Lower Ordovician Conodonts and Other Microfossils from the Columbia Ice Fields Section, Alberta, Canada

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INTRODUCTION

Representative carbonate samples were collected from each of the measured intervals (Rigby 1965, Appendix) in the Columbia Ice Fields section. In general one sample was taken from each unit, but where fossil debris was abundant material was selected from several additional horizons within the measured interval. The carbonates were digested in acetic acid and the residues examined for conodonts.

No conodonts were found in the material taken from the lower 16 units representing the lowest 640 feet of the section. Only one specimen was found in the upper 535 feet of the measured section in which the strata are all dolomites. Of the remaining 38 samples, 23 contained conodonts. In most of these, conodonts occurred only sparingly, but an abundance of material was recovered from some samples, particularly those from units 21, 34, 41, 48, 50 and 53. General similarity can be recognized between the sequence of Early Ordovician conodonts found in Alberta and those from the Pogonip Group and from the Garden City Formation of the Idaho-Utah-Nevada area presently being studied by the writers. A total of 481 identifiable specimens was recovered in addition to many fragmented forms. Catalogued specimens are deposited in the U. S. National Museum.

STRATIGRAPHIC EVALUATION OF CONODONTS

Little has been published on Early Ordovician conodonts in North America since Furnish's study of the Prairie du Chien fauna which appeared in 1938. Recent investigations in northern Europe by Lindström (1955, 1960) and by Sergeeva (1962) provide information which assists in the evaluation of the fauna under consideration here.

Units 17 through 30 in the Columbia Ice Fields section yielded conodonts that indicate earliest Ordovician age. *Acanthodus* Furnish, which was recovered from unit 30, is present near the top of the House Limestone in the House Range of western Utah. It also occurs in the Manitou Formation of central Colorado, the Oneota Formation of the Upper Mississippi Valley, and the Stonehenge Limestone of south-central Pennsylvania. *Cordylodus angulatus* Pander which is present in units 17 and 19 has its greatest abundance in the lower part of the House Formation and the basal Dead Horse Conglomerate member of the Manitou. Lindström (1960) recognized this species as typical of the conodont fauna of the Tremadocian rocks of the Ordovicain sequence of Sweden. *Acodus* n. sp., *Acodus* sp., *Distacodus* n. sp., and *Paltodus spurius* Ethington & Clark which were found in samples 24 and 25 are all typical of the House Limestone.

Acodus deltatus Lindström, *Distacodus stola* Lindström and *Acontiodus* n. sp., which were found to range from units 34 through 41, first appear near the middle of the Fillmore Limestone of the Ibex area of western Utah. Both *Gothodus communis* Ethington & Clark and *Oepikodus quadratus* (Graves & Ellison) are present in samples ranging from units 41 through 50. In the Fillmore these forms also appear in beds above those with *Distacodus stola,* and range up in the Pogonip Group into the base of the Kanosh Formation.

Conodonts here identified as *?Spathognathodus* sp. and as a new genus and species together with *Trichonodella flabellum* Lindström, *Trichonodella* aff. *T. flabellum,* and *Prioniodina? inflata* Lindström are found in samples 50 and 53. The same forms are present in the Wah Wah and Juab Formations of the Pogonip Group. *Ptiloncodus simplex* Harris, which is not a conodont, was recovered from samples 48 and 50. In the Pogonip Group this form ranges from the Wah Wah through the Juab and into the Kanosh Formation. *Periodon aculeatus* Hadding, abundant in sample 53, is only questionably represented in the Pogonip. Lindström (1960) reported this species to be present in the highest Arenigian strata of Scandinavia where it is associated with species of *Falodus* and forms similar to that here identified as *?Spathognathodus* sp.

No platform conodonts such as *Ambalodus* were found in the Canadian section, although Lindström (1960) reported their occurrence above the middle of the Arenigian part of the Scandinavian Ordovician. Platforms also are not present in equivalent rocks of the Pogonip. Perhaps some provincialism of Early Ordovician conodonts is thus indicated.

SUMMARY

In summary, units 17 through 53 appear to be equivalent to the greater part of the Pogonip Group of western Utah. In particular, units 17-30 are correlated with the House Limestone, units 32-48 are equivalent to the Fillmore Limestone, and units 50-53 contain similar conodont faunas to those of the Wah Wah and Juab Formations. Equivalents of the Kanosh-Lehman portion of the Pogonip may be present in the dolomites of the highest part of the Columbia Ice Fields section from which no diagnostic conodonts were recovered and/or the overlying Mt. Wilson Quartzite. The strata from which conodonts were obtained encompass the Tremadocian (units 17-30) and Arenigian (units 32-53) stages of the standard Ordovician section of Europe.

SYSTEMATIC PALEONTOLOGY

Genus *ACANTHODUS* Furnish, 1938

Type species: *A. uncinatus* Furnish, 1938

Acanthodus sp.

Pl. 2, fig. 16

Remarks.—A fragment of the distal portion of a distacodontid has a serrate edge which serves to identify it as an *Acanthodus.* Only the type species has thus far been described. Owing to the loss of all but the tip of the specimen studied here, no specific assignment is made, although the fragment appears to be identical to the corresponding part of *A. uncinatus.*

Occurrence.—Sample 30

Number of specimens.—One

Repository.—Figured specimen, USNM 146231.

Genus *ACODUS* Pander, 1856

Type species: *A. erectus* Pander, 1856

Acodus deltatus Lindström

Pl. 1, fig. 3

Acodus deltatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 544, pl. 3, fig. 30.
Acodus deltatus var. *altior* Lindström, 1955, *ibid.*, p. 544, pl. 3, figs. 27-29.

Remarks.—In describing the original collection from the Early Ordovician of Scandinavia, Lindström recognized two varieties. In the typical form, *Acodus deltatus deltatus*, "the anterior and oral edges diverge at almost 90°". The other variety, *A. deltatus altior*, was proposed to include more slender forms with narrower bases so that the corresponding edges formed an angle of about 30°. The latter were reported to be much less abundant than *A. deltatus deltatus* in the type collection.

The specimens described here, as well as an abundance of material in the author's collections from the Fillmore Formation of western Utah and eastern Nevada, indicate that the angle formed by the opposite margins of the base is quite variable in this species. Although the two varieties described by Lindström represent the extremes in the range of variants, they are linked by a complete series of gradational forms. The development of the lateral costa and of the anterior and posterior edges is also variable among the specimens from Alberta. Typically the anterior and posterior edges are sharply keeled and become increasingly prominent toward the base, but on a few forms the edges are blunt throughout their length. The lateral costa is generally blunt and located approximately at the midline of the conodont. On a few specimens, however, the costa is displaced to a position posterior to the midline, is narrow, and is directed posterolaterally.

Occurrence.—Samples 34, 38, 38A, 40, 41.

Number of specimens.—17

Repository.—Unfigured hypotype, USNM 146232.

Acodus n. sp.

Pl. 2, figs. 3, 4

Remarks.—The material from Alberta described here is comparable to *Acanthodus lineatus* (Furnish) in the development of the lateral costa. A third of the specimens studied here exhibit the marked curvature in the basal region reported by Furnish, whereas the others are only slightly curved. Depth of basal cavity is related to the degree of curvature. Those showing marked curvature have shallow broadly flaring conical cavities like that shown by Furnish (1938, text-fig. 1H) in his line drawing. In the less sharply bent forms the basal cavity is a more slender cone whose sharp tip reaches approximately to midlength near the anterior margin. Nearly complete specimens show no indication of marginal serrations like those developed on *Acanthodus*.

General form, curvature, and deep basal cavity suggest possible affinity with *Distacodus* n. sp. Nevertheless the specimens reported here give no evidence of a second costa, so that it is not possible to assign both of these forms to the same genus under present generic definitions. Perhaps a symmetry transformation series such as that described for other species by Lindström (1964) is represented.

Occurrence.—Sample 24.

Number of specimens.—Six.

Repository.—Figured specimen, USNM 146233.

Acodus sp.

?Acodus gladiatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 544-545, pl. 3, figs. 10-12.

Cusp blade-like, with heavy costa extending entire length somewhat anterior to midline. Base strongly expanded on inner side, somewhat depressed on both sides of costa. Distal portion white or ivory in color, basal portion brown or black, basal cavity is asymmetrical cone whose apex is located near the anterior margin. Inner face of cusp is flat or bears a longitudinal median swelling. Anterior and posterior edges are sharp or blunt, continuously curved throughout entire length. Basal portion of unit is twisted inward from plane occupied by distal reaches of cusp.

Remarks.—The development of the basal region is very similar to that of *A. gladiatus* Lindström. However on the material from Sweden on which that species is based, no carina is present on the face of the cusp. One of the illustrated types (Lindström, 1955, pl. 3, fig. 2) shows the base expanded posteriorly so as to form nearly a right angle in the posterior margin. All of the specimens studied here as well as all individuals in a collection from the House Limestone of western Utah show uninterupted curvature posteriorly.

Occurrence.—Sample 24.

Number of specimens.—Two.

Repository.—Unfigured specimens, USNM 146234

Genus *ACONTIODUS* Pander, 1856

Type species: *A. latus* Pander, 1856

Acontiodus rectus rectus Lindström

Pl. 2, fig. 12

Acontiodus rectus rectus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 549, pl. 2, figs. 7-11, text-figs. 2k-m, 3B; Lamont & Lindström, 1957, Edinburgh Geol. Soc., Trans., v. 17, p. 61; Lindström, 1957, Geol. Fören. Förhandl., Bd. 79, p. 164; Lindström, 1960, Int. Geol. Congress, 21st Sess., Rep., pt. 7, p. 90, text-figs. 2, 3, 8, 10; Wolska, 1961, Acta Palaeont. Polonica, v. 6, p. 345, pl. 1, fig. 1; Sergeeva, 1962, Akad. Nauk USSR Doklady, v. 146, p. 1394.

Remarks.—The specimens studied here agree with those figured by Lindström in the transverse section of the cusp. One individual (from Sample 50) is strongly curved in lateral view and in this respect resembles *Acontiodus reclinatus* Lindström. However the basal portion of this specimen has been lost so that it is not possible to examine the basal cavity whose form is diagnostic for differentiation of these two species. All of the rest of the collection is much less strongly curved and shows basal cavities identical to those in the types of *A. rectus*.

Some of the material from the Lower Ordovician of the Sahara reported by Bazoche (1960) may belong here.

Occurrence.—Samples 43, 47, 48A, 50, 53.

Number of specimens.—Nine.

Repository.—Figured hypotype, USNM 146235.

Acontiodus rectus sulcatus Lindström

Pl. 1, fig. 15

Acontiodus rectus sulcatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 550, pl. 2, figs. 12, 13, text-fig. 3D; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Wolska, 1961, Acta Palaeont. Polonica, v. 6, p. 345-346, pl. 1, fig. 2; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394, tab. 1.

Occurence.—Samples 43, 44, 45, 50, 53.

Number of specimens.—Five.

Repository.—Figured hypotype, USNM 146236.

Acontiodus n. sp.

Pl. 1, fig. 14

Anterior face of cusp planar in basal region becoming gently convex at about midlength. Lateral and posterior costae high and sharp-edged. Base triangular in section, thin-walled, deeply excavated. Cusp bent at about midlength, distal and proximal reaches straight and meeting at an angle of 135-180°.

Remarks.—Most of the specimens assigned here are small and delicate, but individuals from high in the section (samples 43, 48) are much heavier than the others. The base of these latter forms is expanded posteriorly so that in lateral view the basal part of the posterior carina forms an angle of 105° with its continuation on the cusp. The larger specimens are opaque, and shape of their basal cavities cannot be determined. Owing to the stratigraphic separation from the typical specimens, these individuals

may indicate evolutionary change. However the greater size and heavier construction can also be interpreted as evidence of a more advanced stage in growth.

Occurrence.—Samples 38, 40, 43, 48.

Number of specimens.—Eight.

Repository.—Figured specimen, USNM 146238.

Genus *CORDYLODUS* Pander, 1856

Type species: *C. angulatus* Pander, 1856

Cordylodus angulatus Pander

Pl. 1, fig. 7

Cordylodus angulatus Pander, 1856, Mon. foss. Fische Silur. sys. russ.-balt. Gouv., p. 33, pl. 2, figs. 26-31, 34; pl. 3, figs. 10a, b; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 82; Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 551-552, pl. 5, fig. 9, text-figs. 3G, E; Lindström, 1960, Internat. Geol. Congress, 21st Sess., Rep., pt. 7, p. 89, text-fig. 1.

Cordylodus intermedius Furnish, 1938, Jour. Paleontology, v. 12, p. 338, pl. 42, fig. 31, text-fig. 2C.

Belodus sp. A, Sando, 1958, Geol. Soc. America, Bull., v. 69, p. 847, pl. 2, fig. 23.

?Cordylodus proavus Müller, 1959, Zeitschr. deutsch. geol. Gesellsch., Bd. 111, p. 448-449, pl. 15, figs. 11, 12, 18, text-fig. 3B.

Remarks.—This species is represented only sparingly in the conodont collection from the Columbia Ice Fields section. Such paucity is in marked contrast to the abundance found by the writers in the House Limestone of western Utah and by the senior author in the Manitou Formation of central Colorado. *Cordylodus angulatus* comprises nearly half of the conodonts recovered from many of the samples collected from the latter units.

Occurrence.—Samples 17, 19, 19A.

Number of Specimens.—Six.

Repository.—Figured hypotype, USNM 146240.

Genus *DISTACODUS* Hinde, 1879

Type species: *Machairodus incurvus* Pander, 1856

Distacodus stola stola Lindström

Pl. 1, figs. 1, 2

Distacodus stola stola Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 556-557, pl. 3, figs. 43-49; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Lindström, 1960, Internat. Geol. Congress, 21st Sess., Rep., pt. 7, text-fig. 2-2; Wolska, 1961, Acta Palaeont. Polonica, v. 6, p. 348, pl. 2, fig. 4; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, tab. 1.

Coelocerodontus stola Lindström, 1964, Conodonts, Elsevier Pub. Co., p. 84, text-fig. 29.

Remarks.—One half of the specimens assigned here conform closely to Lindström's type description of *D. stola stola.* Anterior and posterior margins are sharp thin keels. Costae are prominent and located approximately along the midline of the lateral faces. Basal two thirds of unit is straight, the distal third is curved posteriorly. Excavation is thin-walled and penetrates to level of curvature. Basal outline is narrowly rhomboid. Basal funnels project slightly below basal margin.

The remainder of the collection studied here shows the costae displaced, one toward the anterior margin and the other toward the posterior margin. The resultant cross section of the unit is quadrilateral rather than rhombic. On one specimen a secondary costa is intercalated posterolaterally. It extends the entire length of the tooth but becomes very faint distally. In other respects these forms are identical to the more typical representatives of this taxon. Lindström (1955, p. 557) noted some irregularity in the development of the costae in the type collection of *D. stola stola* and the specimens described here are presumed therefore to fall within the limits of variation which he suggests.

Occurrence.—Samples 38, 38A.

Number of specimens.—Eight.

Repository.—Figured hypotype, USNM 146241.

Distacodus n. sp.

Pl. 2, figs. 1, 2

Distacodontids with blunt or rounded anterior and posterior margins. Costae rise just above the basal margin in an anterior position and curve posteriorly more rapidly than the anterior margin so that they assume a median position. Costae generally have a narrow posterior face which is nearly normal to the posterolateral flank of the cusp. Anterolateral face of cusp is gently convex on forms with rounded anterior margins, slightly concave on those with blunt anterior edges. Unit is continuously curved throughout its length. Base is not expanded. Basal cavity is a laterally compressed cone with concave margins as seen in lateral view, its sharp tip located near the anterior margin. Basal funnels, where present, project markedly beyond basal margin and may flare out below elliptical base to develop subcircular transverse section.

Remarks.—These forms closely resemble the associated *Acodus* n. sp. in all respects except the number of costae. On some specimens studied here the costae are unequally developed. Additional collections may demonstrate that this new species of *Distacodus* and *Acodus* n. sp. are completely intergradational.

Occurrence.—Samples 24, 25.

Number of specimens.—18.

Repository.—Figured specimen, USNM 146242.

Genus *DREPANODUS* Pander, 1856

Type species: *D. arcuatus* Pander, 1856

Remarks.—The drepanodids in the Alberta collections are in general rather poorly preserved. Most are quite fragmented. In many instances it is impossible to determine the shape of the basal cavity, a character of major importance in differentiating species, owing to filling with foreign material or because much of the basal region has been lost. For this reason nearly half of the drepanodids could not be identified specifically.

Drepanodus deltifer Lindström

Drepanodus deltifer Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 562, pl. 2, figs. 42, 43; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394.

Occurrence.—Sample 26.

Number of specimens.—One.

Repository.—Unfigured hypotype, USNM 146243.

Drepanodus homocurvatus Lindström

Drepanodus homocurvatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 563, pl. 2, figs. 23, 24, 39, text-fig. 4d; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394; Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 688- 689, pl. 113, figs. 13, 16 (includes complete synonymy through August 1962); Barnett, 1965, Micropaleontology, v. 11, p. 70, pl. 1, fig. 15, pl. 2, fig. 5.

Occurrence.—Samples 24, 28, 36, 38, 48A.

Number of specimens.—15.

Repository.—Unfigured hypotype, USNM 146244.

Drepanodus longibasis Lindström

Drepanodus longibasis Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 564, pl. 3, fig. 31.

Occurrence.—Samples 25, 26.

Number of specimens.—Seven.

Repository.—Unfigured hypotype, USNM 146245.

Drepanodus proteus Lindström

Drepanodus proteus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 566-567, pl. 3, figs. 18-21; text-figs. 2a-f; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Lamont & Lindström, 1957, Edinburgh Geol. Soc., Trans., v. 17, p. 62; Lindström, 1960, Internat. Geol. Congress, 21st Sess., Rep., pt. 7, p. 89.

Occurrence.—Samples 36, 38, 47, 48.

Number of specimens.—18.

Repository.—Unfigured hypotype, USNM 146246.

Drepanodus subarcuatus Furnish

Drepanodus arcuatus Branson & Mehl, 1933, Univ. Missouri Studies, v. 8, p. 58, pl. 4, figs. 7, 8, 13, 16; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 89; [*non* Pander, 1856, p. 20, pl. 1, figs. 2, 4, 17, 30, 31].

Drepanodus subarcuatus Furnish, 1938, Jour. Paleontology, v. 12, p. 328-329, pl. 41, figs. 25-32, pl. 42, figs. 2, 3, text-fig. 1G; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 90; Hass, 1962, Treatise Invert. Paleont., pt. W, p. 43, fig. 22 (10a, b); Ethington & Clark, 1964, Jour Paleontology, v. 38, p. 689, pl. 113, figs. 15, 20.

?Drepanodus subaracuatus Carlson, 1960, North Dakota Geol. Survey, Bull. 35, pl. 1, figs. 15, 16; Müller, 1964, N. Jb, Geol. Paläont., Abh., H. 119, p. 96-97, pl. 13, figs. 5, 6.

Occurrence.—Samples 24, 28.

Number of specimens.—Nine.

Repository.—Unfigured hypotype, USNM 146247.

Drepanodus suberectus (Branson & Mehl)

Oistodus suberectus Branson & Mehl, 1933, Univ. Missouri Studies, v. 8, p. 111, pl. 9, fig. 7.

Drepanodus suberectus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 568, pl. 2, figs. 21, 22; Sergeeva, 1962, Akad. Nauk. USSR, Doklady, v. 146, p. 1394; Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 689-690, pl. 113, fig. 18 [includes a complete synonymy through August 1962]; Barnett, 1965, Micropaleontology, v. 11, p. 70, pl. 1, fig. 29, pl. 2, fig. 22.

Occurrence.—Samples 24, 53.

Number of specimens.—Two.

Repository.—Unfigured hypotype, USNM 146247.

Drepanodus sp. cf. *D. arcuatus* Pander

?Drepanodus arcuatus Pander, 1856, Mon. foss. Fische russ-balt. Gouvernements, p. 20, pl. 1, figs. 4, 5 [*non* figs. 2, 17, 30, 31]; Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 558-560, pl. 2, figs. 30-33, text-fig. 3J.

Occurrence.—Sample 17.

Number of Specimens.—Two.

Repository.—Unfigured specimen, USNM 146248.

Drepanodus sp. cf. *D. latus* Lindström

?Drepanodus latus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 564, pl. 3, figs. 22, 23.

Occurrence.—Sample 24.

Number of specimens.—One.

Repository.—Unfigured specimen, USNM 146249.

Genus *FALODUS* Lindström, 1955
Type species: *Oistodus prodentatus* Graves & Ellison, 1941
Falodus prodentatus (Graves & Ellison)
Pl. 1, Fig. 16

Oistodus prodentatus Graves & Ellison, 1941, Univ. Missouri, School Mines Metal., Bull., Tech. Ser., v. 14, no. 2, p. 13-14, pl. 2, figs. 6, 22, 23, 28.

Explanation of Plate 1

All figures X 50.

Fig. 1, 2.—*Distacodus stola stola* Lindström, lateral views, dolomite rhomb distally near posterior margin in left lateral view, USNM 146241.
Fig. 3.—*Acodus deltatus* Lindström, outer lateral view, USNM 146232.
Fig. 4.—*Paltodus* sp., outer lateral view of costate specimen, USNM 146352.
Fig. 5.—*Oistodus longiramis* Lindström, USNM 146259.
Fig. 6.—*Scandodus?* n. sp., outer lateral view, USNM 146249.
Fig. 7.—*Cordylodus angulatus* Pander, dolomite rhomb projecting from basal cavity, USNM 146240.
Fig. 8.—*Ptiloncodus simplex* Harris, USNM 146369.
Fig. 9.—*Trichonodella flabellum* Lindström, USNM 146364.
Fig. 10, 12.—*Scolopodus cornutiformis* Branson & Mehl; 10, USNM 146357; 12, USNM 146356.
Fig. 13.—Form C, top view, USNM 146372.
Fig. 14.—*Acontiodus* n. sp., posterior view, USNM 146238.
Fig. 15.—*Acontiodus rectus sulcatus* Lindström, outer lateral view, dolomite rhombs on surface and in posterior margin, USNM 146236.
Fig. 16.—*Falodus prodentatus* (Graves & Ellison), USNM 146250.
Fig. 17.—Form A, lateral view, USNM 146370.
Fig. 18.—*Oistodus forceps* Lindström, USNM 146256.
Fig. 19.—*Oistodus* sp. C, USNM 146264.
Fig. 20.—Form B, top view, USNM 146371.
Fig. 21.—*Gothodus communis* Ethington & Clark, USNM 146251.

Explanation of Plate 2

All figures X 50.

Fig. 1, 2.—*Distacodus* n. sp., lateral views showing basal funnel, USNM 146242.
Fig. 3, 4.—*Acodus* n. sp.; 3, outer lateral view; 4, inner lateral view; USNM 146233.
Fig. 5.—*?Spathognathodus* sp., USNM 146362.
Fig. 6.—*Subcordylodus* sp., USNM 146363.
Fig. 7, 13.—*Oistodus delta* Lindström; 7, lateral view, USNM 146254; 13, anterior view, USNM 146253.
Fig. 8.—*Prioniodina? inflata* Lindström, USNM 146354.
Fig. 9.—*Oepikodus quadratus* (Graves & Ellison), USNM 146252.
Fig. 10.—*Periodon aculeatus* Hadding, outer lateral view, USNM 146353.
Fig. 11.—*Oistodus* sp. B, outer lateral view, USNM 146263.
Fig. 12.—*Acontiodus rectus rectus* Lindström, USNM 146235.
Fig. 14.—*Acontiodus staufferi* Furnish, posterior view showing basal funnel, USNM 146237.
Fig. 15.—*Oistodus linguatus* Lindström, USNM 146259.
Fig. 16.—*Acanthodus* sp., distal portion of cusp, USNM 146231.
Fig. 17.—New genus and species, lateral view, USNM 146367.
Fig. 18.—*Oistodus* sp. A, USNM 146262.

PLATE 1 — R. L. ETHINGTON & D. L. CLARK

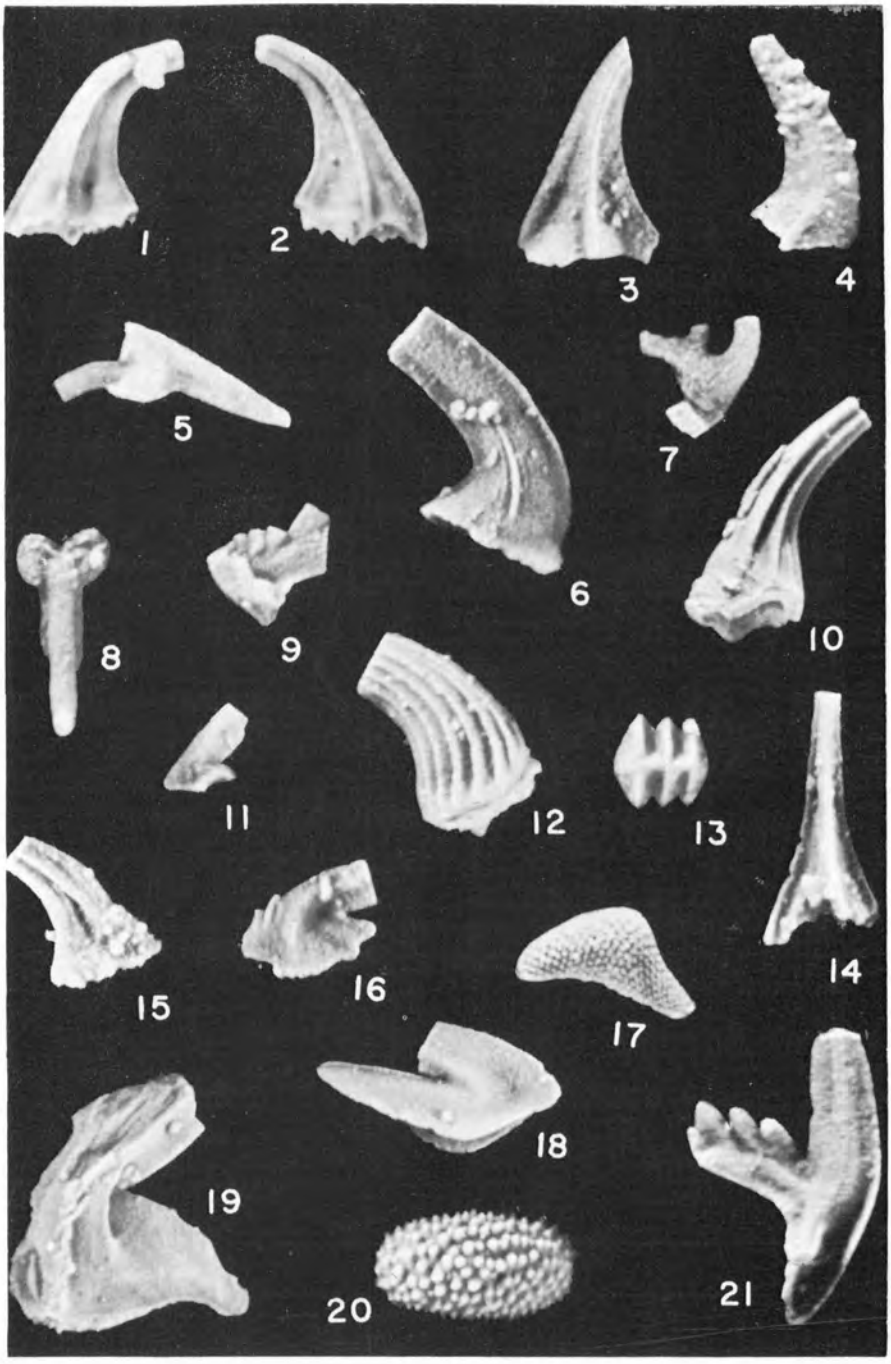
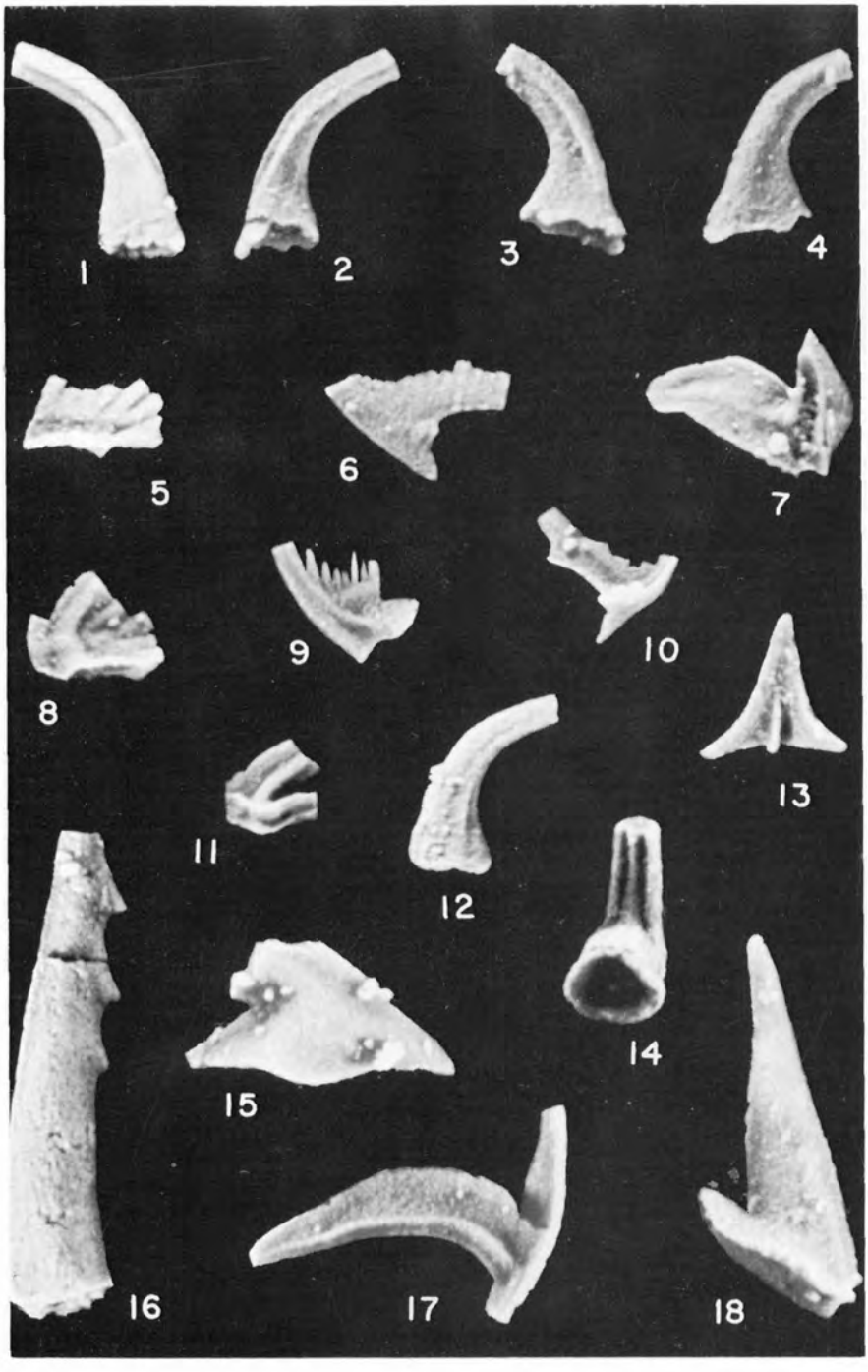


PLATE 2 — R. L. ETHINGTON & D. L. CLARK



Falodus prodentatus Lindstrom, 1955, Geol. Fören. Förhandl., Bd. 76, p. 569, pl 5, figs. 21, 22, 30; Sweet & Bergström, 1962, Jour. Paleontology, v. 36, p. 1227-1228, pl. 170, figs. 2, 3, text-fig. 2B [includes a complete synonymy to that date]; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, tab. 1

Remarks.—In a thorough review of the recorded occurrences of *F. prodentatus,* Sweet & Bergström (1962) noted a progressive increase in depth of the basal region in successively younger representatives of this species. The specimens collected in Alberta were compared directly with the types of *F. prodentatus.* They appear to be virtually identical to them as well as to the Pratt Ferry forms figured by Sweet & Bergström. A nearly complete specimen shows the base extended posteriorly so that its length rivals that of the cusp. The oral margin of the base is strongly arcuate and sharp-edged.

Occurrence.—Sample 53.

Number of specimens.—Five.

Repository.—Figured hypotype, USNM 146250.

Genus *GOTHODUS* Lindstrom, 1955

Type species: *G. costulatus* Lindström, 1955

Gothodus communis Ethington & Clark

Pl. 1, fig. 21

Gothodus communis Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 690, 692, pl. 114, figs 6, 14, text-fig. 2F.

Occurrence.—Samples 41, 43, 48, 48A, 50.

Number of specimens.—20.

Repository.—Figured hypotype, USNM 146251.

Gothodus? n. sp

A fragmented specimen has lost all but basal reaches of cusp which appears to have been somewhat reclined, broad, laterally compressed, and fused to the succeeding denticle. Bar is shallow, narrow, and bears a series of fused denticles which are increasingly inclined posteriorly. Height of denticles decreases regularly away from cusp so that their apices describe a smooth arc A broad anticusp is present anteriorly with its posterior margin continuous through a regular curve with the underside of the bar. A narrow, shallow slit along underside of bar flares somewhat in the region of curvature between bar and anticusp, then decreases in width in its continuation along edge of anticusp. Flare marks position of low conical basal cavity whose apex is directed anteriorly. A median ridge on the outer face of the cusp turns posteriorly to intersect the basal edge at nearly a right angle in the position of the basal cavity. The basal third of the denticles is covered by a thin external layer which continues across the cusp and anticusp, a character which is most clearly revealed in transmitted light

Remarks.—The development of the costa on the specimen described above is not pronounced, and this individual therefore could be assigned to one of the cordylodid genera. However it falls within the limits of variation of a form from the upper half of the Pogonip Group of Utah on which the costa typically is rather prominent. The specimen considered here is provisionally assigned to *Gothodus,* although additional study of more extensive collections may indicate that a distinct genus is represented.

Occurrence.—Sample 43.

Number of specimens.—One.

Repository.—USNM 146239.

Genus *OEPIKODUS* Lindstrom, 1955

Type species: *O. smithensis* Lindström, 1955

Oepikodus quadratus (Graves & Ellison)

Pl. 2, fig. 9

Cordylodus quadratus Graves & Ellison, 1941, Univ. Missouri School Mines Metal., Bull., Tech. Ser., v. 14, no. 2, p. 10-11, pl. 1, figs. 22, 25.

Cordylodus multidentatus Graves & Ellison, 1941, *ibid.,* p. 10, pl. 1, fig. 21.

Oepikodus equidentatus Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 692-693, pl. 113, figs. 6, 8, 10, 11, 14.

Remarks.—Considerable variance is present in the development of the lateral processes. Some individuals have prominent sharp-edged processes which project as free limbs for a short distance posterior to the basal cavity. Others have only faint costae along the cusp which continue as low ridges across the basal region and form short lobes in the basal margin. Both types occur in the same sample and are nearly identical in denticulation and other morphologic characters. Further reduction of the costae and processes would result in a form like that which Ethington & Clark (1964) identified as *Subcordylodus* aff. *S. delicatus*. It is unlikely that variation in size of costae is a function of growth, because the acostate individuals equal or even exceed the size of those forms on which costal development is most prominent.

Occurrence.—Samples 41, 43, 44, 48, 50.

Number of specimens.—34.

Repository.—Figured hypotype USNM 146252.

Genus *OISTODUS* Pander, 1856

Type species: *O. lanceolatus* Pander, 1856

Oistodus delta Lindström

Pl. 2, figs. 7, 13

Oistodus delta Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 573-574, pl. 3, figs. 3-9; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394.

Remarks.—Four specimens fit the general description of Lindström's species, but some of them differ in individual details. The larger and heavier pair have an anterior face that bears a shallow V-shaped longitudinal trough. The length of the anterior face is nearly three times as great as its basal width so that it has the form of an acute isosceles triangle. The basal region is considerably longer on these forms than on the material from Sweden (Lindström, 1965, personal communication). A smaller individual has basal width nearly equal to the length of the anterior face which approximates an equilateral triangle. In this case there is also a shallow anterior longitudinal trough, but the axis of the trough is occupied by a sharp costa which is basally prominent. Above midheight the costa attenuates and is barely visible near the tip of the cusp. Lindström (1964, p. 83) interpreted the forms previously identified as *O. delta* to be members of a group of oistodids representing symmetry transformations of *Oistodus lanceolatus* Pander.

Occurrence.—Samples 40, 44, 45, 47.

Number of specimens.—Four.

Repository.—Figured hypotypes, USNM 146253, 146254.

Oistodus elongatus Lindström

Oistodus elongatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 574, pl. 4, figs. 32, 33, Text-fig. 5b.

Occurrence.—Samples 38, 40, 47, 48, 50.

Number of specimens.—Eight.

Repository.—Unfigured hypotype, USNM 146255.

Oistodus forceps Lindström

Pl. 1, fig. 18

Oistodus forceps Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 574-576, pl. 4, figs. 9-13, text-fig. 3M; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Lamont & Lindström, 1957, Edinburgh Geol. Soc., Trans., v. 17, p. 62; Lindström, 1960, Inter. Geol. Congress, 21st Sess., Rep., pt. 7, text-figs. 2-6, 3-9, 4-13; Wolska, 1961, Acta Palaeont. Polonica, v. 6, p. 351, pl. 3, figs. 5, 6; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1393, tab. 1; Barnett, 1965, Micropaleontology, v. 11, p. 71, pl. 1, fig. 7.

Oistodus fornicalus Graves & Ellison, 1941, Univ. Missouri School Mines Metal., Bull., Tech. Ser., v. 14, no. 2, pl. 1, figs. 15, 17, pl. 2, figs. 15, 18.

?Oistodus forceps Sweet & Bergström, 1963, Jour. Paleontology, v. 36, p. 1231-1232, pl. 168, figs. 14, 15, text-fig. 2D, E.

Occurrence.—Samples 33, 50, 53.

Number of specimens.—Four.

Repository.—Figured hypotype, USNM 146256.

Oistodus inaequalis Pander

Pl. 1, fig. 11

Oistodus inaequalis Pander, 1856, Mon. fossil. Fische Silur. Sys. russ.-balt. Gouvernements, p. 27, pl. 2, fig. 37; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 135; Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 576-577, pl. 3, figs. 52-57.

Occurrence.—Samples 26, 28, 29.

Number of specimens.—21.

Repository.—Figured hypotype USNM 146257.

Oistodus lanceolatus Pander

Oistodus lanceolatus Pander, 1856, Mon. fos. Fische Silur. Sys. russ-balt. Gouvernements, p. 27, pl. 2, figs. 17, 18, 19 [*non* pl. 2, fig. 19]; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1395; Clark & Ethington, 1964, Jour. Paleontology, v. 38, p. 693, pl. 113, fig. 12, pl. 114, figs. 1, 5 (includes synonymy through August 1962).

Occurrence.—Samples 41, 43, 48.

Number of specimens.—Five.

Repository.—Unfigured hypotypes, USNM 146258.

Oistodus linguatus Lindström

Pl. 2, fig. 15

Oistodus linguatus Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 577-578, pl. 3, figs. 39-41; Lamont & Lindström, 1957, Edinburgh, Geol. Soc., Trans., v. 17, p. 62; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394, tab. 1.

Remarks.—In his original definition Lindström recognized three varieties of *Oistodus linguatus*. Subsequently the same author (1960, p. 92, text-fig. 4-11) treated one of these varieties, *O. linguatus complanatus,* as a distinct species in itself. The greater part of the material studied here appears to be identical to the holotype of the species. Some few individuals show an elongated antero-basal region suggestive of those forms which Lindström included in *O. linguatus extenuatus*. Because such small numbers were found in any of the samples, they are here considered to all belong together. Greater numbers might permit recognition of the varieties described in Sweden.

Occurrence.—Samples 38, 40, 41, 43, 48A, 50, 53.

Number of specimens.—48.

Repository.—Figured hypotype, USNM 146259.

Oistodus longiramis Lindström

Pl. 1, fig. 5

Oistodus longiramis Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 579, pl. 4, figs. 35-37; Lindström, 1957, *ibid.,* Bd. 79, p. 164; Lamont & Lindström, 1957, Edinburgh Geol. Society, Trans., v. 17, p. 62; Lindström, 1960, Inter. Geol. Congress, 21st Sess., Rep., pt. 7, text-fig. 2-7; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394, tab. 1; Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 693-694, pl. 114, figs. 5, 7.

Occurrence.—Sample 50.

Number of specimens.—Two.

Repository.—Figured hypotype, USNM 146260

Oistodus parallelus Pander

Oistodus parallelus Pander, 1856, Mon. foss. Fische Silur. Sys. russ-balt. Gouvernements, p. 27, pl. 2, fig. 40; Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 579-580, pl. 4, figs. 26-31, 43, text-fig. 3N, O; Lindström, 1957, *ibid.*, Bd. 79, p. 164; Lamont & Lindström, 1957, Edinburgh Geol. Soc., Trans., v. 17, p. 62; Lindström, 1960, Inter. Geol. Congress, 21st Sess., Rep., pt. 7, text-fig. 3-6; Wolska, 1961, Acta Palaeont. Polonica, v. 6, p. 352, pl. 3, fig. 4; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, p. 1394, tab. 1.

Occurrence.—Samples 36, 40, 50.

Number of specimens.—10.

Repository.—Unfigured hypotype, USNM 146261.

Oistodus sp. A

Pl. 2, fig. 18

A single specimen has a sharp-pointed cusp, anterior and posterior keels, inner lateral face more strongly rounded than outer face. Base is shallow. Aboral margin is nearly straight beneath the cusp and turns up toward the posterior extremity. Anterior basal angle is about 45°. Base is strongly flared to inner side beneath cusp; outer side of base is not expanded. Excavation in form of shallow broad trough whose deepest point is beneath the cusp.

Remarks.—The single specimen is apparently identical to forms from the Pogonip Group of western Utah. Because only one specimen was recovered, no formal name is proposed although it cannot be readily identified with any established species of *Oistodus*. The cusp of this individual is somewhat twisted and shows a posterolateral bulge on the inner side at about two-thirds its length above the base. Diameter of the cusp and rate of taper are markedly reduced above this swelling. This is not exhibited by any of the Pogonip material mentioned above, and the specimen at hand is presumed to be aberrent in this respect. Possibly rejuvenation is represented.

Occurrence.—Sample 48A.

Number of specimens.—One.

Repository.—Figured specimen, USNM 146262.

Oistodus sp. B

Pl. 2, fig. 11

An oistodid with markedly reclined cusp which bears a strong, rounded costa somewhat behind the midline of the outer face. Inner face is less prominently costate. Anterior and posterior edges sharp. Anterobasal angle 45°. Base expanded outward beneath cusp. A pronounced flange extends length of basal region on either side. Basal margin as seen in lateral view is concave to either side of downward bulge beneath cusp. The base is excavated along its entire length, cavity is narrow anteriorly and posteriorly wide below cusp.

Remarks.—This form is one of a group of apparently related species that is common in the Pogonip Group of the Great Basin. A formal name and more detailed specific discussion will be presented in another study.

Occurrence.—Samples 50, 53.

Number of specimens.—Four.

Repository.—Figured specimen, USNM 146263.

Oistodus sp. C

Pl. 1, fig. 19

Remarks.—A fragmented specimen is characterized by blade-like posterior extension of base, large cusp and multicostate lateral faces. Upper edge of base and posterior edge

of cusp are tangential. This form is identical to material from the upper part of the Pogonip Group of Utah and Nevada.

Occurrence.—Sample 50.

Number of specimens.—One.

Repository.—Figured specimen, USNM 146264.

Oistodus sp. D

Remarks.—A basal fragment of an oistodid has a diagnostic outline suggestive of a form which is present high in the Pogonip Group of western Utah. Aboral outline is concave posteriorly becoming strongly convex anteriorly. Basal excavation is narrow and continues from posterior basal extremity across convex anterior region toward base of cusp. No anterior basal angle is present. Loss of the cusp is typical of this form in material under study from the Great Basin, but the shape of the base is so characteristic that even very fragmented specimens can be readily identified.

Occurrence.—Sample 55A.

Number of specimens.—One.

Repository.—Unfigured specimen, USNM 146265.

Genus ONEOTODUS Lindström, 1955
Type species: *Distacodus? simplex* Furnish, 1938

Oneotodus variabilis Lindström

Oneotodus variabilis Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 582, pl. 2, figs. 14-18, 47, pl. 5, figs. 4, 5, text-fig. 6.

Oneotodus sp. a Müller, 1959, Zeitschr. deutsch. geol. Gesellsch., Bd. 111, pl. 13, fig. 17.

Remarks.—The specimens from Alberta here assigned to *O. variabilis* do not exhibit the strong basal expansion of the illustrated types of the species. All are rather strongly bent at about one-third their length above the base so that the posterior margin approximates a right angle. Most specimens show fine longitudinal striations which can be clearly distinguished at magnification of 60 diameters. Lindström reported observing similar surface markings on the types at 250 diameters.

Occurrence.—Samples 17, 19, 19A, 24, 25, 30, 34, 36, 38.

Number of specimens.—21.

Repository.—Unfigured hypotype, USNM 146349.

Genus *PALTODUS* Pander, 1856
Type species: ***P. subaequalis* Pander, 1856**
Paltodus spurius Ethington & Clark

Paltodus spurius Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 695, pl. 114, figs. 3, 10, text-fig. 2B.

Remarks.—A single specimen is heavier than the type material of *P. spurius.* The prominent lateral grooves which characterized previously reported specimens are represented here by shallow linear depressions which are not equally developed. Anterior and posterior margins of the cusp are rounded. The sharp curvature just above the base is identical to that of the type specimens. Possibly the individual at hand is a gerontic form.

Occurrence.—Sample 25.

Number of specimens.—One.

Repository.—Unfigured hypotype, USNM 146350.

Paltodus variabilis Furnish

Paltodus variabilis Furnish, 1938, Jour. Paleontology, v. 12, p. 331, pl. 42, figs. 9, 10, text-fig. 1E; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 144.

non Paltodus variabilis Sergeeva, 1963, Paleont. Zhurnal, p. 99-102, pl. 7, figs. 10-12, text-fig. 5[=junior homonym of *P. variabilis* Furnish].

Remarks.—This form is abundant in samples 19A, 24, and 36, but occurs only sporadically throughout the remainder of the section.

Occurrence.—Samples 19A, 24, 30, 36, 39, 48, 57.

Number of specimens.– 39.

Repository.—Unfigured hypotype, USNM 146351.

Paltodus sp.
Pl. 1, fig. 4

Blade-like cusp has sharp edges and is continuously curved along length. Anterior margin is less strongly curved than posterior margin so that the base is continued posteriorly beyond the cusp. Base is strongly expanded to outside so that aboral outline is triangular. Leading edge is turned inward toward base so that lower part of inner face is concave. Basal expansion may bear a prominent costa which continues along cusp as a rounded swelling. Basal cavity is deep, posterior outline concave. Sharp apex of cavity is directed anteriorly upward near anterior margin of cusp.

Remarks.—Owing to the presence of the costa on one side this form might be referred to *Acodus*. However a great number of individuals from the Wah Wah and Juab formations of western Utah indicate that this costa is not represented on the majority of specimens. Principle identifying characters are the outline of the cusp and the inward flexing of the anterior aboral margin.

Occurrence.—Samples 47, 53.

Number of specimens.—Two.

Repository.—Figured specimen, USNM 146352.

Genus *PERIODON* Hadding, 1913
Type species: *P. aculeatus* Hadding, 1913

Sweet & Bergström (1962) reviewed the concept of *Periodon* and particularly noted the variability of the type species, *P. aculeatus*. They expressed the opinion that the two figured paratypes of *Loxognathus flabellata* Graves & Ellison are within the range of *P. aculeatus*. The authors have studied these two paratypes and concur in this opinion. The holotype of *L. flabellata* is not included in the collection of Graves & Ellison's type material which has been deposited in the Paleontology Collection of the University of Missouri and is presumed to be lost. It is probable that it likewise falls within the limits of *P. aculeatus*, and that *Loxognathus* is thus a junior synonym of *Peridon*.

Periodon aculeatus Hadding
Pl. 2, fig. 10

Periodon aculeatus Hadding, 1913, Lunds Univ. Arsskr., N. F., Afd. 2, Bd. 9, p. 33, pl. 1, fig. 14; Sweet & Bergström, 1962, Jour. Paleontology, v. 36, p. 1235, pl. 171, figs. 3, 9 [includes a complete synonymy through 1962]; Lindström, 1964, Conodonts, Elsevier Pub. Co., p. 83, text-figs. 28 E-G.

Remarks.—The same degree of variation discussed by Sweet & Bergström is represented in the specimens from Alberta. Similar variance is also exhibited by additional material from the Fort Peña of Texas included on the slide with the two paratypes of *L. flabellata*. One individual in the collection reported here has a lateral process developed identically to that of the illustrated holotype of *L. flabellata*. It differs from the illustration in having an anterior process continued aborally as an anticusp which bears a number of small denticles along the inner side.

Occurrence.—Sample 53.

Number of specimens.—10.

Repository.—Figured hypotype, USNM 146353.

Genus *PRIONIODINA* Bassler, 1925

Type species: *P. subcurvata* Ulrich & Bassler, 1926

Prioniodina? inflata Lindström

Pl. 2, fig. 8

Prioniodina inflata Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 588, pl. 6, figs. 26, 27; Sergeeva, 1962, Akad. Nauk USSR, Doklady, tab. 1.

Oulodus inflatus Lindström, 1964, Conodonts, Elsevier Pub. Co., p. 85, text-figs. 30A, B.

Remarks.—Quite variable material from high in the Alberta Ordovician section compares generally with Lindström's species. Principle variation is in the flexing of the unit anterior to the cusp. On some individuals it is turned to a position nearly normal to the plane of the cusp and posterior denticles; on others the axis of the whole specimen lies in a plane. The strong basal flare to one side is like that described by Lindström. On part of the collection the flexed anterior portion is turned toward the same side as the basal flare, on others to the opposite side. On most specimens the cusp is thin and blade-like with low median keels on both sides. A few specimens have markedly biconvex cusps with sharp anterior and posterior keels.

Two individuals have the posterior part of the unit twisted so that the distal denticles lie in a nearly horizontal plane. These forms suggest affinity with *Ligonodina tortilis* Sweet & Bergström, but they are not "basally inverted" posteriorly and the anterior limb forms much greater than a right angle with the axis of the rest of the unit. Lindström (1964, p. 85) concluded that *P. inflata* and *L. tortilis* are related to each other through symmetry transformations, and he reassigned both species to the genus *Oulodus*.

Occurrence.—Sample 53.

Number of specimens.—12.

Repository.—Figured hypotype, USNM 146354.

Genus *SCANDODUS* Lindström, 1955

Type species: *S. furnishi* Lindström, 1955

Scandodus sp.

Cusp has sharp edges. Outer face is uniformly convex, inner face centrally convex with linear marginal concavities. Unit is bent and twisted above basal region so that basal cavity opens aborally inward. Base is expanded inward. Widest part of base not consistently located. On some forms the widest expansion is posterior and the basal outline tapers anteriorly. On other specimens the greatest expansion is anterior, and still others have nearly circular basal outlines.

Occurrence.—Samples 36, 38.

Number of specimens.—Eight.

Repository.—Unfigured specimen USNM 146355.

Scandodus? n. sp.

Pl. 1, fig. 6

Stout distacodontids whose cusps are strongly biconvex basally becoming rhomboid in transverse section toward their apices. Anterior margin is keeled throughout length, posterior keel is restricted to cusp. Base is little expanded posteriorly, strongly expanded to one side, weakly convex or flat on the opposite side. Up to five faint costae have their origin somewhat above the basal margin on the expanded side, follow the curve of the unit upward and die out on the lower part of the cusp. Basal cavity is an asymmetrical cone whose apex is directed orally near the anterior margin above the level of greatest curvature of the cusp. Anterior outline of the cavity is more steeply inclined than the posterior outline.

Remarks.—This form might be assigned to *Paltodus* on the basis of the multicostate asymmetrical basal region. However the form of the cusp and basal region suggest scandodids, and tentative assignment is made to that genus. A larger collection will be required to identify this species with certainty.

Occurrence.—Sample 38.

Number of specimens.—Two.

Repository.—Figured specimen, USNM 146249.

Genus *SCOLOPODUS* Pander, 1856

Type species: *S. sublaevis* Pander, 1856

Scolopodus cornutiformis Branson & Mehl

Pl. 1, figs. 10, 12

Scolopodus cornutiformis Branson & Mehl, 1933, Univ. Missouri Studies, v. 8, p. 62 pl. 4, fig. 23; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 180; Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 698-699, pl. 114, figs. 6, 23.

Remarks.—Material here referred to *S. cornutiformis* displays greater variance than that previously reported. Most of the specimens are in general agreement with the types of this species in having an unornamented anterior face. Lateral and posterior sides of the tooth bear prominent sharp-edged costae which originate slightly above the basal margin. No complete specimens are present in the collection, but the costae continue to the distal broken ends of all individuals. A single specimen is costate on one lateral face, whereas the opposite side bears numerous very fine longitudinal striations. Many individuals retain a basal funnel which projects a short distance beyond the aboral margin of the cusp.

Most of the collection consists of specimens that are circular or somewhat elliptical in transverse section. However some of those found in sample 38 are asymmetrical with the uncostate region forming a convex anterolateral face with a corresponding linear concavity on the opposite side of the tooth. Anterior margin is prominently keeled, posterior margin is keeled or blunt. This shape could have been derived from a typical *S. cornutiformis* through lateral compression and slight torsion of the unit, so that one of the costae was displaced to the anterior position to become the keel. Individuals with this form are associated in the same sample with specimens of more typical morphology. Perhaps specific differentiation can be effected if larger collections become available.

No broken and rejuvenated specimens such as those which Ethington & Clark (1964) found to occur abundantly in the El Paso Formation were recovered here.

Occurrence.—Samples 24, 25, 27, 28, 29, 33, 38, 39, 40, 41.

Number of specimens.—30.

Repository.—Figured hypotypes, USNM 146356, 146357.

Scolopodus filosus Ethington & Clark

Scolopodus filosus Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 699, pl. 114, figs. 12, 17, 18, 19, text-fig. 2E.

Remarks.—Those individuals assigned here are in general agreement with the type specimens from the El Paso Formation in western Texas. Striated surfaces suggest possible affinity with those specimens of *Oneotodus variabilis* Lindström also reported here. However the curvature is much less sharp so that the posterior margin does not approach the right angle which typifies associated forms here referred to the latter species.

Occurrence.—Samples 34, 36, 38, 41.

Number of specimens.—10.

Repository.—Unfigured hypotype USNM 146358.

Scolopodus gracilis Ethington & Clark

Scolopodus gracilis Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 699, pl. 115, figs. 2, 3, 4, 8, 9, text-figs. 2D, G.

Remarks.—An individual from the lowest conodont bearing sample and another from higher in the section have striate surfaces and deep posterior grooves typical of *S. gracilis*. A heavy basal funnel is seated in the basal cavity of the lowest occurring specimen. Ivory color of the funnel contrasts strongly with the dull gray color of the conodont.

Occurrence.—Samples 17, 32.

Number of specimens.—Two.

Repository.—Unfigured hypotype USNM 146359.

Scolopodus quadraplicatus Branson & Mehl

Scolopodus quadraplicatus Branson & Mehl, 1933, Univ. Missouri Studies, v. 8, p. 63, pl. 4, figs. 14, 15; Fay, 1952, Univ. Kansas Paleont. Contrib., Vertebrata, art. 3, p. 180; Sando, 1958, Geol. Soc. America, Bull., v. 69, p. 842, pl. 2, fig. 21; Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 699-700, pl. 115, figs. 12, 25.

Occurrence.—Sample 29.

Number of specimens.—One.

Repository.—Unfigured hypotype, USNM 146360.

Scolopodus triangularis Ethington & Clark

Scolopodus triangularis Ethington & Clark, 1964, Jour. Paleontology, v. 38, p. 700, pl. 115, figs. 6, 11, 13, 17, text-fig. 21.

Occurrence.—Sample 53.

Number of specimens.—Three.

Repository.—Unfigured hypotype USNM 146361.

Genus *SPATHOGNATHODUS* Branson & Mehl, 1941

Type species: *Spathodus primus* Branson & Mehl, 1933

?Spathognathodus sp.

Pl. 2, Fig. 5

?Spathognathodus n. sp. Lindström, 1960, Inter. Geol. Congress, 21st Sess., Rep., pt. 7, text-fig. 5-3.

A blade in which the denticles are increasingly inclined from an erect position at the anterior extremity to horizontal at the posterior end. Inclination increases most rapidly on the posterior half of the blade. Denticles are fused nearly to their apices but have strongly convex lateral faces resulting in deep grooves at the boundary between adjacent teeth. Blade is somewhat constricted below base of denticles, then flares to enclose spaceous basal excavation. Base expanded more strongly to one side than the other so that basal outline is triangular. Posterior part of blade bearing strongly inclined denticles is twisted to the opposite side from that with greater basal expansion so that the last tooth lies horizontally in the plane of the base of the unit.

Remarks.—This is the oldest form that has been assigned to *Spathognathodus*. The broadly expanded base is typical of that genus. However the strongly inclined denticles and twisted posterior reaches are in marked contrast to more typical spathognathodids. Exact relationship between this form and the younger and better known representatives of the genus cannot be evaluated until more material is available for comparison.

Occurrence.—Sample 53.

Number of specimens.—One.

Repository.—Figured specimen, USNM 146362.

Genus *SUBCORDYLODUS* Stauffer, 1935

Type species: *S. elongatus* Stauffer, 1935

Subcordylodus sp.

Pl. 2, fig. 6

Cusp proclined, with blunt anterior and posterior keels, convex lateral faces. Posterior bar rises slightly from juncture with cusp, becoming horizontal distally. Denticles entirely fused, laterally compressed, large. First denticles appear on basal portion of cusp, three being located above juncture of cusp and bar. Direction of growth at an angle of 60° to axis of cusp, those on bar normal to axis of bar. Base of bar excavated by shallow longitudinal groove which continues anteriorly into slightly flaring, thin-walled conical basal cavity that penetrates to a sharp anteriorly directed tip near the anterior margin. In lateral view upper outline of cavity is gently convex, lower outline somewhat more strongly arcuate and concave so that anticusp is crescentic. Unit somewhat flexed inward at point of juncture of bar and cusp.

Remarks.—This form is unlike any previously described species of *Subcordylodus*. Form of basal cavity and flexing of unit as well as relative size of bar and cusp distinguish it from subcordylodus-like forms considered under *Oepikodus equidentatus* above. It lacks the elongate slender anticusp of the forms which have been described as *Paracordylodus* Lindström.

Occurrence.—Sample 53.

Number of specimens.—One.

Repository.—Figured specimen, USNM 146363.

Genus *TRICHONODELLA* Branson & Mehl, 1948

Type species: *Trichognathus prima* Branson & Mehl, 1933
Trichonodella flabellum Lindström

Pl. 1, fig. 9

Trichonodella flabellum Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 599-600, pl. 6, figs. 28-30; Sergeeva, 1962, Akad. Nauk USSR, Doklady, v. 146, tab. 1.

Remarks.—The specimens included here are more robust than the type material of *T. flabellum*. Denticulation of the lateral limbs is more highly developed than on the Scandinavian forms described and illustrated by Lindström in that the teeth are large and completely fused along their length. The limbs are broken, but three denticles occur in the portion remaining. The nature of the stumps suggests that the total number of denticles per limb may have been considerably greater. The large reclining denticles of the posterior bar are identical to those described and figured by Lindström and confirm the identification of these specimens.

Lindström (1964, p. 82) considered *T. flabellum* to represent a morphologic form assumed by some members of a group which he assigns to the genus *Periodon*. Other members of this group which he identifies as *Periodon flabellum* have one or no lateral processes respectively but retain the characteristic denticulation of the posterior bar.

Occurrence.—Sample 53.

Number of specimens.—Two.

Repository.—Figured hypotype, USNM 146364.

Trichonodella aff. *T. flabellum* Lindström

Remarks.—A single fragmented individual resembles *T. flabellum* in the shape and curvature of the cusp and the nature of the denticles immediately following. The distal portion of the bar which would carry the large reclined denticles that characterize *T. flabellum* has been lost. Distal portions of the limbs are missing also, and no denticles are present on the stumps. Proximally the limbs diverge at an angle of less than 30°, much less than that reported for the types of *T. flabellum* by Lindström and also less than that observed on the specimens from Alberta assigned to that species above. Although this specimen cannot be assigned to *T. flabellum*, it stands closer to that species than to other extant trichonodellids.

Occurrence.—Sample 47.

Number of specimens.—One.

Repository.—Unfigured specimen, USNM 146365.

?Trichonodella longa Lindström

?Trichonodella longa Lindström, 1955, Geol. Fören. Förhandl., Bd. 76, p. 600-601, pl. 6, figs. 47, 48.

Remarks.—A slender individual has a slightly proclined cusp and no free limbs. Posterior bar is deep and bears four reclined denticles which increase in size and inclination posteriorly. No denticles are present on the lateral costae which are thin and sharp-edged. Below the level of juncture of the cusp and posterior bar, the costae are twisted so that their edges are directed anterolaterally producing a V-shaped anterior basal trough between them.

The curvature of the anterior margin is less than that shown on Lindström's illustration (pl. 6, fig. 47) of the holotype. He suggests that his material was rather

robust. The specimen studied here is quite slender. Possibly it represents a juvenile growth state which deviates from the typical adult form.

Occurrence.—Sample 53.

Number of specimens.—One.

Repository.—Unfigured specimen, USNM 146366.

NEW GENUS AND SPECIES

Pl. 2, fig. 17

Unit consists of a posterior blade and erect anterior cusp. Flanges extend along either side above basal margin. Leading edge of cusp is turned inward, outer face bears a low rounded costa. Aborally excavated by narrow longitudinal groove which expands into conical cavity beneath cusp.

Remarks.—On the basis of its lateral outline, this species could be assigned to *Oistodus*. The writers have found it in abundance in a collection from the Pogonip Group of eastern Great Basin. In the Pogonip samples it is associated with another blade-like form which bears no cusp. The similarity in development of these two species in all other respects indicates closer affinity between them than is the relationship of the present species to any previously described *Oistodus*. Because the definition of *Oistodus*, as presently understood, will not permit the assignment of forms without a cusp, it is necessary to establish a new genus for these two species. Owing to the greater abundance of material on which to base generic and specific discussions, formal designation of new taxa will be included in the report on the Pogonip fauna which is now in preparation.

Occurrence.—Samples 50, 53.

Number of specimens.—Two.

Repository.—Figured specimen, USNM 146367.

?BASAL FUNNELS

Thin-walled, completely hollow conical structures were found in a number of samples. Three types were recovered. The most common has a triangular transverse section with keels at each margin. The unit is somewhat curved toward the point like the toe of a Persian slipper. A second form which is represented by several specimens has a lachrymoid cross section. Individuals are regularly curved and have a single keel along the concave margin. The convex margin is broadly rounded. The third type, represented by a single specimen, is curved from base to tip. The concave side is straight transversely, whereas the opposite side is convex. These two faces intersect to form lateral keels.

The forms described above might be referred to *Coelocerodontus* Ethington. Hass (1962, p. 63) concluded that this is not a valid conodont genus, but rather represents detached basal funnels from conodonts. The objects reported here are tentatively identified as such, although none of the associated conodonts have basal cavities which could have served as the seat of basal structures of the shapes described.

Occurrence.—Samples 36, 38, 38A, 41.

Number of specimens.—Eight.

Repository.—Unfigured specimens, USNM 146368.

FOSSILS OF UNCERTAIN AFFINITY

Genus *PTILONCODUS* Harris, 1962

Type species: *P. simplex* Harris, 1962

Ptiloncodus simplex Harris

Pl. 1, fig. 8

Ptiloncodus simplex Harris, 1962, Oklahoma Geol. Notes, v. 22, p. 207, pl. 1, figs. 5a-c, 6.

Remarks.—Harris (1962, p. 206-207) considered *Ptilonocodus* to have affinity with *Stereoconus* Branson & Mehl owing to the absence of any distinct seat of attachment. Sweet (1963, p. 505-506) disagreed with this comparison and emphasized that all conodonts have a surface of attachment if not a basal excavation. He noted the

similarity in gross form to hook-shaped holothurian sclerites such as those assigned to the genus *Ancistrum,* although such forms are not as yet known from rocks as old as the Joins of Oklahoma. The authors are in agreement with Sweet's conclusion that *Ptiloncodus* is not a conodont. However the specimens reported here, as well as numerous others from Ordovician rocks of Utah and Nevada in the writers' collections, do not support placement of this genus in the Holothuroidea. *Ptiloncodus* is unaffected by acetic acid digestions, whereas sclerites, being composed of calcite, are etched if not destroyed by prolonged exposure to weak acids.

The specimens at hand are complete individuals which show features that differ somewhat from the described types from the Joins of Oklahoma. Harris reported the presence of "flattened, subovate, auricular lobes" on opposite sides of the shaft. He further noted that the lobes are missing from most specimens, although an attachment scar indicates their former presence. The illustrated Joins specimens are rather short and the auricular lobes are confined to the distal portion of the shaft (Harris, 1962, pl. 1, figs. 5a, b). The Alberta specimens are relatively longer than the type material. The lobes clearly consist of two independent structures which reach nearly to the level at which the hook begins to develop. These structures appear to clasp the postero-lateral portion of the shaft. They are not united along their edges except distally so that the entire length of the shaft is uncovered both anteriorly and posteriorly. No indication of the function of the lobes or the hook is evident. Apparently they were rather easily separated.

Although *Ptiloncodus* cannot be placed among the conodonts as these are presently defined, its affinities, like those of the conodonts themselves, remain uncertain. Nevertheless this form may have some stratigraphic value, because its occurrence within Ordovician strata of North America seems relatively restricted.

Occurrence.—Samples 48, 50.

Number of specimens.—Two.

Repository.—Figured hypotype, USNM 146369.

PLATES

Small phosphatic objects fitting several structural patterns are present in the upper part of the Alberta Ordovician section. Although clearly not conodonts, they are associated with them. Forms A and B described below show gross similarity to structures described as maculae on some trilobite genera (Harrington, 1959, p. 92-94).

FORM A

Pl. 1, fig. 17

This type of plate is a laterally compressed, helmet shaped object. The upper outline in lateral view is straight but inclined near one extremity, becoming highly convex medially and concave toward the other extremity. Entire surface is ornamented with low nodes which are arranged in definite alignments that extend diagonally across the surface. In some cases only one alignment is represented, in others each node occupies a position on two intersecting rows. The underside is shallowly but completely excavated.

Occurrence.—Samples 48, 48A.

Number of specimens.—Four.

Repository.—Figured specimen, USNM 146370.

FORM B

Pl. 1, fig. 20

Elongate plates with ovoid basal outline. Broadly convex form in lateral view with straight basal margin. Surface ornamented with coarse nodes which are randomly arranged. Deeply excavated so that plate is thick hollow shell. Inner surface shows shallow pits or small nodular elevations arranged in rhombic pattern.

Occurrence.—Sample 50.

Number of specimens.—Six.

Repository.—Figured specimen, USNM 146371.

FORM C

Stud-like plate with smooth flat bases. Upper surface bears three chisel-edged transverse ridges which rise from the base at either side to a blunt high point in the middle Ridges are separated by troughs with rounded bottoms which intersect the basal margin to form serrate sides. Midpoints of transverse ridges are connected by a median longitudinal ridge Extremities are steeply sloped. Entire unit is translucent gray or amber in color.

Occurrence.—Sample 50.

Number of specimens.—One.

Repository.—Figured specimen, USNM 146372.

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