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CONODONTS FROM A PLATFORM-TO-BASIN TRANSECT, LOWER ORDOVICIAN TO LOWER SILURIAN, NORTHEASTERN BRITISH COLUMBIA, CANADA[1]

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ABSTRACT—The conodont fauna from nine sections across a platform-to-basin transect in northeastern British Columbia includes species of Early Ordovician (Tremadocian) to Early Silurian (Llandovery) age. A collection of 9,110 conodont elements was recovered from 205 samples taken from nine stratigraphic sections that preserve the platform succession of the Kechika, Skoki, Beaverfoot, McCusker and Nonda Formations and their off-shelf equivalents, the Ospika, Robb, Kenny and Laurier Formations of the Road River Group. The fauna is assigned to 106 species representing 67 genera; the Ordovician species are representative of two faunal realms. One new genus, left in open nomenclature, is described. Five new species include *Drepanoistodus latus* and four new species left in open nomenclature assigned to the following genera: *Walliserodus*, *Multioistodus*?, *Pseudooneotodus*, and *Belodina*. The Midcontinent Realm zones recognized include, in ascending order, the *Acodus kechikaensis*, *Oepikodus communis*, *Jumudontus gananda*, *Tripodus laevis* to *Plectodina aculeata* zones, *Phragmodus undatus* and *Gamachignathus ensifer*? zones. Zonal species of the Atlantic Realm are *Microzarkodina flabellum*, *Eoplacognathus suecicus*, *Baltoniodus variabilis*, *Pygodus anserinus*, and *Amorphognathus tvaerensis*. The Silurian fauna, of lower diversity than the Ordovician fauna, is representative of the *Distomodus staurognathoides* and *Pterospathodus amorphognathoides* zones.

INTRODUCTION

CONODONTS FROM Lower Ordovician to Lower Silurian strata across a platform-to-basin transect in remote northeastern British Columbia, Canada, are described. Nine well-exposed stratigraphic sections were examined (Fig. 1) in which over 7,000 m of strata were measured and described and a total of 205 conodont samples (4–5 kg each) collected. The platform succession is over 2,000 m thick and is represented by the Kechika, Skoki, Beaverfoot, McCusker, and Nonda Formations and their off-shelf equivalents, the Ospika, Robb, Kenny, and Laurier Formations of the Road River Group (Fig. 2). Many of these formations have been revised or have been named formally by Pyle and Barnes (2000, 2001). Few detailed biostratigraphic studies have been conducted for this part of the lower Paleozoic stratigraphic succession. This study builds on the biostratigraphic framework established by Pyle and Barnes (2002) for a separate transect in northeastern British Columbia located approximately 100 km to the north.

The Ordovician faunas described herein represent both the Midcontinent and Atlantic faunal realms. The well preserved conodont fauna is most diverse and abundant within the *Acodus kechikaensis* Zone (of Pyle and Barnes, 2002) in the Kechika Formation (Arenigian). In contrast, conodont abundance decreases in the Skoki Formation (*Oepikodus communis* to *Pygodus anserinus* zones, Arenigian to Caradocian). Both diversity and abundance decrease in the Beaverfoot Formation (*Plectodina aculeata* to *Phragmodus undatus* Zones, Caradocian) and are also low in the Llandovery, within the *Distomodus staurognathoides* and *Pterospathodus amorphognathoides* zones (Fig. 2). A total of 9,110 conodont elements are assigned to 106 species representing 67 genera (Tables 1–12, available on the Journal of Paleontology's Supplemental Database (www.journalofpaleontology.org)). This paper illustrates and documents the conodont fauna and the biostratigraphic distributions. Most species present are well known and require only brief taxonomic remarks. The Ordovician-Silurian conodont biostratigraphic framework established from the transect provides temporal constraints of platformal, slope, and basinal units from a remote, alpine region where there have been few previous biostratigraphic studies.

LITHOSTRATIGRAPHY

Stratigraphy.—The study area in remote northeastern British Columbia includes nine key sections, totaling over 7,000 m of strata, that span a northeast-southwest, platform-shelfbreak-basin transect (Fig. 1). The platformal units representative of the Macdonald Platform examined include the Kechika (Lower Ordovician), Skoki (Lower to Upper Ordovician), Beaverfoot (Upper Ordovician), McCusker (Lower Silurian), and Nonda (Lower Silurian) formations (Fig. 2). The off-shelf equivalents of the Beaverfoot, McCusker, and Nonda Formations within the Ospika Embayment are the Robb (Upper Ordovician), Kenny, and Laurier Formations (Lower Silurian) of the Road River Group, preserved within a narrow transition or shelfbreak zone within a re-entrant to the margin. Further west, basinal facies of the Ordovician Ospika Formation of the Road River Group were measured in the Ware map-area (Fig. 1).

The Kechika Formation represents sedimentation on a broad, gentle ramp as indicated by an east-west transition from shallow to deeper water facies (Cecile and Norford, 1979; Pyle and Barnes, 2000). There is marked change from the gradual lateral and vertical facies changes of the Kechika Formation to the abrupt platform to basin transition, which persisted from the onset of late Early Ordovician Skoki Formation sedimentation into the Devonian (Fig. 2). The details of the stratigraphic framework for this present transect are discussed by Pyle and Barnes (2001).

Measured sections.—Nine well-exposed ridge sections were measured and described in detail across the transect that spans platform and shelf strata in the east (Sections 1, 2, 3, 4, 8), the ancient shelfbreak (Sections 5, 6, 7), and the basin in the west (Section 10) (Fig. 1). Details of the stratigraphy and location of sections is documented in Pyle and Barnes (2001). An additional basinal section, Section 9, initially mapped as Ordovician-Silurian (Taylor, 1979), yielded over 7,600 conodonts of Early to Middle Devonian age that will be discussed in a separate paper (Pyle et al., in press.).

Section 1 is located 4 km north of the Sikanni Chief River (123°51′W, 57°14′N) and conodont samples from this section

[1] All tables available on the Journal of Paleontology's Supplemental Database (www.journalofpaleontology.org).

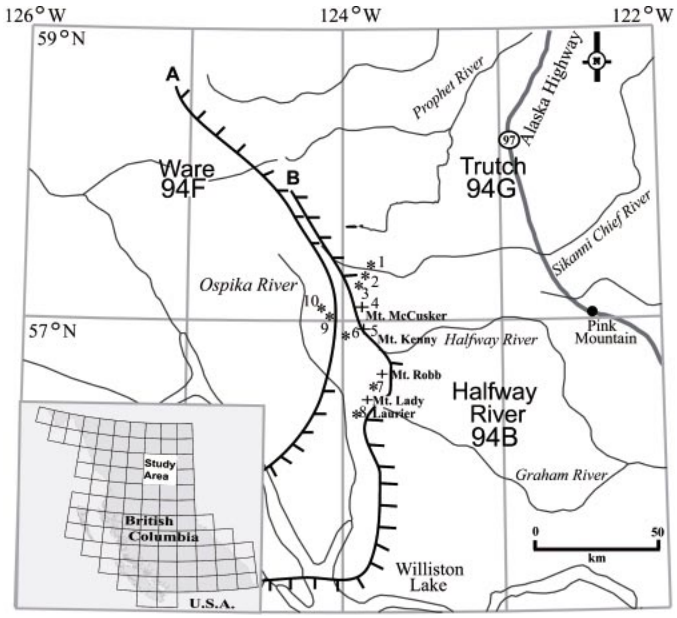


FIGURE *1*—Location map of the study area and sections within the Ware (94F), Trutch (94G) and Halfway River (94B) map-areas. Section localities: 1. Sikanni Chief River North, 2. Sikanni Chief River South, 3. Gautschi Creek, 4. Mount McCusker, 5. Mount Kenny, 6. Mount Kenny East, 7. Mount Robb, 8. Mount Lady Laurier, 9. Ospika River, 10. Ospika River North. A. Eastern edge of Ospika Embayment, Middle Ordovician (after Cecile and Norford, 1979); B. Eastern edge of Ospika Embayment, Late Ordovician-Early Silurian (after Thompson, 1989).

were given the prefix of SCN-98 (Table 1). The section was measured from the top of the Skoki Formation through the Beaverfoot and Nonda formations to the sandstone at the base of the Muncho-McConnell Formation. Section 2 is located 3–4 km south of the Sikanni Chief River (123°55′W, 57°10′N), south of Section 1, and conodont samples were given the prefix of SCS-98 (Fig. 3). The upper Kechika Formation was collected from two parts of the ridge (Tables 2, 3). A complete section of Skoki Formation is present, except for the uppermost Balden Member (cf. Section 8, Fig. 4.1, 4.2). The basal part of the Beaverfoot Formation forms the top of the ridge section. Section 3, located 2 km east of Gautschi Creek and south of the Sikanni Chief Sections (124°11′W, 57°01′N), allowed for additional study and collection of the Beaverfoot, McCusker, and Nonda Formations as a continuation of Section 2. Conodont samples from this section were given the prefix of GC-99 (Fig. 5, Table 6). Section 4, located 3 km southeast of Mount McCusker (123°54′W, 57°04′N), exposes part of the McCusker Formation and the lower Nonda Formation. Samples were given the prefix of MM-99 (Table 7). Section 8 is the first east-west ridge south of Mount Lady Laurier (123°47′W, 56°38′N) and exposes the Kechika Formation and a complete section of the Skoki Formation that is overlain by the Robb Formation. Samples were given the prefix of LL-98 (Fig. 4.1, 4.2, Tables 4, 5).

Section 5 was sampled in two legs and is located 10 km north of Mount Kenny (camp at 123°46.6′W, 56°58.8′N). The first leg, with samples given the prefix of MK-99 (Fig. 6), is along the ridge north of camp and the second leg, with samples given the prefix of MKC-99, extends southwest along the creek south of camp (Tables 8, 9). Section 6 (123°45.9′W, 56°56.8′N) consists of the top of Skoki overlain by the recessive Robb and Kenny Formations and the cliff-forming Laurier Formation. The conodont samples were given the prefix MKR-99 (Fig. 7, Table 10). Section 7 is located on a ridge (123°43′W, 56°50′N) 5.5 km southeast of Mount Robb and samples were given the prefix MR-98 (Fig. 8, Table 11). This section is the type section of three new formations of the Road River Group proposed by Pyle and Barnes (2001), the Robb, Kenny, and Laurier Formations. Section 10 is located on a ridge (124°12.72′W, 57°0.7′N) and consists of Ospika Formation overlain by unfossiliferous Kwadacha Formation. Conodont samples from this section were given the prefix OS-99 (Fig. 9, Table 12).

CONODONT BIOSTRATIGRAPHY

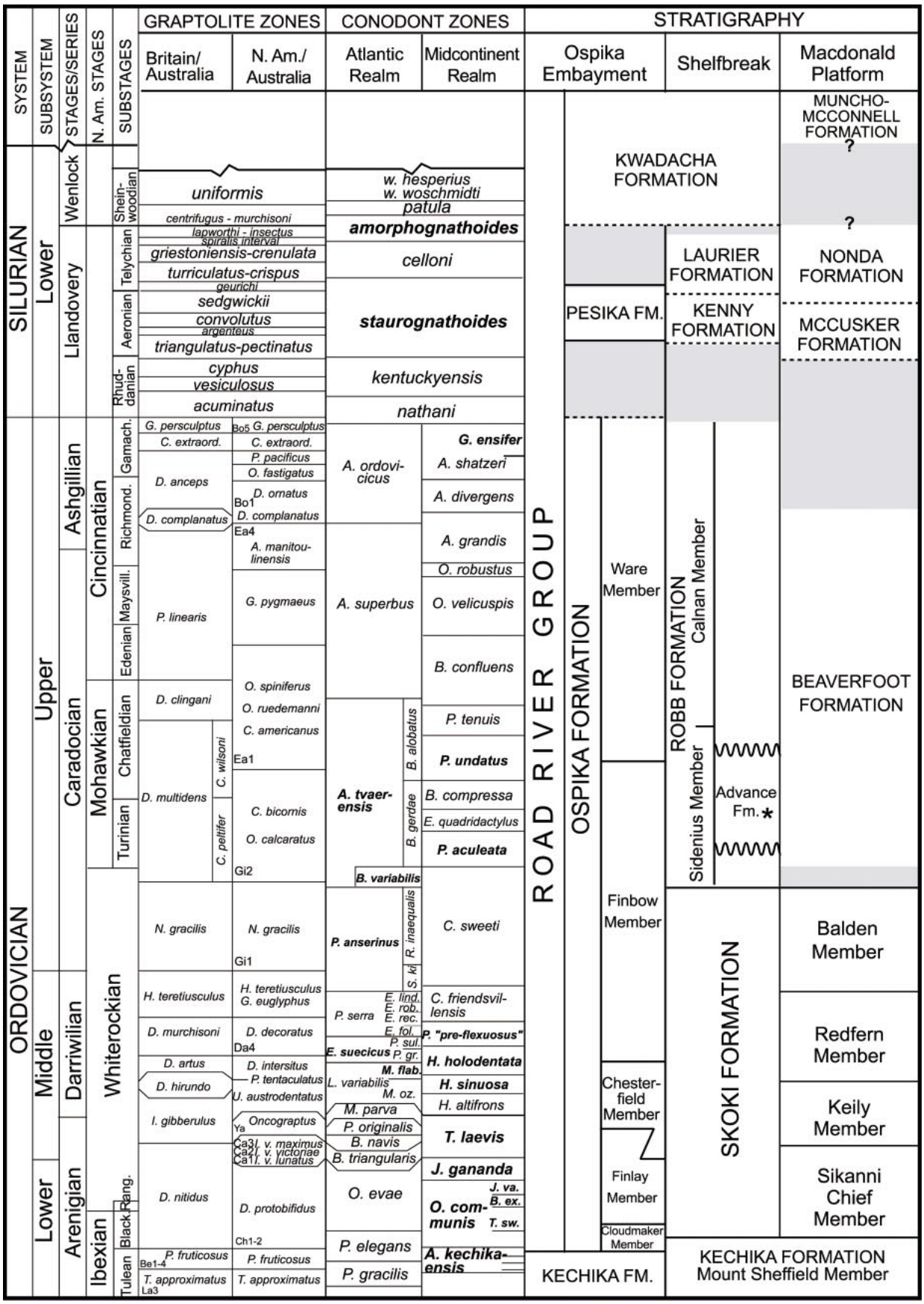
The measured sections range from the *Acodus kechikaensis* Zone (Pyle and Barnes, 2002) to the *Pterospathodus amorphognathoides* Zone (Walliser, 1964) (Fig. 2). The uppermost member of the Kechika Formation lies within the *Acodus kechikaensis* and *Oepikodus communis* zones. The *A. kechikaensis* Zone was defined by Pyle and Barnes (2002) as an interval zone extending from the first appearance of *A. kechikaensis* Pyle and Barnes to the first appearance of *O. communis* (Ethington and Clark). The zone contains three subzones above an unnamed subzone interval, the *Kallidontus serratus* Subzone, *Diaphorodus russoi* Subzone, and *Kallidontus nodosus* Subzone (Pyle and Barnes, 2002). In this present study, the *K. serratus* Subzone is recognized (Fig. 3) and samples from the Kechika taken along strike from the beds shown in Figure 3 yielded the nominate species of the other subzones, although in low abundance (Table 3). *Acodus kechikaensis* extends into deeper water facies but is dominant in shallow water facies. Species of the new genus *Kallidontus* established by Pyle and Barnes (2002) are most abundant in shelf facies but also extend into platformal and off-shelf facies.

The *O. communis* Zone, established by Repetski and Ethington (1983), spans the Kechika-Skoki formational boundary, in the platformal facies. Three subzones, above an unnamed subzone interval, were proposed by Pyle and Barnes (2002) based on the first appearance of the nominate species: *Tropodus sweeti* (Serpagli), *Bergstroemognathus extensus* (Graves and Ellison), and *Juanognathus variabilis* Serpagli. The uppermost Kechika Formation lies within the *T. sweeti* Subzone. The base of the Skoki Formation lies within the *B. extensus* Subzone at Section 2 (Fig. 3). The Skoki Formation ranges through the *Juanognathus variabilis* Subzone and *Jumudontus gananda* Zone defined by Pyle and Barnes (2002) and the *Tripodus laevis* Zone defined by Ross et al. (1997).

At Section 8 (Fig. 4), the strata interpreted to be uppermost Kechika Formation range into the *T. laevis* Zone, but this unit may represent a more argillaceous facies of the Skoki deposited near the ancient shelfbreak. The occurrence of *Microzarkodina flabellum* (Lindström) indicates correlation to the *H. sinuosa* Zone and the occurrence of *Neomultioistodus compressus* Harris and Harris indicates correlation to the *H. holodentata* Zone (Ethington and Clark, 1982). The association of *Erraticodon balticus* Dzik and *Paraprioniodus costatus* (Mound) in Section 2 (Fig. 3) is also indicative of this zonal interval. Species that support assignment to the *Phragmodus "pre-flexuosus"* Zone or faunas 5 and 6 of Sweet et al. (1971) include *Cahabagnathus* sp. and *Phragmodus spicatus* Watson from the upper Skoki Formation in Section 8 (Fig. 4). The uppermost member of the Skoki Formation, the Balden Member, spans the *P. anserinus* Zone defined by Bergström (1971).

The conodont fauna from the basinal facies the Ospika Formation, Section 10 (Fig. 9), includes species indicative of the *Eoplacognathus suecicus* Zone (Löfgren, 1978).

Conodonts from the base of the Beaverfoot Formation at Section 2 (Fig. 3) indicate the *Plectodina aculeata* Zone and the


SYSTEM
SUBSYSTEM
STAGES/SERIES
N. Am. STAGES
SUBSTAGES
GRAPTOLITE ZONES
Britain/ Australia
N. Am./ Australia
CONODONT ZONES
Atlantic Realm
Midcontinent Realm
STRATIGRAPHY
Ospika Embayment
Shelfbreak
Macdonald Platform
ORDOVICIAN
SILURIAN
Upper
Middle
Lower
Caradocian
Ashgillian
Cincinnatian
Mohawkian
Darriwilian
Whiterockian
Arenigian
Ibexian
Llandovery
Wenlock
Gamach.
Richmond.
Maysvill.
Edenian
Chatfieldian
Turinian
Rang.
Black.
Tulean
Shein-woodian
Telychian
Aeronian
Rhud-danian
uniformis
centrifugus - murchisoni
lapworthi - insectus
spiralis interval
griestoniensis-crenulata
turriculatus-crispus
geurichi
sedgwickii
convolutus
argenteus
triangulatus-pectinatus
cyphus
vesiculosus
acuminatus
w. hesperius
w. woschmidti
patula
amorphognathoides
celloni
staurognathoides
kentuckyensis
nathani
G. persculptus
C. extraord.
D. anceps
D. complanatus
D. linearis
D. clingani
D. multidens
C. wilsoni
C. peltifer
N. gracilis
H. teretiusculus
D. murchisoni
D. artus
D. hirundo
I. gibberulus
D. nitidus
P. fruticosus
T. approximatus
Bo5 G. persculptus
C. extraord.
P. pacificus
O. fastigatus
Bo1 D. ornatus
D. complanatus
Ea4
A. manitou-linensis
G. pygmaeus
O. spiniferus
O. ruedemanni
C. americanus
Ea1
C. bicornis
O. calcaratus
Gi2
N. gracilis
Gi1
H. teretiusculus
G. euglyphus
D. decoratus
Da4
D. intersitus
P. tentaculatus
U. austrodentatus
Oncograptus
Ya
Ca3 I. v. maximus
Ca2 I. v. victoriae
Ca1 I. v. lunatus
D. protobifidus
Ch1-2
P. fruticosus
Be1-4
T. approximatus
La3
A. ordovi-cicus
A. superbus
A. tvaer-ensis
B. variabilis
P. anserinus
P. serra
E. suecicus
L. variabilis
M. parva
P. originalis
B. navis
B. triangularis
O. evae
P. elegans
P. gracilis
B. alobatus
B. gerdae
R. inaequalis
S. kl
E. lind.
E. rob.
E. rec.
E. fol.
P. sul.
P. gr.
M. flab.
M. oz.
G. ensifer
A. shatzeri
A. divergens
A. grandis
O. robustus
O. velicuspis
B. confluens
P. tenuis
P. undatus
B. compressa
E. quadridactylus
P. aculeata
C. sweeti
C. friendsvil-lensis
P. "pre-flexuosus"
H. holodentata
H. sinuosa
H. altifrons
T. laevis
J. gananda
J. va.
B. ex.
O. com-munis
T. sw.
A. kechika-ensis
ROAD RIVER GROUP
OSPIKA FORMATION
KECHIKA FM.
KWADACHA FORMATION
PESIKA FM.
Ware Member
Finbow Member
Chester-field Member
Finlay Member
Cloudmaker Member
ROBB FORMATION
Calnan Member
Sidenius Member
Advance Fm. *
LAURIER FORMATION
KENNY FORMATION
SKOKI FORMATION
KECHIKA FORMATION
Mount Sheffield Member
MUNCHO-MCCONNELL FORMATION
?
?
NONDA FORMATION
MCCUSKER FORMATION
BEAVERFOOT FORMATION
Balden Member
Redfern Member
Keily Member
Sikanni Chief Member

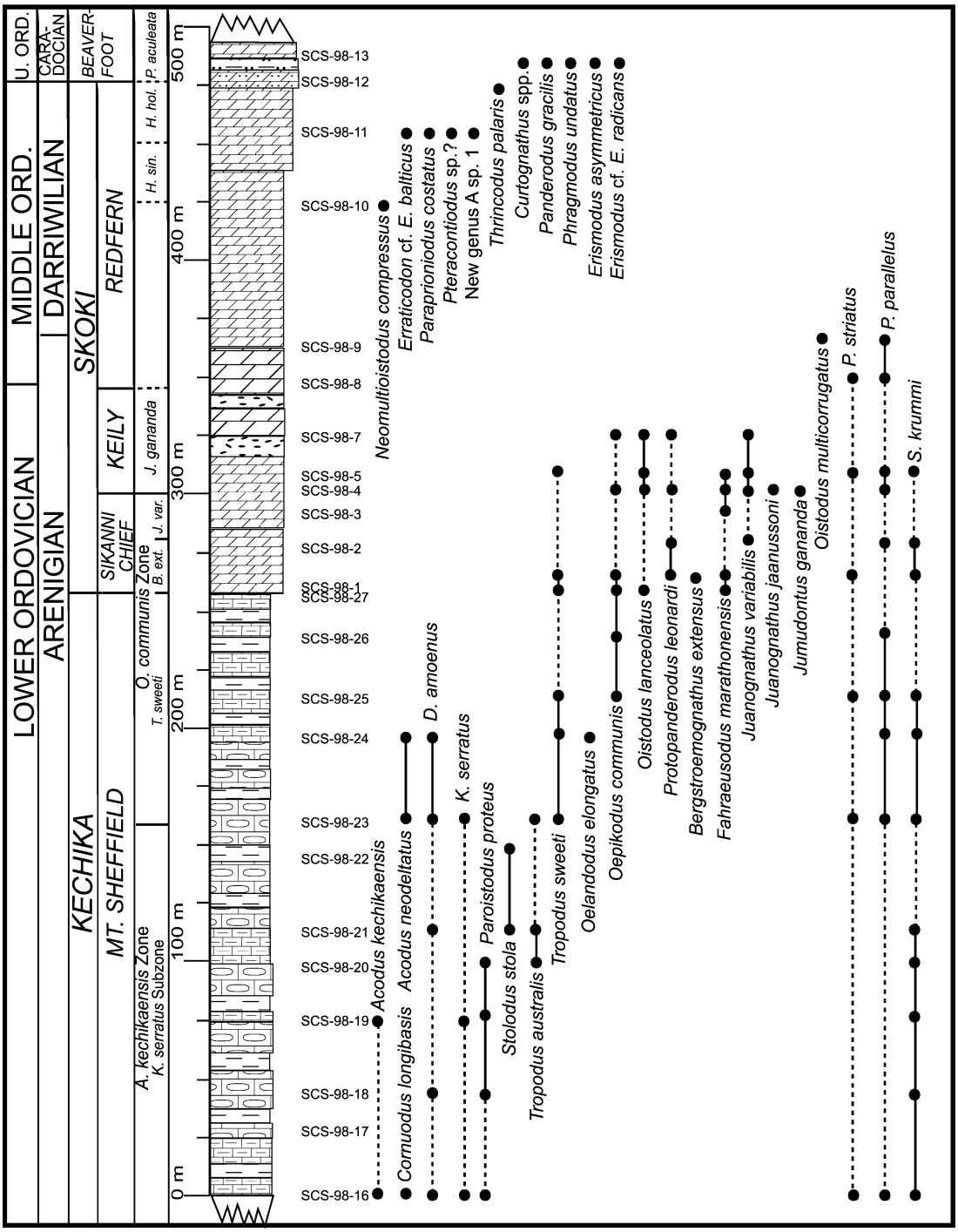


FIGURE 3—Distribution of conodont species from the Kechika, Skoki, and Beaverfoot formations, Section 2.

←

FIGURE 2—Biostratigraphic correlation chart for the Ordovician and Silurian. Standard conodont and graptolite zones for the Ordovician after Fortey et al. (1995) Harris et al. (1995) and Webby (1995) and time scale after Webby (1998) and Cooper et al. (2001). The conodont zonation for the Lower Ordovician as shown is that revised by Pyle and Barnes (2002). Zones in bold are those recognized in the present study. The Silurian standard graptolite and conodont zonations are after Norford et al. (1997). Shading indicates hiatuses and * indicates that the Advance Formation (Norford, 1996) does not occur in this transect.

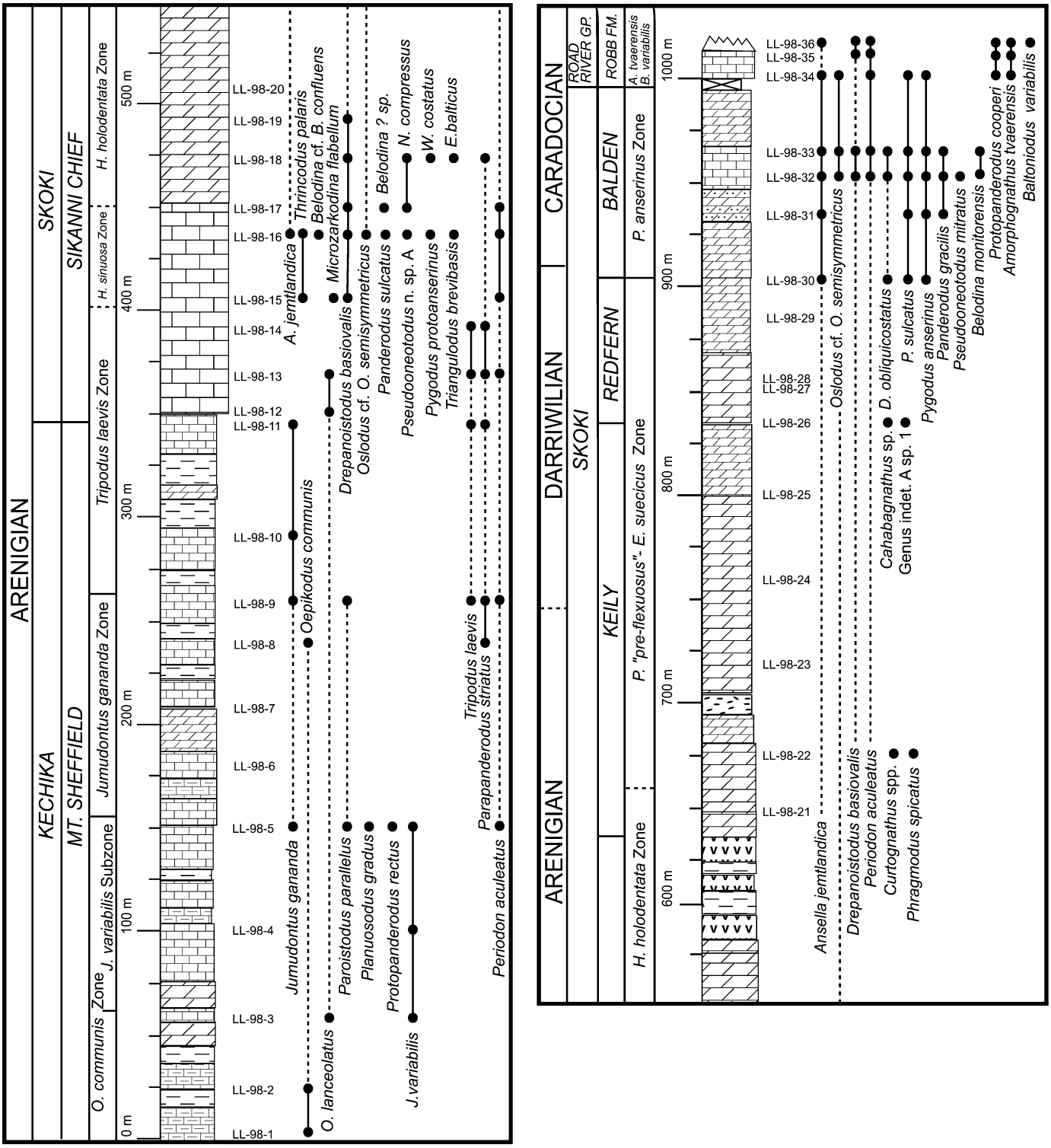


FIGURE 4—Distribution of conodont species from the Kechika, Skoki, and Robb formations, Section 8.

formation ranges into the *Phragmodus undatus* Zone (Sweet, 1984) at Section 3 (Fig. 5). *Phragmodus undatus* Branson and Mehl occurs in carbonate beds within the sandstone unit of the upper part of the formation (Fig. 5) and being a long-ranging species, the age of the Beaverfoot is questionably extended into the Ashgillian.

The next zone recognized in the platformal succession at Section 3, the *Distomodus staurognathoides* Zone (Walliser, 1964), spans the McCusker and Nonda Formations (Fig. 5). The zone has served as a global zone for the middle Llandovery (Aldridge and Schönlaub, 1989).

The off-shelf facies of the Robb Formation are equivalent to

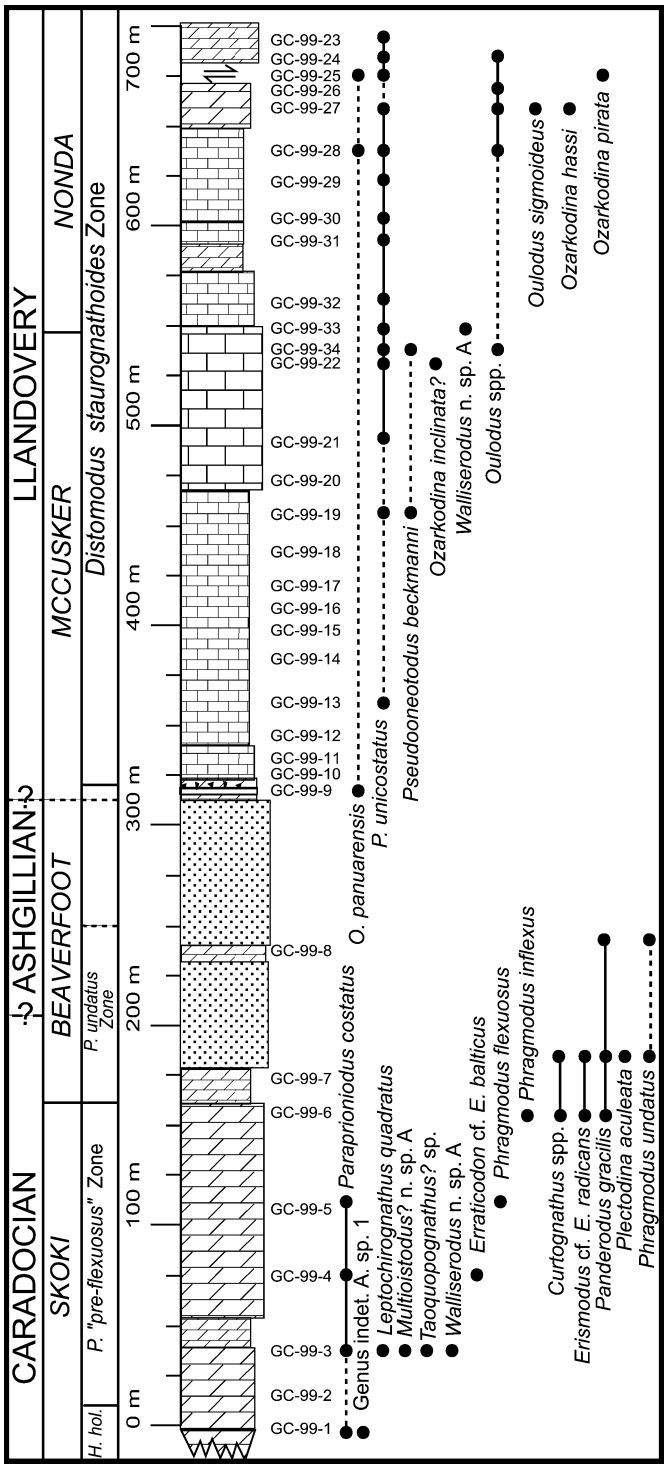


FIGURE 5—Distribution of conodont species from the Skoki, Beaverfoot, McCusker, and Nonda formations, Section 3.

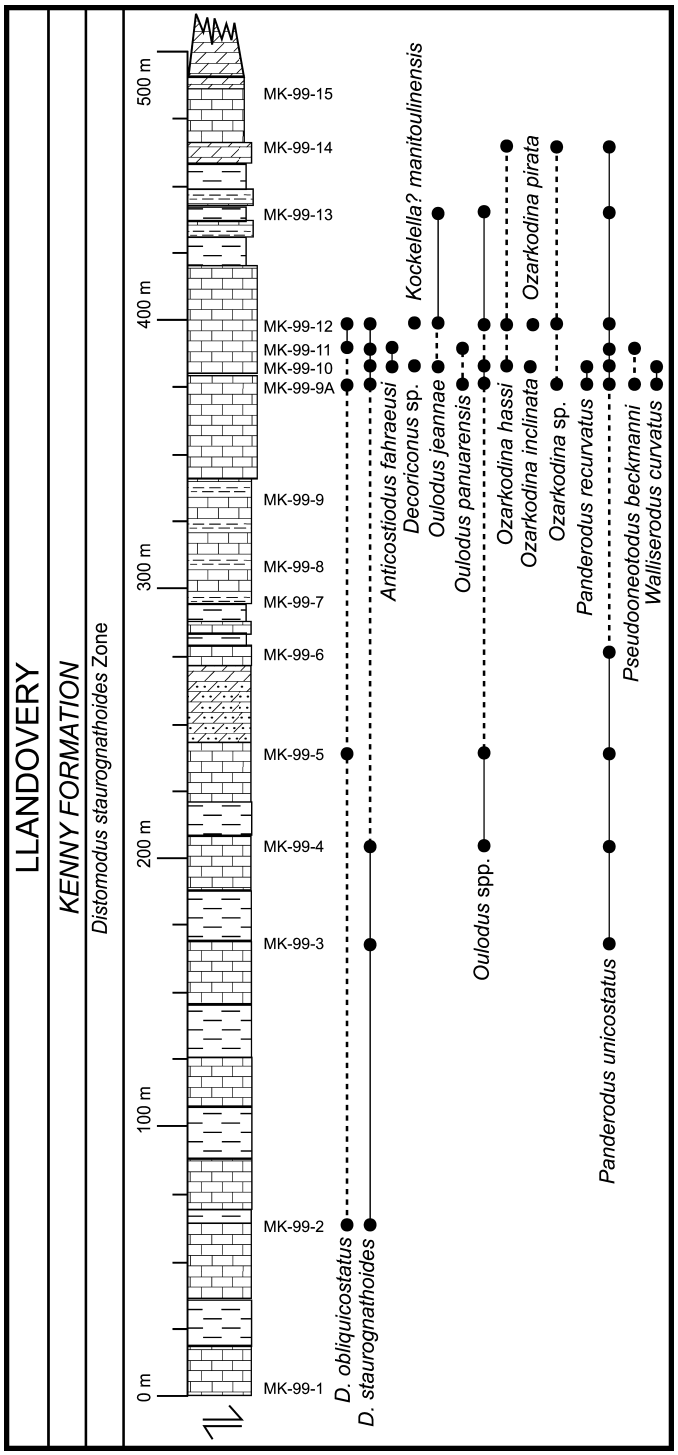


FIGURE 6—Distribution of conodont species from the Kenny Formation, Section 5.

the platformal Beaverfoot Formation. The conodont fauna of the Robb Formation at Section 8 (Fig. 4) is indicative of the *Baltoniodus variabilis* Subzone of the *Amorphognathus tvaerensis* Zone (Bergström, 1971). At Section 6 (Fig. 7), the Robb Formation is extended questionably into the *Gamachignathus ensifer* Zone. The zonal species is characteristic of the Midcontinent Realm fauna around the Laurentian margin and may indicate a lowstand within the Robb Formation. The overlying off-shelf facies of the Kenny Formation at Section 5 (Fig. 6) are equivalent in part to the McCusker and Nonda Formations and yield *D. staurognathoides* (Walliser). The Laurier Formation at Section 6 (Fig. 7) is within the *D. staurognathoides* Zone based on the occurrence of *Kockellela*? *manitoulinensis* (Pollock, Rexroad, and Nicoll), *Ozarkodina pirata* Uyeno, and *Oulodus panuarensis* (Bischoff).

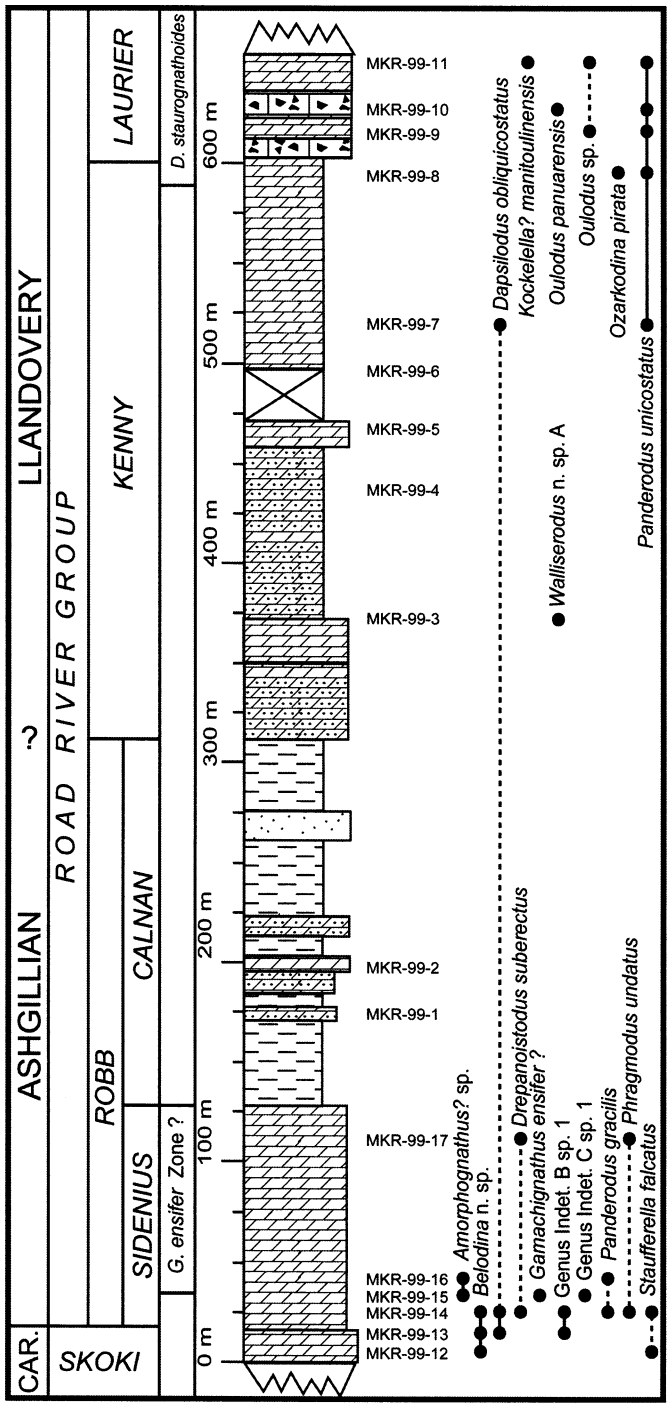


FIGURE 7—Distribution of conodont species from the Skoki, Robb, Kenny and Laurier Formations, Section 6.

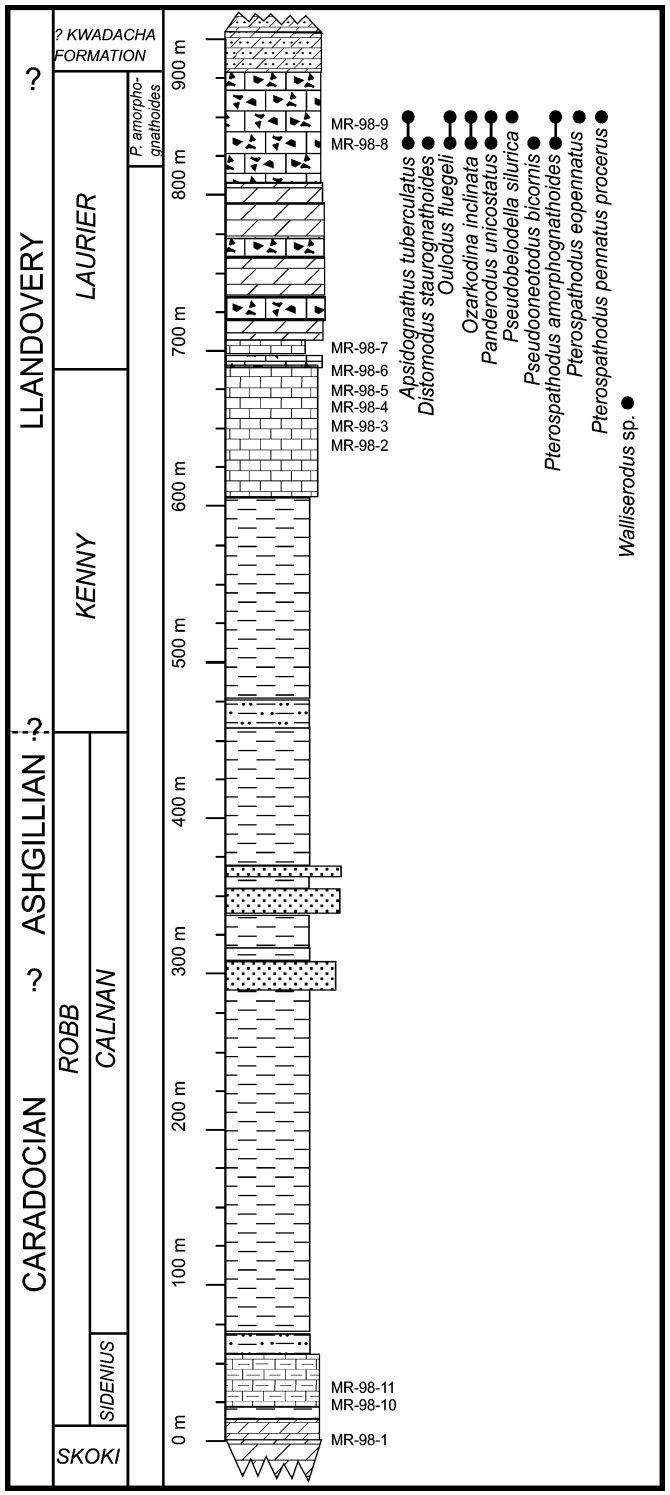


FIGURE 8—Distribution of conodont species from the Laurier Formation, Section 7.

The Laurier Formation exposed at Section 7 extends into the *Pterospathodus amorphognathoides* Zone (Fig. 8).

SELECTED TAXONOMIC AND BIOSTRATIGRAPHIC REMARKS

Many of the figured specimens, described adequately in previous publications, do not require further systematic treatment, but merit selective taxonomic and biostratigraphic comments as discussed briefly in the following remarks. These remarks are arranged sequentially to correspond to their illustrations in Figures 10–18. These figures illustrate the fauna stratigraphically from oldest to youngest. The figured specimens illustrated in Figures 10–18 are housed in the National Type Collection of the Geological Survey of Canada (GSC), Ottawa, Ontario. The distribution and abundance of conodont species for all sections are listed in

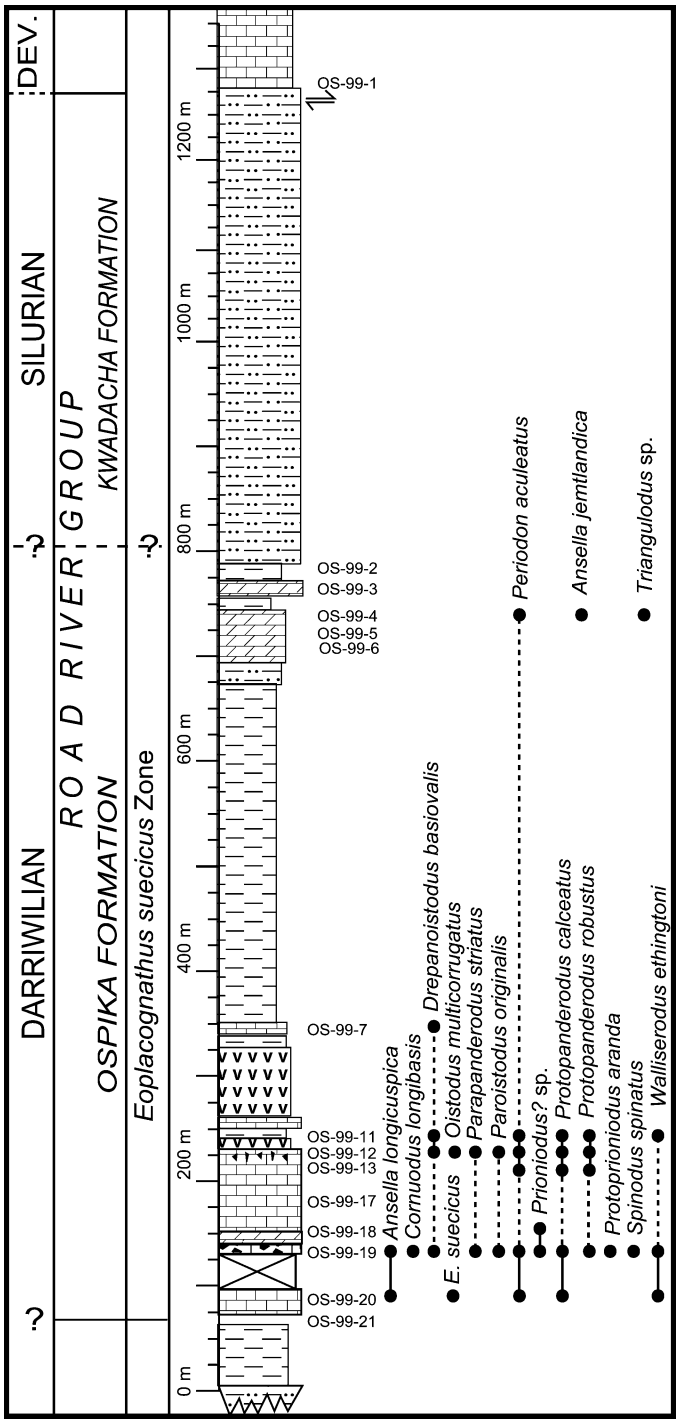


FIGURE 9—Distribution of conodont species from the Ospika Formation, Section 10.

Tables 1–12 (accessible in the Journal of Paleontology's ''Supplemental Database'' located at www.journalofpaleontology.org). Figures 3–9 illustrate the distribution of species for all sections, except Sections 1 and 4 that failed to yield any additional information for the Beaverfoot, McCusker and Nonda Formations.

Fauna of the Kechika Formation.—A detailed account of the conodont fauna and biostratigraphy of the Kechika Formation, which is up to 1,400 m thick in northeastern British Columbia, is documented by Pyle and Barnes (2002) for a transect north of the present study area. In this present study, only the uppermost part of the formation was sampled to provide correlation to the northern transect. The upper Kechika Formation, within the *A. kechikaenesis* Zone (of Pyle and Barnes, 2002) and extending into the *O. communis* Zone, is characterized by the nominate species of the zones (Figs. 10.1–10.6, 12.8–12.10) and an assemblage including *Oistodus lanceolatus* (Pander) (Fig. 10.19), *Paroistodus parallelus* (Pander) (Fig. 10.20–10.21) and *P. proteus* (Lindström) (Fig. 10.22, 10.23), *Scolopodus krummi* (Lehnert) (Fig. 10.24–10.26), *Stolodus stola* (Lindström) (Fig. 10.27), and *Tropodus sweeti* (Serpagli) (Fig. 10.28). Pyle and Barnes (2002) discuss each of these species from the Kechika Formation north of the present study area.

Fauna of the Skoki Formation.—The Skoki Formation spans the *O. communis* Zone to the *P. anserinus* Zone (Fig. 4.1, 4.2). Eighteen elements assigned to three species of *Belodina* were recovered from the Skoki Formation. The quadrimembrate elemental nomenclature follows that of Leslie (1997). *Belodina* cf. *B. confluens* Sweet is similar to the specimens originally described by Sweet (1981) but the S elements have a stronger curvature of the cusp and comparatively lower heel (Fig. 11.5). *Belodina monitorensis* Ethington and Schumacher is characterized by evenly developed denticles and a short heel (Fig. 11.7). One element, assigned questionably to the genus, is a robust, laterally compressed specimen bearing one large, compressed denticle (Fig. 11.9 cf. Pl. 14, fig. 3 of Ethington and Clark, 1982). The cusp has a curved anterior margin and the base is short. The lateral cusp face bears three longitudinal costae that are highest at the point of curvature of the cusp. The denticle bears a costa along its posterior margin and is deflected posteriorly.

The apparatus of *Bergstroemognathus extensus* (Graves and Ellison) (Fig. 11.10) has been described adequately by Serpagli (1974), Stouge and Bagnoli (1988), and Albanesi (1998). Pyle and Barnes (2002) established a subzone within the *O. communis* Zone based on this short-ranging, distinctive species.

One broken element of *Cahabagnathus* Bergström was recovered (Fig. 11.11), but a species was not determined. The specimen bears some resemblance to *C. friendsvillensis* (Bergström) but differs in that the anterior process is narrower than the posterior process and is directed posteriorly to form an angle less than 90 degrees.

A total of 71 elements from the Skoki and Beaverfoot Formations are assigned to *Curtognathus* spp. As Leslie (2000) described, the apparatus of *Curtognathus* has not been reconstructed beyond the assignment of form-genera such as *Cardiodella*, *Polycaulodus*, and *Trucherognathus* to *Curtognathus* spp. Similarly, the limited material from this present study necessitates the use of form genera to describe the element morphotypes (Figs. 11.12–11.14, 14.1–14.4).

Elements assigned to *Erraticodon* cf. *E. balticus* Dzik (Fig. 11.15–11.18) bear a close resemblance to those described by Bauer (1987) and Ethington and Clark (1982) and do not exhibit the large posterior denticle of some specimens illustrated by Dzik (1978).

A total of 55 elements of *Fahraeusodus marathonensis* (Bradshaw) were recovered from the Kechika and Skoki Formations (Fig. 11.20). The apparatus was described adequately by Ethington and Clark (1982).

The apparatus of *Juanognathus variabilis* Serpagli (Fig. 11.21, 11.22) was reconstructed by Pyle and Barnes (2002) to include a compressed element assigned previously to *Reutterodus andinus* Serpagli. The assignment of this compressed coniform element to *J. variabilis* resulted in a modification to the Midcontinent Realm zonation to define a *J. variabilis* Subzone within the *O. communis* Zone to replace the *R. andinus* Zone proposed by Ross et al. (1997).

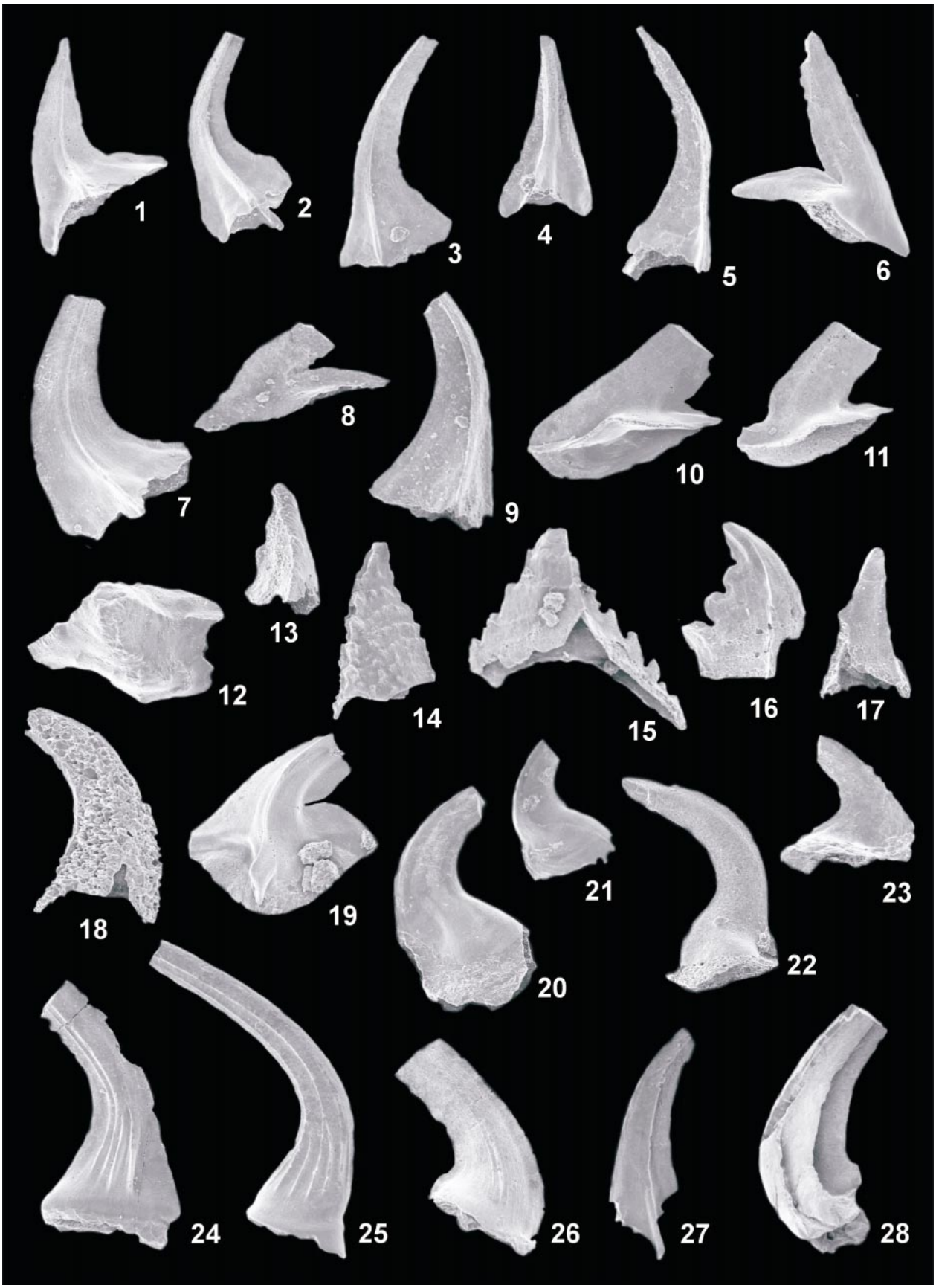

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FIGURE *10*—Scanning electron microscope photomicrographs of conodonts from the Kechika Formation. All specimens in lateral view unless otherwise noted. 1–6, *Acodus kechikaensis* Pyle and Barnes. All specimens ×64 and from sample SCS-98-16. *1*, P element, GSC 122856; *2*, Sd element, GSC 122857; *3*, Sc element, GSC 122858; *4*, Sa element, posterior view, GSC 122859; *5*, Sb element, GSC 122860; *6*, M element, GSC 122861. *7–9*, *Acodus neodeltatus* Pyle and Barnes. All specimens ×100 and from sample SCS-98-31. *7*, P element, GSC 122862; *8*, M element, GSC 122863; *9*, Sb element, GSC 122864. *10–11*, *Drepanoistodus latus* n. sp. Both specimens ×40 and from sample SCS-98-32. *10*, e element, holotype, GSC 122865; *11*, a element, paratype, GSC 122866. *12–14*, *Kallidontus nodosus* Pyle and Barnes. *12*, Pb element, upper view, GSC 122867, ×84, from sample SCS-98-32; 13, Pa element, GSC 122868, ×84, from sample SCS-98-32; *14*, Pb element, GSC 122869, ×35, from sample SCS-98-30. *15–18*, *Kallidontus serratus* Pyle and Barnes. All specimens from sample SCS-98-14. *15*, Pb element, posterior view, GSC 122870, ×72; *16*, Pa element, GSC 122871, ×72; *17–18*, S elements, GSC 122872, 122873, ×82. *19*, *Oistodus lanceolatus* Pander. M element, GSC 122874, ×52, from sample SCS-98-14. 20–21, *Paroistodus parallelus* (Pander). Both specimens ×104 and from sample SCS-98-16. *20*, P element, GSC 122875; *21*, S element, GSC 122876. *22–23*, *Paroistodus proteus* (Lindström). Both specimens ×90 and from sample SCS-98-14. *22*, S element, GSC 122877; *23*, P element, GSC 122878. *24–26*, *Scolopodus krummi* (Lehnert). All specimens ×60 and from sample SCS-98-14. *24*, b element, GSC 122879; *25*, a element, GSC 122880; *26*, e element, GSC 122881. *27*, *Stolodus stola* (Lindström). S element, GSC 122882, ×88, from sample SCS-98-21. *28*, *Tropodus sweeti* (Serpagli). Sb element, GSC 122883, ×40, from sample SCS-98-23.

Jumudontus gananda Cooper (Fig. 11.23) occurs in low abundance in the Skoki Formation, including the large, distinct P elements. The species is an important zonal indicator for the late Arenigian (Pyle and Barnes, 2002).

The specimen of *Leptochirognathus quadratus* Branson and Mehl illustrated in this present study (Fig. 11.24) is most similar to the material of Rexroad et al. (1982) in bearing three denticles. Four elements of *Microzarkodina flabellum* (Lindström) (Fig. 11.25) were recovered from the Skoki Formation and are characterized by a restricted basal cavity.

Oepikodus communis (Ethington and Clark) is abundant in the Kechika and Skoki Formations and is an important zonal indicator (Fig. 12.8–12.10). *Oistodus multicorrugatus* Harris (Fig. 12.11) occurs in low abundance in the Skoki and Ospika Formations and its apparatus has been described by Stouge and Bagnoli (1988). One specimen assigned tentatively to *Taoqupognathus*? sp. resembles the genus described by An *in* An et al. (1985). The element is stout and broad with a lobe-like posterior process.

Neomultioistodus compressus Harris and Harris, 1965 (Fig. 12.4–12.7) is indicative of the *Histiodella sinuosa* Zone. Bauer (1987) differentiated *Neomultioistodus* from *Multioistodus* based on the lack of a geniculate element in the apparatus of the type species of the latter genus, *M. subdentatus* Cullison. The material from the present collection supports a seximembrate apparatus although the M element has a posteriorly deflected, compressed denticle and differs from that illustrated by Bauer (1987) in which the process appears to be broken off.

Species of *Panderodus* are common throughout the Skoki, Beaverfoot, McCusker, Nonda, Robb, Kenny, and Laurier formations and include *Panderodus sulcatus* (Fåhræus) (Fig. 12.16–12.17), *P. gracilis* Branson and Mehl, *P. recurvatus* (Rhodes) (Fig. 17.19), and *P. unicostatus* (Branson and Mehl) (Fig. 17.20–17.23).

A complete apparatus of *Paraprioniodus costatus* (Mound) is

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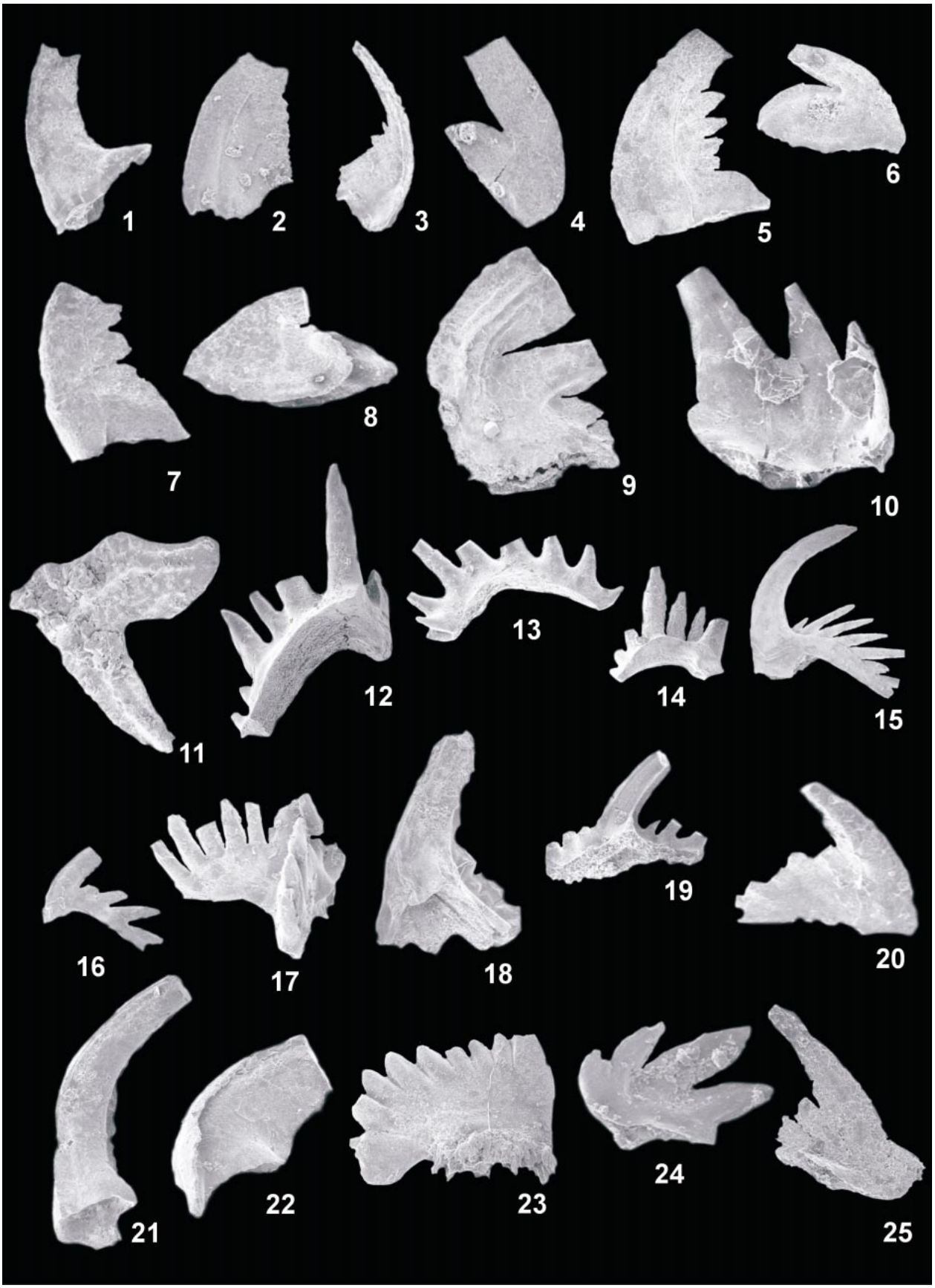
FIGURE *11*—Scanning electron microscope photomicrographs of conodonts from the Skoki Formation. All specimens in lateral view unless otherwise noted. *1–4*, *Ansella jemtlandica* (Löfgren). All specimens ×60 and from sample LL-98-16. *1*, P element, GSC 122884; *2–3*, S elements, GSC 122885, 122886; *4*, M element, GSC 122887. *5–6*, *Belodina* cf. *B. confluens* Sweet. Both specimens in lateral view, ×80 and from sample LL-98-16. *5*, S_1 element, GSC 122888; *6*, M element, GSC 122889. *7–8*, *Belodina monitorensis* Ethington and Schumacher. Both specimens in lateral view, ×75 and from sample LL-98-33. *7*, S_1 element, GSC 122890; *8*, M element, GSC 122891. *9*, *Belodina*? sp., S_1 element, GSC 122892, ×30, from sample LL-98-17. *10*, *Bergstroemognathus extensus* (Graves and Ellison), Sc element, GSC 122893, ×64, from sample SCS-98-1. *11*, *Cahabagnathus* sp., pastiniplanate element, upper view, GSC 122894, ×40, from sample LL-98-26. *12–14*, *Curtognathus* spp. All specimens in posterior view, ×53. *14*, curtognathiform element, GSC 122895, from sample LL-98-22; *13*, microcoelodontiform element, GSC 122896, from sample GC-99-06; *14*, cardiodelliform, GSC 122898, from sample GC-99-06. *15–18*, *Erraticodon* cf. *E. balticus* Dzik. All specimens ×45, from sample SCS-98-11. *15*, ?Sc element, GSC 122899; *16*, M element, GSC 122900; *17*, Pa element, GSC 122901; *18*, Sb element, GSC 122902. *19*, *Erraticodon balticus* Dzik. Pa element, GSC 122902, ×60, from sample LL-98-18. *20*, *Fahraeusodus marathonensis* (Bradshaw). P element, GSC 122903, ×66, from sample SCS-98-1. *21–22*, *Juanognathus variabilis* Serpagli. Both specimens ×60, from sample SCS-98-4. *21*, a element, GSC 122904; *22*, e element, GSC 122905. *23*, *Jumudontus gananda* Cooper. P element, GSC 122906, ×40, from sample LL-98-10. *24*, *Leptochirognathus quadratus* Branson and Mehl. GSC 123097, ×110, from sample GC-99-3. *25*, *Microzarkodina flabellum* (Lindström). P element, GSC 122907, ×36, from sample LL-98-15.

FIGURE *12*—Scanning electron microscope photomicrographs of conodonts from the Skoki Formation. All specimens in lateral view unless otherwise noted. *1–3 Multioistodus*? n. sp. A. All specimens from sample GC-99-3. *1*, P element, GSC 123098, ×60. *2*, Sa element, posterior view, GSC 123099, ×60. *3*, Sb element, GSC 123100, ×40. *4–7*, *Neomultioistodus compressus* Harris and Harris. All specimens ×70 and from sample SCS-98-10. *4*, ?M element, GSC 122908; *5*, Sb element, GSC 122909; *6*, Sa element, posterior view, GSC 122910; *7*, P element, GSC 122911. *8–10*, *Oepikodus communis* (Ethington and Clark). All specimens ×65 and from sample SCS-98-1. *8*, P element, GSC 122912; *9*, S element, GSC 122913; *10*, M element, GSC 122914. *11*, *Oistodus multicorrugatus* Harris. S element, GSC 122915, ×40, from sample SCS-98-9. *12–15*, *Oslodus* cf. *O. semisymmetricus* (Hamar). All specimens ×70. *12*, Sb element, GSC 122916, from sample LL-98-16; *13*, P element, GSC 122917, from sample LL-98-32; *14*, Sa element, GSC 122918, from sample LL-98-32; *15*, Sc element, GSC 122919, from sample LL-98-16; *16–17*, *Panderodus sulcatus* (Fåhræus). Both samples ×63, from sample LL-98-30. *16*, compressiform element, GSC 122920; *17*, aequaliform element, GSC 122921. *18–19*, *Parapanderodus striatus* (Graves and Ellison). Both samples ×70, from sample SCS-98-1. *18*, e element, posterior view, GSC 122922; *19*, a element, GSC 122923. *20*, *Taoqupognathus*? sp. GSC 123101, ×90, from sample GC-99-3. *21–28*, *Paraprioniodus costatus* (Mound). All specimens ×60. *21*, Pa element, posterior view, GSC 122924, from sample SCS-98-11; *22*, *23*, Pb elements, anterior and posterior views, GSC 122925, 122926, from sample SCN-98-1, ×48; *24*, Sb element, posterior view, GSC 122927, from sample SCS-98-11, ×48; *25–26*, Sa element, posterior and anterior views, GSC 122928, 122929, from sample SCS-98-11. *27*, Sc element, postero-lateral view, GSC 122930, from sample SCS-98-11; *28*, M element, GSC 122931, from sample SCN-98-1. *29–30*, *Phragmodus flexuosus* Moskalenko. Both specimens ×45 and from sample GC-99-05. *29*, Sc element, GSC 122932; *30*, Pa element, GSC 122933.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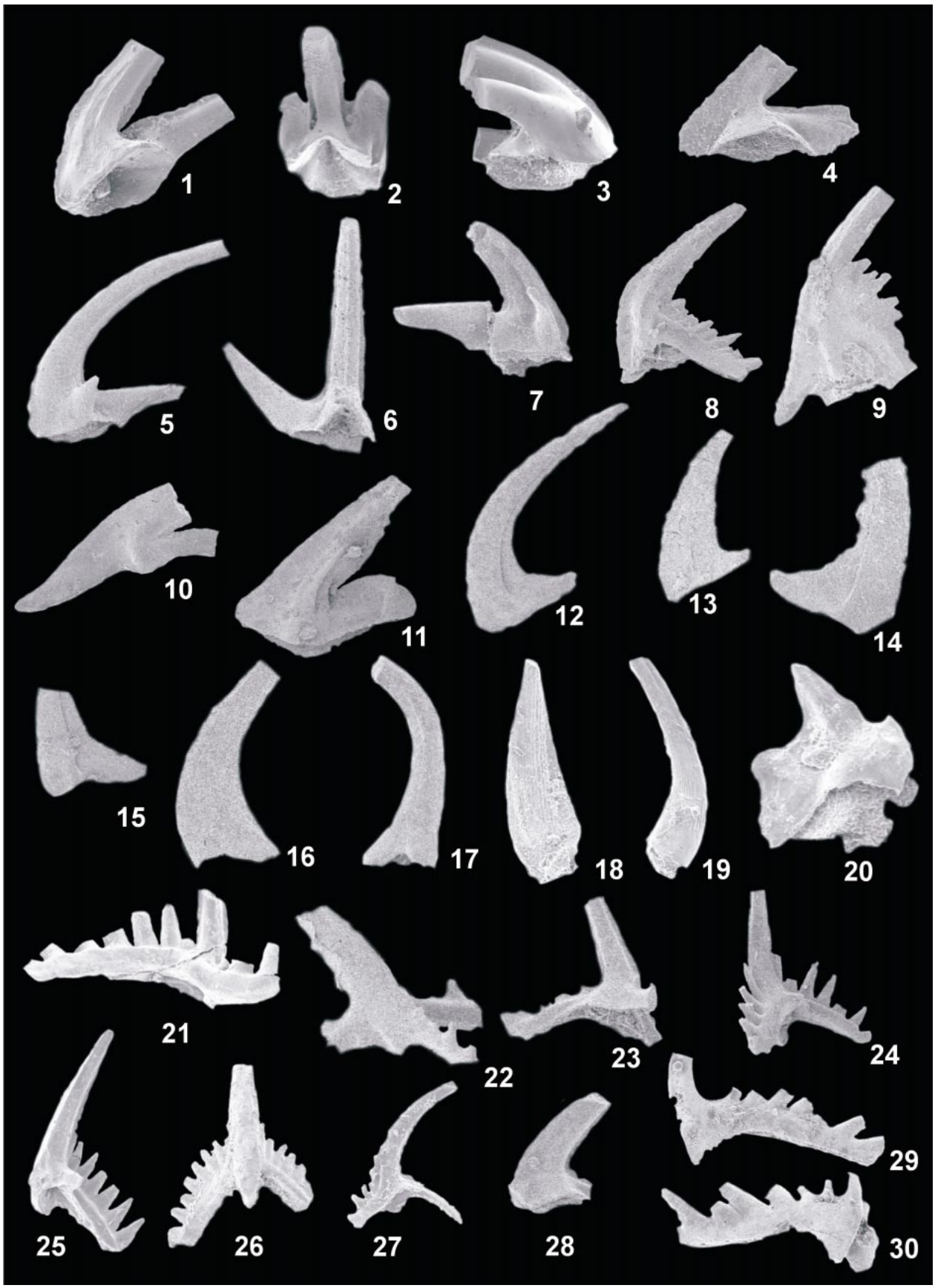
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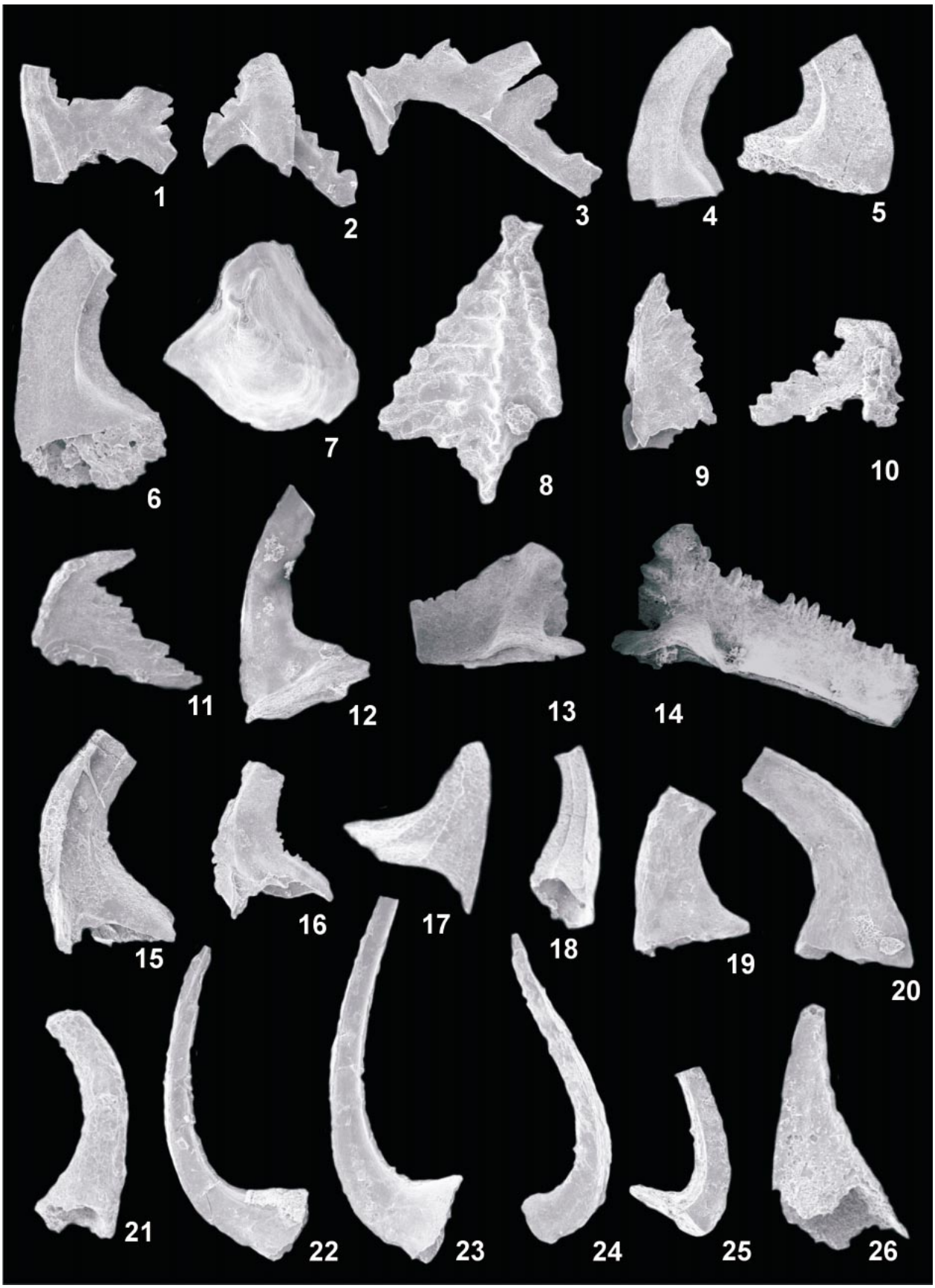
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FIGURE *13*—Scanning electron microscope photomicrographs of conodonts from the Skoki Formation. All specimens in lateral view unless otherwise noted. *1–2*, *Phragmodus inflexus* Stauffer. Both specimens ×60, from sample GC-99-06. *1*, Sb element, GSC 122934; *2*, Pa element, GSC 122935. *3*, *Phragmodus spicatus* Watson. Sb element, GSC 122936, ×65, from sample LL-98-22. *4–6*, *Planusodus gradus* Pyle and Barnes. All specimens ×66, from sample LL-98-5. *4*, a element, GSC 122937; *5*, e element, GSC 122938; *6*, c element, GSC 122939. *7*, *Pseudooneotodus* n. sp. Upper view, GSC 122940, ×45, from sample LL-98-16. *8–10*, *Pygodus anserinus* (Lamont and Lindström). All specimens ×75, from sample LL-98-32. *8*, Pa element, GSC 122941; *9*, S element, GSC 122942; *10*, Pb element, GSC 122943. *11*, *Pygodus protoanserinus* Zhang. Pb element, GSC 122944, ×95, from sample LL-98-16. *12*, *Triangulodus brevibasis* (Sergeeva). Sb element, GSC 122945, ×50, from sample LL-98-16. *13–14*, *Thrincodus palaris* Bauer. Both specimens ×50. *13*, Pb element, GSC 122946, from sample SCS-98-12; *14*, Pb element, GSC 122947, from sample LL-98-16. *15, 16*, *Tripodus laevis* Bradshaw. Both specimens ×60, from sample LL-98-13. *15*, Sc element, GSC 122948; *16*, Sb element, GSC 122949. *17–18*, *Walliserodus costatus* Dzik. Both specimens ×90, from sample LL-98-18. *17*, ?P element, GSC 122950; *18*, S element, GSC 122951. *19–21*, Genus indeterminate A, sp. All specimens ×56. *19*, e element, GSC 122952, from sample LL-98-26; *20*, b element, GSC 122953, from sample LL-98-26; *21*, a element, GSC 122954, from sample GC-99-01. *22–25*, New Genus A sp. A. All specimens ×60 and from sample SCS-98-11. *22*, a element, GSC 122955; *23, 24*, b elements, GSC 122956, 122957; *25*, e element, GSC 122958. *26*. *Coelocerodontus*? sp. ×90, GSC 122959, from sample SCN-981.

illustrated (Fig. 12.21–12.28) and the elements are exactly as described by Ethington and Clark (1982). The species has a restricted distribution through the Redfern and Balden members of the Skoki Formation.

Species of *Phragmodus* represented in the Skoki, Beaverfoot, and Robb Formations include *Phragmodus flexuosus* Moskalenko (Fig. 12.29–12.30), *P. inflexus* Stauffer (Fig. 13.1–13.2), and *P. undatus* Branson and Mehl (Figs. 14.11–14.12; 15.31–15.32). Leslie and Bergström (1995) described the apparatuses of each species. One Sb element assigned to *Phragmodus spicatus* Watson (Fig. 13.3) occurs within the *P. ''pre-flexuosus''* Zone and is the lowest reported occurrence of the genus (Watson, 1988). The element is characterized by wide, outwardly flexed denticles on the posterior process that is arched and sinuous.

Two specimens of both *Triangulodus brevibasis* (Sergeeva) (Fig. 13.12) (see van Wamel, 1974 for a description of the apparatus) and *Pygodus protoanserinus* Zhang (Fig. 13.11) were recovered from the Sikanni Chief Member of the Skoki Formation. Zhang (1998b) proposed that *P. protoanserinus* is the ancestor of *P. anserinus* (Fig. 13.8–13.10), the latter being an important zonal indicator and first appears in the Balden Member of the Skoki Formation.

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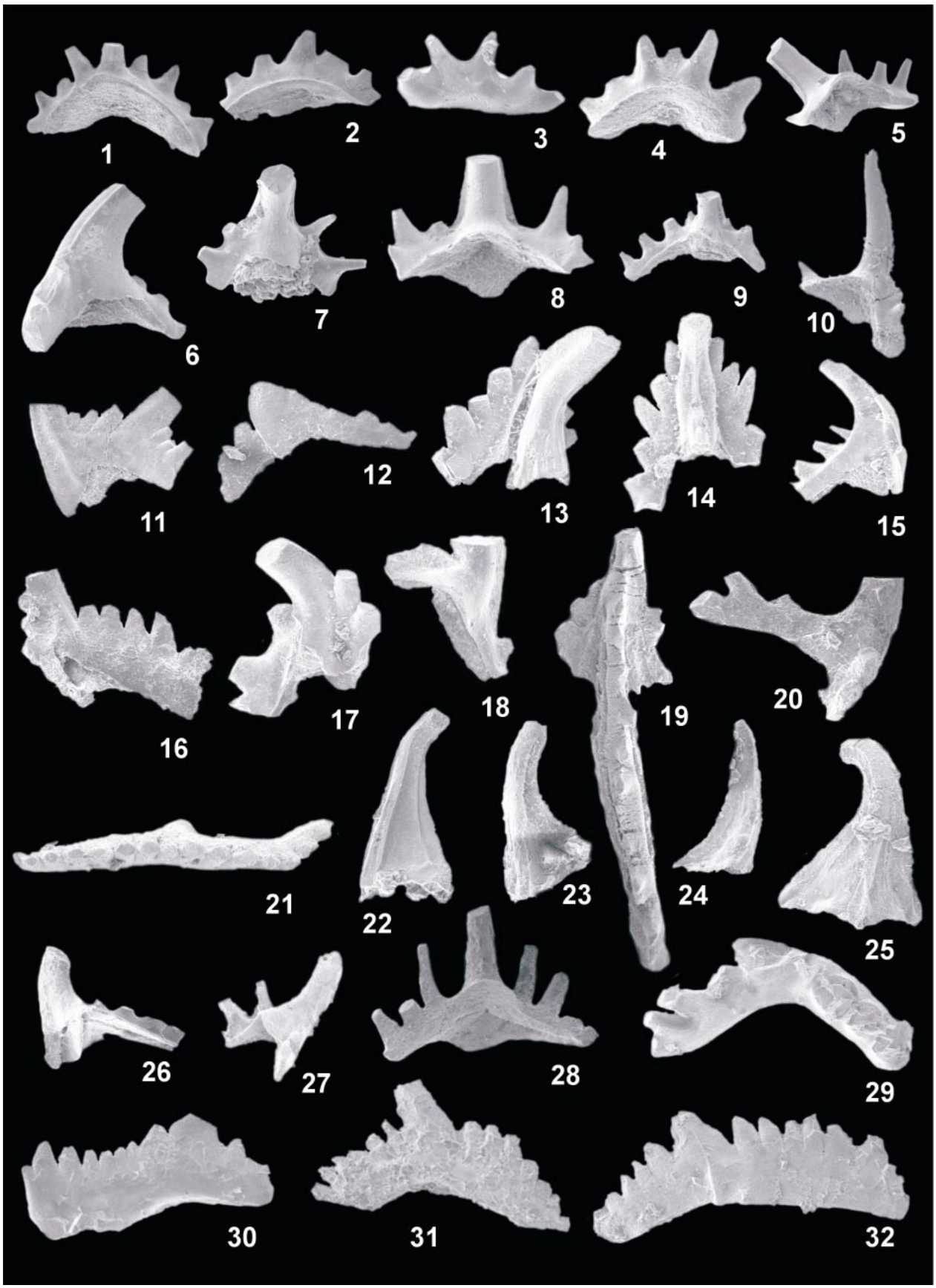
FIGURE *14*—Scanning electron microscope photomicrographs of conodonts from the Beaverfoot Formation (14.1–14.18) and McCusker and Nonda Formations (14.19–14.18). All specimens in posterior view unless otherwise noted. *1–4*, *Curtognathus* spp. All specimens, ×50, 1–3 from sample SCS-98-13. *1*, curtignathiform element, GSC 122960; *2*, cardiodelliform element, GSC 122961; *3*, trucheroform element, anterior view, GSC 122962, *4*, curtognathiform element, GSC 122963, from sample SCN-98-2. *5–7*, *Erismodus asymmetricus* (Branson and Mehl). All specimens from sample SCS-98-13. *5*, Sb element, postero-lateral view, GSC 122964, ×55; *6*, P element, lateral view, GSC 122965, ×50; *7*, Sa element, GSC 122966, ×55. *8–10*, *Erismodus* cf. *radicans* (Hinde). All specimens ×35 and from sample GC-99-07. *8*, Sa element, GSC 122967; *9*, Sb element, GSC 122968; *10*, Sc element, GSC 122969. *11–12*, *Phragmodus undatus* Branson and Mehl. Both specimens ×60 and from sample SCS-98-13. *11*, Sb element, lateral view, GSC 122970; *12*, Pa element, anterior view, GSC 122971. *13–18*, *Plectodina aculeata* (Stauffer). All specimens ×55 and from sample SCN-98-02. *13*, Sb element, GSC 122972; *14*, Sa element, GSC 122973; *15*, Sc element, GSC 122974; *16*, Pa element, GSC 122975; *17*, Pb element, GSC 122976; *18*, M element, GSC 122977. *19*, *Distomodus staurognathoides* (Walliser). Pb element, anterior view, GSC 122978, ×45, from sample MM-99-06. *20*, *Oulodus panuarensis* (Bischoff). Sc element, lateral view, GSC 122979, ×60, from sample GC-99-09. *21*, *Ozarkodina inclinata*? (Rhodes). Pa element, upper view, GSC 122980, ×60, from sample GC-99-22. *22–25*, *Walliserodus* n. sp. A. All specimens in lateral view, ×77, and from sample MM-99-09. *22–23*, S elements, GSC 122981, 122982; *24*, M element, GSC 122983; *25*, P element, GSC 122984. *26–28*, *Oulodus panuarensis* (Bischoff). *26*, M element, lateral view, GSC 122985, ×65, from sample MM-99-17; *27*, Sb element, postero-lateral view, GSC 122986, ×40, from sample GC-99-25. *28*, Pa element, GSC 122987, ×40, from sample MM-99-13. *29*, *Oulodus sigmoideus* Zhang and Barnes. Pa element, lateral view, GSC 122988, ×40, from sample GC-99-27. *30*, *Ozarkodina hassi* (Pollock, Rexroad and Nicoll). Pa element, lateral view, GSC 122989, ×70, from sample GC-99-27. *31*, *Ozarkodina pirata* Uyeno. Pb element, lateral view, GSC 122990, ×40, from sample GC-99-25. *32*, *Ozarkodina* cf. *O. strena* Zhang and Barnes. Pa element, lateral view, GSC 122991, ×40, from sample MM-99-15.

FIGURE *15*—Scanning electron microscope photomicrographs of conodonts from the Ospika Formation (15.1–15.16) and Robb Formation (15.17–15.33). 15.1–15.16, all specimens from sample OS-99-19 and in lateral view unless otherwise noted. *1–2*, *Ansella longicuspica* Zhang. Both specimens ×100. *1*, P element, GSC 122992; *2*, M element, GSC 122993. *3*, *Eoplacognathus suecicus* Bergström. Dextral stelliplanate element, upper view, GSC 122994, ×90, from sample OS-99-20. *4–5*, *Paroistodus originalis* (Sergeeva). Both specimens ×65. *4*, P element, GSC 122995; *5*, M element, GSC 122996. *6–8*, *Periodon aculeatus* (Hadding). All specimens ×50. *6*, M element, GSC 122997; *7*, Sb element, GSC 122998; *8*, Pa element, GSC 122999. *9*, *Protopanderodus calceatus* Bagnoli and Stouge. a element, ×60, GSC 123000. *10–11*, *Protoprioniodus aranda* Cooper. Both specimens, ×70. *10*, M element, GSC 123001; *11*, S element, GSC 123002. *12–14*, *Prioniodus*? sp. All specimens ×80. *12*, Pb element, anterior view, GSC 123003; *13*, Sb element, GSC 123004; *14*, Pa element, GSC 123005. *15*, *Spinodus spinatus* (Hadding). Sb element, ×70, GSC 123006. *16*, *Walliserodus ethingtoni* (Fåhræus). S element, GSC 123007, ×50. 15.17–15.33, All specimens in lateral view unless otherwise noted. *17–19*, *Amorphognathus tvaerensis* Bergström. Both Pa elements, upper view, GSC 123008, 123009, ×40, from sample LL-98-36. *19*, ?S element, GSC 123010, ×48, from sample MKR-99-15. *20–25*, *Baltoniodus variabilis* (Bergström). All specimens ×40, from sample LL-98-36. *20*, M element, GSC 123011; *21*, Pa element, anterior view, GSC 123012; *22*, Sb element, GSC 123013; *23*, Sc element, GSC 123014; *24*, Sd element, GSC 123015; *25*, Pb element, GSC 123016. *26–29*, *Belodina* n. sp. A All specimens ×40, from sample MKR-99-14. *26*, S_1 element, GSC 123017; *27*, S_2 element, GSC 123018; *28*, ?S_3 element, 123019; *29*, M element, GSC 123020. *30*, *Gamachignathus ensifer*? McCracken, Nowlan and Barnes. Pa element, ×43, GSC 123021, from sample MKR-99-15. *31–32*, *Phragmodus undatus* Branson and Mehl. Both specimens ×70, from sample MKR-99-14 *31*, Pa element, anterior view, GSC 123022; *32*, Sb element, GSC 123023. *33*, *Protopanderodus cooperi* (Sweet and Bergström). a element, GSC 123024, ×45, from sample LL-98-34.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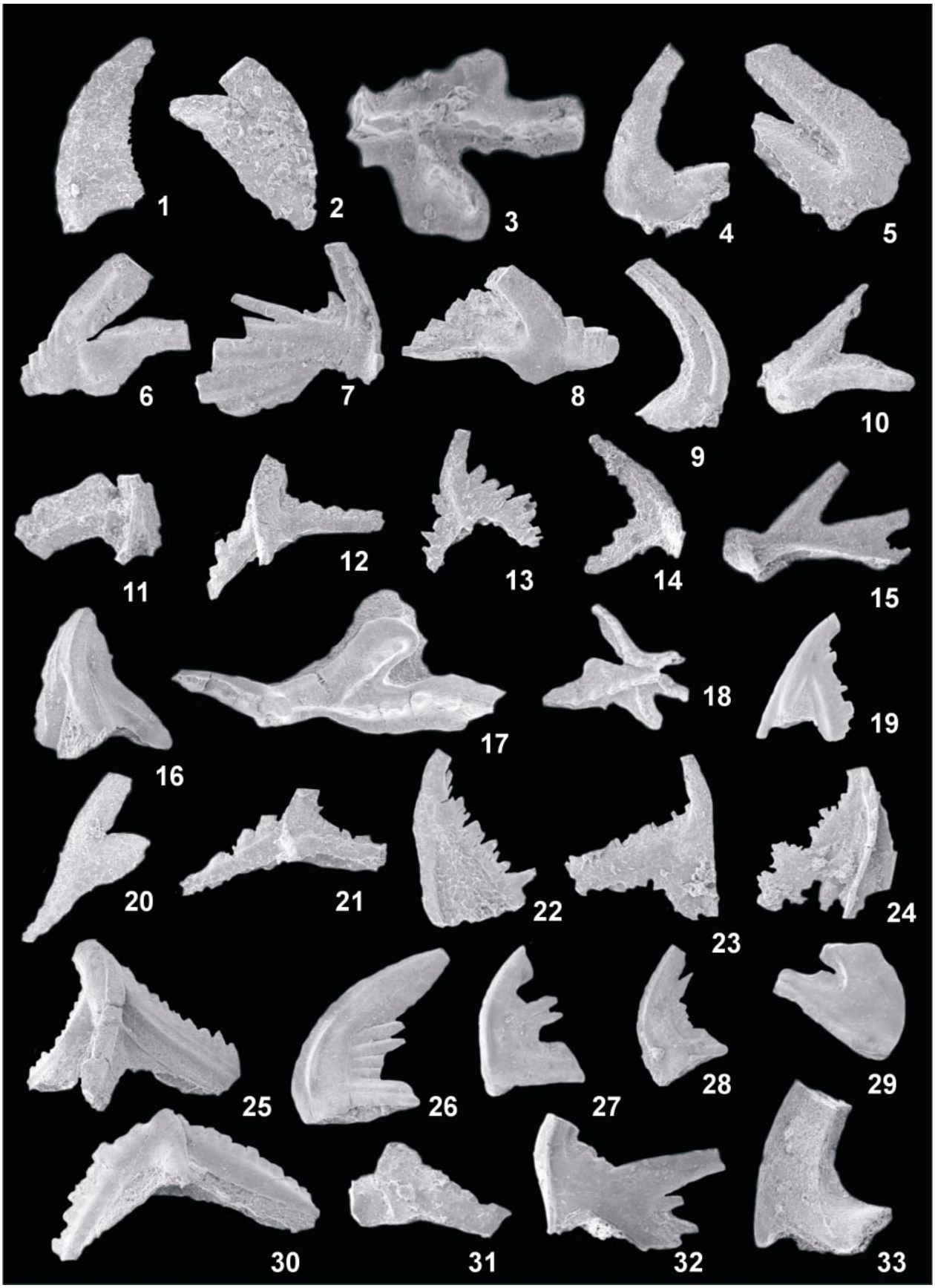
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Thrincodus palaris Bauer (Fig. 13.13, 13.14) is a distinctive and short-ranging species described by Bauer (1987). It occurs in the *H. sinuosa* to *H. holodentata* zones of the Skoki Formation. The apparatus of *Tripodus laevis* Bradshaw (Fig. 13.15, 13.16) was described by Ethington and Clark (1982). Nine specimens are assigned to *Walliserodus costatus* Dzik (Fig. 13.17, 13.18); the apparatus is described by Dzik (1994). One element is questionably assigned as a P element because it is wider than elements described by Dzik (1976, 1994).

Fauna of the Beaverfoot Formation.—A low diversity assemblage from the Beaverfoot Formation includes *Curtognathus* spp. (Fig. 14.1–14.4) and *Plectodina aculeata* Branson and Mehl (Fig. 14.14–14.18) in abundance. Associated species include *Erismodus asymmetricus* (Branson and Mehl) (Fig. 14.5–14.7) and *Erismodus* cf. *E. radicans* (Hinde) (Fig. 14.8–14.10). The material from the present study assigned to *E*. cf. *E. radicans* is similar to the elements illustrated by Leslie (2000). Two other species recovered in low abundance from the Beaverfoot Formation are *Panderodus gracilis* and *Phagmodus undatus* (Fig. 14.11, 14.12).

Fauna of the Ospika Formation.—The deeper water species recovered from the Ospika Formation, Section 10, are indicative of the *Eoplacognathus suecicus* Zone. Some of these species are found in coeval strata in the Skoki Formation at Sections 2 and 8 including *Ansella jemtlandica* (Löfgren) (Fig. 11.1–11.4), *Drepanoistodus basiovalis* (Sergeeva) (not figured), *Oistodus multicorrugatus* (Fig. 12.8), *Parapanderodus striatus* (Graves and Ellison) (Fig. 12.15, 12.16), and *Periodon aculeatus* (Hadding) (Fig. 15.6–15.8). *Ansella longicuspica* Zhang (1998a) (Fig. 15.1, 15.2) differs from *A. jemtlandica* in having elements with a shallower basal cavity and was also reported from the Skoki Formation north of the present study area (Pyle and Barnes, 2002). One broken element of *E. suecicus* Bergström was recovered that corresponds to the emended description of the species by Zhang (1999) in having a central denticle row on each process and an expansion of the posterior process (Fig. 15.3). Other species in the Ospika Formation that occur in the Skoki Formation to the north include *Paroistodus originalis* (Sergeeva) (Fig. 15.4, 15.5) and *Protoprioniodus aranda* Cooper (Fig. 15.10, 15.11). Species reported from the Ospika Formation north of the present study area by Pyle and Barnes (2002) include the bicostate elements of *Protoprioniodus calceatus* Bagnoli and Stouge (Fig. 15.9), *Spinodus spinatus* (Hadding) (Fig. 15.15), and *Walliserodus ethingtoni* (Fåhræus) (Fig. 15.16).

Fauna of the Robb Formation.—Species from the Robb Formation represent cooler or deeper water species of the Atlantic Realm. The Pa element of *Amorphognathus tvaerensis* Bergström (Fig. 15.17, 15.18) is diagnostic for this important zonal indicator (Bergström, 1971, 1982). *Baltoniodus variabilis* (Bergström) is another zonal species characterized by the prominent ledges along the process margins of the Pa and Pb elements (Fig. 15.21, 15.25). One specimen is assigned questionably to the biostratigraphically significant Late Ordovician species *Gamachignathus ensifer* McCracken (Fig. 15.30). Although the specimen is broken, it bears confluent denticles and a high and deeply excavated base characteristic of the genus. The denticles are smaller and more numerous than is typical for the species as described by McCracken et al. (1980). *Protopanderodus cooperi* (Sweet and Bergström) occurs in the Robb Formation at Section 8. It is characterized by having one strong costa on one or two lateral cusp faces and a compressed base with a notch in the aboral basal margin near the antero-basal corner (Fig. 15.33).

Staufferella falcata (Stauffer, 1935) (Fig. 16.1–16.5) occurs in the Robb Formation within the *G. ensifer* Zone?. Leslie (2000) reconstructed the apparatus to include an Sd element that was assigned to the P position by Sweet (1982) and described the Sc element that had not been described previously. The Sc elements from this present study are similar to those illustrated by Leslie (2000) but are not preserved well enough to show two flares in the wall of the element near the base of the element.

Silurian Fauna of the McCusker, Nonda, Kenny and Laurier Formations.—The Silurian conodont fauna from the platformal McCusker and Nonda Formations and correlative Kenny and Laurier Formations contains species from the *Distomodus staurognathoides* Zone. The Pb element of *D. staurognathoides* (Walliser) is variable (see Zhang and Barnes, 2002 for current synonymy and discussion) and some elements have a well-developed anterior process (Figs. 14.19, 16.17, 16.18). Seven distinctive platform and lyriform elements of *Apsidognathus tuberculatus* Walliser (Fig. 18.9–18.11) were recovered from the Laurier Formation, although the subspecies recognized by Armstrong (1990) were not determined herein. *Dapsilodus obliquicostatus* (Branson and Mehl) (Fig. 16.13, 16.14) is a long ranging species that ranges into the Kenny Formation from the underlying Robb Formation.

Eighteen specimens of *Kockelella? manitoulinensis* (Pollock, Rexroad, and Nicoll) were recovered from the Kenny and Laurier Formations. The Pa element has an expansive basal cavity and strong deflection of the posterior process (Figs. 17.1, 18.12). The material is assigned to *Kockelella* in question following the discussion by Armstrong (1990) and Zhang and Barnes (2002).

Zhang and Barnes (2002) proposed new interval zones for the Llandovery including *Ozarkodina hassi* and *Oz. strena* zones, the latter of which was subdivided into *Oulodus jeannae* and *O. panuarensis* subzones. All of these nominate species were found in the present material. Elements of *O. panuarensis* (Bischoff) were recovered from all four Silurian Formations (Figs. 14.20, 14.26–14.28, 17.8, 17.9, 18.15). Zhang and Barnes (2002) provide an emended diagnosis and description. A complete apparatus of *O. jeannae* Schönlaub is illustrated (Fig. 17.2–17.7) in which the Pa element has two processes twisting in opposite directions. Two elements of *O. sigmoideus* Zhang and Barnes were recovered from the Nonda Formation (Fig. 14.29). The Pa element is characterized by its sigmoidal shape in lateral and oral view and close spacing of the denticles. *Oulodus fluegeli* (Walliser) was recovered from the Laurier Formation and elements are characterized

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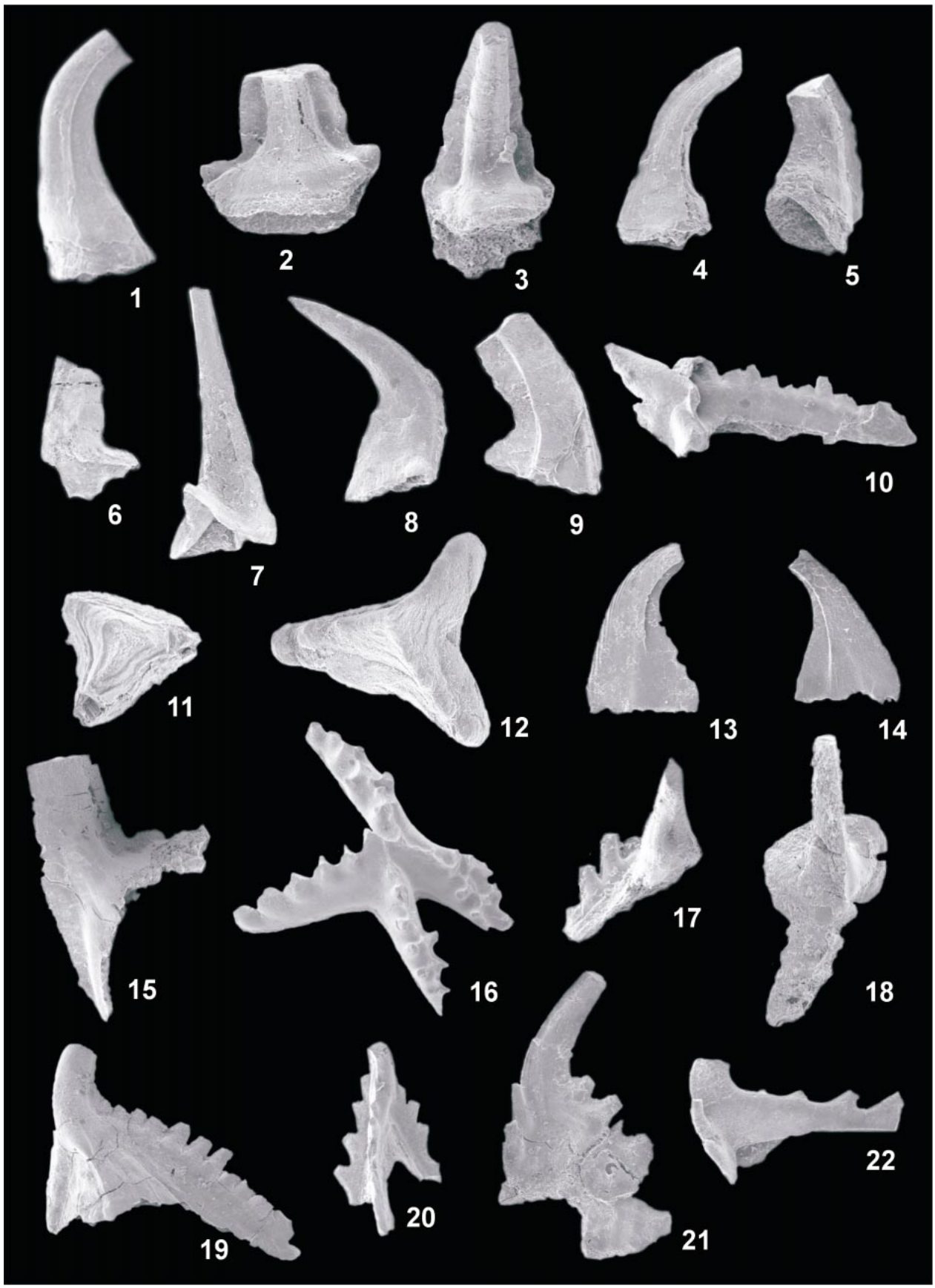
FIGURE *16*—Scanning electron microscope photomicrographs of conodonts from the Robb Formation (16.1–16.10) and Kenny Formation (16.11–16.22). All specimens in lateral view unless otherwise noted. *1–5, Staufferella falcata* (Stauffer). All specimens ×70, from sample MKR-99-14. *1*, Sb element, GSC 123025; *2*, Sa element, posterior view, GSC 123026; *3*, Sa element, posterior view, GSC 123027, ×40; *4*, Sc element, GSC 123028; *5*, Sd element, GSC 123029. *6–9*, Genus indet. B sp. *1*, specimens ×65 and from sample MKR-99-15. *6*, Sc element, GSC 123030; *7*, Sa element, posterior view, GSC 123031; *8*, ?P element, GSC 123032; *9*, Sb element, GSC 123033. *10*, Genus indet. C sp. 1,? P element, GSC 123034, ×45, from sample MKR-99-15. *11–12, Anticostiodus fahraeusi* Zhang and Barnes. Pb elements, upper views, GSC 123035, 123036, ×80, from sample MK-99-11, MK-99-10. *13, 14, Dapsilodus obliquicostatus* (Branson and Mehl). Both specimens ×100 and from sample MK-99-12. *13*, S element, GSC 123037; *14*, S element, GSC 123038. *15–22, Distomodus staurognathoides* (Walliser). All specimens from sample MK-99-10. *15*, M element, GSC 123039, ×55; *16*, Pa element, upper view, GSC 123040, ×45; *17*, Pb element, posterior view, GSC 123041, ×60; *18*, Pb element, anterior view, GSC 123042, ×50; *19*, Sb element, GSC 123043, ×40; *20*, Sa element, posterior view, GSC 123044, ×60; *21*, Sb element, GSC 123045, ×55; *22*, Sc element, GSC 123046, ×60.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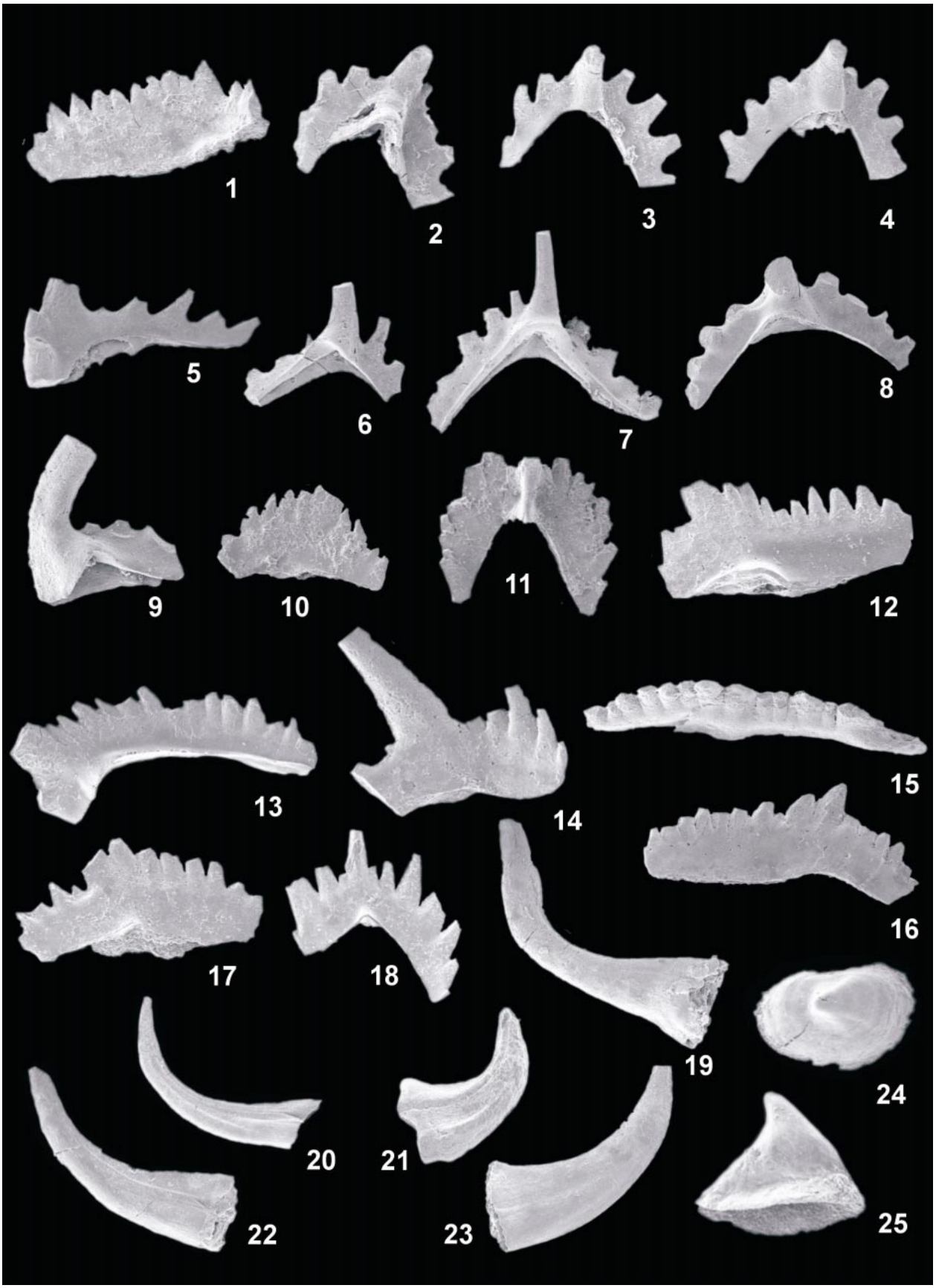
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by the narrow basal cavity (Fig. 18.13, 18.14). The apparatus was described fully by Aldridge (1979).

Among the species of *Ozarkodina*, *Oz. hassi* (Pollock, Rexroad, and Nicoll) occurs in the Nonda (Fig. 14.30; six elements recovered) and Kenny Formations (Fig. 17.10–17.14; 154 elements recovered). Two elements from the Nonda Formation are assigned to *Oz.* cf. *Oz. strena* Zhang and Barnes (Fig. 14.32). Characteristics exhibited by the slightly arched Pa element that are similar to those described by Zhang and Barnes (2002) include the robust, partially fused denticles and prominent, compressed cusp, inclined posteriorly. The posterior process is straighter, shorter and lower than the anterior process. A feature of the specimens from the present collection not shown by Zhang and Barnes (2002) is the prominent lateral costa that extends from the tip of the cusp to the aboral basal margin. Eighteen elements from the Kenny Formation and 24 elements from the Laurier Formation are assigned to *Oz. inclinata* (Rhodes) based on the Pa elements with characteristic highly fused denticles that are inclined posteriorly (Fig. 17.15–17.16). Two Pa elements are assigned to *Oz. inclinata*?. The specimen recovered from the McCusker Formation (Fig. 14.21) has an anterior process that is bent laterally. The specimen recovered from the Laurier Formation (Fig. 18.16) has denticles that are not inclined posteriorly. A total of 20 elements of *Oz. pirata* Uyeno (Figs. 14.31, 17.17, 17.18) were recovered from the Nonda and Kenny Formations [see Zhang and Barnes (2002) for an emended diagnosis of the species].

Four species of *Pterospathodus* were recovered from the Kenny and Laurier formations. Only one specimen of the earliest known species, *P.? originalis* Zhang and Barnes (Fig. 18.1), was recovered. Zhang and Barnes (2002) propose the species represents the ancestral species of *Pterospathodus* based on its biostratigraphic occurrence below all other species of the genus and based on its prominent cusp and development of a lateral lobe on only one side of the basal cavity. In this present study, the species occurs biostratigraphically below other species of *Pterospathodus* including *P. amorphognathoides* Walliser, *P. eopennatus* Männik, and *P. pennatus procerus* (Walliser), all of which occur in the Laurier Formation (Fig. 8; Table 11) and are readily distinguished by the morphology of the Pa elements (Männik and Aldridge, 1989). The three types of P elements for the biostratigraphically important *P. amorphognathoides* were recognized (Fig. 18.21–18.24) as described by Männik (1998). Only the Pa elements of *P. eopennatus* (Fig. 18.25) and *P. pennatus procerus* (Fig. 18.26) were recovered.

SELECTED SYSTEMATIC PALEONTOLOGY

The type specimens illustrated in Figures 10–18 are housed in the National Type Collection of the Geological Survey of Canada (GSC), Ottawa, Ontario. The terminology used for multielement taxonomy follows the letter designations after Sweet and Schönlaub (1975) for the location of elements within well-known septimembrate apparatuses (S, M, P notation). For coniform apparatuses, the letter designations proposed by Ji and Barnes (1994) are followed (a, b, c, e, f).

Genus ACODUS Pander, 1856

Type species.—*Acodus erectus* Pander, 1856.

ACODUS KECHIKAENSIS Pyle and Barnes (2002)
Figure 10.1–10.6

Acodus? aff. *A. emanuelensis* McTavish. ETHINGTON AND CLARK, 1982, p. 19–20, pl. 1, Figs. 11–13 (Sb, Sa, P) only, text-fig. 5 (in part).
Acodus kechikaensis PYLE AND BARNES, 2002, p. 87, pl. 1, Figs. 11–17.

Material examined.—2949 elements; GSC 122856–122861.

Occurrence.—*Acodus kechikaensis* Zone, Kechika Formation, Section 2.

Discussion.—Pyle and Barnes (2002) recognized several species of *Acodus*, among which is an important zonal species, *A. kechikaensis*. The apparatus is seximembrate, characterized by robust elements with elongate cusps and S elements with adentate processes, basally adjoined by a sheath that is concave in interprocess region of element. The P element is diagnostic and laterally compressed with a flat outer lateral margin and a flared inner lateral margin with a carina on base.

ACODUS NEODELTATUS Pyle and Barnes, 2002
Figure 10.7–10.9

Acodus neodeltatus PYLE AND BARNES, 2002, p. 88, pl. 2, Figs. 1–7.

Material examined.—167 elements; GSC 122862–122864.

Occurrence.—*Acodus kechikaensis* Zone, Kechika Formation, Section 2.

Discussion.—This species of *Acodus* recognized in coeval strata north of the present study area is characterized by a seximembrate apparatus of thin walled, delicate, laterally compressed elements that have a strong development of keels (lateral, posterior, and anterior). The species appears to be the direct ancestor of *Oepikodus communis* (Pyle and Barnes, 2002).

Genus ANTICOSTIODUS Zhang and Barnes, 2000

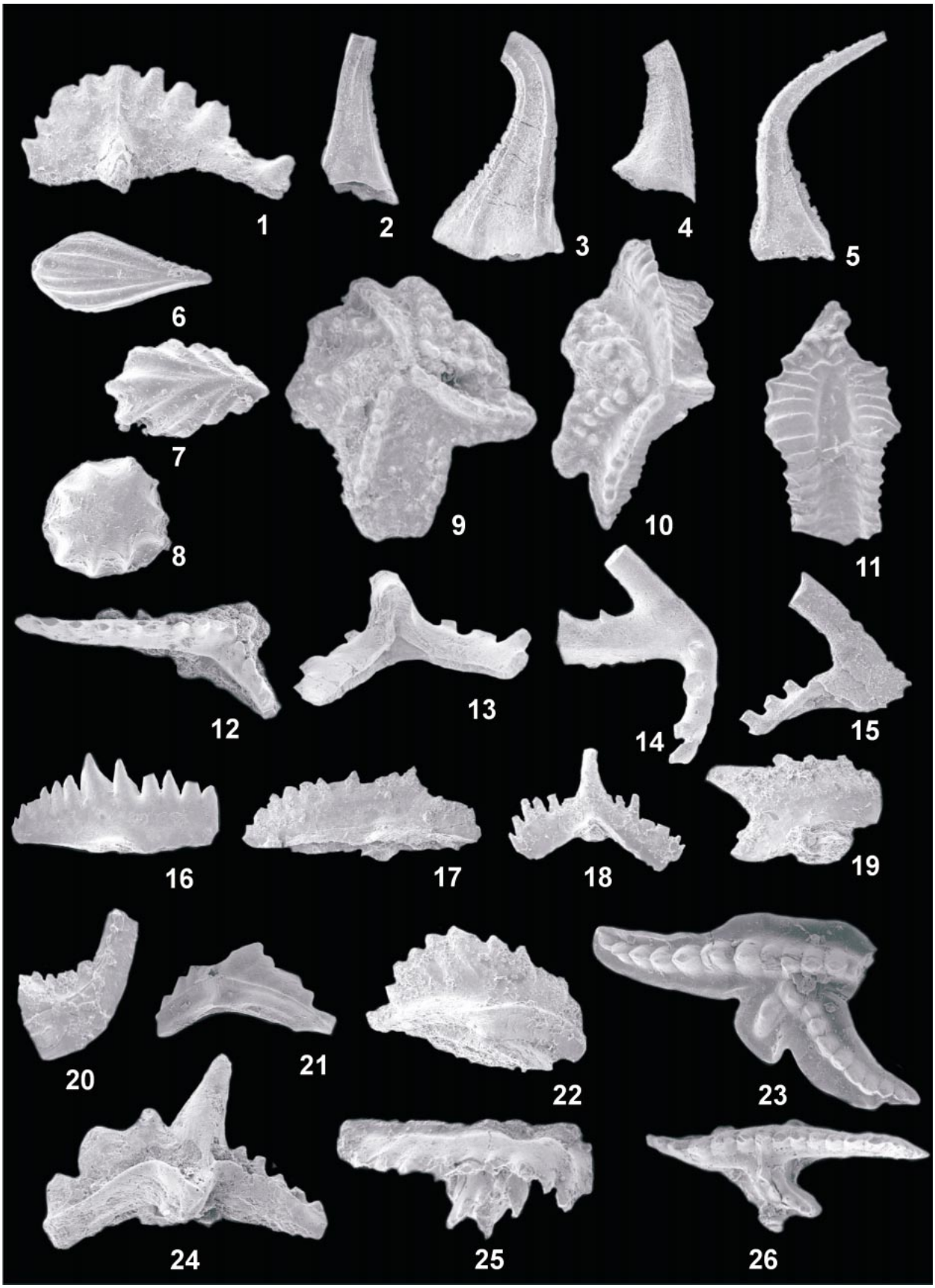
Type species.—*Anticostiodus fahraeusi* Zhang and Barnes, 2000.

ANTICOSTIODUS FAHRAEUSI Zhang and Barnes, 2000
Figure 16.11, 16.12

Anticostiodus fahraeusi ZHANG AND BARNES, 2000, p. 664–667, Fig. 2.1–2.19, 2.22, 2.23.
Ambalodus spp., REXROAD, 1967, p. 27, pl. 3, fig. 4.

←

FIGURE *17*—Scanning electron microscope photomicrographs of conodonts from the Kenny Formation. All specimens in lateral view unless otherwise noted. *1, Kockelella? manitoulinensis* (Pollock, Rexroad and Nicoll). Pa element, GSC 123047, ×60, from sample MK-99-12. *2–7, Oulodus jeannae* Schönlaub. All specimens ×60 and from sample MK-99-12. *2*, Sc element, posterior view, GSC 123048; *3*, Sa element, posterior view, GSC 123049; *4*, Sb element, posterior view, GSC 123050; *5*, M element, GSC 123051; *6*, Pa element, posterior view, GSC 123052; *7*, Pb element, posterior view, GSC 123053. *8–9, Oulodus panuarensis* (Bischoff). Both specimens from sample MK-99-9A. *8*, Pa element, GSC 123054; *9*, M element, GSC 123055. *10–14, Ozarkodina hassi* (Pollock, Rexroad and Nicoll). All specimens ×75 and from sample MK-99-12. *10*, Pa element, GSC 123056; *11*, Sa element, posterior view, GSC 123057; *12*, Pb element, GSC 123058; *13*, Sb element, GSC 123059; *14*, Sc element, GSC 123060. *15, 16, Ozarkodina inclinata* (Rhodes). Pa elements in upper and lateral view, GSC 123061, 123062, ×70, from sample MK-99-10. *17–18, Ozarkodina pirata* Uyeno. Both specimens ×70 and from sample MKR-99-8. *17*, Pa element, GSC 123063; *18*, Sb element, posterior view, GSC 123064. *19, Panderodus recurvatus* (Rhodes). Arcuatiform element, GSC 123065, ×60, from sample MK-99-10. *20–23, Panderodus unicostatus* (Branson and Mehl). All specimens ×55, from sample MK-99-10. *20*, graciliform element, GSC 123066; *21*, truncatiform element, GSC 123067; *22*, arcuatiform element, GSC 123068; *23*, compressiform element, GSC 123069. *24–25, Pseudooneotodus beckmanni* (Bischoff and Sannemann). Both specimens ×80 and from sample MK-99-9A. *24*, upper view, GSC 123070; *25*, lateral view, GSC 123071.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Material examined.—Two elements; GSC 123035, 123036.

Occurrence.—*Distomodus staurognathoides* Zone, Kenny Formation, Section 5.

Discussion.—Zhang and Barnes (2000) described an apparatus of eight morphotypes of which only the Pb element is recognized from the material of this present study. The Pb element has three equal processes, posterior, anterior and lateral that extend from a central cusp, giving the element an equilateral triangle-shaped platform in oral view. The species occurs near the base of the *Distomodus staurognathoides* Zone of the Gun River Formation, Anticosti Island (Zhang and Barnes, 2000) and from the same zone in this present study.

Genus BELODINA Ethington, 1959

Type species.—Belodina compressa (Branson and Mehl, 1933).

BELODINA new species A
Figure 15.26–15.29

Description.—Apparatus of four morphotypes (S_1, S_2, S_3, M) characterized by low heel with flat aboral basal margin. Distinctive S_1 element has a broad cusp that bears a strong costa near the anterior cusp margin. Anterior cusp margin sharp, posterior cusp margin bears at least four denticles, fused basally. Denticles discrete apically. Heel has a straight aboral and oral margin. The S_2 element bears similar denticles, but has a more slender cusp. A possible S_3 element is shown (Fig. 15.28) that has more slender denticles and cusp. The M element geniculate and compressed. The antero-basal corner well rounded, aboral basal margin straight. Heel or posterior extension of the base is short. Lateral cusp face bears a costa near the posterior cusp margin.

Material examined.—21 elements; GSC 123017–123020.

Occurrence.—*G. ensifer* Zone?, Robb Formation, Section 6.

Discussion.—This new species differs from other species of *Belodina* because of the low heel of the elements and the strong lateral costae on the cusp, best developed in the S_1 element.

Genus DREPANOISTODUS Lindström, 1971

Type species.—*Oistodus forceps* Lindström, 1955.

DREPANOISTODUS LATUS new species
Figure 10.10–10.11

Drepanoistodus n. sp. A PYLE AND BARNES, 2002, p. 64, pl. 6, Figs. 19–21.

Diagnosis.—Apparatus of three morphotypes (a, c, e) characterized by base that opens widely to both inner and outer lateral sides of element.

Description.—Base opens widely to both inner and outer lateral sides of the element. Apparatus of three morphotypes (a, c, e). a element compressed with broad, erect cusp. Posterior and anterior cusp margins sharp. Lateral cusp faces smooth. Postero- and antero-basal margins sharp. Posterior cusp margin notched above postero-basal corner, which is drawn out posteriorly. Basal margin flares anteriorly and to inner lateral side. Antero-basal corner drawn out anteriorly.

The c elements are rare and although none are illustrated from this present material, one is figured and described in Pyle and Barnes (2002) as suberect and symmetrical with compressed cusp and base that opens widely laterally.

Compressed e element geniculate. Antero-basal margin rounded; postero-basal margin sharp. Base broad, open widely laterally. Base bears prominent inner lateral flare.

Etymology.—*latus*, Latin for wide, in reference to the base of the elements.

Types.—Holotype, GSC 122865; paratype, GSC 122866; c element: paratype GSC 119399 from Pyle and Barnes (2002).

Other material examined.—86 elements.

Occurrence.—*A. kechikaensis* Zone to *O. communis* Zone, Kechika Formation, Section 2.

Discussion.—The new species occurs with *D. suberectus* and *D. amoenus* but differs from those species in the robust nature and the widely open base of the elements.

Genus KALLIDONTUS Pyle and Barnes, 2002.

Type species.—*Kallidontus serratus* Pyle and Barnes, 2002.

KALLIDONTUS NODOSUS Pyle and Barnes, 2002
Figure 10.12–10.14

Kallidontus nodosus PYLE AND BARNES, 2002, p. 53, pl. 8, Figs. 1–15.

Material examined.—18 elements; GSC 122867–122869.

Occurrence.—*A. kechikaensis* Zone to *O. communis* Zone, Kechika Formation, Section 2.

Discussion.—Elements assigned to the P and S positions of the apparatus of *Kallidontus* were recovered. They are characterized by the development of transverse ridges terminating laterally as strong nodes. *K. nodosus* differs from *K. serratus* by having a stronger development of the lateral ridges on the element faces and nodose, rather than sharp, serrations along the element margins (compare Fig. 10.14 to 10.15).

KALLIDONTUS SERRATUS Pyle and Barnes, 2002
Figure 10.15–10.18

Kallidontus serratus PYLE AND BARNES, 2002, p. 56, pl. 9, Figs. 8–17; pl. 10, Figs. 1–14.

Material examined.—102 elements; GSC 122870–122873.

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FIGURE *18*—Scanning electron microscope photomicrographs of conodonts from the Kenny Formation (1–8) and Laurier Formation (9–26). All specimens in lateral view unless otherwise noted. *1*, *Pterospathodus*? *originalis* Zhang and Barnes. Pb element, GSC 123071, ×55, from sample MKC-99-7. *2–4*, *Walliserodus curvatus* (Branson and Branson). All specimens ×60 and from sample MK-99-9A. *2–3*, S elements, GSC 123072, 123073; *4*, P element, GSC 123074. *5*, *Walliserodus* sp. S element, GSC 123075, ×60, from sample MR-99-4. *6–8*, Ichthyoliths, upper view, GSC 123076, 123077, 123078, ×85, from sample MK-99-12. *9–11*, *Apsidognathus tuberculatus* Walliser. *9*, Pa element, upper view, GSC 123079, ×50, from sample MR-98-9; *10*, Pa element, upper view, GSC 123080, ×50, from sample MR-98-8. *11*, lyriform element, upper view, GSC 123081, ×50, from sample MR-98-8. *12*, *Kockelella*? *manitoulinensis* (Pollock, Rexroad and Nicoll). Pa element, upper view, GSC 123082, ×40, from sample MKR-99-11. *13–14*, *Oulodus fluegeli* (Walliser). Both specimens ×50, from sample MR-98-8. *13*, Sa element, postero-basal view, GSC 123083; *14*, Sc element, GSC 123084. *15*, *Oulodus panuarensis* (Bischoff). M element, GSC 123085, ×40, from sample MKR-99-10. *16*, *Ozarkodina inclinata*? (Rhodes). Pa element, GSC 123086, ×35, from sample MR-98-8. *17–19*, *Ozarkodina inclinata* (Rhodes). All specimens ×35, from sample MR-98-9. *17*, Pa element, GSC 123087; *18*, Sa element, GSC 123088; *19*, Pb element, GSC 123089. *20*, *Pseudobelodella silurica* Armstrong. GSC 123090, ×60, from sample MR-98-9. *21–24*, *Pterospathodus amorphognathoides* Walliser. *21*, Pb2 element, GSC 123091, ×55, from sample MR-98-8; *22*, Pb2 element, GSC 123092 ×60, from sample MR-98-9; *23*, Pa element, GSC 123093, ×55, from sample MR-98-8; *24*, Pb element, GSC 123094, ×50, from sample MR-98-8. *25*, *Pterospathodus eopennatus* Männik. Pa element, GSC 123095, ×66, from sample MR-98-9. *26*, *Pterospathodus pennatus procerus* (Walliser). Pa element, GSC 123096 ×66, from sample MR-98-9.

Occurrence.—*A. kechikaensis* Zone to *O. communis* Zone, Kechika Formation, Section 2.

Discussion.—Elements assigned to the P and S position of the apparatus were recovered, as well as both forms of the species recognized by Pyle and Barnes (2002). The early form of the large, almost symmetrical Pb element is diagnostic. It bears two lateral denticulate processes. In later forms of the Pb elements (Fig. 10.15), a posterior denticulate process is developed and the anterior and posterior cusp faces bear transverse ridges. The three processes bear at least five broad denticles in unbroken specimens.

Genus MULTIOISTODUS Cullison, 1938.

Type species.—*Multioistodus subdentatus* Cullison, 1938.

MULTIOISTODUS? new species A.
Figure 12.1–12.3

Description.—At least three types of S elements (Sa, Sb, Sc) that are hyaline, robust, costate coniforms that bear large denticles, as wide as the height of the base, with a biconvex cross-section. Sa element symmetrical. Cusp has sharp lateral margins. Base short with wide, rounded basal opening, flared posteriorly and anteriorly (Fig. 12.2). Two large lateral denticles somewhat compressed postero-anteriorly. The Sb element asymmetrical with keeled anterior cusp margin. Cusp twisted and compressed laterally, giving biconvex cross-section. Base short with wide basal opening. Two large denticles arise from rounded base and have biconvex cross-section. Sc element asymmetrical. Cusp bears two costae on lateral face (Fig. 12.1). The wide base opens postero-laterally. One large denticle arises basally and is deflected posteriorly.

Material examined.—29 elements; GSC 123098–123100.

Occurrence.—*Phagmodus* ''*pre-flexuosus*'' Zone, Redfern Member, Skoki Formation, Section 3.

Discussion.—This species is assigned questionably to *Multioistodus* because a geniculate M element, which would distinguish it from *Neomultioistodus*, was not found.

Genus OSLODUS Zhang, 1998a

Type species.—*Acontiodus semisymmetricus* Hamar, 1966.

OSLODUS cf. O. SEMISYMMETRICUS (Hamar, 1966)
Figure 12.12–12.15

cf. *Acontiodus semisymmetricus* HAMAR, 1966, p. 51, pl. 7, Figs. 5, 6; text-fig. 3.6.

cf. *Oslodus semisymmetricus* Hamar. ZHANG, 1998a, p. 77–78, pl. 12. 14–12.20 (contains synonymy to 1998).

Besselodus cf. *semisymmetricus* Hamar. LESLIE, 2000, p. 1131, Fig. 3.25–3.29.

Material examined.—23 elements; GSC 122916–122919.

Occurrence.—*Histiodella sinuosa* Zone to *Amorphognathus tvaerensis* Zone, Skoki and Robb Formations, Section 8.

Discussion.—Zhang (1998a) distinguished *Oslodus* from the similar genera *Besselodus* (Aldridge, 1982) and *Dapsilodus* (Cooper, 1976) by the lack of striations on the lateral cusp face. The specimens recovered in the present material have the apparatus plan of S, M, and P elements described by Zhang (1998a). The Sc element differs in having a less arched basal outline and the P element has an erect cusp and more slender base.

Genus PLANUSODUS Pyle and Barnes, 2002

Type species.—*Planusodus gradus* Pyle and Barnes, 2002.

PLANUSODUS GRADUS Pyle and Barnes, 2002
Figure 13.4–13.6

Planusodus gradus PYLE AND BARNES, 2002, p. 77, pl. 26, Figs. 9–18.

Material examined.—15 elements; GSC 122937–122939.

Occurrence.—*Jumudontus gananda* Zone, Kechika Formation, Section 8.

Discussion.—The genus was described initially from coeval strata north of the present study area and has a short stratigraphic range within the *J. gananda* Zone. The apparatus has a plan similar to that of *Protopanderodus* and was reconstructed by Pyle and Barnes (2002) to have four morphotypes (a, b, c, and e elements). The coniform elements are laterally compressed with broad cusps that bear thinly keeled posterior and anterior cusp margins and lateral costa on each lateral cusp face. The basal cavity, in lateral view, has a concave anterior margin and apex that lies close to the anterior cusp margin at point of curvature of cusp.

Genus PRIONIODUS Pander, 1856

Type species.—*Prioniodus elegans* Pander, 1856.

PRIONIODUS? sp.
Figure 15.12–15.14

Material examined.—Six elements; GSC 123003–123005.

Occurrence.—*Eoplacognathus suecicus* Zone, Ospika Formation, Section 10.

Discussion.—Six moderately preserved elements are assigned questionably to *Prioniodus* based on the P elements that bear denticulate posterior, anterior and lateral processes. The denticles are compressed and confluent basally. The Pb element is similar to the Pa, but has a wider angle between the lateral and posterior processes. The Sb element has a denticulate antero-basal corner of the element and posterior denticulate process. The element is more arched than the P elements. No Sa elements were recovered to distinguish the genus from *Oepikodus*. The elements differ from those of *Baltoniodus* because they lack hindiodellid denticulation.

Genus PSEUDOONEOTODUS Drygant, 1974

Type species.—*Oneotodus* (?) *beckmanni* Bischoff and Sannemann, 1958.

PSEUDOONEOTODUS new species A
Figure 13.7

Description.—*Pseudooneotodus* n. sp. A. is characterized by broad simple cones in which the apex of the cusp bifurcates into two ''processes'' from a central cusp apex.

Material examined.—Four elements; GSC 122940.

Occurrence.—*H. sinuosa* Zone, Skoki Formation, Section 8.

Discussion.—The species is treated in open nomenclature because few specimens were recovered. The elements are similar to *P. mitratus* (Moskalenko) in having a broad, flared base and smooth element walls, but the cusp in *P. mitratus* is not bifurcated. *Pseudooneotodus* typically appears in Upper Ordovician strata and this may be the earliest reported occurrence of the genus except from that of Stouge (1984) in the Middle Ordovician Table Head Formation.

Genus WALLISERODUS Serpagli, 1967

Type species.—*Paltodus debolti* Rexroad, 1967 (=*Acodus curvatus* Branson and Branson, 1947).

WALLISERODUS new species A
Figure 14.22–14.25

Description.—Apparatus of three morphotypes (S, M, P) characterized by thinly keeled posterior cusp margins and recurved cusp tips. S elements erect with relatively straight anterior cusp margin in lower two-thirds of element and strong curvature of cusp tip in upper one-third of element. Posterior cusp margin thinly keeled. Lateral cusp faces bear one to two costae. Costae

and keeled postero-basal corner project slightly below the basal margin. M element compressed and non-geniculate with rounded anterior cusp margin and sharply keeled posterior cusp margin. Postero-basal margin drawn posteriorly. One lateral costa occurs on both lateral cusp faces. P element similar to the S elements in curvature of cusp tip and nature of cusp margins and costae, but has a wider base.

Material examined.—8 elements; GSC 122981–22984.

Occurrence.—*D. staurognathoides* Zone, McCusker, Nonda, and Kenny Formations, Sections 3, 4, and 6.

New Genus A, Species 1
Figure 13.22–13.25

Description.—Apparatus of at least three morphotypes (a, b, e) of simple coniforms with greatly elongated, curved to twisted cusps. Symmetrical a element has sharp cusp margins. Cusp bears faint longitudinal costae from base to tip of cusp. Base short and slightly wider than cusp. Asymmetrical b elements have twisted cusps. Cusp margins sharp and lateral costae on cusp lie near the postero-lateral cusp margin. Base drawn out posteriorly. Laterally compressed e element bears well-developed longitudinal costae along postero-lateral cusp margin. Base drawn out posteriorly and has flat upper basal margin.

Material examined.—35 elements; GSC 122955–122958.

Occurrence.—*H. holodentata* Zone, Skoki Formation, Section 2.

Discussion.—The elements are not hyaline, which distinguishes them from elements of *Scandodus*. The apparatus does not include a symmetrical c element characteristic of the genus *Drepanoistodus* and the elements are also bear more strongly keeled cusp margins than elements of *Drepanoistodus*.

Genus indeterminate A, species 1
Figure 13.19–13.21

Description.—Apparatus (a, b, e elements) of unornamented simple coniform elements with deep basal cavity and flat basal outline. Cusp erect with a straight antero-basal margin. Symmetrical a element has rounded cusp margins. Asymmetrical b element laterally compressed. Antero-basal margin drawn out and slightly compressed. Postero-basal corner of laterally compressed e element drawn out more than in a and b element.

Material examined.—Four elements; GSC 122952–122954.

Occurrence.—*H. holodentata* Zone to *P. ''pre-flexuosus''* Zone, Skoki Formation, Sections 3 and 8.

Discussion.—The elements are not assigned to *Drepanoistodus* because of the deep basal cavity and lack of sharp cusp margins.

Genus indeterminate B, species 1
Figure 16.6–16.9

Description.—Apparatus of S and? P elements characterized by strongly costate coniform elements with a long, tapering cusp. Sa element symmetrical and bears four strong costae in anterior, posterior, and lateral positions. Lateral cusp margins extend basally as keels. Base flares anteriorly and posteriorly under costae. Sb element asymmetrical. Cusp proclined, bears costa along anterior cusp margin and one longitudinally along the midline of cusp. Aboral basal margin straight. Antero-basal corner sharp, base drawn out as a thin keel posteriorly. Sc element similar to Sb element and posterior basal keel has flatter oral margin than that of Sb element.? P element has sharp anterior and posterior cusp margins. Base broad and high, about one-half the length of the cusp. Posterior basal margin drawn out into a keel. Antero-basal corner straight from point of curvature of cusp to base.

Material examined.—Four elements; GSC 123030–123033.

Occurrence.—*G. ensifer* Zone?, Robb Formation, Section 6.

Genus indeterminate C, species 1
Figure 16.10

Description.—A single element assigned questionably as a P element with a short, broad cusp and long antero-lateral process bearing large denticles along its length. Element broken posteriorly. Denticulate process has straight oral and aboral margins.

Material examined.—1 element; GSC 123034.

Occurrence.—*G. ensifer* Zone?, Robb Formation, Section 6.

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