4.7	4.0	4.5	3.8
tbv	12.2	(8.4)	9.6	12.0	8.9	11.5	9.5	10.5	7.7
l/w	(0.84)	0.85	0.82	(0.82)	0.84	0.86	(0.86)	0.81	0.78
t/w	0.73	(0.56)	0.58	0.77	0.65	0.78	0.67	0.75	0.65
t/l	(0.86)	(0.66)	0.71	(0.94)	0.78	0.91	(0.78)	0.93	0.83
shoulder angle	(115°)	115°	115°	(115°)	104°	110°	108°	107°	110°

Internal characters. In none of the three specimens sectioned is a connectivum preserved.

Growth. Only one juvenile specimen is available.

Discussion

Synonymy. The specimen identified as a *Camarotoechia* sp. by Shimer (1926) is considered here as hypotype B of *Sinotectirostrum banffense banffense.*

A question mark precedes the *Camarotoechia nordeggi* identified by Warren (1937, 1942, 1949), Warren and Stelck (1950), as well as de Wit and McLaren's (1950) identifications for the reasons given under the discussion of the synonymy of *Sinotectirostrum nordeggi.* [e.p.] is added to de Wit and McLaren's *Camarotoechia* cf. *nordeggi* and *C.* cf. *shimeri,* because these forms are also mentioned lower than the Costigan Member of the Palliser Formation.

At present it is impossible to separate *Camarotoechia radiata* Nalivkin, 1960 mentioned in the synonymy, from the Canadian subspecies (*see* the introduction to the Group *Sinotectirostrum nordeggi-banffense-shimeri*). Figures 6a, b, v, g, plate 82 *in* Nalivkin (1960) are excluded and considered in connection with *Sinotectirostrum shimeri.* The other alternative is to accept a wide range of variability in the number of costae for the Russian species, as some authors (*see* above) have done for the Canadian species. This seems to be Nalivkin's opinion according to the descriptions of 1947 and 1960 and the figures of 1960.

McLaren's (1954) and Belyea and McLaren's (1956) *Camarotoechia banffensis* are excluded from synonymy because the species has never been found in the Morro Member of the Palliser Formation.

Part of the specimens identified as *C.* cf. *C. nordeggi* by Crickmay (1952a) and examined by the writer in Calgary belongs to *Sinotectirostrum banffense shimeri.*

Crickmay (1956a) identified the specimen called *Paurorhyncha*? sp. by Raasch (1956) as *Camarotoechia nordeggi.* This identification must be considered doubtful as the specimen is incomplete.

McLaren's (1958) *Camarotoechia banffensis* is put into synonymy with *Sinotectirostrum banffense shimeri.*

The specimens identified by Sartenaer *in* McLaren and Mountjoy (1962) as *"Camarotoechia" nordeggi banffensis* are put into synonymy with *Sinotectirostrum medicinale.*

The specimen identified by McLaren *in* Belyea and McLaren (1964) as *"Camarotoechia"* sp. cf. *C. nordeggi* is the brachial valve of a juvenile specimen; a definite identification is impossible.

Comparisons. The subspecies is distinguished by medium size, number of median and parietal costae, and commonly abrupt downward curvature of the costae on the fold at the front.

S. nordeggi and *S. banffense banffense,* sometimes found in the same bed, are similar in the following features: shape, general characters of fold, sulcus and tongue, beak, aspect of costae, interior. The main differences are in size and in number of costae. *S. nordeggi* differs by the following characteristics: larger size; more costae; similar width of costae despite the bigger size; commonly, although not systematically, the width is proportionately larger (and thus the contour transversely oval) and the thickness proportionately smaller; the fold is usually lower; the costae on the fold are not recurved abruptly towards the frontal commissure; the shoulder angle (when measurable) is wider.

S. medicinale medicinale can be separated from *S. banffense banffense* by its smaller shoulder angle, abrupt postero-lateral margins and, thus, different contour, stronger and roof-shaped costae, wider sulcus at the front, wider sulcus flanks in ventral view, and wider septum.

Stratigraphic position. "Upper part of Banff limestone" (=upper part of the Palliser Formation], "upper beds and uppermost beds of Minnewanka limestone" [= upper beds of the Palliser Formation], "upper 30 feet of the Upper Minnewanka limestone", "within the upper 200 feet of the Devonian" is the most precise information in the literature subsequent to 1951 related to material from the Canadian Rocky Mountains. All the specimens collected by members of the Geological Survey as well as by the writer, about which precise stratigraphic information is available, fall within the upper 85 feet of the Palliser Formation.

Crickmay's (1952a) *Camarotoechia* cf. *C. sobrina* has been collected in the upper 26 feet of the Palliser Formation.

The Russian species, *Camarotoechia radiata,* is reported in the Famennian.

Geographic distribution. The subspecies is widespread in the Canadian Rocky Mountains where it is found as far north as the Miette and Mount Robson (southeast) map-areas and as far south as the Fernie map-area. Intermediate points are: Reward Creek, Resplendent Creek, Cadomin, Mountain Park area, Deception Creek, Maligne Canyon, Thistle Creek, Nordegg, Alexo map-area, Hummingbird Creek, North Saskatchewan River Gap (Cirrus Mountain), vicinity of Banff (Bourgeau Range, Lake Minnewanka, Sulphur Mountain, Mount Hole-in-the-Wall, Grotto Mountain, Lac des Arcs), and the Wedge. The subspecies exists in the Stettler area.

Crickmay's (1952a) *Camarotoechia* cf. *C. sobrina* derives from Imperial Youngstown borehole No. 1.

The Russian species *Camarotoechia radiata* has been found in Novaya Zemlya and Vaigatch islands.

Remark. In the Museum of Comparative Zoölogy, Cambridge, Mass., U.S.A., in a box containing eleven specimens identified as *Leiorhynchus* cf. *mesacostalis* Hall by Haynes, there is a specimen that might be a small *Sinotectirostrum banffense banffense*; the collection derives from Haynes' member No. 5 in the Three Forks Formation at Three Forks, Montana.

Sinotectirostrum banffense shimeri (Warren)

Plate XII, figure 9; Plate XIII, figures 4, 5, 8; Text-figure 26

	1927.	*Camarotoechia shimeri* sp. nov.—WARREN, pp. 19, 52–3, pl. IV, figs. 5, 6;
	1929.	*Camarotoechia* cf. *shimeri* Kelly—KINDLE, p. 187;
	1942.	*Camarotoechia* cf. *C. nordeggi* Kindle—COOPER *in* COOPER, *et al.*, p. 1771;
[non]	1943.	*Camarotoechia* cf. *shimeri* Warren—BALDWIN, pp. 146, 150–1, pl. 1, fig. 10;
	1943.	*Camarotoechia nordeggi* Kindle—BALDWIN, pp. 146, 150, pl. 1, figs. 15–17 (*coet. excl.*);
	1950.	*Camarotoechia shimeri* Warren—de WIT and McLAREN, p. 11;
[e.p.]	1950.	*Camarotoechia* cf. *shimeri* Warren—de WIT and McLAREN, p. 15;
	1951.	*Camarotoechia nordeggi* Kindle—HOLLAND, p. 128;
	1951.	*Camarotoechia* n. sp. cf. *C. nordeggi* Kindle—HOLLAND, p. 128;
	1951.	*Camarotoechia shimeri* Warren—FOX, p. 842;
	1952.	*Camarotoechia nordeggi* Kindle—HOLLAND, p. 1718;
	1952.	*C.* n.sp. cf. *C. nordeggi* Kindle—HOLLAND, p. 1718;
	1952a.	*C. shimeri* Warren—CRICKMAY, p. 590;
[e.p.]	1952a.	*Camarotoechia* cf. *C. nordeggi* Kindle—CRICKMAY, p. 594;
	1954.	*Camarotoechia shimeri* Warren—FOX, p. 129;
	1956.	*Camarotoechia nordeggi*—SADLICK, p. 66;
	1958.	*Camarotoechia banffensis* Warren—McLAREN, p. 194, pl. V, figs. 13–15;
[?]	1960.	*Camarotoechia radiata* Nalivkin sp. nov.—NALIVKIN, p. 351, pl. 82, figs. 6a, b, v, g (*coet. excl.*);
	1962.	"*Camarotoechia*" *banffensis* Warren—McLAREN *in* McLAREN, NORRIS and McGREGOR, p. 32, pl. XV, figs. 13–15 (= pl. V, figs. 13–15 *in* McLAREN, 1958).

Types

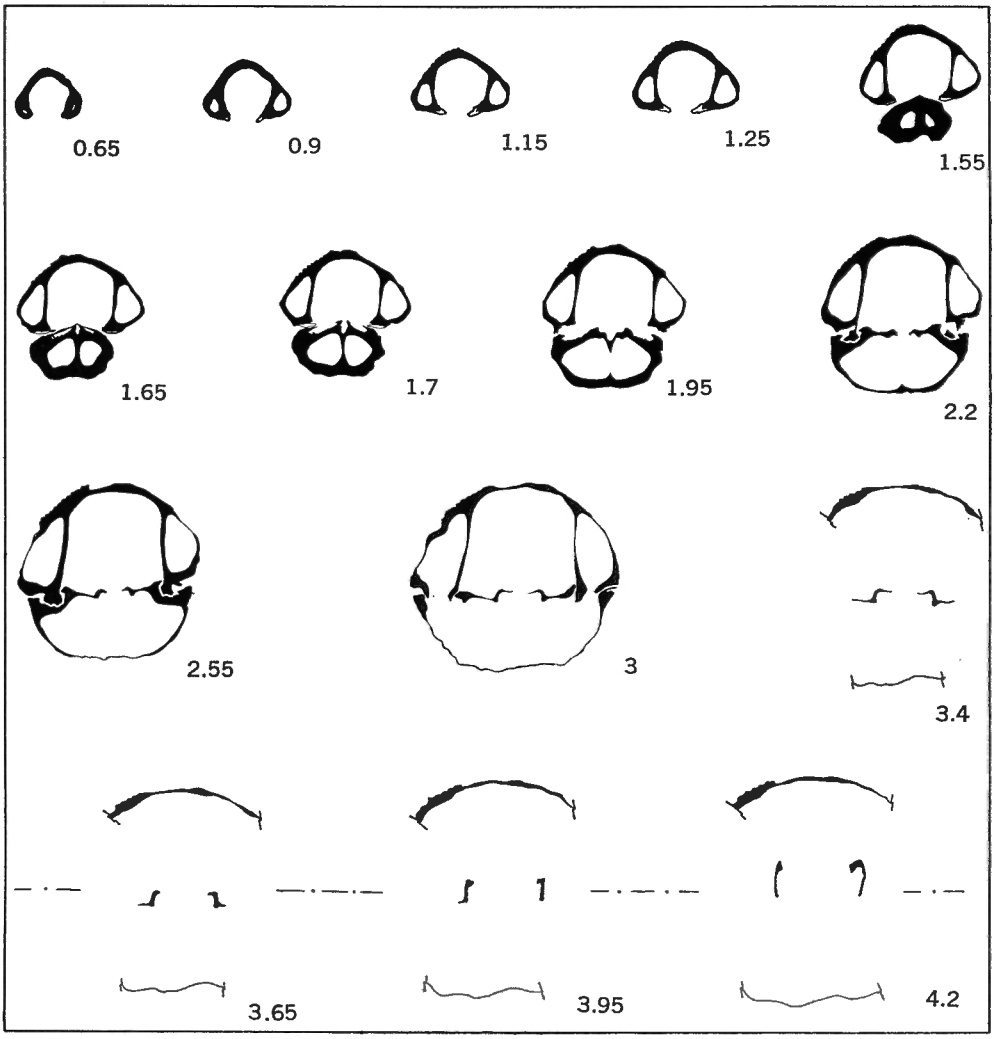
Lectotype (Pl. XII, figs. 9a–e = pl. IV, figs. 5, 6 *in* Warren, 1927). GSC No. 8904. Sulphur Mountain, Banff National Park, Alberta. Upper Devonian; uppermost beds of the Minnewanka Limestone. Collector: P. S. Warren.

Syntype (= paralectotype) (Pl. XIII, figs. 8a–d). GSC No. 8904a. Same locality, formation and collector.

Hypotype A. GSC No. 13796 (= pl. V, figs. 13–15 *in* McLaren, 1958, under *Camarotoechia banffensis* = pl. XV, figs. 13–15 *in* McLaren, Norris and McGregor, 1962 under "*Camarotoechia*" *banffensis*). GSC loc. 18242. Collector: D. J. McLaren, 1949.

Hypotypes B, GSC No. 15644; C, GSC No. 15645 (Pl. XIII, figs. 5a, b). GSC loc. 16942. Collector: D. J. McLaren, 1949.

Hypotype D. GSC No. 15646 (Pl. XIII, figs. 4a–e). GSC loc. 8768. Collector: E. M. Kindle, 1927.



TEXT-FIGURE 26. *Sinotectirostrum banffense shimeri* (Warren)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Hypotype H, USNM No. 155000 (l:17.9 mm; w:20.8 mm; t:13.7 mm).

Hypotypes E and F. USNM Nos. 154998 and 154999. Freighter Spring near Dickey, Idaho, U.S.A., Borah Peak Quad. Within the upper 115 feet of the Three Forks Formation. Collectors: W. Sadlick and P. Sartenaer, 1960.

Hypotype G. PRI No. 6038 (=pl. 1, figs. 15–17 *in* Baldwin, 1943, under *Camarotoechia nordeggi*). One mile east of Freighter Spring near Dickey, Lost River Range, Idaho, U.S.A., Borah Peak Quad. Within the upper 115 feet of the Three Forks Formation. Collector: E. M. Baldwin.

Hypotype H. USNM No. 155000 (Text–fig. 26). Same locality, formation, and collectors as for hypotypes E and F.

Hypotype I. GSC No. 15540. Specimen found with the holotype (GSC No. 8903) of *Camarotoechia banffensis*, but there is no certainty as to the exact locality, formation, and collector.

Material

GSC localities in the Canadian Rocky Mountains: lectotype, paralectotype, hypotype I, 8768 (1), 16942 (2), 18086 (1), 18242 (2), 26717 (1), 38823 (1).

Ninety-one specimens from Idaho: one identified by Baldwin (1943) (PRI No. 6038) as *Camarotoechia nordeggi* and studied by the writer in Ithaca; five received from Dr. E. M. Baldwin; eighty-five collected by Dr. W. Sadlick and the writer in 1960.

Forty-four specimens from Utah: twenty-six on loan from Dr. F. D. Holland, jr. (Lea. Holl.F-1); eight on loan from Dr. W. Sadlick; ten collected by Dr. W. Sadlick and the writer in 1960.

Three quarters of the material are in satisfactory state of preservation.

Description

Only the differences from *S. nordeggi* and *S. banffense banffense* are given.

S. banffense shimeri differs from *S. nordeggi* by its somewhat smaller size, although some specimens may approach the size of *S. nordeggi;* from *S. banffense banffense* in the costae on the fold which never curve abruptly towards the frontal commissure; and from *S. nordeggi* and *S. banffense banffense,* by the following characters:

—the sulcus is wider at the front; its width varies for most specimens between 63 and 71 per cent of the width of the shell; it is generally somewhat deeper;

—the anterior parts of the ventral flanks are generally less convex. The above characters give the sulcus a more scooped-out aspect, the ventral flanks being wider and more distinctive.

—the top of the tongue is seldom recurved posteriorly;

—the fold is proportionally higher;

—the summit of the brachial valve is at the frontal commissure or somewhat posterior to it;

—the internal lateral ventral costae tend more often to become concave anteriorly;

—the costae are more angular;

—extremely rarely one or two of the parietal costae indent the borders of the tongue.

Ornament. The general costal formula is: 5/5 to 7/8; 2/2-2/2 to 4/4-4/4; 14/15 to 18/19.

The ratios of median, parietal, and lateral costae are distributed in the following way:

Median			Median + parietal			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
4/3	1	2.13	9/8	2	3.39	2-2/2-2	12	25.55	10/11	1	2.15
5/4	1	2.13	10/9	1	1.70	3-3/3-3	20	42.55	11/12	1	2.15
6/5	8	17.01	11/10	7	11.85	3-4/3-4	2	4.25	12/13	1	2.15
7/6	20	42.55	12/11	8	13.56	4-4/4-4	13	27.65	13/14	1	2.15
8/7	10	21.28	13/12	12	20.34				14/15	2	4.25
9/8	5	10.64	14/13	10	16.95				15/16	9	19.10
11/10	1	2.13	15/14	12	20.34				16/17	12	25.55
12/11	1	2.13	16/15	4	6.78				17/18	11	23.40
			17/16	2	3.39				18/19	7	14.85
			18/17	1	1.70				20/21	2	4.25
	47	100.—		59	100.—		47	100		47	100.—

S. banffense shimeri has less median costae than *S. nordeggi* but a similar number of lateral costae; it has a similar number of median but more lateral costae than *S. banffense banffense*. The state of preservation may affect this comparison.

Dimensions. Measurements of eight specimens:

in mm	Hypotype A	Hypotype E	Hypotype F	Lectotype	Hypotype B	Hypotype C	Hypotype D	Syntype (paralectotype)
l	19.6	18.9	16.9	15.1	14.6	(13.7)	13.2	12.1
w	24.4	25.8	22.4	19.6	16.5	15.6	15.0	13.7
lpv unrolled	30.0	30.0	27.7	22.0	17.5	(16.5)	15.0	14.0
t	16.5	16.9	15.0	10.7	7.0	7.1	5.5	6.1
tpv	4.7	4.7	3.5	3.8	2.9	2.9	2.8	2.1
tbv	11.8	12.2	11.5	6.9	4.1	4.2	2.7	4.0
l/w	0.80	0.73	0.75	0.77	0.88	(0.88)	0.88	0.88
t/w	0.68	0.66	0.67	0.55	0.42	0.46	0.37	0.45
t/l	0.84	0.89	0.89	0.71	0.48	(0.52)	0.42	0.50
shoulder angle	115°	117°	115°	115°	(110°)	?	110°	115°

The paralectotype and hypotypes B, C, and D refer to juvenile specimens.

S. banffense shimeri is usually transversally oval like *S. nordeggi* and wider than *S. banffense banffense.*

The bottoms of the dental sockets are well crenulated. One of the two specimens sectioned has a connectivum preserved.

Discussion

Synonymy. Part of Crickmay's (1952a) *Camarotoechia* cf. *C. nordeggi* has been put in the synonymy of *Sinotectirostrum banffense banffense.*

Baldwin's (1943) *Camarotoechia* cf. *shimeri* has been put in the synonymy of *Sinotectirostrum nordeggi.*

Some *Camarotoechia* cf. *shimeri* from de Wit and McLaren (1950) are *Sinotectirostrum banffense banffense.*

The Russian specimen of *Camarotoechia radiata* cannot be separated from the Canadian species, but the same remarks as those made under the discussion of *Sinotectirostrum banffense banffense* apply here.

Hypotype A, as an example, is intermediate between the two subspecies.

Comparisons. The differences between *S. banffense banffense* and *S. banffense shimeri* are not considered of specific value.

Remarks. The lectotype, GSC No. 8904, and the syntype (paralectotype), GSC No. 8904a, are juvenile forms; the two other syntypes, GSC Nos. 8904b, 8904c, are fragments of brachial valves of somewhat larger specimens and are unidentifiable. Thus, there is neither an average nor a full grown specimen amongst the original material. Warren (1927) considers the specimen identified as *Camarotoechia* sp. by Shimer (1926, GSC No. 4570) as "apparently the same form" as *C. shimeri,* but it is here described as hypotype B of *Sinotectirostrum banffense banffense. S. banffense shimeri* is associated with and found in the same beds as *S. banffense banffense* (the two subspecies have the same type locality). *S. banffense shimeri* is only represented by very few specimens in the Canadian Rocky Mountains—nine in addition to the lectotype. Finally it must be noted that Warren has not used *Camarotoechia shimeri* since 1927.

Stratigraphic position. In the Canadian Rocky Mountains, the lectotype and the paralectotype occur in the "uppermost beds of the Minnewanka limestone" [= uppermost beds of the Palliser Formation]. Kindle (1929) mentions the species in the "upper division of the Minnewanka limestone." The remainder of the material at hand for which more information is available occurs in the top of the Palliser Formation at 27 feet below the top (GSC loc. 16942), at 28 feet below the top (GSC loc. 18086), in the upper 5 feet (GSC loc. 38823).

The specimens from Idaho have been collected in the upper 115 feet of the Three Forks Formation.

In Utah, the subspecies is common in the "Contact Ledge".

The Russian species, *Camarotoechia radiata,* is reported in the Famennian.

Geographic distribution. In the Canadian Rocky Mountains the subspecies has been found in the following places: Sulphur Mountain, gully west of Mount Standly and other places near Banff, the Gap of the North Saskatchewan River, Brazeau Range, Maligne Canyon, The Palisade.

The subspecies is known from Idaho and Utah.

The Russian species, *Camarotoechia radiata,* has been found in Novaya Zemlya and Vaigatch islands.

Sinotectirostrum saxirubrum nov. sp.

Plate XIV, figures 1–5; Text-figure 27

Saxum, i(Latin, neut.) = stone; *ruber, bra, brum* (Latin) = red; after Redstone River, N.W.T.

Types

Holotype. GSC No. 15863 (Pl. XIV, figs. 1a–e). Paratypes A, GSC No. 15864 (Pl. XIV, figs. 3a–e); B, GSC No. 15865 (Pl. XIV, figs. 2a–d); C, GSC No. 15866; D, GSC No. 15867; E, GSC No. 15868. GSC loc. 32894. Collector: D. F. Stott, 1957.

Paratypes F, GSC No. 15869 (Pl. XIV, 5a, b); G, GSC No. 15870. GSC loc. 32985. Collector: D. F. Stott, 1957.

Paratype H. GSC No. 15871 (Pl. XIV, figs. 4a–c). GSC loc. 32889. Collector: D. F. Stott, 1957.

Paratype I. GSC No. 15872 (Text-fig. 27). Same locality, formation, and collector as for paratypes F and G.

Material

GSC localities on Redstone and Johnson Rivers, N.W.T.: 32886 (2), 32889 (1), 32894 (38), 32985 (23), 44608 (4).

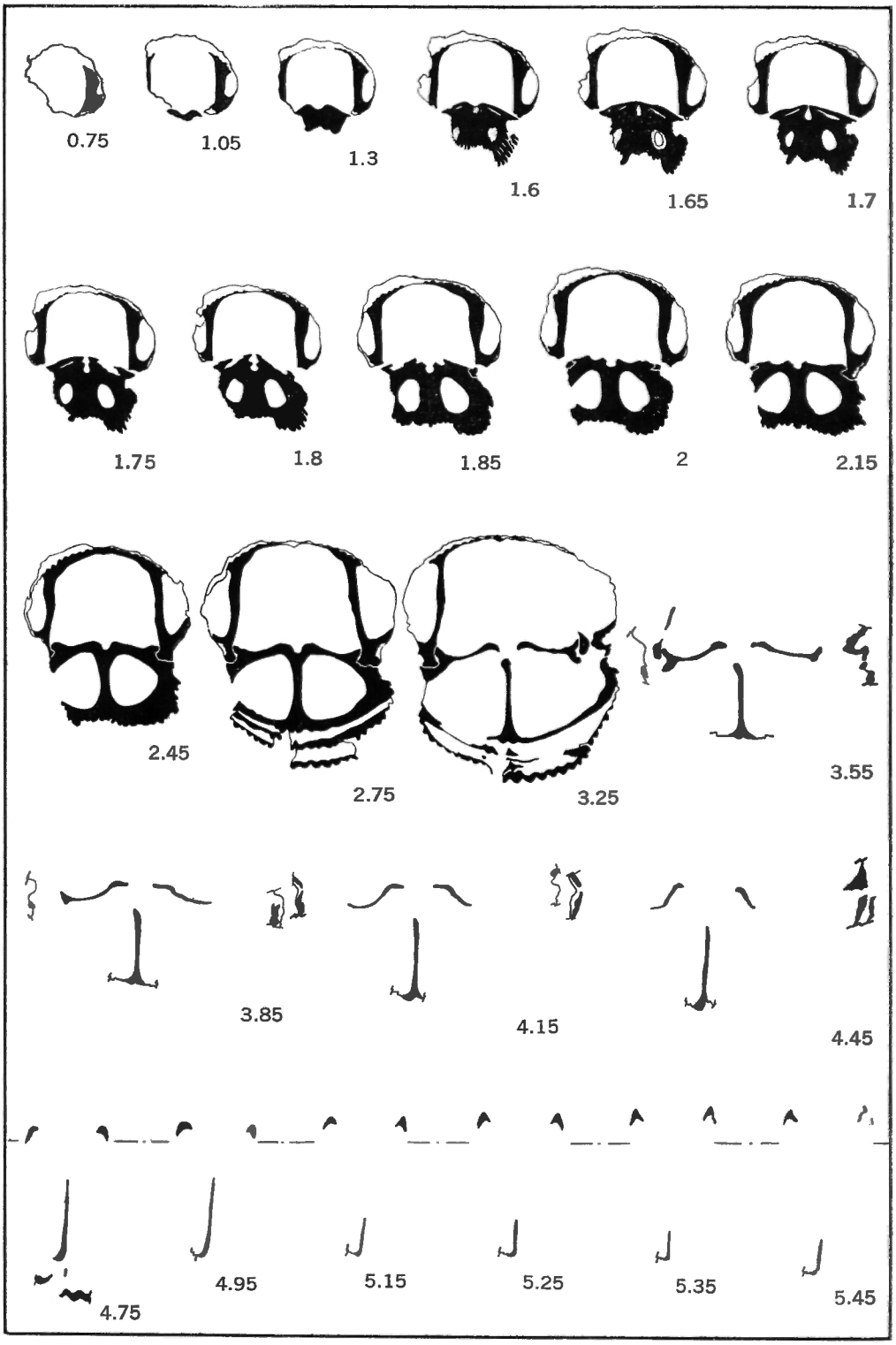
One third of the material is in satisfactory state of preservation.

Description

The species is medium-to-large sized. Except at the borders of the tongue, the commissure is strongly indented by the costae.

Pedicle valve. The flanks slope evenly towards the commissure, more sharply towards the postero-lateral commissures where the margins of the flanks tend to be or are vertical.

The well marked sulcus starts between 27 and 40 per cent of the length of the shell from the beak or between 26 and 37 per cent of the unrolled length of the valve. It widens rapidly and reaches 57 to 66 per cent of the width of the shell at the front. The depth varies between two and four times the height of the median costae. The bottom is flat or slightly concave. The sides are characterized by the parietal costae (*see* Ornament). The sulcus passes forward into a trapezoidal tongue with sharp borders, which becomes vertical to posteriorly recurved at its top.



TEXT-FIGURE 27. *Sinotectirostrum saxirubrum* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype I, GSC No. 15872 (l:(20.5) mm; w:24.7 mm; t:18.0 mm).

The beak is erect to suberect, small and clearly detached; it does not overhang the hinge line. Neither foramen nor deltidial plates have been observed. The interarea is clearly defined and elongate; its length varies between 40 and 50 per cent of the width of the shell.

Brachial valve. The well marked fold starts, like the sulcus, some distance from the beak. It is high and its top is slightly to strongly convex. The greatest thickness of the valve is either at the top of the tongue or somewhat posteriorly to the frontal commissure.

Ornament. The general costal formula is 4/3 to 5/4; 2/2-2/2 to 3/3-3/3; 15/16 to 18/19.

The ratios of the median, parietal, and lateral costae are distributed as follows:

Median + parietal			Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
7/6	2	8.35	3/2	1	4.55	1-1/1-1	1	4.55	15/16	3	21.40
8/7	1	4.15	4/3	6	27.25	2-2/2-2	8	36.35	16/17	2	14.30
9/8	8	33.35	5/4	14	63.65	2-3/2-3 and 3-2/3-2	5	22.75	17/18	5	35.70
10/9	5	20.85	6/5	1	4.55	3-3/3-3	6	27.25			
11/10	7	29.15				3-4/3-4	1	4.55	18/19	2	14.30
13/12	1	4.15				5-3/5-3	1	4.55	20/21	2	14.30
	24	100.—		22	100.—		22	100.—		14	100.—

All costae are simple, strongly marked, start at the umbones, flattish-rounded in their posterior part and angular to sharply angular anteriorly.

Median costae widen strongly near the front where they average 3 to 3.5 mm in width. They sometimes have a fan-shaped aspect in their anterior part. The parietal costae do not indent the borders of the tongue.

The internal ventral lateral costa may be lower than the others.

Dimensions. The measurements of seven specimens:

in mm	Paratype A	Paratype G	Holotype	Paratype B	Paratype E	Paratype D	Paratype C
l	(21.9)	21.9	21.5	20.9	20.4	19.9	19.2
w	24.4	22.7	23.2	23.9	21.4	22.4	21.3
lpv unrolled	(33.5)	35.0	33.0	33.5	?	29.5	29.0
t	16.8	18.9	16.6	18.0	16.4	15.5	14.0
tpv	5.2	5.5	6.0	5.3	5.1	5.2	4.0
tbv	11.6	13.4	10.6	12.7	11.3	10.3	10.0
l/w	(0.90)	0.96	0.93	0.87	0.95	0.89	0.90
t/w	0.69	0.83	0.72	0.75	0.77	0.69	0.66
t/l	(0.77)	0.86	0.77	0.86	0.80	0.78	0.73
shoulder angle	(100°)	107°	102°	105°	108°	101°	103°

The shoulder angle varies between 100 and 110 degrees.

The greatest width lies between 49 and 62 per cent of the length of the shell.

Internal characters. The internal characters are as described under the description of the genus. Structures are slightly thickened in the apical region. The bottom of the dental sockets is somewhat more crenulated than in the type species. The septalium is as deep as in the type species, shallower than in most species; the septalium is almost as wide as deep. The only specimen sectioned has no connectivum preserved.

Growth. Only two juvenile specimens are available. Juvenile characters are: proportionally small thickness; brachial valve proportionally thinner; sulcus and fold almost not developed; parietal costae indent the commissure. Paratype H has developed the h/w ratio of an adult shell.

in mm	Paratype F	Paratype H
l	17.7	14.2
w	17.8	(12.3)
lpv unrolled	(20.0)	25.0
t	(7.9)	13.7
tpv	4.8	4.8
tbv	(3.1)	8.9
l/w	1.00	(1.15)
t/w	(0.44)	(1.20)
t/l	(0.44)	0.96
shoulder angle	(95°)	(95°)

Discussion

Comparisons. The species is distinguished by few median costae, which widen sharply at front.

S. saxirubrum bears some resemblance to *S. medicinale medicinale,* but differs from it by the following features: shoulder angle generally wider; postero-lateral margins rarely abrupt; aspect of the posterior part of the shell less angular in ventral view; sulcus commonly starts nearer to the beak and has smaller width; sulcus widens more rapidly and is narrower at the front; fewer median costae; number of costae less variable; roof-shaped costae less common, although often present; top of the tongue often recurved posteriorly.

S. saxirubrum has also many characters in common with *S. banffense banffense,* but has commonly: a narrower shoulder angle; a sulcus starting nearer to the beak, widening rapidly, less wide where it starts and often deeper; summit of the brachial valve sometimes at the top of the tongue; fewer and wider median costae; sometimes more parietal costae; a proportionately greater length and, thus, a more elongated aspect; sometimes roof-shaped costae.

Stratigraphic position. In the Redstone River valley, the species has been found in the Imperial Formation throughout a 940-foot outcrop; it is associated with *Basilicorhynchus basilicus interpositus* in the lower 15 feet.

In the Johnson River area, the species has been collected with *Gastrodetoechia utahensis rugosa.*

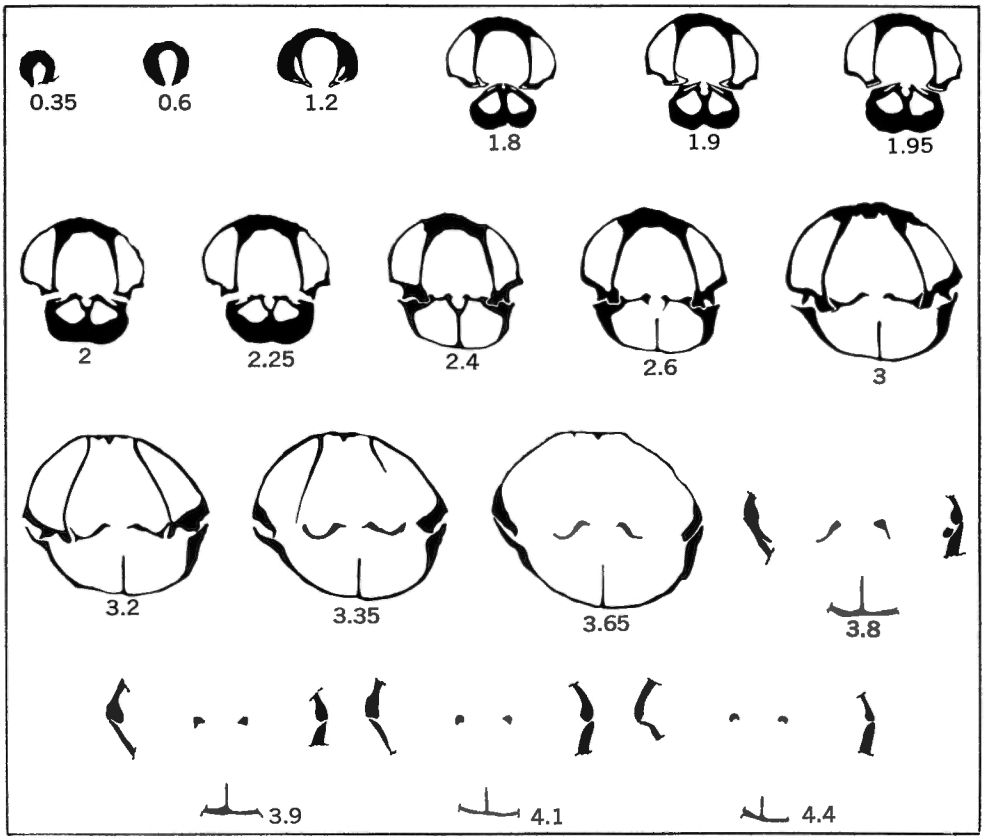
Geographic distribution. The only known collections derive from Redstone River and Johnson River.

Sinotectirostrum avellana nov. sp.

Plate XIV, figures 6–12; Text-figure 28

1922. *Hypothyris cuboides*—HUME, p. 72B;
1945. *Hypothyris cuboides*—HUME and LINK, p. 38, line 50 (*coet. excl.*);
1954. *Hypothyris cuboides*—HUME, p. 46, line 10 (*coet. excl.*).

Avellana (*nux*) (Latin, fem.) = hazel-nut; to draw the attention on the general aspect of the species. Used here in apposition.



TEXT-FIGURE 28. *Sinotectirostrum avellana* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype I, GSC No. 15882 (l:18.3 mm; w:15.8 mm; t:(12.2) mm).
The specimen is somewhat crushed on its left dorsal flank.

Types

Holotype. GSC No. 15873 (Pl. XIV, figs. 6a–e). Paratypes A, GSC No. 15874 (Pl. XIV, figs. 7a, b); I, GSC No. 15882 (Text-fig. 28). GSC loc. 38711. Collector: P. Sartenaer, 1959.

Paratypes B, GSC No. 15875 (Pl. XIV, figs. 10a–e); C, GSC No. 15876; D, GSC No. 15877. GSC loc. 7162. Collector: G. S. Hume, 1921.

Paratypes E, GSC No. 15878 (Pl. XIV, figs. 9a, b); F, GSC No. 15879 (Pl. XIV, figs. 11a, b). GSC loc. 7174. Collector: G. S. Hume, 1921.

Paratypes G, GSC No. 15880 (Pl. XIV, figs. 8a–e); H, GSC No. 15881 (Pl. XIV, figs. 12a–e). GSC loc. 44837. Collector: A. E. Kliske.

Material

GSC localities in the Northwest Territories: 7159 (1), 7162 (7), 7163 (1), 7174 (9), 26784 (3), 26788 (2), 32112 (1), 33417 (2), 38711 (13), 43837 (21), 43842 (10), 44837 (11).

Three specimens derive from wells in NE British Columbia: GSC locs. 42007 (1), 42228 (2).

Two thirds of the material are in satisfactory state of preservation.

Description

The species is small-to-medium sized, inflated to globular. The commissure is weakly indented by the low costae.

Pedicle valve. The flanks slope evenly towards the commissure, more steeply in the postero-lateral part where the margins are vertical or almost vertical and sometimes even slightly concave.

The sulcus starts imperceptibly between 48 and 64 per cent of the length of the shell forward of the beak, or between 40 and 50 per cent of the unrolled length of the valve. The sulcus widens slowly; its width, where it starts, is between 48 and 67 per cent of its maximum width at the front, which varies between 63 and 80 per cent of the width of the shell. The depth of the sulcus is variable, but usually shallow. Its floor is wide and commonly slightly to strongly convex, sometimes flat. The sides are characterized by distinctive parietal costae (*see* Ornament). Sometimes the convexity of the floor of the sulcus results in a median fold in its anterior part. It passes progressively into a trapezoidal tongue which becomes vertical to recurved at its top. The borders of the tongue are sharp.

The beak is erect to suberect, small, clearly detached and does not overhang the hinge line. No foramen has been observed. The interior borders of the triangular deltidial plates are parallel, leaving part of the delthyrium open. The interarea is clearly defined, elongated and high (1 to 1.5 mm), with a length between 42 and 61 per cent of the width of the shell.

Brachial valve. The flanks are steep to vertical. Postero-lateral margins are concave near the commissure.

The fold starts forward of the beak. The top is sometimes flat, but commonly slightly to strongly depressed in the middle; this depression affects the frontal commissure (Pl. XIV, figs. 6a, c, 7b). This depression may result in a median sulcus in the anterior part of the fold, corresponding to a median fold in the sulcus (Pl. XIV, fig. 9b).

The summit of the valve is somewhat posterior to the frontal commissure.

Ornament. The general costal formula is $\frac{9}{8}$ to $\frac{14}{13}$; $\frac{2}{2}$-$\frac{2}{2}$ to $\frac{4}{4}$-$\frac{4}{4}$; $\frac{16}{17}$ to $\frac{25}{26}$.

Ratios of the median and parietal costae:

Median + parietal			Median			Parietal		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
12/11	1	2.50	6/5	1	3.35	2-2/2-2	3	9.65
13/12	3	7.50	7/6	1	3.35	2-3/2-3	1	3.25
14/13	5	12.50	8/7	1	3.35	3-3/3-3	14	45.15
15/14	2	5.—	9/8	5	16.60	3-4/3-4 and 4-3/4-3	3	9.65
16/15	7	17.50	10/9	6	20.—	4-4/4-4	9	29.05
17/16	4	10.—	11/10	2	6.65	5-4/5-4	1	3.25
18/17	4	10.—	12/11	3	10.—			
19/18	3	7.50	13/12	6	20.—			
20/19	4	10.—	14/13	3	10.—			
21/20	2	5.—	15/14	1	3.35			
22/21	3	7.50	19/20	1	3.35			
24/23	1	2.50						
27/26	1	2.50						
	40	100.—		30	100.—		31	100.—

All costae start at the umbones; they are simple, regular and low, flat in the posterior part of the shell, flattish-rounded to rounded in the anterior part. The middle median costae may be somewhat wider than the others. Such costae may reach a width of 1.5 mm at the front, but are commonly between 0.5 mm and 0.75 mm wide. Parietal costae do not indent

the borders of the tongue. Lateral costae are distributed as follows: 14/15: 1 sp; 15/16: 1 sp; 16/17: 2 sp; 18/19: 2 sp; 19/20: 4 sp; 20/21: 4 sp; 21/22: 4 sp; 22/23: 4 sp; 23/24: 3 sp; 24/25: 4 sp; 25/26: 2 sp.

Rarely, the internal ventral lateral costa is lower than the others in ventral views.

Growth lines are seldom observed.

Dimensions. Measurements of six specimens:

in mm	Paratype H	Paratype D	Paratype C	Paratype B	Holotype	Paratype A
l	19.6	16.2	15.6	15.2	(14.1)	(11.8)
w	19.2	15.0	15.5	16.3	12.3	13.0
lpv unrolled	30.0	(22.0)	22.0	19.0	(22.0)	(22.0)
t	15.1	(9.0)	11.2	8.4	10.8	11.4
tpv	6.0	4.0	4.0	3.9	5.0	3.8
tbv	9.1	5.0	7.2	4.5	5.8	7.6
l/w	1.00	1.08	1.00	0.93	(1.15)	(0.91)
t/w	0.79	(0.60)	0.72	0.52	0.88	0.88
t/l	0.77	(0.56)	0.72	0.55	(0.77)	(0.97)
shoulder angle	100°	97°	98°	100°	95°	(102°)

Paratypes B and D are flat specimens, presumably a juvenile character. Length and width have similar values. The shoulder angle varies between 95 and 105 degrees, most commonly between 95 and 100 degrees. The greatest width is between 60 and 65 per cent of the length of the shell.

Internal characters. The internal characters are those mentioned under the description of the genus. The dental plates converge anteriorly and are less widely separated than in most species of the genus. The septalium is deeper than wide, and as deep as in the type species. Structures are slightly thickened in the apical region. The only specimen sectioned has no connectivum preserved.

Growth. The pattern of growth is similar to that of other species of the genus. Measurements of three juvenile specimens (paratype A is intermediate between juvenile and adult):

in mm	Paratype G	Paratype E	Paratype F
l	11.8	10.6	7.4
w	12.8	10.4	7.7
lpv unrolled	(18.0)	15.5	8.3
t	9.3	7.6	3.6
tpv	3.4	2.6	1.7
tbv	5.9	5.0	1.9
l/w	0.92	1.01	0.96
t/w	0.73	0.73	0.47
t/l	0.79	0.72	0.49
shoulder angle	100°	95°	(97°)

Discussion

Comparisons. The species is distinguished by globular aspect, number of costae, wide and shallow sulcus, floor of the sulcus commonly convex resulting sometimes in a median fold anteriorly with a corresponding sulcus in the brachial valve.

Size, shape, low costae, and shoulder angle differentiate the species from *S. nordeggi*, which has a similar development of costae. From all the other species assigned to the genus, *S. avellana* is readily distinguishable by the number and nature of its costae and by its shape.

Stratigraphic position. All the specimens from the Northwest Territories have been collected in Hume's (1922) *Athyris angelica* Zone.

Of the specimens from the subsurface in NE British Columbia, one has been collected 74 feet below the top of the Wabamun Group (GSC loc. 42007), and two in the *Athyris angelica* Zone (GSC loc. 42228).

Geographic distribution. Most of the specimens have been collected in the North Nahanni River valley, N.W.T., most of them in the Yohin syncline in the Camsell Range. Some specimens have been found in the Root River valley, N.W.T. Three specimens are from wells in NE British Columbia.

Sinotectirostrum montosum nov. sp.

Plate XV, figures 10, 11; Text-figure 29

Montosus, a, um (Latin) = mountainous; to draw attention to the occurrence in the Canadian Rocky Mountains.

Types

Holotype. GSC No. 15883 (Pl. XV, figs. 10a–e). Paratypes A, GSC No. 15885 (Pl. XV, figs. 11a–e); B, GSC No. 15886. GSC loc. 17052. Collector: E. W. Peyto, 1925.

Paratype C. GSC No. 15889. GSC loc. 40743. Collector: G. B. Leech, 1959.

Paratype D. GSC No. 15890. GSC loc. 18126. Collector: D. J. McLaren, 1949.

Paratype E. GSC No. 15891 (Text-fig. 29). GSC loc. 18034. Collector: R. de Wit, 1949.

Material

GSC localities in the Canadian Rocky Mountains: 11193 (2), 17044 (2), 17052 (4), 18033 (1), 18034 (1), 18088 (9), 18126 (4), 18127 (1), 18131 (1), 36850 (13), 36900 (4), 40736 (9), 40743 (7).

Half of the material is in satisfactory state of preservation.

Description

The species is small to rarely medium-sized with a dumpy appearance. The commissure is weakly indented by the low costae.

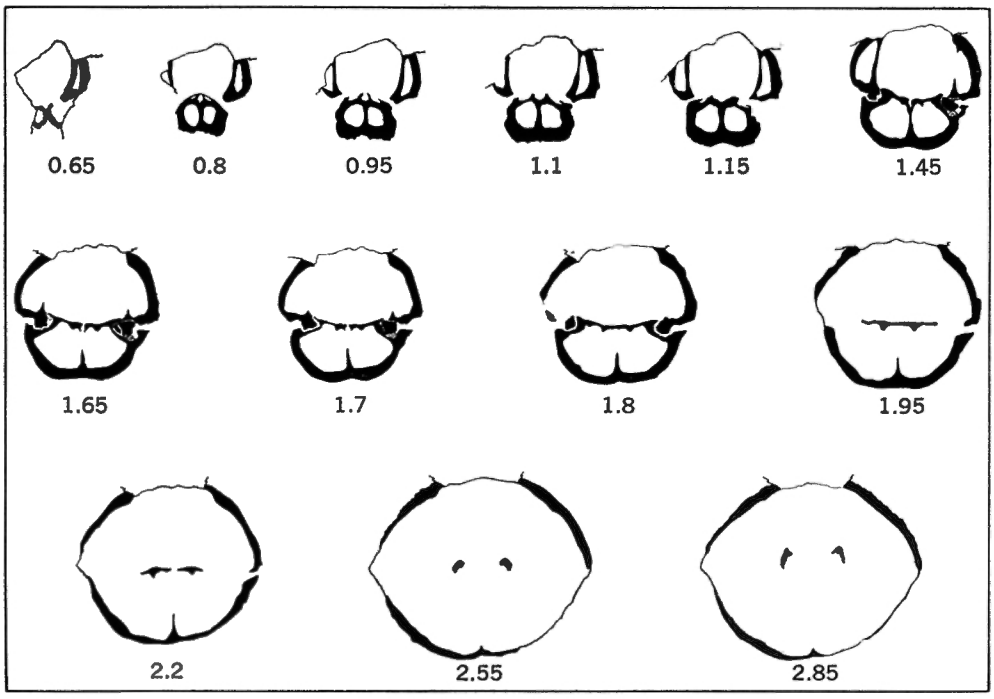
Pedicle valve. The flanks slope evenly towards the commissure, but postero-lateral margins are concave near the commissure.

The sulcus starts imperceptibly between 56 and 81 per cent (in most between 64 and 76) of the length of the shell forward of the beak, or between 40 and 66 per cent (in most between 53 and 57) of the unrolled length of the valve. The sulcus widens slowly; its width, where it starts, is between 56 and 72 per cent of its maximum width at the front, which varies between 62 and 75 per cent of the width of the shell. The depth of the sulcus is variable, but usually shallow. The floor of the sulcus is wide, and flat to slightly convex. The sides are characterized by distinctive parietal costae (*see* Ornament). The sulcus passes progressively into a trapezoidal tongue, with sharp borders, tending to become or becoming vertical at its top.

The beak is suberect to erect, small, clearly detached and does not overhang the hinge line. No foramen has been observed. Deltidial plates have not been observed. The interarea is clearly defined, elongated; its height is about 1 mm; its length varies between 51 and 62 per cent of the width of the shell.

Brachial valve. The flanks are steep near the margins. Postero-lateral margins are concave near the commissure.

The fold starts some distance forward of the beak. The top of the fold may be flat, but commonly slightly convex. The greatest thickness of the valve is either at the frontal commissure or, more commonly, somewhat posterior.



TEXT-FIGURE 29. *Sinotectirostrum montosum* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype E, GSC No. 15891 (l:(11.6)mm; w: 13.0 mm; t: 10.1 mm).

Ornament. The general costal formula is 5/4 to 9/8; 1/1–1/1 to 3/3–3/3; 12/13 to 17/18. The ratios of the median and parietal costae are distributed as follows:

Median + parietal		Median			Parietal	
Number of costae	spec.	Number of costae	spec.		Number of costae	spec.
7/6	1	5/4	2		1–0/1–0	1
8/7	8	6/5	6		1–1/1–1	4
9/8	2	7/6	4	1–2/1–2 or	2–1/2–1	4
10/9	3	8/7	3		2–2/2–2	4
11/10	2	9/8	2		3–3/3–3	5
12/11	5	10/9	1			
13/12	2	11/10	1			
14/13	1					
15/14	2					
17/16	1					
	27		19			18

All costae start at the umbones. They are regular, usually low, flat in the posterior part of the shell, flat and rounded to angular with rounded top anteriorly. All costae are simple except one specimen with one divided costa on the fold and a corresponding intercalated costa in the sulcus.

The middle median costae may be somewhat wider and the external median costa on the fold commonly lower than the others. The width of the median costae at the front varies between 0.5 and 1 mm. Parietal costae rarely indent the borders of the tongue.

Lateral costae are distributed as follows (16 sp.): $^{8}/_{9}$: 1 sp; $^{10}/_{11}$: 1 sp; $^{12}/_{13}$: 2 sp; $^{13}/_{14}$: 3 sp; $^{14}/_{15}$: 3 sp; $^{15}/_{16}$: 2 sp; $^{16}/_{17}$: 1 sp; $^{17}/_{18}$: 2 sp; $^{18}/_{19}$: 1 sp.

The internal ventral lateral costa may be lower than the others. The external lateral costae are often worn; thus, the ratios must be considered as minimal. Growth lines are rarely observed.

Dimensions. Measurements of three specimens:

in mm	Paratype B	Holotype	Paratype C
l	11.8	11.5	(11.1)
w	12.75	12.8	12.6
lpv unrolled	16.0	17.5	(15.0)
t	7.8	8.5	8.1
tpv	3.0	3.0	3.6
tbv	4.8	5.5	4.5
l/w	0.93	0.90	(0.88)
t/w	0.61	0.66	0.64
t/l	0.66	0.74	(0.73)
shoulder angle	?	95°	?

The shoulder angle is rarely measurable and varies between 95 and 100 degrees. The greatest width is located around 65 per cent of the length of the shell.

Internal characters. The internal characters are those mentioned under the description of the genus. The structures are slightly thickened in the apical region. One of the two specimens sectioned has a connectivum preserved.

Growth. The pattern of growth is the same as for the other species of the genus. Measurements of the two smallest specimens:

in mm	Paratype G	Paratype B
l	(9.6)	7.5
w	9.0	8.2
lpv unrolled	(12.0)	10.0
t	5.8	5.5
tpv	2.5	2.2
tbv	3.3	3.3
l/w	(1.07)	0.91
t/w	0.64	0.67
t/l	(0.60)	0.73
shoulder angle	(90°)	95°

Discussion

Comparisons. S. montosum is similar to *S. banffense banffense,* which is found in the same beds, but differs in smaller size; dumpy appearance; smaller shoulder angle, sulcus and fold starting generally farther from the beaks; lower and narrower costae indenting less deeply the commissure; smaller number of median + parietal costae (where there is a similar number of median costae, there are commonly fewer parietal costae). There is a possibility that some of the largest specimens identified as *S. montosum* might be not fully grown specimens of *S. banffense banffense.*

S. montosum is also very near to *S. avellana* found at a corresponding stratigraphic level. The two species share a dumpy appearance, same shoulder angles, steep margins of the flanks, similar development of the sulcus, same type of costae (height, width, angularity). *S. montosum* may be easily identified, however, by a smaller number of median, parietal, and lateral costae as well as by the absence of a median fold in the anterior part of the sulcus and a corresponding depression on the fold. *S. montosum* is also commonly smaller and wider.

Stratigraphic position. All the specimens have been collected in the top beds of the Palliser Formation.

Specimens for which more precise information is available derive from 50 to 55 feet (GSC loc. 18126), 70 feet (GSC loc. 18127), and 85 feet (GSC loc. 18088) below the top of the Palliser Formation.

Geographic distribution. The species has been found in the Canadian Rocky Mountains at Miette map-area, Morro Peak, Brazeau Range, the Gap of the North Saskatchewan River, Sulphur Mountain, Bourgeau Range, Crowsnest Pass, and Fernie map-area (west half).

Sinotectirostrum paucirugosum nov. sp.

Plate XIX, figure 2

1958. *Camarotoechia* n. sp. D—McLAREN *in* LEECH, p. 24.

Paucus, a, um (Latin) = few; *rugosus, a, um* (Latin) = plicated; the species has few costae.

Types

Holotype. GSC No. 15901 (Pl. XIX, figs. 2a–e). GSC loc. 56164. Collector: D. J. McLaren, 1963.

Paratype. GSC No. 15902. GSC loc. 32270. Collector: G.B. Leech, 1957.

Material

GSC localities in the Canadian Rocky Mountains: 32270 (3), 56164 (3). Three specimens are in satisfactory state of preservation.

Description

The species is of medium size. With the exception of the borders of the tongue, the commissure is indented by costae.

Pedicle valve. From an inflated umbonal region the flanks slope evenly towards the commissure, but more abruptly towards the postero-lateral commissures, where they become concave.

The sulcus starts imperceptibly between 50 and 68 per cent of the length of the shell forward of the beak, or between 35 and 46 per cent of the unrolled length of the valve. The sulcus widens slowly; its width, where it starts, varies between 51 and 61 per cent of its maximum width at the front, which varies between 68 and 78 per cent of the width of the shell. The sulcus is shallow. Its floor is slightly convex. The sides are characterized by distinct parietal costae (*see* Ornament).

The sulcus passes progressively into a trapezoidal tongue, with sharp borders tending to be parallel. The upper part of the tongue is perpendicular.

The beak is erect to suberect. No foramen has been observed. The delthyrium is very wide at its base. The interarea is clearly defined and elongated; its length varies around 50 per cent of the width of the shell.

Brachial valve. The fold starts imperceptibly some distance forward of the beak. It is high and its top slightly convex. The greatest thickness of the valve is at or somewhat posterior to frontal commissure.

Ornament. For the three specimens on which the costae could be counted the costal formulae are 4/5; 1/1–1/1; 5/6 or 5/4; 6/6–1/1; 5/6 (holotype), 5/4; 1/1–6/6; 6/7 (paratype), 5/4; 1/1–1/1; 5 or 6.

The costae are simple, regular, and extend from the beaks; they are flattish-rounded. Parietal costae do not indent the borders of the tongue.

Dimensions. Measurements of two specimens:

in mm	Holotype	Paratype
l	(16.3)	(15.1)
w	19.6	18.9
lpv unrolled	(28.0)	28.5
t	14.1	16.5
tpv	6.4	4.7
tbv	7.7	11.8
l/w	(0.83)	(0.80)
t/w	0.72	0.87
t/l	(0.87)	(1.09)
shoulder angle	?	120°

Internal characters. The scarcity of the material does not allow the making of serial sections.

Discussion

Remark. This species is the least well established amongst those attributed to the genus due to the scarcity of well preserved material and specimens.

Comparisons. The species is distinguished by an inflated ventral umbonal region, sulcus and fold starting far from the beaks, very wide sulcus, low number of wide costae.

Stratigraphic position. The species has been found between 244½ and 353 feet (GSC loc. 32270) and between 275 feet and 327 feet (GSC loc. 56164) below the top of the Sassenach Formation.

The species occurs in the same section as *S. medicinale medicinale* at only one outcrop, where it is 90 feet below the latter.

It occurs in the middle part of the Sassenach Formation.

Geographic distribution. In the Canadian Rocky Mountains the species has been found only in the Fernie map-area (west half) and near Elko.

Evanescirostrum Sartenaer, 1965

1965c. *Evanescirostrum* n.gen.—SARTENAER, pp. 8, 9

Type species. Nudirostra gibbosa seversoni McLaren, 1954.

Diagnosis. Bulky; costae few, wide, moderately high, tending to become obsolescent posteriorly; median costae start near the beaks and are only rarely divided; simple lateral costae; parietal costae absent; shoulder angle wide; ventral umbonal region inflated; deep and wide sulcus starting some distance from the beak; slender dental plates; very short and narrow teeth; shallow septalium supported by a long thin septum; lamellar outgrowths covering part of the septalium anteriorly.

Species attributed to the genus. Type species, *E. alblinii,* Sartenaer, 1967; *E.* sp. A, *E.* sp. a *in* Sartenaer, 1967.

Description

The genus is medium-sized, uniplicate to parasulcate, and inequivalve. Costae are wide, moderately high, and tend to become obsolescent in the umbonal regions. The number of

median and lateral costae is low. Median costae start near the beaks; divisions are rare. Lateral costae are simple; only the internal ones extend from the umbonal regions. No parietal costae are present. Width is the greatest dimension. The shoulder angle varies between 100 and 132 degrees. Postero-lateral margins are concave near the commissure. The commissure is sharp and clearly indented by the costae. The greatest thickness of the shell is near the front.

Pedicle valve. The umbonal region is usually inflated. Sulcus is flat to slightly concave, deep, and wide at front. It starts some distance from the beak and widens rapidly. The beak is suberect and generally projecting. The interarea is poorly limited.

The dental plates are slightly divergent posteriorly and become parallel to convergent anteriorly. They are short and slender. The teeth are simple, very short, and narrow. Denticula are strongly developed. The muscle field has a moderate relief.

Brachial valve. The fold is moderately high to high and starts some distance from the beak. The top of the fold is either flat or slightly convex.

A long and thin septum supports a cup-shaped septalium in transverse serial sections, that is shallow, and as wide as deep or less. The outer plates of the hinge plate are concave. The junction with the borders of the septalium is marked by lamellar outgrowths that cover part of the septalium anteriorly. The crura are concave dorsally and shaped like a Phrygian cap in transverse serial sections; they are curved ventrally at their distal end.

Comparisons. Evanescirostrum closely resembles the genus *Porostictia* Cooper, 1955 in well marked sulcus and fold not starting at the beaks; deep and flat-bottomed sulcus; borders of the tongue tending to become parallel; suberect beak; costae few, tending to obsolescence in the umbonal regions; median costae starting near the beaks; short and slender dental plates; shallow septalium. However, many characters make *Porostictia* distinct from *Evanescirostrum*: shell thinner and internal structures more slender; teeth crenulated, wider and longer; crura crescent-shaped in transverse serial sections; cardinal line different; surface covered by costellae separated by rows of small pits; parietal costae sometimes present; median costae usually divided; ventral interarea well limited; ventral flanks almost flat; aspect more inequivalve; sulcus wider at front; median costae starting nearer to the beaks; ventral umbonal region inflated only in its median part; smaller size; contour transverse, posteriorly subtriangular. Micro-ornament forms the major difference between *Evanescirostrum* and *Porostictia*. As yet no micro-ornament has been observed in *Evanescirostrum* and the possibility cannot be completely excluded that this lack of micro-ornament may be due to mode of preservation of the available specimens.

Both *Basilicorhynchus* and *Evanescirostrum* have a bulky appearance; a protuberant ventral umbonal region; a sulcus wide at front; a short ventral interarea; a ventral beak detached and suberect; few costae; similar internal structures. *Basilicorhynchus* differs from *Evanescirostrum* by different contour; sulcus and fold less well marked and starting farther from the beaks; sulcus shallower; fold lower; costae more strictly restricted to the anterior part of the shell.

Eoparaphorhynchus bears some resemblance to *Evanescirostrum* in small number of wide costae, simple lateral costae, inflated ventral umbonal region, well marked sulcus and fold not starting at the beaks, sulcus wide at front, narrow ventral interarea. *Eoparaphorhynchus* differs by a proportionately lesser width and, thus, a different contour; less bulky appearance; occasional presence of parietal costae; median costae starting at the beaks or very near to them; costae more often divided; wider shoulder angle; presence of costellae; thickened internal structures in the apical region; strong dental plates; thick septum; teeth longer, wider and somewhat crenulated.

Although *Gastrodetoechia* shares many characters with *Evanescirostrum* it may be readily distinguished by a shallow sulcus, flatter ventral flanks, the presence of ventral beak ridges, and a different contour.

Stratigraphic position and geographic distribution. The genus occurs in Belgium, Canada, France, and the U.S.A. from the upper part of the lower Famennian to the lower part of the upper Famennian.

Evanescirostrum seversoni (McLaren)

Plate XVII, figures 1–11; Text-figure 30

	1943.	*Leiorhynchus* cf. *dunbarense* Haynes—BALDWIN, pp. 146, 151, pl. 1, figs. 3–5;
[?]	1952a.	*Leiorhynchus* cf. *L. dunbarense* Haynes—CRICKMAY, p. 594;
[e.p.]	1954.	*Nudirostra gibbosa seversoni* McLaren, n. subsp.—McLAREN, pp. 160, 173, 174, line 20, line 34 (*coet. excl.*), p. 180, pl. I, figs. 4–8;
[non]	1954.	*N. gibbosa seversoni*—McLAREN, p. 174, line 26 (*coet. excl.*);
[e.p.]	1955.	*Nudirostra gibbosa walcotti* (Merriam)—McLAREN, p. 29;
	1956.	*Nudirostra gibbosa seversoni* McLaren—BELYEA and McLAREN, p. 89;
[non]	1956.	*Nudirostra walcotti* (Merriam) var. *seversoni* McLaren—WARREN and STELCK, pl. XXVI, figs. 35–46;
	1958.	*Nudirostra gibbosa seversoni* McLaren—McLAREN, p. 194, pl. V, figs. 4–6 (= figs. 4–6 *in* McLAREN, 1954);
[?]	1958.	*Nudirostra* sp. ex gr. *N. walcotti* (Merriam)—McLAREN *in* LEECH, p. 24;
[non]	1961.	*Leiorhynchus* cf. *L. seversoni* McLaren—DUTRO *in* SABLE and DUTRO, p. 590;
[non]	1962.	"*Leiorhynchus*" cf. "*L.*" *seversoni* (McLaren)—BELYEA and McLAREN, p. 11;
	1962.	"*Nudirostra*" *seversoni* McLaren—McLAREN *in* McLAREN, NORRIS, and McGREGOR, p. 32, pl. XV, figs. 4–6 (= pl. I, figs. 4–6 *in* McLAREN, 1954 = pl. V, figs. 4–6 *in* McLAREN, 1958);
	1965c.	*Evanescirostrum seversoni* (McLaren, D. J., 1954)—SARTENAER, p. 10, pl. I, fig. 7, pl. II, fig. C;
[?]	1965.	"*Nudirostra*" *seversoni* McLaren—McLAREN *in* MacKENZIE, p. 9.

Types

Holotype (Pl. XVII, figs. 1a–e=pl. I, figs. 4–6 *in* McLaren, 1954=pl. V, figs. 4–6 *in* McLaren, 1958=pl. XV, figs. 4–6 *in* McLaren, Norris, and McGregor, 1962=pl. I, figs. 7a–e *in* Sartenaer, 1965c). GSC No. 10016. GSC loc. 17767. Collector: J. L. Severson, 1949.

Paratype (Pl. XVII, figs. 11a–e=pl. I, figs. 7, 8 *in* McLaren, 1954). GSC No. 10017. Same locality, formation and collector.

Hypotype A. GSC No. 15609 (Pl. XVII, figs. 4a, b). GSC loc. 17046. Collector: E. W. Peyto, 1925. The outcrop was visited in order to make use of E. W. Peyto's collection; the estimated stratigraphic position is based on fragmentary information with Peyto's collections and on observations by the writer in the field.

Hypotypes B, GSC No. 15610 (Pl. XVII, figs. 3a–d); C, GSC No. 15611; D, GSC No. 15612; E, GSC No. 15613; F, GSC No. 15614 (Pl. XVII, figs. 9a, b); G, GSC No. 15615; H, GSC No. 15616 (Pl. XVII, fig. 6); I, GSC No. 15617; J, GSC No. 15618 (Pl. XVII, figs. 7a–d); K, GSC No. 15619 (Pl. XVII, figs. 8a–d). GSC loc. 17048. Collector: E. W. Peyto, 1925. Same remark as for hypotype A.

Hypotype L. GSC No. 15620 (Pl. XVII, figs. 2a–e). Same locality, formation and collector as for holotype.

Hypotype M. GSC No. 15621. GSC loc. 38871. Collectors: H. R. Belyea and P. Sartenaer, 1959.

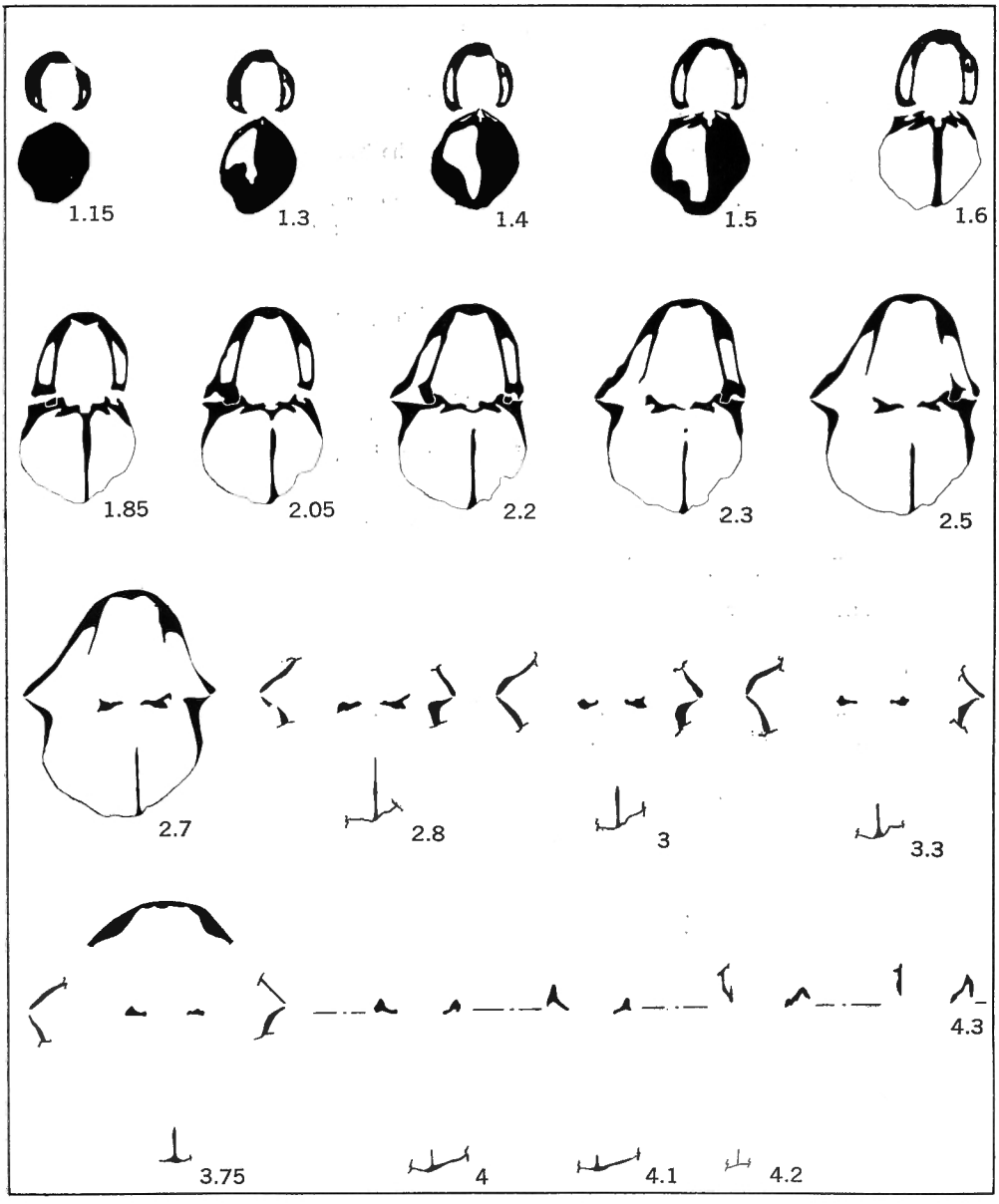
Hypotypes N, GSC No. 15622 (Pl. XVII, figs. 10a, b); O, GSC No. 15623 (Pl. XVII, figs. 5a–c); P, GSC No. 15624; Q, GSC No. 15625 (Text-fig. 30=pl. II, fig. C *in* Sartenaer, 1965c). GSC loc. 38875. Collectors: H. Belyea and P. Sartenaer, 1959.

Material

GSC localities in the Canadian Rocky Mountains: 17046 (31), 17048 (73), 17049 (10), 17767 (7), 20007 (28), 24536 (8), 32266 (1), 32270 (1), 32271 (2), 38862 (1), 38871 (2), 38874 (1), 38875 (66), 38888 (11), 48370 (1).

Fifteen specimens from Idaho: one specimen identified as *Leiorhynchus* cf. *dunbarense* by Baldwin; fourteen specimens collected by Dr. W. Sadlick and the writer in 1960.

More than half of these 258 specimens are in satisfactory state of preservation.



TEXT-FIGURE 30. *Evanescirostrum seversoni* (McLaren)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Hypotype Q, GSC No. 15625 (l:18.0 mm; w:(19.7) mm; t:15.7 mm).

Description

The species is medium-sized. Contour transversely oval to, more commonly, almost circular. Commissure is sharp and strongly crenulated by the costae. Postero-lateral commissures are often very sharp as both valves may reverse their curvature.

Pedicle valve. Flanks of the pedicle valve slope gently towards the commissure, but become steep and concave towards the postero-lateral commissures. The umbonal ventral region is commonly protruded.

The well marked sulcus starts some distance from the beak, sometimes as far forward as half and even, in hypotype N, three quarters of the length of the shell. The sulcus widens quickly. It is usually deep—three to four times the height of median costae, and its floor is flat. The width of the sulcus at the front varies between 61 and 76 per cent (in most between 65 and 75 per cent) of the width of the shell.

The borders of the trapezoidal tongue tend often to be parallel. The upper part of the tongue is perpendicular. In thick specimens the sulcus passes more sharply to the tongue, which is recurved at its top.

The beak is suberect, generally projecting, and resorbed by a circular foramen. The interarea is poorly limited and passes gradually into the flanks of the valve; it is commonly short, 28 to 36 per cent of the width of the shell, with a height of 1.5 mm. Deltidial plates are seen exceptionally; they close part of the delthyrium, their interior borders being separate and parallel.

Brachial valve. Flanks slope progressively towards the commissure, and become steep and concave towards the postero-lateral commissures.

The well marked and moderately high fold starts at a variable distance from the beak but never farther forward than half the length of the shell. Its top is flat or slightly convex.

The greatest thickness of the valve is near the frontal commissure; it rarely coincides with the top of the tongue.

Ornament. The general costal formula is 3/2; 0; 1/2 to 2/3.

Median costae, observed in 196 specimens, have shown the following distribution:

	Adults		Juveniles		Totals	
Number of costae	Number of specimens	%	Number of specimens	%	Number of specimens	%
2/1	17	10.55	5	14.30	22	11.20
3/2	144	89.45	30	85.70	174	88.80
	161	100	35	100	196	100

Distribution at three localities:

	GSC loc. 17046		GSC loc. 17048						GSC loc. 38875					
	Total (all adults)		Adults		Juveniles		Totals		Adults		Juveniles		Totals	
No. of costae	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%	No. of sp.	%
2/1	1	3.–	9	21.40	5	17.85	14	20.–	1	2.30			1	2.10
3/2	29	97.–	33	78.60	23	82.15	56	80.–	43	97.70	4	100.–	47	97.90
	30	100.–	42	100.–	28	100.–	70	100.–	44	100.–	4	100.–	48	100.–

Median costae are simple and start near to the beak. In one specimen, one of the costae on the fold is medially depressed on part of its length. In another specimen, one costa is divided on the fold, and corresponds to an intercalated costa in the sulcus (hypotype O). In two specimens there is an adventitious costa on the fold with a corresponding intercalated costa in the sulcus. In one out of ten specimens, median costae are irregular in the sense that one or two of the external costae are lower than the other(s). Dorsal median costae are round to rounded and flat in the posterior part of the shell and become angular with rounded top anteriorly; ventral median costae are rounded and flat on their whole length. Costae are obsolescent near the beaks, but are otherwise well marked. Common width for median costae at the front is 3 to 4 mm, but values of 2 and 5 mm have also been observed.

There are no parietal costae.

Lateral costae, observed in 145 specimens, show the following distribution:

	Adults		Juveniles		Totals	
Number of costae	Number of specimens	%	Number of specimens	%	Number of specimens	%
0			15	44.10	15	10.35
1/2	46	41.45	17	50.–	63	43.45
2/3	57	51.35	2	5.90	59	40.70
3/4	8	7.20			8	5.50
	111	100.–	34	100.–	145	100.–

Distribution at three localities:

	GSC loc. 17046		GSC loc. 17048						GSC loc. 38875					
	Total (all adults)		Adults		Juveniles		Totals		Adults		Juveniles		Totals	
Number of costae	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%
0					13	46.40	13	19.10			1	33.35	1	3.05
1/2	3	17.65	20	50.–	14	50.–	34	50.–	10	33.35	2	66.65	12	36.35
2/3	11	64.70	19	47.50	1	3.60	20	29.40	17	56.65			17	51.50
3/4	3	17.65	1	2.50			1	1.50	3	10.–			3	9.10
	17	100.–	40	100.–	28	100.–	68	100.–	30	100.–	3	100.–	33	100.–

Lateral costae are simple. The ventral costae are angular with rounded top at the antero-lateral margin of the pedicle valve, but otherwise they are rounded and flat and so are the dorsal costae on their whole length. The internal lateral costa, and very rarely a second one, reach the umbonal region, where they are weak; the other(s) are restricted to the antero-lateral region and may be mere indentations of the commissure. The number may be different on both flanks.

Fine growth lines are commonly present, but no costellae have been observed.

Dimensions. Measurements of ten specimens:

in mm	Hypotype A	Holotype	Hypotype C	Hypotype B	Paratype	Hypotype L	Hypotype E	Hypotype D	Hypotype O	Hypotype N
l	(22.7)	(21.2)	18.5	18.4	18.1	17.7	16.8	16.7	16.5	15.6
w	28.6	23.8	21.4	21.9	23.2	21.0	21.0	20.0	20.1	19.1
lpv unrolled	(37.5)	(32.5)	31.0	30.0	24.0	27.0	28.0	27.3	26.0	25.0
t	22.7	18.0	16.9	17.6	14.7	14.8	17.3	14.8	15.3	15.0
tpv	6.7	6.5	5.5	5.2	3.4	5.5	5.0	4.7	4.1	4.0
tbv	16.0	11.5	11.4	12.4	11.2	9.3	12.3	10.1	11.2	11.0
l/w	(0.80)	(0.89)	0.86	0.84	0.78	0.84	0.80	0.84	0.82	0.82
t/w	0.80	0.76	0.79	0.80	0.63	0.71	0.82	0.74	0.72	0.79
t/l	(1.00)	(0.85)	0.91	0.96	0.81	0.84	1.03	0.88	0.93	0.96
shoulder angle	117°	(120°)	105°	110°	?	(110°)	100°	100°	106°	?

Hypotype A is one of the largest specimens among the collections.

It should be noted that the shoulder angle is not the apical angle; low values are due to the protrusion of the central umbonal region.

The greatest width of the shell lies between 4/10th and 6/10th of the length forward.

Growth. Measurements of eight juvenile specimens:

in mm	Hypotype F	Hypotype G	Hypotype M	Hypotype P	Hypotype H	Hypotype I	Hypotype J	Hypotype K
l	13.1	(11.9)	(11.5)	(11.0)	10.3	(9.0)	8.9	8.0
w	16.2	14.0	14.2	13.5	12.9	10.6	9.8	9.0
lpv unrolled	18.5	(15.5)	(13.0)	(16.5)	18.0	(12.0)	9.5	9.5
t	9.0	7.4	6.3	9.5	9.7	5.5	3.7	3.7
tpv	3.1	3.0	2.9	3.1	2.9	2.4	1.8	1.9
tbv	5.9	4.4	3.4	6.4	6.8	3.1	1.9	1.8
l/w	0.81	(0.85)	(0.81)	(0.82)	0.80	(0.85)	0.90	0.89
t/w	0.56	0.53	0.44	0.71	0.75	0.52	0.38	0.41
t/l	0.69	(0.62)	(0.55)	0.86	0.94	(0.61)	0.42	0.46
shoulder angle	95°	(110°)	?	?	?	(105°)	100°	98°

Hypotypes H and P have almost developed the t/w ratio of adult shells.

Juvenile characters are normal for a species with monocyclic non-constant curvature growth; low sulcus and fold, pedicle valve thicker than brachial valve, greatest length of the shell at the frontal commissure, tongue not developed, shell low.

Discussion

Remark. The specimens from Idaho, including Baldwin's (1943) *Leiorhynchus* cf. *dunbarense,* may later prove to belong to a geographic subspecies. Not enough material is available to decide this problem.

Synonymy. The fragmental state of the specimen of *Leiorhynchus* cf. *L. dunbarense* cited by Crickmay (1952a) does not allow certitude.

McLaren's (1954, p. 174, line 26) *Nudirostra gibbosa seversoni* from Trout River are *Basilicorhynchus basilicus basilicus* as already noted by Taylor (1958, p. 14), and the specimens from Winnifred Pass (p. 173) are *B.* sp. A.

Some of McLaren's (1955) specimens of *Nudirostra gibbosa walcotti* belong to *Eoparaphorhynchus walcotti.*

Warren and Stelck's (1956) specimens have been put into synonymy with *Eoparaphorhynchus maclareni.*

Leech's material (four specimens), identified by McLaren (1958) is in poor state of preservation.

Specimens identified by Dutro *in* Sable and Dutro (1961) have been put into synonymy with *Eoparaphorhynchus maclareni.*

The *"Leiorhynchus"* cf. *"L". seversoni* specimens mentioned by Belyea and McLaren (1962) belong to *Gastrodetoechia utahensis rugosa.*

For McLaren's (*in* MacKenzie, 1965) identification *see* comments under the paragraph devoted to the stratigraphic position.

Reasons why *Nudirostra gibbosa seversoni* [=*Evanescirostrum seversoni*] is not accepted as a variety of *Nudirostra gibbosa* [=*Rugaltarostrum gibbosum*] are the same as those given for *Nudirostra gibbosa walcotti* (=*Eoparaphorhynchus walcotti*].

Comparisons. Evanescirostrum seversoni has some similarity with *Pugnoides chanakchiensis* Abramian, 1954 from the uppermost upper Famennian and the lower Strunian in development of costae, notably their obsolescent nature in the umbonal regions, and in fold and sulcus not starting at the beaks (*see* discussion under *Eoparaphorhynchus maclareni, E. walcotti, E. lentiformis, Basilicorhynchus basilicus basilicus*).

Abramian (1954) pointed out some similarities between *Pugnoides chanakchiensis* and *P. triaequalis,* but Sartenaer (1957c, pp. 15-6), in redescribing *Camarotoechia triaequalis* indicated that this species had been commonly misinterpreted in the U.S.S.R.

McLaren (1954, p. 180) and Sartenaer (1957c, p. 25) have drawn attention to the similarity between *Nudirostra gibbosa seversoni* and *Camarotoechia triaequalis.* Now that more material is available, differences appear more clearly. The two forms are close to each other on general shape, sulcus, and fold not beginning at the beaks, but *Evanescirostrum seversoni* reaches a larger size, has a different general costal formula, notably fewer lateral costae, median costae rarely divide, deeper sulcus and generally a higher fold, shorter ventral interarea, projecting beak, smaller shoulder angle, no parietal costae, obsolescent costae in the umbonal region.

Specimens of *E. seversoni* may be very close to some specimens of *Eoparaphorhynchus walcotti* in similar size, sulcus and fold of similar depth and height, similar measurements of narrow specimens, but differences are numerous. *Evanescirostrum seversoni* has a different number and kind of costae, a short ventral interarea, a projecting ventral beak, a sulcus often wider at the front, borders of the tongue often more inclined, sulcus and fold beginning usually farther from the beaks. Juvenile forms in both species also differ.

In *Eoparaphorhynchus maclareni* and *Evanescirostrum seversoni* the sulcus and fold begin at similar distances from the beak, ventral umbonal regions are similarly swollen, same wide sulcus at the front, similar shoulder angles, often similar number of median and lateral costae, the median costae being rarely divided. The two species have similar size, although specimens of *Eoparaphorhynchus maclareni* may be larger. *Evanescirostrum seversoni,* however, is less variable in shape, has a deeper sulcus, beak commonly projects, ventral interarea shorter and poorly delimited, borders of the tongue commonly more inclined, no costellae, costae less developed on flanks and in the sulcus, and obsolescent in the umbonal regions. Juvenile forms of *E. seversoni* are commonly wider.

Eoparaphorhynchus lentiformis and *Evanescirostrum seversoni* may be comparable in shape, development of fold and sulcus, and projecting ventral beak. But *Eoparaphorhynchus lentiformis* is a smaller species, in which the sulcus begins closer to the beak, the borders of the tongue are generally less inclined, a longer and well defined ventral interarea, proportion-

ally thinner with smaller maximum shoulder angles, a different general costal formula, more divisions in median costae, costae not obsolescent in the umbonal regions, better marked costae especially on the flanks and in the sulcus, and costellae.

Evanescirostrum seversoni has not been found (except GSC loc. 24536 discussed below) in the same bed with any of the species it resembles.

Stratigraphic position. Most specimens were collected from the Palliser Formation: from Mount Coleman, 225 feet down, from Sunwapta Pass at about 150 feet down (GSC loc. 20007) or in the upper part of the Palliser Formation (GSC loc. 38862), from Cadomin (GSC loc. 38871) in the 10 upper feet, in the Bourgeau Range (GSC loc. 38874, 38875, 38888) between 21 and 493 feet down; specimens collected by E. W. Peyto from the same outcrop (GSC locs. 17046, 17048, 17049) are probably from the upper 60 feet.

Some poorly preserved specimens collected from the Sassenach Formation in the Fernie map-area (west half) and in the Brazeau map-area are assigned to *Evanescirostrum seversoni* with doubt: a few specimens (from GSC locs. 32266, 32270, 32271) collected between 244.5 and 353 feet below the top of the formation may belong to *Eoparaphorhynchus lentiformis;* other specimens (from GSC loc. 24536) collected 332 feet below the top of the formation (90 feet above the base) may belong to *E. walcotti;* one specimen (from GSC loc. 48370) collected at 200 feet above the base of the formation, associated with eight specimens of *E. walcotti* may also belong to that species.

With the above possible exceptions, the species is restricted to the upper part of the Palliser Formation.

The specimen figured by Baldwin (1943) from Idaho and the writer's collection occur in the upper 115 feet of the Three Forks Formation.

McLaren (1954) introduced a zone based on the species.

Geographic distribution. In the Canadian Rocky Mountains the species has been found in the Bourgeau Range (most of the material), Mount Coleman, Sunwapta Pass, Cadomin. It may occur in the Brazeau map-area, and in the Fernie map-area (west half) (in the Sassenach Formation). The species is known in Idaho.

Evanescirostrum sp. A

Plate XIX, figure 1

Type

Type (Pl. XIX, figs. 1a–e). GSC No. 15521. GSC loc. 56149. Collector: D. J. McLaren, 1963.

Material

GSC localities in British Columbia: 42627 (5), 42630 (2), 51561 (1), 56149 (10), 56150 (13), 56154 (2).

Description

This species is not formally established due to the scarcity of well preserved material and specimens, and to the lack of precise stratigraphic information. Therefore, no formal types are designated.

However, this form shows sufficient proper features to be separated from other species of the genus: the characters of the sulcus and of the median costae.

Most of the characters are those of *E. seversoni. E.* sp. A differs from *E. seversoni* by a smaller size, a sulcus starting usually nearer to the beak, a different general costal formula, more irregular median costae.

The general costal formula is $\frac{3}{2}$ to $\frac{4}{3}$; 0; $\frac{2}{3}$ to $\frac{3}{4}$.

The ratios of median costae are distributed as follows (25 sp.): 2/1: 1 sp. (4.—%); 3/2: 11 sp. (44.—%); 4/3: 13 sp. (52.—%).

The ratios of lateral costae are distributed as follows (16 sp.): 1/2: 1 sp. (6.25%); 2/3: 6 sp. (37.50%); 3/4: 7 sp. (43.75%); 4/5: 2 sp. (12.50%).

The dimensions of the type are (in mm): l (14.2), w 15.5, lpv unrolled (22.0), t 12.7, tpv 3.2, tbv 9.5, l/w (0.92), t/w 0.82, t/l (0.89), shoulder angle (107°).

Discussion

Comparisons. This species is almost identical to the thirty-seven specimens described by Sartenaer (1956, p. 25) and included, at that time, in *Basilicorhynchus basilicus gerardimontis;* the restriction concerning this identity is due to the present lack of sufficient material both from Canada and from Belgium. The Belgian species has been provisionally named *Evanescirostrum* sp. a by Sartenaer (1967), and is now represented by sixty-eight specimens.

Stratigraphic position. The stratigraphic information is imprecise. GSC localities 56149, 56150, and 56154 refer to the Famennian rocks lying immediately on top of the Frasnian Kakisa Formation. The presence of the genus *Evanescirostrum* is the only reason why the layers are believed to belong to the Kotcho Formation.

Geographic distribution. The species is known from a restricted area west of Fort St. John, British Columbia.

Basilicorhynchus Crickmay, 1952

1952b. *Basilicorhynchus* nov.—CRICKMAY, p. 1.

Type species. Leiorhynchus basilicum Crickmay, 1952.

Diagnosis. Protuberant ventral umbonal region; sulcus and fold starting some distance forward of the beaks; low and not very variable number of simple, wide costae, starting some distance from the beaks; external lateral costae are mere indentations of the commissure. Internal structures thickened in the apical region; divided hinge plate; thick septum.

Species and subspecies attributed to the genus. Type species, *B. basilicus gerardimontis* (Sartenaer, 1956), *B. basilicus interpositus* nov.subsp., *B. basilicus regalis* nov.subsp., *B.* sp. A, and *B.* sp. of McLaren *in* Kerr, McGregor and McLaren (1965, pp. 415, 419, pl. 2, figs. 1–6).

Description

This genus includes strongly inequivalved, uniplicate to parasulcate forms of small to large size. The contour, in dorsal view, is subcircular to subelliptical, sometimes subpentagonal. The general aspect varies from subglobular to non-globular. The cardinal line is undulating. The commissure is sharp and deeply crenulated by the costae; nevertheless, sometimes the antero-lateral commissures do not stick out because the antero-lateral margins of the flanks are deflected near the commissures. The number of lateral costae is low and not very variable. Parietal costae are rare. The median costae start between 27 and 55 per cent of the unrolled length of the valves. The median costae are usually regular and one or both external costae are somewhat lower than the other(s). Lateral costae vary in length from mid-length for the internal ones to mere indentations of the commissure externally; the internal lateral costae are commonly lower than the others. The costae are wide, angular with rounded top, moderately high, well marked, simple with very rare exceptions. Shoulder angle varies between 95 and 125 degrees. Postero-lateral margins are concave near the commissure.

The shell is thickened in the umbonal region.

Pedicle valve. The umbonal region is protuberant. Faint beak ridges are present. The sulcus begins imperceptibly between 45 and 66 per cent of the length of the shell forward of the beak. The sulcus varies in depth from very shallow to deep. The bottom of the sulcus is

flat or slightly convex. The sulcus starts with an appreciable width; its width at the front varies between 66 and 75 per cent of the width of the shell. The beak is suberect and resorbed by the foramen. The tongue is high, trapezoidal, with sharp borders which may tend to become parallel. The tongue is vertical to posteriorly recurved. The interarea is low, and not always clearly delimited ventrally; its length varies between 55 and 65 per cent of the width of the shell.

The dental plates are slightly divergent posteriorly, but become parallel and strongly convergent anteriorly. They are short and thick, due to thickening of the shell in the umbonal region. The thickening of the shell also accounts for the reduced umbonal cavities. The teeth are short, stout, and simple. Denticula are moderately to well marked. Deltidial plates have not been observed.

In juvenile forms there is no apical thickening, the umbonal cavities are well open and the dental plates, which are not thickened, converge only slightly anteriorly.

Brachial valve. The fold is high, well marked; it starts with an appreciable width and widens gradually towards the front. The fold starts between 33 and 40 per cent of the length of the shell forward of the beak. Its top is sometimes flat, but generally slightly convex. The greatest thickness is at the front in low forms, posterior to it in high forms.

The length of the thick septum equals about one third of the shell. It supports a short and deep septalium, which is V- or amphora-shaped in transverse section. The septalium is deeper than wide and partly covered by lamellar outgrowths.

The hinge plate is divided. The outer plates are wide, flat to slightly concave, rarely slightly convex anteriorly, and extend only slightly forward of the septalium in transverse section. The crural bases are well marked. The short and slender crura are subrounded at their base and become, in section, Phrygian cap-shaped distally. They are slightly curved at their distal end.

The dental sockets are simple and rather deep. The outer socket ridges are high.

Comparisons. Resemblances to and differences from the genera *Gastrodetoechia* and *Evanescirostrum* have been discussed under the description of those genera.

The genus *Basilicorhynchus* has nothing in common with the genus *Leiorhynchus* of Givetian to lower Frasnian age.

Sartenaer (1956, p. 24) did not accept the validity of the genus *Basilicorhynchus* because he did not find major differences from the genus *Pugnoides* Weller, 1910. This view was modified after re-examination of the type species of that genus by Sartenaer (1964, pp. 6, 7).

Stratigraphic position and geographic distribution. The species and subspecies referred to this genus are restricted in Belgium, Canada (western Canada and northeastern Bathurst Island), and France, to the upper part of the lower Famennian.

The Siberian *Leiorhynchus* aff. *basilicum* cited by Alekseeva (1965) is considered under the description of *Basilicorhynchus basilicus basilicus.*

Basilicorhynchus basilicus Group

The abundant available Canadian collections allow distinction of three subspecies, in increasing size: *B. basilicus basilicus, B. basilicus interpositus, B. basilicus regalis.*

Although rich, the collections derive from few well studied outcrops. Two outcrops—one in the Root River valley, one in the North Nahanni River valley—show the best known and most complete succession of rocks containing the subspecies. In the Root River valley, in a 274-foot section, the succession is, from base to top: *B. basilicus basilicus* (lower 18 feet), *B. basilicus interpositus* (the next 20 feet), *B. basilicus interpositus* and *B. basilicus regalis* (the succeeding 17 feet), *B. basilicus regalis* (the following 199 feet). In the Yohin syncline in the North Nahanni River valley, in a continuous section of 275 feet, the succession

is, from base to top: *B. basilicus regalis* (throughout the lower 150 feet), *B. basilicus interpositus* (succeeding 10 feet, but talus), *B. basilicus regalis* (at 183 feet above the base of the section), *B. basilicus interpositus* (throughout upper 73 feet)[1]. In summary, from base to top, *B. basilicus basilicus* increases in size and undergoes slight modifications that lead to *B. basilicus interpositus*. *B. basilicus interpositus* continues to increase in size and, with some modification, passes to *B. basilicus regalis,* which, in turn, may revert to *B. basilicus interpositus*. These transitional modifications are interpreted as due to the influence of ecological factors in *Basilicorhynchus basilicus interpositus* and *B. basilicus regalis,* which are considered ecological subspecies. The occurrences of *B. basilicus basilicus* and *B. basilicus regalis,* however, are stratigraphically significant.

It is clear that these modifications are transitional and progressive. Within the range of variability of specimens of *B. basilicus basilicus,* for instance, are forms that might be attributed to *B. basilicus interpositus*. The same happens between *B. basilicus interpositus* and *B. basilicus regalis*. Such intergradation illustrates the arbitrary character of taxonomic separation.

Basilicorhynchus basilicus basilicus (Crickmay)

Plate XVIII, figures 1, 2; Text-figures 31, 32

[e.p.]	1922.	*Leiorhynchus* sp., *Leiorhynchus*—WHITTAKER, pp. 52B–53B;
[e.p.]	1922.	*Leiorhynchus* cf. *clarkei* Prosser—WILLIAMS, p. 64B;
	1950.	*Leiorhynchus* n.s.—WARREN and STELCK, p. 65;
	1952a.	*Leiorhynchus basilicum* Crickmay, n.sp.—CRICKMAY, pp. 595, 600, pl. 70, figs. 12–21;
	1952b.	*Leiorhynchus basilicum* Crickmay—CRICKMAY, p. 1;
	1954.	*Nudirostra gibbosa seversoni*—McLAREN, p. 174, line 26 (*coet. excl.*);
[non]	1956.	*Pugnoides basilicum* (Crickmay, C.H., 1952)—SARTENAER, pp. 16–33, pl. II, figs. 1–7; pl. IV, figs. 1–7;
	1956.	*Basilicorhynchus basilicum* (Crickmay)—WARREN and STELCK, pl. XXVI, figs. 21–24;
[non]	1957b.	*Pugnoides basilicum* (Crickmay, C.H., 1952)—SARTENAER, pp. 438, 440, 441;
[non]	1957c.	*Pugnoides basilicum, P. basilicum* (Crickmay, C.H., 1952)—SARTENAER, pp. 10, 13, 15, 17, 18, 25, 26;
[non]	1957d.	*Pugnoides basilicum*—SARTENAER, p. 142;
	1957.	*Basilicorhynchus basilicum*—CRICKMAY, pp. 1, 11;
	1958.	*Basilicorhynchus basilicum* (Crickmay)—TAYLOR, pp. 14, 15;
[non]	1958.	*Pugnoides basilicum* (Crickmay, C.H., 1952)—SARTENAER, pp. 3, 5, 6;
	1962.	*Basilicorhynchus basilicum* (Crickmay)—BELYEA and McLAREN, p. 10;
[?]	1965.	*Leiorhynchus* aff. *basilicum* Crickmay—ALEKSEEVA, pp. 184, 185.

Types

Holotype (Pl. XVIII, figs. 1a–e=pl. 70, figs. 12–16 *in* Crickmay, 1952a). PRI No. 26934. Isolated limestone outcrop on right bank of Mackenzie River, one mile above mouth of Root River, N.W.T. Hume's *Leiorhynchus* limestones. Collector: C. H. Crickmay.

Paratype (=pl. 70, figs. 17–21 *in* Crickmay, 1952a). PRI No. 26935. Same locality, formation, and collector.

Hypotype A. GSC No. 15905. GSC loc. 43844. Collector: A. E. H. Pedder (Triad Oil Co. Ltd.), 1960.

Hypotype B. GSC No. 15906. GSC loc. 11371. Collectors: M. Y. Williams, H. W. Smithson, 1921.

Hypotype C. GSC No. 15907. GSC loc. 5723. Collector: E. M. Kindle, 1917.

Hypotype D. GSC No. 15908. GSC loc. 7149E. Collector: G. S. Hume, 1921.

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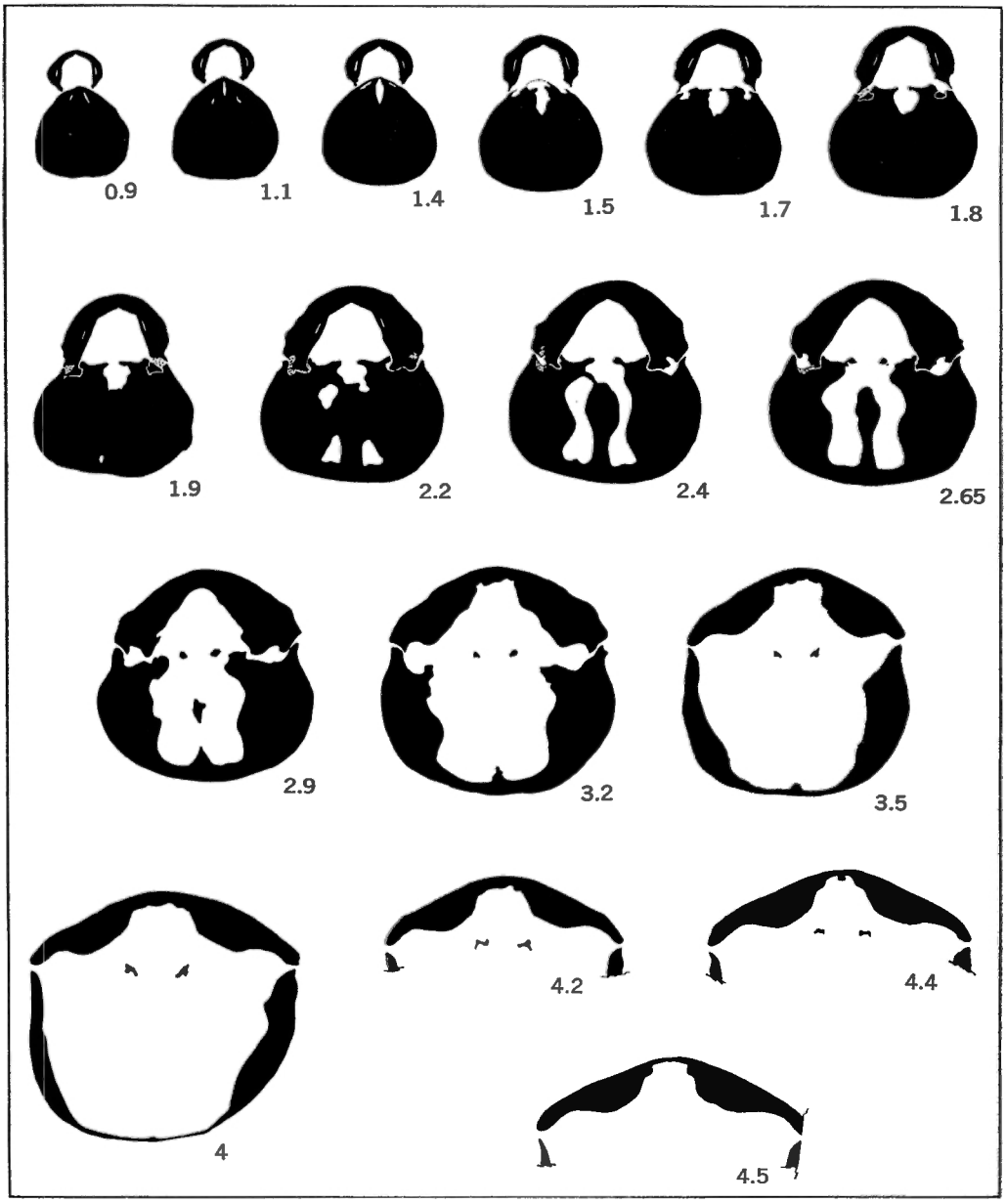
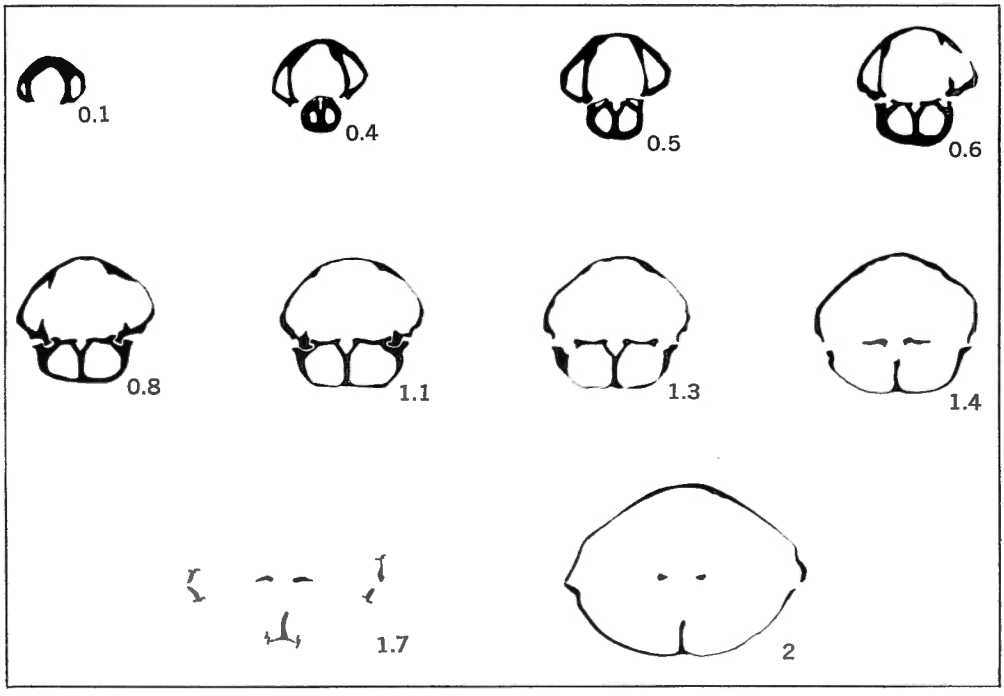
[1] *B. basilicus basilicus* has not been found yet in this outcrop, though the locality has been frequently visited. Two reasons may be suggested: the outcrop is poor at the level where the subspecies might be expected to occur, or local ecological conditions may have played a role. The second explanation is in contradiction to observations made on Root and Redstone Rivers along the same tectonic structure, and the first explanation is favoured.



TEXT-FIGURE 31. *Basilicorhynchus basilicus basilicus* (Crickmay)

Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.

Hypotype J, GSC No. 15914 (l:14.4 mm; w:15.5 mm; t:12.7 mm).



TEXT-FIGURE 32. *Basilicorhynchus basilicus basilicus* (Crickmay)
Camera lucida drawings of serial transverse sections (x5); distances are in mm forward from the crest of the umbo.
Hypotype K, GSC No. 15915 (l:13.0 mm; w:13.1 mm; t:6.7 mm).

Hypotypes E, GSC No. 15909 (Pl. XVIII, figs. 2a–e); F, GSC No. 15910; G, GSC No. 15911. GSC loc. 38694. Collector: P. Sartenaer, 1959.

Hypotype H. GSC No. 15912. GSC loc. 12838. Collector: G. D. Bath, 1944 (Canol project).

Hypotype I. GSC No. 15913. GSC loc. 32994. Collector: D. F. Stott, 1957.

Hypotype J. GSC No. 15914 (Text-fig. 31). GSC loc. 33456. Collector: D. J. McLaren, 1957.

Hypotype K. GSC No. 15915 (Text-fig. 32). GSC loc. 7177. Collector: G. S. Hume, 1921.

Material

Plaster casts have been made of the primary types which were kindly lent by Imperial Oil Ltd.

GSC localities: Mackenzie River valley, N.W.T.: 5721 (1), 5722 (95), 5723 (213), 7149E (179), 11371 (11), 11426 (7), 12895 (1), 38692 (5), 38694 (49), 43836 (20), 43844 (23); Root River valley, N.W.T.: 7169 (7), 7177 (540), 7178 (66), 7179 (17), 7181 (18), 7186 (207), 7189 (457), 7190 (322), 12835 (6), 12838 (1), 22484 (49), 22548 (19), 28634 (1), 28640 (24), 28641 (12), 32660 (29), 33445 (86), 33456 (82), 38710 (57), 43831 (20), 43838 (22); Redstone River valley, N.W.T.: 32994 (22), 32995 (48); Trout River valley, N.W.T.: 6959 (65), 30579 (16), 30589 (11); North Nahanni River valley, N.W.T.: 26786 (13).

More than four fifths of these 2,821 specimens are in satisfactory state of preservation.

Description

The subspecies is small to medium sized, strongly inequivalve with subglobular aspect. The commissure is sharp and clearly indented by the costae. The cardinal line is undulated.

Pedicle valve. The umbonal region is protuberant. From this protuberance the flanks slope gently towards the commissure, but are sharply deflected postero-laterally; beak ridges usually underline this deflection.

The sulcus starts imperceptibly between 45 and 61 per cent of the length of the shell forward of the beak, or between 33 and 48 per cent of the unrolled length of the valve. It is shallow and its floor is generally slightly convex. The width of the sulcus, where it starts, is between 52 and 65 per cent of its maximum width at the front, which varies between 66 and 75 per cent of the width of the shell. It passes progressively to a high trapezoidal tongue with sharp borders which becomes vertical in its upper part. The greatest thickness of the shell may correspond to the top of the tongue, but is more commonly located posterior to it; from this point the fold remains almost horizontal or slopes very gently towards the commissure.

The beak is suberect and truncated by the foramen. The low (about 1 mm) interarea has a length varying between 55 and 65 per cent of the width of the shell and is in the form of two propeller-blades not always clearly delimited ventrally.

Brachial valve. The longitudinal median curvature is regular to the summit of the valve. In the highest forms the posterior part of the valve is vertical. The flanks slope sharply towards the commissure and become concave near the postero-lateral commissures.

The high fold, always well marked, starts between 33 per cent and 40 per cent of the length of the shell forward of the beak. Its width, where it starts, is about 60 per cent of its maximum width at the front. The top is sometimes flat, but is generally slightly convex because the external costae are somewhat lower than the others.

Ornament. The general costal formula is 3/2 to 4/3; rare; 3/4 to 4/5.

To examine possible geographic differentiation, the costae have been counted separately for each river valley in the N.W.T.

MEDIAN COSTAE

	Root River	Redstone River	Trout River	North Nahanni River[1]	Mackenzie River	Totals
2/1	3[2]	11.75	14.50	7.70	6.55	4.30
	(51)	(4)	(9)	(1)	(36)	(101)
3/2	55.70	85.30	77.40	76.90	74.85	61.30
	(940)	(29)	(48)	(10)	(411)	(1,438)
4/3	32.40	2.95	8.10	15.40	15.50	27.25
	(547)	(1)	(5)	(2)	(85)	(640)
5/4	7.15				3.10	5.90
	(121)				(17)	(138)
6/5	1.60					1.15
	(27)					(27)
7/6	0.15					0.10
	(2)					(2)
	100.—	100.—	100.—	100.—	100.—	100.—
	(1,688)	(34)	(62)	(13)	(549)	(2,346)

[1]In the introduction of the *B. basilicus* Group *see* suggestions concerning the absence of *B. basilicus basilicus* in the Yohin syncline.

[2]The first figure indicates percentage and the figure in parentheses is the number of specimens.

LATERAL COSTAE

	Root River	Redstone River	Trout River	North Nahanni River	Mackenzie River	Totals
2/3	3.90 (49)		29.25 (12)	8.35 (1)	9.90 (42)	5.95 (104)
3/4[1]	36.90 (463)	50.– (8)	46.35 (19)	41.65 (5)	53.15 (226)	41.20 (721)
4/5	42.65 (535)	43.75 (7)	14.60 (6)	50.– (6)	32.– (136)	39.45 (690)
5/6	14.80 (186)	6.25 (1)	4.90 (2)		4.70 (20)	11.95 (209)
6/7	1.65 (21)		4.90 (2)			1.30 (23)
7/8	0.10 (1)				0.25 (1)	0.15 (2)
	100.– (1,255)	100.– (16)	100.– (41)	100.– (12)	100.– (425)	100.– (1,749)

[1]Eventual ratios as 3/3, 4/4, etc. are counted with the ratios 3/4, 4/5, etc.

The costae are well marked, angular with rounded top, of medium height, with a width of 2 to 4 mm at the front. All costae are simple with the following exceptions: a divided or intercalated median costa in six specimens; an adventitious median costa in two specimens; a divided lateral costa in one specimen.

Median costae start between 27 and 50 per cent of the unrolled length of the valves forward. They may be irregular when the ratio is higher than ½. One external costa, or both, may be lower than the others, and, in exceptional cases, might be considered as a parietal costa. Parietal costae have been observed in only twenty-seven specimens. Lateral costae decrease in length from internal ones starting around mid-length to external ones often reduced to mere indentations. The internal ventral costae are commonly lower than the others. The number of lateral costae may be different on both flanks; when this is so, the higher ratio has been counted.

When the ratios of median costae increase, the proportion of higher ratios of lateral costae increases slightly.

Dimensions. Measurements of ten specimens:

in mm	Holotype	Hypotype B	Hypotype A	Hypotype G	Hypotype I	Hypotype F	Hypotype D	Hypotype C	Hypotype E	Hypotype H
l	17.6	16.7	15.6	15.4	15.3	15.0	14.9	14.6	14.4	14.4
w	19.5	17.7	16.7	17.2	18.8	18.7	17.7	16.2	15.9	15.5
lpv unrolled	30.2	27.0	25.0	23.2	25.5	23.7	23.0	23.0	23.7	22.0
t	18.7	15.1	13.1	12.9	15.5	15.7	12.8	13.5	14.0	12.8
tpv	5.5	5.8	5.0	4.5	4.7	4.7	4.4	3.8	4.9	3.8
tbv	13.2	9.3	8.1	8.4	10.8	11.0	8.4	9.7	9.1	9.0
l/w	0.90	0.94	0.93	0.90	0.81	0.80	0.84	0.90	0.91	0.93
t/w	0.96	0.85	0.78	0.75	0.82	0.84	0.72	0.83	0.88	0.83
t/l	1.06	0.90	0.84	0.84	1.01	1.05	0.86	0.92	0.97	0.89
shoulder angle	120°	115°	112°	115°	119°	117°	115°	118°	110°	115°

The holotype is a specimen particularly high for the species and has a wide shoulder angle. The shoulder angle varies between 110 and 120 degrees.

Internal characters. The internal characters are given under the description of the genus.

Growth. Young specimens of *B. basilicus basilicus* have a protuberant ventral umbonal region, a pedicle valve higher than the brachial valve, neither sulcus, nor fold, nor costae.

Discussion

Synonymy. Specimens identified as *Leiorhynchus* cf. *clarkei* by Williams (1922) are from GSC locs. 11371 and 11426. Williams' original material includes *Basilicorhynchus basilicus basilicus* and *Eoparaphorhynchus maclareni.*

Whittaker's (1922) collection contains in addition *Rugaltarostrum madisonense* and possibly *Eoparaphorhynchus maclareni* (*see* discussion of those species).

Following redescription of the genus *Pugnoides* Weller, 1910 by Sartenaer (1964), what Sartenaer (1956 to 1962) considered *P. basilicum* (Crickmay, 1952) was put in *Evanescirostrum alblinii* Sartenaer, 1967.

Alekseeva's (1965) specimens have not been studied. The Siberian material is rare and fragmental.

Comparisons. The subspecies is distinguished by small size, subglobular aspect, shallow sulcus, tongue vertical in its upper part.

Crickmay (1957, p. 1) stated correctly that, on Trout River, "*Basilicorhynchus basilicum* has usually been quoted as *Leiorhynchus walcotti*".

The study of some *Pugnoides chanakchiensis* Abramian, 1954 has shown median costae reaching the beaks, and following the redescription by Sartenaer (1964) of the genus *Pugnoides,* the Armenian species is no longer considered a synonym of *P. basilicum. P. chanakchiensis* shows some similarity to various species: *Eoparaphorhynchus maclareni, E. walcotti, E. lentiformis, Evanescirostrum seversoni* (*see* description of these species), also to *Camarotoechia deprati* Mansuy of Nalivkin 1930 (non *C. deprati* Mansuy 1912). Lack of material does not allow definite systematic conclusions.

Comparison with *B. basilicus gerardimontis* is discussed under that subspecies.

Comparison with *B. basilicus interpositus* is discussed under the description of that subspecies.

Remark. Some specimens of GSC locs. 6959, 30589 could be attributed to *B. basilicus interpositus.*

Stratigraphic position. The stratigraphic range given by Crickmay (1952b, p. 1), "equivalents of Alexo and Palliser formations", is not accepted, but Crickmay's (1957, p. 1, p. 11) opinion, "Lowest Palliser", on Trout River, is closer to the truth; together with *Cyrtiopsis nahanniensis,* he considered the species as a marker of his "Zone A".

The only information for some outcrops is *Leiorhynchus* Zone = D4, or Imperial Formation, or Fort Creek Shale.

In some outcrops of Hume's (1922) *Leiorhynchus* Zone (GSC locs. 5722, 5723, 7149E, 7169, 12838, 38694, 38710, 43831, 43838), *Basilicorhynchus basilicus basilicus* is found in rocks immediately above the *Eoparaphorhynchus maclareni* Zone.

On Redstone River, *Basilicorhynchus basilicus basilicus* has been collected in rocks of the Imperial Formation from 135 feet to 153 feet above beds containing *Eoparaphorhynchus maclareni* (GSC locs. 32994, 32995).

On Trout River the subspecies is present in the Tetcho Formation between 18.5 and 34.4 feet below the top (GSC locs. 30579, 30589), and in the upper 25 feet (GSC loc. 6959) of the section.

See *Basilicorhynchus basilicus* Group for information on Root River valley.

B. basilicus basilicus characterizing the base of the *B. basilicus* Zone, it is proposed to consider a *B. basilicus basilicus* Subzone.

The *B. basilicus* Zone is immediately above the *Eoparaphorhynchus maclareni* Zone wherever both zones have been observed.

Geographic distribution. The subspecies is known from the following river valleys in the N.W.T.: Mackenzie, North Nahanni, Redstone, Root, and Trout.

Basilicorhynchus basilicus gerardimontis (Sartenaer)

1956. *Pugnoides gerardimontis*, nov.sp.—SARTENAER, pp. 2–16, 22–31, pl. I, figs. 1–9, pl. III, figs. 1–6;[1]

[non] 1962. *Pugnoides gerardimontanus* Sartenaer (? *C.* cf. *triaequalis*)—SIEBER, p. 391.

The Belgian form is considered to draw attention once more to the change in its generic assignment and to discuss the reasons for considering it a geographic subspecies of *Basilicorhynchus basilicus* rather than a separate species. It should be noted that the holotype of *B. basilicus basilicus,* being high with a wide shoulder angle, is very close to the Belgian subspecies.

The following characters, considered as a group, distinguish *B. basilicus gerardimontis*: antero-lateral margins of the flanks very often deflected near the commissure; antero-lateral parts of the pedicle valve generally flatter; the ventral umbonal protuberance passes progressively to a flattish fold within the sulcus that brings into relief the median part of the valve and continues generally in the tongue (this is extremely rare in *B. basilicus basilicus*); the sulcus starts farther from the beak; it is shallower and the costae near the top of the tongue often project anteriorly to the borders of the tongue; the sulcus passes more sharply (almost at right angle) to the tongue; the tongue is commonly recurved posteriorly at its top; the borders of the tongue tend very often to be parallel; the greatest thickness of the shell is never at the top of the tongue; the fold slopes more sharply from the summit of the shell towards the frontal commissure; length and width are commonly equal, although width is generally greater than length in *B. basilicus basilicus;* the height is proportionally greater; although the values of the shoulder angles overlap, *B. basilicus gerardimontis* has generally smaller shoulder angles.

Most of the characters mentioned above give to *B. basilicus gerardimontis* a typically pugnoid aspect.

Thanks to the courtesy of Pr. R. Sieber, the specimens tentatively identified as *Pugnoides gerardimontanus* Sartenaer (? *C.* cf. *triaequalis*) were examined at the "Geologische Bundesanstalt", in Vienna; they belong to the species *Cyphoterorhynchus koraghensis* (Reed, 1922).

Basilicorhynchus basilicus interpositus nov. subsp.

Plate XVIII, figures 3–8

[e.p.] 1922. *Leiorhynchus* sp.—HUME, p. 71B, line 33 (*coet. excl.*);
[e.p.] 1945. *Leiorhynchus*—HUME and LINK, p. 38, line 60 (*coet. excl.*);
[e.p.] 1954. *Leiorhynchus*—HUME, p. 46, line 19 (*coet. excl.*);
[e.p.] 1963. *Basilicorhynchus basilicum* (Crickmay)—PEDDER *in* HOUSE and PEDDER, p. 497.

Interpositus, a, um (Latin)=intermediate; to draw attention to the intermediate position of the subspecies between *B. basilicus basilicus* and *B. basilicus regalis.*

Types

Holotype. GSC No. 15916 (Pl. XVIII, figs. 3a–e). Paratypes A, GSC No. 15917 (Pl. XVIII, figs. 6a–e); B, GSC No. 15918 (Pl. XVIII, figs. 4a–e); C, GSC No. 15919 (Pl. XVIII, figs. 5a–e); D, GSC No. 15920 (Pl. XVIII, figs. 7a–e); E, GSC No. 15921 (Pl. XVIII, figs. 8a–d). GSC loc. 38706. Collector: P. Sartenaer, 1959.

[1] Since 1956 the species has been cited consistently by the author in various publications not mentioned here because it is not a Canadian form.

Material

GSC localities: North Nahanni River valley, N.W.T.: 7161C (1), 36042 (6), 38706 (386), 38723 (59), 38726 (110), 43834 (26), 43839 (33), 43841 (13); Root River valley, N.W.T.: 7178 (29), 7182 (11), 22537 (3), 28636 (3), 28638 (3), 33257 (57), 33265 (88), 33458 (40); Redstone River valley: 32889 (18).

More than four fifths of these 886 specimens are in satisfactory state of preservation.

Description

Most features are similar to those of *B. basilicus basilicus,* but *B. basilicus interpositus* differs in the following characters: size usually greater (medium); less subglobular to non-subglobular; dorsal flanks may slope less abruptly; sulcus commonly deeper (moderately deep), bottom of sulcus sometimes slightly convex, but generally flat; tongue rarely vertical near the top; its top is the greatest thickness of the shell or the greatest thickness is reached posterior to the top of the tongue and the fold remains at the same level. In the abundant material from North Nahanni River valley, where collections have been made very carefully, the distribution of ratios of costae tends towards smaller values; median and lateral costae are somewhat shorter, lower; width often greater proportionately; shoulder angle commonly wider.

Ornament. The general costal formula is 3/2 to 4/3; rare; 2/3 to 4/5.

The ratios of costae are distributed as follows:

Median	Root River valley	North Nahanni River valley	Totals	Lateral	Root River valley	North Nahanni River valley	Totals
2/1	1.15 (2)	22.75 (89)	16.10 (91)	1/2		1.80 (4)	1.10 (4)
3/2	49.40 (86)	71.60 (280)	64.75 (366)	2/3	9.70 (13)	27.– (60)	20.50 (73)
4/3	37.95 (66)	5.35 (21)	15.40 (87)	3/4	42.55 (57)	51.80 (115)	48.30 (172)
5/4	9.20 (16)	0.30 (1)	3.– (17)	4/5	37.30 (50)	15.75 (35)	23.85 (85)
6/5	2.30 (4)		0.75 (4)	5/6	10.45 (14)	3.65 (8)	6.25 (22)
	100.– (174)	100.– (391)	100.– (565)		100 (134)	100 (222)	100 (356)

A divided or intercalated median costa occurs in two specimens, an adventitious median costa in one, and a parietal costa in four.

Dimensions. Measurements of four specimens:

in mm	Paratype A	Holotype	Paratype C	Paratype B
l	18.6	16.0	15.9	15.3
w	20.05	18.8	17.5	16.1
lpv unrolled	28.5	27.7	23.0	25.0
t	16.8	16.7	14.4	15.3
tpv	5.1	4.7	2.9	4.1
tbv	11.7	12.0	11.5	11.2
l/w	0.93	0.85	0.91	0.95
t/w	0.84	0.89	0.82	0.95
t/l	0.90	1.04	0.91	1.00
shoulder angle	125°	124°	125°	116°

Paratypes A and B are rather high for the subspecies. Paratypes B and C are rather small. The antero-lateral commissure often rises dorsally (e.g. holotype).

Growth. Measurements of two juvenile specimens:

in mm	Paratype D	Paratype E
l	10.3	10.2
w	10.9	10.7
lpv unrolled	12.5	11.0
t	6.7	4.1
tpv	2.5	1.7
tbv	4.2	2.4
l/w	0.95	0.95
t/w	0.61	0.38
t/l	0.65	0.40
shoulder angle	114°	115°

Juvenile characters are: marked protuberant ventral umbonal region; pedicle valve higher than the brachial valve in youngest specimens; greatest thickness of shell located more posteriorly; brachial valve slopes slightly downwards from this point to the frontal commissure; fold and sulcus not developed; no costae in youngest specimens; very sharp commissure.

Compared with *B. basilicus basilicus, B. basilicus interpositus* has lateral costae developed later, juvenile characters maintained longer, and usually a wider shoulder angle although the values overlap.

Discussion

Synonymy. Hume's (1922) original material includes *B. basilicus interpositus, B. basilicus regalis,* and *Eoparaphorhynchus maclareni.* Hence Pedder's (*in* House and Pedder, 1963, p. 497) statement that "the exceptional abundance of this brachiopod (*B. basilicum*) ... prompted Hume to designate the unit (D4) the *'Leiorhynchus* Zone' " cannot be considered as certain.

The subspecies is distinguished by median size, without subglobular aspect, moderately deep sulcus, tongue rarely vertical in its upper part, proportionately lower shell.

Stratigraphic position. When *B. basilicus basilicus* and *B. basilicus interpositus* occur in the same outcrop, *B. basilicus interpositus* is higher.

The only information for some outcrops is *Leiorhynchus* Zone = D4, or Imperial Formation or Fort Creek Shale.

In the Yohin syncline in the North Nahanni River valley, *Basilicorhynchus basilicus interpositus* occurs (five specimens) in beds between 555 and 565 feet (GSC loc. 38723 = talus), and, in great abundance between 607 and 680 feet (GSC loc. 38706) above the base of the section.

For further details, and information on Root River valley *see B. basilicus* Group.

As there is a slight possibility (*see* under discussion of the *B. basilicus* Group) that *B. basilicus basilicus* could be absent in the Yohin syncline (North Nahanni River valley), and also in the same syncline, *B. basilicus interpositus* is lower and higher than *B. basilicus regalis,* the subspecies here discussed has an ecological significance.

On account of this dual character, the erection of a subzone based on the subspecies is inappropriate.

Geographic distribution. The subspecies has only been found in three river valleys in the N.W.T.: North Nahanni, Redstone, and Root.

Basilicorhynchus basilicus regalis nov. subsp.

Plate XVIII, figures 9–11; Text-figure 33

[e.p.] 1922. *Leiorhynchus* sp.—HUME, p. 71B, line 33 (*coet. excl.*);
[e.p.] 1945. *Leiorhynchus*—HUME and LINK, p. 38, line 60 (*coet. excl.*);
[e.p.] 1954. *Leiorhynchus*—HUME, p. 46, line 19 (*coet. excl.*);
[e.p.] 1963. *Basilicorhynchus basilicum* (Crickmay)—PEDDER *in* HOUSE and PEDDER, p. 497.

Regalis, is, e (Latin) = royal; to draw attention to the relations with *B. basilicus basilicus*, the latin adjective *basilicus, a, um* also meaning royal.

Types

Holotype. GSC No. 15922 (Pl. XVIII, figs. 11a–e). Paratypes A, GSC No. 15923 (Pl. XVIII, figs. 9a, b); B, GSC No. 15924 (Pl. XVIII, figs. 10a, b); C, GSC No. 15925 (Text-fig. 33). GSC loc. 33258. Collector: D. J. McLaren, 1957.

Material

GSC localities: North Nahanni River valley, N.W.T.: 7164 (215), 33435 (2), 38698 (76), 38708 (6), 38728 (5), 43833 (27), 43840 (29); Root River valley, N.W.T.: 7178 (214), 7179 (18), 7181 (28), 7190 (4), 22484 (10), 32660 (14), 33256 (5), 33258 (40), 33454 (3), 33458 (8).

More than four fifths of these 704 specimens are in satisfactory state of preservation.

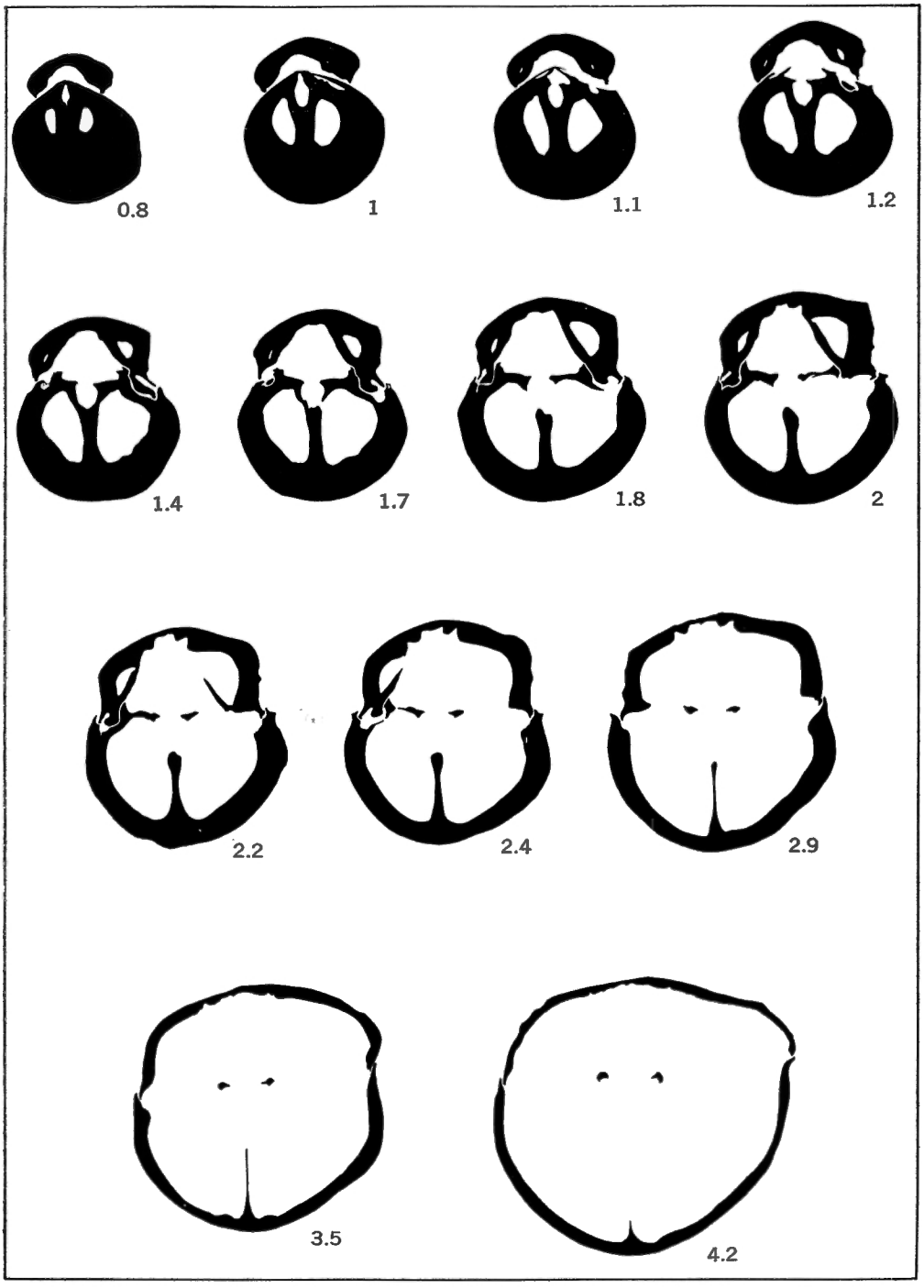
Description

The characters of *B. basilicus regalis* are similar to those of *B. basilicus interpositus* but somewhat more pronounced. The more accentuated features are larger size; non-globular aspect; more gently sloping dorsal flanks; fainter beak ridges; sulcus begins with a median swelling (rarely observed in *B. basilicus basilicus* and sometimes in *B. basilicus interpositus*); sulcus moderately deep to deep; sometimes the fold slopes from the summit of the shell towards the frontal commissure (juvenile character); height proportionately smaller giving a characteristic depressed aspect to the subspecies.

Ornament. The general costal formula is ½ to ⅓; rare; ⅔ to ⅕.

The ratios of costae are distributed as follows:

Median				Lateral			
	Root River valley	North Nahanni River valley	Totals		Root River valley	North Nahanni River valley	Totals
2/1	6.60 (17)	10.50 (24)	8.40 (41)	0		1.80 (3)	0.90 (3)
3/2	64.35 (166)	79.05 (181)	71.25 (347)	1/2	2.80 (5)	8.45 (14)	5.50 (19)
4/3	19.— (49)	10.05 (23)	14.80 (72)	2/3	12.90 (23)	24.70 (41)	18.60 (64)
5/4	7.75 (20)	0.40 (1)	4.30 (21)	3/4	41.55 (74)	40.95 (68)	41.25 (142)
6/5	2.30 (6)		1.25 (6)	4/5	32.60 (58)	24.10 (40)	28.45 (98)
				5/6	9.55 (17)		4.95 (17)
				6/7	0.60 (1)		0.35 (1)
	100.– (258)	100.– (229)	100.– (487)		100.– (178)	100.– (166)	100.– (344)



TEXT-FIGURE 33. *Basilicorhynchus basilicus regalis* nov. subsp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype C, GSC No. 15925 (l:21.5 mm; w:21.2 mm; t:19.0 mm).

A divided median costa occurs in one specimen, an adventitious median costa in one, and a parietal costa in two.

Dimensions. Measurements of three specimens:

in mm	Holotype	Paratype A	Paratype B
l	21.6	18.8	18.2
w	24.5	20.8	21.3
lpv unrolled	31.5	25.5	26.0
t	14.4	12.2	14.6
tpv	5.7	4.8	5.2
tbv	8.7	7.4	9.4
l/w	0.88	0.90	0.85
t/w	0.59	0.59	0.69
t/l	0.67	0.65	0.80
shoulder angle	125°	122°	125°

Growth. The juvenile characters are very similar to those of *B. basilicus interpositus.* At this stage juvenile specimens of both subspecies are almost inseparable. Nevertheless, young specimens of *B. basilicus regalis* are commonly wider, their shoulder angle is often wider, and juvenile characters are longer preserved.

Discussion

Remark. On account of the rather small differences between *B. basilicus basilicus* and *B. basilicus interpositus* and between *B. basilicus interpositus* and *B. basilicus regalis,* separation is sometimes difficult. But as a result of the progressive modification, *B. basilicus basilicus* and *B. basilicus regalis* are easily distinguishable. This raises the problem that will become increasingly familiar in detailed stratigraphic and palaeontologic studies: when to distinguish a taxon as a species, and when a subspecies. *B. basilicus regalis* might have been separated as a species, but is given subspecific status in the expectation of further knowledge derived from new outcrops studied in detail.

Synonymy. Hume's (1922) original material includes *B. basilicus regalis, B. basilicus interpositus,* and *Eoparaphorhynchus maclareni.* Thus Pedder's (*in* House and Pedder, 1963) *Basilicorhynchus basilicum* includes forms of both subspecies.

The subspecies is distinguished by medium to large size, non-globular aspect, moderately deep to deep sulcus, tongue not vertical in its upper part, proportionately smaller height.

Stratigraphic position. As stated under the discussion of *B. basilicus interpositus, B. basilicus regalis* occurs both above and below that subspecies. But, when found in the same outcrop, *B. basilicus regalis* is always higher than *B. basilicus basilicus* and thus, has stratigraphic value. As the two subspecies are easy to separate, a *B. basilicus regalis* Subzone is considered.

The only information for some outcrops is *Leiorhynchus* Zone=D4, or Imperial Formation or Fort Creek Shale.

In the Yohin syncline in the North Nahanni River valley, *Basilicorhynchus basilicus regalis* occurs (eleven specimens) between 405 and 555 feet (GSC locs. 38708, 38728), and, in abundance in a lens at 588 feet (GSC loc. 38698) above the base of the section.

For further details, and information on Root River valley *see B. basilicus* Group.

Geographic distribution. The subspecies has been found only in two river valleys in the N.W.T.: Root, North Nahanni.

Basilicorhynchus sp. A

[e.p.] 1954. *Nudirostra gibbosa seversoni* McLaren, n. subsp.—McLAREN, p. 173.

Type

Type. GSC No. 15678. GSC loc. 45908. Collector: D. J. McLaren, 1961.

Material

GSC localities in the Alberta and British Columbia Rocky Mountains: 5173(43), 19952(9), 45908(35), 57477(16).

Description

This species is not formally established due to the scarcity of available collections. Therefore, no formal types are designated. The species may also prove to be only a geographic subspecies of *B. basilicus,* and it was initially considered by the writer as belonging to *B. basilicus basilicus.*

Most of the characters of *B.* sp. A are those of *B. basilicus basilicus,* but the general costal formula is strikingly different and can be considered a sufficiently proper feature for separating the species from other species and subspecies of the genus.

The general costal formula is 2/1 to 3/2; 1/2 to 3/4.

The ratios of median costae are distributed as follows: 2/1: 49 sp. (71.–%); 3/2: 20 sp. (29.–%).

The ratios of lateral costae are distributed as follows: 1/2: 12 sp. (27.90%); 2/3: 24 sp. (55.80%); 3/4: 6 sp. (13.95%); 4/5: 1 sp. (2.35%).

The dimensions of the type are (in mm):

l	15.0	tbv	8.3
w	14.8	l/w	1.01
lpv unrolled	23.5	t/w	0.85
t	12.6	t/l	0.84
tpv	4.3	shoulder angle	113°

Discussion

Synonymy. As indicated under the discussion of *Evanescirostrum seversoni,* the specimens of Winnifred Pass belong to this species.

Stratigraphic position. McLaren has collected the species at 519.5 feet below the top (GSC loc. 19952) and between 150 and 154 feet above the base (GSC loc. 45908) of the Palliser Formation. Leech has found it at approximately the middle of the same formation (GSC loc. 57477).

Geographic distribution. The species has been found in the Canadian Rocky Mountains at Wardner and 50°14.3′N, 115°08.8′W in British Columbia; Mount Haultain and Winnifred Pass in Alberta.

Ptychomaletoechia Sartenaer, 1961

1961d. *Ptychomaletoechia* n.gen.—SARTENAER, p. 7.

Type species. Rhynchonella Omaliusi Gosselet, 1877.

Diagnosis. Costae simple, starting at the umbones; number of costae variable, but high; parietal costae rare in some species, common in others; well marked sulcus and fold, not starting at the beaks; deep cupule- to amphora-shaped, covered septalium, supported by a septum.

Species attributed to the genus. Six new Canadian species are described in this paper: *P. contractiformis* n. sp., *P. finitima* n. sp., *P. septentrionalis* n. sp., *P. serva* n. sp., *P. sulculifera* n. sp., *P. summa* n. sp. In addition to these species, it should be noted that *P.*? sp. has been recorded in the Arctic Archipelago by McLaren *in* Kerr, McGregor and McLaren (1965).

Many species from various parts of the world were included in the genus when introduced (Sartenaer, 1961d, p.7). They are not listed here and will not be definitely assigned to the genus until they have been thoroughly investigated, notably by sectioning.

The Belgian and French species *Rhynchonella Dumonti* Gosselet, 1877 and *R. Gonthieri* Gosselet, 1887 have been sufficiently studied to be included in the genus; other Belgian species will be added later.

Some lower Famennian species identified as *Camarotoechia* in the U.S.S.R. probably belong to the genus; in particular, *Rhynchonella turanica* Romanovskii, 1878 as indicated by Gaetani (1965, p. 710). The primary types, however, are not to be found in the Leningrad Mining Institute; therefore, the assignment cannot be considered as definite.

Some species from the lower Famennian of the U.S.A. probably belong to *Ptychomaletoechia.*

Westbroek (1964) reported *Cupularostrum* Sartenaer, 1961 and *Ptychomaletoechia* in upper Frasnian and lower Famennian rocks (Crémenes Limestone) of the Aguasalio Mountain, Spain. The former genus is only known elsewhere in the Givetian, and the latter in the Famennian. Therefore, further investigations may be necessary before the modified range of these genera can be accepted.

P. elburzensis Gaetani, 1965 of the upper Frasnian in the Elburz Mountains (Iran) is attributed by Sartenaer (1966, p. 4) to the genus *Ripidiorhynchus* Sartenaer, 1966. The two lower Famennian Iranian subspecies *Ptychomaletoechia? deltidialis deltidialis* Gaetani, 1965 and *P.? deltidialis traversaria* Gaetani, 1965 are not definitely accepted in the genus.

Description

The genus is represented by uniplicate species of small to medium size with variable contour in dorsal view. The commissure is sharp and deeply crenulated by the costae.

The number of median and lateral costae varies from one species to another, but is high. Costae are simple, regular, angular with rounded top, and start at the umbones. Parietal costae are rare in some species, common in others; they may or may not indent the borders of the tongue depending on the species. The shoulder angle is variable. Postero-lateral margins are concave near the commissure. The greatest thickness of the shell is usually at the front, sometimes somewhat posterior to it.

Pedicle valve. The umbonal region is somewhat inflated. The well marked sulcus begins at some distance forward from the beak. It is moderately deep and its width at the front varies between 53 and 78 per cent of the width of the shell. The bottom of the sulcus is flat to slightly convex. The trapezoidal tongue, with sharp borders, is moderately high to high. The beak is prominent, erect to suberect, and does not overhang the hinge line; it is resorbed by a circular foramen. The interarea is variable in width. Deltidial plates are wide and best observed in transverse serial sections.

The dental plates are divergent to parallel in the posterior part, and become progressively convergent anteriorly; sometimes they are somewhat convex towards the general cavity of the shell. The dental plates are short, stout, and widely separated. The umbonal cavities are well marked. The teeth are short, strong, and crenulated on their dorsal face. The denticula are clearly indicated. The muscle field has a low relief.

Brachial valve. The well marked fold starts at some distance forward of the beak; its top is flat to slightly convex.

The moderately deep to deep cupule- to amphora-shaped septalium is supported by a long and strong septum. The outer hinge plates are flat to slightly concave. The dental sockets are wide and crenulated. The crura are supported by strong crural bases; they become crescent- to triangular- and Phrygian cap-shaped (in transverse serial sections) and are slightly to strongly incurved at their distal end. Sartenaer (1961d, p. 7) mentioned that the junction of the outer plates of the hinge plate with the borders of the septalium is usually marked by a distinct ridge. Sartenaer (1961e, p. 6) suggested that this ridge might indicate the presence of a connectivum. This has been confirmed, because since that time fourteen specimens of *P. dumonti* and twenty specimens of *P. omaliusi* have been sectioned; in one specimen of each species a covered septalium was present. A connectivum is also present in some specimens of the species described in this paper: *P. contractiformis* and *P. septentrionalis*. The connectivum has often a median longitudinal crest.

Comparisons. The genus *Camarotoechia* Hall and Clarke, 1893, as revised by Sartenaer (1961c), has nothing in common with the genus *Ptychomaletoechia*. Binnekamp (1965, p. 29), in describing lower Devonian brachiopods, states that "Our knowledge of this (*Camarotoechia*) genus is still incomplete. Since its type material consists exclusively of internal moulds, the possible existence of a covering of the septalium cannot be established." When present, however, the dissolved connectivum leaves a cavity that may often be seen on internal moulds; moreover, various techniques allow internal moulds to be filled and serial sectioned. In fact, the genus *Camarotoechia* is defined by many characters, both external and internal.

Sartenaer (1961e, p. 4) compares *Ptychomaletoechia* and the lower Givetian genus *Cupularostrum*.

Some similarities to and differences from the genera *Ripidiorhynchus* and *Sinotectirostrum* have been considered under the description of the latter genus. The problem is more fully considered by Sartenaer (1966, pp. 6, 7).

Stratigraphic position and geographic distribution. Species definitely referred to the genus are found in Europe, North America, and Asia. The genus extends from the lower part (except the lowermost beds) of the lower Famennian to the lower part of the upper Famennian.

Ptychomaletoechia contractiformis nov. sp.

Plate XV, figures 1–3, 5–9; Text-figure 34

1922. *Camarotoechia contracta*—HUME, p. 71B;
1945. *Camarotoechia*—HUME and LINK, p. 38;
1953. *Camarotoechia*—CRICKMAY, p. 11;
1954. *Camarotoechia*—HUME, p. 46;
1956. *Camarotoechia* cf. *contracta* (Hall)—WARREN and STELCK, pl. XXVI, figs. 25–34;
1956. a species of *Camarotoechia*—WARREN and STELCK, p. 6;
1957. *Camarotoechia* sp.n.—CRICKMAY, p. 1;
[e.p.] 1962. "*Camarotoechia*"—BELYEA and McLAREN, p. 10.

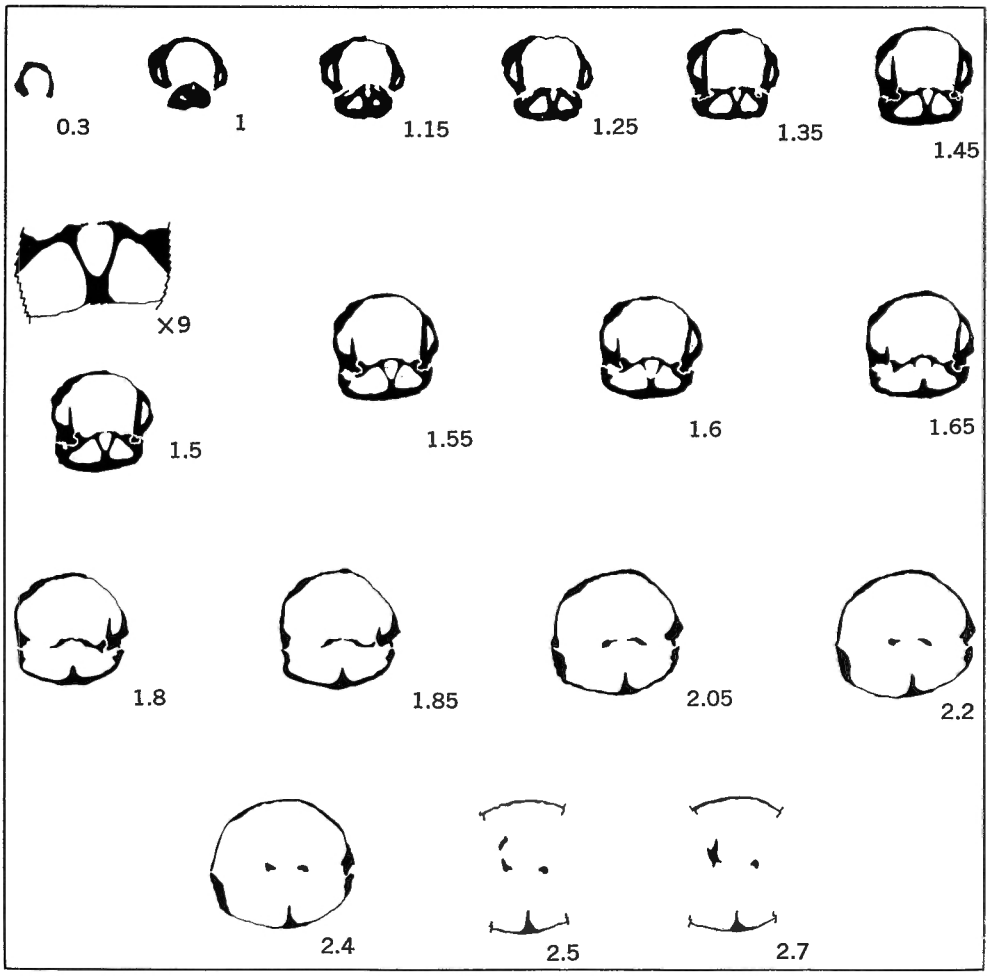
From the species *Atrypa contracta* Hall, 1843, with which it has commonly been confused.

Types

Holotype, GSC No. 15926 (Pl. XV, figs. 1a–e); paratypes A, GSC No. 15927 (Pl. XV, figs. 2a–e); B, GSC No. 15928 (Pl. XV, figs. 5a–c); C, GSC No. 15929 (Pl. XV, figs. 6a–c). GSC loc. 38695. Collector: P. Sartenaer, 1959.

Paratype D. GSC No. 15930 (Pl. XV, figs. 3a–e). GSC loc. 38716. Collector: P. Sartenaer, 1959.

Paratypes E, GSC No. 15931 (Pl. XV, figs. 7a–e); F, GSC No. 15932 (Pl. XV, figs. 9a–d). GSC loc. 7186. Collector: G.S. Hume, 1921.



TEXT-FIGURE 34. *Ptychomaletoechia contractiformis* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype H, GSC No. 15934 (l:11.0 mm; w:12.0 mm; t:9.0 mm).

Paratype G. GSC No. 15933 (Pl. XV, figs. 8a–c). GSC loc. 6962. Collector: E. J. Whittaker, 1921.

Paratype H. GSC No. 15934 (Text-fig. 34). GSC loc. 6493. Collector: E. M. Kindle, 1919.

Material

Blackstone River, N.W.T.: GSC loc. 21965 (32). Jean-Marie River, N.W.T.: GSC loc. 7315 (14). Kakisa River, N.W.T.: GSC loc. 30546 (4). Mackenzie River, N.W.T.: GSC locs. 5721 (15), 5723 (14), 5724 (1), 7149A (2), 7149C (1), 7149E (10), 26756 (4), 38693 (4), 38694 (8), 38695 (85), 38697 (50). North Nahanni River valley, N.W.T.: GSC locs. 7163 (1), 7164 (4), 33317 (2), 33328 (3), 33457 (3), 43840 (2). Redstone River, N.W.T.: GSC locs. 32989 (29), 33000 (7). Root River valley, N.W.T.: GSC locs.

6493 (33), 7169 (1), 7180 (7), 7186 (37), 12837 (1), 22534 (2), 22547 (1), 26759 (8), 33385 (3), 38691 (3), 38716 (9), 38722 (3). Trout River, N.W.T.: GSC locs. 6961 (1), 6962 (50), 30579 (3), 30581 (3), 30584 (3), 30589 (1), 30595 (20), 30599 (1), 30608 (8), 30769 (1).

Two fifths of the material are in satisfactory state of preservation.

Description

The species is small. The contour, in dorsal view, is generally transversally subelliptical to subrounded, exceptionally longitudinally subelliptical. The commissure is sharp and clearly indented by the costae. Postero-lateral margins are concave near the commissure.

Pedicle valve. The umbonal region is somewhat inflated. The flanks slope gently towards the commissure, but more sharply towards the postero-lateral commissures where the valve becomes concave.

The well marked sulcus begins at a distance from the beak varying between 40 and 50 per cent of the length of the shell or between 32 and 38 per cent of the unrolled length of the valve, and widens and deepens slowly. It is moderately deep and its width at the front varies between 60 and 70 per cent of the width of the shell, most of the values being near 60 per cent. The bottom of the sulcus is flat to slightly convex.

The trapezoidal tongue, with sharp borders, is moderately high; its upper part becomes vertical in the thickest specimens.

The beak is suberect to erect, projecting, does not overhang the hinge line, and is resorbed by a circular foramen. The interarea is narrow and very poorly delimited; its height varies around 1 mm. Deltidial plates are rarely seen, and are best observed in transverse serial sections.

Brachial valve. Flanks slope progressively towards the lateral commissures with a steepness in relation to the thickness of the valve. The flanks become steep and concave towards the postero-lateral commissures.

The well marked and high fold starts at some distance forward of the beak; its top is flat to slightly convex. The greatest thickness of the valve may be at the front, but is more commonly somewhat posterior to it.

Ornament. The general costal formula is 3/2 to 4/3; 0 to 1/1–1/1; 7/8 to 13/14.

Median costae, counted on 206 specimens, show the following distribution:

	Trout River		Jean-Marie River		Blackstone River		Mackenzie River		North Nahanni River		Root River		Redstone River		Totals	
Number of costae	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%
2/1	1	5.55					1	1.70			2	2.70			4	2.—
3/2	3	16.65	4	44.45	4	17.40	18	30.50			30	40.55	3	18.75	62	30.—
4/3	11	61.15	5	55.55	11	47.80	28	47.45	7	100.—	32	43.25	11	68.75	105	51.—
5/4	2	11.10			5	21.75	11	18.65			6	8.10	2	12.50	26	12.5
6/5	1	5.55			3	13.05	1	1.70			4	5.40			9	4.5
	18	100.—	9	100.—	23	100.—	59	100.—	7	100.—	74	100.—	16	100.—	206	100.—

Median costae are simple, of moderate height and start at the beaks. They are regular, but often one or two external costae are lower than the others. They are commonly 1.5 to 2 mm wide at the front. Dorsal median costae are rounded to rounded and flat near the beaks and become angular with rounded top towards the front; ventral median costae are rounded and flat on their whole length.

Parietal costae occur in about 80 per cent of all specimens. With rare exceptions, they do not indent the borders of the tongue; they show the following distribution:

	Trout River		Jean-Marie River		Blackstone River		Mackenzie River		North Nahanni River		Root River		Redstone River		Totals	
Number of costae	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%
0	1	5.90	2	22.25	3	13.65	12	24.50			14	18.90	5	33.35	37	19.15
0-1/0-1 or 1-0/1-0					1	4.55	8	16.30			15	20.30	4	26.65	28	14.50
1-1/1-1	16	94.10	7	77.75	17	77.25	26	53.05	7	100.—	41	55.40	6	40.—	120	62.20
1-2/1-2							1	2.05			2	2.70			3	1.55
2-2/2-2					1	4.55	2	4.10			2	2.70			5	2.60
	17	100.—	9	100.—	22	100.—	49	100.—	7	100.—	74	100.—	15	100.—	193	100.—

Lateral costae, counted on 148 specimens, show the following distribution:

	Trout River		Jean-Marie River		Blackstone River		Mackenzie River		North Nahanni River		Root River		Redstone River		Totals	
Number of costae	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%	Number of spec.	%
3/4											1	1.65			1	0.5
4/5							3	7.50							3	2.—
5/6							1	2.50			1	1.65			2	1.5
6/7							7	17.50			8	13.35			15	10.—
7/8							8	20.—	2	28.55	16	26.65	3	42.85	29	19.5
8/9	1	11.10			1	5.90	3	7.50			9	15.—			14	9.5
9/10	1	11.10	1	12.50	2	11.75	6	15.—			6	10.—	2	28.55	18	12.—
10/11	4	44.50	3	37.50			3	7.50			8	13.35			18	12.—
11/12	1	11.10	1	12.50	2	11.75	5	12.50	2	28.55	5	8.35	1	14.30	17	11.5
12/13	1	11.10	1	12.50	4	23.50	1	2.50			3	5.—	1	14.30	11	7.5
13/14	1	11.10	2	25.—	5	29.40	1	2.50	2	28.55	3	5.—			14	9.5
14/15					1	5.90			1	14.35					2	1.5
15/16					1	5.90	1	2.50							2	1.5
16/17					1	5.90	1	2.50							2	1.5
	9	100.—	8	100.—	17	100.—	40	100.—	7	100.—	60	100.—	7	100.—	148	100.—

Lateral costae are simple, low, and start at the umbones. They are regular, with few exceptions. The costae are rounded and flat, but the ventral costae are angular with rounded top anteriorly. The numbers given for the lateral costae must be considered as minimal, because the most external lateral costae are often worn.

Dimensions. Measurements of eight specimens:

in mm	Paratype A	Holotype	Paratype B	Paratype C	Paratype D	Paratype F	Paratype E	Paratype G
l	11.0	11.0	10.2	9.9	9.9	9.3	7.7	7.7
w	12.5	12.3	11.1	11.3	11.1	10.0	8.6	7.7
lpv unrolled	17.5	17.0	14.0	15.5	15.3	10.5	9.0	8.5
t	10.2	9.4	8.2	8.9	9.2	4.8	4.1	3.8
tpv	2.9	3.7	2.8	2.9	2.8	2.2	1.9	1.3
tbv	7.3	5.7	5.4	6.0	6.4	2.6	2.2	2.5
l/w	0.88	0.89	0.92	0.87	0.90	0.93	0.89	1.00
t/w	0.82	0.76	0.74	0.79	0.83	0.48	0.48	0.49
t/l	0.93	0.85	0.80	0.90	0.93	0.52	0.53	0.49
shoulder angle	107°	103°	104°	103°	105°	(102°)	102°	90°

The holotype and paratypes A to D are adult specimens; paratypes E and G are juvenile forms; paratype F is a specimen which retains juvenile characters.

The l/w ratio of adult specimens explains the transversally elliptical contour.

In adult specimens the value of the shoulder angle varies around 105 degrees.

Internal characters. The dental plates are divergent posteriorly, becoming parallel anteriorly; they are short, stout, and widely separated. The ventral umbonal cavities are well marked, but reduced by shell thickening in the apical region. The teeth are very short, strong, and crenulated on their dorsal face. The denticula are clearly indicated.

The deep amphora-shaped septalium is supported by a long and strong septum (three to four tenths of the unrolled length of the brachial valve) and covered, in its anterior part, by a connectivum with a median longitudinal crest. The outer hinge plates are concave. The dental sockets are wide and crenulated. The crura are supported by strong crural bases, they become Phrygian cap-shaped (in transverse serial sections) and are slightly incurved distally.

Transverse serial sections indicate low relief of the ventral muscle field.

Growth. Measurements of juvenile specimens have been given above.

Some low values of the shoulder angle (90 degrees) have been measured on juvenile specimens, but such specimens are rare.

Juvenile characters are normal: no recognizable sulcus and fold, pedicle valve thicker than the brachial valve, no tongue, small thickness.

Discussion

Synonymy. Crickmay (1957) was the first to suggest that this form might be a new species.

Only part of Belyea and McLaren's (1962) "*Camarotoechia*" are put into synonymy because specimens of *Sinotectirostrum mackenziei* occur at the same level.

It should be noted that Kindle identified specimens as *Camarotoechia contracta, C.* cf. *contracta,* and *C. contracta?* in collections GSC locs. 5721, 5723, 5724.

Comparisons. The species is distinguished by a somewhat inflated ventral umbonal region, regular costae, the general costal formula, parietal costae common, sulcus not starting near the beak.

The species is not easily confused with *Atrypa contracta* Hall, 1843. Records of that species from the Givetian to the Famennian outside the type area in New York State are commonly incorrect.

Ptychomaletoechia contractiformis is similar to *Camarotoechia contracta* (Hall) in the Three Forks Formation of Montana (Raymond, 1909; Haynes 1916b) and Idaho (Baldwin, 1943) by size, trapezoidal tongue with sharp borders becoming vertical in its upper part, erect to suberect projecting ventral beak, bottom of the wide sulcus flat to slightly convex, postero-lateral commissures very sharp, simple costae starting at the beaks. The Three Forks form differs in many characters, namely: systematically more transversally elliptical contour; ventral umbonal region not inflated and, thus, postero-lateral commissures lower; less convex ventral flanks and, thus, antero-lateral commissures notably lower; sulcus deeper, often beginning nearer to the beak; sulcus widens and deepens more rapidly; width of the sulcus at the front usually higher, although similar values exist; higher tongue; well marked spurs at the junction of the sulcus and the ventral flanks at the front; upper part of the tongue recurved posteriorly in the thickest specimens; clearly delimited and wide ventral interarea; greatest thickness of the shell always at the front; different general costal formula (tendency of the median costae towards higher values, ⅔ being the commonest ratio; parietal costae rare, indenting or not indenting the borders of the tongue; lower number of lateral costae); more angular costae; higher values of the shoulder angle. The internal characters of the Three Forks Formation form have not been investigated.

The Ouray limestone specimens described by Girty (1900) and Kindle (1909) are considered by Haynes (1916b, p. 43) as apparently identical with those of the Three Forks Formation of Montana; they have not been examined because sufficient material is not available.

The differences distinguishing *P. contractiformis* from *Camarotoechia sobrina* Stainbrook, 1947 of the Bella Member (upper member of the Percha Formation) in New Mexico are identical to those that separate the Three Forks Formation form from the former species. It is highly probable that a study based on abundant collections would show that the Three Forks Formation form belongs to that species. Raymond (1909, p. 142) doubted the identification of the Three Forks Formation form as *C. contracta.*

Camarotoechia nitidula Stainbrook, 1950, from the Aplington Formation of Iowa, is easily separable from *Ptychomaletoechia contractiformis* by shape, greater shoulder angle, higher number of median costae, etc. *Camarotoechia lauta* Stainbrook, 1950, from the same formation, is distinguishable from *Ptychomaletoechia contractiformis* by the same characters as the Three Forks Formation form discussed above, with the exception of the shoulder angle that has often similar values, and the spurs at the front that are not so well marked.

Ptychomaletoechia omaliusi (Gosselet, 1877) is the closest species to *P. contractiformis,* with most features in common. Nevertheless, *P. omaliusi* is easily separable by its general costal formula: 5/4 for median costae; rare parietal costae; less numerous lateral costae.

At present under study, are various species under the term "*Rhynchonella letiensis* Gosselet, 1879".

Ptychomaletoechia contractiformis resembles some species identified in the literature as *Camarotoechia letiensis,* but may be separated from all of them, although it is close to forms from Belgium and France at a similar stratigraphic level. *Ptychomaletoechia contractiformis* is different, however, from the topotypical material of *Camarotoechia letiensis.*

Stratigraphic position. Specimens collected on Blackstone River are from Douglas and Norris' (1960) map-unit 26.

On Jean-Marie and Middle Kakisa Rivers, the species is found in the Trout River Formation.

The collections from the Mackenzie River made by Hume, Kindle, and Sartenaer are from a single outcrop and may be located with great accuracy (Douglas and Norris' (1961) map-unit 22). Specimens are abundant at the top of the *Eoparaphorhynchus maclareni* Zone and fewer below; they are rare in the base of the *Basilicorhynchus basilicus* Zone. Warren and Stelck's (1956) *Camarotoechia* cf. *contracta* has been collected at Camsell Bend in what they called the *Nudirostra walcotti* fauna. This is probably from the same outcrop, mentioned above.

The well known outcrop in the Yohin syncline (North Nahanni River valley) has furnished collections for Hume, McLaren, Pedder, and Sartenaer. The specimens are from Douglas and Norris' (1961) map-unit 21 in the upper part of the *Eoparaphorhynchus maclareni* Zone and the lower part of the *Basilicorhynchus basilicus* Zone. Collections from GSC loc. 7163 contain both *Ptychomaletoechia contractiformis* and forms that occur only in the *Athyris angelica* Zone; this association is presumably due to mixing at some time subsequent to their collection in the field. The collection from Carlson Lake (Douglas and Norris' (1961), map-unit 21) is from above the *Eoparaphorhynchus maclareni* Zone.

Specimens from the Redstone River occur in the Imperial Formation in the upper part of the *Eoparaphorhynchus maclareni* Zone.

The only outcrop on Root River on which precise information exists has yielded collections to Bath, Hume, Hudson's Bay Oil Co., Kindle, McLaren, and Sartenaer. Specimens are from *Eoparaphorhynchus maclareni* Zone in Douglas and Norris' (1961) map-unit 22.

Specimens from the Trout River occur in the Tetcho and Trout River Formations as much as 55.9 feet below the top of the latter formation. The highest specimens in the Tetcho Formation are in the *Basilicorhynchus basilicus* Zone, and Whittaker's (1922) abundant collection from the zones o and p is immediately below the *B. basilicus* Zone.

In short, the species has been found in the *Eoparaphorhynchus maclareni* Zone (very abundant in the upper part) and in the *Basilicorhynchus basilicus* Zone (chiefly in the lower part).

Geographic distribution. The species is restricted to the N.W.T., where it has been found on the Blackstone, Jean-Marie, Kakisa, Mackenzie, North Nahanni, Redstone, Root and Trout Rivers.

Ptychomaletoechia sulculifera nov. sp.

Plate XVI, figures 1–10; Text-figure 35

1927. *Camarotoechia horsfordi* (Hall)—WARREN, pp. 19, 20;
1928. *Camarotoechia horsfordi* (Hall)—WARREN, p. 113;
1929. *Camarotoechia horsfordi* (Hall)—KINDLE, p. 187;
1932. *Camarotoechia horsfordi* Hall—ALLAN, WARREN, and RUTHERFORD, p. 235;
1933. *Camarotoechia horsfordi* (Hall)—WARREN, p. 151;
1942. *Camarotoechia horsfordi* (Hall)—WARREN, p. 132;
1949. *Camarotoechia horsfordi* Hall—WARREN, p. 568;
1950. *Camarotoechia horsfordi* (Hall)—WARREN and STELCK, p. 64;
1950. *Camarotoechia horsfordi* (Hall)—de WIT and McLAREN, p. 11;
1951. *Camarotoechia horsfordi* Hall—FOX, p. 842;
1954. *Camarotoechia horsfordi* Hall—FOX, p. 129;
1954. *Camarotoechia sobrina* Stainbrook—McLAREN, p. 173;
1955. *Camarotoechia* sp.—McLAREN, pp. 27, 46, line 22 (*coet. excl.*);
1956. *Camarotoechia* cf. *C. sobrina* Stainbrook—BELYEA and McLAREN, p. 89;
1956. *Camarotoechia horsfordi* (Hall)—WARREN and STELCK, pl. XXVII, figs. 7, 8;
1958. *Camarotoechia* cf. *sobrina* Stainbrook—TAYLOR, p. 15;
1962. *Camarotoechia nordeggi* Kindle—McLAREN *in* MOUNTJOY, p. 28, line 21 (*coet. excl.*);
[?] 1964. "*Camarotoechia*" sp.—McLAREN *in* BELYEA and McLAREN, p. 796.

Sulculus (Latin, masc.)=small furrow; suffix *fer, fera, ferum* (Latin); to draw attention to the occasional occurrence of a deep furrow on the fold.

Types

Holotype, GSC No. 15935 (Pl. XVI, figs. 1a–e); paratype A, GSC No. 15936 (Pl. XVI, figs. 2a–e). GSC loc. 24566. Collector: A. N. Thomas, 1954.

Paratypes B, GSC No. 15937 (Pl. XVI, figs. 3a–e); C, GSC No. 15938; D, GSC No. 15939. GSC loc. 19973. Collector: D. J. McLaren, 1951.

Paratype E. GSC No. 15940 (Pl. XVI, figs. 4a–e). GSC loc. 7878. Collector: P. S. Warren.

Paratype F. GSC No. 15941 (Pl. XVI, figs. 5a–e). GSC loc. 8775. Collector: E. M. Kindle, 1927.

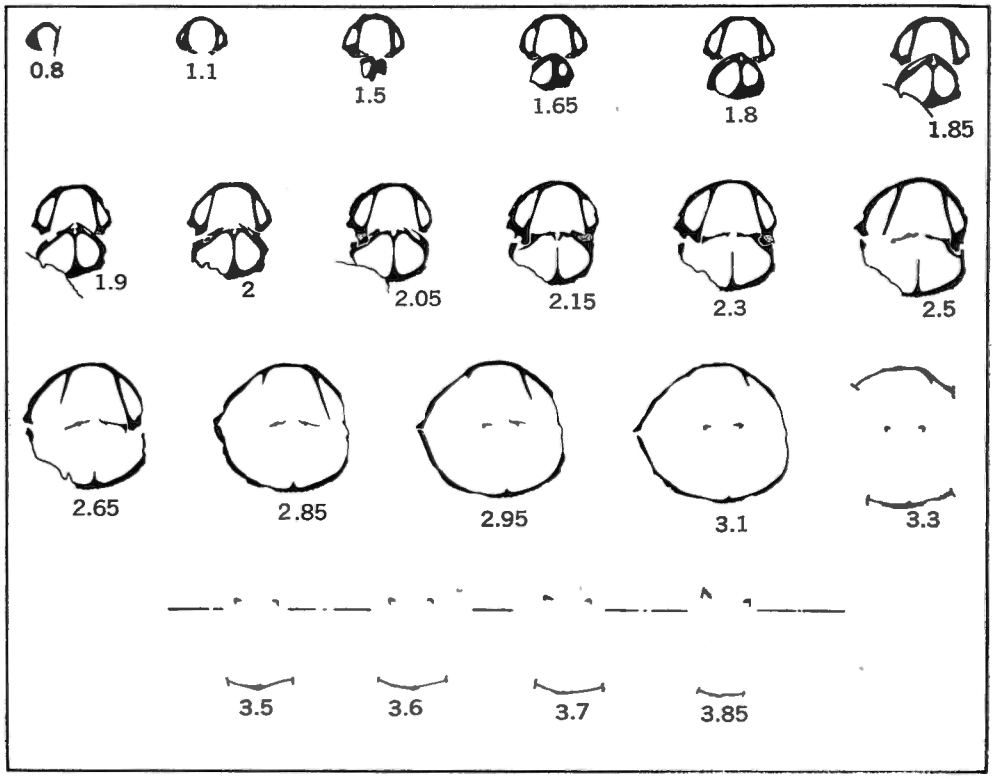
Paratypes G, GSC No. 15942 (Pl. XVI, figs. 7a, b); H, GSC No. 15943 (Pl. XVI, figs. 6a–d); I, GSC No. 15944 (Pl. XVI, figs. 9a–d); J, GSC No. 15945 (Pl. XVI, figs. 8a, b). GSC loc. 38825. Collectors: H. R. Belyea, M. J. Copeland, and P. Sartenaer, 1959.

Paratype K. GSC No. 15946 (Pl. XVI, figs. 10a, b; Text-fig. 35). GSC loc. 19959. Collector: D. J. McLaren, 1951.

Material

GSC localities in the Canadian Rocky Mountains: 7878 (7), 8769 (1), 8772 (7), 8775 (11), 11188 (1), 19623 (1), 19959 (7), 19961 (4), 19973 (14), 24409 (6), 24544 (4), 24566(11), 32313 (1), 38825 (7), 38836 (2), 38840 (11), 40195 (1), 40205 (2), 40741 (10), 43333 (9), 45887 (1), 45935 (1), (49560 (1)), 65089 (1).

Half of the specimens are in satisfactory state of preservation.



TEXT-FIGURE 35. *Ptychomaletoechia sulculifera* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype K, GSC No. 15946 (l:12.1 mm; w:? mm; t:9.6 mm).

Description

The species is small-sized, to rarely medium sized. The contour, in dorsal view, is generally subrounded, sometimes slightly transversely subelliptical. The commissure is sharp and deeply indented by the costae, but sharpness of the lateral commissures may be lessened by the deflection of the borders of the flanks. Postero-lateral margins are concave near the commissure.

Pedicle valve. The umbonal region is well marked, and may be somewhat inflated. Flanks slope gently towards the commissure, more steeply towards the postero-lateral commissures where the valve becomes concave. Sometimes the margins of the flanks are vertical and the ends of the costae geniculated.

The sulcus starts imperceptibly between 45 and 60 per cent of the length of the shell forward of the beak. The sulcus widens slowly; where it starts, its width is more than half its maximum width at the front, which varies between 53 and 64 per cent of the width of the shell. The sulcus is moderately deep to deep, and well marked. Its floor is wide, and flat to slightly convex. The sides are characterized by distinctive parietal costae (*see* Ornament).

The borders of the trapezoidal tongue are sharp and not indented by the costae. The upper part of the tongue is either vertical or slightly recurved posteriorly. Sometimes the

median part of the tongue protrudes beyond its borders. The suberect to erect beak projects. The minute rounded foramen was observed in only one specimen, at the extremity of the beak. The interarea is high and clearly delimited. Its length varies between 46 and 56 per cent of the width of the shell. The deltidial plates are wide, low and triangular, leaving the largest part of the delthyrium open; they are best observed in transverse serial sections.

Brachial valve. The valve is high with slopes increasing in steepness towards the commissure. Generally the margins of the flanks are deflected more or less vertically giving the shell the shape of half a barrel in frontal view.

The fold is moderately high and well marked, with flat to slightly convex top. It starts some distance from the beak, but somewhat nearer to it than the sulcus. The aspect of the fold's costae is characteristic of the species (*see* Ornament). The greatest thickness of the valve is somewhat posterior to the frontal commissure.

Ornament. The general costal formula is 4/3 to 5/4; 1/1-1/1 to 3/3-3/3; 8/9 to 15/16.

The ratios of median and parietal costae are distributed as follows:

Median + parietal			Median			Parietal		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
5/4	3	5.45	3/2	2	4.–	1–1/1–1	7	14.30
6/5	4	7.30	3/3	1	2.–	1–1/2–1	2	4.05
7/6	5	9.10	4/3	31	62.–	1–2/1–2	2	4.05
8/7	15	27.25	5/3	1	2.–	2–2/2–2	18	36.75
9/8	11	20.–	5/4	12	24.–	3–2/3–2, 2–3/2–3	7	14.30
10/9	15	27.25	6/5	3	6.–	3–3/3–3	13	26.55
11/10	2	3.65						
	55	100.–		50	100.–		49	100.–

Median costae are simple, of moderate height, and start at the beaks. They widen quickly producing a fan-shaped arrangement and usually reach a width of 1.5 to 2 mm at the front. Median costae are angular but are commonly worn. Costae in the sulcus are lower and less angular than those on the fold. In two out of five specimens there is a wider and deeper median furrow on the fold. Rarely it may be off-centre, which gives a distorted appearance (Pl. XVI, fig. 10) to the adjoining costae. Usually a wider costa corresponds to this furrow in the sulcus. Most median costae are regular (i.e., in width, thickness, elevation); they are wider than the parietal costae.

Parietal costae are simple and characteristically do not indent the borders of the tongue; they start at the beaks.

The lateral costae could be counted only in thirty-four specimens, but the state of preservation may affect the following figures: 8/9: 4 sp.; 9/10: 2 sp.; 10/11: 2 sp.; 11/12: 2 sp.; 12/13: 2 sp.; 13/14: 5 sp.; 14/15: 5 sp.; 15/16: 5 sp.; 16/17: 1 sp.; 17/18: 3 sp.; 18/19: 1 sp.; 20/21: 1 sp.; 21/22: 1 sp. Lateral costae are simple, low, and start at the umbones. They are angular, especially the ventral costae at the front, where they form spurs.

Sometimes costae are geniculated near the commissure; in those cases, the commissure does not protrude; this geniculation is especially common at the frontal commissure.

Dimensions. Measurements of seven specimens:

in mm	Paratype G	Paratype D	Paratype E	Holotype	Paratype A	Paratype B	Paratype C
l	(16.2)	13.8	13.8	13.2	11.8	11.8	11.8
w	(18.7)	17.4	16.8	14.4	14.2	13.8	13.6
tpv unrolled	26.5	20.0	18.5	21.5	18.5	19.5	19.0
t	15.1	9.9	14.4	11.8	11.7	11.7	10.4
tpv	3.5	2.2	3.2	3.4	2.7	2.7	2.8
tbv	11.6	7.7	11.2	8.4	9.0	9.0	7.6
l/w	(0.87)	0.80	0.81	0.92	0.83	0.86	0.87
t/w	(0.81)	0.57	0.85	0.82	0.82	0.85	0.76
t/l	(0.93)	0.71	1.04	0.89	0.99	0.99	0.88
shoulder angle	(105°)	108°	(106°)	97°	107°	110°	105°

Paratype D is exceptionally flat.

The greatest width of the shell is located around the two thirds of the length from the beak.

Internal characters. The dental plates are divergent posteriorly becoming progressively parallel, then convergent anteriorly. The umbonal cavities are large. The slender dental plates support short and strong teeth crenulated on their dorsal face. The denticula are clearly indicated.

The septalium is moderately deep and supported by a long septum. In the only specimen sectioned no connectivum has been observed, but slender lamellae at the junction of the outer plates and the septalium suggest its existence. The outer plates are concave. The dental sockets are wide and crenulated. The crura are Phrygian cap-shaped in transverse serial sections.

The ventral muscle field has been observed in paratype B (Pl. XVI, fig. 3b) and is vaguely delimited with low relief; its width corresponds to 45 per cent of the width of the shell and its length to 70 per cent of the length of the shell. The various muscle scars cannot be distinguished.

The dorsal muscle field is vaguely observable on paratype G.

Growth. The species has a non-constant and monocyclic curvature growth.

in mm	Paratype J	Paratype I	Paratype F
l	(12.5)	10.2	(9.2)
w	13.1	10.3	11.5
lpv unrolled	17.0	12.0	(15.0)
t	7.5	4.8	8.2
tpv	2.9	2.3	2.3
tbv	4.6	2.5	5.9
l/w	(0.95)	1.00	(0.80)
t/w	0.57	0.47	0.71
t/l	(0.60)	0.47	(0.89)
shoulder angle	(105°)	95°	?

Paratype F is a juvenile form having developed an appreciable thickness; paratype J is an adult specimen with some juvenile characters. Juvenile characters are: sulcus and fold not developed; parietal costae cannot be separated from the others, and indent the com-

missure; thicknesses of the valves similar; thickness proportionately smaller and consequently tongue scarcely marked. The shoulder angle of juvenile forms is not known.

Discussion

Synonymy. Specimens identified in the literature as *Camarotoechia horsfordi* belong to this species. De Wit and McLaren (1950, p. 11) drew attention to the probable incorrectness of this identification.

The specimen identified as *"Camarotoechia"* sp. by McLaren (*in* Belyea and McLaren, 1964) is fragmental, but belongs probably to *Ptychomaletoechia sulculifera.*

Comparisons. The species is distinguished by subrounded contour, sulcus starting some distance forward of the beak, general costal formula, median costae wider than other costae, and occasional deep and wide furrow in the fold.

Apart from the size, and sometimes the gibbosity, there are few similarities between *P. sulculifera* and *Rhynchonella horsfordi* Hall, 1860. The New York State species is recognizable by its shallow sulcus and low fold, generally fewer median costae, rare single parietal costae, complete absence of a wide furrow on the fold.

Camarotoechia sobrina Stainbrook, 1947 from the Bella Member (upper member of the Percha Formation) is easily separated from *Ptychomaletoechia sulculifera* by the following characters: transversely elliptical contour; lateral commissure lower in the shell; less convex ventral flanks; sulcus deeper, beginning often nearer to the beak; sulcus widening and deepening more rapidly; higher tongue; greatest thickness of the shell always at the frontal commissure; parietal costae rare; median costae regular; costae more angular; larger shoulder angle.

By its shape and size *P. sulculifera* resembles *P. omaliusi* (Gosselet, 1877), but the Belgo-French species may be easily distinguished by nearly constant number of median costae (5/4 (and 4/5)); fewer lateral costae; the absence of a furrow on the fold; parietal costae generally absent, and single when present.

Resemblances with *Sinotectirostrum banffense banffense* are numerous: aspect of costae, notably the parietal ones; general shape; depth of sulcus; height of fold. However, the smaller size and the number and distribution of costae in *Ptychomaletoechia sulculifera* make it easily separable. Also the latter has a narrower sulcus at the front, is often proportionately higher, with commonly a smaller shoulder angle and, in two specimens out of five, a deep furrow on the fold (such a furrow is exceptional in *Sinotectirostrum banffense banffense*).

Stratigraphic position. According to the information found in the literature, the species has been collected in: "upper part of the Minnewanka limestone" [= upper part of the Palliser Formation], "upper division of the Minnewanka limestone", "throughout most of the upper part of the Minnewanka limestone", "upper beds of the Minnewanka limestone", "in the upper 500 feet of the Minnewanka formation and especially abundant in the uppermost beds", "upper 600 feet to 800 feet of the Minnewanka", "upper beds of the Palliser formation", "Palliser formation", "top of Palliser", "base of Palliser Formation".

Precise stratigraphic information concerning the collections is as follows: 96 feet (GSC loc. 38836), 100 feet (GSC loc. 24566), 145 feet (GSC loc. 18266), 165 feet (GSC locs. 38825, 38840), 183 feet (GSC loc. 24409) above the base of the Palliser Formation; between 74 feet and 330 feet (GSC loc. 19623) above the base of the Palliser Formation; 248.5 feet to 263.5 feet (GSC loc. 24544), between 477 feet and 519.5 feet (GSC loc. 19961), between 448.5 feet and 477 feet (GSC loc. 19973), between 422.5 feet and 448.5 feet (GSC loc. 19959) below the top of the Palliser Formation. The information for the fragmental specimen (GSC loc. 49560) identified as *"Camarotoechia"* sp. by McLaren *in* Belyea and McLaren (1964) is: basal three feet of the Palliser Formation.

Thus, the species is found in the lower and middle part of the Palliser Formation.

One specimen (GSC loc. 45887) has been collected in the Upper Sassenach Formation; another one (GSC loc. 45935) derives from the lower 11 feet of a 23-foot thick Sassenach Formation.

Geographic distribution. The species is known in the Canadian Rocky Mountains between Winnifred Pass in the north and Fernie map-area (west half) in the south at Devonian Mountain, Blue Creek map-area (west half), The Ancient Wall, Mount Rajah, The Palisade, Maligne River valley, Proposal Mountain, Cardinal Mountain, Deception Creek (Sunwapta Pass), Bighorn Range, Tay River map-area, Sulphur Mountain, Kananaskis Lake map-area (west half), Crowsnest Pass.

Ptychomaletoechia serva nov. sp.

Plate XI, figures 10–13; Text-figure 36

1922. *Camarotoechia*—WHITTAKER, p. 52B.

Serva (Lat., fem.) =female slave; after Great Slave Lake.

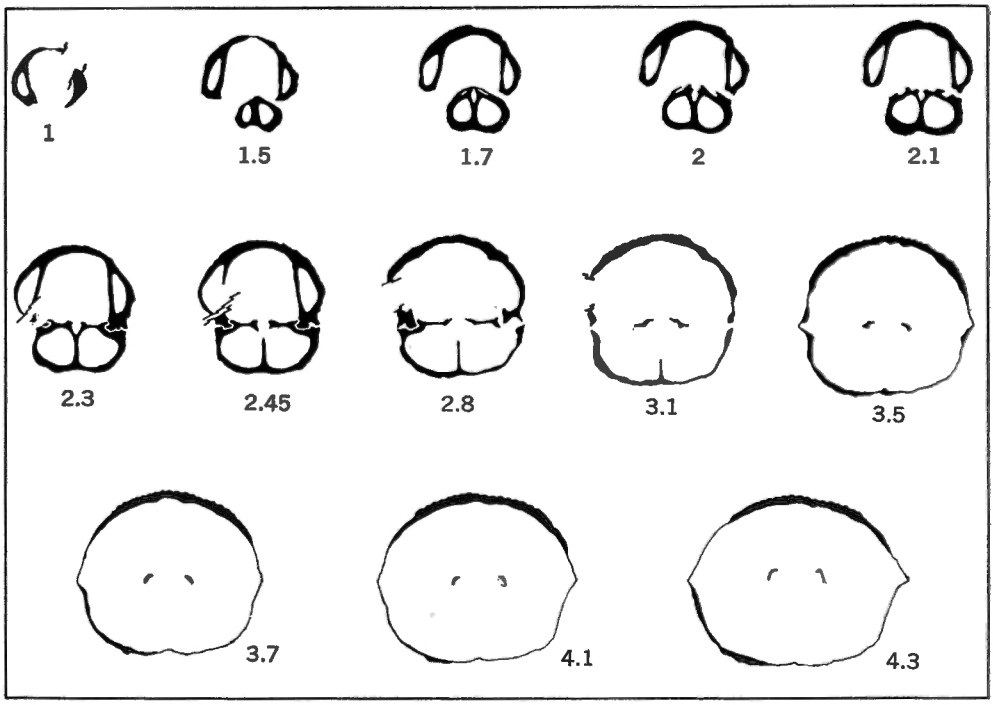
Types

Holotype. GSC No. 15947 (Pl. XI, figs. 10a–e). Paratypes A, GSC No. 15948 (Pl. XI, figs. 11a, b); B, GSC No. 15949 (Pl. XI, figs. 12a, b). GSC loc. 6959. Collector: E. J. Whittaker, 1921.

Paratype C. GSC No. 15950 (Pl. XI, figs. 13a, b). GSC loc. 7283. Collector: E. J. Whittaker, 1922.

Paratype D. GSC No. 15951. GSC loc. 6962. Collector: E. J. Whittaker, 1921.

Paratype E. GSC No. 15952 (Text-fig. 36). GSC loc. 31544. Collector: D. F. Stott, 1957.



TEXT-FIGURE 36. *Ptychomaletoechia serva* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype E, GSC No. 15952 (l:13.9 mm; w:15.2 mm; t:10.9 mm).

Material

GSC locs. in N.W.T.: Jean-Marie River, 7303 (1); Kakisa River, 17486 (1); Redknife River (15), 7283 (9), 30568 (6); Trout River (16), 6956 (3), 6959 (12), 6962 (1); Rabbit Lake area (41): 31544 (40), 31545 (1).

About one quarter of the material is in satisfactory state of preservation.

Description

This species is represented by few well preserved specimens and precise stratigraphic information is lacking for most of the material. Constant differences from other species of the genus and of *Sinotectirostrum* can be established, but larger collection would be desirable.

The species is similar in many respects to *Ptychomaletoechia sulculifera*. It differs in the following characteristics: sulcus usually shallower; width at the front somewhat greater (64 to 67 per cent); height proportionally less; top of the brachial valve at the frontal commissure in the few specimens in which it could be observed; no median furrow on the fold, and, thus, no distortion of the costae; median costae are regular, never with a fan-shaped arrangement.

Ornament. The general costal formula is 5/4 to 6/5; 1/1-1/1 to 3/3-3/3; 14/15 to 16/17.

The ratios of costae are distributed as follows:

Median + parietal			Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
6/5	1	5.90	4/3	2	11.75	1–1/1–1	1	5.90	13/14	2	18.20
8/7	2	11.75	5/4	12	70.60	2–1/2–1	1	5.90	14/15	3	27.25
9/8	10	58.80	6/5	2	11.75	2–2/2–2	13	76.40	15/16	2	18.20
10/9	1	5.90	8/7	1	5.90	2–3/2–3	1	5.90	16/17	3	27.25
11/10	2	11.75				3–3/3–3	1	5.90	18/19	1	9.10
12/11	1	5.90									
	17	100.–		17	100.–		17	100.–		11	100.–

Dimensions. Measurements of five specimens. The holotype and paratypes A and D are adult specimens; paratype C is a juvenile form; paratype B is a specimen that retains juvenile characters.

in mm	Paratype D	Paratype A	Holotype	Paratype B	Paratype C
l	14.2	12.0	11.9	(9.9)	(7.4)
w	14.9	13.7	13.5	10.4	7.8
lpv unrolled	22.5	18.0	18.5	(14.0)	(7.5)
t	(12.3)	10.3	10.0	6.9	2.8
tpv	3.9	2.9	3.8	2.8	1.3
tbv	(8.4)	7.4	6.2	4.1	1.5
l/w	0.95	0.88	0.88	(0.95)	(0.95)
t/w	(0.83)	0.75	0.74	0.66	0.36
t/l	(0.87)	0.86	0.84	(0.69)	(0.38)
shoulder angle	100°	106°	100°	95°	105°

Internal characters. The internal characters are the same as for *Ptychomaletoechia contractiformis* with the following differences (based on serial sections made in one specimen): crura not Phrygian cap-shaped, but rather like a crescent or walking-stick in section distally.

No connectivum has been observed, but lamellae at the junction of the outer hinge plates and the septalium suggest its existence.

Muscle scars have not been observed. Transverse serial sections indicate a low relief of the ventral muscle field.

Discussion

Comparisons. The species is distinguished by regular costae and the general costal formula.

Most of the characters of the species are the same as in *P. omaliusi,* but the Belgo-French form has a more constant number of costae, fewer lateral costae, and parietal costae are rare.

Some of the poorly preserved specimens in the Lower Trout River Formation resemble—and may even belong—to *Sinotectirostrum mackenziei*; the only observable difference lies in the number of median costae.

Stratigraphic position. Precise stratigraphic information is only available for collections on Trout River where the species is found in the upper part of the Tetcho Formation, most of them from the upper 25 feet of the section.

In the other localities the specimens may be from the lower part of the Trout River Formation, although Whittaker, in his notebook, considers GSC loc. 7283 (Redknife River) as "corresponding to the fauna of the highest beds on Trout River."

The species appears to be present both in the *Basilicorhynchus basilicus basilicus* Subzone and the *Eoparaphorhynchus maclareni* Zone.

Geographic distribution. The species is known only in Upper Mackenzie River valley, in the Rabbit Lake area, and on Jean-Marie, Kakisa, Redknife, and Trout Rivers.

Ptychomaletoechia septentrionalis nov. sp.

Plate XIX, figures 3–6; Text-figures 37, 38

Septentrionalis, is, e (Latin)=north; occurrence in the Northwest Territories.

Types

Holotype. GSC No. 20621 (Pl. XIX, figs. 3a–e). GSC loc. 7158B. Collector: G.S. Hume, 1921.

Paratype A. GSC No. 20622 (Pl. XIX, figs. 6a–c). GSC loc. 7159. Collector: G.S. Hume, 1921.

Paratypes B, GSC No. 20623 (Pl. XIX, figs. 4a–e); C, GSC No. 20624. GSC loc. 7154. Collector: G. S. Hume, 1921.

Paratypes D, GSC No. 20625 (Pl. XIX, figs. 5a–e); E, GSC No. 20626; F, GSC No. 20627. Same locality, formation, and collector as for the holotype.

Paratypes G, GSC No. 20628; H, GSC No. 20629. Same locality, formation, and collector as for paratype A.

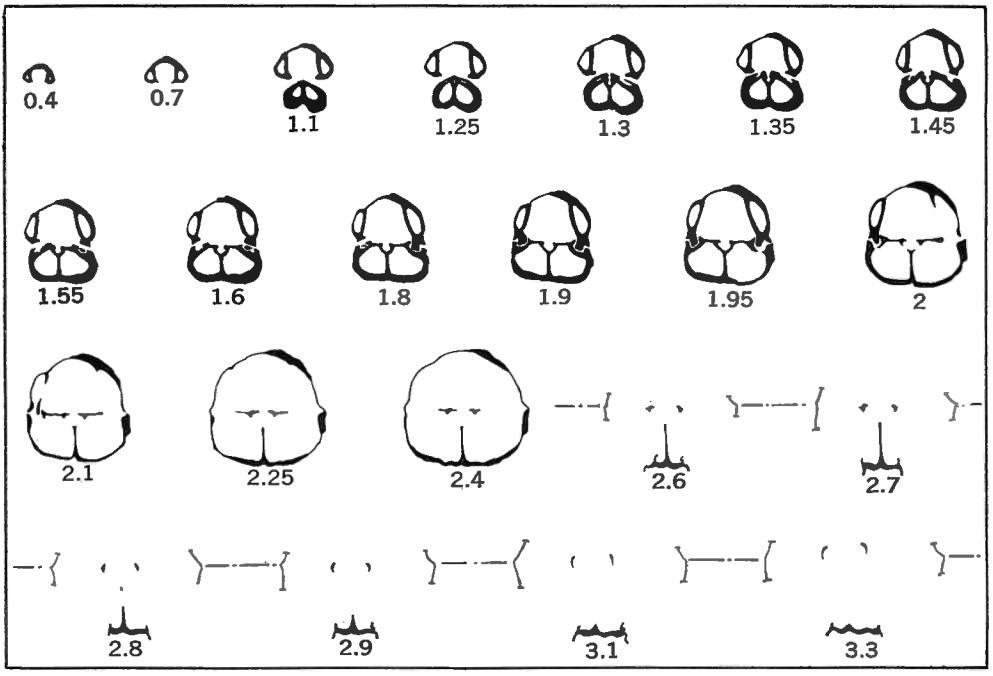
Paratypes I, GSC No. 20630 (Text-fig. 37); J, GSC No. 20631 (Text-fig. 38). GSC loc. 7161C. Collector: G.S. Hume, 1921.

Material

GSC localities in Northwest Territories: Imperial Island River well No. 1: 28389 (10); Jean-Marie River: 30633 (1), 30654 (3), 30661 (1), 30706 (1); North Nahanni River valley: 7154 (44), 7154B (6), 7158B (10), 7159 (13), 7161C (70), 33413 (1), 33418 (2), 33421 (2), 33429 (2), 38714 (2), 38720 (1); Redstone River valley: 32890 (10), 32986 (20), 32992 (7); Root River valley: 7190 (10).

Description

The species is small-sized. The contour, in dorsal view, is transversely subelliptical to rarely subrounded or longitudinally subelliptical. The commissure is sharp and deeply indented by the costae.



TEXT-FIGURE 37. *Ptychomaletoechia septentrionalis* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype I, GSC No. 20630 (l:10.5 mm; w:13.1 mm; t:(8.3) mm).

Pedicle valve. From the umbonal region the flanks slope gently and then sharply towards the postero-lateral commissures; the antero-lateral parts of the valve are flat to gently concave.

The well marked sulcus starts between 28 and 43 per cent of the length of the shell forward of the beak, or between 26 and 30 per cent of the unrolled length of the valve. The sulcus widens and deepens rapidly. It is moderately deep to deep, and its maximum width at the front varies between 62 and 78 per cent (in most between 62 and 70 per cent) of the width of the shell. The floor of the sulcus is flat.

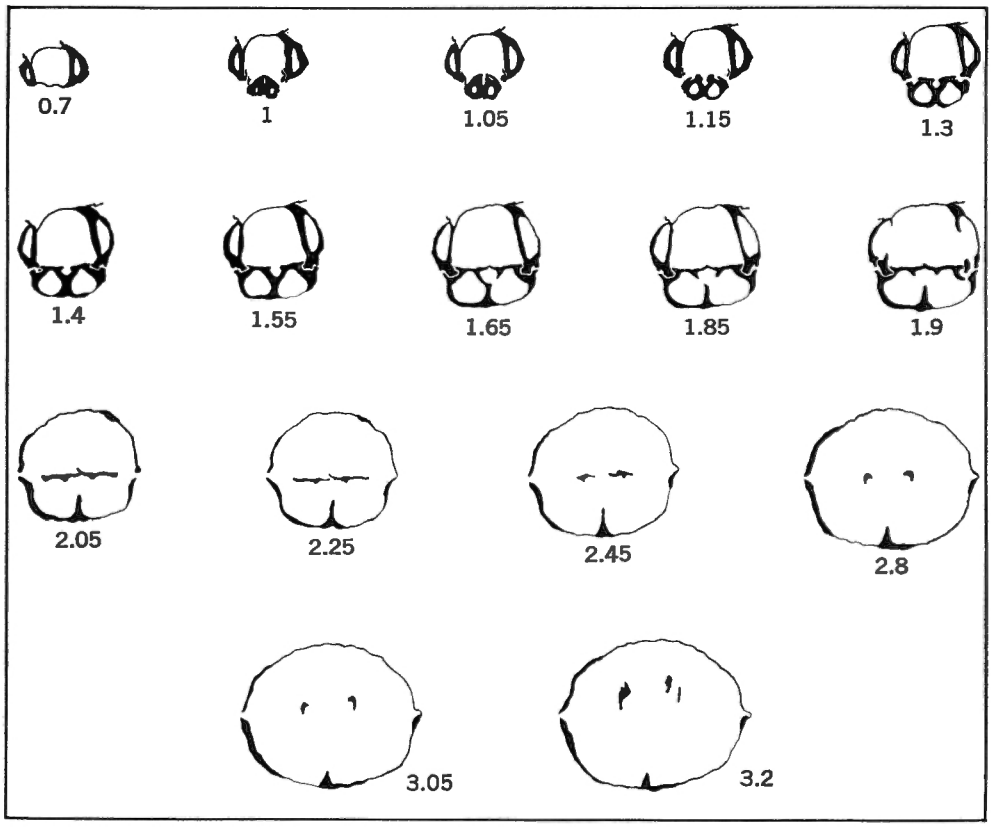
The high tongue is trapezoidal with sharp borders. Its upper part is perpendicular to more commonly recurved posteriorly. Median costae often protrude beyond the borders of the tongue.

The beak is suberect. The foramen has not been observed. The interarea is clearly delimited; its length is about 35 per cent of the width of the shell and its height 1 to 1.5 mm. The triangular deltidial plates do not join and leave an opening in the delthyrium.

Brachial valve. Flanks slope progressively towards the lateral commissures and are sharply bent very near to them.

The well marked and high fold starts some distance forward of the beak; its top is flat to slightly convex. The greatest thickness of the valve is not always at the frontal commissure; the ends of the costae are often abruptly bent downwards before reaching the commissure. The fold may be depressed longitudinally in the anterior half of the shell, developing a shallow saddle in lateral view (*see* Pl. XIX, fig. 3e).

Ornament. The general costal formula is 4/8; 0; 4/8 to 8/8.



TEXT-FIGURE 38. *Ptychomaletoechia septentrionalis* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype J, GSC No. 20631 (l:10.5 mm; w:(13.3) mm; t:(9.1) mm).

The distribution of costae is as follows:

Median			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%
3/2	13	12.75	4/5	6	11.30
4/3	83	81.35	5/6	4	7.55
5/4	6	5.90	6/7	9	17.—
			7/8	12	22.65
			8/9	15	28.30
			9/10	4	7.55
			10/11	3	5.65
	102	100.—		53	100.—

Parietal costae occur in six specimens out of 100: ¼–⅝ (2 sp.); ⅝–¼ (3 sp.); ¼–¼ (1 sp.).

Costae are simple, angular, high (especially the dorsal median and ventral lateral), regular, and start at the beaks. Median costae at the front are commonly 2 to 2.5 mm wide.

Dimensions. Measurements of nine specimens:

in mm	Paratype B	Holotype	Paratype A	Paratype G	Paratype C	Paratype H	Paratype D	Paratype E	Paratype F
l	13.1	13.0	(12.8)	(12.4)	12.2	(12.2)	9.6	9.6	7.7
w	16.1	16.4	16.2	13.4	15.4	14.4	12.3	10.2	8.55
lpv unrolled	19.5	20.0	21.0	(20.0)	18.5	(18.5)	15.5	10.0	8.0
t	11.3	12.7	13.1	10.7	11.2	11.6	9.4	3.8	2.9
tpv	3.4	2.6	2.9	3.2	2.6	2.0	2.7	2.0	1.7
tbv	7.9	10.1	10.2	7.5	8.6	9.6	6.7	1.8	1.2
l/w	0.81	0.79	(0.79)	(0.93)	0.79	(0.85)	0.78	0.94	0.90
t/w	0.70	0.77	0.81	0.80	0.73	0.81	0.76	0.37	0.34
t/l	0.86	0.98	(1.02)	(0.86)	0.92	(0.95)	0.98	0.40	0.38
shoulder angle	(102°)	(110°)	(105°)	?	(107°)	?	105°	(100°)	100°

Paratypes E and F are juvenile specimens. Paratype D is a small specimen having developed all adult characters.

Internal characters. The internal characters are similar to those of *P. contractiformis* with the following restrictions: the apical region is not reduced by shell thickening; the connectivum has been observed; the outer hinge plates are flat with a median convexity; the crura have a Phrygian cap to walking-stick shape (in transverse serial sections) in their distal part.

Growth. Juvenile characters are normal (*see* under ***P. contractiformis***).

Discussion

Remarks. The many specimens in Hume's collection were usually identified by him as *Camarotoechia contracta.* The best preserved material is not precisely localized geographically and stratigraphically.

Comparisons. The species is distinguished by transverse contour, antero-lateral parts of the pedicle valve flat or slightly concave, general costal formula, regular costae, rare parietal costae, few lateral costae.

Ptychomaletoechia contractiformis and *P. septentrionalis* have many features in common: size; sharp commissure deeply indented by the costae; well marked sulcus and fold not beginning at the beaks; trapezoidal tongue with sharp borders; projecting ventral beak not overhanging the hinge line; high fold; simple wide and regular costae starting at the umbones; shoulder angle; internal characters. Nevertheless, *P. septentrionalis* is easily separated by: more transversely subelliptical and less variable contour; ventral umbonal region not inflated and lateral commissures lower in the shell; sulcus commonly begins nearer the beak, commonly deeper and widens and deepens more rapidly towards the front; sulcus commonly wider at the front; higher tongue, generally recurved posteriorly; beak always erect; clearly delimited ventral interarea; higher fold; greatest thickness of the shell commonly at frontal commissure; different general costal formula; less variability in the number of median costae; rare parietal costae; fewer lateral costae; higher costae; antero-lateral parts of the pedicle valve flat or slightly recurved.

P. septentrionalis is very close to *Camarotoechia sobrina* Stainbrook, 1947 and thus to the form described as *C. contracta* in the Three Forks Formation. *C. sobrina* is a smaller species, with a deep sulcus and a more transverse contour; differences in the general costal formula seem small, but this has not been clearly established on account of an insufficient number of specimens from the Percha Formation of New Mexico.

Differences between *Ptychomaletoechia omaliusi* and *P. septentrionalis* are numerous. The number of median costae in the latter and the characteristic shape of the antero-

lateral portions of the pedicle valve allow quick separation. This last character allows rapid differentiation from the "*Camarotoechia letiensis* group" to which they are similar in many features, including the costal formula.

Stratigraphic position. For most of the outcrops, the stratigraphic information is insufficient. In some *Ptychomaletoechia septentrionalis* is associated with *Eoparaphorhynchus maclareni, Rugaltarostrum madisonense, Basilicorhynchus basilicus interpositus, B. basilicus basilicus,* and *B. basilicus regalis* (*see* Locality Index).

In Imperial Island River well No. 1, it is associated with *Sinotectirostrum mackenziei,* at 483 feet below a bed containing *Gastrodetoechia utahensis rugosa.* On Redstone River between 473 and 1,062 feet below the first beds containing *Eoparaphorhynchus maclareni.* In the North Nahanni River valley (Yohin syncline), between 90 and 280 feet above the base of the Famennian in the *Eoparaphorhynchus maclareni* Zone.

It seems likely that the species is found only in the *Eoparaphorhynchus maclareni* Zone, but not in its lowest part.

Geographic distribution. Restricted to the N.W.T., in the valleys of Island, Jean-Marie, North Nahanni, Redstone and Root Rivers.

Ptychomaletoechia summa nov. sp.

Plate XVI, figures 11–13

1952a. *Camarotoechia* cf. *C. sobrina* Stainbrook—CRICKMAY, p. 593.

Summus, a, um (Latin) = very high, the highest; occurrence in the highest beds of the Palliser Formation.

Types

Holotype. GSC No. 20632 (Pl. XVI, figs. 13a–e). GSC loc. 17044. Collector: E. W. Peyto, 1925.

Paratype A. GSC No. 20633 (Pl. XVI, figs. 11a–d). GSC loc. 38897. Collectors: H. R. Belyea and P. Sartenaer, 1959.

Paratypes B, GSC No. 20634; C, GSC No. 20635. GSC loc. 18120. Collector: D. J. McLaren, 1949.

Paratype D. GSC No. 20636. GSC loc. 18121. Same collector.

Paratypes E, GSC No. 15884 (Pl. XVI, figs. 12a–d); F, GSC No. 15887. GSC loc. 17052. Collector: E. W. Peyto, 1925.

Paratype G. GSC No. 15888. GSC loc. 36900. Collector: E. W. Mountjoy, 1958.

Material

GSC localities in the Canadian Rocky Mountains: 17044 (2), 17052 (4), 18120 (12), 18121 (14), 26718 (14), 36900 (8), 38824 (4), 38837 (1), 38865 (1), 38867 (1), 38882 (1), 38890 (1), 38892 (1), 38897 (1), 38899 (3), 40736 (4), 40743 (37), 43332 (19).

Less than half the material is in satisfactory state of preservation.

Description

The species is small-sized. The contour, in dorsal view, is subrounded to transversely elliptical. The commissure is sharp and clearly indented by the costae. Both valves reverse their curvature at the postero-lateral commissures.

Pedicle valve. From the well marked umbonal region the flanks slope gently towards the commissure, but more sharply towards the postero-lateral commissures.

The well marked sulcus starts between 45 and 57 per cent of the length of the shell forward of the beak, or between 30 and 50 per cent of the unrolled length of the valve. The sulcus widens slowly; its width, where it starts, is about half of its maximum width at the front, which varies between 60 and 75 per cent (in most between 60 and 65 per cent) of the width of the shell. The sulcus is moderately deep and its floor is flat to slightly convex.

The trapezoidal tongue with sharp borders is moderately high; its upper part is perpendicular to slightly recurved in the highest specimens.

The beak is suberect and projecting. No foramen has been observed. The interarea is clearly delimited, high, with a length about 50 per cent of the width of the shell.

Brachial valve. Flanks slope progressively towards the lateral commissures with a steepness in relation to the thickness of the valve. The flanks become steep and concave towards the postero-lateral commissures.

The well marked and moderately high fold starts some distance forward of the beak; its top is slightly convex. The greatest thickness of the valve is posterior to the frontal commissure, sometimes rather far from it.

Ornament. The general costal formula is $^{3}/_{2}$ to $^{6}/_{5}$; $^{0}/_{0}$-$^{1}/_{1}$ to $^{2}/_{2}$-$^{2}/_{2}$; $^{6}/_{7}$ to $^{13}/_{14}$.

The distribution of costae is as follows:

Median + parietal			Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
2/1	1	2.50	2/1	1	3.35	0	4	12.50	5/6	2	9.10
3/2	1	2.50	3/2	10	33.35	0–1/0–1	5	15.60	6/7	4	18.15
4/3	5	12.50	4/3	9	30. —	1–1/1–1	15	46.85	7/8	1	4.55
5/4	4	10. —	5/4	4	13.30	1–2/1–2 and 2–1/2–1	3	9.40	8/9	1	4.55
6/5	13	32.50	6/5	5	16.65	2–2/2–2	4	12.50	9/10	6	27.25
7/6	6	15.00	7/6	1	3.35	3–3/3–3	1	3.15	10/11	1	4.55
8/7	5	12.50							11/12	1	4.55
9/8	1	2.50							12/13	2	9.10
10/9	4	10. —							13/14	1	4.55
									14/15	2	9.10
									16/17	1	4.55
	40	100. —		30	100. —		32	100. —		22	100. —

The costae are simple, regular, of moderate height, and start at the beaks. They are angular with rounded top. Median costae at the front are commonly 1.5 mm wide.

The external median costae are lower than the others. The parietal costae rarely indent the borders of the tongue.

Dimensions. Measurements of eight specimens:

in mm	Paratype G	Paratype E	Holotype	Paratype A	Paratype F	Paratype C	Paratype B	Paratype D
l	12.7	11.8	(11.5)	(11.0)	10.3	8.4	(7.8)	6.6
w	12.7	12.5	13.9	13.1	13.0	8.1	8.7	8.4
lpv unrolled	(19.0)	(16.0)	(18.0)	(17.0)	(15.0)	9.0	(10.0)	10.0
t	8.4	8.5	10.5	9.9	7.2	4.2	5.5	5.9
tpv	3.5	2.6	2.8	3.2	2.5	1.9	2.0	1.2
tbv	4.9	5.9	7.7	6.7	4.7	2.3	3.5	4.7
l/w	1.00	0.94	(0.83)	(0.84)	(0.80)	1.04	(0.90)	0.79
t/w	0.66	0.68	0.76	0.76	0.55	0.52	0.63	0.70
t/l	0.66	(0.72)	(0.91)	(0.90)	(0.70)	0.50	(0.70)	0.89
shoulder angle	(100°)	100°	115°	(110°)	?	94°	(100°)	(115°)

The holotype and paratype A are adult specimens. Paratypes B, C, and D are juvenile forms.

Growth. Juvenile characters are normal: no recognizable sulcus and fold, pedicle valve thicker than the brachial valve, tongue not developed, low shell.

Discussion

Remarks. This species shows sufficient proper characters to merit separation from other species of the genus. It can not, however, be considered firmly established because of the poor preservation of many specimens, coupled with insufficient stratigraphic information. The range of variation of some characters is not established.

Synonymy. The specimen identified as *Camarotoechia* cf. *C. sobrina* by Crickmay (1952a) has the following costal formula: ⅘; ⅓–⅓; $^{11}/_{12}$.

Comparisons. The species is distinguished by the general costal formula, the moderately deep sulcus, and the absence of a fan-shaped disposition of the median costae.

P. sulculifera differs from *P. summa* by the usual deflection or geniculation of the costae near the commissure, a common fan-shaped disposition of the median costae, a higher number of parietal costae. Some specimens of *P. summa* are very close to specimens of *P. sulculifera* that do not have fan-shaped median costae, e.g., the holotype which, furthermore, has an unusually high number of parietal costae.

The characters of *Camarotoechia sobrina* Stainbrook, 1947 have been discussed under *Ptychomaletoechia contractiformis; P. summa* cannot be confused with that species.

There are some similarities between *P. summa* and *Camarotoechia nitidula* Stainbrook, 1950 and *C. lauta* Stainbrook, 1950, both from the Aplington Formation. The two Iowan species are easily separable by more transversely elliptical contour, different general costal formula, and rare parietal costae.

There are great similarities with forms of the *"Camarotoechia letiensis* group" already mentioned. The Belgo-French forms show some differences, the most important being in relation with the general costal formula that shows less variability, and rare parietal costae.

Stratigraphic position. Nine feet below the top of the Palliser Formation (GSC loc. 18121); upper 5 to 10 feet of the Palliser Formation (GSC locs. 38824, 38837, 38865, 38882, 38892, 38897); upper 30 feet of the Palliser Formation (GSC loc. 38899); top beds of the Palliser Formation (GSC locs. 17044, 17052, 18120, 26718, 36900, 38890); high in the Palliser Formation (GSC locs. 40736, 40743).

Crickmay's (1952a) *Camarotoechia* cf. *C. sobrina* has been collected at about 9 feet below the Exshaw Formation.

The species is thus restricted to the highest beds of the Palliser Formation.

Geographic distribution. Canadian Rocky Mountains: Greenock Mountain, Morro Peak, Miette area, Beaver Ridge, Maligne Canyon, Dizzy Creek (Brazeau Range), Mount Rundle, Healy Creek (Bourgeau Range), Lac des Arcs, Crowsnest Pass, Fernie map-area (west half).

Crickmay's (1952a), *Camarotoechia* cf. C. *sobrina* is from Imperial Normandville well No. 1, about 220 miles northwest of Edmonton, Alberta.

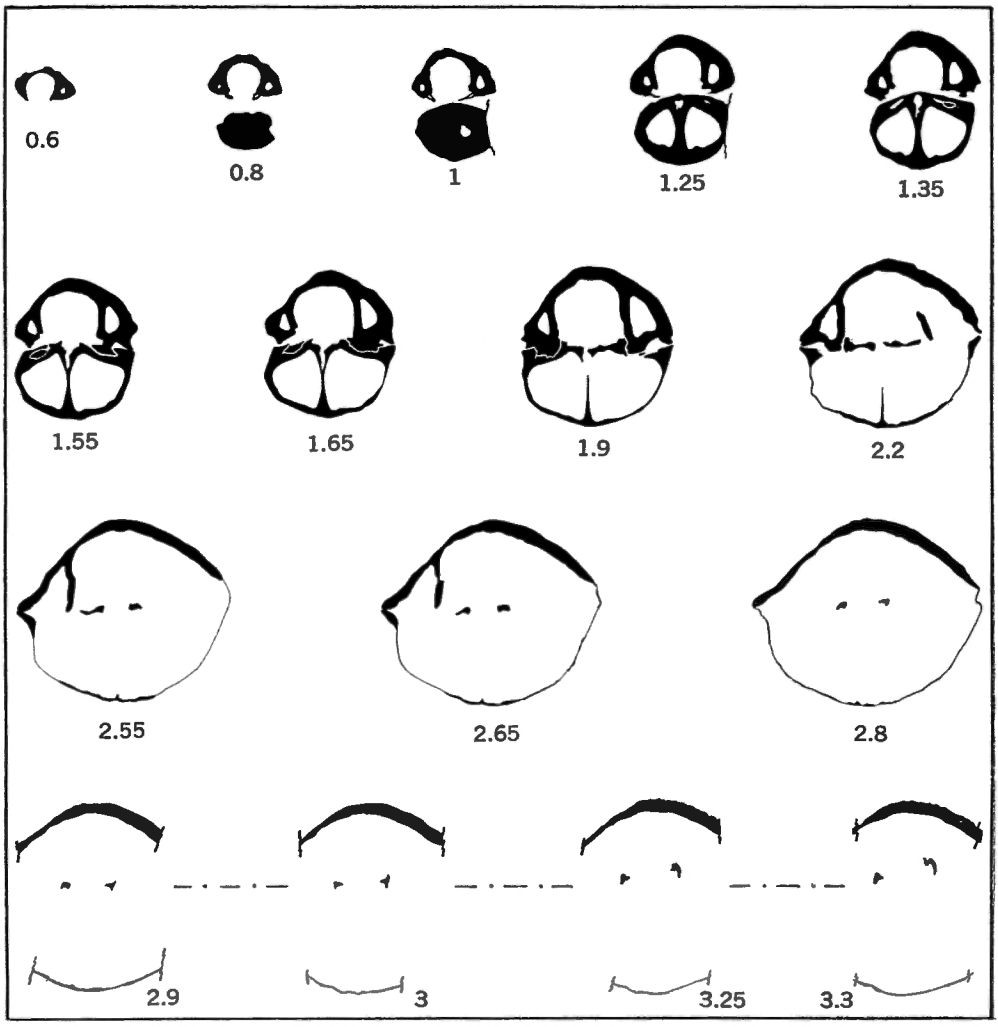
Ptychomaletoechia finitima nov. sp.

Plate XV, figures 4, 12; Text-figure 39

Finitimus, a, um (Latin)=contiguous, adjoining; species has been collected only in the Fernie map-area, British Columbia, near the International Boundary.

Types

Holotype. GSC No. 20637 (Pl. XV, figs. 4a–e). Paratypes A, GSC No. 20638 (Pl. XV, figs. 12a–e); B, GSC No. 20639; C, GSC No. 20642 (Text-fig. 39). GSC loc. 43335. Collector: G. B. Leech, 1960.



TEXT-FIGURE 39. *Ptychomaletoechia finitima* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype C, GSC No. 20642 (l:11.7 mm; w:? mm; t:10.1 mm).

Material

GSC localities in British Columbia: 43335 (30), 43339 (1).
One quarter of the material is in satisfactory state of preservation.

Description

The species is small-sized. The contour, in dorsal view, is transversely elliptical, exceptionally subrounded. The commissure is clearly but not deeply indented by low costae. Postero-lateral margins are concave near the commissure.

Pedicle valve. The umbonal region is somewhat inflated. From the umbonal region the flanks slope gently towards the commissure, but more sharply towards the postero-lateral commissures.

The sulcus starts imperceptibly between 58 and 68 per cent of the length of the shell forward of the beak, or between 43 and 50 per cent of the unrolled length of the valve. It widens and deepens slowly. The sulcus is moderately deep to shallow. Its maximum width at the front varies between 59 and 73 per cent (in most between 65 and 73 per cent) of the width of the shell. The floor of the sulcus is flat to slightly convex.

The trapezoidal tongue, with sharp borders, is moderately high to high; it rarely becomes vertical.

The beak is suberect to erect, projecting and resorbed by a circular foramen. The interarea is moderately well delimited; its height varies around 1 mm and its length around 45 per cent of the width of the shell. Deltidial plates are best observed in transverse serial sections.

Brachial valve. The fold starts some distance forward of the beak; its top is slightly convex. The greatest thickness of the valve is posterior to the frontal commissure.

Ornament. The general costal formula is 3/2 to 5/4; 1/1-1/1 to 2/2-2/2; 3/3 to 17/18.

The distribution of costae is as follows:

Median + parietal			Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
4/3	1	7.70	3/2	1	20.–						
6/5	8	61.50	4/3	3	60.–	1–1/1–1	3	60.–			
7/6	2	15.40	5/4	1	20.–				8/9	1	12.50
8/7	2	15.40				2–2/2–2	2	40.–	9/10	1	12.50
									11/12	1	12.50
									12/13	1	12.50
									13/14	2	25.–
									15/16	1	12.50
									17/18	1	12.50
	13	100.–		5	100.–		5	100.–		8	100.–

The costae are simple, regular, low, and start at the umbones. They are angular with rounded top. Median costae, at the front, are about 1.5 mm wide. External median costae are lower than the others.

Parietal costae may indent the borders of the tongue.

The poor preservation of the external lateral costae may affect the figures given in the table below.

Dimensions. Measurements of three specimens:

in mm	Holotype	Paratype A	Paratype B
l	10.7	8.5	6.8
w	13.6	9.6	7.0
lpv unrolled	18.0	11.5	8.0
t	11.3	5.8	3.3
tpv	2.9	2.1	2.0
tbv	8.4	3.7	1.3
l/w	0.79	0.89	0.97
t/w	0.83	0.60	0.47
t/l	1.06	0.68	0.48
shoulder angle	119°	100°	105°

The holotype is an adult specimen; paratype A is immature; paratype B is a juvenile.

Growth. Juvenile characters are normal: no recognizable sulcus and fold, pedicle valve thicker than the brachial valve, tongue not developed, shell thin.

Discussion

Remarks. This species shows sufficient proper characters to be separated from other species of the genus. Nevertheless, large collections would be desirable.

Comparisons. P. finitima differs from the other species of the genus in its more transversely elliptical contour and the characteristic of its sulcus (distance of starting from the beak, width at the front, depth). In addition, the somewhat inflated ventral umbonal region allows separation of *P. finitima* from *P. summa.*

Stratigraphic position. The only available information is as follows: Sassenach Formation (GSC loc. 43335); Sassenach Formation, 20 feet below the base of the Palliser Formation (GSC loc. 43339).

Geographic distribution. The species is known only from the Fernie map-area, west half, British Columbia.

Plectorhynchella Cooper and Muir-Wood, 1951

In the literature, this genus is represented by many species in various countries, and its supposed stratigraphic extension is considerable: Lower Devonian to Lower Tournaisian (*see* Schmidt and McLaren, 1965, p. H596).

The genus, as accepted, is mentioned in this paper to draw attention to its occurrence in the Famennian of Canada, and to note its presence in Belgium. Although ill defined, it may prove extremely helpful for correlation of Famennian rocks between Western Australia, Belgium, western Canada, Germany, Morocco, and the U.S.S.R. (Kazakhstan, Mugodjary, Ural). As it is poorly known and is not even unquestionably assigned to the Rhynchonellida, the Canadian form is described in the present work only for the sake of information.

Drevermann (1901, p. 171) had suggested that the form subsequently chosen by Frech (1902) as type species of the genus might belong to the genus *Pentamerus,* but Frech (p. 99) rejected this conclusion. Havliček (1961, p. 203) suggested that the Bohemian species assigned to the genus belonged to the superfamily Atrypacea. Veevers (1959, pp. 113–6) assigned his genus *Nyege* to the superfamily Atrypacea; the validity of this genus in relation to the genus *Plectorhynchella* has still to be examined (*see* Schmidt and McLaren, 1965, pp. H594, H596).

There is a strong suspicion that many species attributed to the genus *Plectorhynchella* do not belong to it, and it is probable that these will have to be included in more than one genus. Before any answer is given in this matter, the type species, *Athyris collinensis* Frech, 1902, must be studied. This brings up very difficult problems, because the primary types were probably destroyed during the war (1939-45) and topotypical material is not available.

The genus, as accepted in recent literature, occurs in the lower Famennian of Belgium.

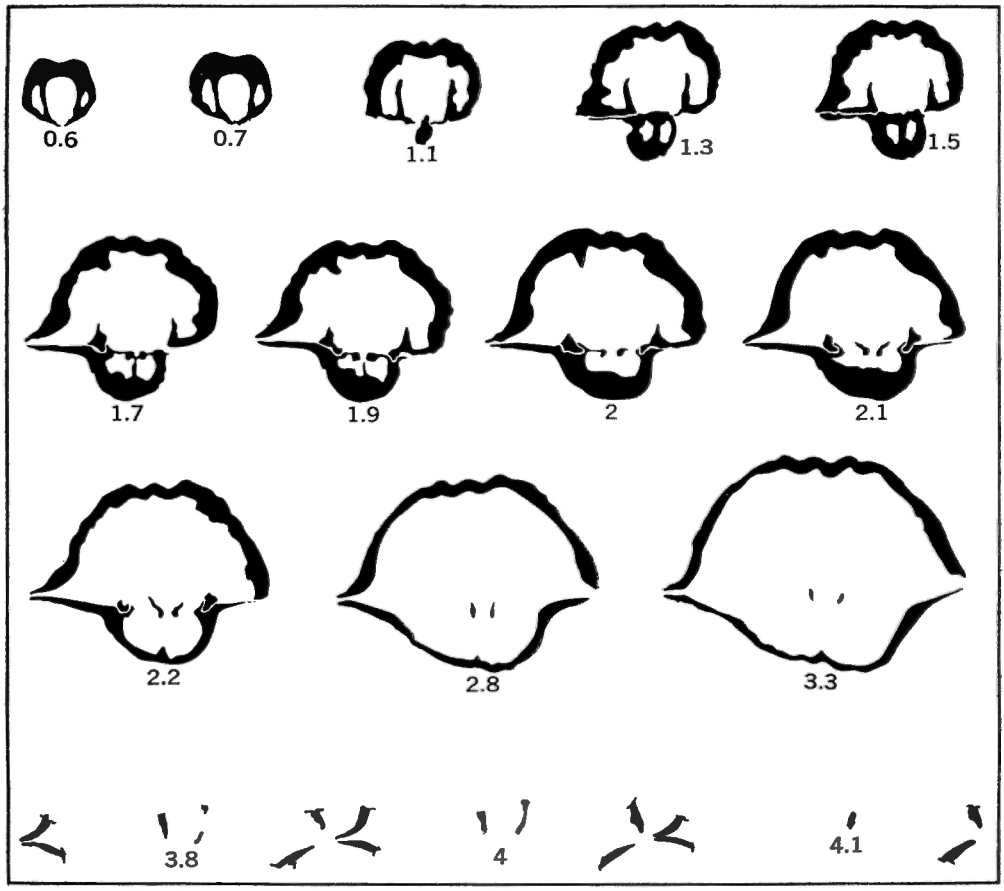
"*Plectorhynchella*" *montifelicitatis* nov.sp.

Plate XIX, figures 7–9; Text-figure 40

Mons, montis (Latin, masc.) = mount, mountain; *felicitas, felicitatis* (Latin, fem.) = good fortune, good luck, success; to indicate that the material was collected by E. W. Mountjoy, professor at McGill University.

Types

Holotype. GSC No. 15522 (Pl. XIX, figs. 7a–e). Paratypes A, GSC No. 15524 (Pl. XIX, figs. 8a–d); B, GSC No. 15539 (Pl. XIX, figs. 9a–c); C, GSC No. 15543 (Text-fig. 40). GSC loc. 36887. Collector: E. W. Mountjoy, 1958.



TEXT-FIGURE 40. *"Plectorhynchella" montifelicitatis* nov. sp.
Camera lucida drawings of serial transverse sections (x3); distances are in mm forward from the crest of the umbo.
Paratype C, GSC No. 15543 (l:17.5 mm; w:17.3 mm; t:(11.7) mm).

Material

GSC loc. 36887, 61 specimens. Eighty per cent of the material is in poor state of preservation and is composed of separated valves.

Description

The species is small- to medium-sized, intraplicate to sulcate, more or less equivalve, the pedicle valve being higher than the brachial. The contour, in dorsal view is subrounded to subelliptical. The general aspect is more or less globular. The commissure is sharp and projecting; this is well seen in transverse serial sections. The greatest thickness of the pedicle valve is located anteriorly, about 60 per cent of the length of the shell forward of the beak.

Pedicle valve. Flanks are uniformly convex, except in the postero-lateral parts, and even sometimes on the lateral parts, where they are concave near the commissure.

The fold starts almost at the beak. It is low and often depressed. This depression affects the greatest part of the fold, of which only the external costae (one on each side) keep their relief. Usually there is no tongue.

A circular foramen cuts the extremity of the beak. There is no well marked or well limited interarea.

Brachial valve. Flanks are uniformly convex. The region of the valve that is ornamented by the median costae has almost no relief (the height of the costae); its median part is sometimes slightly depressed and simulates a sulcus. There is a trapezoidal tongue, with the frontal commissure undulated by the two bounding costae and the median depression of the fold of the pedicle valve.

Ornament. Median costae are low, subrounded, and irregular. They start very near the beaks, with divisions and intercalations at variable distances forward of the beaks. Their average width at the front is one to 1.5 mm. The bounding costae are commonly wider than the others. Median costae, observed in eleven specimens, have the following ratios: $^{7}/?$: 1 sp.; $?/_{7}$: 2 sp.; $?/_{6}$: 1 sp.; $^{6}/_{5}$: 2 sp.; $^{5}/_{5}$: 1 sp.; $?/_{5}$: 2 sp.; $^{(4)}/_{(4)}$: 1 sp.; $?/_{4}$: 1 sp.

Lateral costae are vaguely indicated on three specimens only: ($^{1}/_{1}$) (holotype); $^{5}/?$ (paratype A); $?/_{3}$.

Internal characters. There are wide lateral zones of contact between the two valves.

Pedicle valve. In the posterior part of the shell, the dental plates are divergent, and become more or less parallel anteriorly. The dental plates are short (2.1 mm) and quickly detached from the bottom of the valve. The umbonal cavities are small in comparison with the large delthyrial cavity. The teeth are short (0.8 mm) and small. The state of preservation of the material has not allowed observation of the muscle field.

Brachial valve. A short (2 mm) septum supports a short divided hinge plate. A shallow "crural trough" is in the middle of the hinge plate. The crural bases are strong. The slender crura diverge ventrally and are flame-shaped posteriorly; they are slightly curved at their distal end. The dental sockets are short and shallow. The state of preservation of the material has not allowed observation of the muscle field.

Dimensions. Measurements of three specimens:

in mm	Holotype	Paratype A	Paratype B
l	17.9	(17.4)	15.1
w	17.2	18.0	17.6
lpv unrolled	(24.0)	?	18.0
t	12.6	13.6	12.4
tpv	7.6	8.3	7.5
tbv	5.0	5.3	4.9
l/w	1.04	(0.97)	0.86
t/w	0.73	0.76	0.70
t/l	0.70	(0.78)	0.82
shoulder angle	115°	?	115°

Discussion

Stratigraphic position. The species is known only from one outcrop at the top of the Palliser Formation.

Geographic distribution. The species is known only from one locality in the Alberta Rocky Mountains: Sphinx Creek.

Pugnax Hall and Clarke, 1893

Two species are placed in this genus on account of the great external similarities and of the lack of apparent reasons for separating them. However the internal characters have not been fully investigated.

Nevertheless, some forms exist in the lower Famennian of the world with a few common characters not typical of the genus *Pugnax*. The most important of these characters are small size; median costae high, never irregular, and with little variability in their number. The attribution to the genus *Pugnax* is, therefore, not considered as definite and "*Pugnax*" is adopted provisionally.

"*Pugnax*" *rara* nov.sp.

Plate XV, figures 13, 14; Text-figure 41

Rarus, a, um (Latin) = rare; to draw attention to the scarcity of the species.

Types

Holotype. GSC No. 20643 (Pl. XV, figs. 13a–e). GSC loc. 38706. Collector: P. Sartenaer, 1959.

Paratype A. GSC No. 20644 (Pl. XV, figs. 14a–e). GSC loc. 38727. Collector: P. Sartenaer, 1959.

Paratype B. GSC No. 20645. Same locality, formation, and collector as for the holotype.

Paratype C. GSC No. 20646. GSC loc. 7178. Collector: G. S. Hume, 1921.

Paratype D. GSC No. 20647. GSC loc. 7189. Collector: G. S. Hume, 1921.

Paratype E. GSC No. 20648. GSC loc. 5723. Collector: E. M. Kindle, 1917.

Paratype F. GSC No. 20649 (Text-fig. 41). GSC loc. 38722. Collector: P. Sartenaer, 1959.

Material

GSC localities in the Mackenzie River valley, N.W.T.: 5721(1), 5723(1), 6493(5), 7149E(2), 7159(1), 7161C(1), 7164(2), 7168A(1), 7178(3), 7181(2), 7186(1), 7189(3), 7190(3), 7315(1), 21965(2), 26789(1), 28389(1), 32660(1), 38706(4), 38722(8), 38727(1).

Description

The species is small-sized. The contour, in dorsal view, is transversely oval-pentagonal. Commissure is sharp and strongly crenulated by the costae. The top of the tongue represents the greatest thickness of the shell.

Pedicle valve. Flanks are much reduced, low and slightly convex, except in the postero-lateral part where they are steep. On account of the low relief of the flanks, the umbonal region is protuberant.

The sulcus starts imperceptibly between 31 and 43 per cent of the length of the shell forward of the beak, or between 20 and 23 per cent of the unrolled length of the valve, and widens quickly. Its width, where it starts, is between 43 and 55 per cent of its maximum width at the front, which varies between 75 and 83 per cent of the width of the shell. The sulcus is deep: two to four times the height of median costae at the front. Its floor is flat. The sulcus passes progressively into a trapezoidal tongue which is always recurved posteriorly at its top. The borders of the tongue are sharp.

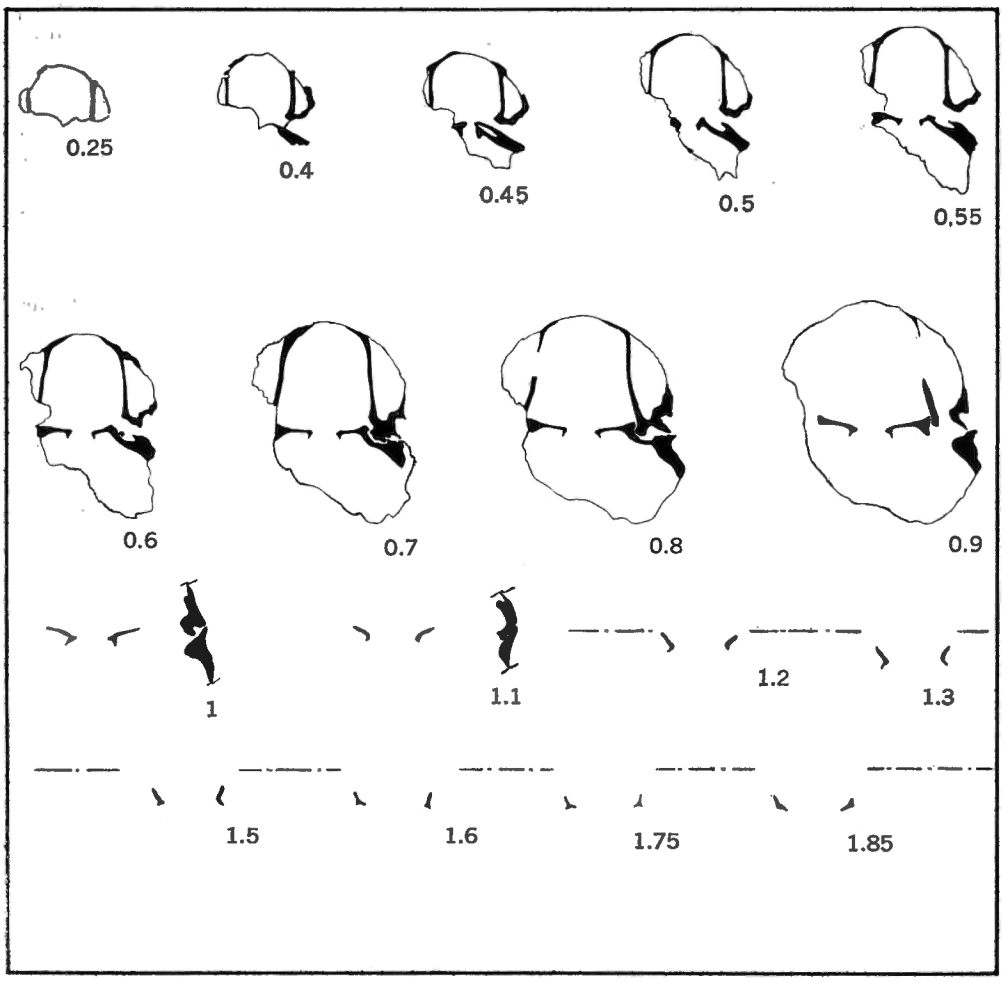
The beak is straight to nearly straight, sometimes suberect; at its apex is a minute circular foramen. The beak does not overhang the hinge line. The interarea is clearly limited ventrally. It is low; its length corresponds to 40 to 56 per cent of the width of the shell. Deltidial plates have not been observed.

Brachial valve. Flanks are steep. Postero-lateral margins are concave near the commissure.

The high fold starts forward of the beak and its top is slightly convex. Sometimes it passes imperceptibly to the flanks of the valve. The fold is sometimes (e.g., holotype) depressed longitudinally in the anterior half of the shell, developing a shallow saddle in lateral view (*see* Pl. XV, fig. 13e).

The summit of the valve is located very posteriorly on account of the recurved top of the tongue of the pedicle valve.

Ornament. The general costal formula is ⅝; 0; ⅔.



TEXT-FIGURE 41. "*Pugnax*" *rara* nov. sp.
Camera lucida drawings of serial transverse sections (x8); distances are in mm forward from the crest of the umbo.
Paratype F, GSC No. 20649 (l:9.2 mm; w:9.8 mm; t:9.8 mm).

Ratios of costae are:

Median			Parietal			Lateral		
Number of costae	spec.	%	Number of costae	spec.	%	Number of costae	spec.	%
2/1	1	2.40	0–1/0–1	2	50.–	1/2	3	7.90
3/2	35	83.30	1–0/1–0	1	25.–	2/3	31	81.55
4/3	6	14.30	1–1/1–1	1	25.–	3/4	4	10.55
	42	100.–		4	100.–		38	100.–

All costae are simple, regular, and high. They start at a variable distance forward from the beak. They are flattish-rounded in their posterior part, angular with rounded top in their anterior part.

Median costae start around mid-length; the ventral ones starting nearer to the beak than the dorsal ones. The middle median dorsal costa, when the ratio is ½, is somewhat wider than the others; it has a width varying between 2.5 and 3.5 mm at the front. Dorsal median costae are high. The external dorsal median costae are somewhat lower.

The rare parietal costae could be considered as median costae as they correspond to extremely low bounding costae of the fold.

Only the most internal lateral dorsal costa starts around mid-length; the other(s) is(are) restricted to the anterior part of the shell and is(are) often a mere indentation(s) of the commissure.

Dimensions. Measurements of six specimens:

in mm	Paratype B	Paratype C	Holotype	Paratype D	Paratype A	Paratype E
l	10.6	10.5	10.3	9.6	9.4	7.5
w	14.4	12.5	13.6	12.6	11.9	9.4
lpv unrolled	20.0	19.0	20.0	18.0	16.2	10.7
t	13.3	11.9	13.4	11.2	9.9	5.6
tpv	2.6	2.8	2.6	2.7	2.0	2.3
tbv	10.7	9.1	10.8	8.5	7.9	3.3
l/w	0.74	0.84	0.76	0.76	0.79	0.80
t/w	0.92	0.95	0.98	0.89	0.83	0.60
t/l	1.25	1.13	1.30	1.17	1.05	0.75
shoulder angle	110°	107°	105°	109°	?	110°

Paratype E is a juvenile specimen.

One of the most characteristic features of the species is its great height.

Internal characters. In the posterior part of the shell, the dental plates are divergent to parallel and become slightly convergent anteriorly. The dental plates are short and widely separated. The umbonal cavities are clearly indicated. The teeth are stout and very short. The denticula are strong and clearly marked.

There is neither a dorsal septum nor a septalium. The hinge plate is divided. The outer plates of the hinge plate are narrow, slender, and inclined towards each other. The slender crura have a typical trifid aspect.

No muscle field has been observed.

Growth. The measurements of a juvenile specimen (paratype E) have been given.

Juvenile characters are proportionally smaller thickness; pedicle valve thicker than the brachial valve; sulcus, tongue, fold, and costae not marked. With increasing size, sulcus and fold appear, but start at a great distance forward from the beak.

Discussion

Stratigraphic position. Specimens collected on Blackstone River are from Douglas and Norris' (1960) map-unit 26 and associated with *Eoparaphorhynchus maclareni, Ptychomaletoechia contractiformis,* and *Sinotectirostrum mackenziei.*

On Jean-Marie River, the species is found in the Trout River Formation.

In Imperial Island River well No. 1, it is associated with *Sinotectirostrum mackenziei* and *Ptychomaletoechia septentrionalis,* at 483 feet below a bed containing *Gastrodetoechia utahensis rugosa.*

The collection from the Mackenzie River made by Hume is from a single outcrop in his *Leiorhynchus* Zone, where he collected also *Basilicorhynchus basilicus basilicus, Eoparaphorhynchus maclareni, Ptychomaletoechia contractiformis,* and *Sinotectirostrum mackenziei.*

The well known outcrop in the Yohin syncline (North Nahanni River valley) has furnished collections for Hume and Sartenaer. The specimens are from Douglas and Norris' (1961) map-unit 21 and associated with *Basilicorhynchus basilicus interpositus, B. basilicus regalis, Ptychomaletoechia contractiformis,* and *Rugaltarostrum madisonense.* Other collections in the North Nahanni River valley derive from the same map-unit.

The only outcrop on Root River about which precise information exists has yielded collections to Kindle and Sartenaer. Specimens are from *Eoparaphorhynchus maclareni* Zone in Douglas and Norris' (1961) map-unit 22. *Leiorhynchus* Zone is the only information for other outcrops in the Root River valley; the species is associated with the three subspecies of *Basilicorhynchus basilicus,* with *Eoparaphorhynchus maclareni, Ptychomaletoechia contractiformis, P. septentrionalis,* and *Sinotectirostrum mackenziei.*

In short, the species has been found in the *Eoparaphorhynchus maclareni* and *Basilicorhynchus basilicus* Zones.

Geographic distribution. In the Northwest Territories the species is known from the valleys of Blackstone, Jean-Marie, Island, Mackenzie, North Nahanni and Root Rivers.

"Pugnax" sp.

Representatives of the genus *"Pugnax"* are present in the Sassenach Formation in the Rocky Mountains. Specimens are still too few to allow any description.

LOCALITY INDEX

5173 Station 19, 2 miles at rock-cut along log road, southwest of Wardner, British Columbia. Devonian. E.M. Kindle, 1915:

Basilicorhynchus sp. A

Left bank, 10¾ miles above mouth of North Nahanni River, Mackenzie River, N.W.T. Hay River Limestone and Shale. E.M. Kindle, 1917:

5721
Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis
"Pugnax" rara

5722 Upper 10 feet of section:

Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus

5723 Ten to twenty feet below top of section:

Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis
"Pugnax" rara

5724 From 22 to 31 feet below top of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

6493 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 95-foot section. Hay River Limestone and Shale. E.M. Kindle, 1919:

Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis
"Pugnax" rara

6956 Station 712, Bed C, Trout River, N.W.T. Zone s *in* Whittaker (1922, p. 52B). E.J. Whittaker, 1921:

Ptychomaletoechia serva

6959 Station 712, Trout River, N.W.T. Scree from zones q to t = highest 25 feet of the section *in* Whittaker (1922, p. 52B). E.J. Whittaker, 1921:

Rugaltarostrum madisonense
Basilicorhynchus basilicus basilicus
Ptychomaletoechia serva

6961 Station 650, Trout River, N.W.T. Zone p *in* Whittaker (1922, p. 52B). E.J. Whittaker, 1921:

Ptychomaletoechia contractiformis

6962 Station 637, Trout River, N.W.T. Zone o *in* Whittaker (1922, p. 53B). E.J. Whittaker, 1921:

Ptychomaletoechia contractiformis
Ptychomaletoechia serva

Left bank, 10¾ miles above mouth of North Nahanni River, Mackenzie River, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G.S. Hume, 1921:

7149A At 40 feet from base of section:

Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis

7149B From 35 to 55 feet above base of section:

Eoparaphorhynchus maclareni

7149C From 65 to 75 feet above base of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

7149E Upper 5½ feet of section:

Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis
"Pugnax" rara

7149F Talus:

Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei

7154 Mountain on west side of river, 220° and about 2 miles from station 22, gentle anticline, elevation of 390 above station 22, North Nahanni River valley. Upper 2 feet of the 5 feet exposed, Limestone No. 2 = *Leiorhynchus* Zone = D4. G.S. Hume 1921:

Ptychomaletoechia septentrionalis

7154B Mountain on west side of river, 220° and about 2 miles from station 22, elevation of 640 above station 22, North Nahanni River valley. About the upper 2 feet of the 6 feet exposed, Limestone No. 2 = *Leiorhynchus* Zone = D4. G.S. Hume, 1921:

Ptychomaletoechia septentrionalis

Mountain on west side of river, North Nahanni River valley, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G.S. Hume, 1921:

7158A Cliff exposure, at 480 feet above station 36. In 6 feet of limestone:

Eoparaphorhynchus maclareni

7158B Cliff exposure, at 975 feet above station 36:

Eoparaphorhynchus maclareni
Ptychomaletoechia septentrionalis

7158C Cliff exposure, between 1,170 and 1,200 feet above station 36:

Eoparaphorhynchus maclareni

7159 Between 2 and 3 miles from station 36. Talus:

Eoparaphorhynchus maclareni
Sinotectirostrum avellana
Ptychomaletoechia septentrionalis
"Pugnax" rara

Mountain on east side of river, near station 65, North Nahanni River valley, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G. S. Hume, 1921:

7161B Talus from between 1,100 and 1,250 feet above river:
Eoparaphorhynchus maclareni

7161C Between 1,100 and 1,200 feet above river:
Eoparaphorhynchus maclareni
Rugaltarostrum madisonense
Basilicorhynchus basilicus interpositus
Ptychomaletoechia septentrionalis
"Pugnax" rara

62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Limestone No. 1 = *Athyris angelica* Zone = D6. G.S. Hume 1921:

7162 *Sinotectirostrum avellana*

7163 *Rugaltarostrum madisonense*
Sinotectirostrum avellana
Ptychomaletoechia contractiformis

7164 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. *Leiorhynchus* Zone = D4. G.S. Hume, 1921:
Basilicorhynchus basilicus regalis
Rugaltarostrum madisonense
Ptychomaletoechia contractiformis
"Pugnax" rara

Northeast side of river, 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Shale No. 1 = Second Shale Zone = D5. G.S. Hume, 1921:

7165 In 500 feet of purple shale and limestone:
Gastrodetoechia utahensis rugosa

7165A Below 6 feet of very bright red shale:
Gastrodetoechia utahensis rugosa

7168A 62°21′28″N, 99°46′40″W, on top of mountain abrupt at elevation 1,270 above station 116, northeast side of North Nahanni River valley, N.W.T. Twenty feet of red shaly limestone. Devonian. G.S. Hume, 1921:
"Pugnax" rara

7169 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G.S. Hume 1921:
Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis

7172 Near station 19, northeast side of Root River, Camsell Range, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone=D4. G. S. Hume, 1921:
Rugaltarostrum madisonense

Southwest side of Root River, N.W.T. Limestone No. 1=*Athyris angelica* Zone=D6. G. S. Hume, 1921:

7174 *Rugaltarostrum madisonense*
Sinotectirostrum avellana

7175 *Rugaltarostrum madisonense*

7176 About 1,200 m to the east of creek of GSC loc. 7174, Root River valley, N.W.T. Shale No. 1 = Second Shale Zone = D5. G. S. Hume, 1921:
Gastrodetoechia utahensis rugosa

7177 Outcrop 4, near station 37, northeast side of Root River, N.W.T. 130-foot outcrop. Limestone No. 2 = *Leiorhynchus* Zone = D4. G. S. Hume, 1921:
Basilicorhynchus basilicus basilicus

7178 In direction 70 from GSC loc. 7177, 110 feet higher in elevation, about half a mile up gully, northeast side of Root River, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G. S. Hume, 1921:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus interpositus
Basilicorhynchus basilicus regalis
"Pugnax" rara

7179 In direction 70 from GSC loc. 7178, 160 feet higher in elevation, 1,780 feet up gully, northeast side of Root River, N.W.T. Limestone No. 2 = *Leiorhynchus* Zone = D4. G. S. Hume, 1921:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus regalis

7180 Fifty feet higher in elevation and 200 feet up gully from GSC loc. 7179, northeast side of Root River, N.W.T. Shale No. 1 = Second Shale Zone = D5 and Limestone No. 2 = *Leiorhynchus* Zone = D4. G. S. Hume, 1921:
Eoparaphorhynchus maclareni
Gastrodetoechia utahensis rugosa
Ptychomaletoechia contractiformis

Root River valley, N.W.T. Limestone No. 2=*Leiorhynchus* Zone=D4. G.S. Hume, 1921:

7181 South of station 43, at elevation of 520 feet:
Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus regalis
"Pugnax" rara

7182 South from station 43:
Basilicorhynchus basilicus interpositus

7183 Southwest side of the river, south from station 43:
Eoparaphorhynchus maclareni

7184 Southwest side of the river, south from station 43:
Eoparaphorhynchus maclareni

7186 Northeast side of river, near station 69:
Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis
"Pugnax" rara

7189 Southwest side of river, ridge outcrop:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
"Pugnax" rara

7190 Northeast side of river, ridge outcrop at 1,120-foot elevation above station 81:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus regalis
Ptychomaletoechia septentrionalis
"Pugnax" rara

7283 Forty miles above mouth and 4 miles below Redknife Lake, Redknife River, N.W.T. Highest beds exposed. Trout River Formation. E. J. Whittaker, 1922:
Ptychomaletoechia serva

7284 Twenty-three miles above the mouth of Redknife River, N.W.T. Upper Devonian, map-unit D5. E. J. Whittaker, 1922:
Sinotectirostrum mackenziei

7286 Quarter of a mile above upper falls, Redknife River, N.W.T. Upper Devonian, map-unit D5. E.J. Whittaker, 1922:
Sinotectirostrum mackenziei

Jean-Marie River, N.W.T. Upper Devonian, map-unit D5. E.J. Whittaker and A. K. McGill, 1922:

7303 Station 1312, upper end of middle gorge:
Ptychomaletoechia serva

7312 Upper gorge:
Sinotectirostrum mackenziei

7315 Falls on stream entering Jean-Marie River from south about 4 miles above McGill Lake, N.W.T. Upper Devonian, map-unit D5. A. K. McGill and E. J. Whittaker, 1922:
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis
"Pugnax" rara

7878 Sulphur Mountain, Banff National Park, Alberta. Lower Banff Limestone. P. S. Warren:
Ptychomaletoechia sulculifera

8768 Maligne Canyon, Jasper National Park, Alberta. Uppermost beds of the Palliser Formation. E. M. Kindle, 1927:
Trifidorostellum cascadense cascadense
Sinotectirostrum banffense banffense
Sinotectirostrum banffense shimeri

Maligne River valley, Jasper National Park, Alberta. Devonian. E. M. Kindle, 1927:

8769 Station 14a. Mouth of Two Valley Creek:
Ptychomaletoechia sulculifera

8772 North side of bay opposite permanent camp:
Ptychomaletoechia sulculifera

8775 "7 miles north of Jasper brook section, Swift's ranch, 350 feet above station 20 near trail, up south fork of brook", Jasper National Park, Alberta. Devonian. E.M. Kindle, 1927:
Ptychomaletoechia sulculifera

Tay River area, Alberta. Near contact with Banff Formation = Warren's Upper Minnewanka Limestone. J.F. Henderson, 1943:

11187 Southwest flank of Idlewilde anticline. Upper Devonian:
Sinotectirostrum nordeggi

11188 Near Ram No. 2 on southwest side of anticline on bank of Prairie Creek:
Ptychomaletoechia sulculifera

11189 Near Ram No. 2, 1,000 feet northeast well on northeast flank of anticline, Alberta. Upper Devonian. R.J.W. Douglas and J.F. Henderson, 1943:
Gastrodetoechia utahensis utahensis

Alexo map-area, Alberta. Within the upper 200 feet of the Upper Devonian. O.A. Erdman, 1943:

11193 East slope of Brazeau Range, 3/16 mile north of 52°25′ latitude line at elevation 6,300 feet:
Gastrodetoechia utahensis utahensis
Sinotectirostrum montosum

11194 On ridge west of Dizzy Creek, at elevation 5,700 feet on northeast slope of 6,000-foot peak:
Sinotectirostrum nordeggi

11197 At elevation 5,000 feet in northwest corner of area and ¾ mile from west border:
Sinotectirostrum nordeggi

11200 South of North Saskatchewan River Gap, at elevation 4,650 feet on third creek west of Dizzy Creek:
Sinotectirostrum banffense banffense

11213 On north side of 7,130-foot peak, a mile west of head of Lundine Creek:
Sinotectirostrum nordeggi

11214 One mile northwest of North Saskatchewan River Gap, at elevation 6,400 feet on east slope of Brazeau Range:
Gastrodetoechia utahensis utahensis
Sinotectirostrum nordeggi

11217 Not mentioned specifically as to location:
Sinotectirostrum nordeggi

11218 East side of Brazeau Range, south of Shunda Creek:
Gastrodetoechia utahensis utahensis
Sinotectirostrum nordeggi

11220 At elevation 5,400 feet, ¼ mile east of west border and 1¼ miles south of north border of area:
Gastrodetoechia utahensis utahensis
Sinotectirostrum nordeggi

11225 South slope of Mount Lindsay, in tributary of Deception Creek, Cadomin map-area, Alberta. Upper Minnewanka Limestone. W.A. Kelly, 1924:
Sinotectirostrum banffense banffense

11241 Deception Creek, Mountain Park area, Alberta (no other information available). Upper Minnewanka Limestone. W.A. Kelly, 1924:
Sinotectirostrum banffense banffense

11245 Head of Harlequin Creek, Mountain Park area, Alberta. Upper Minnewanka Limestone. W.A. Kelly, 1924:
Sinotectirostrum banffense banffense

Alexo map-area, Alberta. Within the upper 200 feet of the Upper Devonian. O.A. Erdman, 1943:

11273 On first ridge north of Lundine Creek, ½ mile from east border of area:
Sinotectirostrum banffense banffense

11275 2,600 feet due north of 7,000-foot knob at head of Lundine Creek:
Gastrodetoechia utahensis utahensis
Sinotectirostrum nordeggi

11276 On second ridge east of head of Dizzy Creek, on 5,800-foot knob, a little more than 2 miles west of east border of area, Alexo map-area, Alberta. O.A. Erdman, 1943:
Sinotectirostrum nordeggi

11371 Small island near right bank of river, just below long island, below mouth of Root River, on Mackenzie River, N.W.T. Hume's *Leiorhynchus* Zone = D4. M.Y. Williams and H.W. Smithson, 1921:
Basilicorhynchus basilicus basilicus

11375 Left bank, 10¾ miles above mouth of North Nahanni River, Mackenzie River, N.W.T. Limestone of Upper Devonian age. M.Y. Williams and F. Ebbott, 1921:
Eoparaphorhynchus maclareni

11426 Small outcrop on east side of river, bearing 293 on signal at mouth of Root River, on Mackenzie River, N.W.T. Hume's *Leiorhynchus* Zone = D4. M.Y. Williams and A.H. Bell, 1921:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus

12835 Four miles farther up than R2, Root River valley, N.W.T. Hay River Limestones. G.D. Bath (Canol Project), 1944:
Basilicorhynchus basilicus basilicus

Root River, N.W.T. *Leiorhynchus* Zone. G.D. Bath (Canol Project), 1944:

12837 One mile downstream, prominent ridge:
Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

12838 5¾ miles upstream, on north side, south end of prominent scarp:
Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus

12895 East bank of river, opposite mouth of Root River, on Mackenzie River, N.W.T. Fort Creek Shale. G.D. Bath (Canol Project), 1944:
Basilicorhynchus basilicus basilicus

16887 16889 Lake Minnewanka, east end, ridge above junction of Main Lake and first lake to the east, on the north side, Banff National Park, Alberta. Top 3 feet of the Palliser Formation. D.J. McLaren, 1949:
Gastrodetoechia utahensis utahensis

16942 In gully west of Mount Standly, 300 feet above waterfall, Banff National Park, Alberta. Twenty-seven feet from the top of the Palliser Formation. D.J. McLaren, 1949:
Sinotectirostrum banffense shimeri

16958 Sulphur Mountain, Banff National Park, Alberta. Below dolomite bed, top of Palliser Formation. D.J. McLaren, 1949:
Trifidorostellum cascadense cascadense

16987 Gully, west side of Idlewilde Mountain, Clearwater River, Alberta. Top of Palliser Formation. D.J. McLaren, 1949:
Gastrodetoechia utahensis utahensis

Section along Healy Creek, Bourgeau Range, Banff National Park, Alberta. E.W. Peyto, 1925:

17044 Top beds of the Palliser Formation:
Sinotectirostrum banffense banffense
Sinotectirostrum montosum
Ptychomaletoechia summa

17045 Top beds of the Palliser Formation:
Sinotectirostrum banffense banffense

17046 Probably about 60 feet down in the Palliser Formation:
Evanescirostrum seversoni

17048 Probably about 50 feet down in the Palliser Formation:
Evanescirostrum seversoni

17049 About 55 feet down in the Palliser Formation:
Evanescirostrum seversoni

17050 An 8-inch bed somewhere in the upper 55 feet of the Palliser Formation:
Trifidorostellum cascadense cascadense

17051 A 9-inch bed, somewhere in the upper 25 feet of the Palliser Formation:
Gastrodetoechia utahensis utahensis
Megalopterorhynchus haynesi

17052 Top beds of the Palliser Formation:
Sinotectirostrum banffense banffense
Sinotectirostrum montosum
Ptychomaletoechia summa

17486 Top of section, between Kakisa and Tathlina Lake, Kakisa River, N.W.T. Upper Devonian, Hay River Group. D.B. Bullock (Socony-Vacuum Exploration Co.), 1950:
Sinotectirostrum mackenziei
Ptychomaletoechia serva

17767 Mount Coleman, Banff National Park, Alberta. Palliser Formation, 225 feet down. J.L. Severson, 1949:
Evanescirostrum seversoni

South of the lake and 500 feet above the highway, Crowsnest Pass, Alberta. R. de Wit, 1949:

18033 Thirty feet below top of crinoidal limestone, Palliser Formation:
Sinotectirostrum montosum

18034 Upper 3 feet of bedded limestone, Palliser Formation:
Sinotectirostrum montosum

18074 Creek 1½ miles to the north, on west side of Idlewilde Mountain, Alberta. Fourteen feet from the top of the Palliser Formation. D.J. McLaren, 1949:
Gastrodetoechia utahensis utahensis

18077 Mountain between Limestone Creek and Clearwater River, Alberta. Top 10 feet of the Palliser Formation. D.J. McLaren, 1949:
Gastrodetoechia utahensis utahensis

North side of the Gap, North Saskatchewan River, Alberta. Palliser Formation. D.J. McLaren, 1949:

18080 Top few feet of formation:
Gastrodetoechia utahensis utahensis

18081 7.5 feet below top of formation:
Gastrodetoechia utahensis utahensis

18082 Nine feet below top of formation:
Gastrodetoechia utahensis utahensis

18085 Talus from top 15 feet of formation:
Gastrodetoechia utahensis utahensis
Sinotectirostrum nordeggi

18086 The Gap, North Saskatchewan River, Alberta. Twenty-eight feet below top of the Palliser Formation. D.J. McLaren, 1949:
Sinotectirostrum nordeggi
Sinotectirostrum banffense banffense
Sinotectirostrum banffense shimeri

18088 South side of the Gap, North Saskatchewan River, Alberta. Eighty-five feet from top of the Palliser Formation. D.J. McLaren, 1949:
Sinotectirostrum montosum
Sinotectirostrum banffense banffense

18119 Southwest flank of Mount Hawk summit, Jasper National Park, Alberta. Top 20 feet of the Palliser Formation. D.J. McLaren, 1949:
Gastrodetoechia utahensis utahensis

Southwest flank of Morro Peak, Jasper National Park, Alberta. Palliser Formation. D.J. McLaren, 1949:

18120 Top beds of the formation:
Ptychomaletoechia summa

18121 Nine feet below top of formation:
Ptychomaletoechia summa

18126 From 50 to 55 feet below top of formation:
Sinotectirostrum montosum

18127 Seventy feet below top of formation:
Sinotectirostrum montosum

18131 Talus from the upper 250 feet of formation:
Sinotectirostrum montosum

18136 825 feet down from top of formation:
Sinotectirostrum medicinale medicinale

18138 Southwest flank of Morro Peak, Jasper National Park, Alberta. Between 39½ and 60 feet above the base of the Sassenach Formation. D.J. McLaren, 1949:
Sinotectirostrum medicinale deceptum

The Palisade, Jasper National Park, Alberta. D.J. McLaren, 1949:

18222 Sixteen feet down from the top of the Sassenach Formation:
Sinotectirostrum medicinale medicinale

18225 194 feet down from the top of the Sassenach Formation:
Sinotectirostrum medicinale medicinale

Proposal Mountain, south end of Medicine Lake, Jasper National Park, Alberta. Sassenach Formation. D.J. McLaren, 1949:

18227 200 feet from base of formation:
Eoparaphorhynchus lentiformis

18228 Talus:
Sinotectirostrum medicinale medicinale

18229 Fifty-seven feet below top of formation:
Sinotectirostrum medicinale medicinale

18230 Ninety feet below top of formation
Sinotectirostrum medicinale medicinale

18231 127 feet below top of formation:
Sinotectirostrum medicinale medicinale

18232 130 feet below top of formation:
Sinotectirostrum medicinale medicinale

18233 160 feet below top of formation:
Eoparaphorhynchus lentiformis
Sinotectirostrum medicinale medicinale

18234 165 to 168 feet below top of formation:
Sinotectirostrum medicinale medicinale

18235 Mount Norquay, at 7,800 feet, Banff National Park, Alberta. Upper part of Palliser Formation. D. J. McLaren, 1949:

Trifidorostellum cascadense cascadense

Proposal Mountain, south end of Medicine Lake, Jasper National Park, Alberta. Sassenach Formation. D. J. McLaren, 1949:

18236 175 to 200 feet below top of formation:

Sinotectirostrum medicinale medicinale

18237 Talus from the upper part of the formation:

Sinotectirostrum medicinale medicinale

18238 250 feet below top of formation:

Sinotectirostrum medicinale medicinale

18239 325 feet below top of formation:

Sinotectirostrum medicinale medicinale

18240 Side of mountain, 405 feet below top of formation:

Eoparaphorhynchus lentiformis

18241 Middle part of Member B of the Sassenach Formation (= unit 42 *in* McLaren, 1955, p. 47):

Sinotectirostrum medicinale medicinale

18242 Lower Maligne Canyon, Jasper National Park, Alberta. Near the top of the Palliser Formation. D. J. McLaren, 1949:

Sinotectirostrum banffense banffense
Sinotectirostrum banffense shimeri

18243 Proposal Mountain, south end of Medicine Lake, Jasper National Park, Alberta. Sassenach Formation, Member A. D. J. McLaren, 1949:

Eoparaphorhynchus lentiformis

18259 Same locality as 18262

18262 Top of Prospect Mountain, near Mountain Park, Alberta. Lowest beds of the Sassenach Formation. R. de Wit, 1949:

Eoparaphorhynchus walcotti

18263 Base of Climax Mountain, near Mountain Park, Alberta. Lower Sassenach Formation. R. de Wit, 1949:

Eoparaphorhynchus walcotti

19430 Mount Coleman, Banff National Park, Alberta. Upper 15 feet of the Costigan Member, Palliser Formation. J. L. Severson, 1949:

Gastrodetoechia utahensis utahensis

Beaver Ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Sassenach Formation. D. J. McLaren, 1951:

19597 "*Camarotoechia* Zone" *in* unit 42 *in* McLaren, 1955, p. 47, in middle part of Member B of the formation:

Sinotectirostrum medicinale medicinale

19598 285 feet from base of formation:

Eoparaphorhynchus lentiformis

19605 200 feet from base of formation:
Eoparaphorhynchus lentiformis

19606 Talus
Eoparaphorhynchus lentiformis
Sinotectirostrum medicinale medicinale

Proposal Mountain, south end of Medicine Lake, Jasper National Park, Alberta. D. J. McLaren, 1951:

19622 Talus from the Sassenach Formation:
Sinotectirostrum medicinale medicinale

19623 Between 74 and 330 feet above base of Palliser Formation:
Ptychomaletoechia sulculifera

19626 Top beds of the Sassenach Formation:
Sinotectirostrum medicinale medicinale

19628 Upper beds of the Sassenach Formation:
Sinotectirostrum medicinale medicinale

19629 Beaver Ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Talus from the Sassenach Formation. D. J. McLaren, 1951:
Eoparaphorhynchus lentiformis
Sinotectirostrum medicinale medicinale

19630 Slope above second gully on the mountain to the north of Beaver Lake, Jasper National Park, Alberta. Member A, Sassenach Formation, D.J. McLaren, 1951:
Eoparaphorhynchus lentiformis

19638 Slope above second gully on the mountain to the north of Beaver Lake, Jasper National Park, Alberta. Lower Sassenach Formation, below the outcrop GSC loc. 19630. D.J. McLaren, 1951:
Eoparaphorhynchus lentiformis

19651 Beaver Ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. About 500 feet above base of the Sassenach Formation. D.J. McLaren, 1951:
Sinotectirostrum medicinale medicinale

19656 Mountain north of Beaver Lake, Jasper National Park, Alberta. Talus mainly from the Sassenach Formation. D.J. McLaren, 1951:
Eoparaphorhynchus lentiformis
Sinotectirostrum medicinale medicinale

19660 Slope above third gully on the mountain to the north of Beaver Lake, Jasper National Park, Alberta. Member A, Sassenach Formation. D.J. McLaren, 1951:
Eoparaphorhynchus lentiformis

19661 Slope above second gully on the mountain to the north of Beaver Lake, Jasper National Park, Alberta. Member A, Sassenach Formation. D.J. McLaren, 1951:
Eoparaphorhynchus lentiformis

19952 Devonian Mountain, Kvass Creek, Winnifred Pass, Alberta. 519½ feet below the top of the Palliser Formation. D.J. McLaren, 1951:
Basilicorhynchus sp. A

19959 Devonian Mountain, Winnifred Pass, Alberta. Between 422.5 and 448.5 feet below top of Palliser Formation. D.J. McLaren, 1951:

Ptychomaletoechia sulculifera

19960 South side of Winnifred Pass, Alberta. Top few feet of the Costigan Member, Palliser Formation. D.J. McLaren, 1951:

Gastrodetoechia utahensis utahensis

Devonian Mountain, Winnifred Pass, Alberta. D.J. McLaren, 1951:

19961 Between 477 and 519.5 feet below top of Palliser Formation:

Ptychomaletoechia sulculifera

19973 Between 448.5 and 477 feet below top of Palliser Formation:

Ptychomaletoechia sulculifera

19975 Eight lower feet of the Sassenach Formation (thickness of the Sassenach Formation = 40 feet):

Sinotectirostrum medicinale medicinale

Sunwapta Pass, ridge immediately to the east of the Banff–Jasper Park boundary, Alberta. D.J. McLaren, 1951:

20007 Palliser Formation, 150 feet down:

Evanescirostrum seversoni

20011 Upper 20 feet of the Palliser Formation:

Gastrodetoechia utahensis utahensis

21718 Maligne Canyon, Jasper National Park, Alberta. Top of the Palliser Formation. P. Harker, 1952:

(*Sinotectirostrum nordeggi*)
Sinotectirostrum banffense banffense

21965 Liard Range, 25 miles above Liard River, Blackstone River, N.W.T. *Leiorhynchus* Zone. Socony Vacuum Exploration Co., 1952.

Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis
"Pugnax" rara

Root River, N.W.T. (no other information available). Hudson's Bay Oil Co., 1952:

22484 *Eoparaphorhynchus maclareni*
Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus regalis

22493 *Eoparaphorhynchus maclareni*

22534 *Eoparaphorhynchus maclareni*
Ptychomaletoechia contractiformis

22537 *Basilicorhynchus basilicus interpositus*

22538 *Eoparaphorhynchus maclareni*

22547 *Eoparaphorhynchus maclareni*
Ptychomaletoechia contractiformis

22548 *Basilicorhynchus basilicus basilicus*

24409 Northeast spur of Cardinal Mountain, 5 miles south of Mountain Park, Alberta. 183 feet above the base of the Palliser Formation. D. J. McLaren, 1953:
Ptychomaletoechia sulculifera

24441 Hummingbird Creek, Alberta. Devonian. No other information available. P. Harker, 1954:
Sinotectirostrum banffense banffense

Northwest side of Deception Creek, Alberta. Lower Member of the Sassenach Formation. D. J. McLaren, 1953:

24528 Talus:
Eoparaphorhynchus walcotti
Sinotectirostrum medicinale deceptum

24529 Between 90 feet and 126 feet from the base of formation:
Eoparaphorhynchus walcotti

Ridge southwest of Rocky River Forks, Alberta. Lower Member of the Sassenach Formation. D. J. McLaren, 1953:

24536 90 feet up:
(*Evanescirostrum seversoni*)

24539 131 feet up:
Eoparaphorhynchus walcotti

Northwest side of Deception Creek, Alberta. Lower Member of the Sassenach Formation. Talus. D.J. McLaren, 1953:

24540 *Sinotectirostrum medicinale deceptum*

24541 *Eoparaphorhynchus walcotti*
Sinotectirostrum medicinale deceptum

24542 *Eoparaphorhynchus walcotti*

24544 East side of Deception Creek, Alberta. Between 248.5 and 263.5 feet below top of Palliser Formation. D. J. McLaren, 1953:
Ptychomaletoechia sulculifera

24549 Northeast side of Deception Creek, Alberta. Palliser Formation. D. J. McLaren, 1953:
Sinotectirostrum banffense banffense

24555 Southeast side of Deception Creek, Alberta. Between 28 and 34 feet above base of Lower Member of the Sassenach Formation. D. J. McLaren, 1953:
Sinotectirostrum medicinale deceptum

24566 Bighorn Range, Blackstone River Gap, Alberta. 100 feet above base of Palliser Formation. D. J. McLaren, 1953:
Ptychomaletoechia sulculifera

25205 First creek on east side of Shankland Creek, Alberta. Between 14 and 44 feet below top of Palliser Formation. D. J. McLaren, 1953.
Sinotectirostrum nordeggi

25474 James Pass, northwest side, Front Range, north of Red Deer River, section W, unit 51, Alberta. Top of the Palliser Formation. D. J. McLaren, 1953:
Gastrodetoechia utahensis utahensis

Dizzy Creek, Brazeau Range, Alberta. Top of the Palliser Formation. Triad Oil Co. Ltd., 1955:

26717 *Sinotectirostrum banffense shimeri*

26718 *Ptychomaletoechia summa*

26756 Left bank, above Ram River, Mackenzie River, 62°10′N, 123°08′W, N.W.T. Upper Devonian, Mobiloil, 1955:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

26759 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. *Leiorhynchus* Zone. Mobiloil, 1955:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

26763 62°22′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Upper Devonian. Mobiloil, 1955:

Gastrodetoechia utahensis rugosa

26784 62°07′N, 123°18′W, Nahanni Mountain, North Nahanni River valley, N.W.T. Talus. Upper Devonian. Mobiloil, 1955:

Sinotectirostrum avellana

26786 62°08′N, 123°17′W, northeast slope, Nahanni Mountain, N.W.T. Upper Devonian. Mobiloil, 1955:

Basilicorhynchus basilicus basilicus

26788 62°07′N, 123°16′W, Nahanni Mountain, northeast side, North Nahanni River valley, N.W.T. Upper Devonian. Mobiloil, 1955:

Sinotectirostrum avellana

26789 62°22′N, 123°46′W, North Nahanni River valley, N.W.T. Upper Devonian. Mobiloil, 1955:

"Pugnax" rara

Imperial Island River well No. 1, 60°09′29″N, 121°08′16″W, N.W.T. Upper Devonian. H.R. Belyea. 1958:

28380 Between 3,790 and 3,795 feet:

Gastrodetoechia utahensis rugosa

28386 At 3,800 feet:

Gastrodetoechia utahensis rugosa

28389 At 4,278 feet:

Sinotectirostrum mackenziei
Ptychomaletoechia septentrionalis
"Pugnax" rara

North bank, 17 miles west of Camsell Range, Root River, N.W.T. Imperial Formation. Mobiloil Co., 1956.

28633 *Eoparaphorhynchus maclareni*

28634 *Basilicorhynchus basilicus basilicus*

28636 *Basilicorhynchus basilicus interpositus*

28638 *Eoparaphorhynchus maclareni*
Basilicorhynchus basilicus interpositus

28640 Small tributary, 13½ miles west of mouth of Willowlake River, on Root River,
28641 N.W.T. Imperial Formation. Mobiloil Co., 1956:
Basilicorhynchus basilicus basilicus

30546 ¾ mile up Gull Creek, Middle Kakisa River, N.W.T. Near the base of the Trout River Formation. D.J. McLaren, 1957:
Rugaltarostrum madisonense
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis

30568 Three miles downstream from Redknife Lake, Redknife River, N.W.T. Upper Devonian. D.J. McLaren, 1957:
Ptychomaletoechia serva

30579 Upper dome, 3 miles west-northwest upstream from the big bend in the river, Trout River, N.W.T. Between 18.1 and 22.4 feet from top of section, Tetcho Formation. D.J. McLaren, 1957:
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis

Continuous exposure, 4.8 miles at a bearing of 211° from Whittaker Falls downstream to Table Rock Rapids, right bank, Trout River, N.W.T. D.J. McLaren, 1957:

30581 Between 55.3 and 57.4 feet above base of Tetcho Formation:
Ptychomaletoechia contractiformis

30584 Between 48.9 and 55.9 feet below the top of the Trout River Formation:
Ptychomaletoechia contractiformis

30586 Trout River, N.W.T. At 81.5 feet up from base of Trout River Formation. D. J. McLaren, 1957:
Sinotectirostrum mackenziei

30589 Upper dome, 3 miles west-northwest upstream from the big bend in the river, Trout River, N.W.T. Between 22.4 and 34.4 feet from top of section. Tetcho Formation. D.J. McLaren, 1957:
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis

Continuous exposure, 4.8 miles at a bearing of 211° from Whittaker Falls downstream to Table Rock Rapids, right bank, Trout River, N.W.T. D. J. McLaren, 1957:

30595 Lower 17 feet of the Tetcho Formation:
Ptychomaletoechia contractiformis

30599 Between 25.3 and 29.3 feet above base of Tetcho Formation:
Ptychomaletoechia contractiformis

30608 Between 29.3 and 36.3 feet above base of Tetcho Formation:
Ptychomaletoechia contractiformis

30610 Trout River, N.W.T. Between 64 and 69 feet from base of Trout River Formation. D. J. McLaren, 1957:

Sinotectirostrum mackenziei

30633 North shore of eastern arm of Deep Lake, Jean-Marie River, N.W.T. Trout River Formation. D. J. McLaren, 1957:

Ptychomaletoechia septentrionalis

30654
30661 East side of Deep Lake, one mile from lower end, Jean-Marie River, N.W.T. Trout River Formation. D. J. McLaren, 1957:

Ptychomaletoechia septentrionalis

30706 East side of Deep Lake, half a mile from lower end, Jean-Marie River, N.W.T. Trout River Formation. D. J. McLaren, 1957:

Ptychomaletoechia septentrionalis

30727 Three quarters of a mile up Gull Creek, Middle Kakisa River, N.W.T. Near the base of the Trout River Formation. D. J. McLaren, 1957:

Rugaltarostrum madisonense
Sinotectirostrum mackenziei

30769 Continuous exposure, 4.8 miles at a bearing of 211° from Whittaker Falls downstream to Table Rock Rapids, right bank, Trout River, N.W.T. Between 66.9 and 87.1 feet above base of Tetcho Formation. D. J. McLaren, 1957:

Ptychomaletoechia contractiformis

31531 Southwest of Rabbit Lake, N.W.T. Upper Trout River Formation. D. F. Stott. 1957:

Gastrodetoechia utahensis rugosa

31544 Rabbit Lake, N.W.T. Lower Trout River Formation. D. F. Stott, 1957:

Ptychomaletoechia serva

31545 South of Cloud Lake, N.W.T. Lower Trout River Formation? D. F. Stott, 1957:

Ptychomaletoechia serva

62°21′N, 123°43′W, "Hume's syncline" (= Yohin syncline), North Nahanni River valley, N.W.T. *Leiorhynchus* Zone. J. Lowther (Texaco Exploration Co.), 1957:

32109 *Gastrodetoechia utahensis rugosa*

32110 *Gastrodetoechia utahensis rugosa*

32112 *Sinotectirostrum avellana*

32113 *Gastrodetoechia utahensis rugosa*

Fernie west half map-area, 49°20′32″N, 115°04′20″W, British Columbia. Between 244.5 and 353 feet below top of Sassenach Formation. G. B. Leech, 1957:

32266 (*Evanescirostrum seversoni*)

32270 (*Evanescirostrum seversoni*)
Sinotectirostrum paucirugosum

32271 (*Evanescirostrum seversoni*)

32276 141.5 to 155 feet below top of Sassenach Formation:
Sinotectirostrum medicinale medicinale

32313 Fernie west half map-area, 49°21′25″N, 115°17′56″W, British Columbia. Palliser Formation. G.B. Leech, 1957:

Ptychomaletoechia sulculifera

32660 East of Camsell thrust, 12 miles north of Root River Gap, Root River valley, N.W.T. Hume's *Leiorhynchus* Zone = D4. P. Harker, 1957:

Basilicorhynchus basilicus basilicus
Basilicorhynchus basilicus regalis
"Pugnax" rara

63°47′N, 125°34′W, Dahadinni map-area, intermittent channel on left bank, 55 miles from mouth, Redstone River, N.W.T. D.F. Stott, 1957:

32886 Between 536 and 582 feet above base of section, Imperial Formation:

Sinotectirostrum saxirubrum

32889 Fifteen lower feet of the section, Imperial Formation:

Rugaltarostrum madisonense
Sinotectirostrum saxirubrum
Basilicorhynchus basilicus interpositus

32890 63°44′N, 125°32′W, Creek on left bank of river, 59 miles from mouth, Redstone River, N.W.T. At 1,305.5 feet above base of section. Imperial Formation. D.F. Stott, 1957:

Ptychomaletoechia septentrionalis

63°47′N, 125°34′W, Dahadinni map-area, intermittent channel on left bank, 55 miles from mouth, Redstone River, N.W.T. Imperial Formation. D.F. Stott, 1957:

32894 Talus from the beds between 930 and 1,105 feet above base of section:

Sinotectirostrum saxirubrum

32985 At 940 feet above base of section:

Sinotectirostrum saxirubrum

63°44′N, 125°32′W, Creek on left bank of river, 59 miles from mouth, Redstone River, N.W.T. Imperial Formation. D.F. Stott, 1957:

32986 Between 1,784.5 and 1,830.5 feet above base of section:

Ptychomaletoechia septentrionalis

32989 Between 2,399.5 and 2,402.5 feet above base of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

32992 At 1,241.5 feet above base of section:

Ptychomaletoechia septentrionalis

32993 Between 2,312.5 and 2,351.5 feet above base of section:

Eoparaphorhynchus maclareni

32994 Between 2,552.5 and 2,555.5 feet above base of section:

Basilicorhynchus basilicus basilicus

32995 Between 2,537.5 and 2,541.5 feet above base of section:

Basilicorhynchus basilicus basilicus

33000 Between 2,470.5 and 2,474.5 feet above base of section:

Ptychomaletoechia contractiformis

33001 At 2,303.5 feet above base of section:
Eoparaphorhynchus maclareni

West side of Camsell Range, south side of Root River, N.W.T. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:

33256 At 244 feet above base of section:
Basilicorhynchus basilicus regalis

33257 Between 43 and 58 feet above base of section:
Basilicorhynchus basilicus interpositus

33258 Between 75 and 94 feet above base of section:
Basilicorhynchus basilicus regalis

33265 Between 38 and 43 feet above base of section:
Basilicorhynchus basilicus interpositus

Carlson Lake, N.W.T. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:

33317 Upper 35 feet of the section:
Ptychomaletoechia contractiformis

33318 35 to 40 feet below top of section:
Rugaltarostrum madisonense

33328 118 feet below top of section:
Ptychomaletoechia contractiformis

33332
33341 Two miles northwest of west end of lake. North Nahanni River valley, N.W.T.:
Eoparaphorhynchus maclareni

5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. Hume's *Leiorhynchus* Zone=D4. D.J. McLaren, 1957:

33384 *Eoparaphorhynchus maclareni*

33385 *Eoparaphorhynchus maclareni*
Ptychomaletoechia contractiformis

33412 Cliff 1½ miles south of east end of Carlson Lake, North Nahanni River valley, N.W.T. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:
Eoparaphorhynchus maclareni

33413 Deceiver Creek, Yohin syncline, North Nahanni River valley, N.W.T. Lower Famennian. D.J. McLaren, 1957:
Ptychomaletoechia septentrionalis

33417 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. 75-foot section. Hume's *Athyris angelica* Zone = D6. D.J. McLaren, 1957:
Sinotectirostrum avellana

33418 Cliff 3 miles south of Carlson Lake, North Nahanni River valley, N.W.T. Douglas and Norris' (1961) map-unit 21. D.J. McLaren, 1957:
Eoparaphorhynchus maclareni
Ptychomaletoechia septentrionalis

33421
33429 Deceiver Creek, Yohin syncline, North Nahanni River valley, N.W.T. Lower Famennian. D.J. McLaren, 1957:
Ptychomaletoechia septentrionalis

33430 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Hume's Shale Zone No. 2 = D5, below red beds. D.J. McLaren, 1957:

Gastrodetoechia utahensis rugosa

33435 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Below covered interval. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:

Basilicorhynchus basilicus regalis

West side of Camsell Range, south side of Root River, N.W.T. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:

33445 Between 28 and 38 feet above base of section:

Basilicorhynchus basilicus basilicus

33454 At 274 feet above base of section:

Basilicorhynchus basilicus regalis

33456 Between 20 and 28 feet above base of section:

Basilicorhynchus basilicus basilicus

33457 Carlson Lake, 2 miles northwest of west end, North Nahanni River valley, N.W.T. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren 1957:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

33458 West side of Camsell Range, south side of Root River, N.W.T. Between 58 and 75 feet above base of section. Hume's *Leiorhynchus* Zone = D4. D.J. McLaren, 1957:

Basilicorhynchus basilicus interpositus
Basilicorhynchus basilicus regalis

North Nahanni River area, N.W.T. (no other information available). Upper Devonian. J.C. Sproule, 1958:

36042 *Basilicorhynchus basilicus interpositus*

36043
36045 *Eoparaphorhynchus maclareni*

36061 Blackstone River, N.W.T. (no other information available). Upper Devonian. J.C. Sproule, 1958:

Eoparaphorhynchus maclareni

Alpine valley, Fiddle River, Miette map-area, east half, Jasper National Park, Alberta. Top of the Palliser Formation. E. W. Mountjoy, 1958:

36850 *Sinotectirostrum montosum*

36856 *Sinotectirostrum banffense banffense*

36887 Ridge east of Sphinx Creek, Alberta. Top of the Palliser Formation. E. W. Mountjoy, 1958:

"Plectorhynchella" montifelicitatis

36900 Mystery Lake, trail east of Fiddle River, Miette area, Alberta. Top of the Palliser Formation. E. W. Mountjoy, 1958:

Sinotectirostrum montosum
Ptychomaletoechia summa

36904 Head of Fiddle River, Miette area, east half, Alberta. Lower 30 feet of the Palliser Formation. E. W. Mountjoy, 1958:

Sinotectirostrum medicinale medicinale

36914 South boundary of the Miette map-area, east half, Jasper National Park, Alberta. Top of the Palliser Formation. E. W. Mountjoy, 1958:

Sinotectirostrum banffense banffense

36936 Head of Little Drinnan Creek, Miette map-area, east half, Alberta. Palliser Formation. E. W. Mountjoy, 1958:

Sinotectirostrum banffense banffense

38691 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni
Sinotectirostrum mackenziei
Ptychomaletoechia contractiformis

Left bank, 10¾ miles above mouth of North Nahanni River, Mackenzie River, N.W.T. Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

38692 Talus:

Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus

38693 35 to 51 feet above base of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

38694 65½ to 75½ feet above base of section:

Eoparaphorhynchus maclareni
Basilicorhynchus basilicus basilicus
Ptychomaletoechia contractiformis

38695 60 to 65½ feet above base of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

38697 51 to 60 feet above base of section:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

62°21'N, 123°44'W, Yohin syncline, North Nahanni River valley, N.W.T. Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

38698 Between 555 and 607 feet above base of section:

Basilicorhynchus basilicus regalis

38699 Between 152 and 202 feet above base of section:

Eoparaphorhynchus maclareni

62°21'N, 123°43'W, Yohin syncline, North Nahanni River valley, N.W.T. Hume's Shale Zone No. 2. P. Sartenaer, 1959:

38700 Between 300 and 330 feet above base of section:

Gastrodetoechia utahensis rugosa

38701 Talus from lower 355 feet of section:

Gastrodetoechia utahensis rugosa

38703 Left bank, 10¾ miles above mouth of North Nahanni River, Mackenzie River, N.W.T. Lower 35 feet of section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni

38704 62°21'N, 123°44'W, Yohin syncline, North Nahanni River valley, N.W.T. Between 143 and 152 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni

38705 62°21'N, 123°43'W, Yohin syncline, North Nahanni River valley, N.W.T. Between 385 and 760 feet above base of section, Hume's Shale Zone No. 2. P. Sartenaer, 1959:

Gastrodetoechia utahensis rugosa

38706 62°21'N, 123°44'W, Yohin syncline, North Nahanni River valley, N.W.T. Between 607 and 680 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Basilicorhynchus basilicus interpositus
"Pugnax" rara

38707 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 44 to 50 feet above the base of the section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni

62°21'N, 123°44'W, Yohin syncline, North Nahanni River valley, N.W.T. Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

38708 Between 405 and 535 feet above base of section:

Basilicorhynchus basilicus regalis

38709 Between 210 and 250 feet above base of section:

Eoparaphorhynchus maclareni

38710 Creek on left bank of river, 10¾ miles upstream, Root River, N.W.T. Talus between one and two miles up creek, deriving from GSC loc. 43831, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Basilicorhynchus basilicus basilicus

38711 62°21'N, 123°43'W, Yohin syncline, North Nahanni River valley, N.W.T. Upper bluff of the section, lower 40 feet of Hume's *Athyris angelica* Zone. P. Sartenaer, 1959:

Rugaltarostrum madisonense
Sinotectirostrum avellana

38713 62°21'N, 123°43'W, Yohin syncline, North Nahanni River valley, N.W.T. Between 355 and 442 feet above base of section, Hume's Shale Zone No. 2. P. Sartenaer, 1959:

Gastrodetoechia utahensis rugosa

38714 62°21'N, 123°44'W, Yohin syncline, North Nahanni River valley, N.W.T. Between 90 and 130 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni
Ptychomaletoechia septentrionalis

38716 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 60 feet to 80 feet above the base of the section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis

62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

38717 Between 202 and 210 feet above base of section:

Eoparaphorhynchus maclareni

38718 Between 280 and 310 feet above base of section:

Eoparaphorhynchus maclareni

38719 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Between 330 and 355 feet above base of section, Hume's Shale Zone No. 2. P. Sartenaer, 1959:

Gastrodetoechia utahensis rugosa

38720 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Between 250 and 280 feet above the base of the section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni
Ptychomaletoechia septentrionalis

38722 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 8 to 10 feet above base of section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni
Ptychomaletoechia contractiformis
"Pugnax" rara

38723 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Talus deriving probably from between 525 and 565 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Basilicorhynchus basilicus interpositus

38725 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 23 to 25½ feet above base of section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

Eoparaphorhynchus maclareni

38726 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Talus deriving from between 565 and 680 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Basilicorhynchus basilicus interpositus

38727 5¾ miles upstream, on north side, south end of prominent scarp, Root River, N.W.T. 10 to 14 feet above base of section, Douglas and Norris' (1961) map-unit 22. P. Sartenaer, 1959:

"Pugnax" rara

38728 62°21′N, 123°44′W, Yohin syncline, North Nahanni River valley, N.W.T. Between 535 and 555 feet above base of section, Douglas and Norris' (1961) map-unit 21. P. Sartenaer, 1959:

Basilicorhynchus basilicus regalis

38815 Southeastern end of Mount Rundle, Banff National Park, Alberta. 30 to 34 feet below top of Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense

38823 First gulch south of the Gondola lift, Sulphur Mountain. Banff National Park, Alberta. Upper 5 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense
Sinotectirostrum banffense banffense
Sinotectirostrum banffense shimeri

Crowsnest Pass, sec. 8, tp. 8, rge. 5, W. 5, Alberta, on the southern side of the Alberta–British Columbia highway No. 3 along Crowsnest Lake. H. R. Belyea and P. Sartenaer, 1959:

38824 Upper 5 to 10 feet of the Palliser Formation:

Ptychomaletoechia summa

38825 165 feet above the base of the Palliser Formation:

Ptychomaletoechia sulculifera

38836 96 feet above the base of the Palliser Formation:

Ptychomaletoechia sulculifera

38837 Upper 5 to 10 feet of the Palliser Formation:

Ptychomaletoechia summa

38838 Logan (Manhattan 15′ Quad.), Montana, U.S.A. Type locality of the Three Forks Formation. Six feet below the top of Haynes member No. 5 in the Three Forks Formation. C. A. Sandberg and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis

38840 Crowsnest Pass, sec. 8, tp. 8, rge. 5, W. 5, Alberta, on the southern side of the Alberta–British Columbia highway No. 3 along Crowsnest Lake. 165 feet above base of Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia sulculifera

38841 Milligan Canyon (= type locality of the Sappington Sandstone) (Three Forks 15′ Quad.), Montana, U.S.A. Three Forks Formation, between 100 and 110 feet below base of the Sappington Sandstone. C. A. Sandberg and P. Sartenaer, 1959:

Rugaltarostrum jeffersonense

38854 Red Hill section (Jefferson Island 15′ Quad.), Montana, U.S.A. 35 to 40 feet under the "5-foot massive limestone bed" *in* Gutschick and Perry (1957, p. 1894), Three Forks Formation. C. A. Sandberg and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis

38855 Left bank of McLeod River, opposite the Inland Cement quarry, Cadomin, Alberta. 40 feet below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Sinotectirostrum banffense banffense

38857 Gully on the southwestern flank of Nigel Peak, Jasper National Park, Alberta. Top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis

38862 Southwest flank of Nigel Peak, Jasper National Park, Alberta. Upper part of the Palliser Formation. Talus. H. R. Belyea and P. Sartenaer, 1959:

Evanescirostrum seversoni

38864 Beaver ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Between 250 and 300 feet from base of the Sassenach Formation. H. R. Belyea and P. Sartenaer, 1959:

Eoparaphorhynchus lentiformis

38865 Southeastern end of Mount Greenock, Jasper National Park, Alberta. Upper 10 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis
Ptychomaletoechia summa

38866 Left bank of McLeod River, opposite the Inland Cement quarry, Cadomin, Alberta. Between 33 and 40 feet below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Sinotectirostrum banffense banffense

38867 Ridge between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Between 20 and 60 feet below the ridge. Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia summa

38871 Left bank of McLeod River, opposite the Inland Cement quarry, Cadomin, Alberta. Upper 10 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis
Evanescirostrum seversoni
Sinotectirostrum nordeggi

38874 Section along Healy Creek, Bourgeau Range, Banff National Park, Alberta. Between 21 and 25 feet below top of Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Evanescirostrum seversoni
Megalopterorhynchus haynesi

38875 Section along Healy Creek, Bourgeau Range, Banff National Park, Alberta. Palliser Formation, 493 feet down. H. R. Belyea and P. Sartenaer, 1959:

Evanescirostrum seversoni

38876 Along the railway-cut beneath the bridge of highway 11, Nordegg, Alberta. Upper 30 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Sinotectirostrum banffense banffense

38879 Gully branching from the gulch of GSC loc. 38823, Sulphur Mountain, Banff National Park, Alberta. Eleven feet below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense

38882 Old highway Calgary–Banff 1a, section along the northeastern border of Lac des Arcs, Alberta. Upper 5 to 10 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia summa

38884 Beaver Ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Between 150 and 250 feet from base of Sassenach Formation. H. R. Belyea and P. Sartenaer, 1959:

Eoparaphorhynchus lentiformis

38885 The Wedge, Alberta. Upper 5 feet of the Palliser Formation. P. F. Moore, G. O. Raasch, H. R. Belyea, and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense
Sinotectirostrum banffense banffense

38887 First gulch south of the Gondola lift, Sulphur Mountain, Banff National Park, Alberta. 30 feet below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Sinotectirostrum banffense banffense

38888 Section along Healy Creek, Bourgeau Range, Banff National Park, Alberta. Between 53 and 58 feet below top of Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense
Evanescirostrum seversoni

38890 Southeastern tip of Mount Rundle, Banff National Park, Alberta. Top foot of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia summa

38892 North side of the old highway 1a Calgary–Banff, on northeast side of Lac des Arcs, Alberta. Upper 5 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Sinotectirostrum banffense banffense
Ptychomaletoechia summa

38897 Maligne Canyon, Jasper National Park, Alberta. Upper 5 to 10 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia summa

38899 Mount Rundle, northwestern tip of a small head south of the golf course of Banff Springs hotel, Banff National Park, Alberta. Upper 30 feet of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Ptychomaletoechia summa

38901 Jura Creek, Grotto Mountain, Alberta. Five feet below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Trifidorostellum cascadense cascadense

38902 Jura Creek, Grotto Mountain, Alberta. One foot below the top of the Palliser Formation. H. R. Belyea and P. Sartenaer, 1959:

Gastrodetoechia utahensis utahensis

38968 Southernmost mountain of Lizard Range, elevation approx. 6,500 feet, 4½ miles northeast of Elko, British Columbia. 100 to 110 feet above base of the orange weathering silty beds, Upper Devonian. H. R. Belyea, 1959:

Eoparaphorhynchus lentiformis

Brewsters Wall, Blue Creek map-area, west half, Jasper National Park, Alberta. E. Mountjoy, 1959:

40195 Sassenach Formation?:
Ptychomaletoechia sulculifera

40205 Base of the Palliser Formation:
Ptychomaletoechia sulculifera

40677 Peak 7,500 feet northeast of Broadwood Peak, Fernie map-area, east half, British Columbia. 664 feet above base of Palliser Formation. R. A. Price and G. C. Taylor, 1959:
Sinotectirostrum banffense banffense

40682 Immediately northwest of Tornado Pass, Highrock Range, Fernie map-area, east half, British Columbia. Thirteen feet below the Exshaw Formation. R. A. Price, 1959:
Sinotectirostrum banffense banffense

40736 48°59′45″N, 115°02′45″W, Fernie map-area, west half, British Columbia. 6-inch zone in the top of the grey limestone, high in the Palliser Formation. G. B. Leech, 1959:
Rugaltarostrum madisonense
Sinotectirostrum montosum
Ptychomaletoechia summa

40741 48°59′50″N, 115°03′10″W, Fernie map-area, west half, British Columbia. Lower part of the Palliser Formation. G. B. Leech, 1959:
Ptychomaletoechia sulculifera

40743 49°19′10″N, 115°01′10″W, Fernie map-area, west half, British Columbia. High in the Palliser Formation. G. B. Leech, 1959:
Rugaltarostrum madisonense
Sinotectirostrum montosum
Ptychomaletoechia summa

58°4′45″N, 121°53′30″W, Imperial Sikanni Chief No. 1 well, British Columbia. Upper Devonian. H. R. Belyea, 1960:

41898 At 5,164 feet:
(*Eoparaphorhynchus maclareni*)

41899 At 5,165 feet:
(*Eoparaphorhynchus maclareni*)

41902 At 5,171 feet:
(*Eoparaphorhynchus maclareni*)

41903 At 5,173 feet:
(*Eoparaphorhynchus maclareni*)

41905 At 5,178 feet:
(*Eoparaphorhynchus maclareni*)
(*Sinotectirostrum mackenziei*)

42007 58°16′03″N, 120°51′25″W, Imperial Kahntah No. 1 well, northeast British Columbia. 74 feet below the top of the Wabamun Group. H. R. Belyea, 1960:
Sinotectirostrum avellana

42121 Crest of northwest spur of Mount de Smet, Alberta. Palliser Formation. E. W. Mountjoy, 1960:
Gastrodetoechia utahensis utahensis

42125 Reward Creek, Snaring River area, west half, Alberta. Palliser Formation. E. W. Mountjoy, 1960:
Sinotectirostrum banffense banffense

42139 Traverse along west fork of Strange Creek, Resplendent Creek, east half, Alberta. Palliser Formation. E. W. Mountjoy, 1960:
Sinotectirostrum banffense banffense

42187 Beaver Ridge, between Medicine Lake and Beaver Lake, Jasper National Park, Alberta. Talus from the Sassenach Formation. D. J. McLaren, 1951:
Sinotectirostrum medicinale medicinale

42228 Drilling core from Pacific Fort St. John 2-18, lsd. 2-18-84-19-W6th, British Columbia. Depth: 11,287 to 11,317 feet. *Athyris angelica* Zone. H. R. Belyea, 1960:
Sinotectirostrum avellana

42627 3½ miles bearing 070 west of junction of Horn Creek and Graham River, British Columbia. "Devonian?". E. J. W. Irish, 1960:
Evanescirostrum sp. A

42630 At junction of Horn Creek and Graham River, British Columbia. "Upper Devonian?". E. J. W. Irish, 1960:
Evanescirostrum sp. A

43328 West bank, mile 272, Mackenzie River, N.W.T. L. V. Brandon, 1960:
Eoparaphorhynchus maclareni

43332 49°22′6″N, 115°25′W, Fernie map-area, west half, British Columbia. Palliser Formation. G. B. Leech, 1960:
Ptychomaletoechia summa

43333 49°22′4″N, 115°24′9″W, Fernie map-area, west half, British Columbia. Palliser Formation. G. B. Leech, 1960:
Ptychomaletoechia sulculifera

43335 49°20′5″N, 115°23′9″W, Fernie map-area, west half, British Columbia. Sassenach Formation. G. B. Leech, 1960:
Ptychomaletoechia finitima

43339 49°24′N, 115°25′8″W, Fernie map-area, west half, British Columbia. Sassenach Formation, 20 feet below the base of the Palliser Formation. G. B. Leech, 1960:
Ptychomaletoechia finitima

43831 Short exposure about 1½ miles up creek on left bank of river, 10¼ miles upstream, Root River, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:
Basilicorhynchus basilicus basilicus

43833 Top of section 23-51, North Nahanni River valley, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:
Basilicorhynchus basilicus regalis

43834 Just east of Nahanni Mountain, North Nahanni River valley, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Basilicorhynchus basilicus interpositus

43835 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Between 898 and 908 feet below top of section. Hume's Shale Zone No. 2=D5. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Gastrodetoechia utahensis rugosa

43836 Short exposure, about 8 miles east of Camsell Bend, Mackenzie River valley, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Basilicorhynchus basilicus basilicus

43837 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T., 90 feet outcrop (highest outcrop of the section), between 88 and 90 feet below top of section, Hume's *Athyris angelica* Zone=D6. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Sinotectirostrum avellana

43838 Short exposure half a mile south of creek on left bank, 10¼ miles upstream, and a mile east of Root River, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Basilicorhynchus basilicus basilicus

62°21′N, 123°44′N, Yohin syncline, North Nahanni River valley, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

43839 1,452 to 1,462 feet from top of section:

Basilicorhynchus basilicus interpositus

43840 1,553 to 1,562 feet from top of the section:

Basilicorhynchus basilicus regalis
Ptychomaletoechia contractiformis

43841 1,613 to 1,622 feet from top of the section:

Basilicorhynchus basilicus interpositus

43842 62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. 90-foot section, between 20 and 30 feet from top of the section, Hume's *Athyris angelica* Zone=D6. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Sinotectirostrum avellana

43844 Right bank of river, 2½ miles below mouth of Root River, Mackenzie River, N.W.T. Hume's *Leiorhynchus* Zone=D4. A. E. H. Pedder (Triad Oil Co. Ltd.), 1960:

Basilicorhynchus basilicus basilicus

44608 63°30′N, 124°30′W, Johnson River area, N.W.T. Varicoloured silty shale with interbeds of coquinoid limestones. Texaco Exploration Co., 1960:

Gastrodetoechia utahensis rugosa
Sinotectirostrum saxirubrum

44837 62°21′N, 123°43′W, Yohin syncline, North Nahanni River Valley, N.W.T. Calcareous siltstone in upper 40 feet of exposed section, Douglas and Norris' (1961) map-unit 24. A. E. Kliske (California Standard Co.), 1951:

Sinotectirostrum avellana

Ridge southeast of Thornton Creek, Jasper National Park, Alberta. Sassenach Formation. D. J. McLaren, 1961:

45867 Between 175 and 200 feet above base of formation:
Eoparaphorhynchus lentiformis

45868 61 feet above base of formation:
Eoparaphorhynchus lentiformis

45879 Mountainside southeast of creek on southeast side of Mount Rajah, Jasper National Park, Alberta. D.J. McLaren, 1961:
Sinotectirostrum banffense banffense

45887 Southeast side of Mount Rajah, Jasper National Park, Alberta. Upper Sassenach Formation. D. J. McLaren, 1961:
Ptychomaletoechia sulculifera

45908 Northwest side of Mount Haultain, Jasper National Park, Alberta. 150 to 154 feet above the base of the Palliser Formation. D. J. McLaren, 1961:
Basilicorhynchus sp. A

45915 Mountain side southeast of creek on southeast side of Mount Rajah, Jasper National Park. Upper Sassenach Formation. D. J. McLaren, 1961:
Sinotectirostrum medicinale medicinale

45919 Ridge southeast of Thornton Creek, Jasper National Park, Alberta. Between 80 and 85 feet above base of the Sassenach Formation. D. J. McLaren, 1961:
Eoparaphorhynchus lentiformis

Face of Ancient Wall, 1½ miles northwest of Camp Creek, Jasper National Park, Alberta. Sassenach Formation. D. J. McLaren, 1961:

45927 Upper 2 feet of formation:
Sinotectirostrum medicinale medicinale

45935 Lower 11 feet of formation:
Sinotectirostrum medicinale medicinale
Ptychomaletoechia sulculifera

45941 Between 11 and 21 feet above base of formation:
Sinotectirostrum medicinale medicinale

48370 52°44′50″N, 117°14′50″W, Brazeau map-area, Alberta. 200 feet above the base of the Sassenach Formation. W. S. MacKenzie, 1961:
Eoparaphorhynchus walcotti
Sinotectirostrum medicinale medicinale
(*Evanescirostrum seversoni*)

48396 Thistle Creek, near headwaters, Brazeau map-area, Alberta. Palliser Formation. W. S. MacKenzie, 1961:
Sinotectirostrum banffense banffense

49559 Cirrus Mountain, ¼ mile northwest of Cirrus Mountain camp site, Banff National Park, Alberta. 16 feet above base of Palliser Formation. D. J. McLaren, 1962:
(*Sinotectirostrum banffense banffense*)

49560 Hillside east of Columbia Icefield Chalet, Jasper National Park, Alberta. Basal 3 feet of the Palliser Formation. D. J. McLaren, 1962:

(Ptychomaletoechia sulculifera)

51561 56°23′N, 123°28′W, Middle–Upper Nabesche River, Halfway River area, British Columbia. Talus probably from about 3,200 to 3,300 feet above base of the section. A. W. Byrne (Texaco Exploration Co.), 1962:

Evanescirostrum sp. A

56149 56°22′N, 123°27′W, ridge, north end of Nabesche River, British Columbia,
56150 Kotcho Formation. D. J. McLaren, 1963:

56154 *Evanescirostrum* sp. A

South face of mountain, 3 miles north–northeast of Elko, Fernie map-area, west half, British Columbia. D. J. McLaren, 1963:

56161 222 to 234 feet below top of the Sassenach Formation:

Eoparaphorhynchus lentiformis

56164 275 to 327 feet below top of the Sassenach Formation:

Sinotectirostrum paucirugosum

50°14.3′N, 115°08.8′W, British Columbia. Approximately middle of Palliser Formation. G. B. Leech, 1963:

57476 *Eoparaphorhynchus lentiformis*

57477 *Basilicorhynchus* sp. A

65089 50°53.1′N, 115°25.6′W, Kananaskis Lakes map-area, west half, Alberta. Palliser Formation. G. B. Leech, 1964:

Ptychomaletoechia sulculifera

Sheep Creek Ridge, Burnt Timber area, Alberta. Costigan Member of the Palliser Formation. N. C. Ollerenshaw, 1965:

69277 *Sinotectirostrum nordeggi*

69278 *Gastrodetoechia utahensis utahensis*

62°21′N, 123°43′W, Yohin syncline, North Nahanni River valley, N.W.T. Douglas and Norris' (1961) map-unit 23. A. E. Kliske (California Standard Co.), 1951:

73020 Shale, 605 to 625 feet below top of exposed section:

Gastrodetoechia utahensis rugosa

73021 Shale and calcareous sandstone, 920 to 935 feet below top of exposed section:

Gastrodetoechia utahensis rugosa

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1922: Exploration east of Mackenzie River, between Simpson and Wrigley; *Geol. Surv. Can.*, Sum. Rept. 1921, Pt. B, pp. 56B–66B.

Wulff, R.

1923: Das Famennien der Aachener Gegend; *Preus. Geol. Landesanstalt*, Jhb. für das Jahr 1922, Bd. XLIII, pp. 1–70.

PLATES I to XIX

All figures are natural size unless otherwise stated

PLATE I

Trifidorostellum dunbarense (Haynes) PAGE 18

Figures 1a–e Holotype. CM No. 2704

Apical, ventral, dorsal, frontal, and lateral views. Ventral, dorsal, and frontal views are not exactly oriented with the plane of commissure horizontal, but the ventral view is oriented as in fig. 8, pl. VIII *in* Haynes, 1916b.

Trifidorostellum cascadense cascadense (Warren) PAGE 22

Figures 2a–e Hypotype A. GSC No. 15525

Apical, ventral, dorsal, frontal, and lateral views. One of the specimens with the greatest number of median costae: 7/6. Figs. 2a and 2c show what is probably a bifurcation of one of the middle costae on the fold; fig. 2c shows also the external adventitious costa on each side of the fold. Figs. 2b and 2d show what might be a bifurcation in the middle of the sulcus; fig. 2d shows also an external adventitious costa on the left side of the sulcus.

Figures 3a–c Hypotype B. GSC No. 15526

Lateral, dorsal, and ventral views of the smallest specimen. Fig. 3c shows the posteriorly projected dorsal umbo.

Figure 4 Hypotype C. GSC No. 15527

Ventral view of the specimen with the greatest number of lateral costae: 6. Apparent bifurcations at the extremities of the lateral costae, as well as in the sulcus, are due to the state of preservation. The dorsal umbo is artificially (by deformation) projected posteriorly.

Figures 5a–e Hypotype D. GSC No. 15528

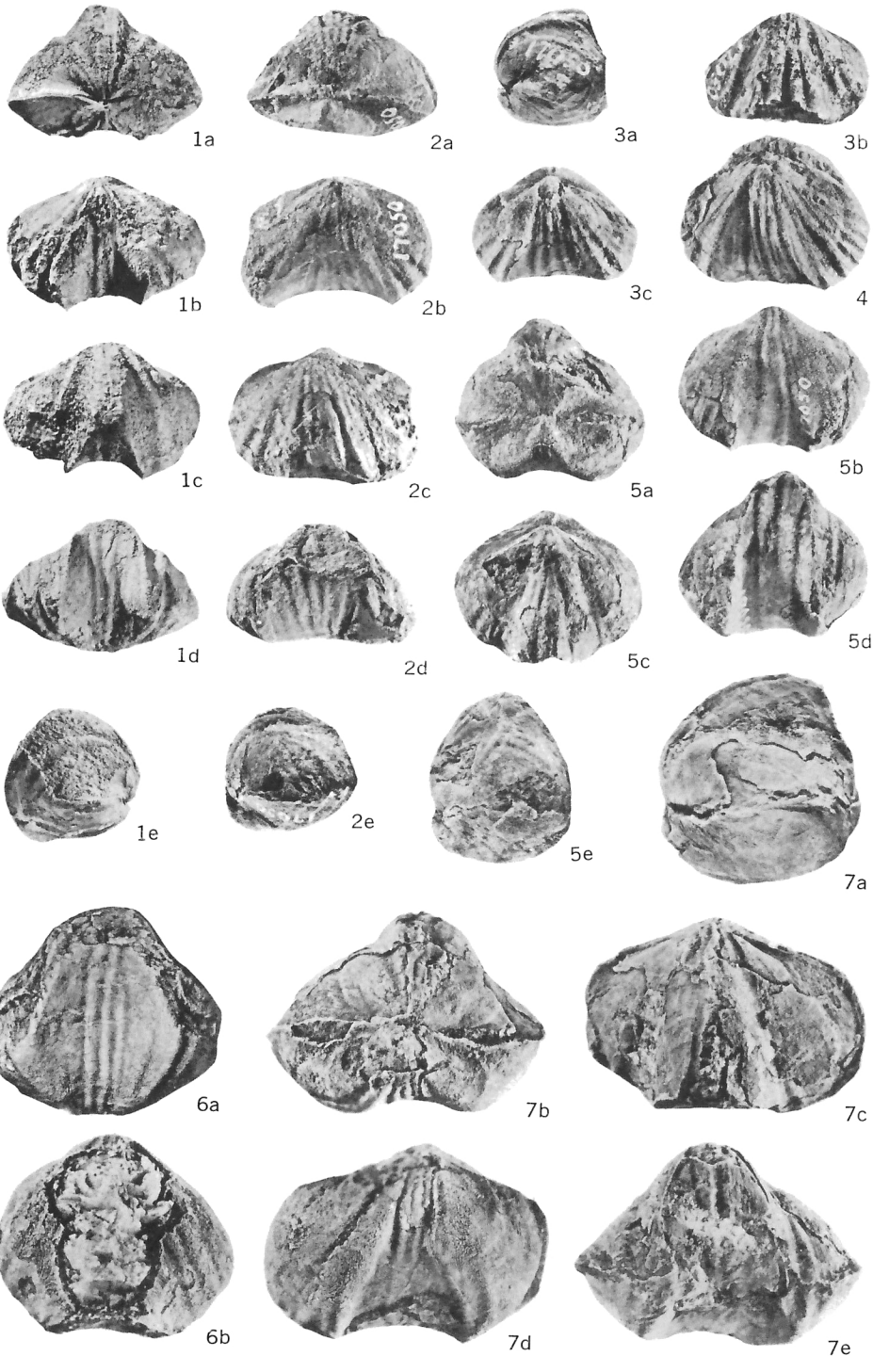
Apical, ventral, dorsal, frontal, and lateral views of a thick specimen. Fig. 5b shows an adventitious costa in the sulcus on the right side.

Figures 6a, b Syntype (paralectotype). GSC No. 8905a

Frontal and dorsal views. The frontal view is slightly oblique as the plane of commissure is not perpendicular to the plane of the photograph. Fig. 6a shows an adventitious costa in the sulcus.

Figures 7a–e Lectotype. GSC No. 8905

Lateral, apical, dorsal, ventral, and frontal views. Figs. 7c and 7e show striae on the right side of the brachial valve near to the commissure.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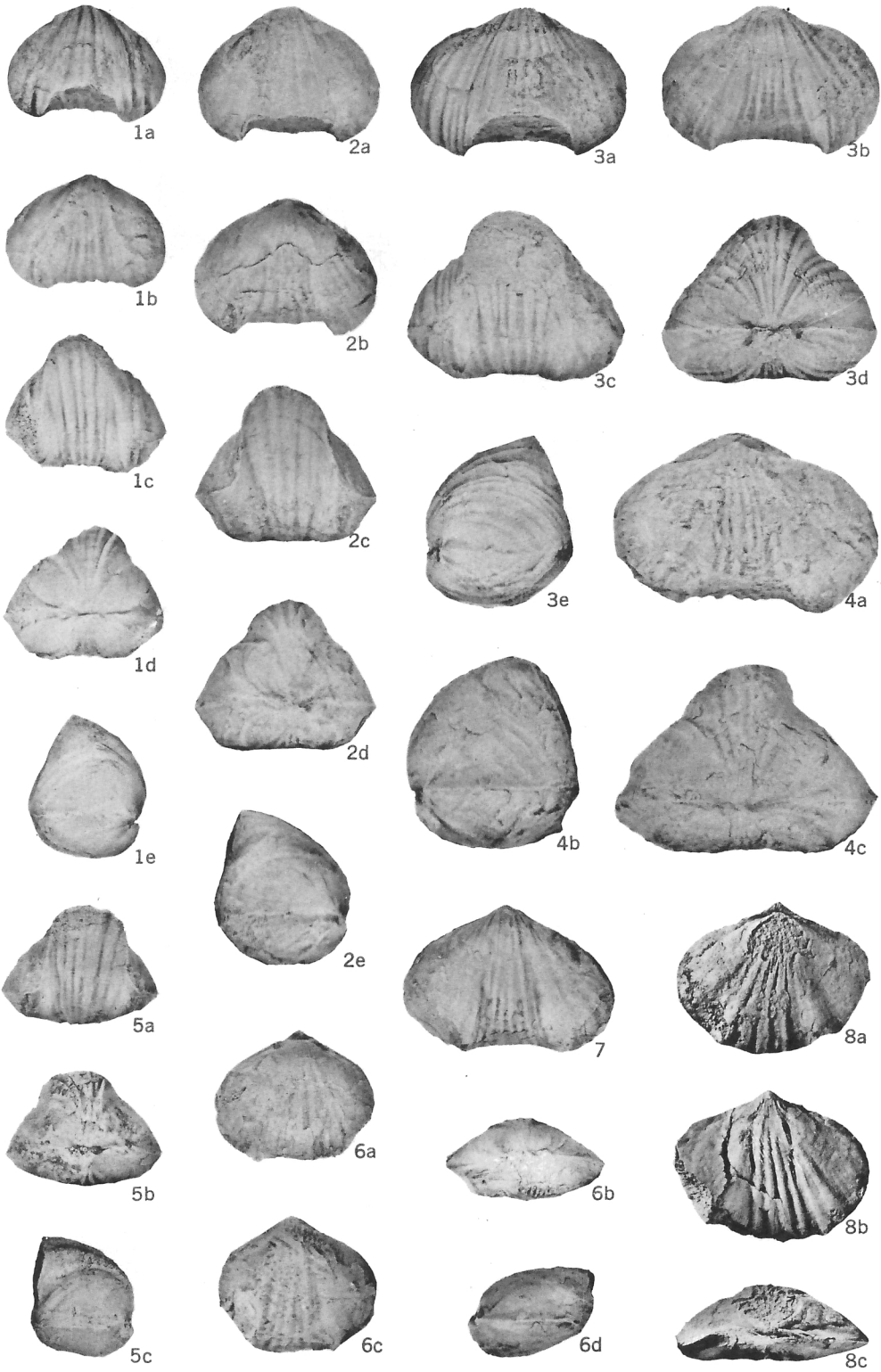
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5c
6c
6d
8c

PLATE II

Trifidorostellum uralicum fontis nov. subsp. PAGE 26

Figures 1a–e — Holotype. PRI No. 6042
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 6/6; 0; 3/4.

Figures 2a–e — Paratype A. USNM No. 154976
Dorsal, ventral, frontal, apical, and lateral views of a mean size specimen; costal formula 6/6; 0; 3/4.

Figures 3a–e — Paratype B. USNM No. 154977
Dorsal, ventral, frontal, apical, and lateral views of a large specimen; costal formula: 7/6; $^{1-1}/_{1-1}$; 7/8. Parietal costae are adventitious.

Figures 4a–c — Paratype C. USNM No. 154978
Ventral, lateral, and apical views of one of the largest specimens in the collections; costal formula: 8/7; ?; 5/6.

Figures 5a–c — Paratype D. USNM No. 154979
Frontal, apical, and lateral views of a small specimen; costal formula: 6/6; $^{1-1}/_{1-1}$; 2/3.

Figures 6a–d — Paratype J. USNM No. 154985
Dorsal, apical, ventral, and lateral views of a specimen with juvenile features; costal formula: 7/6; 0; 1/2.

Figure 7 — Paratype I. USNM No. 154984
Ventral view; costal formula: 8/7; 0; 3/4. The muscle field is vaguely seen.

Rugaltarostrum jeffersonense (Haynes) PAGE 40

Figures 8a–c — Hypotype A. USNM No. 154986
Dorsal, ventral, and apical views of a specimen having not reached adult size.

PLATE III

Rugaltarostrum madisonense (Haynes) PAGE 31

Figures 1a–e — Holotype. CM No. 2701
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/8; 0; 3/?. Lateral costae are only observed on the right dorsal flank; the most internal costa reaches somewhat further than mid-length; the median costa does not reach mid-length; the external costa is a mere indentation of the commissure. The top of the tongue is broken. The holotype is one of the largest specimens.

Figures 2a–d — Paratype. CM No. 2702
Dorsal, ventral, frontal, and lateral views; costal formula: 3/2; $^{0-1}/_{0-1}$; 9/1.

Figures 3a–d — Hypotype L. GSC No. 15676
Dorsal, apical, frontal, and lateral views; costal formula: 3/2; 0; 9/1. Large Canadian specimen. Elevated tongue with borders tending to be parallel. Fig. 3d shows the costellae on the dorsal flank of the shell.

Figures 4a, b — Hypotype E. GSC No. 15669
Dorsal and apical views; costal formula: 5/4; $^{1-1}/_{1-1}$; 9/1.

Figure 5 — Hypotype A. PRI No. 6043
Dorso-lateral view (x 3). This specimen shows an elevated tongue and the costellae (*see also* figs. 18–20, pl. 1 *in* Baldwin, 1943)

Figures 6a–d — Hypotype B. GSC No. 15666
Dorsal, ventral, frontal, and apical views; costal formula: 3/2; 0; 9/1.

Figures 7a, b — Hypotype C. GSC No. 15667
Dorsal and apical views; costal formula: 3/2; 0; 1/2.

Figures 8a–e — Hypotype D. GSC No. 15668
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/8; 0; 4/6. The borders of the tongue tend to be parallel. Figs. 8a, b show a divided costa. The number of lateral costae is different on both flanks (3/4 and 4/6).

Figures 9a, b — Hypotype F. GSC No. 15670
Dorsal and apical views; costal formula: 4/8; $^{0-1}/_{0-1}$; 2/3.

Figures 10a, b — Hypotype H. GSC No. 15672
Dorsal and frontal views; costal formula: 2/1; 0; 9/1. Delthyrium partly closed by deltidial plates.

Figures 11a, b — Hypotype I. GSC No. 15673
Dorsal and ventral views; costal formula: 3/2; 0; 9/1.

Figures 12a–c — Hypotype J. GSC No. 15674
Dorsal, ventral, and frontal views; costal formula: 3/2; 0; 9/1.

Figures 13a, b — Hypotype K. GSC No. 15675
Dorsal and ventral views; costal formula: 3/2; 0; 9/1.

Rugaltarostrum gibbosum (Haynes) PAGE 38

Figures 14a–e — Holotype. CM No. 2703
Lateral, dorsal, ventral, frontal, and apical views; costal formula: 5/4; $^{0-1}/_{0-1}$; 5/6. The "fine radiating striae" mentioned by Haynes (1916b) may be seen on the antero-lateral part of the dorsal flanks.


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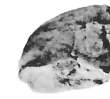
1c


1d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2b


2c

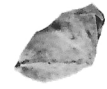

2d


4a


3a


3b


3c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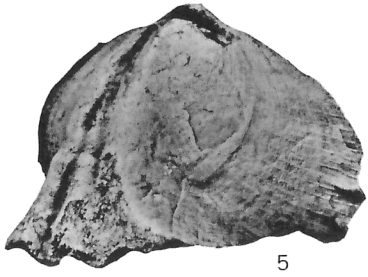
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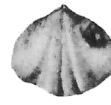
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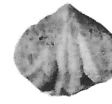
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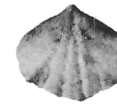
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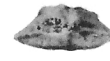
8b


8c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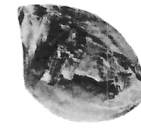
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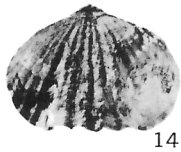
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PLATE IV

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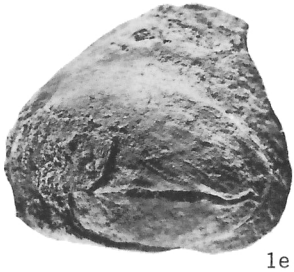

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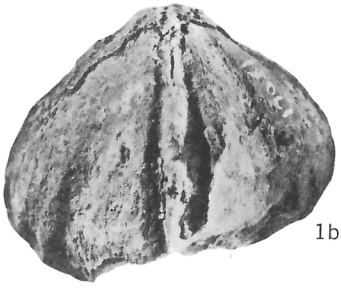

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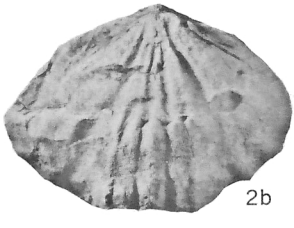

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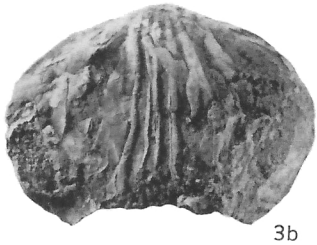

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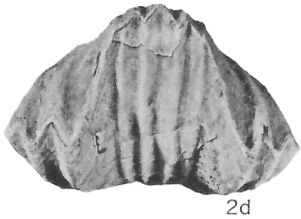
1c

2c

3c

1d



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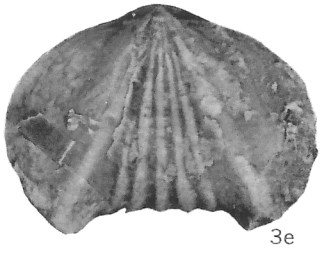
2a

2e



3e

PLATE IV

Megalopterorhynchus haynesi Sartenaer — PAGE 57

Figures 1a–e — Holotype. GSC No. 15692

Ventral, dorsal, apical, frontal, and lateral views; costal formula: 3/2; $^{1-(1)}/_{1-(1)}$; 2/3. Fig. 1e shows an adventitious costa (counted as parietal) on the fold and the posteriorly projected dorsal umbonal region.

Figures 2a–e — Paratype D. GSC No. 15709

Lateral, dorsal, apical, frontal, and ventral views (before sectioning); costal formula: 5/4; 0; 2/3. Figs. 2b, c show the fold starting very near to the beak and two biparted costae on the fold. Fig. 2e shows an intercalated costa on each side in the sulcus. Figs. 2a, d show faint costellae.

Rugaltarostrum jeffersonense (Haynes) — PAGE 40

Figures 3a–e — Holotype. MCZ No. 8762

Lateral, dorsal, apical, frontal, and ventral views. Fig. 3c shows the fold reaching the beak, the sulcus reaching it almost, and two divided costae on the fold. Fig. 3e shows an intercalated costa on each side in the sulcus.

PLATE V

Gastrodetoechia utahensis utahensis (Kindle) PAGE 47

Figures 1a, b — Holotype. USNM No. 62235a

Ventral and frontal views. There are four costae in the sulcus, the external ones being fainter than the internal ones; it is most probable that both the internal costae reach the beak, but one of them is broken at a short distance from it. One of the external costae is also partly absent on account of the fragmental state of the specimen; the other is an intercalated costa that does not reach the beak. A ridge may be seen on the left side bordering the posterior part of the sulcus.

Figures 2a, b — Hypotype L. GSC No. 15544

Ventral and frontal views of a Canadian specimen similar to those of the holotype (figs. 1a, b).

Figure 3 — Paratype B. USNM No. 62235c

Ventral view. Ridges border the posterior part of the sulcus. There are four costae in the sulcus.

Figure 4 — Hypotype M. GSC No. 15545

Ventral view of a Canadian specimen similar to that of paratype B (fig. 3).

Figure 5 — Hypotype K. USNM No. 154992

Apical view of a small specimen with appreciable height.

Figure 6 — Hypotype R. GSC No. 15563

Dorsal view of a Canadian specimen similar to that of paratype A (fig. 9).

Figures 7a–c — Hypotype A=Holotype CM No. 2705 of *Leiorhynchus utahense* var. *ventricosum*

Frontal, lateral, and ventral views. Figs. 7b, c show faint costellae; fig. 7b shows also vascular impressions below the shell. Fig. 7c shows two ridges bordering the sulcus, starting at the beak and disappearing shortly after the beginning of the sulcus.

Figures 8a–d — Hypotype O. GSC No. 15547

Lateral, dorsal, frontal, and apical views.

Figure 9 — Paratype A. USNM No. 62235b

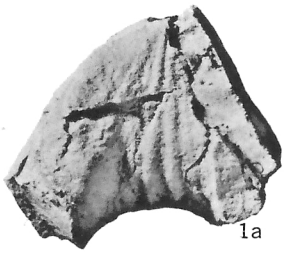
Dorsal view. There are three visible costae on the fold, which is limited on one side—the other side is broken—by a groove.

Figures 10a–c — Hypotype F. GSC No. 11210

Frontal, dorsal, and apical views.

Figures 11a–d — Hypotype G. USNM No. 154990

Ventral, dorsal, apical, and frontal views. The number of median costae is: 5/4. Fig. 11b shows a biparted costa on the right side of the fold. Fig. 11d shows the two external costae of the fold lower than the three others.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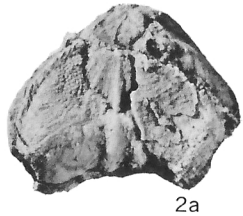
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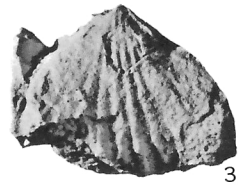
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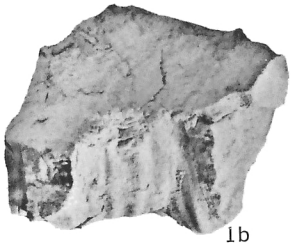
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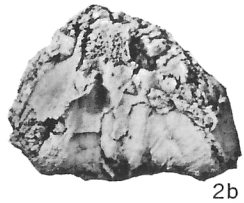
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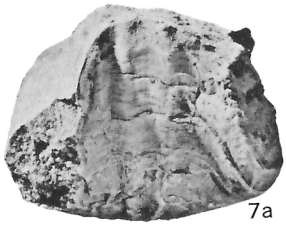
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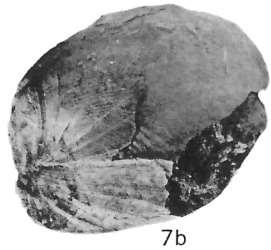
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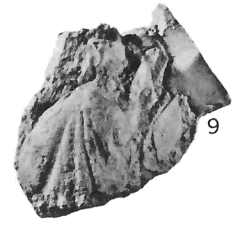
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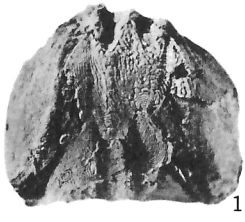
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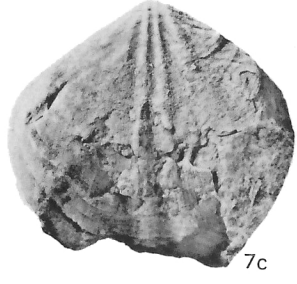
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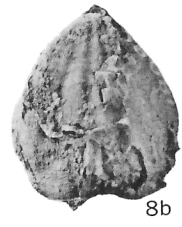
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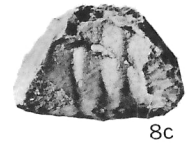
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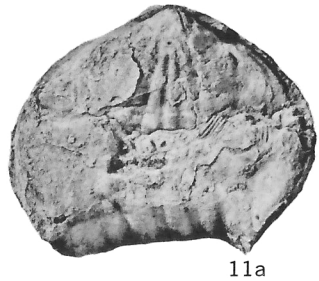
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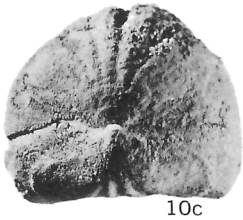
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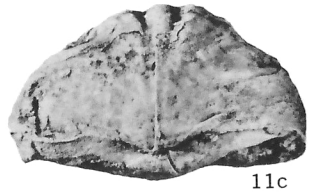
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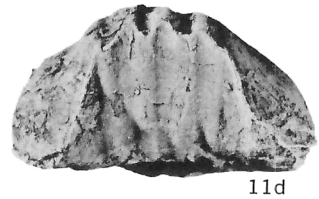
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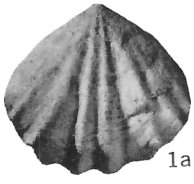
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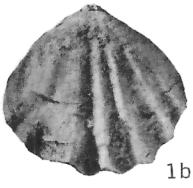
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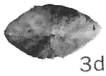
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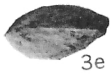
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4


5a


5b


5c


1c


2c


6a


6b

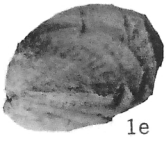

8a


1d


2d


7


8b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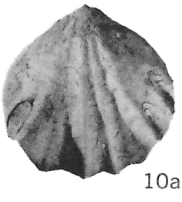
2e


9a


9b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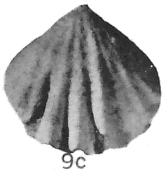
11a


9c


12a


10b


11b


11c


12b

PLATE VI

Eoparaphorhynchus maclareni Sartenaer — PAGE 63

Figures 1a–e — Holotype. GSC No. 15578
Ventral, dorsal, frontal, apical, and lateral views of a specimen with the usual adult size; costal formula: 3½; 0; 2/3.

Figures 2a–e — Paratype C. GSC No. 15581
Ventral, dorsal, frontal, apical, and lateral views of a specimen with the usual adult size; costal formula: 3½; 0; ¾.

Figures 3a–e — Paratype G. GSC No. 15585
Ventral, dorsal, frontal, apical, and lateral views of a young and narrow specimen; costal formula: 3½; 0; ½.

Figure 4 — Paratype M. GSC No. 15591
Dorsal view of a juvenile specimen; costal formula: 3½; 0; 1/1.

Figures 5a–c — Paratype K. GSC No. 15589
Ventral, dorsal, and frontal views of a juvenile specimen; costal formula: 3½; 0; 0.

Figures 6a, b — Paratype H. GSC No. 15586
Ventral and frontal views of a juvenile specimen; costal formula: 3½; 0; ½.

Figure 7 — Paratype S. GSC No. 15597
Frontal view of a wide and large specimen; costal formula: 3½; 0; 2/3. Median costae are irregular. This specimen has the common shape of specimens of *E. walcotti* (Merriam).

Figures 8a, b — Paratype Z. GSC No. 15604
Frontal and lateral views of a high young specimen; costal formula: 3½; 0; ½.

Figures 9a–c — Paratype E. GSC No. 15583
Ventral, lateral, and dorsal views; costal formula: 3½; 0; ¾. The right internal dorsal lateral costa corresponds to a ventral costa in depression in relation to the other lateral costae.

Figures 10a, b — Paratype D. GSC No. 15582
Ventral and frontal views of a specimen of the usual adult size; costal formula: 3½; $^{0-1}/_{0-1}$; 3/3. Median costae are irregular. The number of lateral costae is 3/3 on one side and ½ on the other side. The parietal costae do not reach the beak.

Figures 11a–c — Paratype B. GSC No. 15580
Ventral, apical, and frontal views; costal formula: 3½; 0; ½. The ventral umbonal region is somewhat inflated and the median part of the sulcus is swollen. Median costae are irregular. This specimen is particularly close to any specimen of *E. triaequalis triaequalis* (Gosselet).

Figures 12a, b — Paratype Q. GSC No. 15595
Dorsal and frontal views; costal formula: 4/3; 0; 4/5.

PLATE VII

Gastrodetoechia utahensis rugosa nov. subsp. PAGE 53

Figures 1a–e — Holotype. GSC No. 15857
Ventral, dorsal, frontal, apical, and lateral views; costal formula: 4/8; 0; 3/4 and 4/6.

Figure 2 — Paratype B. GSC No. 15859
Frontal view; costal formula: 2/1; $^{0-1}/_{0-1}$; 2/8.

Figure 3 — Paratype A. GSC No. 15858
Frontal view of a large specimen; costal formula: 4/8; 0; 2/8.

Figure 4 — Paratype C. GSC No. 15860
Frontal view; costal formula: 2/1; 0; 3/8.

Eoparaphorhynchus maclareni Sartenaer PAGE 63

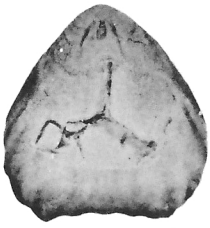
Figures 5a, b — Paratype R. GSC No. 15596
Ventral and lateral views of a high and inflated specimen; costal formula: $^{3+1}/_{2+1}$; 0; 3/4. An adventitious costa may be seen on the lateral view. The number of lateral costae is 3/4 on one side and 2/3 on the other side. The median part of the sulcus is swollen.

Figure 6 — Paratype U. GSC No. 15599
Frontal view; costal formula: 4/8; 0; 2/8. This specimen is very close to some specimens of *E. triaequalis praetriaequalis* (Sartenaer).

Figures 7a, b — Paratype N. GSC No. 15592
Frontal and ventral (x3) views of an inflated specimen; costal formula: 5/4; 0; 3/4. The sulcus has no depth and shows the faint costellae.

Figures 8a–c — Paratype A. GSC No. 15579
Ventral (x3), frontal, and dorsal views of a flat specimen; costal formula: 3/2; 0; 1/2. The faint costellae may be observed in the sulcus and on the brachial valve. Median costae are irregular.

Figures 9a, b — Paratype T. GSC No. 15598
Frontal and dorsal views of a wide and large specimen; costal formula: 3/2; $^{1-0}/_{1-0}$; 3/4. The parietal costae reach the beak. This specimen has the shape common to specimens of *E. walcotti* (Merriam).



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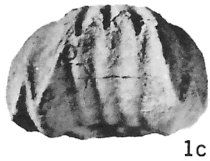

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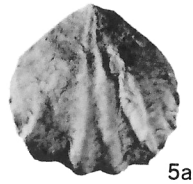


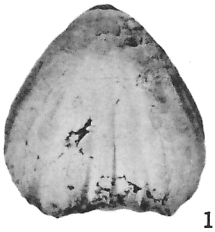
5a

5b

1d

6

7a



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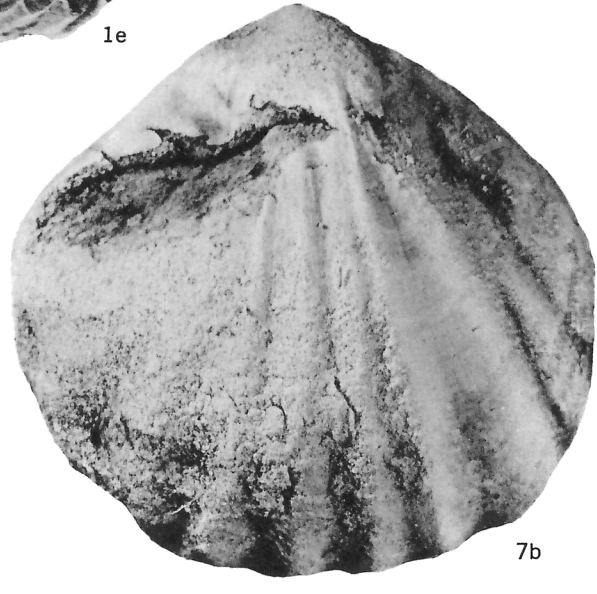
1e

2



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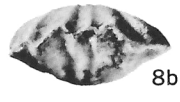
3

4

8a



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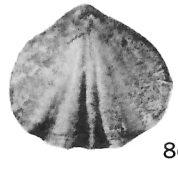

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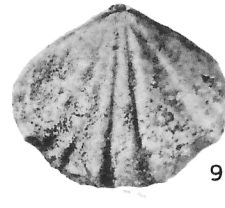

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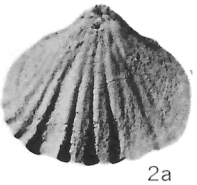
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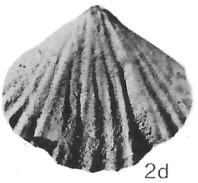
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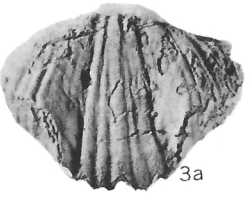
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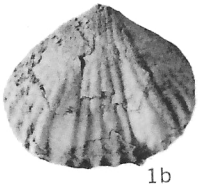
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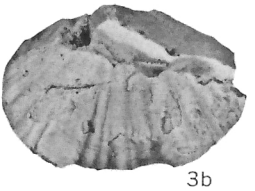
2b


2e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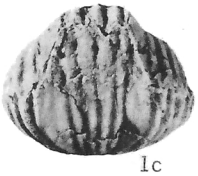
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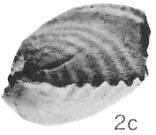
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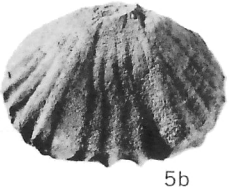
4a


4b


4c


1d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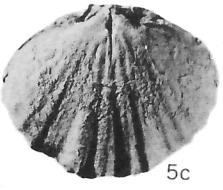
6a


4d


1e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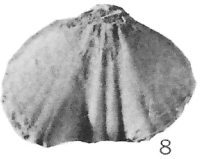
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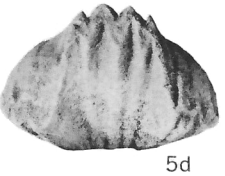
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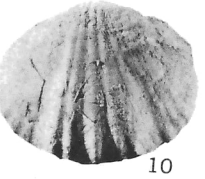
6c


9


7a


7b


6d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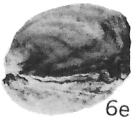
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7d


7e

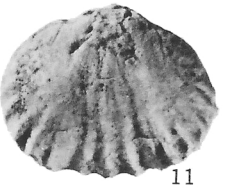
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PLATE VIII

Eoparaphorhynchus walcotti (Merriam) PAGE 72

Figures 1a–e — Hypotype C. USNM No. 154993

Dorsal, ventral, frontal, apical, and lateral views of a high and wide specimen with oval contour; costal formula: 5/4; 0; 7/8. Median costae are irregular. On figure 1c, the ventral internal lateral costae are narrower and depressed in relation to other lateral costae.

Figures 2a–e — Hypotype A. GSC No. 10012

Dorsal, frontal, lateral, ventral, and apical views of a shallow specimen; costal formula: 4/3; $^{0\text{-}1}/_{0\text{-}1}$; 5/6 on one side, 6/7 on the other.

Figures 3a, b — Paratype C. USNM No. 96382c

Frontal and ventral views; costal formula: 6/5; 0; 4/6. Some external "virtual" lateral costae may be seen on the left side of fig. 3b. Two intercalated costae in the sulcus correspond to the two biparted costae on the fold. Median costae are irregular. On the left side of fig. 3a the internal lateral costa is narrower and depressed in relation to other lateral costae.

Figures 4a–d — Hypotype H. GSC No. 15555

Dorsal, ventral, lateral, and frontal views of a young specimen; costal formula: 3/2; $^{1\text{-}0}/_{1\text{-}0}$; (6/7).

Figures 5a–d — Hypotype B. GSC No. 13800

Lateral, ventral, dorsal, and frontal views; costal formula: 4/3; 0; 6/7. Median costae are irregular. On the right side of fig. 5d the ventral internal lateral costa is narrower and depressed in relation to other lateral costae; a corresponding costa may be seen in the brachial valve on fig. 5a.

Figures 6a–e — Hypotype L. GSC No. 15559

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/2; $^{1\text{-}0}/_{1\text{-}0}$; 5/6.

Figures 7a–e — Hypotype I. GSC No. 154995

Lateral, dorsal, apical, ventral, and frontal views; costal formula: 4/3; 0; 5/6. Median costae are irregular.

Figure 8 — Hypotype K. GSC No. 15558

Ventral view; costal formula: 3/2; 0; 7/8. The most internal lateral costa on the left side is the result of a bipartition.

Figure 9 — Paratype A. USNM No. 96382a

Ventral view of a narrow specimen with subcircular contour; costal formula $?/_{1}$; $?/_{(1)\text{-}0}$; 4/6.

Figure 10 — Holotype. USNM No. 96381

Dorsal view; costal formula: 5/4; $^{0\text{-}1}/_{0\text{-}1}$; 6/7 (without the "virtual" costae). Median costae are irregular. The external median costa on the right side is biparted.

Figure 11 — Hypotype J. GSC No. 15557

Ventral view; costal formula: 4/3; $^{1\text{-}0}/_{1\text{-}0}$; 7/8 at least. On the left side the internal lateral costa is narrower and depressed in relation to other lateral costae.

PLATE IX

Eoparaphorhynchus lentiformis (Nalivkin) (*non* Gürich) PAGE 79

Figures 1a–e Hypotype A. GSC No. 15564

Dorsal, ventral, apical, frontal, and lateral views of one of the largest specimens; costal formula: 3/2; 0; 5/6 and 3/4.

Figures 2a–e Hypotype L. GSC No. 10014

Dorsal, ventral, apical, frontal, and lateral views of one of the largest specimens; costal formula: 4/3; 0; 4/5. Dorsal median costae are irregular.

Figures 3a–e Hypotype G. GSC No. 15570

Dorsal, ventral, frontal, apical, and lateral views of a young specimen; costal formula: 3/2; 0; 2/3.

Figures 4a–d Hypotype F. GSC No. 15569

Ventral, apical, frontal, and lateral views of a young specimen; costal formula: 4/3; 0; 2/3.

Figures 5a–d Hypotype B. GSC No. 15565

Lateral (x3), ventral, frontal, and apical views; costal formula: 3/2; 0; 4/5. The costellae are clearly seen on fig. 5a; the growth lines contribute to give a reticulate aspect.

Figures 6a–e Hypotype J. GSC No. 15573

Dorsal, ventral, lateral, frontal, and apical views of the youngest specimen; costal formula: 3/2; 0; 9/1. The internal median costa on the fold is lower than the two others.

Figures 7a–d Hypotype M. GSC No. 15575

Dorsal, ventral, frontal, and apical views; costal formula: 3/2; 0; 2/3. Median dorsal costae are irregular.

Figures 8a–e Hypotype O. GSC No. 15577

Dorsal, ventral, lateral, frontal, and apical views; costal formula: 4/3; 0; 3/4. One divided median costa may be observed on both valves. Median costae are irregular.


1a


2a


3a


3b


3c


1b


2b


4a


3d


3e


1c


2c


4b


4c


4d


1d


2d


5a


1e


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6e


6b


6c


7a

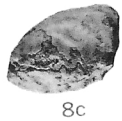

7b


7c


7d


8a


8b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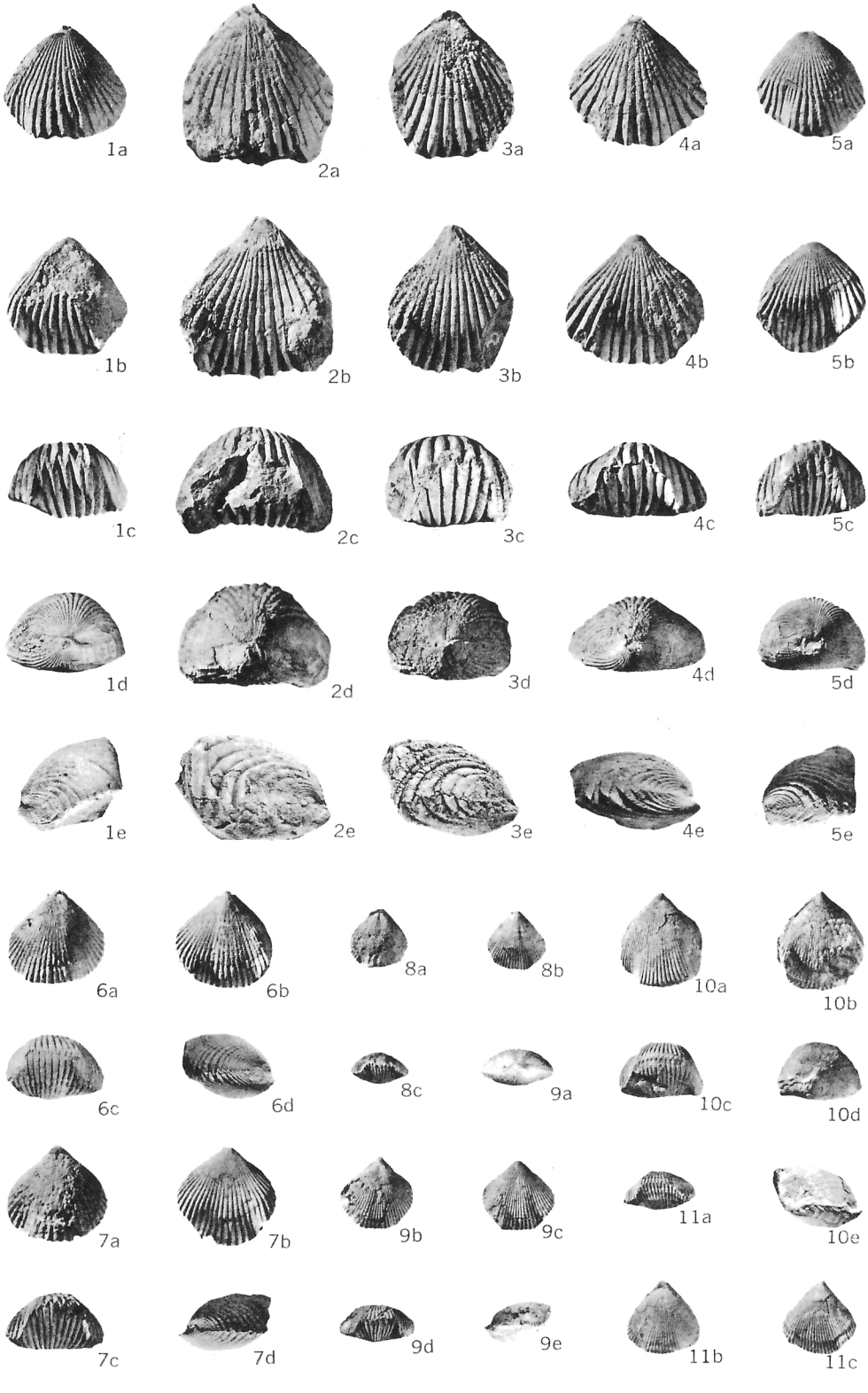
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5b
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2d
3d
4d
5d
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6d
8c
9a
10c
10d
7a
7b
9b
9c
11a
10e
7c
7d
9d
9e
11b
11c

PLATE X

Sinotectirostrum medicinale medicinale Sartenaer — PAGE 84

Figures 1a–e — Holotype. GSC No. 13797

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 7/8; $^{1\text{-}1}/_{1\text{-}1}$; $^{11}/_{12}$.

Figures 2a–e — Paratype A. GSC No. 15648

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 6/8; $^{2\text{-}2}/_{2\text{-}2}$; $^{9}/_{10}$. Figs. 2a,b show the roof-shaped costae.

Figures 3a–e — Paratype B. GSC No. 15649

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 6/8; $^{7\text{-}(2)}/_{?\text{-}(2)}$; ?

Figures 4a–e — Paratype C. GSC No. 15650

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/8; $^{2\text{-}2}/_{2\text{-}2}$; $^{10}/_{11}$. Figs. 4a,c show the borders of the tongue slightly indented by the parietal costae. Figs. 4a,b show the roof-shaped costae.

Figures 5a–e — Paratype D. GSC No. 15651

Dorsal, ventral, frontal, apical, and lateral views; costal formula: 6/8; $^{3\text{-}3}/_{3\text{-}3}$; $^{12}/_{13}$.

Figures 6a–d — Paratype I. GSC No. 15656

Dorsal, ventral, frontal, and lateral views of a juvenile specimen with adult features; costal formula: 6/8; $^{3\text{-}3}/_{3\text{-}3}$; $^{14}/_{15}$.

Figures 7a–d — Paratype J. GSC No. 15657

Dorsal, ventral, frontal, and lateral views of a juvenile specimen with adult features; costal formula: 6/8; $^{2\text{-}2}/_{2\text{-}2}$; $^{14}/_{15}$.

Figures 8a–c — Paratype M. GSC No. 15660

Dorsal, ventral, and frontal views of a juvenile specimen; costal formula: $^{10}/_{8}$; $^{2\text{-}2}/_{2\text{-}2}$; $^{17}/_{18}$.

Figures 9a–e — Paratype L. GSC No. 15659

Apical, dorsal, ventral, frontal, and lateral views of a juvenile specimen; costal formula: $^{11}/_{10}$; $^{2\text{-}2}/_{2\text{-}2}$; $^{15}/_{16}$.

Figures 10a–e — Paratype K. GSC No. 15658

Dorsal, ventral, frontal, apical, and lateral views of a juvenile specimen with adult features; costal formula: $^{14}/_{13}$; $^{4\text{-}3}/_{4\text{-}3}$; $^{15}/_{16}$.

Figures 11a–c — Paratype N. GSC No. 15661

Frontal, dorsal, and ventral views; costal formula: $^{11}/_{10}$; $^{3\text{-}3}/_{3\text{-}3}$; $^{16}/_{17}$.

PLATE XI

Sinotectirostrum mackenziei nov. sp. PAGE 94

Figures 1a–e — Holotype. GSC No. 15698
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 7/6; $^{2-2}/_{2-2}$; $^{12}/_{13}$.

Figures 2a–e — Paratype A. GSC No. 15699
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 7/6; $^{2-2}/_{2-2}$; $^{15}/_{16}$.

Figures 3a–e — Paratype B. GSC No. 15700
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 8/7; $^{2-2}/_{2-2}$; $^{18}/_{19}$.

Figures 4a–d — Paratype G. GSC No. 15705
Dorsal, ventral, frontal, and lateral views of a young specimen; costal formula: 7/6; $^{2-2}/_{2-2}$; $^{15}/_{16}$.

Figures 5a–d — Paratype I. GSC No. 15707
Dorsal, ventral, frontal, and lateral views of a juvenile specimen; costal formula: 6/5; $^{?-2}/_{?-2}$; ?

Figures 6a–c — Paratype H. GSC No. 15706
Dorsal, ventral, and frontal views of a juvenile specimen; costal formula: 6/5; $^{2-2}/_{2-2}$; ?

Sinotectirostrum medicinale deceptum nov. subsp. PAGE 91

Figures 7a–e — Holotype. GSC No. 15892
Lateral, dorsal, ventral, frontal, and apical views; costal formula: 5/4; $^{2-3}/_{2-3}$; $^{19}/_{20}$. Fig. 7c shows some divisions in the lateral costae.

Figures 8a–e — Paratype E. GSC No. 15900
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 5/4; $^{2-2}/_{2-2}$; $^{15+}/_{16+}$.

Figures 9a–e — Paratype A. GSC No. 15893
Dorsal, ventral, frontal, apical, and lateral views of a young specimen; costal formula: 5/4; 0; $^{10}/_{11}$.

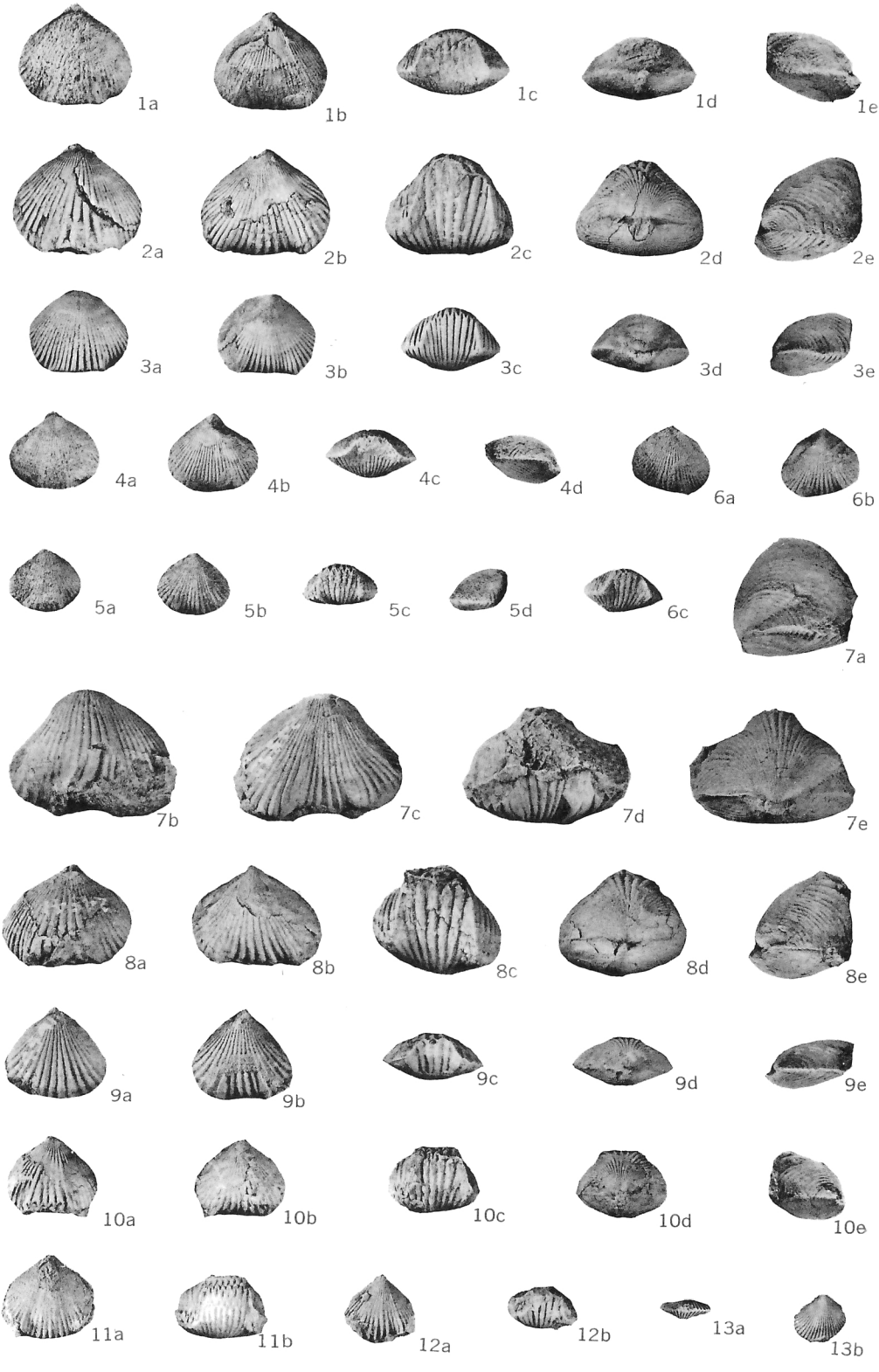
Ptychomaletoechia serva nov. sp. PAGE 160

Figures 10a–e — Holotype. GSC No. 15947
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 5/4; $^{2-2}/_{2-2}$; $^{15}/_{16}$.

Figures 11a, b — Paratype A. GSC No. 15948
Ventral and frontal views; costal formula: 8/7; $^{2-2}/_{2-2}$; $^{13+}/_{14+}$.

Figures 12a, b — Paratype B. GSC No. 15949
Ventral and frontal views; costal formula: 5/4; $^{2-2}/_{2-2}$; $^{16}/_{17}$.

Figures 13a, b — Paratype C. GSC No. 15950
Frontal and ventral views of a juvenile specimen.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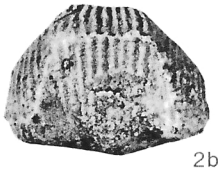
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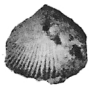
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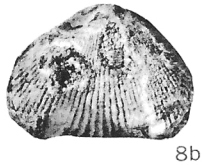
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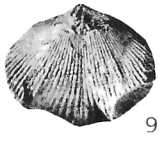
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PLATE XII

Sinotectirostrum nordeggi (Kindle) PAGE 98

Figures 1a–e Lectotype. GSC No. 5821
Dorsal, apical, lateral, ventral, and frontal views; costal formula: $^{11}/_{10}$; $^{3-3}/_{3-3}$; $^{19}/_{20}$. The characteristic parietal costae not indenting the borders of the tongue are very clearly seen.

Figures 2a, b Hypotype B. GSC No. 15627
Dorsal and frontal views of a narrower specimen than the lectotype; costal formula: $^{11}/_{10}$; $^{3-3}/_{3-3}$; ? The contour, in dorsal view, tends to become round.

Figures 3a–e Hypotype A. GSC 15626
Dorsal, ventral, frontal, apical, and lateral views of another specimen narrower than the lectotype. Costal formula: $^{1}/_{8}$; $^{3-3}/_{3-3}$; $^{16}/_{17}$.

Figures 4a, b Hypotype H. PRI No. 6040
Frontal and lateral views of a specimen with juvenile features. Costal formula: $^{18}/_{17}$; $(^{16}/_{17})$. The figures are of a plaster cast made from the original specimen.

Sinotectirostrum banffense banffense (Warren) PAGE 103

Figure 5 Hypotype M. GSC No. 15633
Dorsal view of a juvenile specimen.

Figures 6a–e Holotype. GSC No. 8903
Dorsal, ventral, apical, frontal, and lateral views; costal formula: $^{8}/_{8}$; $^{2-2}/_{2-2}$; $^{13}/_{14}$.

Figures 7a–e Hypotype A. GSC No. 5821a
Dorsal, ventral, apical, frontal, and lateral views; costal formula: $^{7}/_{8}$; $^{4-4}/_{4-4}$; $^{10}/_{11}$.

Figures 8a–c Hypotype B. GSC No. 4570
Dorsal, ventral, and frontal views; costal formula: $^{8}/_{8}$; $^{4-4}/_{4-4}$; $^{15}/_{(16)}$.

Sinotectirostrum banffense shimeri (Warren) PAGE 109

Figures 9a–e Lectotype. GSC No. 8904
Lateral, dorsal, apical, ventral, and frontal views; costal formula: $^{8}/_{8}$; $^{4-4}/_{4-4}$; $^{(20)}/_{21}$.

PLATE XIII

Sinotectirostrum banffense banffense (Warren) PAGE 103

Figures 1a–c Hypotype G. GSC No. 15638
Dorsal, ventral, and frontal views; costal formula: 7/6; $^{3-3}/_{3-3}$; $^{13}/_{14}$.

Figures 2a–c Hypotype H. GSC No. 15639
Dorsal, ventral, and frontal views; costal formula: 7/6; $^{2-2}/_{2-2}$; $^{14}/_{15}$.

Figures 3a–c Hypotype I. GSC No. 15640
Dorsal, ventral, and frontal views; costal formula: 7/6; $^{3-4}/_{3-4}$; $^{10}/_{11}$.
Figs. 1 to 3 correspond to specimens from the same bed and show the variability of the dimensions.

Figures 6a–d Hypotype E. GSC No. 15636
Dorsal, frontal, apical, and lateral views; costal formula: 8/7; $^{3-3}/_{3-3}$; $^{10}/_{11}$.

Figures 7a–d Hypotype J. GSC No. 15641
Dorsal, frontal, ventral, and lateral views; costal formula: 8/7; $^{4-4}/_{4-4}$; $^{14}/_{15}$.

Sinotectirostrum banffense shimeri (Warren) PAGE 109

Figures 4a–e Hypotype D. GSC No. 15646
Dorsal, frontal, ventral, apical, and lateral views of a juvenile specimen. Median, parietal, and lateral costae cannot be separated.

Figures 5a, b Hypotype C. GSC No. 15645
Ventral and frontal views of a juvenile specimen. Median + parietal costae: $^{13}/_{12}$. Lateral costae: ?

Figures 8a–d Syntype (=paralectotype). GSC No. 8904a
Dorsal, ventral, frontal, and lateral views of a juvenile specimen. Median + parietal costae: $^{13}/_{12}$. Lateral costae: $^{15}/_{16}$.

Sinotectirostrum medicinale medicinale Sartenaer PAGE 84

Figures 9a–c Paratype E. GSC No. 15652
Dorsal, ventral, and frontal views; costal formula: $^{11}/_{10}$; $^{2-2}/_{2-2}$; ?

Figures 10a–e Paratype O. GSC No. 15662
Dorsal, ventral, lateral, frontal, and apical views of a juvenile specimen; costal formula: 6/5; $^{1-2}/_{1-2}$; $^{15}/_{16}$.

Figures 11a, b Paratype P. GSC No. 15663
Ventral and frontal views of a juvenile specimen. Median + parietal costae: $^{13}/_{12}$. Lateral costae: $^{14}/_{15}$.

Figures 12a–d Paratype H. GSC No. 15655
Dorsal, frontal, ventral, and apical views of a juvenile specimen. Median + parietal costae: $^{11}/_{10}$. Lateral costae: $^{13}/_{14}$.

Figures 13a–d Paratype G. GSC No. 15654
Apical, dorsal, ventral, and frontal views of a juvenile specimen; costal formula: 6/5; $^{2-2}/_{2-2}$; $^{12}/_{13}$.

Figures 14a–c Paratype F. GSC No. 15653
Ventral, frontal, and lateral views; costal formula: 8/7; $^{2-2}/_{2-2}$; $^{11}/_{12}$.


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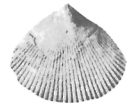
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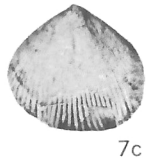
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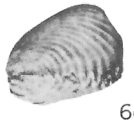
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PLATE XIV

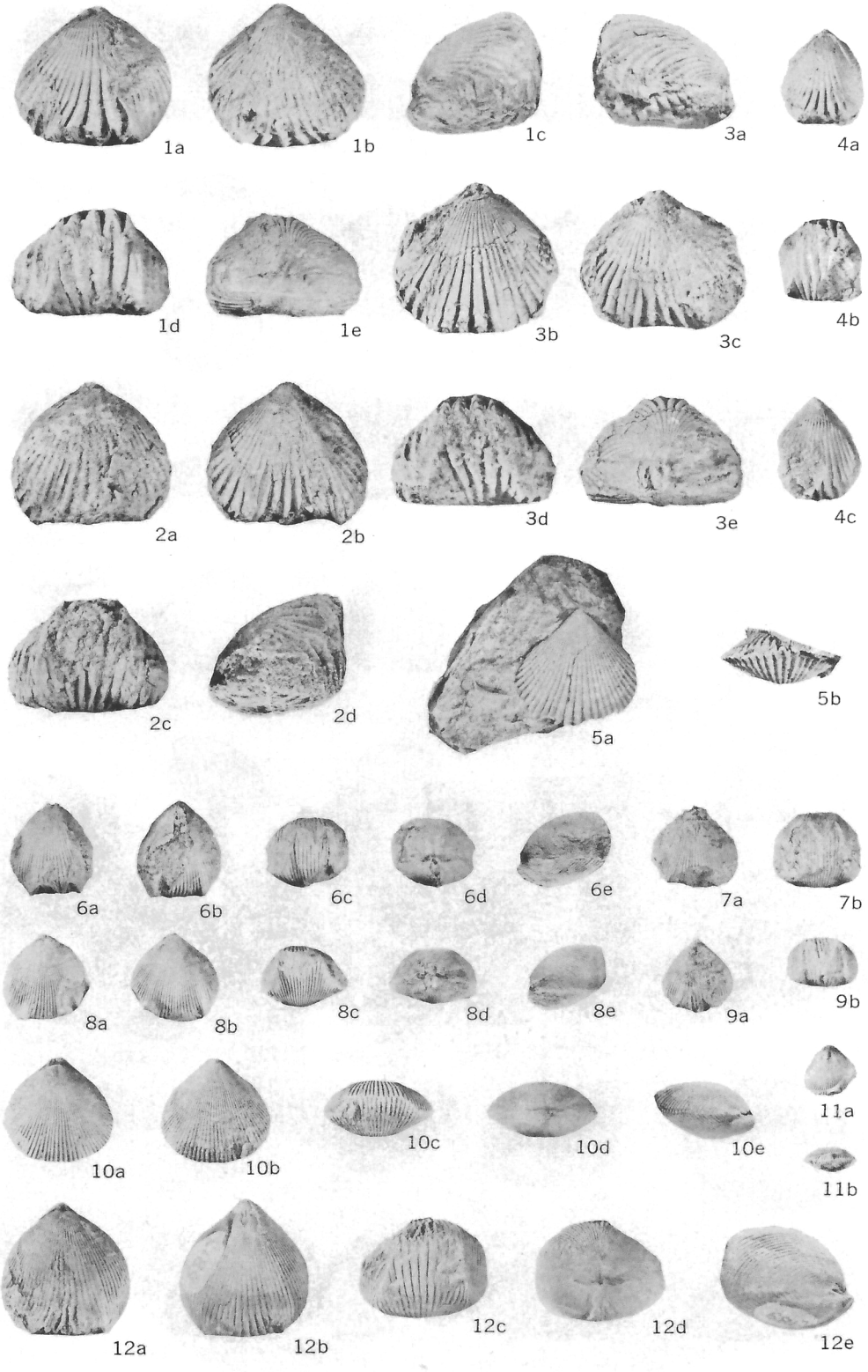
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PLATE XIV

Sinotectirostrum saxirubrum nov. sp. PAGE 113

Figures 1a–e — Holotype. GSC No. 15863
Dorsal, ventral, lateral, frontal, and apical views; costal formula: 5/4; 3-3/3-3; 17/18.

Figures 2a–d — Paratype B. GSC No. 15865
Dorsal, ventral, frontal, and lateral views; costal formula: 5/4, 2-2/2-2; 15/16.

Figures 3a–e — Paratype A. GSC No. 15864
Lateral, dorsal, ventral, frontal, and apical views; costal formula: 5/4; 2-2/2-2; 15/16.

Figures 4a–c — Paratype H. GSC No. 15871
Dorsal, frontal, and ventral views of a juvenile specimen; costal formula: 6/5; 3-?/3-?; 20/21.

Figures 5a, b — Paratype F. GSC No. 15869
Ventral and frontal views of a juvenile specimen. Distinction between median, parietal, and lateral costae is not possible.

Sinotectirostrum avellana nov. sp. PAGE 116

Figures 6a–e — Holotype. GSC No. 15873
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 11/10; 3-3/3-3; 23/24. The median depression of the anterior part of the fold and the convexity of the sulcus are clearly seen.

Figures 7a, b — Paratype A. GSC No. 15874
Dorsal and frontal views; costal formula: 13/12; 4-4/4-4; 18/19. The median depression of the anterior part of the fold is clearly seen.

Figures 8a–e — Paratype G. GSC No. 15880
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 13/12; 4-4/4-4; 20/21.

Figures 9a, b — Paratype E. GSC No. 15878
Dorsal and frontal views of a juvenile specimen; costal formula: 9/8; 4-3/4-3; 14/15. The median fold and the median sulcus in the anterior part respectively of the sulcus and the fold are clearly seen.

Figures 10a–e — Paratype B. GSC No. 15875
Dorsal, ventral, frontal, apical, and lateral views of a flat specimen; costal formula: 13/12; 3-3/3-3; 24/25. The indentation of the borders of the tongue by the parietal costae indicates the maintenance of a juvenile character.

Figures 11a, b — Paratype F. GSC No. 15879
Dorsal and frontal views of a juvenile specimen.

Figures 12a–e — Paratype H. GSC No. 15881
Dorsal, ventral, frontal, apical, and lateral views of the largest specimen; costal formula: 8/7; 4-4/4-4; 21/22.

Plate XV

Ptychomaletoechia contractiformis nov. sp. — Page 149

Figures 1a–e — Holotype. GSC No. 15926
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/2; $^{1\text{-}1}/_{1\text{-}1}$; $^{6+}/_{7+}$.

Figures 2a–e — Paratype A. GSC No. 15927
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 2/1; $^{1\text{-}1}/_{1\text{-}1}$; $^{6+}/_{7+}$.

Figures 3a–e — Paratype D. GSC No. 15930
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/2; $^{1\text{-}2}/_{1\text{-}2}$; $^{7+}/_{8+}$.

Figures 5a–c — Paratype B. GSC No. 15928
Dorsal, ventral, and frontal views; costal formula: 3/2; $^{1\text{-}1}/_{1\text{-}1}$; $^{7+}/_{8+}$.

Figures 6a–c — Paratype C. GSC No. 15929
Dorsal, ventral, and frontal views; costal formula: 3/2; $^{1\text{-}1}/_{1\text{-}1}$; $^{7+}/_{8+}$.

Figures 7a–e — Paratype E. GSC No. 15931
Dorsal, ventral, frontal, apical, and lateral views of a juvenile specimen; costal formula: 3/2; $^{1\text{-}1}/_{1\text{-}1}$; 8/9.

Figures 8a–c — Paratype G. GSC No. 15933
Lateral, dorsal, and ventral views of a juvenile specimen.

Figures 9a–d — Paratype F. GSC No. 15932
Dorsal, frontal, apical, and lateral views of a specimen with juvenile features: costal formula: 6/5; 0; $^{12}/_{13}$.

Ptychomaletoechia finitima nov. sp. — Page 168

Figures 4a–e — Holotype. GSC No. 20637
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/3; $^{1\text{-}1}/_{1\text{-}1}$; $^{13}/_{14}$.

Figures 12a–e — Paratype A. GSC No. 20638
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 5/4; $^{1\text{-}1}/_{1\text{-}1}$; $^{17}/_{18}$.

Sinotectirostrum montosum nov. sp. — Page 120

Figures 10a–e — Holotype. GSC No. 15883
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 8/7; $^{2\text{-}2}/_{2\text{-}2}$; $^{13}/_{14}$.

Figures 11a–e — Paratype A. GSC No. 15885
Dorsal, ventral, frontal, apical, and lateral views of a juvenile specimen; costal formula: 6/5; $^{1\text{-}2}/_{1\text{-}2}$; $^{15}/_{16}$.

"Pugnax" rara nov. sp. — Page 174

Figures 13a–e — Holotype. GSC No. 20643
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/2; $^{1\text{-}1}/_{1\text{-}1}$; 3/4.

Figures 14a–e — Paratype A. GSC No. 20644
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/2; 0; 2/3.

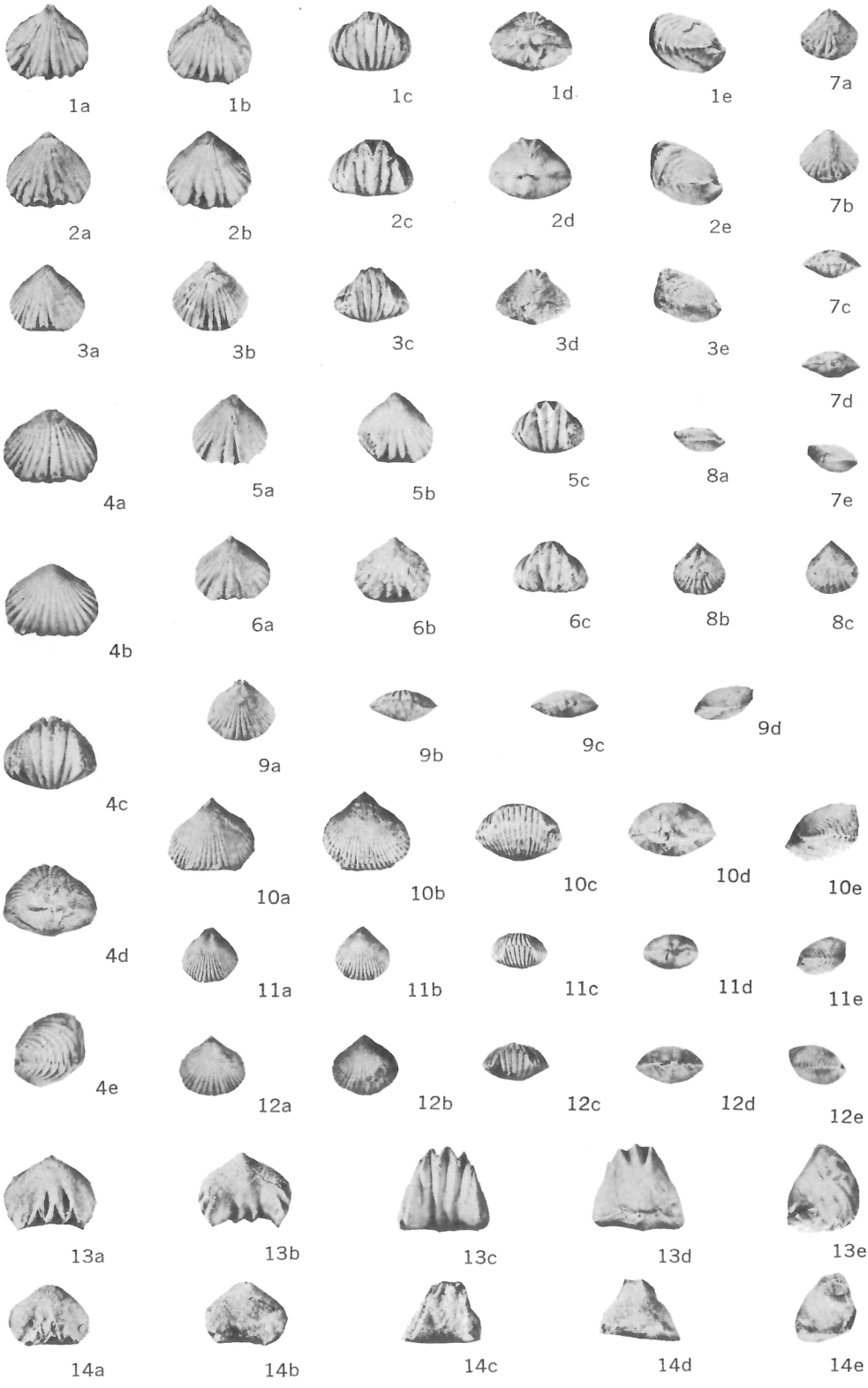
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PLATE XVI


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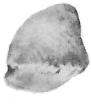
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13c

13d

13e

PLATE XVI

Ptychomaletoechia sulculifera nov. sp. PAGE 155

Figures 1a–e — Holotype. GSC No. 15935
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 5/4; 1-1/1-1; 15/16.

Figures 2a–e — Paratype A. GSC No. 15936
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 5/4; 8-8/8-8; 13/14.

Figures 3a–e — Paratype B. GSC No. 15937
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 8-8/8-8; ?. The ventral muscle field is vaguely seen on fig. 3b.

Figures 4a–e — Paratype E. GSC No. 15940
Dorsal, ventral, apical, frontal, and lateral views of one of the largest specimens in the collection; costal formula: 6/5; 2-2/2-2; 16/17.

Figures 5a–e — Paratype F. GSC No. 15941
Dorsal, ventral, apical, frontal, and lateral views of a juvenile specimen with adult features; costal formula: 4/3; 2-2/2-2; 9+/10+.

Figures 6a–d — Paratype H. GSC No. 15943
Dorsal, ventral, frontal, and lateral views; costal formula: 4/3; 2-2/2-2; 13/14.

Figures 7a, b — Paratype G. GSC No. 15942
Dorsal and lateral views of the largest specimen; costal formula: 5/4; 8-8/8-8; 15/16.

Figures 8a, b — Paratype J. GSC No. 15945
Ventral and frontal views of an adult specimen with juvenile features; costal formula: 6/5; 1-1/1-1; 21/22.

Figures 9a–d — Paratype I. GSC No. 15944
Dorsal, ventral, frontal, and lateral views of a juvenile specimen.

Figures 10a, b — Paratype K. GSC No. 15946
Frontal and dorsal views; costal formula: 4/3; 8-?/8-?; ?. This is the photograph of a plaster cast, the specimen having been ground for serial sections (*see* Text-fig. 35).

Ptychomaletoechia summa nov. sp. PAGE 166

Figures 11a–d — Paratype A. GSC No. 20633
Dorsal, ventral, apical, and lateral views; costal formula: 3/2; 2-2/2-2; 10/11.

Figures 12a–d — Paratype E. GSC No. 15884
Dorsal, ventral, frontal, and lateral views; costal formula: 6/5; 2-2/2-2; 14/15.

Figures 13a–e — Holotype. GSC No. 20632
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 3-3/3-3; 12/13.

PLATE XVII

Evanescirostrum seversoni (McLaren) PAGE 126

Figures 1a–e — Holotype. GSC No. 10016
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 8/2; 0; 2/3.

Figures 2a–e — Hypotype L. GSC No. 15620
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 2/1; 0; 2/3.

Figures 3a–d — Hypotype B. GSC No. 15610
Dorsal, ventral, lateral, and frontal views; costal formula: 8/2; 0; 2/3.

Figures 4a, b — Hypotype A. GSC No. 15609
Dorsal and frontal views of one of the largest specimens available; costal formula: 3/2; 0; 2/3.

Figures 5a–c — Hypotype O. GSC No. 15623
Dorsal, ventral, and frontal views; costal formula: 3/2; 0; 2/3. One costa is biparted on the fold and corresponds to an intercalated costa in the sulcus.

Figure 6 — Hypotype H. GSC No. 15616
Frontal view of a juvenile specimen having already developed a noticeable height; costal formula: 2/1; 0; 1/2.

Figures 7a–d — Hypotype J. GSC No. 15618
Dorsal, ventral, frontal, and lateral views of a juvenile specimen; costal formula: 3/2; 0; 0.

Figures 8a–d — Hypotype K. GSC No. 15619
Dorsal, ventral, frontal, and apical views of a juvenile specimen; costal formula: 3/2; 0; 0.

Figures 9a, b — Hypotype F. GSC No. 15614.
Ventral and frontal views of a juvenile specimen with adult features; costal formula: 3/2; 0; 2/3.

Figures 10a, b — Hypotype N. GSC No. 15622
Ventral and frontal views; costal formula: 3/2; 0; 2/3.
Figure 10a shows the sulcus beginning at 3/4 of the length of the shell.

Figures 11a–e — Paratype. GSC No. 10017
Frontal, dorsal, ventral, apical, and lateral views; costal formula: 3/2; 0; 2/3.


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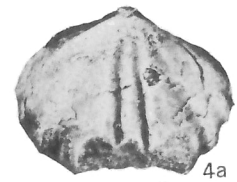
3a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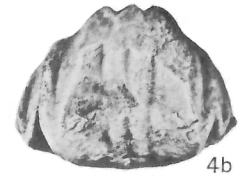
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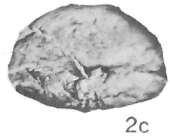
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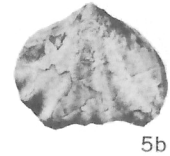
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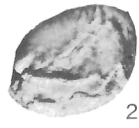
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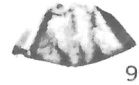
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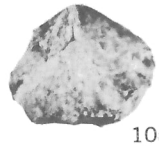
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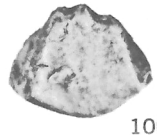
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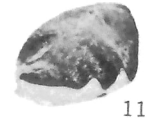
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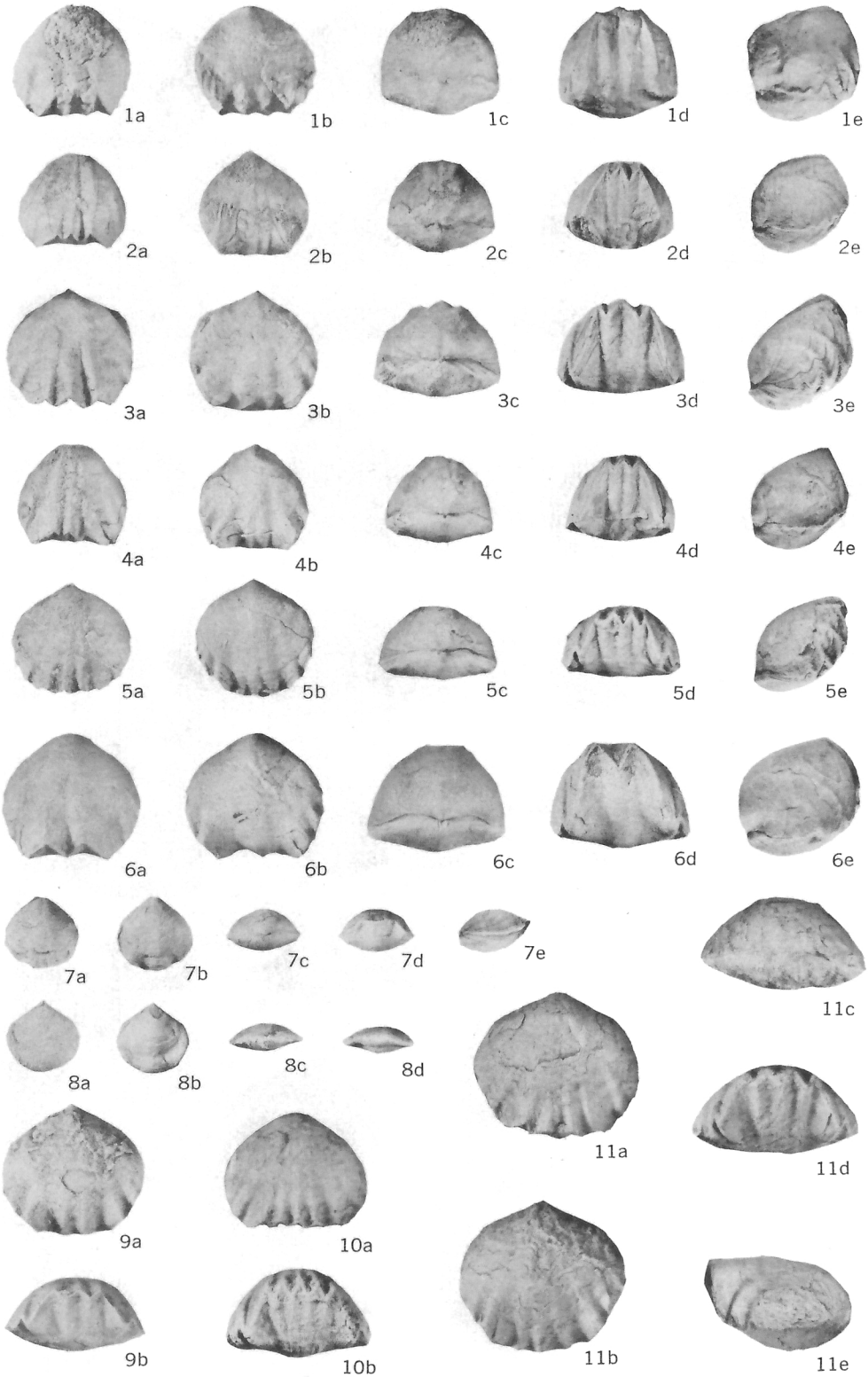
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7e
11c
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8b
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11a
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10b
11b
11e

PLATE XVIII

Basilicorhynchus basilicus basilicus (Crickmay) PAGE 135

Figures 1a–e Holotype. PRI No. 26934
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 3/2; 0; 5/6 and 6/7.

Figures 2a–e Hypotype E. GSC No. 15909
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 3/2; 0; 4/5.

Basilicorhynchus basilicus interpositus nov. subsp. PAGE 141

Figures 3a–e Holotype. GSC No. 15916
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 3/2; 0; 3/4.

Figures 4a–e Paratype B. GSC No. 15918
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 3/2; 0; 3/4.

Figures 5a–e Paratype C. GSC No. 15919
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 0; 3/4 and 5/6.

Figures 6a–e Paratype A. GSC No. 15917
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 2/1; 0; 3/4.

Figures 7a–e Paratype D. GSC No. 15920
Dorsal, ventral, apical, frontal, and lateral views of a juvenile specimen; costal formula: 2/1; 0; 0.

Figures 8a–d Paratype E. GSC No. 15921
Dorsal, ventral, apical, and frontal views of a juvenile specimen.

Basilicorhynchus basilicus regalis nov. subsp. PAGE 144

Figures 9a, b Paratype A. GSC No. 15923
Ventral and frontal views; costal formula: 3/2; 0; 2/3.

Figures 10a, b Paratype B. GSC No. 15924
Dorsal and frontal views; costal formula: 5/4; 0; 3/4.

Figures 11a–e Holotype. GSC No. 15922
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 0; 3/4.

PLATE XIX

Evanescirostrum sp. A — PAGE 132

Figures 1a–e — GSC No. 15521
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 3/3; 0; 3/4.

Sinotectirostrum paucirugosum nov. sp. — PAGE 123

Figures 2a–e — Holotype. GSC No. 15901
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/3; $^{1-1}/_{1-1}$; 5/6 or 5/4; $^{0-1}/_{0-1}$; 5/6.

Ptychomaletoechia septentrionalis nov. sp. — PAGE 162

Figures 3a–e — Holotype. GSC No. 20621
Dorsal, ventral, frontal, apical, and lateral views; costal formula: 4/3; 0; 7/8.

Figures 4a–e — Paratype B. GSC No. 20623
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 0; 7/8.

Figures 5a–e — Paratype D. GSC No. 20625
Dorsal, ventral, apical, frontal, and lateral views; costal formula: 4/3; 0; 5/6.

Figures 6a–c — Paratype A. GSC No. 20622
Dorsal, ventral, and frontal views; costal formula: 4/3; 0; 6/7.

"Plectorhynchella" montifelicitatis nov. sp. — PAGE 171

Figures 7a–e — Holotype. GSC No. 15522
Dorsal, ventral, lateral, apical, and frontal views; costal formula: 6/5; 0; $^{(1)}/_{(1)}$.

Figures 8a–d — Paratype A. GSC No. 15524
Ventral, dorsal, frontal, and apical views; costal formula: 6/5; 0; 5/?.

Figures 9a–c — Paratype B. GSC No. 15539
Ventral, apical, and lateral views; costal formula: $^{(4)}/_{(4)}$; 0; 0.


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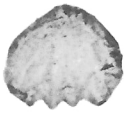
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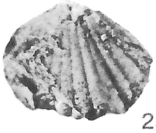
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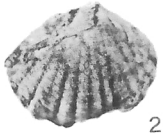
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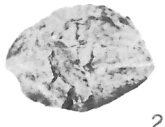
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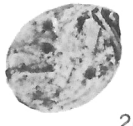
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3b


3c


3d


3e


4a


4b


4c

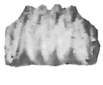

4d


4e


5a


5b


5c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6a


6b


6c


8a


8b


7a

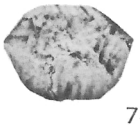

7b


7c


8c


8d


7d


7e


9a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9c

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Numbers in **bold face** type indicate pages where taxa are described

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