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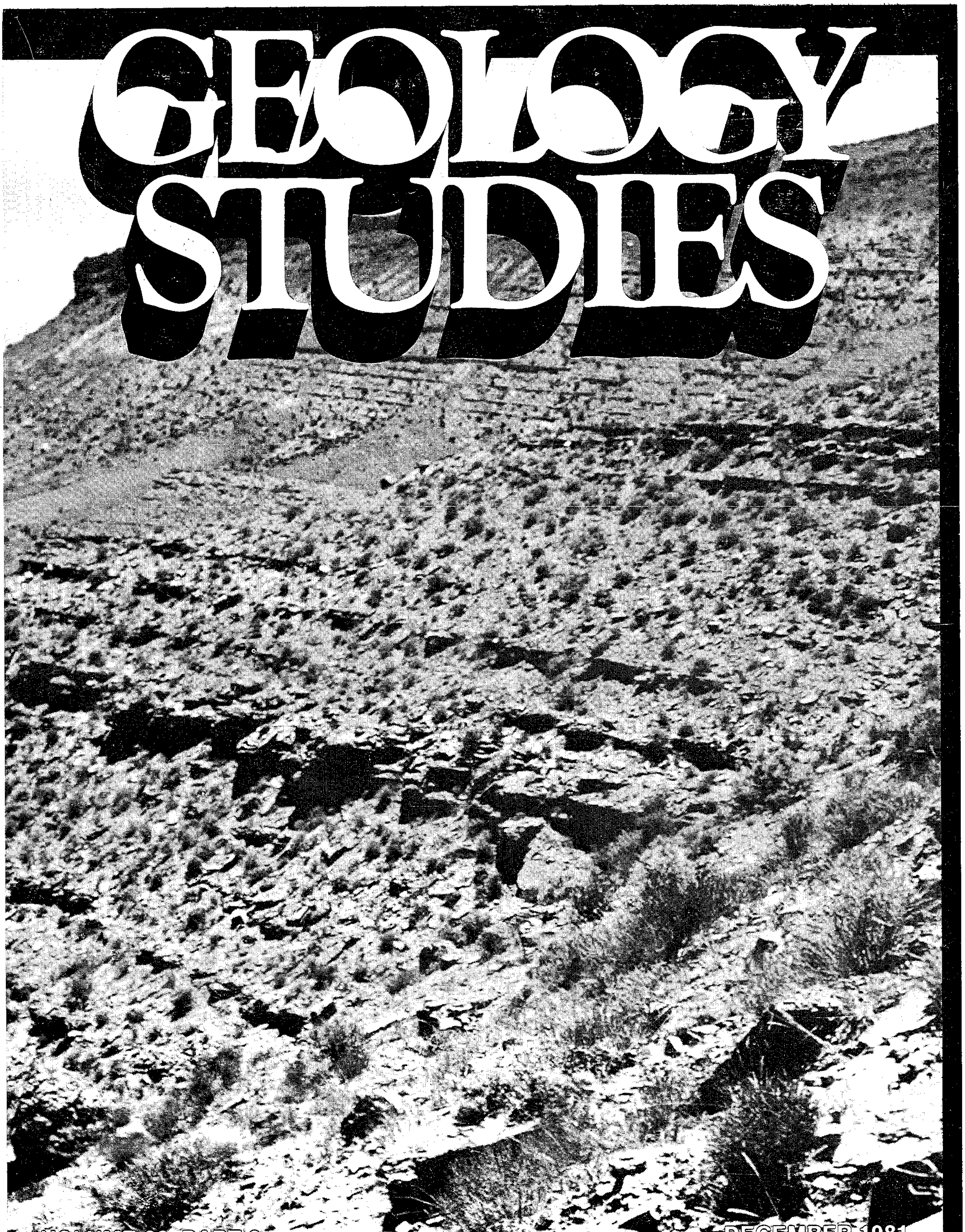

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Cover: The Pogonip Group at Section G, Ibex, Utah.

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Lower and Middle Ordovician Conodonts from the Ibex Area Western Millard County, Utah

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ABSTRACT.—Conodonts are present throughout the entire 1,065-m (3,500-foot) succession of Lower and Middle Ordovician carbonate rocks beneath the Eureka Quartzite of the House and Confusion Ranges in the Ibex Area just east of the Utah-Nevada border. The conodonts primarily represent faunas of the Midcontinent Province, although in some parts of the section they include forms from the North Atlantic Province. At most stratigraphic levels the conodonts are at least moderately abundant; all are somewhat thermally altered, and most of them show incipient fractures and surface frosting.

The conodonts include 151 named categories. They are discussed as multielement species in those cases in which the apparatuses can be identified with previously established reconstructions or can be assembled from the evidence at hand. Many elements are reported in form-taxonomy because they cannot be related to known apparatuses or because their occurrences in the Ibex sections do not indicate with which other elements they properly belong. Two new genera are recognized: *Dischidognathus* and *Paraprioniodus*; 10 new species are named: *Belodella robusta, Chosonodina rigbyi, Dischidognathus primus, Histiodella holodentata, Oistodus bransoni, Oistodus cristatus, Pteracontiodus gracilis, Scalpellodus striatus, Scolopodus paracornuformis,* and *Ulrichodina simplex.* Five additional new genera are reported but not named because adequate material for their definition is not available in the collections. Occurrences of the associated phosphatic microfossils *?Astraspis* Walcott, *Ptiloncodus* Harris, *Utahphospha* Müller and Miller, and *Milaculum* Müller are recorded; and four new species of the latter are described: *M. muelleri, M. reticulatum, M. rossi,* and *M. spinoreticulatum.*

The conodont "faunas" earlier reported for these rocks (Ethington and Clark 1971; Sweet, Ethington, and Barnes 1971) are reviewed on the basis of more recent and more detailed collecting in the region. Although the overall succession of these "faunas" is supported by the additional evidence, the ranges of some of the taxa are adjusted. The new data allow the recognition of 13 successive intervals, each characterized by a particular conodont association, within the pre-Eureka Ordovicion rocks of the Ibex region. Comparisons with information regarding equivalent sections elsewhere suggest that similarly defined intervals may be present in other areas where conodonts of the Midcontinent Province occur. These intervals, therefore, may lead to eventual biostratigraphic zonation for the Lower and Middle Ordovician rocks of that province. At present the ranges of many of these species are not known adequately from enough other locations to justify formalizing most of these intervals as zones. Accordingly we identify them informally as intervals and recommend that these designations be substituted for the earlier "faunas" in future references to the conodonts of the Ibex Area.

INTRODUCTION

The Ordovician rocks beneath the Eureka Quartzite in the House and Confusion Ranges of western Millard County, Utah, include about 1,160 m (3,800 ft) of strata. Except for a few hundred feet of quartzite near the top, the entire succession consists primarily of carbonate rocks. Vegetation is sparse owing to the extremely arid climate of this part of the Great Basin, and the steep slopes of the basin ranges preclude much accumulation of soil or other residuum so that complete exposures of the entire sequence can be examined.

This succession has been studied in detail by Lehi Hintze and his students and colleagues at Brigham Young University who have used the informal name *Ibex Area* to designate this general region of outcrop of lower Paleozoic rocks. Hintze (1951) recognized six units within the Pogonip Group of the Ibex Area, the House, Fillmore, Wah Wah, Juab, Kanosh, and Lehman Formations in stratigraphic order, which comprise the lower 1,065 m (3,500 ft) of the Ordovician sequence (fig. 1). Conodonts from these formations together with those from thin carbonate units in the Watson Ranch Quartzite and from the Crystal Peak Dolomite, which are situated in that stratigraphic order between the top of the Pogonip Group and the base of the Eureka Quartzite, are described in this report.

The Pogonip Group of the Ibex Area has yielded a diversity of fossil invertebrates. In particular the occurrences there of trilobites allowed Hintze (1951) to recognize a succession of zones within the Pogonip which he identified in stratigraphic order by the letters B through N, and an additional Zone O was defined in the Crystal Peak Dolomite. These zones have proven to be useful for the biostratigraphy of the Ordovician strata of western North America for which the Ibex sequence has become a standard of reference. The formations of the Ibex sections have been measured and described in great detail over the past decade by Hintze (1973), and the various fossil groups have been collected systematically for study by appropriate specialists in a comprehensive investigation that seeks to refine the biostratigraphic base represented by this important sequence and to provide even greater stratigraphic resolution than is afforded by trilobites alone. In particular, reports already have been published on graptolites (Braithwaite 1976), nautiloid cephalopods (Flower 1968), brachiopods (Jensen 1967), bryozoans (Hinds 1970), crinoids (Lane 1970), cystoids (Paul 1972), and pelecypods (Pojeta 1971) from the Pogonip as well as comprehensive studies of the trilobites (Hintze 1962; Hintze and Jaanusson 1956, Demeter 1973, Terrell 1973, Young 1973). Primitive corals from near the top of the Pogonip and from the Crystal Peak Dolomite were described by Rigby and Hintze (1977). Except for the graptolites and trilobites, these several kinds of fossils

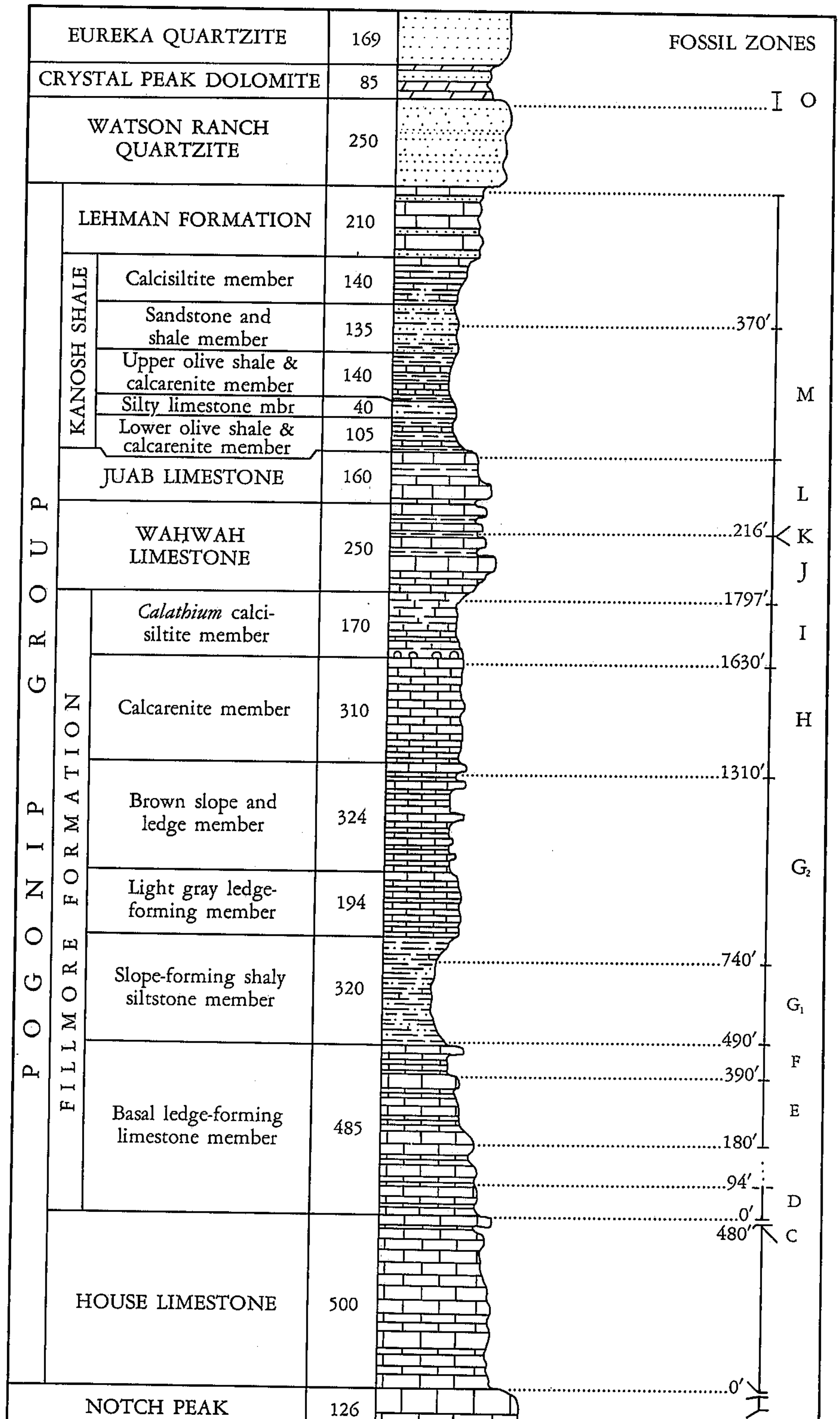

Figure 1.—Stratigraphic succession of Ordovician rocks beneath the Eureka Quartzite in the Ibex Area, western Utah (after Hintze 1973); thickness in feet.

occur in small numbers or are distributed sporadically through the section, so that they have not added materially to the original zonation established by Hintze. By contrast conodonts are relatively abundant at virtually all stratigraphic levels sampled by us, and approximately 150 taxa, many with relatively limited stratigraphic ranges, are reported here.

SAMPLED SECTIONS

Our initial collections were made in 1962 in the course of a reconnaissance to evaluate the potential for conodont studies of the lower Paleozoic rocks of the eastern and central Great Basin. At that time we sampled the type section of the House Limestone, several sections in the Fillmore Formation, and the upper Wah Wah through Kanosh. Our sampling intervals generally were rather broad in this early effort, and some parts of the succession were not represented. Nevertheless, sufficient evidence was developed to allow preliminary recognition of a conodont succession (Ethington and Clark 1971; Sweet, Ethington, and Barnes 1971; Hintze and others 1968). Because the ranges of many of the conodonts were not believed to have been established with sufficient precision in these reports, the entire sequence has been reexamined over the past decade. All the sections from which we collected in the Ibex Area have been measured and described exhaustively by Hintze (1951, 1973); readers are referred to his publications for accurate location maps and comprehensive descriptions of the lithologic succession for each of them. Thickness measurements in yellow paint have been placed on the outcrop at 5-foot (1.5-m) intervals for each of the sections.

The House Limestone was sampled by Mr. Ron Larsen at three localities (A, B, and E in fig. 2), with an arbitrary sample spacing of 1.7 m (5.5 ft) in each one. His work, which was intended to be the basis for a master's thesis at the University of Wisconsin—Madison, was not completed, but his collections, together with our reconnaissance samples, are the basis for our knowledge of the conodonts of the House Limestone. Larsen's collections came from the type section of the House Limestone, from the Section B of Hintze (1951), and from a section in the Willden Hills in the southwestern part of the Ibex Area (Section E of Hintze 1951).

The Fillmore Formation (549 m; 1,803 ft) represents almost one-half the sequence studied here. It is exposed in roadcuts along U. S. 6–50 in Skull Rock Pass where the highway crosses the House Range and in the west-facing slope of Yersin Ridge to the south of the highway. A complete sequence of the Fillmore can be assembled on Yersin Ridge, which is oriented approximately normal to the axis of a shallow syncline. The lower half of the Fillmore was sampled on the south limb of the syncline and somewhat to the north of the Lava Dam (Section C of Hintze 1973), but the upper part of the formation is not present there. The middle of the Fillmore is available somewhat farther to the north (Mesa Section of Hintze 1973; M on fig. 2 herein), and the upper beds of the formation are present still farther to the north near the axis of the syncline (Square Top Section of Hintze 1973; ST on fig. 2 herein). The upper half of the Fillmore is exposed also across the valley from the Lava Dam in the southern part of the Confusion Range (Section H of Hintze 1973). Samples from these four sections, collected at intervals of from 1.5 to 3 m (5 to 10 ft), provided complete coverage for the entire Fillmore. All but the lower 148 m (485 ft) of the formation is duplicated in at least two of the four sections.

The Wah Wah Formation (79 m; 258 ft) was sampled in entirety at Hintze's (1973) Section J in the central Confusion Range, and the upper part of the formation was sampled farther to the north at the foot of Fossil Mountain (Section K—Clark-Braithwaite in Hintze 1973). Samples from the Juab Formation (48 m; 157 ft) and from the Kanosh Shale (172 m; 564 ft) were collected at the latter locality. The Lehman Formation (51 m; 168 ft), the highest unit in the Pogonip Group, was sampled near Crystal Peak in the southern part of the Confusion Range with a sampling interval of approximately 3 m (10 ft). Three thin dolostone ledges in the lower part of the overlying Watson Ranch Quartzite were sampled at this locality, as was the Crystal Peak Dolomite (27 m; 89 ft), which immediately underlies the Eureka Quartzite.

In total, 668 samples were processed from 10 sections in the Ibex Area. Most of these samples were productive of identifiable conodonts, yielding in excess of 25,000 elements, although a broad spectrum of abundance was encountered among the samples. Poorest recovery was from the basal part of the Fillmore Formation in Section C (Zones D, E of Hintze 1951), in which most samples yielded few specimens and displayed little diversity. Almost 20 percent of the samples in the lower 120 m (400 ft) of the Fillmore were barren and account for almost one-half of the barren samples encountered in the entire project. The conodonts recovered from each section are tabulated by sample in the appendix.

Preservation of the conodonts varies considerably within the sequence. Specimens from the House and Fillmore show frosted surfaces suggesting incipient chemical corrosion, perhaps during diagenesis. By contrast, the conodonts of the Wah Wah and younger units generally have smooth surfaces. Many specimens from the Juab, which is quite silty, have silt particles adhering to their surfaces too tightly to be dislodged without fracturing the specimens; not uncommonly these grains are present in such numbers as to render identifications difficult. Relatively complete specimens are rare in our collections. Distal extremities of cusps and denticles almost invariably have been lost. Many specimens show incipient transverse fractures in transmitted light, and they must be handled carefully to present further fragmentation. Probably some of the breakage that we observed occurred during processing of the samples. However, the most severely fragmented specimens are from the lower Fillmore in an interval dominated by intraformational flat-pebble conglomerate beds that likely represent relatively turbulent conditions of deposition in which primary fracturing of some of the conodonts would be expected to occur. All the specimens show discoloration by thermal alteration. The color alteration indices generally are within the range of 3 to 4 on the scale of Epstein, Epstein, and Harris (1977), thus indicating paleotemperatures of the order of 120 to 200°C.

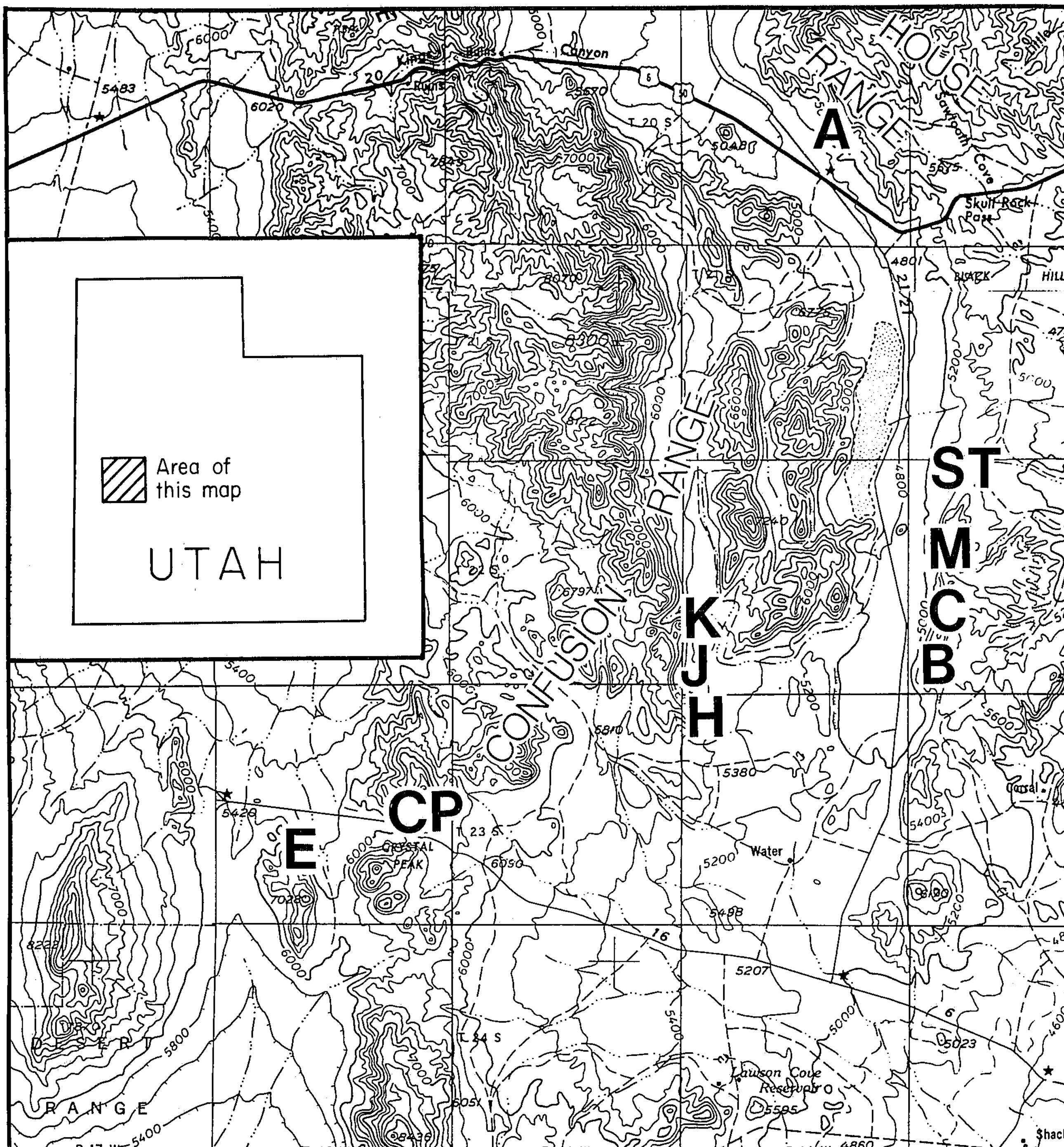

Figure 2.—Location of sampled sections within the Ibex Area (topographic base taken from the Barn Quadrangle, 1:62,500).

Despite their somewhat variable preservation, almost all of the specimens that we examined could be identified with confidence.

BIOSTRATIGRAPHY

General

Figure 3 is a chart showing the stratigraphic ranges of the conodonts recovered from the Ibex Area plotted against the formations and the fossil zones that Hintze has identified within the sequence. The chart shows that the ranges of the conodonts generally do not coincide with either the lithostratigraphic subdivisions or with the standard zones. Generally taxa do not make their appearance in the sequence at zonal or formational boundaries, nor do they disappear at such stratigraphic levels. As should be expected, Hintze's trilobite zones cannot be differentiated via conodonts. Although the "life style" of conodonts is still debated (Seddon and Sweet 1971, Barnes and Fåhraeus 1975), many if not most species are believed to have lived in the water column and above the substrate so that they likely would not have responded to or been controlled by the same environmental factors as the benthic organisms on which the traditional zonation is based.

The order of appearance of conodont taxa within the Ordovician section of the Ibex Area is very nearly a continuum (see fig. 3), although several levels can be recognized at or near which a number of forms are introduced. Some of these levels were identified by us in our reconnaissance efforts and were used to divide the conodont succession into a series of sequentially arranged "faunas" (Ethington and Clark 1971; Sweet, Ethington, and Barnes 1971). These faunas have been considered subsequently in reports dealing with conodonts from the Lower and lower Middle Ordovician rocks of North America. In many instances these faunas have been discussed as biostratigraphic zones although they were not proposed as such. As mentioned above, the ranges of the respective taxa were not established with certainty at Ibex in 1971, so that the "faunas" recognized at that time represented a status report rather than a conclusion. Conodonts have been recovered from Lower and lower Middle Ordovician rocks from diverse localities in North America since 1971 (e.g., Moore 1970; Repetski 1975, 1977, 1979; Potter 1975; Brand 1976; Nowlan 1976), and the overall conodont succession hinted at by the 1971 report generally is consistent with the conodonts found in these other areas. The more extensive collections, both stratigraphically within the Ibex Area and geographically within North America, offer promise for evolution to a conodont zonation for Canadian and lower Champlainian strata of the Midcontinent Province with more stratigraphic resolution than the 1971 reports allowed.

Specific Zones and Intervals

Cordylodus proavus Zone

We earlier (1971) recognized three faunas in homotaxial succession within the strata of the House Limestone. The oldest of these, which we identified as Fauna A, is characterized by *Cordylodus proavus* Müller, an assortment of "simple cones," and species of *Clavohamulus*. This faunal association has been recognized widely in North America in rocks of latest Cambrian and earliest Ordovician age (Miller and Melby 1971; Derby, Lane, and Norford 1972; Miller, Robison, and Clark 1974; Kurtz 1976; Nowlan 1976; Landing 1976; Miller 1978; Landing, Taylor, and Erdtmann 1978; Repetski 1977). Miller (1970, 1975, 1978) recognized the *Cordylodus proavus* Zone with five subzones in the upper Notch Peak and lower House Formations of the Ibex Area. Fauna A of Ethington and Clark (1971) corresponds to the two highest subzones identified by Miller in the *C. proavus* Zone, and those designations should be used in future publications in preference to Fauna A.

The boundary between the Cambrian and Ordovician Systems appears to lie within this zone; in the Ibex Area the boundary is in the upper part of the Notch Peak Formation which underlies the House Limestone (Miller 1978). The *Cordylodus proavus* Zone has been recognized outside North America in Australia (Druce and Jones 1971), in Iran (Müller 1973a), and in central Siberia (Abaimova 1972, 1975).

Only the lowermost beds in the measured section of the type House Limestone belong in the *C. proavus* Zone. More advanced species of *Cordylodus* that are typical of Fauna B of Ethington and Clark (1971) are introduced 10 m (33 ft) above the base of the section, and these forms and *C. proavus* occur together, although sporadically, through the next 20 m (60 ft) of the section. This distribution is consistent with our observations in the Willden Hills and with Miller's (1978) data on the Lava Dam Five Section. Miller included the lowest 31 m (103 ft) of the House Formation in the latter section in the *C. proavus* Zone. The difference in the thickness of the interval within the House assigned to this zone in the two sections probably indicates that a different horizon was selected for the base of the formation in the two measurements. The top of the *C. proavus* Zone is interpreted here as coinciding with the lowest occurrence of *Cordylodus intermedius* Furnish. The latter species occurs sporadically in the lower part of its range at Ibex and is not found in abundance below 38.6 m (126.5 ft) in our measured section of the type House.

Occurrence of *Cordylodus proavus* beneath *C. intermedius* is consistent with what is known of Cambrian–lowest Ordovician conodonts elsewhere in North America. Kurtz (1976, text-fig. 2) showed this basic relationship in the northern Rocky Mountains, and it is developed also in the Rocky Mountains of Alberta (Derby, Lane, and Norford 1972; Ethington and Clark 1965). The same succession of forms is present low in the Manitou Formation in Glenwood Canyon in central Colorado (collections of RLE). It is supported, although not conclusively, by the published information on the oldest conodonts known in the Upper Mississippi Valley (Furnish 1938, Miller and Melby 1971). *Cordylodus proavus* is present in basal Ordovician strata high in the Signal Mountain Limestone of southern Oklahoma (Müller 1959); Mound's (1968) report of conodonts from the higher McKenzie Hill Formation deals only with the uppermost 10 m (35 ft) of that formation and reports conodonts that occur near the top of the House. A systematic examination of the strata in southern Oklahoma between the top of the Signal

Mountain Limestone and the base of the Cool Creek Formation will provide an important comparison for the sequence described here. Miller, Robison, and Clark (1974) recorded the *C. proavus* Zone in the lower part of the Tiñu Formation of Oaxaca, Mexico, and noted that the zone is overlain in that unit by strata with *C. intermedius.* Finally, Nowlan (1976) observed a succession in the Arctic Islands of Canada in which *C. proavus* is succeeded upward by beds with *Cordylodus intermedius.*

The upper part of the range of *C. proavus* overlaps the basal part of the range of *C. intermedius* in the Lower Ordovician (Datsonian) of western Queensland, Australia (Jones, Shergold, and Druce 1971). Müller (1973a) found *C. proavus* and *C. intermedius* in different samples in his collections from northern Iran, but, as he noted, he is uncertain as to the stratigraphic relation among his samples because of the complex structure of the sampled region. His data neither supports nor refutes our zonal interpretation for the lower House. Abaimova (1972, 1975) found *C. proavus* beneath *C. intermedius* in Lower Ordovician strata along the Lena River in central Siberia, but she had relatively few specimens of each species distributed through a limited number of samples. Nevertheless, she recognized from this sequence assemblages (complexes) of conodonts, the oldest of which includes *C. proavus* and the next two younger of which contain *C. intermedius.*

Cordylodus intermedius *Interval*

We (1971) recognized Fauna B for an assemblage of conodonts containing *C. intermedius* [*Cordylodus angulatus* in the 1971 paper] and associated "simple cones" in that part of their ranges below the lowest occurrence of *Loxodus bransoni,* which is at 67 m (220 ft) in the type section of the House Limestone. In its range in the Ibex Area, *C. intermedius* is associated with *Acanthodus lineatus* Furnish, *"Acontiodus" iowensis* Furnish, *"Oistodus" triangularis* Furnish, *"Drepanodus" parallelus* Branson and Mehl, and *Cordylodus prion* Lindström. All but one of these species were described by Furnish (1938) from the Oneota Formation and from the underlying "Blue Earth Beds" of the Upper Mississippi Valley. Unfortunately, Furnish's material was assembled from three widely separated localities, none of which was sampled in such a way that a stratigraphic order of occurrence of these conodonts within the lowest Ordovician of Minnesota-Wisconsin-Iowa can be reconstructed from his published report. In his study of a thick section in the Arctic Islands of Canada, Nowlan (1976) found an interval in the Copes Bay Formation beneath the lowest occurrence of *Loxodus bransoni* in which *C. intermedius* occurs with *C. prion* and *Oneotodus nakamurai,* but he did not find the typical Ibex associates such as *A. lineatus* and *"A." iowensis.* In Nowlan's section *"Paltodus" bassleri* is present throughout the range of *C. intermedius,* whereas in the House Limestone it is introduced not far below *Loxodus.* Undescribed collections (RLE) from the Manitou Formation in Glenwood Canyon, central Colorado, include an interval of 12.6 m (41.5 ft) between the top of the *C. proavus* Zone and the first occurrence of *Loxodus,* in which *C. intermedius* occurs together with *"P." bassleri,* New Genus 3 [herein], and *"Oistodus triangularis.*

Abaimova (1972, 1975) reported *C. intermedius* and *Loxodus bransoni* to occur together in the assemblages she identified as Complex II and Complex III, respectively. Their mutual occurrence in the strata containing Complex II is based on a single sample near the top of the range of this fauna, so that a lower interval with only *C. intermedius* is possible. Jones, Shergold, and Druce (1971) recognized an interval in the Lower Ordovician of Queensland, Australia, that is characterized by *C. intermedius,* but they did not find *Loxodus. Cordylodus angulatus,* a species that we recovered in minimal numbers within the range of *L. bransoni* at Ibex, is present in Queensland in strata above those with *C. intermedius.*

Evidence is insufficient to date to warrant the recognition of a zone of *C. intermedius* between that of *C. proavus* and that of *Loxodus bransoni.* At this time such a zone would be based on the absence of a species (*L. bransoni*) as much as on the presence of *C. intermedius* and its associates. Pending careful examination of the ranges of the several species through this part of the Ordovician in continuous sequences elsewhere, e.g., southern Oklahoma, we suggest the informal designation of *Cordylodus intermedius* Interval instead of Fauna B for the conodonts of those strata beneath the lowest occurrence of *Loxodus* but above the lowest occurrence of *C. intermedius.*

Loxodus bransoni *Interval*

Numerous species make their appearance at about 67 m (220 ft) in the type section of the House Limestone and continue to, or nearly to, the top of the formation. We identified this assemblage as Fauna C in our 1971 paper. It includes the species of Fauna B which continue upward from lower in the formation. Species that are introduced in the House at or near this level are *Loxodus bransoni, "Acodus" oneotensis, "Paltodus" bassleri, "Paltodus" spurius,* and *Cordylodus angulatus.* All but the latter two species are present in the Oneota Formation and related strata of the upper Mississippi Valley (Furnish 1938). *Loxodus bransoni* is rather widespread within the Midcontinent Province. It occurs in the basal El Paso Group in west Texas (Repetski 1975, and in press), in the Collier Shale in the Ouachita Mountains of Arkansas (Repetski and Ethington 1977), at the top of the McKenzie Hill Formation of southern Oklahoma (Mound 1968), and in the Stonehenge Limestone of Pennsylvania (Sando 1958). It is present in the Manitou Formation in Colorado (Ethington and Clark 1971) and in the Grove Creek Limestone in Montana (Goodwin 1964). Nowlan (1976) recovered a few specimens of *L. bransoni* in the upper part of the Copes Bay Formation of the Arctic Islands of Canada, and a similar number of them low in the overlying Baumann Fiord Formation. In this sequence *L. bransoni* appears higher in the section than does *C. intermedius,* so that the succession is consistent with the one that we observed in the House and which also occurs in the Manitou in Colorado. However, Nowlan recovered only 8 specimens of *L. bransoni* distributed among 6 samples, so that the similar homotaxial relationship to the Utah-Colorado occurrences could be unreliable. These reports have demonstrated that *Loxodus bransoni* is widely distributed in North America, and its stratigraphic relations to other conodonts seem to be consistent.

The only report of *L. bransoni* from outside North America is that of Abaimova (1975), who recovered it from Lower Ordovician strata along the Lena River in central Siberia. Like Nowlan, she found very few specimens (11) and no more than 2 specimens in any single sample, so that the range of this species in that region probably is not established. *Loxodus* is associated in Siberia with many of the conodonts that occur with it in North America, so that this occurrence must represent the Midcontinent Province whose geographic distribution is known better for Middle Ordovician rocks. Because this assemblage is confined largely to North America, precise correlation with the well-known Lower Ordovician conodont successions of other parts of the world is difficult. For example, *Loxodus* does not occur among the conodonts from Queensland described by Druce and Jones (1971), nor is it present in the well-documented faunas of the Baltic region (Lindström 1955, Sergeeva 1962, van Wamel 1974, Viira 1974). Nevertheless, possible correlation of the *Loxodus bransoni* Interval with these sequences can be effected on the basis of conodonts that are as yet poorly known from North America but which occur within the range of *L. bransoni. Chosonodina herfurthi* occurs in Queensland together with *C. angulatus* in strata (Warrendian) above those containing *C. intermedius.* The former species are sparingly represented in the range of *L. bransoni* in the House and in the Manitou Formation in Colorado. *Chosonodina* occurs with *Loxodus* in the uppermost McKenzie Hill Formation in Oklahoma (Mound 1968) and in the Collier Formation of Arkansas (Repetski and Ethington 1977). On this basis, those strata in Australia and in Korea (Müller 1964) with *C. herfurthi* may be approximate correlatives of the *Loxodus bransoni* Interval of the Midcontinent Province.

Correlation of the *L. bransoni* Interval with the thoroughly studied sequences of conodonts of northern Europe is even less certain because the latter faunas represent the North Atlantic Province. The only species held in common is *Cordylodus angulatus.* Clearly Lindström (1955, text-figs. 3e, G) included in this species cordylodiform elements that we, following Druce and Jones (1971) and Müller (1973a), separate as *C. intermedius* and *C. angulatus.* In our collections the latter species is restricted to the interval of *L. bransoni,* although we have so few specimens that we cannot assume that this range is definitive. Other European workers (Sergeeva 1963, van Wamel 1974, Viira 1974) have interpreted *C. angulatus* in the less restricted sense of Lindström and have recognized a zone based on its occurrences as the lowest interval in the known Ordovocian conodont succession of the Baltic region (see Lindström 1971). The *Loxodus bransoni* Interval and the underlying strata characterized by the conodonts of Fauna B in the Ibex Area must correlate approximately with the *Cordylodus angulatus* Zone (*Cordylodus angulatus* Zone of authors) of northern Europe. Whether greater resolution can be achieved will depend upon whether (1) a distinction between *C. intermedius* and *C. angulatus* can be recognized in the conodonts of the Baltic region and (2) whether further investigations demonstrate that the latter species is restricted in North America to strata containing *L. bransoni.*

The *Loxodus bransoni* Interval corresponds to approximately the upper half of trilobite Zone B plus Zone C of Hintze. *Loxodus* was not recovered from the strata of trilobite Zone C, only 3–6 m (10–20 ft) thick in the Ibex Area, but other conodonts typical of the *L. bransoni* Interval, e.g., *Clavohamulus densus* and New Genus 3 [herein], continue upward into that interval. Trilobite Zone C of Hintze cannot be recognized with confidence by the seeming absence of *L. bransoni,* and we group this thin biostratigraphic unit with the strata containing *L. bransoni* because of the presence of other diagnostic conodonts of that interval.

The top of the *Loxodus bransoni* Interval constitutes the most pronounced change in the entire succession of conodonts of the Ibex Area. Some 20 species of conodonts have their highest occurrence near that level, and among these most range through at least 60 m (200 ft) of strata beneath the top of the House Limestone. Only *"Drepanodus" parallelus* was found in the basal part of the overlying Fillmore Formation. The conodonts recovered from the lower Fillmore show no clear affinity to those in the upper House, and no close phylogenetic relations between the two groups are indicated. The same abrupt replacement of the older fauna with *Loxodus* with a younger one is displayed by the conodonts of the El Paso Group (Repetski 1975, and in press), by faunas from the Arctic region of Canada (Nowlan 1976), and perhaps also in the lower Arbuckle Group of Oklahoma (Mound 1968). Abaimova's (1975) collections from central Siberia do not offer strong support for similar abrupt replacement of an older fauna at the top of the range of *Loxodus bransoni* although *"Scolopodus" quadraplicatus,* one of the members of the fauna introduced at Ibex in the lower Fillmore, does enter the sequence just above the highest occurrence of *Loxodus.* The marked contrast between these two faunas in North America supports this level as offering very firm correlations in the Lower Ordovician of the Midcontinent Province.

"Scolopodus" quadraplicatus–*aff.* Scolopodus rex *Interval*

The conodonts of the lower 102 m (335 ft) in the Fillmore Formation (trilobite Zone D through the lower two-thirds of Zone E of Hintze) are lacking in diversity, and they generally are found in low numbers and with relatively poor preservation when compared with the conodonts from other parts of the Pogonip in the Ibex Area. Except for *"Drepanodus" parallelus,* the fauna of this interval is totally different from that of the immediately underlying House Limestone. Most of the species introduced in the lower Fillmore are long-ranging, some of them continuing upward into the Wah Wah or younger units in the section. We earlier (1971) included these species within what we identified as Fauna D, an assemblage of conodonts of the Midcontinent Province in that part of their collective ranges below the lowest occurrence of *Oepikodus communis* (Ethington and Clark). Data summarized here together with information accumulated over the past decade about the ranges of the conodonts of Fauna D indicate that greater biostratigraphic resolution probably is possible in the rocks in which they occur than is permitted by grouping them as a single fauna.

The dominant elements in lowest Fillmore are aff. *Drepanoistodus basiovalis* and aff. *Scolopodus rex,* species that are close to if not conspecific with forms best known from northern Europe. Neither of these species has been identified widely in North America as yet, so that at present they do not serve well for comparison with Lower Ordovician conodonts from other parts of the continent They are associated in this part of the Fillmore, however, with at least occasional specimens of *"Scolopodus" quadraplicatus* Branson and Mehl and *"Drepanodus" parallelus* Branson and Mehl, species which are almost ubiquitous in middle Lower Ordovician faunas known thus far from the Midcontinent Province. The interval in the lower Fillmore below the introduction of *Acodus deltatus* is characterized by these species, which we recognize as a distinct association, although evidence is not sufficient to justify formal designation of a zone based upon them.

Information is equivocal as to whether similar intervals occur in other sections below the lowest occurrence of *A. deltatus.* Repetski (1975, and in press) recovered *S. rex, "S." quadraplicatus, "D." parallelus,* and *"Scolopodus" filosus* beginning 55 m (180 ft) above the base of the El Paso Group and continuing to near the top of that sequence. He found the lowest occurrence of *A. deltatus* in the El Paso to be at 189 m (621 ft) in the same section. The only other continuous sequences that have been studied and that might contain such an interval are in the Arbuckle Group in Oklahoma, in the Arctic Islands of Canada, and in the Rocky Mountains of Alberta. Mound (1968) has identified *A. deltatus* from the upper McKenzie Hill and the lower half of the Cool Creek Formation in the Arbuckle Mountains. If this is verified, *A. deltatus* has a lower limit to its range there than does *"S." quadraplicatus;* unfortunately, stratigraphic data in this report have not proven reliable. Nowlan (1976) found *Scolopodus rex, "S." quadraplicatus, "D." parallelus, Drepanoistodus basiovalis,* and *Scandodus flexuosus* in the upper part of the Baumann Fiord Formation of northern Canada. He observed only one occurrence of a species of *Acodus,* probably *A. delicatus* Branson and Mehl, at 134 m (441 ft) above the base of the overlying Eleanor River Formation. Abundance of conodonts is low in the Baumann Fiord Formation, only about 4 elements per kilogram, perhaps because of severe environmental conditions indicated by the abundance of evaporites in the formation, and Nowlan's sample spacing of necessity was broad. For this reason we cannot consider his results as confirming the presence in Arctic Canada of a counterpart of the *"S." quadraplicatus*–aff. *S. rex* Interval at Ibex.

The same order of appearance of conodonts was found by us in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965), but sample size and spacing in our collections were inadequate to affirm this sequence A detailed study by David Kennedy (in preparation) on that section should clarify the relations there. Conodonts dominated by *"S." quadraplicatus* and by *"D." parallelus* are present in the Shakopee Dolomite in the Upper Mississippi Valley (Furnish 1938), but no elements of the *Acodus* apparatus are known from that unit. Furnish's material came from clay seams in a sequence that is dominantly dolostone, and his collection represents a composite assembled from several stratigraphic levels and a number of localities. The *Acodus* apparatus is represented abundantly in a collection from low in the St. Peter Sandstone (Readstown Member) which unconformably overlies the Shakopee in southwestern Wisconsin (Grether 1977). This relationship duplicates the sequence of conodonts outlined here for the lower Fillmore at Ibex, but the scanty evidence is not compelling. An interval with abundant *"S." quadraplicatus* and *"D." parallelus* but lacking species of *Acodus* has been found low in the Jefferson City Formation of central Missouri (Stanley Fagerlin personal communication 1976) and has been observed also in the Knox Dolomite of southern Kentucky (Alice Cooper personal communication 1979). *Acodus delicatus* Branson and Mehl occurs higher in both successions, but *A. deltatus* has not been found in either of them. Other reported occurrences of *"S." quadraplicatus* in North America are from isolated samples (e.g., Sando 1958, Barnes and Tuke 1970, Barnes and Poplawski 1973, Repetski and Ethington 1977) and offer no information as to conodont sequences.

In the section that Abaimova (1972, 1975) studied along the Lena River in Siberia, *"S." quadraplicatus, "D." parallelus, D. basiovalis, S. rex* and *"Scandodus" flexuosus* [identified as *Scandodus furnishi* Lindström] occur together in an interval between the highest occurrence of *Loxodus bransoni* and the lowest occurrence of *A. deltatus.* This interval, which is about 40 m (130 ft) thick, includes the upper part of the range of the association of conodonts that she reported as Complex II, the lower part of which is correlated here with the *Loxodus bransoni* Interval at Ibex, and the lower half of the range of the conodonts that she treated collectively as Complex IV. Although the numbers of specimens that she recovered are relatively small, the succession was sampled systematically, and the conodonts that she reported probably are representative of the potentially recoverable species. The order of appearance of the species enumerated above duplicates in the Siberian section the succession in the lower Fillmore at Ibex.

Correlation with the Lower Ordovician rocks of the Baltic Platform cannot be effected because the faunas there represent the North Atlantic Province and are almost totally different from those in the lower Fillmore. The only comparable forms between the two areas, *S. rex* and *D. basiovalis,* have long stratigraphic ranges in both regions. Further, *A. deltatus* appears in the section in southern Sweden at a lower level than does *S. rex* (van Wamel 1974). Lindström (1971) and Löfgren (1978) considered *D. basiovalis* to be much younger than either of these species and to be a descendant of *D. forceps* (Lindström). In contrast, van Wamel (1974) reported inability to distinguish *D. basiovalis* from *D. forceps* and believed that the latter has a very long range. Even approximate correlations between the two provinces at this stratigraphic level will not be possible if these discrepancies in ranges are verified by further studies.

Acodus deltatus–Macerodus dianae *Interval*

The long-ranging conodonts of the *"S." quadraplicatus*–aff. *S. rex* Interval are joined in the upper part of trilobite Zone E and Zone F of Hintze by a variety of species, some of which have been reported from widely scattered localities in North America and which therefore suggest that a conodont zone eventually may be recognized within this stratigraphic interval. The most frequently reported of these species to this time is *Acodus deltatus* Lindström, a species first described from the North Atlantic Province. The lowest occurrence of the distinctive acodiform element of *A. deltatus* in our collection is a fragment found at 102 m (335 ft) above the base of the Fillmore. All the elements of the apparatus are common beginning at 146 m (480 ft) in the formation, and they are present continuously through about 380 m (1,250 ft) of section, i.e., into the upper part of Hintze's Zone G_2. The range chart (fig. 3) shows this species ranging to the top of the Fillmore, but the upper part of that range is based on oistodiform and trichonodelliform elements recovered in the ST Section. No acodiform elements were found in any of these samples despite the relatively common occurrence of these nondiagnostic elements, so that the top of the range of *A. deltatus* may be lower than is shown. The upper limit of the *A. deltatus-M. dianae* Interval is drawn at the lowest occurrence in the Ibex sequence of *Oepikodus communis* (Ethington and Clark); it thereby coincides with the lowest occurrence of Fauna E in the sense of the 1971 paper.

Other forms that probably represent species typical of the North Atlantic Province and that appear with or near the lowest occurrence of *A. deltatus* are aff. *Drepanoistodus forceps* (Lindström), *Drepanodus arcuatus* Pander, and elements that are morphologically similar to *"Oistodus" inaequalis* Pander s.f. The Midcontinent Province is represented by aff. *Oneotodus simplex* Furnish, *Drepanodus gracilis* Branson and Mehl, *Macerodus dianae* Fåhraeus and Nowlan, and several elements identified with *Ulrichodina* Furnish. One species, aff. *Acodus? emanuelensis* McTavish, suggests possible connection with Australian faunas. All of these species have long ranges, except *M. dianae.* Two species that make their first appearance below the middle of Zone G_2 of Hintze, *Walliserodus ethington* (Fåhraeus) and *"Scolopodus" emarginatus* Barnes and Tuke, are present in the higher part of the strata at Ibex that we assign to the *A. deltatus–M. dianae* Interval. The former is not widely known from North America but has been identified in northern Europe and may be useful for correlations with faunas of the North Atlantic Province. *"S." emarginatus* occurs in middle and upper Canadian faunas in the Midcontinent Province, but its range there is not as yet clearly defined.

Repetski (1975, and in press) identified *A. deltatus* in the El Paso Group of west Texas through an interval of about 76 m (250 ft) beginning 189 m (621 ft) above the base. It is associated in these strata with *"S." emarginatus,* aff. *Oneotodus simplex,* species of *Ulrichodina,* and probably with aff. *Acodus? emanuelensis. Macerodus dianae* has its lowest occurrence about 91 m (360 ft) lower in the El Paso, and the form reported herein as a new species of *Histiodella* appears at about the same level in the El Paso. Repetski's data indicate that neither of these forms overlaps with *A. deltatus* in their respective ranges in the El Paso.

Nowlan (1976) recovered *M. dianae* and aff. *"O." inaequalis* s.f. from the Baumann Fiord Formation in the Canadian Arctic. The few specimens he identified as *Acodus deltatus* came from the overlying Eleanor River Formation; they may represent *Acodus delicatus* Branson and Mehl instead. *Acodus deltatus* is present in the section at the Columbia Ice Fields of Alberta where it has its lowest occurrence at least 30 m (100 ft) below that of *Oepikodus communis* (Ethington and Clark 1965). Studies in progress (David Kennedy personal communication) will provide a thorough documentation of the ranges of these species in that section. *Acodus deltatus* is present also in the Ninemile Formation in Nevada, but is associated there with species such as *O. communis* which do not occur at Ibex below the upper part of Zone G_2 of Hintze. The Ninemile is thus equivalent to strata that occur in a higher part of the range of *A. deltatus* in the Ibex Area.

Probable equivalents of the *A. deltatus–M. dianae* Interval are present in the Lower Ordovician of the craton. Both *M. dianae* and *Histiodella* n. sp. [herein] occur in the Manitou Formation in Williams Canyon near Colorado Springs, Colorado, in beds that Berg and Ross (1959) have correlated via trilobites with faunal Zone F of the Ibex Area. The associated conodonts in this part of the Manitou are dominated by a species of *Drepanoistodus; A. deltatus* has not been found there. Mound (1968) found *M. dianae* [identified as several species of *Panderodus*] to range from 122 m through 168 m (400–550 ft) above the base of the Cool Creek Formation of southern Oklahoma. He reported *A. deltatus* to be present in the same general part of the formation. Unfortunately this report must be interpreted with caution because of uncertainty regarding consistency of identification of species so that reported stratigraphic ranges may not be dependable.

Equivalents of the *A. deltatus–M. dianae* Interval must exist within the widespread platform carbonates of the upper Sauk Sequence on the North American craton, but they have not been reported. The interval probably is missing in the Upper Mississippi Valley owing to development of the pre-St. Peter unconformity. The Shakopee Dolomite there is correlative with the beds of the *"S." quadraplicatus*–aff. *S. rex* Interval, and the overlying Readstown Member has elements that appear to belong to *A. delicatus* (Grether 1977). *Acodus delicatus* was described from near the top of the Jefferson City Formation of central Missouri (Branson and Mehl 1933), and all other information available to date about the conodonts of that unit (Moore 1970, Kennedy in preparation) is developed from the same part of the formation. Stanley Fagerlin (personal communication 1979) has collected samples from the entire thickness of the Jefferson City, but he did not recover the *A. deltatus–M. dianae* fauna; *A. delicatus* is confined to the upper part of the formation above an interval characterized by *"S." quadraplicatus, "D." parallelus,* and a species of *Drepanoistodus.* A similar sequence of conodonts occurs in the Knox Dolomite in southern Kentucky (Alice Cooper personal communication 1979). Barnes and Tuke (1970) described a small collection from the upper part of the St. George Group of Newfoundland in which they found conodonts that they identified as a species of *Loxodus.* These elements, which are not related to *L. bransoni* despite superficial similarity in morphology, occur in the upper Jefferson City Formation (Moore 1970) and equivalent strata in the West Spring Creek Formation of Oklahoma (Richard Felton and William Mills in preparation) and the El Paso

Group in Texas (Repetski 1975, and in press). Because Barnes and Tuke's specimens came from near the top of the St. George Group, an *A. deltatus–M. dianae* Interval equivalent might be present lower in that unit.

Macerodus dianae was defined by Fåhraeus and Nowlan (1978) for conodonts in Bed 8 of the Cow Head Group of Newfoundland. According to Kindle and Whittington (1958), *Tetragraptus approximatus,* a species that has been used to identify the base of the Arenigian in North America, occurs in the upper part of this bed. On this basis, *M. dianae* might be used to identify lower Arenigian strata in North America in the absence of diagnostic graptolites if its range proves to be sufficiently restricted.

Acodus deltatus occurs in the upper two-thirds of the range of Complex IV and is a characteristic component of Complex V in Abaimova's (1975) subdivision of the conodonts of the Lower Ordovician along the Lena River. It is present in the Zone of *Paroistodus proteus* in the Lower Ordovician of northern Europe (Lindström 1971, van Wamel 1974, Viira 1974). Whereas the occurrence reported by Abaimova is in association with conodonts of the Midcontinent Province (*"S." quadraplicatus, "D." parallelus*), all the associated conodonts in northern Europe represent the North Atlantic Province.

Oepikodus communis–"Microzarkodina" marathonensis *Interval*

In our preliminary treatment of the conodonts of the Pogonip Group, we differentiated a lower Fauna D characterized by *"S." quadraplicatus* and associated species from a younger population that we designated Fauna E. The latter fauna consisted of an association of conodonts of which the most significant member was *Oepikodus communis.* The lowest occurrence of that species is somewhat above the middle of Hintze's Zone G_2, i.e., about 335 m (1,100 ft) above the bottom of the Fillmore Formation. At about this level *"Microzarkodina" marathonensis, Reutterodus* sp., *Oistodus bransoni,* and *Walliserodus comptus* also make their first appearance in the section in the Ibex Area. All these forms except the species of *Reutterodus* range upward in the Ibex section through at least the Wah Wah Formation. The long-ranging taxa of the lower Fillmore persist into the upper part of the formation but in lesser numbers than lower.

The conodont sequence of the El Paso Group in west Texas displays an interval similar to this one (Repetski 1975, and in press). The species listed above all occur there and are introduced in that section with a 30-m (100–ft) interval beginning 225 m (740 ft) above the base of the El Paso. The part of the El Paso just below this interval is characterized by *Acodus deltatus,* and at a still higher level *O. communis* and *"M." marathonensis* co-occur with *Reutterodus andinus* and *Jumudontus gananda* just as at Ibex.

Whether a similar biostratigraphic succession is present in other parts of North America is unclear at present. Nowlan (1976) did not encounter most of the characteristic species in his study in the Arctic region of Canada. He found *Walliserodus australis* Serpagli, a form that is close to, if not conspecific with, *W. comptus,* to be present about 30 m (100 ft) above the base of the Eleanor River Formation and about 152 m (500 ft) above the occurrence of *Macerodus dianae* in the underlying Baumann Fiord Formation. *Oepikodus communis* is introduced at about 259 m (850 ft) in the Eleanor River Formation, but it is not so common there as it is among the conodonts of the Ibex Area. *Protopanderodus asymmetricus* and *Jumudontus gananda,* major components of our next younger interval at Ibex, are introduced in Nowlan's measured section at about 284 m (933 ft) and 390 m (1,281 ft), respectively, in the Eleanor River Formation. These occurrences are consistent with our observations in western Utah in that diagnostic elements are introduced in the same general order in the two areas. However, the numbers of specimens that Nowlan recovered are so small and the species are distributed so sporadically within their ranges in his collection that at best they do not negate the subdivisions we have recognized; they do not provide strong confirming evidence either.

An interval approximating this one seems to be present in the Arbuckle Group in southern Oklahoma. Brand (1976) recorded the lowest occurrence of *O. communis* to be about 29 m (95 ft) below the top of the Kindblade Formation; this species ranges upward through almost all of the overlying West Spring Creek Formation (Potter 1975, Richard Felton 1979, and William Mills 1980). *Walliserodus comptus* is not known from the Kindblade but is present in the lower part of the West Spring Creek in association with *Oistodus bransoni* and *"Microzarkodina" marathonensis.* New Genus 2 [herein] is present through the upper half of the Kindblade but has not been found in the West Spring Creek. It thus can range lower than the *O. communis–"M." marathonensis* Interval, although its known occurrences in the El Paso (*Rhipidognathus* sp. of Ethington and Clark 1964) and in the sequence at Ibex are so restricted.

Walliserodus comptus and *Oistodus bransoni* (= *Paltodus jeffersonensis* of Branson and Mehl 1933) were described originally from near the top of the Jefferson City Formation of central Missouri. The upper part of that formation has produced *O. communis* and *"M." marathonensis* as well (Moore 1970, Stanley Fagerlin personal communication 1979) so that this interval appears to be represented there, although its stratigraphic range remains to be documented precisely.

All the species that characterize this interval are restricted to the Midcontinent Province, so that comparisons cannot be made with most of the upper Lower Ordovician conodont faunas known from other than North America. None of the species just discussed are present among the conodonts that Moskalenko (1967) described from along the Moiero and Stony Tunguska Rivers in Siberia. The presence of elements of a species of *Acodus* that appears to be close to *A. delicatus* Branson and Mehl suggests that these conodonts are from the same general part of the Ordovician system as the *O. communis–"M." marathonensis* Interval. Although we did not recognize *A. delicatus* at Ibex, it is a dominant component of the faunas of the upper part of the Jefferson City Formation and of much of the West Spring Creek Formation, units that we have concluded are at least in part equivalent to these beds at Ibex.

Jumudontus gananda–Reutterodus andinus *Interval*

A decade ago when the succession of conodonts in the Ordovician of North America was reviewed (Ethington and Clark 1971; Sweet, Ethington, and Barnes 1971), the oldest Middle Ordovician was believed to be characterized by an assemblage of species that appear in the section near the bottom of the Wah Wah Formation and continue upward through the Juab Formation. Following Ross (1964), who concluded that Zone L of Hintze (= uppermost Wah Wah and Juab) is equivalent to the *Orthidiella* Zone (lowest zone in the Whiterock Stage in Nevada), we identified this association as Fauna 1, the oldest of the Middle Ordovician faunas that we recognized. Subsequent collecting has necessitated revision of this interpretation. Some of the species that were considered to be diagnostic of Fauna 1 are now known to be present in the upper part of the Fillmore Formation where they occur as low as the middle of trilobite Zone H in rocks that unquestionably are of Canadian age. The *J. gananda–R. andinus* Interval is interpreted here as beginning with the lowest known occurrence of the latter species, which is 121 m (398 ft) below the top of the Fillmore Formation.

Reutterodus andinus, Protopanderodus asymmetricus, Jumudontus gananda and *Oistodus multicorrugatus* are introduced in the El Paso Group about 60 m (200 ft) below the top. The lowest occurrence of these species is some 91 m (300 ft) above the level at which the *O. communis–"M." marathonensis* group first appears (Repetski 1975, and in press). At a higher level in the El Paso these species are joined by *Protoprioniodus aranda* and *Juanognathus jaanussoni,* so that the order of appearance of these forms is the same in the El Paso Group as in the Ibex Area.

The most widely known of these species is *Jumudontus gananda,* which has been reported from several localities in North America. Unfortunately, most of these reports have recorded isolated specimens, some of which were obtained from samples that are not in measured sequences. Thus, Landing (1976) found a specimen of *J. gananda* in the lower part of the Deep Kill Shale of eastern New York. The same sample produced *Oepikodus evae,* a zonal index for the North Atlantic Province that has not been found in the Ibex Area, but did not include *Reutterodus andinus* or *Protopanderodus asymmetricus.* Fåhraeus and Nowlan (1978) found one specimen of *J. gananda* in Bed 13 of the Cow Head Group of Newfoundland; *O. evae* occurs lower in that section, but neither *Reutterodus andinus* nor *P. asymmetricus* is present. We (1965) found a lone specimen of *J. gananda* near the top of the sequence that we sampled in the Rocky Mountains of Alberta, Canada; associated species in the sample from which we obtained the specimen include *Protoprioniodus aranda* and *"Paltodus" sweeti,* but neither *P. asymmetricus* nor *R. andinus* was found there. In the West Spring Creek Formation in southern Oklahoma *J. gananda* appears for the first time about 151 m (500 ft) above the base of the formation (Richard Felton personal communication 1979), *P. asymmetricus* is introduced somewhat higher in the section, and the two species are associated with *P. aranda* in the highest several hundred feet of the formation (Potter 1975).

J. gananda is associated with *P. aranda* in the upper part of the Eleanor River Formation on Devon Island in Arctic Canada (Nowlan 1976), and Barnes (1974) found the same association in the Ship Point Formation of northern Baffin Island. This species occurs with *Pteracontiodus* in the Ship Point Formation of the Melville Peninsula in the District of Franklin (Barnes 1977). Serpagli (1974) found one specimen of *J. gananda* in a sample from the San Juan Formation in Argentina; it is associated with *R. andinus* and *O. evae.* Serpagli noted that the species occurs in undescribed collections from Sweden that were obtained from the Zone of *Prioniodus elegans* in the North Atlantic Province. Kennedy (1976) found *J. gananda* with *P. aranda* in Lower Ordovician strata at Mount Arrowsmith in New South Wales, Australia, and Cooper (1981) reported the same association in the Horn Valley Siltstone of central Australia.

This scattered evidence indicates that *J. gananda* occurs in at least parts of two of the conodont zones recognized in the North Atlantic Province, those of *P. elegans* and of *O. evae.* Its range at Ibex may correspond to part or all of this interval. Neither of the zonal indices is present in western Utah, so that we cannot evaluate this possibility. The presence of *Microzarkodina flabellum* in the higher part of the range of *J. gananda* argues for equivalence of that part of the Pogonip with at least some part of the *O. evae* Zone. In northern Europe *M. flabellum* occurs in middle Arenigian rocks (highest Latorpian and lowest Volkhovian Stages according to Lindström 1971), whereas *O. evae* is restricted to slightly older rocks (Billingen Substage; see van Wamel 1974, Viira 1974). *Oepikodus evae* is present in the Ninemile Formation in central Nevada (Ethington 1972), but neither *J. gananda* nor *P. asymmetricus* has been found there. Ross (1970, p. 31) has interpreted a collection of trilobites and brachiopods from high in the type section of the Ninemile as indicative of Zone J, which at Ibex includes all but the uppermost Wah Wah. These invertebrates were found much higher in the Ninemile than *O. evae,* however, so they do not offer via correlation a more precise limit for the range of *J. gananda* at Ibex.

Reutterodus andinus is a common component of the conodont fauna of the Black Rock Member of the Smithville Formation in northern Arkansas (collections of RLE), where it is associated with *Juanognathus variabilis, Oepikodus communis, "Scolopodus" emarginatus,* and *Walliserodus* aff. *W. australis. Jumudontus gananda* has not been found there, however. The locality from which these Black Rock conodonts were recovered is the one from which Berry (1970) reported *Didymograptus bifidus.* The occurrence in these beds of *D. bifidus* with late Canadian conodonts further documents the observation of Bergström and Cooper (1973) concerning the range of this graptolite species in North America.

Protoprioniodus aranda–Juanognathus jaanussoni *Interval*

The lowest occurrence of *P. aranda* (= New Genus A of Sweet, Ethington, and Barnes 1971), one of the species designated as diagnostic of Fauna 1, near the middle of the Wah Wah Formation marks the base of this interval. This species continues upward through the lower half of the Juab Formation and is associated throughout its range with *J. jaanussoni* and *"Scolopodus" paracornuformis,* n. sp. The lower part of its range is shared with long-ranging forms that have persisted upward from lower in the section, e.g., *Oepikodus communis, Oistodus bransoni, Walliserodus comptus, Reutterodus andinus, Protopanderodus asymmetricus,* and *Jumudontus gananda.*

Both *J. jaanussoni* and *P. aranda* occur in the top 12 m (40 ft) of the El Paso Group in the Franklin Mountains of west Texas (Repetski 1975, and in press). Correlation of uppermost El Paso with an interval high in the Wah Wah through Juab on this basis is consistent with earlier interpretations of Flower (1965, p. 121). *P. aranda* and *"S." paracornuformis* both occur in the West Spring Creek Formation in southern Oklahoma; the former is not known below 91 m (300 ft) beneath the top of the unit (Potter 1975), whereas the latter has a longer range there (Richard Felton personal communication). As noted above, *P. aranda* is known to occur in the Rocky Mountains of Alberta (Ethington and Clark 1965) and in the Arctic Islands of Canada (Barnes 1974, Nowlan 1976). A related, if not conspecific, form, *P. papiliosus* (van Wamel), occurs with *J. jaanussoni* in Argentina (Serpagli 1974), and the same species is known from southern Sweden (van Wamel 1974), where *P. aranda* probably occurs also (Löfgren 1978). The latter species has been found in Lower Ordovician rocks in New South Wales (Kennedy 1978).

Microzarkodina flabellum-Tripodus laevis *Interval*

This interval is established with the lowest known occurrence of *T. laevis* at 72 m (232 ft) above the base of the Wah Wah; *M. flabellum* is present 3 m (10 ft) higher in the section. Both species have short stratigraphic ranges at Ibex but longer ranges elsewhere.

Tripodus laevis is known elsewhere on the basis of 6 specimens from the Fort Peña Formation of the Marathon region of west Texas (Bradshaw 1969). The published evidence is scanty, but the species appears to range throughout the Fort Peña and to occur there in strata that also yielded species of *Histiodella* and of *Multioistodus* that do not occur beneath the Kanosh Shale in the Ibex Area. The species is present in the lower Antelope Valley Limestone and in the underlying shaly sequence at the Whiterock Canyon Narrows, Monitor Range, central Nevada (collections of RLE). It may be represented also by specimens from low in the Eleanor River Formation in Arctic Canada (Nowlan 1976) that occur there beneath the lowest occurrence of *P. aranda.* On the basis of occurrence in the Fort Peña and the possible occurrence in northern Canada, it seems likely that *T. laevis* occupies only a portion of its potential range at Ibex.

Aff. *Oepikodus? minutus,* a species introduced to the Ibex section in this interval, occurs in a very restricted interval about 34 m (110 ft) below the top of the West Spring Creek Formation in southern Oklahoma (Potter 1975, William Mills personal communication 1979), and the same form is present in the Ninemile Formation in Nevada (collections of RLE). A very similar species is known from the Emanuel Formation of western Australia (McTavish 1973) and in a Lower Ordovician sequence at Mt. Arrowsmith in New South Wales, Australia (Kennedy 1976). The distribution of this species, both geographically and stratigraphically, is too poorly known at present to permit its use for detailed correlations.

Microzarkodina flabellum has not been reported previously from North America; it is, however, a widespread species in northern Europe. Its presence at Ibex constitutes the introduction to the region of a species that is characteristic of the North Atlantic Province in a part of the section where the conodonts over a long stratigraphic interval are dominated by representatives of the Midcontinent Province. According to Lindström (1971) and van Wamel (1974), this species is largely restricted in southern Sweden to the middle Arenigian Volkhovian Stage, whereas Löfgren (1978) reported it to range from this interval through the lower Llanvirnian (Kundan) in north central Sweden. She included in *M. flabellum* specimens like those that Lindström (1971) assigned to *M. parva,* a species that he reported to range through the higher Volkhovian. Should the more restricted definition of *M. flabellum* and thereby more limited range of the species advanced by Lindström be supported, this occurrence in the Juab will provide a valuable link between important reference sections in western North America and northern Europe. Should the more generalized definition and longer range offered by Löfgren be substantiated, the correlation of the two regions via this species will accordingly be more generalized.

Pteracontiodus cryptodens–Histiodella altifrons–Multioistodus auritus *Interval*

Sweet, Ethington, and Barnes (1971) described an association in lower Whiterockian strata of western North America and of southern Oklahoma that includes the lowest common occurrence of the genus *Histiodella* and a variety of chiefly hyaline forms; they designated this assemblage of species Fauna 2. This association is present in the lower part of the Kanosh Shale, where the diagnostic species are introduced in the section beginning with *P. crytodens* at 1.8 m (6 ft) above the base of the formation. The three species listed above, together with the long-ranging *Drepanoistodus angulensis* and *Scandodus sinuosus,* dominate the conodont faunas of the lower Kanosh, which are less diverse but more abundant than those of the underlying formations.

This species association is present also in the Arbuckle Mountains of Oklahoma. There *Pteracontiodus aquilatus* and *Tricladiodus clypeus,* neither of which has been found at Ibex, are present in the highest beds of the West Spring Formation (William Mills personal communication 1979). The *P. cryptodens–H. altifrons–M. auritus* association is introduced there about 9 m (30 ft) above the base of the Joins Formation and is the dominant aspect of the conodont fauna of that unit through the overlying 46 m (150 ft) of strata (McHargue 1975). This assemblage is present also in the lower Antelope Valley Formation in central Nevada (Ethington 1979), and it almost certainly is represented in the Fort Peña Formation of west Texas (Bradshaw 1969), although the known fauna from that unit is sparse and detailed stratigraphic control over its distribution is not available. Correlative beds are present in Arctic Canada. Workum, Bolton, and Barnes (1976) reported *H. altifrons* in association with forms that seem close to *S. sinuosus* and *P. cryptodens* from the subsurface of Akpatok Island in Ungava Bay. However, in the only systemmatically collected surface section from the Arctic region, Nowlan (1976) did not find *H. altifrons* or other species that we recovered from the lower Kanosh. He observed that much of the succession in which these forms might be expected to occur (Eleanor River and Bay Fiord Formations) was deposited in very shallow water. By contrast the diverse and abundant invertebrate fauna of the Kanosh clearly indicates open marine conditions, so that the absence of the species of this interval from Nowlan's collections probably reflects a different environmental regime.

Histiodella sinuosa *Interval*

Fauna 3 of Sweet, Ethington, and Barnes (1971) is characterized by *H. sinuosa* [reported as *H. serrata* in the 1971 paper; see systematics section below for discussion of taxonomy]. The lowest occurrence of *H. sinuosa* at Ibex is at 66 m (217 ft) above the base of the Kanosh Shale, i.e., somewhat above the base of trilobite Zone M. *Multioistodus auritus, Scandodus flexuosus,* and *Drepanoistodus angulensis,* species that are characteristic of the fauna of lowermost Kanosh, are abundant in this interval also; *H. altifrons* does not range far above the lowest occurrence of *H. sinuosa. Multioistodus compressus,* which is present 17.4 m (57 ft) beneath the lowest recovered specimens of *H. sinuosa,* is common throughout the *H. sinuosa* Interval.

A comparable faunal interval can be recognized in the Antelope Valley Formation in central Nevada (Ethington 1979, Harris and others 1979), and it is represented also in the Joins Formation of Oklahoma beginning at 57 m (187 ft) (McHargue 1976) and continuing to the top of the formation. This association cannot be identified within the conodont succession described from Arctic Canada by Nowlan (1976), but, as noted above, its absence may be due to the very shallow water conditions that prevailed during deposition of the possibly correlative strata in that region. Stouge (1977) reported that conodonts of Fauna 3 occur in the lower part of the Table Head Formation of Newfoundland, and Fåhraeus (1970) mentioned the presence of *H. altifrons* near the middle of lower Table Head.

Paraprioniodus costatus–Chosonodina rigbyi–Histiodella holodentata *Interval*

Components of Fauna 4 of Sweet, Ethington, and Barnes (1971) are introduced to the Ibex section in the Lehman Formation (upper half of Zone N of Hintze). *Histiodella sinuosa, Scandodus sinuosus,* and *Drepanoistodus angulensis* continue upward from the underlying strata, and the latter two species represent the most abundant forms in this part of the Pogonip Group. In the section at Crystal Peak, *H. holodentata* is restricted in its distribution to the upper Lehman and basal Watson Ranch Quartzite, whereas the other species occupy the entire interval.

The distribution of these forms in the Antelope Valley Formation in central Nevada argues against recognizing a separate interval based upon the range of *H. holodentata* (Harris and others 1979). In the section at Martin Ridge in the Monitor Range, *H. holodentata* appears at the same level as *P. costatus,* and both are present beneath the lowest occurrence of *C. rigbyi.* In the Steptoe section in the northern Egan Range, about 145 km (90 mi) northwest of the Ibex Area in eastern Nevada, *C. rigbyi* occurs about 30 m (100 ft) lower in the upper Pogonip than *H. holodentata* and *P. costatus.* At Copper Mountain in the Toquima Range (Ike's Canyan Section of authors), *H. holodentata* is introduced at least 183 m (600 ft) below *P. costatus,* and *C. rigbyi* is not known to occur there.

Chosonodina rigbyi and *P. costatus* both occur in the Everton Formation in northern Arkansas (Golden 1969). They are associated there with *H. sinuosa,* but *H. holodentata* has not been found. *Multioistodus* sp. [herein], which is restricted at Ibex to the base of the Lehman and thereby to the upper part of the *H. sinuosa–M. compressus* Interval, ranges throughout the Everton. *Multioistodus subdentatus* is present but not abundant in the Everton; it spans most of the upper Lehman and the basal Watson Ranch Quartzite at Ibex. A species of *Leptochirognathus* is common in the Everton at all the sections that Golden examined. This species has not been found in the upper Pogonip of the Ibex Area, but it occurs in the upper Antelope Valley Formation in central Nevada in strata that contain *H. holodentata* and its associates (Harris and others 1979).

Mound (1965b) found *C. rigbyi* and *P. costatus* to occur near the top of the Joins Formation in southern Oklahoma but did not record the presence there of *H. holodentata.* McHargue (1975), in a more comprehensive study of the conodonts of the Joins, did not find either of these species; his data support equivalence of the Joins to the *P. cryptodens–H. altifrons–M. auritus* and *H. sinuosa–M. compressus* Intervals of the Ibex sections. Conodonts of the *P. costatus–C. rigbyi–H. holodentata* Interval are present in undescribed collections from the Oil Creek Formation which overlies the Joins.

Dischidognathus primus occurs sporadically in the Antelope Valley Limestone of Nevada but has a very limited range in each of the sections where it has been found (Harris and others 1979). In all these occurrences it is wholly within the range of the other species with which it occurs in the Ibex area.

The conodonts of the *P. costatus–C. rigbyi–H. holodentata* Interval are represented in northern Canada in the lower part of the Bay Fiord Formation on Ellesmere Island (Nowlan 1976). *H. holodentata, P. costatus,* and *M. subdentatus* are present there through about 190 m (625 ft) of section; the higher part of the formation is dominated by *? Phragmodus flexuosus* and species of *Erraticodon* and *Panderodus.* The Bay Fioard Formation thereby shows the same general sequence of conodonts that is present in the Lehman through the Crystal Peak Formation of the Ibex Area.

Bergström (1977) reported the presence of *H. holodentata* in the Hølonda Limestone near Trondheim, Norway. It occurs there with *"Cordylodus" horridus,* a species not known from Ibex but which is present with *H. holodentata* in the Antelope Valley Formation of the Toquima Range and Meiklejohn Peak in Nevada (Harris and others 1979). The same faunal association occurs in the Mystic Formation in Quebec (Barnes and Poplawski 1973).

These formations probably represent deposition on outer shelves or slopes in contrast to the inner shelf conditions under which the upper Pogonip of the Ibex Area accumulated. The range of *C. horridus* is not clearly established as yet. It occurs in the Fort Peña Formation of west Texas (Bradshaw 1969) in strata that seem to be older than the Lehman–Watson Ranch interval at Ibex. Nevertheless, the *"C." horridus–H. holodentata* association in the Antelope Valley seems to be a deeper water equivalent of the *P. costatus–C. rigbyi–H. holodentata* fauna.

?Phragmodus flexuosus *Interval*

The *Phragmodus flexuosus* Interval, which corresponds to the Crystal Peak Dolomite, is characterized by an association of conodonts that is almost unique in the Ibex Area. Of the conodonts of the uppermost Pogonip and basal Watson Ranch, only *Belodella robusta* and *Erraticodon* aff. *E. balticus* occur in this interval, and they are very subordinate elements of the fauna. Sweet, Ethington, and Barnes (1971) reported the assemblage of this interval as Fauna 5 and noted that it includes the oldest species of the hyaline conodont genera *Erismodus* and *Chirognathus*. The dominant conodont in the Crystal Peak is the species here described with question as *Phragmodus flexuosus* Moskalenko. The apparatus in the Crystal Peak has an oistodiform instead of a cyrtoniodiform element as has been described for most conodonts from North America identified under that name. The nature of the apparatus of *P. flexuosus* is discussed further in the systematic section that follows. When the 1971 paper was written, this distinction was not appreciated, and both apparatuses were identified as *Phragmodus* sp. A [subsequently named *P. flexuosus* by Moskalenko 1973a], which was treated as an integral component of both Faunas 5 and 6 in the scheme of Sweet, Ethington, and Barnes (1971). The distribution of *P. flexuosus* with cyrtoniodiform elements in the apparatus was discussed for the Middle Ordovician strata of eastern Tennessee by Bergström (1973) and by Bergström and Carnes (1976). Raring (1972) reported this form to be the most abundant conodont in the fauna of the type Chazyan rocks in New York, and Sweet and Bergström (1976) recorded its presence in the Bromide Formation in Oklahoma.

Recent work in Nevada (Harris and others 1979) has shown clearly that two apparatuses have been identified under this name and adds some insight to the stratigraphic relations of the two. The apparatus with the oistodiform element, which is the one that occurs in the Crystal Peak Dolomite, is present in the upper Antelope Valley Limestone in Nevada; in one of its occurrences (Meiklejohn Peak) it is associated in the lower part of its range with *Eoplacognathus suecicus,* a species that is diagnostic of lower Llanvirnian rocks in the North Atlantic Province. In the northern Egan Range of Nevada, the form with cyrtoniodiform elements in its apparatus is present in upper Antelope Valley Limestone; the form with oistodiform elements occurs in lower beds in the same section (Anita Harris personal communication 1979). Elsewhere in Nevada the form with cyrtoniodiform elements occurs near the north end of Martin Ridge in the Monitor Range with conodonts characteristic of the *Eoplacognathus foliaceus* Zone (middle Llanvirnian) of the North Atlantic Province.

Ethington (1979) interpreted the Crystal Peak Dolomite to be of Chazyan age because of the presence of an apparatus he identified with *P. flexuosus,* which Sweet and Bergström (1976) considered characteristic of Chazyan rocks. It is clear however, that the *P. flexuosus* apparatus in the Chazyan strata of eastern United States is the one with the cyrtoniodiform element. The species with this apparatus, according to the evidence from Nevada reviewed above, is younger than the one in the Crystal Peak. Sweet and Bergström (1976) discussed the problems of the relationship of the Whiterock Stage, which is based on sections in Nevada, with the Chazyan Stage, whose type area is in the Lake Champlain region in New York. Harris and others (1976) summarized the problems attendant to establishing a top for the Whiterock Stage among the several sections in central Nevada that play a role in its definition and of the associated difficulties related to correlating the sections in the Great Basin with those in the Appalachian region. Whether the Crystal Peak Dolomite and the *?P. flexuosus* Interval therein are Chazyan or Whiterockian depends upon where and how the boundary ultimately is defined.

The only other recorded occurrence of *?P. flexuosus* with oistodiform elements in its apparatus is in the upper part of the Bay Fiord Formation of Arctic Canada (Nowlan 1976).

CONCLUSIONS

1. Although not intended to serve as such, the "faunas" outlined by Ethington and Clark (1971) and by Sweet, Ethington, and Barnes (1971) have been treated as biostratigraphic zones. Because of the way the faunas were defined and because the ranges of some of the critical species proved to be longer than originally supposed, these faunas have not served satisfactorily as biostratigraphic units. Conodonts from the Ibex sections played a major role in the recognition of Faunas A–E and 1–4 in these reports. We recommend that the intervals defined herein by conodont occurrences in the Ibex area be substituted in future studies for the "Faunas" to which they correspond. These intervals offer the advantage of being collected from and defined by a measured section of strata that has served for three decades as a standard for studies of the Ordovician rocks of the eastern Great Basin in particular and of western North America in general, and a sequence of strata in which the stratigraphic distributions of other fossil groups are known also. The stratigraphic ranges of the conodonts of most of these intervals is not known sufficiently well from other localities in North America to establish them as biostratigraphic zones of widespread utility, but they offer a better "launching pad" for the development of such zones than do the "faunas" of a decade ago.

2. The upper part of the *Cordylodus proavus* Zone, a biostratigraphic unit already well established by previous workers, is present in the lower House Limestone. The conodont fauna in this zone corresponds to Fauna A of Ethington and Clark (1971). This zone is continued upward from the underlying Notch Peak Formation and

includes the basal part of trilobite Zone B in the sense of Hintze (1951, 1973).

3. At many places in North America *Cordylodus intermedius* is introduced in Lower Ordovician rocks at a lower level than is *Loxodus bransoni,* and a similar order of appearance is suggested by known Lower Ordovician faunas of the Siberian Platform and of Queensland. At Ibex, the interval with *C. intermedius* (but lacking *L. bransoni*) corresponds to much of lower and middle trilobite Zone B of Hintze.

4. *Loxodus bransoni* is widespread in the Midcontinent Province, ranging from Pennsylvania to western Utah, and from central Arkansas and southern Oklahoma on the south to the Arctic islands of northern Canada. In all occurrences where it has been reported from a thick section, it occurs between underlying strata characterized by *C. intermedius* and beds with *"Scolopodus" quadraplicatus.* This consistency of occurrence justifies recognition at Ibex of a *Loxodus bransoni* Interval which corresponds to the stratigraphic distribution of Fauna C of Ethington and Clark. Equivalents in Korea and in Australia may be indicated by *Chosonodina herfurthi* which occurs with *Loxodus bransoni* in Oklahoma and in Colorado. *Loxodus* and the associated distacodontid species that occur in this zone are unknown from the North Atlantic Province so that correlation with northern Europe is difficult. The *L. bransoni* Interval may represent part of the *C. angulatus* Zone that has been widely reported from the Baltic region. At Ibex the *L. bransoni* Interval includes the upper part of trilobite Zone B and all of Zone C in the sense of Hintze.

5. The most sweeping change in the conodont succession of the Ibex area is at the top of the *L. bransoni* Interval, above which virtually no conodonts are continued from older strata. The new population that is introduced in the lower Fillmore Formation is dominated by *"Scolopodus" quadraplicatus, "Drepanodus" parallelus,* and aff. *Scolopodus rex,* an association that we identified as Fauna D in 1971. The former two species are restricted to the Midcontinent Province, whereas the latter is typical of the North Atlantic Province. At Ibex the range of these three species includes a lower interval characterized by these long-ranging forms alone and corresponding to trilobite Zone D and most of Zone E of Hintze. In the upper part of trilobite Zone E, in Zone F, and through the middle of Zone G_2 these species are associated with *Acodus deltatus* and *Macerodus dianae.* The latter species either are unknown in most localities where Lower Ordovician conodonts have been studied in the Midcontinent Province, or they have been recorded from discontinuous and/or inadequately studied sections. Until more is known from these areas, establishment of conodont zones for this interval based on the Ibex occurrences is premature. The sequence of conodont occurrences in the El Paso Group of west Texas (Repetski 1975) is consistent with that reported here, however. Direct correlation with northern Europe is not possible owing to almost exclusively different conodont faunas. Probably much of the interval in question at Ibex is the equivalent of lowermost Arenigian strata of Europe, but the Tremandocian-Arenigian boundary level cannot be identified with confidence at Ibex using conodonts because of the provinciality of the respective faunas.

6. Fauna E of Ethington and Clark (1971) and Fauna 1 of Sweet, Ethington, and Barnes (1971) have many species of conodonts in common, so that practice has shown the distinction between the two faunas to be blurred at best. Detailed study of the conodonts of the Ibex region over the past decade has shown that many of the forms formerly considered diagnostic of Middle Ordovician Fauna 1 are present in Canadian rocks in the lower parts of their ranges. In this study we recognize four intervals, each characterized by an assemblage of conodonts, in the strata that provided the basis for Faunas E and 1, respectively. From lowest to highest, these are intervals containing *Oepikodus communis* and *"Microzarkodina" marathonensis* [upper half of the Fillmore Formation; middle of faunal Zone G_2 through the lower one-third of faunal Zone H of Hintze], by *Jumudontus gananda* and *Reutterodus andinus* [highest Fillmore and lower Wah Wah; remainder of faunal Zone H through the lower part of faunal Zone J], by *Protoprioniodus aranda* and *Juanognathus jaanussoni* [middle Wah Wah; middle third of faunal Zone J], and by *Microzarkodina flabellum* and *Tripodus laevis* [upper Wah Wah and Juab; upper third of trilobite Zone J through trilobite Zone L]. The succession of conodonts in the upper El Paso Group of west Texas essentially duplicates that reported here, but many of these forms are not known elsewhere in North America or have not had their ranges recorded from continuous sections. They are offered here as tentative substitutes for Faunas E and 1 as informal subdivisions of the conodont succession of the high Lower Ordovician of the Midcontinent Province. Species from these intervals are known to occur in Argentina, Australia, and northern Europe, so that interprovincial correlation eventually may be possible.

7. Undoubted Middle Ordovician (Whiterockian) conodonts are introduced at Ibex low in the Kanosh [low in faunal zone M] with the appearance of a variety of hyaline forms and of *Histiodella altifrons* [= *H. sinuosa* in Sweet, Ethington, and Barnes 1971]. This association of conodonts [Fauna 2 of Sweet, Ethington, and Barnes] persists through about 46 m (150 ft) of strata in the lower Kanosh and is supplanted near the middle of Hintze's faunal Zone M by a population with *Histiodella sinuosa* [= *H. serrata* in the 1971 paper] and *Multioistodus compressus.* The latter fauna, which is present throughout the upper three-fourths of the Kanosh and the lower one-fourth of the Lehman Formation [upper faunal Zone M through the lower half of faunal Zone N of Hintze] corresponds to Fauna 3 of Sweet, Ethington, and Barnes. The remainder of the Lehman and the lowest Watson Ranch Quartzite [upper half of faunal Zone N] have yielded *Paraprioniodus costatus, Chosonodina rigbyi,* and *Histiodella holodentata,* the species of Fauna 4 of Sweet, Ethington, and Barnes.

The conodonts of these three intervals in the upper Pogonip of the Ibex region are at present known almost exclusively from North America. *Histiodella holodentata* occurs in the Hølonda Limestone of Norway (Bergström 1977), but this occurrence is in strata that may have been deposited on the North American side of Iapetus and later incorporated into Europe. Correlation between the lower Middle Ordovician rocks at Ibex and strata of northern Europe in which the most diagnostic zonal indices are those with platform elements, e.g., *Eoplacognathus,* cannot be accomplished directly. However, some of the species of the European zonation occur in strata in Nevada that can be correlated with these beds in the Ibex area (Harris, Bergström, Ethington, and Ross 1979), so that at least provisional correlations between the conodont succession at Ibex and the Middle Ordovician of northern Europe can be made indirectly.

The hyaline forms, e.g., species of *Multioistodus,* display considerable interspecific variation, and their taxonomy has not been stabilized as yet. Further, the species of *Histiodella* mentioned above overlap in their ranges at Ibex and in Nevada, so that they may offer problems for correlation with more interior sections of the Midcontinent Province.

8. The conodonts of the Crystal Peak Dolomite are dominated by the elements of *?Phragmodus flexuosus,* a species with an oistodiform element in its apparatus instead of the cyrtoniodiform element present in most reported occurrences of that species. In Nevada these two apparatuses have been found in stratigraphic succession with the form with oistodiform elements being slightly older. Because the oistodiform elements have been reported from only one locality outside the Great Basin, this stratigraphic relationship requires additional documentation before it can be accepted as of significant biostratigraphic value.

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SYSTEMATIC PALEONTOLOGY

In the systematic section that follows, conodonts are treated as multielement natural species in those cases where the apparatus has already been defined elsewhere or where we are confident that we can reconstruct it from the evidence at hand. In some cases we have considered as form-species elements that have been reported to be parts of apparatuses elsewhere but whose associates in those apparatuses cannot be identified in our collections. Other elements are treated as form-species because we believe the evidence at hand is insufficient to allow a reliable estimate of which other elements they belong with. Those elements that are treated in the form sense only are identified by the letters s.f. (*sensu formo*) or by enclosing the generic designation in quotation marks. The latter form is used also to identify multielement associations whose generic assignment we believe to be questionable but for which we are reluctant to identify a different genus because of insufficient evidence as to affinity.

Elements within multielement apparatuses are identified in the manner that has been commonly used over the past decade, e.g., oistodiform element, etc. To avoid confusion in comparison of our material with that already described, we have used the elemental designation employed by previous authors. Unfortunately, these terms have been at best descriptive and have not been used consistently by individual authors or by conodont specialists collectively. For this reason these terms are used ambiguously herein among the several species for which they are employed. Several schemes of notation using symbols to identify homologous elements are in use or in preparation, but no standard system has yet been generally accepted. To convert the species reported here to one of these systems, most of which were designed to deal with younger conodonts, would have delayed this manuscript still longer. Accordingly, we opted to retain elemental nomenclature even though it may be obsolete soon after publication.

Specimens are catalogued and deposited in the conodont collections of the University of Missouri—Columbia (UMC).

Genus ACANTHODUS Furnish, 1938
Type species.—Acanthodus uncinatus Furnish, 1938.

Remarks.—Furnish (1938) established this genus in form-taxonomy for simple conodonts that are characterized by serration of the posterior margin of the cusp. Although he stated that these elements are "clearly of a transitional type" between simple and compound forms, he doubted that they gave rise to "more advanced" (i.e., typically multidenticulate) conodonts. Furnish concluded that the serrations do not correspond to the denticles of such elements as the beolodinids which appear in somewhat younger Ordovician strata. Lindström (1964, p. 125) speculated that the serrations served as supports for papillae that branched from a fingerlike, fleshy organ whose axis was the acanthodid element. Symmetry transitions were reported by Lindström (1964, p. 84) to occur in *Acanthodus,* although no specific discussion of them was presented. Sweet and Bergström (1972, p. 32) suggested that *Acanthodus* elements are part of an apparatus that also includes a variety of other morphotypes including scandodiform, acodiform, and oistodiform elements.

Moskalenko (1972, fig. 18) illustrated as *A. lineatus* (Furnish) a specimen from Ordovician deposits along the Lena River in the southeastern part of the Siberian Platform. She (1972) described new species of *Acanthodus* from rocks of Middle and Late Ordovician age along the Stony Tungusky River, also on the Siberian Platform, as well as two new compound conodont form-genera, *Acanthocordylodus* and *Acanthodina,* and form-species that she assigned to *Scandodus* Lindström, all of them characterized by serrate margins of cusps and denticles. Species of *Acanthodus* also are known to occur in the Ninmaroo Formation of Queensland, Australia (Druce and Jones 1971).

ACANTHODUS LINEATUS (Furnish)
Pl. 1, fig. 7

Drepanodus lineatus FURNISH, 1938, p. 328, Pl. 41, figs. 33, 34.
Acanthodus sp. A SANDO, 1958, p. 842, Pl. 2, fig. 20.
Scandodus lineatus (Furnish). LINDSTRÖM, 1964, text-fig. 10C.
Acodus n. sp. ETHINGTON & CLARK, 1965, p. 187, Pl. 2, figs. 3,4.
Distacodus n. sp. ETHINGTON & CLARK, 1965, p. 190, Pl. 2, figs. 1, 2.
? *Drepanodus subarcuatus* Furnish. LOCHMAN, 1966, p. 535, Pl. 65, fig. 18.
Acanthodus lineatus (Furnish). ETHINGTON & CLARK, 1971, p. 72, Pl. 1, fig. 4; ABAIMOVA, 1975, p. 29-30, Pl. 1, figs. 1–5, text-fig. 6 (1, 2); REPETSKI & ETHINGTON, 1977, p. 96, Pl. 1, fig. 7.
Acanthodus costatus Druce & Jones. JONES, 1971, p. 42–43, Pl. 1, figs. 4a, b.
Scandodus ? sp. A JONES, 1971, p. 61, Pl. 1, figs. 2a, b.
Scolopodus quadraplicatus Branson & Mehl. JONES, 1971, p. 65, Pl. 6, figs. 6a–c.

Remarks.—Furnish (1938) based this form-species on specimens that had lost the distal portions of their cusps. The arrangement of the costae on one or both lateral faces and the distally sharp edges of the cusp permit recognition of fragments of which only the smallest portion of the basal region is retained. We (1965) found such broken specimens in a fauna from the area of the Columbia Ice Fields in Alberta, but assigned them to *Acodus* or *Distacodus* depending on the number and disposition of the costae that they carried. Goodwin (1964) found complete specimens showing that *D. lineatus sensu* Furnish (1938) has distal serrations on the cusp. Earlier Sando (1958) had figured a specimen of this type from the Stonehenge Limestone of Pennsylvania as *Acanthodus* sp. A. Both Furnish (1938) and we (1965) failed to recognize this form as an acanthodid because of the fragmentary material we studied. The lateral costae, which are a significant feature of this species, do not continue far above mid-length of the cusp and do not overlap the region of serration on most specimens. Thus broken tips that show acanthodid serrations have been assumed to belong to *A. uncinatus* Furnish.

Only a few relatively complete individuals are present in our collections from the House Limestone. Many more basal portions are present than can be accounted for by the number of acanthodid tips in the residues. This may indicate that the acanthodid margin was not developed on all individuals. Lindström (1964, text-fig. 10C) illustrated a nonserrate specimen from the Oneota Formation as *Scandodus lineatus* (Furnish).

As noted by Furnish, the species is quite variable in the development of the costae. All specimens have at least one lateral costa. The opposite face may be rounded, have a faint ridge, or bear a comparable costa. The basal margin is elliptical; the cavity is a slender cone whose apex is near the anterior margin in the region of greatest curvature. Most specimens are moderately robust and lie in a plane; a few are compressed and somewhat flexed.

Occurrence.—In addition to its first reported occurrence in the Oneota Formation of southern Minnesota (Furnish 1938), this species is also known from the Stonehenge and Rockdale Run Formations of Pennsylvania (Sando 1958), the Grove Creek Formation of Montana (Goodwin 1964), the Columbia Ice Fields Section of Alberta (Ethington and Clark 1965), the Manitou Formation of Colorado (Ethington and Clark 1971), and the Collier Formation of Arkansas (Repetski and Ethington 1977). Repetski (1975, and in press) found it in the El Paso Group of west Texas. Lochman (1966) illustrated a specimen from the Ordovician (Late Tremadocian) in the subsurface of the Williston Basin of Montana that displays a serrate margin and which may belong here. Jones (1971) found two specimens in the Pander Greensand of Northwestern Australia that seem to belong here also. Abaimova (1975) has reported this species from exposures along the Lena River on the Siberian Platform.

Range in the Pogonip.—Our initial sampling of the House Limestone yielded *A. lineatus* in the section between 49 and 91 m (160 and 300 ft) above the base of the formation (H-H-15 through H-H-24A). Larsen found this species in the interval between 62 and 152.6 m (203.5 and 500.5 ft) above the base of the type section of the House. In his collection from Section B of Hintze (1951) it is present in samples collected between 10 m (33 ft) and the top of the section, and in his section in the Willden Hills between 71.6 m (235 ft) and the top of the measured interval.

Number of specimens.—248.

Repository.—Figured hypotype UMC 1086–2; unfigured hypotype UMC 1086–3.

ACANTHODUS UNCINATUS Furnish
Pl. 1, fig. 8

Acanthodus uncinatus FURNISH, 1938, p. 337, Pl. 42, fig. 30, text-fig. 2B; HASS, 1962, p. 45, text-fig. 23(3); LINDSTRÖM, 1964, p. 138, text-figs. 10D, 47f.
?*Acanthodus uncinatus* Furnish. DRUCE & JONES, 1971, p. 55–56, Pl. 6, figs. 9a–12c, text-fig. 19b.

Remarks.—This species differs from the more common and abundant *A. lineatus* (Furnish) in lacking costae. The base is expanded posteriorly but narrow anteriorly. Sharp edges of the cusp continue to the basal margin. Were it not for the acanthodid serrations on the distal margin of the cusp, this would be a typical drepanodiform element. Perhaps this accounts for the few published reports of its occurrence, because basal fragments likely would be considered drepanodiform elements.

Occurrence.—Furnish reported this form from the Oneota Dolomite of southern Minnesota; those specimens from the Ninmaroo Formation of Queensland that Druce and Jones (1971) identified with this species seem to be less bladelike in their cusps than is Furnish's type. Repetski (1975, and in press) found this species to be rare in the lower part of the El Paso Group at its type area in west Texas.

Range in the Pogonip.—Larsen found two specimens in the House Formation in his collections from the Willden Hills at 94 m (308 ft) above base.

Number of specimens.—2.

Repository.—Figured hypotype UMC 1086–4; unfigured hypotype UMC 1086–5.

Genus ACODUS Pander, 1856

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

Remarks.—In volume 1 of the *Catalogue of Conodonts,* Lindström (1973) suggested that the holotype of the type species of *Acodus* might be part of the apparatus of a primitive panderodont conodont whose processes are adenticulate. He suggested further that the type species of *Acontiodus* Pander, *A. latus,* is another element of that apparatus. Subsequently, McTavish (1973), Serpagli (1974), and Kennedy (1978) discussed in depth the elemental composition of the apparatus of *Acodus* based on material from Lower Ordovician rocks of Australia, Argentina, and Missouri, respectively. Tentatively they included a prioniodiform element, a symmetry transition series with three elemental variations, and an oistodiform element in their reconstructions. Lindström (1977) adopted this model in his reconsideration of *Acodus* in volume 3 of the *Catalogue* and provided a list of species identified under this name in traditional form-taxonomy that must be reassigned because they seem not to be parts of prioniodont apparatuses. Lindström inferred that *Acodus* is the progenitor of *Baltoniodus* Lindström and probably also of *Prionodus* Pander. He also suggested relationship to *Oistodus* Pander and to *Pteracontiodus* Harris and Harris, but these genera are characterized by hyaline elements whereas species assigned to *Acodus* display white matter. Dzik (1976) assigned *Acodus* to the Oistodontidae together with *Oistodus* and *Protoprioniodus,* and expressed belief that the hyaline versus albid condition is not significant to the classification of conodonts.

Löfgren (1978) chose to retain *"Acodus" mutatus* (Branson and Mehl) in *Acodus* because she believed that it might be a descendant of the type species, *A. erectus.* As presently understood, *"A." mutatus* has an apparatus with two (or possibly three) elements. The morphology of these elements bears little similarity to any of the five elements of the *Acodus* apparatus. It seems better to follow Cooper (1976) and assign *"A." mutatus* to *Dapsilodus,* a genus whose relationship to other Ordovician conodonts has not been established.

ACODUS DELTATUS Lindström

Pl. 1, figs. 1-6; fig. 4

Acodus deltatus LINDSTRÖM, 1955, p. 544, Pl. 3, fig. 30; ETHINGTON & CLARK, 1965, p. 187, Pl. 1, fig. 3; MOUND, 1968, p. 406, Pl. 1, figs. 1, 2.

Acodus deltatus n. sp. var. *altior* nov. LINDSTRÖM, 1955, p. 544, Pl. 3, figs. 27–29.

Distacodus rhombicus LINDSTRÖM, 1955, p. 556, Pl. 3, figs. 35, 36.

Drepanodus latus LINDSTRÖM, 1955, p. 564, Pl. 3, figs. 22, 23; ETHINGTON, 1972, p. 23, Pl. 1, fig. 10.

Oistodus linguatus LINDSTRÖM, 1955, p. 577–578, Pl. 3, figs. 39, 40 (*non* fig. 41); ETHINGTON & CLARK, 1971, Pl. 2, fig. 20.

Acontiodus n. sp. ETHINGTON & CLARK, 1965, p. 188–189, Pl. 1, fig. 14.

Distacodus stola Lindström. ETHINGTON & CLARK, 1965, p. 189, Pl. 1, figs. 1, 2; ETHINGTON & CLARK, 1971, p. 76, Pl. 2, fig. 16; ETHINGTON, 1972, p. 23, Pl. 1, fig. 13.

Gothodus costulatus Lindström. LINDSTRÖM, 1971, p. 54–55, Pl. 1, figs. 1–3, 5 (*non* fig. 4).

Acodus sp. A. ETHINGTON & CLARK, 1971, p. 76, Pl. 2, fig. 17.

Acontiodus sp. A. ETHINGTON & CLARK, 1971, p. 76, Pl. 2, fig. 19.

Acodus deltatus deltatus Lindström. ETHINGTON, 1972, p. 23, Pl. 1, fig. 11; MCTAVISH, 1973, p. 39–40, Pl. 1, figs. 1–9, 12–14, text-figs. 3p–t, Table 1; LINDSTRÖM, 1977, p. 7–8, Acodus-Plate 2, figs. 8–13.

Acodus deltatus altior Lindström. ETHINGTON, 1972, p. 23, Pl. 1, fig. 12.

Prioniodus deltatus (Lindström). VAN WAMEL, 1974, p. 84–87, Pl. 8, figs. 1, 2, 4, 6–9 (*non* figs. 3, 5).

?*Acodus deltatus* Lindström. VIIRA, 1974, p. 41, Pl. 2, fig. 28, text-fig. 16.

non Acodus deltatus Lindström. ABAIMOVA, 1975, p. 42–43, Pl. 1, figs. 17, 18; COOPER & DRUCE, 1975, p. 569–570, figs. 10–12; LEE, 1975, p. 80, Pl. 1, fig. 2, text-fig. 3b; LEE, 1976, p. 161, Pl. 1, fig. 1, text-fig. 2A.

? *Prioniodus* cf. *P. deltatus* (Lindström). TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 2, figs. 25, 28, ? fig. 30.

Prioniodiform element.—All specimens, which correspond to *Acodus deltatus* s.f. of Lindström (1955), possess a narrow, near median longitudinal costa on one side; it takes the form of a sharp ridge that is most strongly developed basally. It may continue to the distal extremity of the cusp without change, or it may disappear into the bluntly convex lateral face of the cusp. The costate side of the element is strongly expanded in the basal region to produce a basal outline that is very near to that of an equilateral triangle. The proximal and distal portions of the posterior margin meet at an angle of approximately 120°.

Ramiform elements.—At one extremity of the symmetry transition series are elements that correspond to *Drepanodus latus* s.f. of Lindström (1955). They are laterally compressed with slender, slightly recurved cusps.

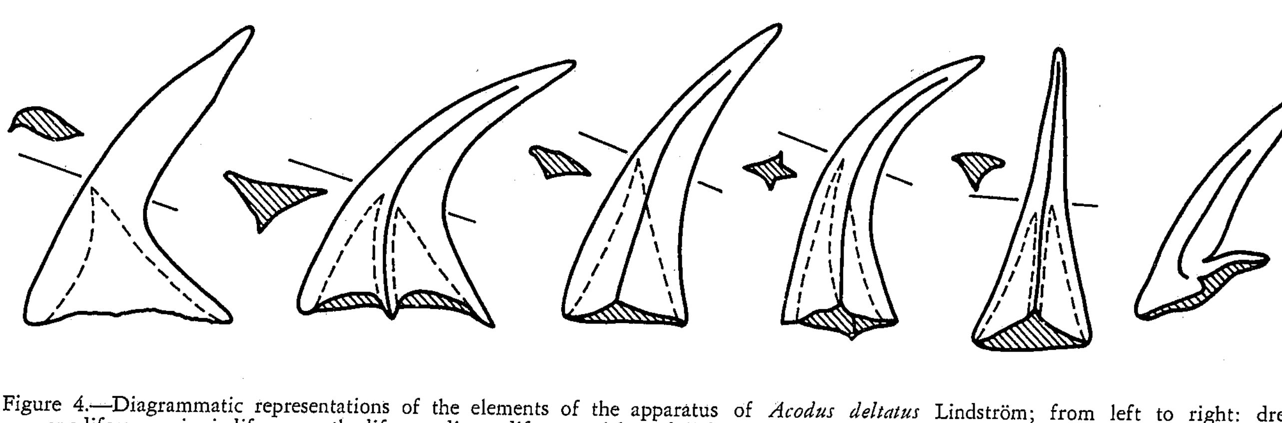

Figure 4.—Diagrammatic representations of the elements of the apparatus of *Acodus deltatus* Lindström; from left to right: drepanodiform, prioniodiform, gothodiform, distacodiform, trichonodelliform, and oistodiform elements.

Edges are blunt, lateral faces gently convex to swollen. Base is not differentiated clearly from cusp and is not expanded laterally. Cavity has thin walls and is deep. Outline of cavity is curved anteriorly and is nearly straight posteriorly, so that its sharp tip is directed anteriorly upward near the leading edge of the element. Cusp may lie in a plane, be somewhat twisted, or be slightly bowed laterally.

Specimens that correspond to *Acodus deltatus* var. *altior* s.f. of Lindström (1955) are slender, gently recurved, and somewhat flexed. A low median costa is present on the longitudinally convex outer surface; the opposite face is gently swollen. The base is not expanded; the basal cavity is deep.

Distacodiform specimens correspond to *Distacodus rhombicus* s.f. of Lindström (1955). They have sharp anterior and posterior edges; their lateral faces both have costae located in near median positions. Base is not expanded, basal cavity is deep.

Trichonodelliform elements have three keeled edges, two directed laterally and the other occupying the posterior midline. Anterior face of the unit is flat or somewhat swollen from side to side except in the basal region where it may be somewhat deflated. Lateral edges become faint or absent above midlength, whereas posterior edge is continuous to the apex of the cusp. Basal outline is triangular, formed by thin sheaths enclosing basal cavity between the edges. Most specimens in our collection are broken distally, but nearly complete individuals indicate that the sharp tip of the basal cavity is near the anterior face at about one-third length above the base.

Oistodiform element.—The oistodiform elements correspond to specimens from Sweden that Lindström (1955) identified as *Oistodus linguatus* s.f. They have a strongly reclined cusp with the proximal portion of the rear margin tangential to the keeled upper surface of the base. Anterobasal corner is drawn out to an anterobasal angle of 30° or less. One side of the cusp is strongly swollen centrally, and the base shows corresponding expansion to this side. Opposite side of cusp and base are regularly convex. Basal cavity is shallow.

Occurrence.—This species is widespread in the Canadian rocks of western North America. We earlier reported several of its elements as form-species in collections from the Columbia Ice Fields Section of Alberta and from the Ninemile Formation of Nevada. Repetski (1975, and in press) found it in the El Paso Group of west Texas; it is present in the Cool Creek and Kindblade Formations of southern Oklahoma (Mound 1968, Brand 1976). It occurs in the Lower Ordovician (Latorp Stage) of southern Sweden (Lindström 1955; van Wamel 1974) and of Estonia (Viira 1974). McTavish (1973) found it in the Emanuel Formation of Western Australia.

Range in the Pogonip.—This species is restricted to the Fillmore Formation. Scattered occurrences of some of the elements were found as low as 56 m (185 ft) above the base of the formation, but the species is not common below about 183 m (600 ft). Most of the elements do not occur higher than about 76 m (250 ft) below the top of the Fillmore, but oistodiform and trichonodelliform elements are moderately common in this upper interval. They are generalized elements that we had difficulty in interpreting throughout the Pogonip succession, so that those from this interval probably represent another species. We cannot determine from our collections where they belong.

Number of specimens.—Prioniodiform element, 281; drepanodiform element, 130; gothodiform element, 80; distacodiform element, 105; trichonodelliform element, 87; oistodiform element, 966.

Repository.—Figured prioniodiform element UMC 1086–6; unfigured prioniodiform elements UMC 1086–7, 8; figured drepanodiform element UMC 1086–9; unfigured drepanodiform element UMC 1086–10; figured distacodiform element UMC 1086–11; unfigured distacodiform element UMC 1086–12; figured gothodiform element UMC 1086–13; unfigured gothodiform element UMC 1086–14; figured trichonodelliform element UMC 1086–15; unfigured trichonodelliform element UMC 1086–16; figured oistodiform element UMC 1086–17; unifgured oistodiform elements UMC 1086–18, 19, 20.

ACODUS? aff. A. EMANUELENSIS McTavish
Pl. 1, figs. 9–13; fig. 5

aff. *Acodus emanuelensis* MCTAVISH, 1973, p. 40–41, Pl. 2, figs. 16-21, text-fig. 3e–i.

Remarks.—Included here are numerous elements that were particularly difficult for us to evaluate. They show almost total intergradation in morphology, so that attempts to group them into morphologic categories have been very frustrating. Five general morphotypes are recognized here, but many specimens are transitional so that perhaps one-half of the specimens that we considered are assigned only tentatively to a particular morphotype. Nevertheless all of them are similar in such features as general size and shape of the basal cavity, and in the development of ridges on the cusp. A common character is the presence

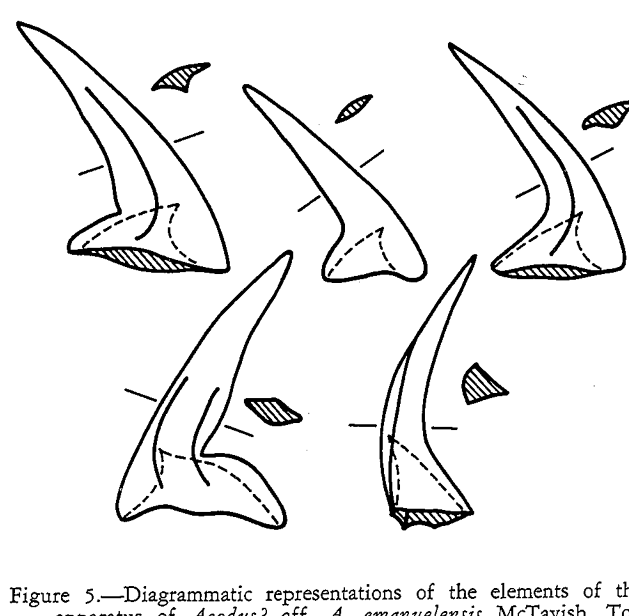

Figure 5.—Diagrammatic representations of the elements of the apparatus of *Acodus?* aff. *A. emanuelensis* McTavish. Top row from left to right: prioniodiform, drepanodiform, gothodiform elements; bottom row: cordylodiform, trichonodelliform elements.

of closely spaced prisms arranged normal to the edge within the posterior keel and the keeled margin of the base. McTavish (1973, p. 40) referred to the latter feature as "rudimentary denticles" on a related species, *Acodus deltatus longibasis,* from Western Australia.

Our morphototypes do not correspond exactly to those which McTavish recognized in *A. emanuelensis.* In particular the base is not produced as far posteriorly as is the case on the figured specimens shown in his report. We did not find elements with quadrilateral symmetry like those he identified as tetraprioniodiform elements, and we did not find the oistodiform elements that he illustrated. Our collections duplicate the cordylodiform elements and prioniodiform elements that McTavish described, and also contain drepanodiform elements which he did not report. Rare elements in our collections that seemingly belong here but which McTavish did not include in his interpretation of *A. emanuelensis* are identified as gothodiform elements.

McTavish's assignment of his reconstructed apparatus to a species of *Acodus* is based on a phylogeny interpreted from samples collected from a section in Western Australia. Although he assigned numerous specimens to the several elements he recognized as comprising the apparatus of *A. emanuelensis,* they came from only two samples from that sequence. The postulated ancestral form, *Acodus deltatus,* is present about 30 m (100 ft) lower in the section, but neither form occurs in the sample taken at about the midpoint between the highest occurrence of the supposed ancestor and the lowest occurrence of the presumed descendant species. The suggested phylogeny has not been duplicated by subsequent work. In our collections from the Pogonip, the range of *A. deltatus* overlaps that of the specimens that we compare with *A. emanuelensis.* Furthermore, the elemental components of the apparatus of *A. deltatus* do not correspond to those that McTavish included in *A. emanuelensis* nor to those that we compare with the latter species. Pending evaluation of the seemingly different elemental compositions of the respective apparatuses, we compare our species to that described by McTavish with which it has affinity. The relationship to species of *Acodus* is tentative, and a new genus may be dictated when further element-by-element comparisons among the apparatuses have been made.

Occurrence.—McTavish's species occurs in the Emanuel Formation in the Canning Basin of Western Australia.

Range in the Pogonip.—We found these forms in the upper half of the Fillmore Formation and in the lower Wah Wah.

Number of Specimens.—Prioniodiform element, 422; drepanodiform element, 134; cordylodiform element, 201; gothodiform element, 102; trichonodelliform element, 101.

Repository.—Figured prioniodiform element UMC 1087–1; figured drepanodiform element UMC 1087–2; unfigured drepanodiform element UMC 1087–3; figured gothodiform element UMC 1087–4; figured cordylodiform element UMC 1087–5; figured trichonodelliform element UMC 1087–6; unfigured ? prioniodiform element UMC 1087–7.

aff. ACODUS GLADIATUS Lindström s.f.
Pl. 1, fig. 14

aff. *Acodus gladiatus* LINDSTRÖM, 1955, p. 544–545, Pl. 3, figs. 10, 11 (*non* fig. 12); LINDSTRÖM, 1973, p. 15, Acodus Pl. 3, figs. 4, 5 (*non* fig. 6).
non aff. *Acodus gladiatus* Lindström. SERPAGLI, 1974, p. 34–35, Pl. 7, figs. 5a–10c, Pl. 20, figs. 1–6, Pl. 30, fig. 6, text-fig. 4.

Remarks.—A few specimens from the House Limestone closely resemble in their outline the illustration that Lindström (1955, Pl. 3, figs. 10, 11) provided for the holotype of *Acodus gladiatus.* Like that form they have a rather deep base with triangular cross section. The lateral costa is located not far behind the anterior margin. One of our specimens has a short ridge located between the anterior margin and the lateral costa, and another has a prominent laterally directed ridge just behind the anterior edge on the otherwise planar side of the element.

We did not find any specimens that correspond to the other form that Lindström (1955, Pl. 3, fig. 12) illustrated in his definition of *A. gladiatus.* His material came from somewhat younger strata than the House Limestone, and the similarity of form between his specimen and our collection may be homeomorphic.

Range in the Pogonip.—The specimens were found by Larsen at 90.5, 111, and 139 m (279, 363, and 457 ft), respectively, in his section in the type area of the House Limestone.

Number of specimens.—3.

Repository.—Figured specimens UMC 1087–8; unfigured specimens UMC 1087–9, 10.

"ACODUS" ONEOTENSIS Furnish
Pl. 1, fig. 16

Acodus oneotensis FURNISH, 1938, p. 325, Pl. 42, figs. 26–29; ETHINGTON & CLARK, 1964, p. 686–687; ETHINGTON & CLARK, 1971, p. 72, Pl. 1, figs. 3, 6, 8; JONES, 1971, p. 44, Pl. 1, figs. 5a–c (*non* Pl. 1, figs. 6a–c, 7a–c, Pl. 8, fig. 1); REPETSKI & ETHINGTON, 1977, Table 1.
non Acodus oneotensis Furnish. MÜLLER, 1964, p. 95–96, Pl. 13, figs. 1a, b, 8; IGO & KOIKE, 1967, p. 13, Pl. 3, figs. 3a, b, text-fig. 4D; MOUND, 1968, p. 406, Pl. 1, fig. 4; DRUCE & JONES, 1971, p. 56–57, Pl. 12, figs. 3a–7c, text-fig. 20; MÜLLER, 1973a, p. 26–27, Pl. 7, figs. 1a–c, 3–5, 6a–c, 7a, b, 8; LEE, 1975, p. 80, 82, Pl. 1, fig. 1, text-fig. 3A.

Remarks.—The specimens from the House Limestone that we identify with *"A." oneotensis* have been compared with Furnish's type specimens to which they seem to compare quite closely. They are more variable in the placement of the lateral costa and the resultant cross section of the cusp than was indicated in Furnish's description. However, they conform so closely to each other in the character of the basal region, the shape of the basal cavity, and in the general rounded to blunt edges that we are confident that all belong together. The same general range of variation is expressed by a more abundant and better-preserved collection from the Manitou Formation of Colorado assembled by one of us (RLE).

Although frequently cited from widely scattered localities, this species has not been identified correctly except from North America and Australia (see Jones 1971). The specimen figured by Mound (1968) does not belong here; it came from the Cool Creek Formation which seems too young for *"A." oneotensis* to be present on the basis of the rest of the conodont fauna from that unit.

Lindström (1977, p. 429–430) and Sweet and Bergström (1972), p. 32, text-fig. 1 L) considered *"A." oneotensis* to be part of an apparatus that they believed to also include *Paltodus bassleri* Furnish, *Paltodus variabilis* Furnish and *Oistodus ? triangularis* Furnish and which they interpreted to represent the apparatus of *Paltodus Pander.* All of these elements are present in the House Limestone, but they do not occur there in great numbers. They are abundant in the Manitou Formation of east central Colorado, however. In collections from that unit (RLE) *"O.?" triangularis* is much more robust than *"A." oneotensis,* and the former shows a symmetry transition not reported by Furnish (1938). We think it unlikely that *"A." oneotensis* elements belong in the same apparatus as *"O." triangularis.* Furthermore, we believe *Paltodus bassleri* (including *P. asymmetricus* s.f.) to be a separate multielement species.

Occurrence.—In addition to its occurrence in the Oneota Formation of southern Minnesota and northeastern Iowa (Furnish 1938), this species is present in the Manitou Formation of Colorado (Ethington and Clark 1971), the El Paso Group of west Texas (Ethington and Clark 1964; Repetski 1975, and in press), and the Collier Formation of Arkansas (Repetski and Ethington 1977). Jones (1971, Pl. 1, figs. 5a–c) illustrated a specimen from the Pander Greensand of Northwestern Australia.

Range in the Pogonip.—*Acodus oneotensis* was not found in the lower part of the House Limestone. In the type area we found it to range from 29 m (95 ft) above the base of our reconnaissance section (H-H-10) through a level 28 m (93 ft) below the top (H-H-21A). Larsen found it between 67 and 149 m (220 and 490 ft) in his collection at the type section of the House, between 67 and 91 m (220 and 297 ft) at Section B of Hintze (1951), and between 52 and 114 m (171 and 374 ft) in the Willden Hills.

Number of specimens.—58.

Repository.—Figured specimen UMC 1087–11; unfigured specimen UMC 1087–12.

ACODUS sp. 1 s.f.
Pl. 1, fig. 17; fig. 6

Remarks.—We include here a collection of drepanodiform elements having a well-defined but narrow lateral costa that begins slightly above the basal margin and continues orally at approximately the midline of the cusp as viewed laterally. Surface anterior to the costa is swollen and terminates anteriorly at a blunt edge that is turned toward the noncostate side. Surface posterior to costa is continuous through a broadly rounded posterior region with the surface of the noncostate side of the element None of the specimens is complete, but the remnants suggest that they were recurved below midlength. Basal cavity is a tapering cone with its apex near the anterior margin; base is not inflated. The most robust specimens show poorly defined linear ridges developed on the noncostate face and posterior to the costa on the opposite side.

The specimens do not correspond to any previously described elements. Because they all are fragmented, we are unwilling to propose a formal name for them. They are reported here under the name *Acodus* in the form sense only; their affinity is uncertain.

Range in the Pogonip.—Fillmore Formation, Section C between 36.6 and 84.7 m (120 and 278 ft).

Number of specimens.—15.

Repository.—Figured specimen UMC 1087–13; unfigured specimen UMC 1087–14.

? ACODUS sp. 2
Pl. 1, figs. 19, 20; fig. 7

Remarks.—Because we found so few of them, we cannot be certain about the systematic assignment of these specimens. A symmetry transition seems to be present among them, but not all of the symmetry variants that commonly occur in species of *Acodus* were found. Particularly we did not find an oistodiform element that is associated with these specimens.

All of the elements are moderately recurved. Acodiform elements have a linear costa located ahead of the middle on one side, and a flat to gently rounded opposite surface. The acodiform elements in our small collection are evenly divided between those with a blunt anterior edge and those with a rounded anterior region. Posterior edges are blunt. Base is not inflated; cavity is subtriangular in lateral outline, with its apex near the anterior margin.

Distacodiform elements resemble the acodiform elements except that both lateral surfaces are costate. One costa is at or slightly posterior to the midline, whereas the other is anteriorly located basally but migrates to a medial position on the distal part of the element. A few faint, short ridges may be present basally just behind the costa that is displaced anteriorly. The basal cavity is similar in outline to that of the acodiform elements but is more slender.

Range in the Pogonip.—Fillmore Formation, Section C (90, 93, 99 m [295, 305, 325 ft]).

Number of specimens.—Acodiform element, 7; distacodiform element, 1.

Repository.—Figured acodiform element UMC 1087–15; unfigured acodiform element UMC 1087–16; figured distacodiform element UMC 1087–17.

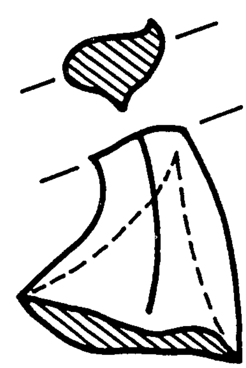

Figure 6.—Diagrammatic representation of a specimen of *Acodus* sp. 1 s.f.

? ACODUS sp. 3
Pl. 1, figs. 22, 23; fig. 8

? *Distacodus rhombicus* Lindström. BARNES & TUKE, 1970, p. 84, Pl. 19, figs. 1, 4, text-fig. 6H.

Remarks.—Included here are two kinds of elements that occur together near the middle of the Fillmore Formation but whose proper systematic position is unclear. They may be unrelated elements, but because of their mutual occurrences we tentatively consider them to be parts of the same apparatus.

The asymmetrical element has four keeled edges ,two in posterior positions separated by a narrow but deep trough, one anterolateral, and one at the front margin. These elements are moderately recurved; their bases are depressed between the four edgs. Basal cavity is spacious and of moderate depth.

Symmetrical elements have a rounded anterior surface, posteriorly facing anterolateral ridges to either side, and a prominent, sharp posterior ridge. Base is not inflated; the cavity is an anteriorly inclined cone with its apex adjacent to the anterior midline.

Elements having the general symmetry of these two types have been included in the reconstructed apparatuses of several Ordovician genera. They are present in species of *Acodus* (see, e.g., McTavish 1973, Serpagli 1974, Lindström 1977), in *Scandodus* (see Lindström 1971, Löfgren 1978), and *Triangulodus* (see van Wamel 1974). Serpagli (1974) reported costate elements suggestive of these forms in Lower Ordovician species he assigned to *Walliserodus.* The interrelationships among these genera are poorly understood, and all of them need extensive systematic investigation. In the absence of complete apparatuses, generic assignment is not possible at this time.

The specimens described and illustrated here occur within the stratigraphic range of *Acodus deltatus* Lindström, but they do not intergrade with the elements of that species that have corresponding symmetry. In particular the keeled edges are more prominently developed, particularly in the basal region, than in *A. deltatus* where the edges are subdued and blunt. In this respect they are suggestive of *Distacodus baikiticus* Moskalenko, which Lindström (1977) has interpreted as part of the apparatus of *A. brevis* Branson & Mehl that corresponds to the elements originally described as *Paltodus distortus* (Bransan and Mehl 1933). Our specimens retain well-defined edges onto the distal reaches of the cusp, whereas those illustrated by Moskalenko and by Branson and Mehl show very subdued edges above their bases. Neither of these forms has been discussed from the perspective of a large population, so that possibly they may include elements like those described above.

Range in the Pogonip.—Fillmore Formation, Section C, 143 through 290 m (470 through 951 ft).

Number of specimens.—Symmetrical element, 14; asymmetrical element, 24.

Repository.—Figured symmetrical element UMC 1087–18; figured asymmetrical element UMC 1087–19.

ACODUS sp. 4
Pl. 1, fig. 25

Distacodontid elements with relatively large basal regions as compared to length and breadth of the cusps. Base has form of equilateral triangle in lateral view; cusp is inclined at 45° to midline of base. Edges are blunt to rounded; anterior edge generally is deflected to one side. Medial region of base and cusp are swollen to side opposite that to which the anterior edge is turned. The swollen region typically bears a narrow ridge in the basal region. Basal cavity is symmetrically developed, subtriangular in outline; its sharp tip is located near the front margin of the cusp.

Remarks.—This form is quite variable in the degree to which the lateral swelling of the base is developed into a costa. Some specimens have the base inflated, others do not. In some cases the leading edge is turned strongly to one side to form a posteriorly directed flange, whereas on other specimens this edge is deflected only slightly. A few specimens have the surface modified by coarse, linear striae.

We are uncertain of the proper affinity of these elements. The limited collection available to us indicates some symmetry variation, but we do not observe distacodiform, trichonodelliform, or oistodiform elements such as are present in *A. deltatus,* for example. Nevertheless, the obviously costate elements in our collection are very similar in general plan to the prioniodiform elements of that species and could be precursors of it as they occur in older strata.

Occurrence.—This form is present in the Manitou Formation of east central Colorado (undescribed collections of RLE).

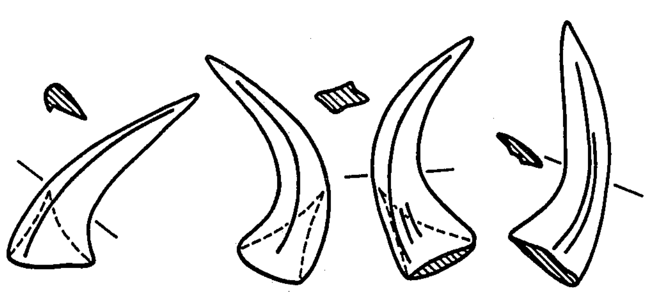

Figure 7.—Diagrammatic representation of elements ? *Acodus* sp. 2; from left to right: acodiform element with rounded anterior margin, opposite sides of distacodiform element, and acodiform element with blunt anterior margin.

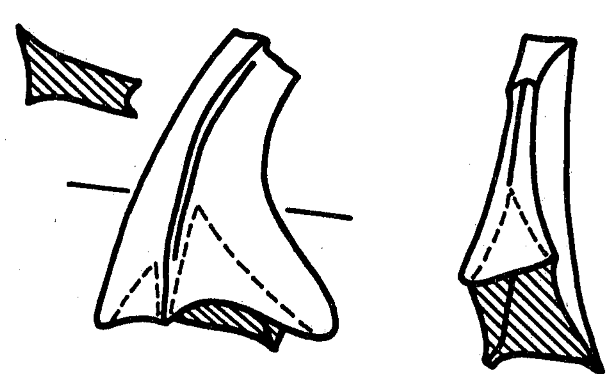

Figure 8.—Lateral and posterior view of asymmetrical element of ? *Acodus* sp. 3.

Range in the Pogonip.—This form occurs in the House Limestone in the interval from 77 through 152.5 m (253 through 500.5 ft) at the type area, from 35 through 97.2 m (126.5 through 319 ft) in the collection from Section B of Hintze (1951), and from 77 through 129 m (253 through 423.5 ft) in the Willden Hills.

Number of specimens.—20.

Repository.—Figured specimen UMC 1087–20; unfigured specimen UMC 1088–1.

Genus ACONTIODUS Pander, 1856
Type species.—Acontiodus latus Pander, 1856.

Remarks.—This genus has been interpreted in different ways by various authors who have treated it as a form taxon. All of the species that have been described under this name are now reassigned to various other form- or multielement genera except the type species, *A. latus.* Although not demonstrated objectively, recent interpretations (Sweet and Bergström 1972, Lindström 1977) have considered *A. latus* probably to be an element of an apparatus that also included the kind of element on which Pander based *Acodus,* of which *Acontiodus* is the junior synonym by the interpretation of the first reviser.

Furnish (1938) described a number of species of *Acontiodus* in the form sense that are characterized by depressed cusps with rounded costae or ridges and grooves. These have been reassigned to *Scolopodus* by recent workers, e.g., Druce and Jones (1971), because they characteristically are hyaline and also, perhaps, because they show general similarity in their rounded contours and inflated bases to *"S." quadraplicatus* Branson & Mehl. Fåhraeus and Nowlan (1978) commented on the troubled state of the genus *Scolopodus* and on the departure of Furnish's species from the elemental composition of the apparatus of *Scolopodus* based on Lindström's interpretation of *Scolopodus rex.* This complex of forms requires thorough study; unfortunately, it is not represented in our collections in sufficient numbers or with adequate preservation to allow us to evaluate the relations among these several forms. They may be components of the apparatus of a single taxon that will require a new name. For this study we report them under the generic name Furnish used in the original discussion.

"ACONTIODUS" IOWENSIS Furnish s.f.
Pl. 1, fig. 15

Acontiodus iowensis FURNISH, 1938, p. 325–326, Pl. 42, figs. 16, 17, text-fig. 1L; ETHINGTON & CLARK, 1964, p. 687, Pl. 113, fig. 3.
Acontiodus staufferi FURNISH, 1938, p. 326, Pl. 42, fig. 12 (*non* fig. 11, = *"A." staufferi*).
non Acontiodus iowensis Furnish. MOUND, 1968, p. 407, Pl. 1, figs. 20–27.
? *Scolopodus iowensis* (Furnish). DRUCE & JONES, 1971, p. 93, Pl. 16, figs. 1a–7e, text-figs. 30d, e; JONES, 1971, p. 64, Pl. 6, figs. 3a–c, 4a–c, Pl. 9, figs. 5a–c; FÅHRAEUS & NOWLAN, 1978, p. 468, Pl. 1, figs. 12, 13.
? *Acontiodus iowensis* Furnish. JAKOVLEV, 1973, p. 209-210, text-fig. 38 (1a, b); LEE, 1975, p. 82–83, Pl. 1, figs. 8, 12, text-fig. 3G.

Remarks.—Furnish (1938) included within *Acontiodus staufferi* s.f. forms in which the posterior carina is either rounded or bears a median longitudinal slit. The former are identical to *"A." iowensis* except for being somewhat more slender and possessing a base which is not "regularly elliptical." Specimens in our collection show considerable variation in these characters, which, therefore, seem not to be of value for differentiating elements. In consesequence, only those forms with a posterior slit are retained in *"A." staufferi,* and all others are treated as *"A." iowensis.*

Occurrence.—The only previously reported occurrences of this species that we accept without reservation are those from the Oneota Formation of the Upper Mississippi Valley (Furnish 1938) and the El Paso Group of west Texas (Ethington and Clark 1964; Repetski 1975, and in press). Elements similar to these have been reported from Australia (Druce and Jones 1971, Jones 1971) and Korea (Lee 1975), and Fåhraeus and Nowlan (1978) illustrated specimens that may belong here from the Cow Head Group of Newfoundland. Mound's material from the Cool Creek Formation of Oklahoma does not represent this element, although it might be expected to occur in the McKenzie Hill and Cool Creek Formations. Brand (1976) identified it from the Kindblade Formation of Oklahoma.

Range in the Pogonip.—This form occurs sporadically in the House Limestone in all of the sections where that unit was studied. It was recovered from all but the lowest part of the formation.

Number of specimens.—61.

Repository.—Figured hypotype UMC 1088–2; unfigured hypotype UMC 1088–3.

"ACONTIODUS" aff. "A." LATUS Pander s.f.
Pl. 1, fig. 18; fig. 9

Broad, compressed, gently recurved elements. Bilaterally symmetrical with acutely triangular outline in anterior and posterior views. Lateral edges sharp, posterior carina high and narrow. Anterior face with low median ridge that is most prominent in region of curvature of cusp and attentuates orally and aborally from there. Posterior surface slopes toward central carina from either lateral margin, so that entire surface forms a broad trough in transverse section. Basal cavity is relatively shallow; basal region not inflated.

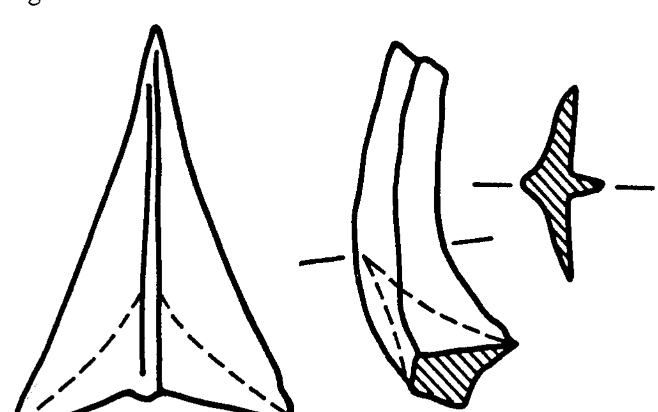

Figure 9.—Anterior and lateral views of *"Acontiodus"* aff. *"A." latus* Pander s. f.

Remarks.—This element occurs in the same part of the lower Fillmore as those forms reported here as *Scandodus* sp. 2 and aff. *Paltodus sexplicatus* (Jones), and these three elements may represent the same species. The material described here is altered thermally but seems to have had considerable albid matter in the cusp. In this respect and in their general shapes and cross sections, specimens of "*A*." aff. *A. latus* are suggestive of "*Acodina*" *euryptera* which Abaimova (1975) described from Lower Ordovician rocks along the middle reaches of the Lena River in central Siberia. Her material seems to have come from slightly older rocks than the lower Fillmore, however, on the basis of the other conodonts that she reported from the rocks that produced "*A*." *euryptera*. She found only six specimens distributed among three samples, so that the range of her species may be even greater than she was able to demonstrate. We found even fewer specimens, so that the range of our element is equally uncertain.

Range in the Pogonip.—Fillmore Formation, between 111 and 143 m (365 and 470 ft) in Section C.

Number of specimens.—4.

Repository.—Figured specimen UMC 1088–4.

"ACONTIODUS" PROPINQUUS Furnish s.f.
Pl. 1, fig. 26

Acontiodus propinquus FURNISH, 1938, p. 326, Pl. 42, figs. 13–15, text-fig. 1M; REPETSKI & ETHINGTON, 1977, p. 95.
? *Acontiodus* cf. *propinquus* Furnish. MÜLLER, 1964, p. 96, Pl. 12, fig. 8.
? *Acontiodus propinquus* Furnish. ABAIMOVA, 1975, p. 49–50, Pl. 2, figs. 6, 7.

Remarks.—The specimens assigned here are rather variable in cross section. Some are rounded across the anterior margin, whereas others taper anteriorly to a blunt edge resulting in wedgelike cross sections. In most cases the posterior face is less deeply dished than in the type specimen. However, the Pogonip forms are sufficiently close to the type collection to consider them to represent the same elements.

Occurrence.—"*Acontiodus*" *propinquus* was discovered in the Oneota Formation of the Upper Mississippi Valley (Furnish 1938), and it has been reported to occur in the Collier Formation of Arkansas (Repetski and Ethington 1977). It is present in undescribed collections (RLE) from the Manitou Formation in east central Colorado and has been recorded from the El Paso Group of west Texas (Repetski 1975, and in press) and from the Kindblade Formation of Oklahoma (Brand 1976). Abaimova (1975) illustrated specimens from the Lower Ordovician of Siberia under this name, but they seem, to judge from her photographs, to have cusps that consist almost entirely of albid matter. Müller (1964) illustrated a specimen from Korea that is grossly similar to "*A*." *propinquus*.

Range in the Pogonip.—Scattered occurrence were found in the House Limestone at all of the four collection sites.

Number of specimens.—35.

Repository.—Figured hypotype UMC 1088–5; unfigured hypotype UMC 1088–6.

"ACONTIODUS" STAUFFERI Furnish s.f.
Pl. 1, fig. 24

Acontiodus staufferi FURNISH, 1938, p. 326, Pl. 42, fig. 11, text-fig. 1K (*non* Pl. 42, fig. 2, = "*A*." *iowensis* Furnish); BARNES & TUKE, 1970, p. 84, Pl. 19, figs. 2, 3; ABAIMOVA, 1975, p. 52–52, Pl. 2, figs. 8, 9, text-fig. 6 (14, 17).
non Acontiodus staufferi Furnish. ETHINGTON & CLARK, 1964, p. 687, Pl. 113, figs. 4, 9 (Scolopodiform C herein); MOUND, 1965b, p. 12–13, Pl. 1, fig. 22; MOUND, 1968, p. 408, Pl. 1, figs. 36–49.
non Scolopodus staufferi (Furnish). JONES, 1971, p. 67–68, Pl. 6, figs. 7a–c.

Remarks.—As noted above under the discussion of "*Acontiodus*" *iowensis* Furnish, the original description of "*A*." *staufferi* included two types of elements, one with a posterior carina bearing a longitudinal slit and the other with a simple, unmodified carina. The latter seem to us to be indistinguishable from typical specimens of "*A*." *iowensis* elements, and only the grooved forms are retained in this form-species.

The specimens from the Joins Formation of Oklahoma which Mound (1965b) identified with this form are wholly hyaline, their cusps are deeply dished posteriorly, and their lateral edges are more prominently keeled than in the forms considered here.

Occurrence.—These elements occur in the Shakopee Formation in southwestern Wisconsin (Furnish 1938) and in the El Paso Formation of west Texas (Repetski 1975, and in press). Brand (1976) found them in the Kindblade Formation in southern Oklahoma, and Barnes and Tuke (1970) reported them from the St. George Formation of Newfoundland. Abaimova (1975) figured specimens that seem to belong here from Lower Ordovician rocks along the middle reaches of the Lena River on the Siberian Platform.

Range in the Pogonip.—Relatively rare in the House Formation at all collecting localities.

Number of specimens.—65.

Repository.—Figured hypotype UMC 1088–7; unfigured hypotype UMC 1088–8.

"ACONTIODUS" sp. s.f.
Pl. 1, fig. 21

Element has blunt anterior edge that dies out basally, sharp lateral edges, and a blunt median posterior costa. Cross section of cusp is rhombic with longest diagonal oriented in lateral direction; cross section of base is triangular with posterior costa at apex and front face of base forming opposite leg of triangle. Elements are rather strongly curved in the lower reaches and straight distally. The deep basal cavity penetrates to the level of greatest curvature.

Remarks.—One specimen shows a satellite costa located on one flank of the main posterior costa between the bend of the cusp and the basal margin. Another departs from the general bilateral symmetry that characterizes these forms by being slightly twisted basally.

In general form these elements are suggestive of the trichonodelliform elements that we include in *Acodus deltatus* and *Tripodus laevis*. They occur well above the ranges of those species in western Utah, however. Probably they are homologous to those elements in an apparatus whose other members cannot be determined from our collections. We report them under the name *Acontiodus* s.f., rather than assign them to either of the above two genera in order to avoid forcing an interpretation of them.

Range in the Pogonip.—These specimens were found in a limited interval in the Kanosh (I-K-9A through I-K-13B); one specimen from the Crystal Peak Dolomite seems to belong here also.

Number of specimens.—18.

Repository.—Figured specimen UMC 1088–9.

Genus BELODELLA Ethington, 1959

Type species.—*Belodus devonicus* Stauffer, 1940.

Remarks.—The type species of *Belodella* was reported for the first time as a form-taxon (Stauffer 1940) from a clay deposit that lies above the Middle Devonian Cedar Valley Limestone near Austin, Minnesota. It is clear from Stauffer's discussion (p. 417) that he considered these elements, which he identified with *Belodus* Pander, to be of Ordovician age and to be reworked into the Devonian clays. He reported two form-species of which one, *B. devonicus,* is lenticular in section whereas the other, *B. triangularis,* has three keeled edges. Ethington (1959) transferred both of them to a new genus, *Belodella,* and noted that these elements are morphologically quite distinct from any Ordovician conodonts known at that time. He concluded that Stauffer's species are indigenous to the Devonian rocks from which they were recovered. Species of *Belodella* have been recognized in the Upper Silurian and Devonian rocks of Europe and Australia as well as of North America (see e.g., Druce 1975, for summary).

Cooper (1974, 1976) interpreted the apparatus of *Belodella* to consist of elements of two types. One of these has two sharp edges, of which one is denticulate, and gently swollen lateral surfaces. Commonly these elements, which conform to the general morphology of *Belodus devonicus* Stauffer s.f., are twisted at some position along their length. The other kind of element in the apparatus has three keeled edges, one of which is denticulate, and triangular cross section; it corresponds to *Belodus triangularis* Stauffer s.f. in its overall shape. According to Cooper's interpretation a complete apparatus of the type species of *Belodella* is represented in Stauffer's collection. One of us (RLE) has a collection from the Tor Limestone (Toquima Range, central Nevada) in which elements of *Belodella* occur in great numbers and to the exclusion of other conodonts. Cooper's model fits those conodonts very well; no other kind of element is present in these samples providing overwhelming support for Cooper's interpretation.

Serpagli (1967) described and illustrated specimens from Upper Ordovician (Ashgillian) rocks of the Carnic Alps that he identified with *B. devonica* and with another species previously known only from Devonian rocks, *B. erecta* (Rhodes & Dineley). Subsequently representatives of *Belodella* have been reported by many authors from Middle Ordovician rocks of North America (see, e.g., Fåhraeus 1970, Bergström 1973, Bergström and Carnes 1976), although no discussion of the apparatus of those species was provided. Recently Löfgren (1978) concluded (following an earlier interpretation of Carnes 1975) that the apparatus of these Ordovician species includes three kinds of denticulate elements which she termed biconvex, plano-convex, and triangular, respectively, on the basis of their cross sections. These morphologies have homologues among the biconvex and triangular elements of Cooper's model. Löfgren also assigned an oistodiform element to the apparatus of Ordovician species of *Belodella,* including those of Serpagli. This model is consistent with our material from the Crystal Peak Dolomite, and we accept it here. However, it poses a question as to the relationship of the Upper Silurian–Devonian species to those from the Ordovician. No oistodiform elements have been reported in association with any of the younger occurrences of *Belodella,* and no obvious elements are present that could be interpreted as homologous to oistodiform elements. As yet the belodellids of the Ordovician have not been studied systematically except for Löfgren's recent effort, and those of the Upper Silurian and Devonian have received little more attention. The genus has not been identified from Lower and Middle Silurian rocks. The significance of this hiatus in the range of belodellid conodonts will be uncertain until more comprehensive studies have been made on both the older and the younger group.

Schwab (1969) and Dzik (1976) have interpreted *Belodella* as a genus that is closely related to *Panderodus* Ethington. The latter author's conclusion was influenced by a species, *B. serrata,* that he recovered from a drift boulder. His illustration suggests that it is a panderodont with its posterior edge subdivided into a series of stubby denticles. Such forms appear occasionally among Ordovician and Silurian populations of *Panderodus.* They do not resemble any of the species of *Belodella,* and close affinity between these two genera is not likely on morphologic grounds alone.

BELODELLA ROBUSTA n. sp.

Pl. 2, figs. 1–4

aff. *Oepikodus copenhagenensis* ETHINGTON & SCHUMACHER, 1969, p. 465, Pl. 68, figs. 5, 9, text-fig. 4L.
aff. *Oepikodus* aff. *O. copenhagenensis* ETHINGTON & SCHUMACHER, 1969, p. 465–466, Pl. 68, fig. 14, text-fig. 41.
aff. *Oistodus nevadensis* ETHINGTON & SCHUMACHER, 1969, p. 467–468, Pl. 68, figs 1–4, text-fig. 5C.
Paltodus? sp. ETHINGTON & SCHUMACHER, 1969, p. 468, Pl. 69, fig. 13; REPETSKI & ETHINGTON, 1977, Table 2.
Roundya sp. B ETHINGTON & SCHUMACHER, 1969, p. 475–476, Pl. 67, fig. 24.
? *Tokognathus* sp. NIEPER, 1969, Pl. O VII, fig. 11.
? *Belodella erecta* (Rhodes & Dineley). BARNES & POPLAWSKI, 1973, p. 769, Pl. 4, figs. 19, 20; LEE, 1975, p. 130, Pl. 2, figs. 8, 9; BARNES, 1977, p. 101, Pl. 2, fig. 7.
? *Belodella* n. sp. BARNES & POPLAWSKI, 1973, p. 769–770, Pl. 4, figs. 9, 10; ? figs. 5, 18.
? "*Belodella*" sp. A SERPAGLI, 1974, p. 38–39, Pl. 8, figs. 7a, b, Pl. 20, fig. 10.
? "*Belodella*" sp. B SERPAGLI, 1974, p. 39, Pl. 7, figs. 1a–c, Pl. 20, fig. 11.
? *Belodella* n. sp. s.f. BARNES, 1974, p. 230, Pl. 1, fig. 11; BARNES, 1977, p. 101, Pl. 2, figs. 5, 6.
"*Belodella*" sp. REPETSKI & ETHINGTON, 1977, Table 2.
"*Oepikodus*" *copenhagenensis* Ethington & Schumacher. REPETSKI & ETHINGTON, 1977, Table 2.
"*O.*" aff. "*O.*" *copenhagenensis* Ethington & Schumacher. REPETSKI & ETHINGTON, 1977, Table 2.

Oistodus nevadensis Ethington & Schumacher. REPETSKI & ETHINGTON, 1977, Table 2.

? *Belodella* sp. A. FÅHRAEUS, 1970, text-fig. 3,(O); FÅHRAEUS & NOWLAN, 1978, p. 461, Pl. 3, fig. 21; BERGSTRÖM, 1979, p. 306, figs. 4L, M.

The triangular elements have three bluntly keeled edges, two anterolateral in position on the cusp and one posterior, that are produced as basal processes interconnected by thin sheaths enclosing a spacious basal cavity. Cross section of the cusp is triangular; anterior face is somewhat swollen whereas the two posterolateral faces are slightly depressed, particularly basally where the edges become increasingly prominent. On some specimens the cusp is only slightly recurved and maintains a proclined position, whereas on others the cusp is strongly recurved in its lower part and erect distally. Most of these specimens in our collection are bilaterally symmetrical with the anterolateral keels continuing downward and posteriorly as undenticulate processes whose edges are turned laterally proximal to the base but become increasingly aborally directed distally. The region between the aboral processes is deeply infolded. A few of the specimens are asymmetrical with one of the anterolateral edges of the cusp becoming a lateral process; such elements appear twisted when compared with the more numerous symmetrical forms. The rear edge of the cusp is produced as a denticulate process. Denticles are of uneven size, have sharp points, and are fused nearly to their apices. Basal cavity is an elongate, prostrate cone which opens posteriorly and whose sharp tip penetrates to the base of the cusp.

"Plano-convex" elements have convex lateral faces and sharp edges, one of which is set with stubby denticles of varying sizes, fused throughout most their length and oriented almost normal to the margin of the element. Cusp is slender, oriented at almost a right angle to the denticulate edge, and flexed to one side. That surface toward which the cusp is turned is more strongly swollen than the opposite side, and the undenticulate edge commonly is turned toward that side. The basal cavity is a prostrate cone, somewhat curved along its length so that the tip is aborally directed and situated adjacent to the nondenticulate edge.

Biconvex elements are sickle-shaped, with rhomboid cross sections. Posterior margin is sharp; anterior margin is marked by a blunt keel that is turned slightly to one side on the basal third of the element. Lateral surfaces are dominated by longitudinal ridges, the ridge to one side at or slightly ahead of the midline whereas the opposite ridge is located about halfway between the midline and the anterior margin. Ridges decline distally and are poorly differentiated near the tip of the element. Basal cavity is triangular as seen in lateral view; its posterior outline is nearly straight, rising at an angle to basal margin of 45–60° at the posterolateral corner. The tip of the cavity is located near the front of the blade. Anterior outline of the cavity drops in a straight line or a slight curve from the point of deepest penetration to the anterobasal corner. Region of the blade above the basal cavity is albid matter which is interrupted by prisms of clear material oriented normal to the posterior margin and suggesting incipient denticles. No surface expression of the latter phenomenon was observed on any of the specimens.

Oistodiform elements have slender, reclined cusps that are slightly twisted along their entire length. Cusp is at least as long as the anterior-posterior dimension of the base. Concave side of flexed cusp has strong median swollen region flanked by narrow marginal shoulders; opposite face is uniformly convex from edge to edge. Base is nearly symmetrical with posterior region having arcuate upper surface that mimics the anterobasal part of the element. Base is swollen to one side as a continuation of the swollen median part of the cusp to that side. Basal cavity is shallow, its tip turned over in the anterior direction beneath the cusp.

Remarks.—We have used the elemental designations of Löfgren (1978) to allow comparison of homologous elements in this species with those of other species of Ordovician belodellids.

The triangular elements have denticles that vary somewhat in size. They are coarser than the corresponding elements of *B. nevadensis;* those of *B. jemtlandica* seem to be of uniform size. Further these denticles are normal to the denticulate edge in *B. robusta,* whereas they are inclined anteriorly in *B. nevadensis* and *B. jemtlandica. "Belodella"* sp. A of Serpagli (1974) and *Belodella* sp. A of Fåhraeus (1970) are very close in morphology to these elements. *Belodella* n. sp. of Barnes (1974, 1977) has erect denticles, but they seem to be more nearly uniform in size than is the case with our material. Denticles of *Belodella erecta* (Rhodes & Dineley) *sensu* Barnes & Poplawski (1973) are inclined anteriorly, and are of nearly uniform size. *Roundya* sp. B of Ethington and Schumacher (1969) is a fragment of the element described above.

The plano-convex elements likewise have nearly erect denticles and in this respect differ from the corresponding elements of *B. jemtlandica* and of *B. nevadensis,* in which the denticles are inclined anteriorly. Further, the plano-convex elements of *B. robusta* seem to be more strongly flexed than those of the latter species. *"Belodella"* sp. B of Serpagli (1974) is very similar to the plano-convex element of *B. robusta.*

Biconvex forms differ from *Belodella* n. sp. of Barnes and Poplawski (1973) and from the biconvex elements of *B. jemtlandica* in having pronounced lateral costae on their surfaces. In this respect they resemble the biconvex elements of *B. nevadensis* (= *Oepikodus copenhagenensis* of Ethington and Schumacher 1969), but the latter have the posterior margin broken by well-developed denticles. The species that Serpagli (1967) identified with *B. erecta* (Rhodes & Dineley) seems not to have had this kind of element, unless some of the specimens he treated under the form-genera *Distomodus* or *Drepanodus* are of this type, or, as Löfgren suggested, it had a denticulate biconvex element.

The oistodiform elements of *B. robusta* are very similar in general outline to those of *B. jemtlandica, B. nevadensis,* and the species illustrated by Serpagli (1967). The basal region is not as deep as in the case of the first and last species, and the posterior part of the base is shorter and less inflated than in *B. nevadensis.*

Derivation of name.—Robusta, in recognition of the stout nature of the elements and the heavy denticles.

Occurrence.—This species is represented by a few elements in the fauna of the Copenhagen Formation of central Nevada (Ethington and Schumacher 1969) but is much less common there than *Belodella nevadensis.* The belodellids of the San Juan Limestone of Argentina (Serpagli 1974) are not well known, but they seem to be very similar to *B. robusta;* they occur in rocks that are well below the documented range of the latter species. Closely related if not conspecific forms are known from the Ship Point Formation of the Canadian Arctic (Barnes 1974, 1977) from the Tablehead Formation and Cow Head Group of Newfoundland (Fåhraeus 1970, Fåhraeus and Nowlan 1978), from the Mystic Conglomerate of Quebec (Barnes and Poplawski 1973), and from the Hølonda Limestone in Norway (Bergström 1979). The species is present in the Womble Shale of Arkansas (Repetski and Ethington 1977).

Range in the Crystal Peak.—Present in all but upper 6.1 m (20 ft) of the Crystal Peak Dolomite at the type section; also found at 44.2 and 47.2 m (145 and 155 ft) in the Lehman Formation at Crystal Peak.

Number of specimens.—Triangular element, 47; planoconvex element, 12; biconvex element, 35; oistodiform element, 49.

Repository.—Figured holotype, triangulariform element UMC 1088–10; unfigured paratype, triangulariform element UMC 1088–11; figured paratype, plano-convex element UMC 1088–12; figured paratype, biconvex element UMC 1088–13; figured paratype, oistodiform element UMC 1088–14.

Genus BELODINA Ethington, 1959
Type species.—*Belodus compressus* Branson & Mehl, 1933.

? aff. BELODINA sp.
Pl. 2, fig. 5

Remarks.—A single specimen from near the middle of the Crystal Peak Dolomite has the general configuration of a species of *Belodina* Ethington. A major denticle, curved throughout its length, has three inclined denticles rising along its concave margin. The basal region is somewhat inflated with greatest swelling posterior to the midline. A "heel" is developed along the posterior edge between the basal margin and the position of emergence of the first auxiliary denticle. The major denticle is swollen medially on each side resulting in lenticular section. Basal cavity is a simple compressed cone whose apex is near the convex margin of the major denticle about opposite the lower part of the first auxiliary denticle.

This specimen differs in important respects from typical elements of *Belodina* and does not belong with that form genus. It does not possess on the major denticle a longitudinal slit that terminates in a notch in the basal margin. The surface of the element is very smooth, even at high (ca. 200X) magnification. Belodinids characteristically show fine striae on the surface; these striations are visible at magnifications of the order of 50X. The base of typical belodinids is commonly swollen ahead of the midline but is compressed posteriorly in the region of the "heel." In contrast, the present specimen shows a strongly flared base.

At this time, the affinity of this distinctive specimen is not known.

Range in the Pogonip.—Sample 4 in the Crystal Peak Dolomite (12.5 m [41 ft] below the top of the formation) at the type locality.

Number of specimens.—1.

Repository.—Figured specimen UMC 1088–15.

Genus BRYANTODINA Stauffer, 1935
Type species.—*Bryantodina typicalis* Stauffer, 1935.

? BRYANTODINA sp.
Pl. 2, fig. 6

Remarks.—Fragmented bladelike specimens from near the bottom of the Crystal Peak Dolomite resemble the elements for which Stauffer (1935) established *Bryantodina* in form-taxonomy. All of the specimens are portions of blades that are characterized in their central reaches by slender, nearly erect, closely crowded to fused denticles. The basal outline of these blades seems to have been nearly straight, at least medially. A linear aboral trough flares markedly near the middle of each specimen. The distal extremities of the blades are not represented on any of the limited number of specimens available to us.

Webers (1966) concluded that *Bryantodina typicalis* s.f. was part of an apparatus that included several other kinds of "blades and bars" among the forms that Stauffer (1935) described from the Glenwood Formation of Minnesota. Sweet and Bergström (1972, p. 40) accepted this interpretation with some reservation. No apparent homologues of the other elements of the *Bryantodina* apparatus as interpreted by Webers are present among our collection from the Crystal Peak. This may be the result of the modest numbers in which the species is represented. Alternatively, the elements reported here may be bladelike elements from the apparatus of the species of *Plectodina* reported below. The apparently straight aboral margin argues against that interpretation, however.

Range in the Crystal Peak.—These elements were recovered from the two lowest samples at the type section.

Number of specimens.—13.

Repository.—Figures specimen UMC 1088–16.

Genus CHIROGNATHUS Branson & Mehl, 1933
Type species.—*C. duodactyla* Branson & Mehl, 1933.

CHIROGNATHUS
Pl. 2, fig. 7

Poorly preserved specimens, most of them from the Crystal Peak Dolomite, are included here. They have slender, generally widely spaced denticles surmounting an arched or straight basal region. A distinct basal cavity is not developed; instead the lower surface commonly shows a broad scarlike area. The specimens are too poorly preserved to permit identification with an extant species of *Chirognathus.* They were compared with topotypes of the Harding Sandstone species described by Branson and Mehl (1933) and may indeed be fragments of some of the same forms.

Occurrence.—Lindström (1964, p. 41) and Bergström (1964, p. 42, text-gi. 21D) have reported chirognathids in Llandeilian strata of Great Britain and northern Europe. In North America this genus is known from the Harding Formation of Colorado and from the Glenwood beds of the Upper Mississippi Valley. Amsden and Miller (1942) found *Chirognathus* in the Bighorn Mountains of Wyoming in strata which Sweet (1955) correlated with the Harding Formation. A specimen from the Dutchtown of southeastern Missouri which Branson (1944, Pl. 9, fig. 1) figured as *Chirognathus* properly belongs in *Leptochirognathus* Branson & Mehl. Carlson (1960) reported the presence of chirognathids in the Winnipeg Formation in the subsurface of North Dakota, an occurrence subsequently confirmed by Oberg (1966). *Chirognathus neossa* Cooper, reported from Lower Mississippian strata in Oklahoma, is based on a fragment which may be from a species of *Lonchodina;* whatever its origin, it clearly is not a chirognathid. The youngest strata from which a valid chirognathid has been reported are in the upper part of the Plattin ("Decorah") in northeastern Missouri (Branson and Mehl, 1933, p. 103). However, the specimens are dark, unlike typical conodonts from this part of the Ordovician of Missouri. Unless further chirognathid elements are recovered from the "Decorah" in Missouri, this occurrence is of questionable stratigraphic value. We suspect that the specimens were reworked from older strata.

Range in the Crystal Peak.—Representatives of *Chirognathus* are scattered through the Crystal Peak Dolomite; they were present in half of the samples collected in that unit but not abundant in any of them.

Number of specimens.—16.

Repository.—Figured specimen and unfigured specimens UMC 1088–20; unfigured specimens UMC 1089–1.

Genus CHOSONODINA Müller, 1964

Type species.—Chosonodina herfurthi Müller, 1964.

Remarks.—Although known previously from only three species, each recovered from only a few localities on three continents, *Chosonodina* has tempted several authors to speculate about its phylogenetic position relative to other conodonts in Cambrian and Lower Ordovician rocks. Thus Müller (1964, p. 99) concluded at the time that he defined the genus that *Chosonodina* evolved from *Westergaardodina* Müller through the insertion of additional denticles between the lateral limbs of the latter. This interpretation may have been influenced by Müller's conclusion that the basal cavity in the type species, *C. herfurthi,* is subdivided into two regions, each toward an extremity of the strongly arcuate lower margin, a condition suggestive of the paired lateral cavities of some species of *Westergaardodina. Chosonodina herfurthi,* found in Australia by Druce and Jones (1971) and in southern Oklahoma by Mound (1968), is present in the Manitou Formation of Colorado (collections of RLE), and in all of these occurrences the basal cavity extends the entire length of the aboral surface. It is deepest toward the extremities and quite shallow in the median region. Müller's type specimens either are unusual representatives of the species, or they are somewhat worn so that the basal cavity has been obscured medially.

In their report on conodonts from the West Spring Creek Formation of southern Oklahoma, Harris and Harris (1965, p. 44–45) considered *Chosonodina lunata* Harris & Harris to be a descendant of a species of *Coleodus* Branson and Mehl. The known stratigraphic occurrences of these forms do not support this conclusion. *Coleodus* occurs in the Dutchtown and Joachim Formations of Missouri and in the Harding Formation in Colorado, stratigraphic units that are younger than the West Spring Creek. Furthermore, *Coleodus* is a typical hyaline conodont, whereas *Chosonodina* clearly is not. Harris and Harris indirectly implied that *Chirognathus* Branson and Mehl and *Leptochirognathus* descended from *Chosonodina.* The former genera are characterized by hyaline species, however, although one of the specimens on which Branson and Mehl (1943, pl. 64, fig. 35) based *Leptochirognathus extensa* may be a fragment of a form close to *C. lunata* and *C. rigbyi,* n. sp. The other two syntypes of *L. extensa* are not related to *Chosonodina,* however.

Druce and Jones (1971, p. 35, text-fig. 15) postulated that *Chosonodina* evolved from a W-shaped species of *Westergaardodina,* e.g., *W. amplicava* Müller, during Tremadocian time. They speculated further that *Loxodus* and *Coleodus* also may be part of this lineage. *Loxodus* is present in the same part of the section as *C. herfurthi* in the McKenzie Hill Formation (Mound 1968) and in the Manitou Formation, so that a phylogenetic relationship between the two is not supported. As stated previously, *Coleodus* and *Chosonodina* seem unrelated on structural grounds. Dzik (1976, text-fig. 1) supported *W. amplicava* as the progenitor of *Chosonodina* and concluded that *Chirognathus* evolved from the latter in early Middle Ordovician time.

Considering the minimal data accumulated so far on the geographic and stratigraphic development of species of *Chosonodina,* inferences as to the relations between that genus and other Cambro-Ordovician conodonts are inherently speculative.

CHOSONODINA HERFURTHI Müller
Pl. 2, fig. 12

Chosonodina herfurthi MÜLLER, 1964, p. 99, Pl. 13, figs. 3a–c; MOUND, 1968, p. 408–409, Pl. 2, figs. 1–3; DRUCE & JONES, 1971, p. 59, Pl. 4, figs. 1a–6c, 9a, b, text-fig. 21b, c; ETHINGTON & CLARK, 1971, p. 72, Pl. 1, fig. 10; COOPER & DRUCE, 1975, p. 570, 572, text-fig. 13; REPETSKI & ETHINGTON, 1977, p. 96, Pl. 1, fig. 4.

? *Chosonodina herfurthi* Müller. JONES, 1971, p. 44–45, Pl. 8, figs. 2a–c.

Remarks.—A well-preserved specimen was found in the House Limestone by Larsen, who regrettably did not record from which section or at what horizon he obtained it. Despite this unfortunate lack of essential stratigraphic information, we report it here to document the occurrence of this species in western Utah. On the basis of other occurrences in North America, we believe it probably came from the upper part of the House. The specimen has four denticles between the two extremities of the base; one of the denticles is represented only by a basal stub. The basal cavity is deep and open toward the extremities but is reduced to a mere slit in the median region. The specimen is relatively thin and small as compared to those we have seen from the Manitou Formation of Colorado. Perhaps it represents a juvenile, and a more advanced growth stage would show a clearly defined, although shallow, segment of the basal cavity near the center of the base.

Occurrence.—*Chosonodina herfurthi* occurs in Lower Ordovician rocks of Korea (Müller 1964), in the upper part of the McKenzie Hill Formation of southern Oklahoma (Mound 1968), in the Manitou Formation of Colorado (Ethington and Clark 1971), in the Collier Formation of Arkansas (Repetski and Ethington 1977), in the Ninmaroo Formation of Queensland (Druce and Jones 1971), and in the Ordovician of New Zealand (Cooper and Druce 1975).

Range in the Pogonip.—House Limestone, section and horizon unknown.

Number of specimens.—1.

Repository.—Figured specimen UMC 1089–2.

CHOSONODINA RIGBYI n. sp.
Pl. 2, figs. 8, 11

Coleodus cf. *C. simplex* Branson & Mehl. MOUND 1965b, p. 13, Pl. 1, fig. 14.
Chosonodina ? sp. A SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 41; HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, fig. 8.
? *Chosonodina* ? sp. A Sweet, Ethington & Barnes. BARNES, 1974, p. 230, Pl. 1, fig. 15.

Thin, flexed blade with denticles arranged in palmate manner, erect centrally and becoming increasingly inclined at either end of element. Distal denticles subparallel to aboral margin. Denticles fused almost to apices; fusion nearly complete on convex side of blade where interdenticle troughs are found only in upper half of blade. Fusion much less advanced on concave side where each denticle has a strongly convex transverse section and is separated from its neighbors by prominent grooves. Central denticles longest; length decreases toward either end of blade. Reduction in length of denticles is accompanied by increased inclination toward the extremities, resulting in moderately arcuate oral outline. Denticles are bent above their bases so that element is concavo-convex in the oral-aboral direction as well as from end to end. Basal part of blade is heavy, deepest in center and decreasing in depth to either side. Aboral margin is somewhat convex to nearly straight. Underside of unit is excavated from end to end by trough with thin walls. Width of trough is rather uniform along entire length, although some specimens show minor widening toward the center of the element. Convex face of blade is recessed basally so that wall of cavity is set inward beneath a longitudinal shoulder. No comparable feature is seen on the opposite side. Most, but not all, specimens have a minor swelling on the shoulder and basal wall beneath the largest denticle.

Remarks.—The holotype of *Chosonodina lunata* Harris and Harris was compared directly with the conodonts from the Lehman Formation which we describe here as *C. rigbyi.* General morphology of the two is quite similar, and both clearly are related to *C. herfurthi;* the reservation of Harris and Harris as to the generic identity of their species is unfounded since the type species clearly does not have a subdivided basal cavity as Müller (1964) believed. The illustration (Harris and Harris 1965, Pl. 1, fig. 1b) of the concave ("posterior") surface of *C. lunata* does not depict clearly the strong bowing of the blade in that species, although this character was reported in the description. Specimens of *C. rigbyi* are much less strongly bent than is the holotype of the Oklahoma form; indeed some specimens are almost planar. The faces of the denticles are covered to above midheight by a surficial deposit on the concave side of *C. lunata,* whereas they are fused but do not lose their identity in *C. rigbyi.* The Oklahoma material is from the West Spring Creek Limestone and occurs in the lower part of the range of an abundant hyaline fauna that continues upward into the Joins Formation. The upper Joins has produced a form that Mound (1965b) identified as *Coleodus simplex* but which clearly belongs in *C. rigbyi.*

Mound recognized the similarity between the specimens that he placed in *Coleodus* and *Chosonodina lunata* and suggested that that species might better be assigned to *Coleodus* also. The type collection of *Coleodus simplex,* the type species, is from the Harding Sandstone of Colorado and consists of fragments. Nevertheless, this broken material is sufficient to demonstrate that it is not closely related to either *C. rigbyi* or to *C. lunata.* The denticles are almost wholly fused in *Coleodus,* so that they are expressed only as a serrate oral edge with shallow interdenticular troughs on the lateral faces. Denticles are inclined slightly from the erect position, and all of them are parallel in contrast to the fanlike arrangement in both *C. lunata* and *C. rigbyi.* In addition, *Coleodus,* as presently understood, does not include bowed or flexed units; instead this genus characteristically has hyaline, bladelike elements with a straight longitudinal axis.

Derivation of name.—Rigbyi in honor of Dr. J. Keith Rigby of Brigham Young University whose many suggestions have been invaluable in this investigation.

Occurrence.—*Chosonodina rigbyi* occurs in the upper part of the Joins Formation in Oklahoma (Mound 1965b) and is present in the Everton Formation of northern Arkansas (Golden 1969). It also occurs in the Antelope Valley Formation in Nevada (Harris and others 1979).

Range in the Pogonip.—These elements have their lowest occurrence somewhat below the middle of the Lehman Formation at Crystal Peak (CP–6–6) and range through the higher parts of the formation. A few specimens were found in carbonate beds low in the Watson Ranch Quartzite (CP–WR–C, B).

Number of specimens.—57.

Repository.—Figured holotype UMC 1089–3; figured paratype UMC 1089–4.

Genus CLAVOHAMULUS Furnish, 1938
Type species.—*C. densus* Furnish, 1938

Clavohamulus was reported by Furnish (1938, p. 326–327) from the Oneota Dolomite of the Upper Mississippi Valley. Although he did not recognize a basal cavity from his material, Furnish considered this form to be a conodont perhaps in part owing to its association with unquestionable simple cone elements. Ellison (1946, p. 94, 108) accepted *Clavohamulus* as a valid conodont genus whose occurrence, based on its presence in the Oneota, was stated to be restricted to rocks of Beekmantown age. Hass (1962, p. 65) listed this genus with others that he did not believe to be conodonts, although he did not state the basis for this conclusion. Because Hass's "utilitarian classification" of conodonts stressed the development of the basal cavity, he may have rejected *Clavohamulus* because of Furnish's indication that no basal cavity is present.

Furnish, in his generic diagnosis, considered the bulbous portion of the element to be homologous to the inflated basal reaches of many simple cones. A shallow pit which he recognized on his specimens was interpreted as anteriorly located and not as a basal cavity. Restudy of the type collection as well as of the few specimens we found in the House Limestone indicates that the pit which Furnish mentioned in the description of *C. densus* should be considered a true basal excavation. As a result of this interpretation, the orientation of *Clavohamulus* has been revised to conform to the arbitrary nomenclature that generally has been applied to conodont elements (Miller 1969). The pit (anterior according to Furnish) is located aborally. The bulbous portion (basal of Furnish) is anterior and is oriented vertically. The cusp is directed posteriorly and orally from its origin near the center of the bulb.

Lindström (1964, p. 35, 143) considered the bulb to be homologous to the platform of younger forms such as polygnathiform elements, and he concluded that *Clavohamulus* thus is the oldest platform conodont. In an appendix to his book about conodonts, Lindström (1964, p. 186) speculated about possible affinity between *Clavohamulus* and *Platyvillosus* Clark, Sincavage and Stone. Because the latter genus is known only from Triassic strata and the former apparently is restricted to rocks of Late Cambrian and Early Ordovician age, no direct connection between the two is apparent.

Recent work by Miller (1969) indicated that *C. densus* descended from noncuspate forms early in Tremadocian time. The new species reported below shows that the genus persisted into at least middle Canadian time. Lindström (1964, p. 176) cited unpublished information that representatives of this genus have been found in Upper Devonian rocks. However, Chauff and Price (1980) described a new genus of conodonts, *Mitrellataxis*, based on these specimens. They compared the elements of the new genus with known species of *Clavohamulus* and concluded that little morphologic similarity exists between them. We concur with their opinion that the two genera are not related.

CLAVOHAMULUS DENSUS Furnish
Pl. 2, fig. 21

Clavoramulus densus FURNISH, 1938, p. 327, Pl. 42, figs. 18–21, text-fig. 1D; LINDSTRÖM, 1964, p. 143, text-fig. 49; ETHINGTON & CLARK, 1971, p. 72, Pl. 1, fig. 13.

Remarks.—Only a few specimens were recovered from the House Limestone. They depart from Furnish's illustrations and discussion of the type material in several respects. The cusp is slender and small in comparison to the bulb. The latter is not flexed as shown by Furnish (Pl. 42, figs. 20, 21), and a linear series of pits such as was reported along the upper margin of the type is not present. Furnish's interpretation of this species was based almost wholly on a single large specimen, and it is probable that the differences mentioned here are the result of different stages in ontogeny. The range in variation of this species is not clearly defined as yet, primarily because of its relative scarcity in all of its known occurrences.

Occurrence.—This species is present in the Manitou Formation in the Colorado Springs, Colorado, region (undescribed collections of RLE). Furnish (1938) found it in the Oneota Dolomite of northeastern Iowa and southeastern Minnesota; it also occurs in the El Paso Group in Texas (Repetski 1975).

Range in the Pogonip.—The species was recovered only from the House Limestone. Although its occurrence seems to be restricted to the highest part of that formation, we recovered too few specimens to establish reliable limits for its stratigraphic distribution. Two specimens were found in the type section of the House Formation, both from the same sample (H-H-19). Two more were found by Larsen at Section B of Hintze (1951), one 92 m (302 ft) above the base of the section and the other at 104 m (341 ft).

Number of specimens.—4.

Repository.—Figured hypotype UMC 1089–5; unfigured hypotype UMC 1089–6.

CLAVOHAMULUS ELONGATUS Miller, 1969
Pl. 2, fig. 23

Clavohamulus elongatus MILLER, 1969, p. 422, Pl. 64, figs. 13–18.

Remarks.—We found only a few specimens that conform in general to the description and illustrations of this species as given by Miller. Only one has a clearly defined cusp. Miller (1969) concluded that *C. elongatus* is transitional with *C. densus;* however the latter species generally has a bulb that is flattened in the anterior-posterior direction and expanded laterally. In contrast, *C. elongatus* has a bulb whose long dimension is in the anterior-posterior direction and rarely displays a cusp. In a later consideration of the genus *Clavohamulus*, Miller and Kurtz (1975) concluded that *C. densus* descended from *C. hintzei.*

Occurrence.—Miller's collection came from the Notch Peak Limestone in which it is restricted to the top 30.5 m (100 ft) or less in four sections in the House Range of western Utah. The specimens reported here extend its range into the lower part of the Pogonip of the same area.

Range in the Pogonip.—Larsen found a few specimens in the uppermost Notch Peak Formation and in the basal sample that he collected from the House Limestone in his measured section at the type area of the latter unit. He found an additional few specimens in the interval 11.7–13.4 m (38.5–44.0 ft) in the House Limestone in his section in the Willden Hills.

Number of specimens.—16.

Repository.—Figured hypotype UMC 1089–7; unfigured hypotype UMC 1089–8.

CLAVOHAMULUS PRIMITUS Miller, 1969
Pl. 2, fig. 20

Clavohamulus primitus Miller, 1969, p. 423, Pl. 64, figs. 7–12.

Remarks.—These specimens, which came from a single sample, are simple elements having subcircular outline when viewed from above and appear as low mounds in lateral view. Surface is rather rough and seems to be ornamented by low nodes at about the resolution limit of the optical microscope. The aboral surface is flat to concave with concentric bands or ridges. This generalized plan conforms to the description of *C. primitus* provided by Miller (1969). Miller postulated that this species might represent a transition between *Clavohamulus bulbousus* (Miller), which he believed to be its direct ancestor, and more typical species of *Clavohamulus.*

Occurrence.—Miller found the species in the upper member of the Notch Peak Formation in the House Range of western Utah.

Range in the Pogonip.—Larsen recovered this species from the lowest sample in his measured section of the type House Limestone.

Number of specimens.—4.

Repository.—Figured hypotype UMC 1089–9.

CLAVOHAMULUS n. sp.
Pl. 2, fig. 22

Bulbous region divided into two lobes by an approximately medial constriction that extends from the aboral margin up the anterior face and across the top of the element. Constriction is deepest and broadest near center of anterior face and becomes progressively less prominent orally and aborally from that position. It disappears near the distal end of the cusp. Both lobes of the bulb are strongly swollen. Cusp is stout, somewhat twisted to one side. The cusp arises from a recess in the posterior face of the bulb and is fused along its posterior side to the overhanging surface of the bulb. The recess is deep and has greater lateral dimension than height, extending almost completely across the bulb. Aboral surface shows a broad, gently convex attachment surface with a poorly defined subcentral pit from which an equally ill-defined linear depression leads to the position of the intersection of the basal margin and the constriction of the anterior face. Faint ridges, concentric around the pit, occupy the whole aboral surface. Upper portion of bulb is ornamented by a pattern of delicate ridges suggestive of the arrangement of ridges in a human fingerprint. Lower reaches of the bulb bear nodes of a size near the limits of resolution of the optical microscope; they seem to be randomly arranged.

Remarks.—The morphology of this distinctive form clearly identifies it as a new species of *Clavohamulus,* but, because we have only one well preserved specimen, we are not proposing a name for it. It differs drastically from any of the other known species in having the bulb bisected by a constriction. The basal surface is very similar to that of *C. primitus* Miller, but the latter lacks a trough leading from the pit to the basal margin. Miller (1969, p. 422) amended the generic definition to include nodes on all but the basal surface of the bulb. The ridges reported here are a departure from that definition; they have not been reported to occur on any of the other species.

Our specimens come from near the middle of the Fillmore Formation, which is approximately 305 m (1000 fe) stratigraphically higher than the highest occurrence of *C. densus* in the House Limestone. The two species are quite distinct morphologically, and direct descent of the new species from *C. densus* seems unlikely.

Range in the Pogonip.—Fillmore Formation, samples at 173.7 and 179.8 m (570 and 590 ft) in the Mesa Section.

Number of specimens.—2.

Repository.—Figured specimen UMC 1089–10; unfigured specimen UMC 1089–11.

Genus CORDYLODUS Pander, 1856
Type species.—Cordylodus angulatus Pander, 1856.

Remarks.—Bergström and Sweet (1966, p. 323) concluded that the apparatus of the type species of *Cordylodus* includes two kinds of elements, those that Pander (1856) described as *C. angulatus* and as *C. rotundatus,* respectively,, and they selected the latter name as the one to be used for the apparatus. In so doing they suppressed the name that traditionally has been considered to be that of the type species.

The type material came from Lower Ordovician strata of the eastern Baltic region; its elements have slender, discrete, peglike denticles following a relatively prominent cusp. Other elements from younger Ordovician strata have been assigned or reassigned to *Cordylodus* on the basis of having a cusp and a denticulate posterior process but no lateral or anterior processes. During the past decade most of these forms have been interpreted as components of apparatuses identified under other generic names and have been removed from *Cordylodus.*

Cordylodus horridus Barnes and Poplawski occurs in Middle Ordovician (Whiterockian) strata in North America and is present in Ordovician exposures on the west side of the Urals (see *Cordylodus uralicus* Nassedkina, 1975). It has a deep, sinuous posterior process with poorly differentiated denticles that are quite widely spaced. Thus far only one element has been reported. This species seemingly does not display a *Cordylodus* apparatus; a new generic name is needed for this form. Recently Dzik (1976, p. 424) reassigned another Middle Ordovician species, *Cordylodus spinatus* Hadding, to a new monotypic genus that he named *Spinodus.*

As now interpreted, *Cordylodus* is restricted to highest Cambrian and Lower Ordovician (Tremadocian) strata in which it is a prominent component of the conodont faunas in many parts of the world including North America, northern Europe, southern Asia, and Australia.

? CORDYLODUS CASEYI Druce & Jones s.f.
Pl. 2, fig. 25

Cordylodus angulatus Pander. ETHINGTON & CLARK, 1971, p. 68, Pl. 1, fig. 15 (*non* figs. 16, 20); REPETSKI & ETHINGTON, 1977, p. 95, Pl. 1, fig. 3.

? *Cordylodus caseyi* DRUCE & JONES, 1971, p. 67–68, Pl. 2, figs. 9a–12c, text-figs. 23d, e; JONES, 1971, p. 46, Pl. 2, figs. 2a–3c.

? *Cordylodus lenzi* MÜLLER, 1973a, p. 31, Pl. 10, figs. 5–9, text-figs. 2F, 5a, b.

Remarks.—Although not mentioned in either of the respective descriptions, both *C. caseyi* Druce & Jones and *C. lenzi* Müller have markedly flexed posterior processes as shown by the photographs of the types. The specimens at hand show not only flexure of the process but also arching with the denticles irregularly inclined, some leaning toward the outside (convex side) of the element, others toward the opposite side, and some occupying the same plane as the cusp.

These specimens and those reported below as *Cordylodus* sp. A s.f. share the lower part of the stratigraphic range in the Ibex area of *Cordylodus intermedius* Furnish. and we earlier (1971) had interpreted all of these elements as comprising parts of the apparatus of *Cordylodus angulatus* Pander. However, *Cordylodus intermedius* seems to be morphologically distinct from *C. angulatus,* and no specimens like those we compare with *C. caseyi* were reported by Furnish from the Oneota Dolomite from which he obtained the types of that species. At this time the affinities of these flexed cordylodids is uncertain.

Occurrence.—Flexed cordylodiform elements are known to occur in the Ninmaroo Formation of Australia (Druce and Jones 1971), in the Shirgesht Formation of Iran (Müller 1973a), and in the Collier Formation of Oklahoma (Repetski and Ethington 1977).

Range in the Pogonip.—These elements are common but not abundant in all but the lower House Limestone at the type section, at Hintze's (1951) Section B, and in the Willden Hills.

Number of specimens.—97.

Repository.—Figured specimen UMC 1089–12; unfigured specimen UMC 1089–13.

CORDYLODUS INTERMEDIUS Furnish
Pl. 2, figs. 16, 17

Cordylodus intermedius FURNISH, 1938, p. 338, Pl. 42, fig. 31; DRUCE & JONES, 1971, p. 68, Pl. 3, figs. 1a–3b, text-fig. 23f, g; MÜLLER, 1973a, p. 30, Pl. 10, figs. 1a, b, 2, 3, text-figs. 2C, 4a, b.
Cordylodus subangulatus FURNISH, 1938, p. 338, Pl. 42, fig. 32.
Cordylodus angulatus Pander. LINDSTRÖM, 1955, p. 551–552, Pl. 5, fig. 9, text-fig. 3E (*non* text-fig. 3G); ETHINGTON & CLARK, 1965, p. 189, Pl. 1, fig. 7; ETHINGTON & CLARK, 1971, p. 68–69, Pl. 1, fig. 20 (? figs. 15, 16).
? *Cordylodus rotundatus* Pander. MOUND, 1968, p. 409, Pl 2, figs. 4, 5.
? *Cordylodus intermedius* Furnish. JONES, 1971, p. 46–47, Pl. 2, figs. 2a–3c.
? *Cordylodus angulatus* Pander. BARNES, 1974, p. 226, Pl. 1, fig. 3.
Cordylodus cf. *intermedius* Furnish. ABAIMOVA, 1975, Pl. 10, fig. 10.
Cordylodus angulatus Pander. VAN WAMEL, 1974, p. 58–59, Pl. 1, figs. 5–7.

Remarks.—Furnish (1938, p. 338) considered *Cordylodus intermedius,* which he found in the "Blue Earth" beds of southern Minnesota, to be very similar to but "somewhat more primitive" than *Cordylodus angulatus* Pander. In the same way he interpreted *Cordylodus subangulatus,* which he described from the same collection as *C. intermedius,* to resemble *Cordylodus rotundatus* Pander, although he believed the latter form-species to be "a somewhat more advanced type." Lindström (1955, p. 552) concluded that Furnish had interpreted *C. angulatus* too narrowly and reported that *C. intermedius* fell within the range of variation displayed by the specimens from southern Sweden that he identified under the latter name. Van Wamel (1974) accepted this interpretation. All references to *Cordylodus subangulatus* since 1938 have treated it as a junior synonym of *C. rotundatus.*

Druce and Jones (1971) observed that two kinds of elements had been included within *C. angulatus* by Lindström (1955, text-figs. 3E, G) in his reinterpretation of Pander's species. One of these morphotypes is like the holotype of *C. intermedius* in having a basal cavity that displays a simple, acutely triangular outline when viewed from the side; the tip of the basal cavity in these forms is directed anteriorly upward in the lower part of the cusp. The other morphototype has a basal cavity that displays a "phrygian cap" outline with the tip of the cavity directed anteriorly and with the anterior outline of the cavity strongly sinuous. They restricted *C. angulatus* to the latter forms, and recognized the former as *C. intermedius.* None of the species of *Cordylodus* that they recognized in their report was represented by many specimens, and their ranges did not coincide. Druce and Jones interpreted *C. intermedius* as a lineal descendant of *C. proavus* Müller, and believed that it gave rise in turn to *C. angulatus.* Müller (1973a) recognized both *C. intermedius* and *C. angulatus* in the sense of Druce and Jones in his paper on conodonts from northern Iran but recorded both species as occurring in the same samples.

Both of the morphotypes considered above are present in the House Limestone. Unfortunately, the conodonts of the House commonly are altered thermally so that the outlines of their basal cavities cannot be discerned clearly. The simple outline that Druce and Jones considered to be diagnostic of *C. intermedius* appears to be much more frequent than that of *C. angulatus* s.f. and to be distributed through a much greater stratigraphic range, although the forms co-occur near the top of the formation. We found no indication of a spectrum of variants such as was suggested by Lindström, and therefore we follow Druce and Jones and Müller in recognizing these morphotypes as separate species. Nevertheless, we believe this whole problem requires careful evaluation of better-preserved material than we have, involving more specimens than were available either to Druce and Jones or to Müller before the relationships between these possibly distinct morphotypes can be resolved with confidence.

We are unable to separate *Cordylodus subangulatus* and *Cordylodus rotundatus* s.f. and therefore have included all of those forms found with *Cordylodus intermedius* s.f. under that name. Assuming that the distinction between *C. intermedius* and *C. angulatus* proves to be valid, the apparatus of each species includes at least two elements, one of which has the distinctive rotundatiform anterior aboral outline. We are uncertain about the affinity of *C. intermedius* to the other cordylodiform elements that co-occur with it and that we identify here as ?*Cordylodus caseyi* Druce and Jones and *Cordylodus* sp. A s.f. Such elements have not been noted in any of the reported occurrences of *C. angulatus* s.f. (Lindström 1955, van Wamel 1974), and Furnish did not indicate their presence in the Prairie du Chien occurrence of *C. intermedius.* At least one of them (*C. caseyi*) occurs with *C. intermedius* and *C. angulatus* in Iran and in Australia, although the collections of Müller (1973a) and of Druce and Jones (1971) include too few cordylodid elements to permit evalauation of their occurrences.

Occurrence.—*Cordylodus intermedius* occurs in the Oneota Formation (Blue Earth Beds) of southern Minnesota (Furnish 1938), in the El Paso Group of Texas (Repetski 1975), and in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965). One of us (RLE) has found it in the Manitou Formation of central Colorado, and it may be represented by specimens from the McKenzie Hill Formation of southern Oklahoma that Mound (1968) identified as *Cordylodus rotundatus.* Barnes (1974) figured a specimen from the Copes Bay Formation of Devon Island, arctic Canada, that may belong here also. The species is present in the Lower Ordovician of northern Europe, but its range there is not clearly defined because it has been treated as a variant of *Cordylodus angulatus* s.f. (see above). Abaimova (1975) illustrated a specimen that probably belongs here from Lower Ordovician strata along the Lena River on the Siberian Platform. Druce and Jones (1971) reported its occurrence in the Ninmaroo Formation of Queensland, and Müller (1973a) found it in the Shirgesht Formation of the Darenjal Mountains in northern Iran.

Range in the Pogonip.—This species is common throughout almost the entire House Limestone in the type area, at Section B of Hintze (1951), and in the Willden Hills.

Number of specimens.—Intermedius element, 487; subangulatus element, 56.

Repository.—Figured intermedius element UMC 1089–14; unfigured intermedius element UMC 1089–15; figured subangulatus element UMC 1089–16; unfigured subangulatus element UMC 1089–17.

CORDYLODUS PRION Lindström s.f.
Pl. 2, figs. 13, 14

Cordylodus prion LINDSTRÖM, 1955, p. 552–553, Pl. 5, figs. 14–16; DRUCE & JONES, 1971, p. 70, Pl. 2, figs. 1a–7b, text-figs. 23i, k-o; MÜLLER, 1973a, p. 33, Pl. 10, figs. 4a, b, text-figs. 2E, 8; VIIRA, 1974, p. 63, Pl. 1, figs. 6, 7; VAN WAMEL, 1974, p. 59–60, Pl. 1, figs. 8, 9.
non Crytoniodus [*sic*] *prion* (Lindström). MILLER & MELBY, 1971, p. 79, Pl. 1, figs. 14–16, 17 (= *oklahomensis* element of *C. proavus*).

Cusp large, sharp-edged, laterally compressed, erect or somewhat proclined. Anterior margin distally straight and becoming curved near base. Anterior process low, with sharp oral edge carrying basally crowded or partially fused denticlues. Cross sections of denticles are lenticular; they become increasingly inclined posteriorly away from the cusp. Basal cavity is an aboral trough beneath the process that penetrates anteriorly into the base of the cusp but seems not to be continued orally as low cones in the bases of individual denticles. The base is flared somewhat to one side beneath the posterior half of the cusp and the proximal part of the process; this flaring is quite variable among the several specimens in our collection and in some cases is only slightly developed. The cusp generally is somewhat twisted from the plane of the process and denticles.

Remarks.—Müller (1959) distinguished *Cordylodus oklahomensis,* which he described from the Signal Mountain Limestone of southern Oklahoma, from *C. prion* on twisting of the cusp and lesser number of denticles on the former species. Number of denticles has not proved a satisfactory basis for differentiation of species in previous studies of conodonts, and it was not useful to us in separating these two forms in our collections from the House Limestone. In general, we found the denticles to be more nearly fused in *C. prion* than in the elements we interpreted as the *oklahomensis* component of *Cordylodus proavus.* Nevertheless, immature specimens of *C. prion* probably could not be distinguished from the latter elements if they occurred in isolation from more typical mature specimens.

Lindström (1955) noted similarity in form between *C. prion* and *Cordylodus? spurius* Branson and Mehl. The latter is based on a cyrtoniodiform element and probably is part of the apparatus of a species of *Plectodina* or of *Phragmodus.* The close resemblance to cyrtoniodiform elements led Miller and Melby (1971) to reassign *C. prion* to *Cyrtoniodus* as a form-taxon; the specimens they were studying came from Upper Cambrian rocks (Trempeleauan) of southern Wisconsin and probably represent the *oklahomensis* element of *C. proavus.* In any case, none of the elements associated with *C. prion* can be interpreted as direct homologues of elements from apparatuses containing cyrtoniodiform components, so that the morphologic similarity must be due to homeomorphy rather than biologic affinity. *Cordylodus prion* may be part of an apparatus that contains other cordylodiform members, but our data and that provided in previous records of its occurrence do not identify obvious associates. For this reason we treat these elements as form-taxa in this report.

Occurrence.—This form has been reported from the Lower Ordovician of southern Sweden (Lindström 1955, van Wamel 1974), of Estonia (Viira 1974), and of the Leningrad region (Sergeeva 1963). It is known from Afghanistan (Wolfart 1969), Iran (Müller 1973a), and Australia (Druce and Jones 1971). Kurtz (1976) noted its presence in Lower Ordovician rocks in the Bighorn Mountains, Wyoming.

Range in the Pogonip.—*Cordylodus prion* is present in the upper three-fourths of the House Limestone in the type area and occurs in the same general interval at Hintze's (1951) Section B and in the Willden Hills.

Number of specimens.—202.

Repository.—Figured hopotypes UMC 1089–18, 19.

CORDYLODUS PROAVUS Müller
Pl. 2, figs. 18, 19

Cordylodus proavus MÜLLER, 1959, p. 448–449, Pl. 15, figs. 11, 12, 18, text-fig. 3B; MILLER, 1969, p. 424–426, Pl. 65, figs. 37–45, text-fig. 3D; DRUCE & JONES, 1971, p. 70–71, Pl. 1, figs. 1–6, text-figs. 23p–r; JONES, 1971, p. 48, Pl. 2, figs. 9a–c; ETHINGTON & CLARK, 1971, p. 68, Pl. 1. fig. 19; MILLER & MELBY, 1971, p. 79, Pl. 1, figs. 18, 19; MÜLLER, 1973a, p. 35, Pl. 9, figs. 1, 2, 3a, b, 4–9, text-figs. 2A, 9a, b; ABAIMOVA, 1975, p. 109–110, Pl. 10, fig. 16, text-fig. 8(27, 28); LANDING, TAYLOR & ERDTMANN, 1978, p. 77, text-fig. 2F; FÅHRAEUS & NOWLAN, 1978, p. 453, Pl. 1, figs. 8, 9; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 1, figs. 8, 9.
Cordylodus oklahomensis MÜLLER, 1959, p. 447–448, Pl. 15, figs. 15, 16, text-fig. 3A; MILLER, 1969, p. 423–424, Pl. 65, figs. 46–53; DRUCE & JONES, 1971, p. 69, Pl. 5, figs. 6a–7c; text-fig. 23j; JONES, 1971, p. 47–48, Pl. 2, figs. 5a–8b; ETHINGTON & CLARK, 1971, p. 68, Pl. 1, fig. 24; MÜLLER & NOGAMI, 1971, p. 34, Pl. 7, figs. 3, 4, Pl. 19, fig. 1, text-fig. 7A; MÜLLER, 1973a, p. 33, Pl. 7, figs. 12, 13a, b, text-figs. 2B, 7a, b; LANDING, LUDVIGSEN & VON BITTER, 1980, p. 21–25, figs. 5A, D, 6C–E.

Crytoniodus [*sic*] *prion* (Lindström). MILLER & MELBY, 1971, p. 79, Pl. 1, figs. 14–16, 17.
non Cordylodus oklahomensis Müller. ABAIMOVA, 1975, Pl. 10, figs. 7a, b.

Remarks.—The specimens that we assign to *C. proavus* conform closely to two morphotypes that traditionally have been reported under that name and under *C. oklahomensis*, respectively. Those generally identified under the former name typically have a slender, erect to proclined cusp and widely spaced, peglike denticles. The basal cavity is a deep, slender, horizontally directed cone. Specimens identified under the latter name typically have a relatively broad cusp with sharp edges and lenticular cross section. Denticles characteristically are reclined posteriorly, basally crowded but discrete, and thin with sharp edges. The base is inflated somewhat to one side, and the entire element may be flexed.

We are treating these two kinds of elements under the single name *C. proavus* because they appear to have the same general ranges in the Pogonip collections in hand and because they also co-occur in most of their previously reported occurrences. The apparatus of *C. proavus* conforms to that postulated for the type species of *Cordylodus* (Bergström and Sweet 1966, p. 323; Sweet and Bergström 1972, p. 40), which is believed to have included two kinds of elements.

The *proavus* elements may be confused with juvenile specimens of *C. intermedius* Furnish, which have slender, anteriorly directed basal cavities also. In the same way the *oklahomensis* element resembles juvenile specimens of *C. prion* Lindström. We have identified questionable specimens with the latter names if they occur with typical mature specimens of the respective species or where they occur within the range of those species but in the absence of mature forms from the same sample. Occurrence of *C. proavus* has been used to identify oldest Ordovician rocks (Fauna A of Ethington and Clark 1971), and it has been suggested as a potential marker taxon for identifying the boundary between Cambrian and Ordovician strata (Stitt and others 1976). Care should be exercised in this interpretation based on isolated specimens which might be juveniles of the younger species and hence represent a level well above the base of the Ordovician System.

Occurrence.—This species was based on material from the Signal Mountain Limestone of southern Oklahoma (Müller 1959). It has been reported subsequently from the Notch Peak Formation of the Ibex area (Miller 1969), from the Jordan Sandstone of Wisconsin (Miller and Melby 1971), from the "Narrows Formation" at Navy Island, New Brunswick (Landing and others 1978), from the Rabbitkettle Formation of northern Canada (Tipnis and others 1978, Landing and others 1980) and from the Cow Head Group of Newfoundland (Fåhraeus and Nowlan 1978). Derby and others (1972) found it in the Survey Peak Formation at Mount Wilson in the Rocky Mountains of Alberta. The species is present in lower Paleozoic rocks in Oaxaca, Mexico (Pantoja-Alor and Robison 1967), in Cambro-Ordovician strata of northern Iran (Müller 1973a), in exposures along the Lena River in Siberia (Abaimova 1975), and in the Ninmaroo Formation and Pander Greensand in Australia (Druce and Jones 1971, Jones 1971).

Range in the Pogonip.—We previously (1971) identified this species and the conodonts that occur with it in the lower House Limestone and equivalent strata as constituting conodont Fauna A. This species is present in lower House at the type section; one specimen was found in the Willden Hills.

Number of specimens.—Proavus element, 48; oklahomensis element, 53.

Repository.—Figured proavus element UMC 1089–20; unfigured proavus element UMC 1090–1; figured oklahomensis element UMC 1090–2; unfigured oklahomensis element UMC 1090–3.

CORDYLODUS ANGULATUS Pander
Pl. 2, fig. 24

Cordylodus angulatus PANDER, 1856, p. 33, Pl. 2, figs. 26–31, Pl. 3, figs. 10a, b; LINDSTRÖM, 1955, p. 551–552, Pl. 5, fig. 9, text-fig. 3G (*non* text-fig. 3E); LINDSTRÖM, 1960, text-fig. 1(I–1); HASS, 1962, p. 45, text-fig. 23(5); LINDSTRÖM, 1964, p. 147, text-fig. 50h; DRUCE & JONES, 1971, p. 66–67, Pl. 3, figs. 4a, 7b; text-fig. 23a, b; JONES, 1971, p. 45–46, Pl. 8, figs. 3a–c; MÜLLER, 1973a, p. 27–28, Pl. 11, figs. 1–7, text-figs. 2G, 3a–c; VIIRA, 1974, p. 63, Pl. 1, figs. 1–3, 8, 11–13.
Cordylodus rotundatus PANDER, 1856, p. 33, Pl. 2, figs. 32, 33; LINDSTRÖM, 1960, text-fig. 1(I–4); VIIRA, 1974, p. 63, Pl. 1, figs. 4, 5, 9, 10.
? *Cordylodus rotundatus* Pander. MOUND, 1968, p. 409, Pl. 2, figs. 4, 5; DRUCE & JONES, 1971, p. 71–72, Pl. 3, figs. 8a–10c, text-fig. 23t; MÜLLER, 1973a, p. 36, Pl. 11, figs. 8a, b, 9, 10, text-figs. 2H, 10a, b; VAN WAMEL, 1974, p. 60–61, Pl. 1, fig. 14.
? *Cordylodus subangulatus* Furnish. ABAIMOVA, 1975, p. 110–111, Pl. 10, figs. 6, 8a, b, 9, 11a, b, text-fig. 8(29–31, 36, 37).
? *Cordylodus oklahomensis* Müller. ABAIMOVA, 1975, Pl. 10, figs. 7a, b.
? *Cordylodus angulatus* Pander. GEDIK, 1977, p. 41, Pl. 2, figs. 5, 10.

Remarks.—We follow Druce and Jones (1971) and Müller (1973) in distinguishing this species from *C. intermedius* Furnish on the basis of the configuration of their respective basal cavities. As noted by Mound (1968), *Cordylodus rotundatus* was selected by Bergström and Sweet (1966) for the name of this species at the time that they interpreted its apparatus as consisting of two of Pander's form-species, *C. angulatus* and *C. rotundatus.*

This genus has been reported frequently from Europe and North America under the name *Cordylodus angulatus.* Unfortunately, many of these reports have not included a description of the outline of the basal cavity so that some of them may include specimens that we would assign to *Cordylodus intermedius.* We have listed with question in the synonymy occurrences that have been reported under various names, frequently with only an illustration but no discussion, that we believe may belong here.

Occurrence.—This species is known to occur in northern Europe (Lindström 1955, Viira 1974), in Iran (Müller 1973a) and in Australia (Druce and Jones 1971, Jones 1971). It may be present also on the Siberian Platform (Abaimova 1975) and in Turkey (Gedik 1977).

Range in the Pogonip.—Rare in upper House Limestone at the type section, at Section B of Hintze (1951), and in the Willden Hills.

Number of specimens.—Angulatus element, 17, ?rotundatus element, 2.

Repository.—Figured angulatus element UMC 1090–4; unfigured angulatus element UMC 1090–5.

CORDYLODUS sp. A s.f.
Pl. 2, fig. 26

Cordylodus angulatus Pander. ETHINGTON & CLARK, 1971, p. 68, Pl. 1, fig. 16 (*non* figs. 15, 20).

Remarks.—Specimens included here have robust cusps that are thick and display broad anterior surfaces that become increasingly wide basally. Anterior faces are transversely convex distally but become nearly planar toward the base. A thick anticusp commonly is developed anteriorly. Posterior process is shallow; denticles are inclined posteriorly and may be unequal in size.

In an earlier paper (1971) we interpreted these elements as part of the apparatus of *Cordylodus angulatus* Pander. We now recognize that the species in question is *C. intermedius* Furnish, and we are unsure whether the elements described above actually belong with it. Such elements were not reported to be present in the type collection that produced *C. intermedius* (Furnish 1938), so that we describe them here as form-elements only. They may be parts of an apparatus that includes those specimens we described above as having affinity with *Cordylodus caseyi* Druce and Jones.

Some of the specimens that we consider here, as well as some of those that we interpret as juveniles of *Cordylodus intermedius,* show conical projections of the basal cavity in the bases of the denticles. Druce and Joues (1971) used this feature as the basis for recognition of a separate species (*Cordylodus lindstromi*), and Miller (1970) reached the same conclusion in an unpublished dissertation. We find this to be an inconsistent character among the cordylodids we have studied here and, like Müller (1973), do not consider it a reliable feature for discrimination of species.

Range in the Pogonip.—Middle House Limestone at the type section, at Hintze's (1951) Section B, and in the Willden Hills.

Number of specimens.—102.

Repository.—Figured specimen UMC 1090–6; unfigured specimen UMC 1090–7.

Genus DAPSILODUS Cooper, 1976

Type species.—*Distacodus obliquicostatus* Branson & Mehl, 1933.

DAPSILODUS ? NEVADENSIS (Ethington & Schumacher)
Pl. 3, fig. 1

? *Distacodus variabilis* WEBERS, 1966, p. 28, Pl. 2, figs. 15–17.
Acontiodus nevadensis ETHINGTON & SCHUMACHER, 1969, p. 450, 452, Pl. 67, figs. 21, 22, text-fig. 4C.
Distacodus aff. *D. bigdoeyensis* [*sic*] Hamar. ETHINGTON & SCHUMACHER, 1969, p. 460–461, Pl. 68, fig. 23, text-fig. 4G.
? *Protopanderodus* cf. *P. insculptus* (Branson & Mehl). TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 9, fig. 6.

Remarks.—A small number of specimens from the Crystal Peak Dolomite generally correspond to the material from the Copenhagen Formation described by Ethington and Schumacher (1969). The basal cavities are not as deep as is the case in the specimens from Nevada, but the range in morphologies exhibited by the cross sections and the development of a "knob" at the proximal end of the posterior edge correspond to *"A." nevadensis.* One specimen is relatively short and broad and is costate on only one face; it corresponds to that form from the Copenhagen that Ethington and Schumacher compared with *Distacodus bygdoyensis.* Another specimen is short and bladelike also but lacks any obvious grooves or costae on the surface. In all other respects, and particularly in the configuration of the base, it is identical to the others considered here.

We transfer these forms with question from *Acontiodus* to *Dapsilodus.* They suggest the latter genus in having both squat and elongate elements with several cross-sectional symmetry plans. Should this generic assignment be substantiated, this is the oldest representative of that genus known to date.

Occurrence.—Ethington and Schumacher (1969) found this species in the middle and upper members of the Copenhagen Formation in the Monitor Range, central Nevada. A very similar if not conspecific form, *Dapsilodus variabilis* (Webers), has been reported from the Platteville Formation of the Upper Mississippi Valley region (Webers 1966). Tipnis and other (1978) illustrated a specimen from the Road River Formation of the southern District of Franklin, Canada, that is close to this species.

Range in the Crystal Peak.—Specimens were found at 12.5 and at 14.6 m (41 and at 48 ft) below the top of the formation at the type section.

Number of specimens.—9.

Repository.—Figured hypotype UMC 1090–8; unfigured hypotypes UMC 1090–9, 10.

Genus DISCHIDOGNATHUS Ethington & Clark, n. gen.

Type species.—*Dischidognathus primus* Ethington and Clark, n. sp.

The only elements recognized so far are multidenticulate with the denticles arranged in palmate fashion. The denticles are crowded to fused basally but discrete distally. The elements are thin and cupped posteriorly. Basal excavation is deep; it opens posteriorly and aborally into a posterobasal recess. A narrow slit extends orally from the recess and follows the posterior midline of the central denticle. No elements that share an apparatus with these forms have been identified.

Remarks.—This genus has been studied by us from three occurrences, that reported here, from the upper Antelope Valley Limestone of central Nevada, and from a locality in the lower part of the Everton Formation of northern Arkansas (Golden 1969). The specimens from the Great Basin and from the southern Ozark region are distinct in details but are essentially alike in their general features. In all occurrences only three denticles are present on each specimen with the central one being the largest. The denticles are thick in the anterior-posterior direction but narrow from edge to edge in the case of the Arkansas specimens, in contrast to broad and bladelike in those from the western states. The posterobasal recess is broad and open in the Arkansas specimens and opens more downward than posteriorly, whereas it is deep and narrow and opens more posteriorly in the material from the Great

Basin. The posterior groove is a narrow slit on the latter specimens but is an open trough on those from Arkansas. The groove is separated from the posterobasal recess by a thin lip on the Arkansas material rather than continuous with it as is the case in *D. primus*. The specimens from the Everton are more strongly flexed than those from Utah-Nevada. Probably two species are represented, but Golden's collection consisted of only four specimens, which is insufficient to evaluate the variability of that population.

The forms that Golden recovered from the Everton Formation are very close morphologically to two specimens that Nowlan (1976) found in the middle of the Eleanor River Formation in the Arctic region of Canada. The latter occurrence is in strata generally assigned late Canadian age, and the associated conodonts suggest equivalence to the higher part of the Fillmore. Golden's specimens came from low in the Everton, and they are associated there with a species of *Multioistodus* that occurs in the lower part of the Kanosh. This suggests that the specimens from the Everton, those from Arctic Canada, and specimens from Ordovician strata of northern Greenland reported by Kurtz and Miller (1978) represent a species of *Dischidognathus* that is older than *D. primus*.

Some Ordovician distacodontids have basal cavities that are incomplete as a result of "basal inversion," but none of them display a cavity that is so open as to permit the tip of the cavity to be seen in posterior view. The posterobasal recess and slit are not part of an enlarged basal cavity that extends up the rear side of elements of *Dischidognathus primus*. The surface of the element within the posterobasal recess is smooth and strongly reflective of incident light. By contrast the walls of the true basal cavity are dull and show evidence of striae indicating the edges of the growth lamellae. A well-defined border separates the two kinds of surface in the anterobasal area.

Longitudinal slits occur in *Panderodus* and in *Belodina*, but in elements of these two genera they are located off the midline and general asymmetry is characteristic. Furthermore, the slits continue to the basal margin in elements of both of these genera, and a characteristic notch in the basal margin is produced. Elements of *Dischidognathus primus* resemble those of some species of *Multioistodus* in the arrangement and development of the denticles, but we consider this similarity to be superficial because the denticles of *Dischidognathus* are albid in contrast to the generally hyaline elements of multioistodids. The multioistodids display a symmetry transition of elements in their apparatuses, a character that so far cannot be demonstrated in *Dischidognathus*.

The two species that we believe to be represented in this genus are minor components of the total conodont fauna in all of their occurrences known to us. They have limited stratigraphic ranges in the local sections, but their entire ranges cannot be established with certainty owing to the paucity of their occurrence. The genus ranges from upper Canadian rocks through the Whiterockian Stage.

Derivation of name.—Dischides, Greek meaning cut; and gnathos, jaw. To call attention to the slit which divides the posterior surface of the element into equal parts.

DISCHIDOGNATHUS PRIMUS Ethington & Clark, n. sp
Pl. 3, figs. 2, 3

New Genus C SWEET, ETHINGTON & BARNES, 1971, p. 167, Pl. 1, fig. 25; HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, figs. 1, 2.

Elements thin anteroposteriorly and bilaterally symmetrical about a median denticle. This denticle is somewhat curved along its length so that the element is cupped posteriorly. Median denticle has rhombic cross section with major diagonal of rhomb oriented transversely. A bladelike denticle is fused basally to each side of this central denticle, but all three of them are discrete distally. Axes of lateral denticles form angles of about 25–30° with the midline of the element. Lateral edges of denticles are sharp distally but broadly rounded basally. Outer surface of element is broadly convex except for linear rib along midline of central denticle. Posterior face is depressed with midline of denticle forming a central rib. Lower portion of element is thick with a deep medial recess that opens posteriorly. This recess is continued upward as a narrow slit along the midline of the central denticle. The basal cavity is open posteriorly into the recess; the boundary between cavity and recess is sharp and separates smooth reflective material like that of the face of the denticle (recess) from dull material (cavity wall). Basal region may be somewhat compressed laterally beneath the denticles.

Derivation of name.—Primus, first; this is the first species of the genus to be named.

Occurrence.—We found this species in the upper Antelope Valley Limestone on Martin Ridge in the Monitor Range of central Nevada (Harris and others 1979). As noted in the generic discussion above, a related but older species is known from the Everton Formation of Arkansas, from the Eleanor River Formation of the Arctic islands of Canada, and from northern Greenland.

Range in the Pogonip.—Upper Lehman Formation at Crystal Peak (CP–L–10) through CP–L–14).

Number of specimens.—25.

Repository.—Figured holotype UMC 1090–11, figured paratype UMC 1090–12, unfigured paratypes UMC 1090-13, 14.

Genus DREPANODUS Pander, 1856
Type species.—Drepanodus arcuatus Pander, 1856.

? DREPANODUS ARCUATUS Pander
Pl. 3, figs 4–6, 12

Drepanodus arcuatus PANDER, 1856, p. 20, Pl. 1, figs. 2, 4, 5, (*non* figs. 17, 30, 31); LINDSTRÖM, 1955, p. 558–560, Pl. 2, figs. 30–33; FÅHRAEUS, 1966, p. 21, Pl. 3, fig. 15, VIIRA, 1967, p. 321, fig. 1–14; LINDSTRÖM, 1971, p. 41, figs. 4, 8; LINDSTRÖM, 1973, p. 67–68, Pl. 1, figs. 1, 2; SERPAGLI, 1974, p. 43, Pl. 8, figs. 8–10, Pl. 20, figs. 13–15; VAN WAMEL, 1974, p. 61–62, Pl. 1, figs. 10–13; DZIK, 1976, fig. 17a–c; LANDING, 1976, p. 632, Pl. 1, figs. 16–19, 21–23; FÅHRAEUS & NOWLAN, 1978, p. 458, Pl. 2, figs. 1?, 2, 8; LÖFGREN, 1978, p. 51, Pl. 2, figs. 1–8; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 2, figs. 1–3.

Drepanodus flexuosus PANDER, 1856, p. 20, Pl. 1, figs. 6–8.

non Drepanodus arcuatus Pander. HINDE, 1879, p. 357, Pl. 15, figs. 7, 8; BRANSON & MEHL, 1933, p. 58, Pl. 4, fig. 13; BRANSON & MEHL, 1933, p. 153–154, Pl. 12, figs. 12, 13; RHODES, 1953, p. 292, Pl. 110, fig. 21; RHODES, 1955,

p. 126, Pl. 10, fig. 24; HAMAR, 1964, p. 264, Pl. 2, figs. 1, 2, text-fig. 6–4; WINDER, 1966, p. 56, Pl. 9, fig. 10, text-fig. 3–10.

Drepanodus cf. *arcuatus* Pander. LINDSTRÖM, 1955, p. 560–561, Pl. 2, figs. 45, 46, text-fig. 4C.

Drepanodus sculponea LINDSTRÖM, 1955, p. 593, Pl. 2, fig. 40, text-fig. 3L.

Scandodus pipa LINDSTRÖM, 1955, p. 593, Pl. 4, figs. 38–42, text-fig. 3P; ETHINGTON & CLARK, 1964, p. 698, Pl. 114, fig. 8; FÅHRAEUS, 1966, p. 30, Pl. 3, fig. 13, text-fig. 21; VIIRA, 1967, p. 321, fig. 1–11; BEDNARCZYK, 1969, Pl. 2, fig. 3; ETHINGTON, 1972, Pl. 1, fig. 22.

? *Drepanodus arcuatus* Pander. MOUND, 1968, p. 410–411, Pl. 2, figs. 15–17; NIEPER, 1969, Pl. O VII, fig. 1; LEE, 1970, p. 319, Pl. 7, fig. 15; Pl. 8, fig. 11; LEE, 1975, p. 84, Pl. 1, fig. 13, text-fig. 3L.

Remarks.—Lindström (1971, 1973) reconstructed the apparatus of *Drepanodus arcuatus* to include the form elements previously described as *Scandodus pipa* Lindström (= *Drepanodus flexuosus* Pander), *Drepanodus sculponea* Lindström, and *Drepanodus* cf. *arcuatus* Pander *sensu* Lindström, as well as the nominate element. Subsequently van Wamel (1974) concluded that the apparatus includes a fourth kind of element, that which had been identified in form taxonomy as *Acontiodus arcuatus* Lindström. Landing (1976) and Löfgren (1978) accepted this interpretation. However, Serpagli (1974) did not find the latter elements in his collections from the San Juan Formation of Argentina, although this was not a conclusive observation since he had only a few specimens of the other elements. None of the specimens in our collections from the Pogonip Group can be identified with *A. arcuatus* s.f., but the other elements of the *Drepanodus* apparatus are present in modest abundance. We cannot identify obvious differences between these three elements and the corresponding forms from northern Europe. The apparatus in the Pogonip thus seems to be the same as the one reported from Argentina. Löfgren (1978) has suggested that absence of posteriorly costate elements from the apparatus may indicate that the Argentina occurrence represents a different subspecies from the one in the Baltic region. We cannot evaluate this suggestion on the basis of our collections.

The elements we consider to be like *Drepanodus* cf. *arcuatus* Pander *sensu* Lindström (1955, p. 560–561) were not found below the middle of the Fillmore Formation; only 14 specimens were obtained, and their occurrences are scattered through the upper half of the formation. In contrast to the rounded faces illustrated for the specimens from Sweden (Lindström 1955, Löfgren 1978), our material shows a blunt medial ridge on the outer side of the cusp. The identification is based on general curvature of the elements and the marked reentrant in the basal margin of the outer side. Serpagli did not find such specimens in the San Juan Limestone. If our species is the same one that he reported, these specimens may not belong in the apparatus.

Occurrence.—This species has been recognized from numerous Lower Ordovician (Tremadocian-Arenigian) sections in northern Europe (see, e.g., Lindström 1955; Viira 1967, Dzik 1976, Löfgren 1978), and it occurs in Argentina (Serpagli 1974). It has been recovered in North America from the Ordovician of the Hamburg Klippe of Pennsylvania (Bergström and others 1972), from the Deepkill Shale of eastern New York (Landing 1976), from the Cow Head Group of Newfoundland (Fåhraeus and Nowlan 1978), from the Broken Skull Formation of northern Canada (Tipnis and others 1978), from the El Paso Group of Texas (Ethington and Clark 1964), and from the Ninemile Formation of Nevada (Ethington 1972). The specimens from the Cool Creek Formation of Oklahoma that Mound reported as *D. arcuatus* are incorrectly identified. Illustrations in Lee (1970, 1975) of material from Korea do not appear to represent *D. arcuatus*.

Range in the Pogonip.—Elements of ? *Drepanodus arcuatus* were found throughout the Fillmore Formation except for the lowest 107 m (350 ft). They range upward through the Wah Wah Formation but were not found in the Juab or younger formations of the Pogonip.

Number of specimens.—Arcuatiform element, 193; sculponeaform element, 88; cf. arcuatiform element, 14; oistodiform element, 179.

Repository.—Figured arcuatiform element UMC 1090–15; figured cf. arcuatiform element UMC 1090–16; figured sculponeaform element UMC 1090–17; figured oistodiform element UMC 1090–18; unfigured arcuatiform elements UMC 1090–19, 20, UMC 1091–1, 2; unfigured sculponeaform elements UMC 1091–3, 4; unfigured oistodiform elements UMC 1091–5, 6, 7.

DREPANODUS GRACILIS (Branson & Mehl) s.f. SENSU Lindström, 1955
Pl. 3, fig. 7; fig. 10

non Oistodus gracilis BRANSON & MEHL, 1933, p. 60, Pl. 4, fig. 20.

Drepanodus? gracilis (Branson & Mehl). LINDSTRÖM, 1955, p. 562–563, Pl. 4, fig. 44, Pl. 5, figs. 6, 7.

Oistodus gracilis Branson & Mehl. MÜLLER, 1964, p. 97–98, Pl. 12, figs. 5, 7, Pl. 13, fig. 7.

non Drepanodus? gracilis (Branson & Mehl). JONES, 1971, p. 49–50, Pl. 3, figs. 1a–c, text-fig. 15a, b.

Remarks.—Our specimens conform generally to those illustrated by Lindström (1955) and particularly to those whose base he observed to be "somewhat unsymmetrical."

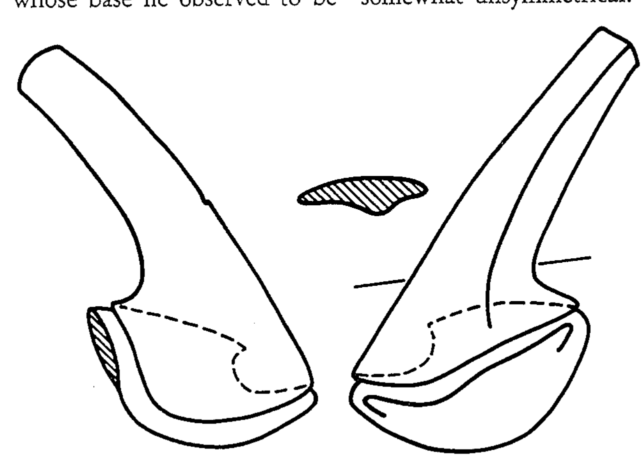

Figure 10.—Opposite views of *Drepanodus gracilis* (Branson & Mehl) s.f. *sensu Lindström;* short basal funnel projects beyond aboral margin of element.

They have slender, reclined cusps, one side of which is broadly convex and whose opposite side has a poorly defined linear ridge located posterior to the midline. The basal region is foreshortened and turned laterally on the costate side; it opens aborolaterally to that side to provide the lack of symmetry to which Lindström referred. The basal region is fully developed to the opposite side and displays a broadly arcuate lower margin. The basal cavity has its distal tip overturned in the anterior direction, the configuration that Lindström has compared to the outline of a phrygian cap. Many specimens retain heavy basal funnels that protrude for a short distance beyond the aboral margin.

These forms are broadly similar in outline to *"Oistodus" gracilis* Branson and Mehl when viewed from the noncostate side. When viewed from the opposite side, the two forms are distinct, however. The cusp in *"O." gracilis* is uniformly biconvex in section, and does not have a costa. The basal region is uniformly developed to either side and opens aborally rather than downward and to one side.

In his study of conodonts from Öland, Sweden, van Wamel (1974) included *D. gracilis* (Branson and Mehl) *sensu* Lindström in the apparatus of *Drepanodus arcuatus* Pander. He interpreted it to be one extreme in a morphologic spectrum whose opposite counterpart is *Scandodus pipa* Lindström, and reported that a continuum of forms exists between these two. Lindström (1971, 1973) assigned *S. pipa* to the apparatus of *D. arcuatus*, but forms like those we consider here were not part of his reconstruction. Our collections do not contain elements of intermediate character like those reported by van Wamel; we found no difficulty in identifying typical oistodiform elements of *D. arcuatus* in contrast to the forms we consider here. We therefore report these elements under the name that Lindström (1955) used for them. Probably they are part of the apparatus of a species of *Drepanodus*, although we cannot establish with what other elements they should be associated. In our collections their range is within that of the elements of *D. arcuatus*, so that van Wamel's conclusion that they are rare variants of the *S. pipa* element may be correct despite the lack of intermediate forms here.

Occurrence.—Lindström (1955) found elements of this kind to be present but not common in the Planilimbata Limestone of southern Sweden. Müller (1964) illustrated specimens from the Lower Ordovician of South Korea that may belong here also.

Range in the Pogonip.—Upper two-thirds of the Fillmore Formation; lowest occurrence is in Zone G_2 (160 m [525 ft] in the Mesa Section). Occurrences are sporadic through the remainder of the formation.

Number of specimens.—18.

Repository.—Figured specimen UMC 1091-8; unfigured specimen UMC 1091-9.

"DREPANODUS" PARALLELUS Branson & Mehl
Pl. 3, fig. 8

Drepanodus arcuatus BRANSON & MEHL, 1933, p. 58, Pl. 4, figs. 7, 8, 13, 16 (*non Drepanodus arcuatus* Pander, 1856).

Drepanodus parallelus BRANSON & MEHL, 1933, p. 59, Pl. 4, fig. 17; JONES, 1971, p. 52–53, Pl. 8, figs. 5a–c; LEE, 1975, p. 85–86, Pl. 1, fig. 16, text-fig. 3M; BARNES, 1977, p. 101, Pl. 1, figs. 1–3.

Drepanodus simplex BRANSON & MEHL, 1933, p. 58, Pl. 4, fig. 2; BARNES & TUKE, 1970, p. 86, Pl. 19, figs. 8, 12, 13; DRUCE & JONES, 1971, p. 74, Pl. 13, figs. 1a–4c, text-fig. 24b; GREGGS & BOND, 1971, p. 1467, Pl. 1, figs, 3, 4; FÅHRAEUS & NOWLAN, 1978, p. 457, Pl. 2, fig. 14.

Drepanodus subarcuatus FURNISH, 1938, p. 328–329, Pl. 41, figs. 25–32, Pl. 42, figs. 2, 3, text-fig. 1G; HASS, 1962, p. 43, text-fig. 22(10a, b); LINDSTRÖM, 1964, text-fig. 10B; ETHINGTON & CLARK, 1964, p. 689, Pl. 113, figs. 15, 20; ETHINGTON & CLARK, 1965, p. 191; MERRILL, 1965, p. 375–376, Pl. 1, fig. 13; DRUCE & JONES, 1971, p. 74–75, Pl. 20, figs. 1a–4c, text-fig. 24c; ETHINGTON & CLARK, 1971, p. 73, Pl. 2, fig. 1; REPETSKI & ETHINGTON, 1977, p. 97.

Drepanodus tortus FURNISH, 1938, p. 329, Pl. 42, fig. 6.

? *Drepanodus parallelus* Branson & Mehl. GRAVES & ELLISON, 1941, p. 3, Pl. 1, fig. 13; MOUND, 1968, p. 412, Pl. 2, figs. 44–49, Pl. 3, figs. 1–11, 58, 60; WORKUM, BOLTON & BARNES, 1976, p. 171, Pl. 4, fig. 3.

non Drepanodus subarcuatus Furnish. GRAVES & ELLISON, 1941, p. 4, Pl. 2, fig. 12; MÜLLER, 1964, p. 96–97, Pl. 13, figs. 5, 6; MOUND, 1965b, p. 19, Pl. 2, figs. 14, 18, 19; LOCHMAN, 1965, p. 484, Pl. 63, fig. 13; LOCHMAN, 1966, p. 535, Pl. 65, figs. 17–20; MÜLLER, 1973a, p. 37, Pl. 5, figs. 8–11.

non Drepanodus parallelus Branson & Mehl. SANNEMANN, 1955, p. 26–27, Pl. 1, figs. 13, 15; ABAIMOVA, 1975, p. 62–63, Pl. 4, fig. 6, text-fig. 7(6, 40).

non Drepanodus cf. *D. subarcuatus* Furnish. SANNEMANN, 1955, p. 27, Pl. 1, figs. 16, 19.

? *Drepanodus subarcuatus* Furnish. CARLSON, 1960, Pl. 1, figs. 15, 16; HIGGINS, 1967, p. 384; ABAIMOVA, 1975, p. 66–67, Pl. 5, figs. 1–7, text-fig. 7(1); ABAIMOVA & MARKOV, 1977, p. 89, Pl. 14, fig. 15.

? *Drepanodus* cf. *D. subarcuatus* Furnish. WOLSKA, 1961, p. 349, Pl. 1, figs. 5, 7.

? *Oneotodus gracilis* (Furnish). MOSKALENKO, 1967, p. 111–112, Pl. 24, figs. 3, 4.

? *Drepanodus simplex* Branson & Mehl. MOSKALENKO, 1972, Table (no. 14); MÜLLER, 1973a, p. 37, Pl. 5, fig. 5.

non Drepanodus simplex Branson & Mehl. ABAIMOVA, 1975, p. 64, 66, Pl. 4, figs. 8, 12, Pl. 5, fig. 8, text-fig. 6(32, 33).

Drepanodus acutus Pander. FÅHRAEUS & NOWLAN, 1978, p. 457, Pl 2, fig. 11.

Remarks.—The specimens on which *Drepanodus parallelus* Branson and Mehl, *Drepanodus simplex* Branson and Mehl, *Drepanodus subarcuatus* Furnish, and *Drepanodus tortus* Furnish are based all lack albid matter in their cusps and have shallow basal cavities. The type specimens are distinct morphologically, and each is duplicated by elements within the population that we consider here. We cannot consistently subdivide that population into morphologic units and therefore conclude that the types of these four form-species represent elements from one apparatus. The elements of that apparatus display a broad spectrum of variation in curvature and twisting of their cusps. All of the elements lack albid matter, and the apices of their shallow basal cavities are located near the anterior surfaces. Bases are not inflated. Cross sections of the cusps range from subcircular through lenticular. Faint striae are present on some specimens, but are not present invariably. We are unable to separate the specimens into groups on this basis as was suggested by Miller (1971, p. 79–80).

We noted earlier (Ethington and Clark 1964, p. 689) that *D. subarcuatus* and *D. parallelus* might be synonyms, and Mound (1968, p. 412) included *D. subarcuatus* and *Drepanodus simplex* in his synonymy of *D. parallelus*.

Barnes and Tuke (1970, p. 86) recognized the same synonymy, but considered *D. simplex* to be the valid name. Subsequently, Jones (1971, p. 52–53) interpreted *D. simplex* as a distinct species, but supported the synonymy of *D. subarcuatus* with *D. parallelus.* We have specimens whose cusps have spatulate distal extremities, the character that Jones believed made *D. simplex* unique, but they represent another aspect in the variation plan of these elements. Accordingly, we accept the interpretation of Mound (1968) who, as first reviser, identified all of these elements under the name *D. parallelus.*

This species is not typical of *Drepanodus* as that generic concept has developed since Lindström's emendations (1955, 1971) of Pander's original definition. In particular, the absence of an obvious oistodiform element in association with *"D." parallelus* precludes assignment to the genus. The elements we recognize under the name *"D." parallelus* are associated with *Scolopodus quadraplicatus* Branson and Mehl in most of the reported occurrences of the two, and they have very similar but not identical ranges in the Pogonip. They may represent a single species, for which a new generic name would be necessary. Until that relationship can be confirmed, we prefer to retain the elements considered here in *"Drepanodus."*

Occurrence.—These elements occur in most of the Lower Ordovician faunas of the North American Midcontinent Province. They are known to be present in the El Paso Group of west Texas (Ethington and Clark 1964; Repetski 1975, and in press), the Arbuckle Group of Oklahoma (Mound 1968, Potter 1975, Brand 1976), the Mazarn Shale of Arkansas (Repetski and Ethington 1977), the Jefferson City Formation of Missouri (Branson and Mehl 1933), and the Prairie du Chien beds of Iowa-Minnesota-Wisconsin (Furnish 1938). Occurrences in Canada include the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965), the March and Oxford Formations of southern Ontario (Greggs and Bond 1971), the St. George Formation of Newfoundland (Barnes and Tuke 1970), the Bad Cache Rapids Formation of the Canadian Arctic (Barnes 1977), and the Cow Head Group of Newfoundland (Fåhraeus and Nowlan 1978). Of the several reports of their occurrence outside North America, only those of the Dumogol Formation of Korea (Lee 1975) and of the Ninmaroo (Druce and Jones 1971) and Jinduckin (Jones 1971) Formations of Australia actually are *"D." parallelus.* The species may be represented by specimens from Siberia that Moskalenko (1967) reported as *Oneotodus gracilis.*

Range in the Pogonip.—The lowest occurrence of this species is below the middle of the House Formation (47 m [154 ft] above the base of Larsen's section in the type area). It occurs sparingly through the remainder of the House and becomes more common in the Fillmore. The highest observed occurrence in the Fillmore is 6 m (20 ft) below the top of the formation; two specimens were found high in the Wah Wah Formation, and another was recovered from the Juab.

Number of specimens.—280.

Repository.—Figured hypotype UMC 1091–10; unfigured hypotypes UMC 1091–11, 12, 13.

"DREPANODUS" SIMPLEX Branson & Mehl
SENSU Druce & Jones
Pl. 3, fig. 9

Drepanodus simplex Branson & Mehl. DRUCE & JONES, 1971, p. 74–75, Pl. 13, figs. 1a–4b, text-fig. 24b.

Remarks.—Druce and Jones (1971) identified drepanodiform elements with spatulate terminations of the cusp which they recovered from the Ninmaroo Formation of Queensland, Australia, with *D. simplex* Branson and Mehl whose holotype also shows a flattened, broad tip. We note elsewhere in this report that *D. simplex* is based on a variant within a complex of hyaline, simple elements that we identify under *"Drepanodus" parallelus* Branson and Mehl. The similarity that led Druce and Jones to identify their material with Branson and Mehl's species probably is superficial.

Most of the specimens that we identify here are broken, but several show spatulate terminations of the cusp. One of them (UMC 1106–1) appears to have minor serration of the posterior margin in the broadened terminal region. This tends to support possible affinity with *Acanthodus uncinatus* Furnish which was suggested by Druce and Jones, although they failed to find any serrations on their specimens.

Range in the Pogonip.—Sporadic in middle to upper House Limestone in the type area and at Section B of Hintze (1951).

Number of specimens.—56.

Repository.—Figured specimen UMC 1106–1; unfigured specimen UMC 1106–2.

"DREPANODUS" TOOMEYI Ethington & Clark
Pl. 3, fig. 11

Drepanodus toomeyi ETHINGTON & CLARK, 1964, p. 690, Pl. 113, fig. 17, Pl. 114, fig. 22, text-fig. 2H; BARNES & TUKE, 1970, p. 86, Pl. 19, figs. 9–11, text-fig. 6I.

? *Drepanodus toomeyi* Ethington & Clark. NIEPER, 1969, Pl. O VII, fig. 3; BARNES & POPLAWSKI, 1973, Pl. 2, fig. 10.

Remarks.—When we reported this species for the first time (1964), we noted that it is not close to any of the elements that had been described as form-species of *Drepanodus* Pander. Lindström's (1971) redefinition of *Drepanodus* as a multielement taxon made the reassignment of these forms mandatory, for they do not conform to any of the element types that he included in species of that genus. Barnes and Poplawski (1973) suggested that these elements belong to a species of *Drepanoistodus* Lindström, but they did not elaborate on their reasons for this interpretation.

The type specimens of *"D." toomeyi,* as well as those reported here, are hyaline elements, which further argues against retention in *Drepanodus* as well as placement in *Drepanoistodus.* All of the material available to us is virtually identical in plan with no symmetry transition being indicated. No obvious associated elements can be identified in our collections from either the El Paso or the Pogonip, so that we cannot establish to what type of apparatus these forms belong. Perhaps they come from a species whose apparatus had only this kind of element. Until further evaluations can be made, we believe it best not to reassign these elements provisionally to another genus.

Occurrence.—Presence of this species in the El Paso Group has been documented by Ethington and Clark (1964) and by Repetski (1975, and in press). Barnes and Tuke (1970) recovered it from the St. George Formation of western Newfoundland. It is present also in the upper West Spring Creek Formation of Oklahoma (Potter 1975). The specimen from the Mystic Formation of Quebec illustrated by Barnes and Poplawski (1973) is very generalized and may not belong here.

Range in the Pogonip.—We found this species in the upper Fillmore of the ST Section but did not recover it from any of the other sections where that formation was studied. One specimen was found in basal Wah Wah at Section J.

Number of specimens.—5.

Repository.—Figured hypotype UMC 1091–14.

DREPANODUS sp. 1
Pl. 3, fig. 13; fig. 11

aff. *Drepanodus pandus* (Branson & Mehl). MOSKALENKO, 1967, p. 106–107, Pl. 23, figs. 1–4, text-fig. 8; ABAIMOVA, 1975, p. 62–63, Pl. 4, figs. 7, 10, 11, text-fig. 6(31, 34).
Drepanodus homocurvatus Lindström. BARNES & TUKE, 1970, p. 85, Pl. 19, figs. 14, 15.

Drepanodiform elements that are moderately recurved basally and straight distally. Cusp is biconvex in section with blunt to sharp edges. Length of the base is up to twice the anterior-posterior dimension of the proximal part of the cusp. Posterior part of base modestly inflated, more strongly so to one side than to the other. Basal margin is nearly straight posteriorly, becoming strongly convex beneath the posterior half of the cusp, and rising nearly vertically anteriorly to meet the front margin of the cusp. When viewed from the anterior direction, the base displays a prominent notch, with the basal edge flared outward to form a distinct anterior lip. Outline of basal cavity in lateral view is that of a phrygian cap; cavity is deep posteriorly but very shallow anteriorly owing to the anterior notch in the basal margin.

Remarks.—Moskalenko (1967) and Abaimova (1975) illustrated specimens that are very like those described above and identified them with *Drepanodus pandus* (Branson and Mehl). In their specimens, that part of the basal cavity anterior to its tip seems to be deeper than is the case in our material, if the configuration shown by Moskalenko's diagram (1967, text-fig. 8) is typical. These specimens cannot be identified with *D. pandus,* in which the anterobasal corner is drawn out rather than truncated.

Barnes and Tuke (1970) indicate that the specimens they assigned to *Drepanodus homocurvatus* Lindström were those elements in their collections that they could not identify with the other species of *Drepanodus* Pander that they recognized. They acknowledged that they admitted a broad range of morphology to *D. homocurvatus* thereby, so that their figured specimens do not represent the entire spectrum. The two specimens that they illustrated (and particularly the one shown in their Pl. 19, fig. 15) appear to be identical to the elements discussed above.

We believe these elements occupy the oistodiform position in the apparatus of a species of *Drepanodus* and thereby are homologous with *Scandodus pipa* Lindström, the oistodiform element of *D. arcuatus* Pander. We have been unable to identify the other elements of the apparatus from our collections, however. Unfortunately, the drepanodiform elements of the Fillmore Formation generally are broken, and we are unable to subdivide them with confidence. These oistodiform elements occur within the stratigraphic range of *D. arcuatus* in the Pogonip, and perhaps some of the drepanodiform elements that we have listed there actually belong here.

Occurrence.—The generally similar specimens reported by Moskalenko and by Abaimova were found in Lower Ordovician strata of central Siberia. Barnes and Tuke obtained their collection from St. George Formation of northwestern Newfoundland.

Range in the Pogonip.—These forms range throughout the Fillmore but are most common in the lower half of the formation. One specimen was found in lower Wah Wah at Section J.

Number of specimens.—54.

Repository.—Figured specimen UMC 1091–15.

DREPANODUS? sp. 2
Pl. 3, fig. 14; fig. 12

? aff. *Oistodus gracilis* BRANSON & MEHL, 1933, p. 60, Pl. 4, fig. 20.
Paroistodus parallelus (Pander). FÅHRAEUS & NOWLAN, 1978, p. 460, Pl. 2, fig. 13 (*non* fig. 12, = drepanodiform element of *P. parallelus.*

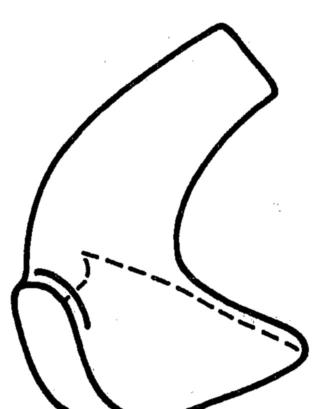

Figure 11.—*Drepanodus* sp. 1

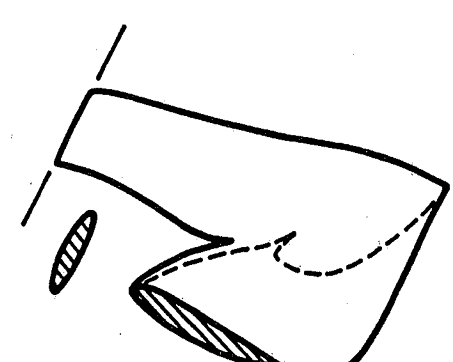

Figure 12.—*Drepanodus* ? sp. 2.

Remarks.—The specimens that we include here are broadly similar to *Oistodus gracilis* Branson and Mehl s.f. in their lateral outline. They are distinct, however, in that the cusp is more strongly reclined than is the case with the latter elements. Whereas the anterior margin is uniformly convex in lateral view in Branson and Mehl's specimens, it is straight to somewhat concave in our material. Our specimens have the posterior edge of the cusp following a sinuous outline with the proximal portion tangential to the keeled margin of the base; in contrast, *O. gracilis* has a cusp whose posterior margin is regularly curved and meets the base at almost a right angle.

We believe our specimens probably are oistodiform elements of a species of *Drepanodus,* but we cannot identify the associated elements of the apparatus because the drepanodiforms from that part of the Pogonip are fragmentary.

Occurrence.—The specimen that Fåhraeus and Nowlan (1978) figured as oistodiform element of *Paroistodus parallelus* (Pander) is identical to the specimens reported above.

Range in the Pogonip.—Present but not common in the Fillmore Formation beginning 55 m (180 ft) above the base of the formation; several specimens were recovered from the Wah Wah Formation.

Number of specimens.—112.

Repository.—Figured specimen UMC 1091–16; unfigured specimen UMC 1091–17.

Drepanodiform 1
Pl. 3, figs. 10, 15

Remarks.—The elements considered here have their cusps recurved through a right angle so that the greater part of their length is parallel to the basal margin. Anterior and posterior edges are sharp; lateral faces of cusp are uniformly convex. Basal region is moderately inflated; not uncommonly the inflation increases noticeably adjacent to the aboral margin to produce a bell-shaped base. Basal cavity is shallow and has a triangular outline in lateral view. The tip of the cavity is located well ahead of the midpoint of the lowest part of the cusp. Striae are visible at high magnification.

This generalized drepanodiform element cannot be identified with any previously described conodont. Some of the specimens that we include here may be juveniles of "*Drepanodus*" *parallelus,* although the knifelike edges of their cusps do not conform to typical development in that species. The range of these forms is essentially that of "*Paltodus*" *spurius,* and the general outline is similar to that species. The characteristic groove in the lower cusp and adjacent portion of the base is not present, however.

Range in the Pogonip.—Specimens of this type were found in many samples in the upper two-thirds of the House Limestone at all localities where it was sampled. In none of these samples are they a dominant component of the conodont fauna.

Number of specimens.—52.

Repository.—Figured specimen UMC 1091–18; unfigured specimen UMC 1091–19.

Genus DREPANOISTODUS Lindström, 1971
Type species.—*Oistodus forceps* Lindström, 1955

DREPANOISTODUS ANGULENSIS (Harris)
Pl. 3, figs. 18–21

Oistodus inclinatus Branson & Mehl. GRAVES & ELLISON, 1941, p. 5, Pl. 2, fig. 16.
Oistodus angulensis HARRIS, 1962, p. 199–201, Pl. 1, figs. 1a–c.
Drepanodus concavus Branson & Mehl. MOUND, 1965b, p. 16–17, Pl. 2, figs. 4–6.
Drepanodus incurvus (Pander). MOUND, 1965b, p. 18, Pl. 2, fig. 7 (*non* figs. 9, 11).
Drepanodus proteus Lindström. MOUND, 1965b, p. 18–19, Pl. 2, figs. 12, 13.
Oistodus contractus Lindström. MOUND, 1965b, p. 27, Pl. 3, figs. 27, 28.
Drepanodus homocurvatus Lindström. BRADSHAW, 1969, p. 1150, Pl. 135, fig. 8.
Drepanodus suberectus Branson & Mehl. BRADSHAW, 1969, p. 1150, Pl. 135, fig. 7.
Oistodus parallelus Pander. BRADSHAW, 1969, p. 1157, Pl. 134, figs. 1–3.
? *Scandodus* cf. *S. pipa* Lindström. BRADSHAW, 1969, p. 1161, Pl. 135, figs. 3, 4.
? *Drepanoistodus basiovalis* (Sergeeva). BARNES & POPLAWSKI, 1973, p. 775, Pl. 4, figs. 3, 4, 7.

The apparatus of this species is comprised of oistodiform elements, scandodiform elements, homocurvatiform elements, and suberectiform elements.

The suberectiform element has a relatively large basal region whose anterior-posterior dimension is well over half the length of the cusp. Cusp is biconvex with sharp edges; its surfaces may be smoothly swollen or they may have median ribs flanked by thin keels. The cusp is slightly curved along its length; base is continued slightly in the anterior direction at the base of the cusp and markedly in the posterior direction. Aboral margin of base is nearly straight from the anterobasal corner to a position beneath the posterior margin of the cusp, from which it rises in a regular curve to the posterior basal corner. Overall basal outline is markedly convex in the aboral direction. Base is thin anteriorly but inflated posteriorly.

Homocurvatiform elements are of the type generally identified under *Drepanodus homocurvatus* Lindström s.f. They are curved basally but straight distally. Cusp has lenticular section with sharp edges; leading edge may be turned to one side through region of curvature to basal margin. Anterior basal angle is ca. 60°; posterior basal angle ca. 45°. Base is swollen posteriorly but compressed anteriorly; basal cavity shallow with outline of "phrygian cap."

Scandodiform element is similar to the homocurvatiform element in the size and configuration of the cusp and the posterior part of the base. It differs in lacking a drawn out anterior basal region. Instead the anterior basal margin is curved throughout its length and rises to meet the leading edge of the cusp in a very obtuse angle or a continuous curve. No evidence of basal inversion was seen.

Oistodiform elements have a straight, reclined cusp whose length is about four times its basal width. Cusp is unequally biconvex with sharp edges. The more strongly swollen face has a rounded median ridge that is more prominent on small (juvenile?) individuals than on larger ones. Anterior basal corner is somewhat rounded at extremity; angle subtended by basal and anterior margins is about 80°. Basal outline is straight or slightly recessed in anterior basal region and rises in a marked curve from beneath the midpoint of the cusp to the posterior basal corner, where it meets the upper edge of the base in an approximate right angle. Free upper edge of base is short, of the order of one-third the basal width of the cusp or less. Basal cavity has "phrygian cap" outline and is very shallow anterior to the tip which is located beneath the midpoint of the bottom of the cusp. Base is inflated posteriorly and somewhat more strongly to one side than the other, compressed anteriorly.

Remarks.—The apparatus of this species generally compares to those of species of *Drepanoistodus* previously reported. The homocurvatiform and scandodiform elements are very similar to the corresponding elements that van Wamel (1974) and Löfgren (1978) included in their interpretations of the apparatus of the type species, *D. forceps* (Lindström). We did not find any drepanodiform elements that have lateral costae such as they reported in that species, however. The suberectiform element is more prominently expanded in the posterior part of the base than is the case in *D. forceps;* in this respect it resembles the suberectiform element of *D. basiovalis* (Sergeeva). The oistodiform element is the most easily identified component of the apparatus. It differs from most other species in the relatively short posterior base. In *D. forceps, D. basiovalis,* and *D. venustus* (Stauffer) the upper margin of the base is as long as or longer than the width of the lower part of the cusp. *Oistodus inclinatus* Branson and Mehl s.f., the oistodiform element of *Drepanoistodus suberectus* (Branson and Mehl), is similar to the oistodiform element of *D. angulensis* in having a short free base, but the angle between the cusp and the upper edge of the base is nearly a right angle in that form whereas it is an acute angle here.

Some of the oistodiform elements we include here are very similar in the conformation of their basal region to the oistodiform elements of *D. arcuatus* Pander, and isolated elements likely could not be identified as to species. We include these elements with more typical representative of *D. angulensis* because no drepanodiform elements of the *arcuatus* type are present in that part of the Kanosh Shale in which they occur.

Occurrence.—This species occurs in the Joins Formation in southern Oklahoma (Harris 1967, Mound 1965b) and in the Ft. Peña Formation of west Texas (Graves and Ellison 1941, Bradshaw 1969). Golden (1969) found it in the Everton Formation in northern Arkansas.

Range in the Pogonip.—This species ranges throughout the Kanosh and Lehman Formations and is present in the lower Watson Ranch Quartzite. It may be present also in the Crystal Peak Dolomite (see ? *D. angulensis* below).

Number of specimens.—Homocurvatiform and scandodiform elements, 681; suberectiform element, 96; oistodiform element, 287.

Repository.—Figured homocurvatiform element UMC 1091–20; figured scandodiform element UMC 1092–1; figured suberectiform element UMC 1092–2; figured oistodiform element UMC 1092–3; unfigured homocurvatiform element UMC 1092–4; unfigured scandodiform element UMC 1092–5; unfigured suberectiform element UMC 1092–6; unfigured oistodiform elements UMC 1092–7, 8.

? DREPANOISTODUS ANGULENSIS (Harris)
Pl. 3, figs. 16, 17

Remarks.—A species of *Drepanoistodus* is a minor component in the fauna of the Crystal Peak Dolomite. The homocurvatiform elements are generalized types that cannot be distinguished from those of *D. angulensis.* We did not find forms that conform to those we report as scandodiform in our discussion of that species, but this lack may be due to the relatively few specimens in our collections. The oistodiform and suberectiform elements seem transitional between those of *D. angulensis* and of *D. suberectus.* We exclude these from *D. angulensis* at this time in order to avoid giving a possibly erroneous report of the range of that species. Larger collections will be needed to evaluate the seeming differences in the suberectiform and oistodiform elements from those typical of *D. angulensis* and the absence of scandodiform elements.

Range in the Crystal Peak.—Homocurvatiform elements were recovered from the entire Crystal Peak, oistodiform elements were found only in the lower half of the formation and suberectiform elements in the upper half.

Number of specimens.—Homocurvatiform element, 64; suberectiform element, 10; oistodiform element, 14.

Repository.—Figured oistodiform element UMC 1092–9; figured suberectiform element UMC 1092–10; unfigured homocurvatiform elements UMC 1092–11, 12.

DREPANOISTODUS aff. D. BASIOVALIS (Sergeeva)
Pl. 3, figs. 25–27; fig. 13

aff. *Drepanoistodus basiovalis* (Sergeeva). LINDSTRÖM, 1971, p. 43, text-figs. 6, 8; LINDSTRÖM, 1973, p. 73, Drepanodus-Pl. 1, figs. 3, 4, LÖFGREN, 1978, p. 55–56, Pl. 1, figs. 11–17; text-fig. 26B, C.

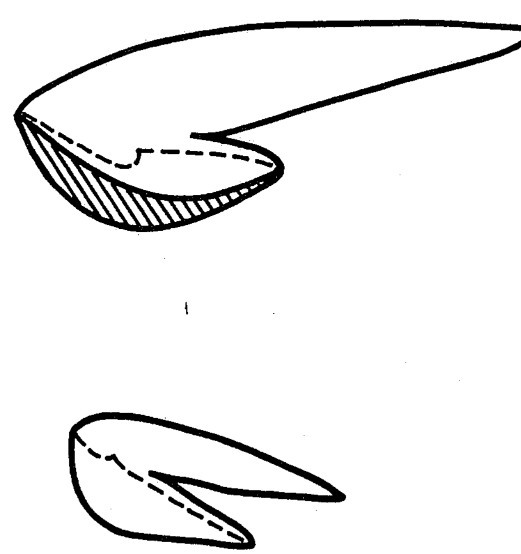

Figure 13.—Oistodiform elements of *Drepanoistodus* aff. *D. basiovalis* (top) and *Drepanoistodus* aff. *D. forceps* (bottom).

Remarks.—Oistodiform elements are similar in lateral view to the oistodiform elements of *D. basiovalis* in that the anterobasal region is rounded to somewhat pointed. The length of the base is about twice the anterior-posterior dimension of the proximal part of the cusp or slightly less. Aboral margin is broadly rounded on both sides. Sergeeva (1963) reported a ridge to be present on one face of the cusp in the type collection, but Löfgren (1978) observed that this ridge is faint if present on her specimens from central Sweden. Our material shows the cusp to be uniformly rounded to either side. The basal cavity is shallow with its apex overturned strongly in the anterior direction and located behind the middle of the cusp.

The drepanodiform elements associated with these oistodiforms are quite fragmentary, but homocurvatiform and suberectiform elements are present, thus representing a complete apparatus of *Drepanoistodus.* As noted by Löfgren (1978, p. 54), drepanodiform elements of species of *Drepanoistodus* are difficult to distinguish from each other. We found no objective differences between those we include here and those we list under *Drepanodus* aff. *D. forceps.* Assignment of the drepanodiform elements is made on the basis of the oistodiform elements with which they are associated.

Range in the Pogonip.—This species ranges through the lower 145 m (475 ft) of Fillmore Formation. It is associated in the upper part of that interval with the forms considered to have affinity with *D. forceps,* which in turn continues upward through the rest of the Fillmore and into the Wah Wah and Juab Formations as well. Lindström (1973) and Löfgren (1978) have shown that the species with which our forms are compared appear in the reverse stratigraphic order in the Lower Ordovician sequence of Sweden with *D. forceps* being the predecessor of *D. basiovalis.*

Number of specimens.—Homocurvatiform element, 277; oistodiform element, 196; suberectiform element, 60.

Repository.—Figured homocurvatiform element UMC 1092–13; figured oistodiform element UMC 1092–14; figured suberectiform element UMC 1092–15; unfigured suberectiform element UMC 1092–16.

DREPANOISTODUS aff. D. FORCEPS (Lindström)
Pl. 3, figs. 22–24; fig. 13

Oistodus forceps Lindström. ETHINGTON & CLARK, 1965, p. 194–195, Pl. 1, fig. 18; ETHINGTON & CLARK, 1971, p. 76, Pl. 2, fig. 8.
aff. *Drepanoistodus forceps* (Lindström). LINDSTRÖM, 1971, p. 42–43, text-figs. 5, 8; LINDSTRÖM, 1973, p. 75–76, Drepanodus—Pl. 1, figs. 5, 6; LÖFGREN, 1978, p. 53–55, Pl. 1, figs. 1–6, text-fig. 26A.
? *Drepanoistodus forceps* (Lindström). SERPAGLI, 1974, p. 46–47, Pl. 10, figs. 8a–12c, Pl. 21, figs. 9–14.

Remarks.—Oistodiform elements are broadly similar in lateral view to *Oistodus forceps* s.f. in having the base elongated in the posterior direction to resemble, as Lindström (1955) suggested, "the pincer of a crustacean." They differ, however, from the oistodiform elements of *D. forceps* in several characters that render identification of them with that species uncertain. In particular, the base is deeper than is typical among the numerous specimens of *D. forceps* in our collections from its type area in Sweden, and the anterobasal angle is less acute than on representatives of the latter species. *D. forceps* displays a pronounced costa on one face of the cusp, and the elements are somewhat flexed. By contract, our specimens show subdued costae and occupy a plane. Our collections of *D. forceps* s.s. display rather broad variation in all these characters, as well as in the length of the base relative to the cusp, so that selected specimens nearly duplicate those we consider here. The median characters of the two populations seem to be different, however. This evaluation may be biased by the relative sizes of the two collections, for a single sample from Sweden produces large numbers of specimens of *D. forceps* whereas the most abundant occurrence in the samples from the Pogonip was 17 specimens. They are closely related if not conspecific forms.

As noted under the discussion of *D.* aff. *D. basiovalis,* homocurvatiform and suberectiform elements from the Pogonip were assigned to species of *Drepanoistodus* on the basis of the associated oistodiform elements.

Occurrence.—We reported these forms earlier (1965, 1971) from the Columbia Ice Fields Section of Alberta and from the Ninemile Formation of Nevada. The oistodiform elements from the San Juan Limestone of Argentina that Serpagli (1974) illustrated as *D. forceps* seem close to those described above.

Range in the Pogonip.—This species is common in the Fillmore Formation above 133 m (435 ft) above the base and is present also in the Wah Wah and Juab Formations. One specimen was recovered from the lowest sample taken from the Kanosh Formation.

Number of specimens.—Homocurvatiform element, 468; oistodiform element, 149; suberectiform element, 58.

Repository.—Figured homocurvatiform element UMC 1092–17; figured oistodiform element UMC 1092–18; figured suberectiform element UMC 1092–19; unfigured oistodiform elements UMC 1092–20, UMC 1093–1, 2; unfigured suberectiform element UMC 1093–3.

Genus ERISMODUS Branson & Mehl, 1933
Type species.—*Erismodus typus* Branson & Mehl, 1933.

Remarks.—Branson and Mehl (1933) established the genus *Erismodus* to include some of the "fibrous" elements in the conodont fauna of the Harding Sandstone of central Colorado. The type material, like all of their Harding collection, is badly fragmented and is not satisfactory to display characters of the genus. Later in the same year Branson and Mehl established two additional form-genera, *Microcoelodus* and *Pteroconus* (subsequently renamed *Ptiloconus* by Sweet [1955] because the original name is preoccupied) for "fibrous" conodonts in the Joachim Formation of eastern Missouri. Lindström (1964, p. 145, 176) combined *Microcoelodus* and *Ptiloconus* under the former name as a form-group in which the denticles are situated anteriorly and posteriorly with respect to the cusp. He distinguished *Microcoelodus* from *Erismodus* whose denticles he considered to be arranged laterally relative to the cusp. Harris (1964b) reported difficulty in recognizing species of these genera and sought to differentiate them on the basis of symmetry by assigning symmetrical forms to *Microcoelodus* and asymmetrical forms to *Eris-*

modus. In contrast, Lindström (1964, p. 145) and Andrews (1967, p. 890–891) considered *Erismodus* to consist of symmetrical elements and *Microcoelodus* to be comprised of asymmetrical forms. Andrews ultimately concluded that the two form-genera constitute a transition series and that only one name, *Erismodus,* is required or valid.

Sweet and Bergström (1972, p. 34, 40, 41, 43) did not accept Andrews's conclusion, however. They interpreted *Ptiloconus gracilis* as an element of the apparatus of *Microcoelodus typus,* and indicated that this apparatus contains a transition series of elements, some of which cannot be distinguished from elements of the apparatus of *Erismodus.* They retained *Erismodus* as a multielement genus that is distinct from *Microcoelodus,* but they seemed to believe that the apparatuses of both consist of symmetrical elements and a transition sequence of increasingly asymmetrical forms.

We have compared the specimens we identify below with the type specimens of the several form-species of *Microcoelodus* that Branson and Mehl (1933) identified from the Joachim Formation and to well-preserved material from the Harding Formation. We have been unable to establish any objective criteria for distinguishing between *Microcoelodus* and *Erismodus* and accept Andrews's suppression of the former name as the junior subjective synonym.

ERISMODUS ASYMMETRICUS (Branson & Mehl)
Pl. 4, figs. 19–22

Microcoelodus alatus BRANSON & MEHL, 1933, p. 90, Pl. 6, figs. 31, 32.
Microcoelodus asymmetricus BRANSON & MEHL, 1933, p. 91, Pl. 7, figs. 5, 10, 11, 14, 15; BRANSON & MEHL, 1943, p. 383–384, Pl. 64, figs. 37, 39, 41, 46; BRANSON, 1944, p. 69, Pl. 10, figs. 13, 14, 24, 25, 31, 32.
Microcoelodus brevibrachiatus BRANSON & MEHL, 1933, p. 91–92, Pl. 7, figs. 3, 27.
Microcoelodus breviconus BRANSON & MEHL, 1933, p. 93, Pl. 6, fig. 29.
Microcoelodus duodentatus BRANSON & MEHL, 1933, p. 92, Pl. 7, fig. 7; BRANSON, 1944, p. 69, Pl. 10, fig. 18.
? *Microcoelodus expansus* BRANSON & MEHL, 1933, p. 93, Pl. 6, fig. 7.
Microcoelodus magnicornis BRANSON & MEHL, 1933, p. 93–94, Pl. 7, figs. 13, 17; BRANSON, 1944, p. 69, Pl. 10, figs. 27, 37.
Microcoelodus simplex BRANSON & MEHL, 1933, p. 94–95, Pl. 6, fig. 30, Pl. 7, fig. 23; BRANSON, 1944, p. 69, Pl. 10, figs. 48, 54.
Microcoelodus magnidentatus BRANSON & MEHL, 1933, p. 94, Pl. 7, figs. 8, 9.
Microcoelodus symmetricus BRANSON & MEHL, 1933, p. 95, Pl. 7, fig. 21; BRANSON, 1944, p. 69, Pl. 10, fig. 47.
Microcoelodus typus BRANSON & MEHL, 1933, p. 90, Pl. 6, figs. 31, 32; BRANSON & MEHL, 1943, p. 383–385, Pl. 64, figs. 12, 36, 54–56; BRANSON & MEHL, 1944, p. 241, Pl. 93, fig. 70; HASS, 1962, p. 45, text-fig. 23(2); LINDSTRÖM, 1964, p. 145, text-fig. 50a.
Microcoelodus unibrachiatus BRANSON & MEHL, 1933, p. 95, Pl. 6, fig. 23.
Microcoelodus unicornis BRANSON & MEHL, 1933, p. 96, Pl. 6, fig. 23.
Microcoelodus unilateralis BRANSON & MEHL, 1933, p. 96, Pl. 7, fig. 4; BRANSON, 1944, p. 69, Pl. 10, fig. 12.
Erismodus asymmetricus (Branson & Mehl). ANDREWS, 1967, p. 893–894, Pl. 112, figs. 1, 3, 6, 7, 14, 17, Pl. 113, fig. 1, Pl. 114, figs. 7, 9, 13.
Erismodus ? expansus (Branson & Mehl) ANDREWS, 1967, p. 895, Pl. 114, figs. 16, 23.
Erismodus gracilis (Branson & Mehl). ANDREWS, 1967, p. 894–895, Pl. 112, fig. 9.
Erismodus symmetricus (Branson & Mehl). ANDREWS, 1967, p. 892–893, Pl. 112, figs. 4, 5, 13, 16, 21, Pl. 113, fig. 7, Pl. 114, figs. 4, 18, 24.

Remarks.—The elements representing *Erismodus* in our collection from the Crystal Peak Dolomite were compared directly with specimens from the Joachim Dolomite of Missouri that Branson and Mehl (1933) and Andrews (1967) assembled as well as with material from the Dutchtown Formation of Missouri (Repetski 1973) and the Bromide Formation of Oklahoma (Branson and Mehl 1943). No obvious differences were discerned among the *Erismodus* elements of these collections. The range of morphologies in each case conforms to that indicated for *Erismodus* by Andrews (1967, text-fig. 2) and by Sweet and Bergström (1972, text-fig. 2F). The least common element is bilaterally symmetrical, the others are moderately asymmetrical and strongly asymmetrical elements, respectively. The latter elements outnumber the former in the entire Crystal Peak collection by a ratio of 3:2, although this is not a consistent relationship among the samples.

We have followed Andrews (1967) who, as first reviser, combined most of the form-species of *Microcoelodus* that Branson and Mehl identified from the Joachim Dolomite under *Erismodus asymmetricus.* Should *Microcoelodus* prove to be distinct from *Erismodus,* as hinted by Sweet and Bergström (1972), the valid name for the species is *M. typus,* the type species of the genus by original designation. That is not an available name for a species of *Erismodus,* however, because it becomes a homonym of the type species of that genus.

Erismodus asymmetricus is very similar to *Erismodus typus* from the Harding Sandstone, and isolated specimens certainly could not be identified with confidence. A restudy of the Harding fauna would be required to establish whether these are really two separate species.

Occurrence.—Because of the uncertain status of this species, we have interpreted it narrowly. As a consequence we are confident that the species in the Crystal Peak occurs also in the Joachim and Dutchtown Formations of Missouri (Branson and Mehl 1933, Repetski 1973); elements similar to some of those included here are known to occur as high as the Plattin Formation in Missouri (Branson and Mehl 1933), but the complete apparatus has not been recorded from those strata. The species also occurs in the Bromide Formation in Oklahoma (Branson and Mehl 1943). It has been reported to be present in the Glenwood Formation of Minnesota (Webers 1966) and in the lower Middle Ordovician of the Ottawa Valley (Barnes 1967) and New York (Schopf 1966).

Range in the Crystal Peak.—This species occurs in most of the samples collected from the type section of the Crystal Peak; greatest abundance was found in the highest sample which was obtained just beneath the Eureka Quartzite.

Number of specimens.—Symmetrical element, 1; moderately asymmetrical element, 38; strongly asymmetrical element, 62.

Repository.—Figured symmetrical element UMC 1093–4; figured moderately asymmetrical element UMC 1093–5;

figured strongly asymmetrical element UMC 1093–6; unfigured asymmetrical elements UMC 1093–7, 8.

Genus ERRATICODON Dzik, 1978
Type species.—*Erraticodon balticus* Dzik, 1978.

ERRATICODON aff. E. BALTICUS Dzik
Pl. 4, figs. 15, 17, 23, 24

"Fibrous" conodont-elements SWEET & BERGSTRÖM, 1962, p. 1249–1250, Pl. 169, figs. 1, 5, 13, 15, 16 (*non* figs. 2, 10).
"Crytoniodus" sp. ETHINGTON & SCHUMACHER, 1969, p. 479–480, Pl. 67, fig. 10; LEE, 1975, p. 131, Pl. 2, figs. 1, 2.
"Eoligonodina" sp. ETHINGTON & SCHUMACHER, 1969, p. 480, Pl. 68, fig. 17.
Oepikodus? sp. LEE, 1975, p. 135–136, Pl. 2, fig. 13.
Phragmodus inflexus Stauffer. LEE, 1975, p. 138–139, Pl. 2, fig. 11 (*non* fig. 10).
"Cordylodus" sp. of Sweet & Bergström. REPETSKI & ETHINGTON, 1977, p. 99.
"Tvaerenognathus" sp. REPETSKI & ETHINGTON, 1977, p. 100, Pl. 2, fig. 6.
? *Erismodus horridus* Harris. BARNES, 1977, p. 103, Pl. 2, fig. 8.
aff. *Erraticodon balticus* DZIK, 1978, p. 66, Pl. 15, figs. 1–3, 5, 6, text-fig. 6.
Subcordylodus sp. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 15.
Erismodus sp. A TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, figs. 23, 24.
Erraticodon sp. HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 3, figs. 1–5.

Neoprioniodiform element has denticles that are sharp edged, discrete, turned inward from the oral margin. Cusp is identical to all succeeding denticles except in length. Length of each denticle, of which at least three are present following cusp, is about half that of the denticle anterior to it. Aboral margin on convex side of element is convex downward both anteriorly and posteriorly of a shallow median recess. Outline of basal margin on opposite side is markedly sinuous, strongly convex anteriorly but becoming nearly straight posteriorly. Base is expanded on concave side of element in the region beneath the cusp.

Plectospathodiform element has a slender, erect cusp with a sharp posterior edge. Three processes bearing discrete, slender denticles are arranged posteriorly and laterally relative to the base of the cusp. The two lateral processes define a plane that intersects that of the posterior process at an angle of ca. 75° as seen from above. Each process is produced orally as a hairlike ridge on the lower part of the cusp. That costa that corresponds to the posterolaterally directed process extends diagonally across the cusp and assumes an anterior position at midheight; the opposite costa maintains a lateral position and dies out orally. A flaring basal cavity is located beneath the cusp and continues as troughs that radiate outward beneath the processes.

The cusp of the hindeodelliform element is proclined proximally and recurved to erect distally. It is sharp anteriorly; this edge may be keeled and deflected to one side in the lower reaches. Cusp is rounded laterally with a pair of posterolateral costae, one to each side, whose position and development are variable. Posterior edge of cusp is produced as an arched process that bears discrete denticles whose length increases away from the cusp. One of the lateral costae is produced as a deep process that bears discrete denticles. The angle between the lateral and posterior processes ranges from 30 to 70° among the specimens at hand. Hairlike slits on the blunt undersides of the processes lead into a conical excavation in the base of the cusp.

Cusp of the trichonodelliform element is flanked by a pair of stout lateral denticles and is continued posteriorly as a denticulate process. Low, sharp costae are located anterolaterally on the cusp, and a posterior median costa is present. Anterior face of cusp is broadly convex, posterior face strongly so. Cusp is recurved posteriorly above its juncture with the basal region. Lateral denticles are heavy; they begin beneath the level of the aboral margin of the posterior process and rise nearly to midheight of the cusp. Basal cavity is broad and shallow with its greatest depth in the anterior region.

Remarks.—We have followed the elemental designations used by Dzik (1978) in order to facilitate comparison with his species. The neoprioniodiform and plectospathodiform elements in our collection seem very close to those described by Dzik, but the hindeodelliform elements from Utah are quite different from the material from Poland. We did not find specimens that we could identify with the ozarkadiniform elements of *E. balticus*, although some of the forms we assigned to *Erismodus* may be of this type.

Occurrence.—This species occurs in the Copenhagen and Antelope Valley Formations of central Nevada (Ethington and Schumacher 1969, Harris and others 1979); the Womble Shale of Arkansas (Repetski and Ethington 1977); the Pratt Ferry Formation of Alabama (Sweet and Bergström 1962); and the Sunblood Formation of the southern District of Franklin, Canada (Tipnis and others 1978). Lee (1976) has illustrated specimens from Korea that probably belong here. Dzik's (1978) material was collected from an erratic boulder.

Range.—A specimen was found near the base of the Lehman Formation at Crystal Peak; the species is present in the lower Watson Ranch Quartzite and ranges to the top of the Crystal Peak Dolomite.

Number of specimens.—Neoprioniodiform element, 27; plectospathodiform element, 8; hindeodelliform element, 24; trichonodelliform element, 1.

Repository.—Figured hindeodelliform element UMC 1093–9; figured neoprioniodiform element UMC 1093–10; figured plectospathodiform element UMC 1093–11; figured trichonodelliform element UMC 1093–12; unfigured plectospathodiform element UMC 1093–13.

? ERRATICODON sp.
Pl. 4, fig. 18

Remarks.—The elements considered here occur sporadically in the section at Crystal Peak where they are associated with the elements of *Erraticodon* aff. *E. balticus*. Perhaps they are an unusual and infrequent variant of one of those elements, but we are reporting them separately because they do not occur with the frequency of the others. The elements are hyaline with a prominent, slender recurved cusp that is somewhat twisted along its length. Edges of the cusp are keeled. Denticles posterior to the cusp alternate in size. At least one anterolateral denticle is present as an extension of the anterior costa of the cusp.

These elements have moderate similarity to the specimen that Dzik (1978, Pl. 15, fig. 1) illustrated as an ozarkodiniform element of *E. balticus*. That specimen has two denticles anterior to the cusp, and the posterior denticles are subuniform in size.

Range in the Ibex area.—Specimens were recovered from near the base of the Lehman Formation and from the lower part of the Crystal Peak Dolomite at Crystal Peak.

Number of specimens.—12.

Repository.—Figured specimen UMC 1114–12.

Genus FALODUS Lindström, 1955
Type species.—*Oistodus prodentatus* Graves & Ellison, 1941.

FALODUS sp. s.f.
Pl. 4, figs. 13, 14

Falodid with arched base; cusp reclined at angle of about 45° to oral margin of free base. Cusp biconvex in transverse section, with anterior and posterior keels. Cusp is in line with anterior basal extension but may be twisted and bent so that it does not lie wholly in plane of base. Anterior keel breaks up into short fused denticles, of which two or more are present, near anterior basal extremity. Posterior free base bears sharp keel which increases in height away from the cusp. Base is expanded laterally near the middle as a continuation of swollen lateral faces of the cusp. Aboral surface is excavated along entire length in the form of shallow anterior and posterior troughs that merge to form a flared, subconical pit beneath cusp. Basal inversion is shown along the aboral margin of the elongate anterior part of the base.

Remarks.—Falodiform elements commonly are present as homologues of the oistodiform element in the apparatus of a number of Ordovician conodonts. We suspect that is the case with the elements described above, but we are unable to identify with which apparatus they properly belong. Their stratigraphic range overlaps several possible species, but does not coincide with any of them. Possible assignment includes the oistodiform position in the apparatus of *Scandodus sinuosus* Mound or of a species of *Pteracontiodus*. The falodiform elements have the same general range as the elements of *Pteracontiodus gracilis*, n. sp., but they are much more robust in the samples in which they occur together than are the elements of that species. We considered the possibility that the apparatus of *Paraprioniodus costatus* n. sp. includes an oistodiform (falodiform) element, but these specimens are distributed too sporadically and in too few numbers in the Lehman Formation to provide much support for that interpretation.

Harris (1964b) reported elements generally similar to those described above as *Eofalodus brevis* from the lower Joins Formation of southern Oklahoma. His study was a superficial treatment of the rather voluminous conodont fauna of that formation and did not cover most of the elements represented there. Another species that he recognized, *Oistodus linguatus bilongatus* Harris, closely resembles the falodiform elements except that the anterior denticles are lacking. Owing to inadequacy of treatment, it is not possible to interpret elemental associations in the Joins from Harris's work. Mound's (1965b) study of the conodonts of the Joins has not proven reliable either for identification or for stratigraphic distribution of taxa within the formation. He illustrated (1965b, Pl. 2, fig. 17, Pl. 3, fig. 36) specimens that seem to be the same as the forms reported by Harris, treating them both as form-taxa. McHargue (1975) reexamined the conodonts of the Joins systematically and found falodiform elements like those reported here to occur near the top of the unit. He interpreted them as parts of the apparatus of an unnamed species of *Eoneoprioniodus* (= *Pteracontiodus* herein).

We conclude that the most probable interpretation of these specimens, based on what is known of conodonts from the Joins, is that they belong to a species of *Pteracontiodus* in which they represent an unusual variant of the oistodiform element. We cannot establish on the basis of our material and the associated elements to which species they should be assigned.

Range in the Pogonip.—Present throughout the Lehman Formation at Crystal Peak.

Number of specimens.—71.

Repository.—Figured specimens UMC 1113–15, 16; unfigured specimen UMC 1113–17.

Genus HISTIODELLA Harris, 1962
Type species.—*Histiodella altifrons* Harris, 1962.

Remarks.—*Histiodella* was established in form-taxonomy by Harris for blade-shaped elements with peaked oral margins that are composed of albid material in all but their basal regions. Subsequently, Mound (1965b) described an element, also in form-taxonomy, that has a prominent median rib arranged normal to a bilaterally symmetrical blade. Both Mound (1965b) and Sweet, Ethington, and Barnes (1971) reviewed the species of *Histiodella* known to them and concluded that increasing differentiation of the blade into fused denticles is displayed by successively younger forms. Abundant specimens of *Histiodella* were recovered from the Joins Formation of Oklahoma by McHargue (1975) who reconstructed an apparatus for the older species of the genus that includes at least five kinds of elements. His interpretation is consistent with the histiodellids in our collections from the Kanosh Shale and we follow it here, although we have very few specimens of elements other than the blades for which the generic name was proposed. Further, the nonblade elements have not been found in occurrences of the youngest species identified with *Histiodella*. A detailed evaluation of the elemental structure of the apparatus of *Histiodella* is being prepared separately (McHargue, in preparation).

HISTIODELLA ALTIFRONS Harris
Pl. 4, figs. 5–12

Histiodella altifrons HARRIS, 1962, p. 208–209, Pl. 1, figs. 4a–c; MOUND, 1965b, p. 21, Pl. 2, figs. 23, 26, 27.
Histiodella triquetra MOUND, 1965b, p. 23–24, Pl. 3, figs. 10, 11, text-fig. 1G.
Histiodella sinuosa (Graves & Ellison). BRADSHAW, 1969, p. 1151–1152, Pl. 137, fig. 26 (*non* figs. 24, 25); SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 43; HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, fig. 12.

Remarks.—The most abundant component of the apparatus of this species in our collections is the elongate blade-shaped element. Typically it is about 2.5 times as long as the greatest vertical dimension. The blade is albid, whereas the narrow basal region is dark. The most distinctive feature of these elements is their oral outline, which rises steeply at the anterior extremity and follows a straight to slightly depressed course from that position to the peak which is located about one-fifth of the way anterior from the posterior extremity. Posterior to the peak the oral outline descends steeply to the posterobasal corner. The oral outline may be sharply defined, or it may display pronounced indentations, particularly near the anterior end. No indication of denticles is to be seen on or within the blade. Poorly defined ribs to either side extend from the peak anteriorly and downward to the position of the basal cavity. The element is swollen slightly to each side at the bottom of the blade, then constricts before expanding again to the basal margin. The base is excavated throughout by a wide trough that deepens regularly from either end to a point at or slightly behind midlength, at which position the base is slightly flared to one side. A few specimens have lateral ridges that extend from the base to the oral margin and suggest incipient lateral processes.

Two specimens from the lower Kanosh are foreshortened blades (see Pl. 4, fig. 8) that generally resemble the elements described above except that the oral margin descends steeply to the basal margin just ahead of the peak. The holotype of the species has this form. Such elements may be juveniles of the elongate blades; if so, growth in the anterior direction far exceeded growth in all other directions during ontogeny of these elements.

One specimen is a thin, slender, acuminate blade (Pl. 4, fig. 12) that is somewhat bowed and twisted, but with no modifications of the lateral surfaces. Two other specimens (Pl. 4, figs. 10, 11) are quite similar in overall form but distinct in having a prominent lateral process developed on the concave side. The aboral margin is arched on these specimens, and the lateral process and main blade are excavated to form a common basal cavity. The process is curved from bottom to top; it abuts against the blade slightly behind the midpoint and is situated increasingly posteriorly at higher levels. The twisted blade may be a juvenile form of the latter kind of element; McHargue (1975) recognized these two forms as distinct elements of the *H. altifrons* apparatus in his study of conodonts from the Joins Formation.

We found only one specimen (Pl. 4, fig. 9) of the form of *Histiodella triquetra* Mound, which McHargue interpreted as a symmetrical element in the apparatus of *H. altifrons.* It has an inverted heart-shaped blade with unmodified margins, and a low process normal to the surface of the blade and occupying the plane of symmetry.

The oistodiform elements (Pl. 4, figs. 5, 6) are characterized by having a broad cusp with thin, sharp edges. The cusp may be biconvex, but more commonly it is bladelike with a faint to strong, rounded ridge on the inner side just ahead of the posterior margin. The anterior margin has a straight outline distally but becomes more strongly curved near the base. The leading edge may be continuous with the aboral margin, but typically an obtuse anterobasal angle is present. The base is little inflated except for minor swelling where the ridge continues across it from the cusp. The basal region is very shallow in comparison to the size of the cusp. Posterior part of the base is short, low; its keeled upper margin forms an angle of 10–20° with the posterior margin of the cusp. Basal cavity is very shallow anteriorly; it deepens abruptly to a point beneath the rear part of the cusp. Posterior to this point of deepest penetration, the cavity becomes progressively shallow. The aboral margin is arcuate with strongest curvature beneath the cusp. In lateral view, the lower margin of the posterior region of the base is subparallel to the leading edge of the cusp. The cusp and the oral keel of the base are wholly albid.

Mound (1965b) and Sweet and others (1971) interpreted the specimen that Graves and Ellison (1941) described as *Bryantodus sinuosa* as showing incipient denticulation reflected by serration of the oral margin in the anterior region. The specimens which they reported as *Histiodella sinuosa* (Graves and Ellison) and which are characteristic of Fauna 2 of Sweet and others are the elongate bladelike elements of *Histiodella altifrons* described above.

Occurrence.—Histiodella altifrons is present in the lower Joins Formation of Oklahoma (Harris 1962, Mound 1965b, McHargue 1975) and in the Fort Peña Formation of the Marathon Region of west Texas (Bradshaw 1969). It also occurs low in the Antelope Valley Formation in central Nevada (Harris and others 1978). Fåhraeus (1970 reported *H. altifrons* to be present near the middle of the Table Head Formation in western Newfoundland.

Range in the Pogonip.—The lowest occurrence of this species is just above the base of the Kanosh Formation at Fossil Mountain (I–K–3A); it ranges throughout most of the formation with its highest occurrence in sample I–K–13A.

Number of specimens.—Elongate blade, 212; short blade, 2; twisted slender blade, 1; asymmetrical element, 2; symmetrical element 1; oistodiform element, 17.

Repository.—Figured specimens: elongate blade UMC 1093–14; short blade UMC 1093–15– twisted blade UMC 1093–16; asymmetrical elements UMC 1093–17, 18; symmetrical element UMC 1093–19; oistodiform elements UMC 1093–20, UMC 1094–1.

HISTIODELLA HOLODENTATA n. sp.
Pl. 4, figs. 1, 3, 4, 16

? *Spathognathodus* n. sp. 4 LINDSTRÖM, 1960, text-fig. 5(3).

? *Spathognathodus* n. sp. Lindström. FÅHRAEUS, 1970, p. 2073, text-fig. 3I.

? *Spathognathodus* sp. UYENO & BARNES, 1970, p. 117, Pl. 24, figs. 12, 13; VIIRA, 1974, p. 125, Pl. 5, figs. 39, 40, text-fig. 163a, b.

Histiodella sp. A SWEET, ETHINGTON & BARNES, 1971, p. 167, Pl. 1, fig. 16; BERGSTRÖM, 1977, p. 573.

Histiodella sinuosa (Graves and Ellison). BARNES & POPLAWSKI, 1973, p. 776, Pl. 1, figs. 17, 18.

? *Histiodella serrata* Harris. LANDING, 1976, p. 633–634, Pl. 1, fig. 20; DZIK, 1976, text-fig. 12d; DZIK, 1978, p. 53, Pl. 14, fig. 7, text-fig. 1(21), Table 1.

Histiodella n. sp. 1 HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, fig. 9.

Blade-shaped elements in which the blade is differentiated into numerous slender, fused denticles. A large, reclined denticle whose basal length is about one-fourth that of the entire blade has its front margin located about at midlength. Lateral faces of this denticle may carry faint median costae, although on many specimens this denticle is uniformly biconvex in transverse section. Large denticle is fused to those immediately anterior and posterior to it; its apex is the highest point along the oral margin. Free edge of major denticle is more steeply inclined posterior to the apex than anteriorly. Posterior denticles all are reclined parallel to the major denticle; they are fused throughout almost their entire lengths and decline in length to a short peg at the posterior extremity. The number of posterior denticles varies from 6 to 10 with most specimens toward the lower end of that range. Anterior denticles are broader than those located posteriorly. Those adjacent to the large denticle are reclined posteriorly, but those farther away are oriented vertically; slight decrease in length occurs anteriorly in the series. Anterior extremity of the blade is flexed to one side on most specimens. The blade is crimped in the basal region; many specimens are somewhat swollen to produce a faint longitudinal ledge just above the crimped region. The narrow aboral region is occupied by a longitudinal slit that expands slightly beneath the base of the largest denticle. The basal region of the blade is hyaline in contrast to the albid matter of the blade. Some specimens retain a basal trough (funnel) which adheres to the aboral surface throughout its length and is expanded medially.

Remarks.—We did not find oistodiform elements in association with these bladelike elements in any of the occurrences reported here, and such elements are not present in large collections of this species from the Antelope Valley Formation of central Nevada assembled by one of us (RLE). A single specimen resembling *Histiodella triquetra* Mound was found within the range of these blades in the Lehman Formation, but none have been found in Nevada. This species appears to have had an apparatus comprised almost exclusively of bladelike elements, assuming that the symmetrical element from the Lehman belongs here. That specimen could, however, represent an element of *H. sinuosa* which was recovered above the interval in which that species is abundant. *Histiodella holodentata* and *H. sinuosa* have overlapping stratigraphic ranges in Nevada, so that mutual occurrence of the two species in the Lehman is not impossible.

If the apparatus of *Histiodella* was interpreted correctly by McHargue (1975), the species defined here lacks two of the elements. Should this be documented conclusively by further work, a new genus may be necessary for *H. holodentata.* The concentration of white matter throughout the blade and the hyaline, crimped base are so similar to the characters displayed by bladelike elements of species of *Histiodella* that affinity is obvious.

Harris and others (1979) recognized a generally similar histiodellid element in the Antelope Valley Formation of Nevada and identified it as *Histiodella* n. sp. 2 in contrast to *H. holodentata* which they termed *Histiodella* n. sp. 1. That species resembles *H. holodentata* in overall outline but is distinct in having the basal shoulder more strongly developed along the length of the blade than is typical here. The most distinguishing characteristic is a pronounced, laterally directed knob or lip that projects from the lateral shoulder at midlength; such a feature is never present on *H. holodentata.* Although the two forms occur together in at least one sample from the upper Antelope Valley Limestone on Martin Ridge in the Monitor Range, central Nevada, *H. holodentata* is the older of the two and probably is a direct ancestor of the other form. The younger species apparently has an apparatus comprised almost totally of blades also, although one sample (collection of RLE) from the Antelope Valley Limestone at the March Spring Section in the Toquima Range, central Nevada, has two oistodiform specimens with falodid anterior denticles which resemble in overall outline the oistodiform elements included above in *H. altifrons* and *H. sinuosa.*

Derivation of New Name.—*Holo,* wholly, plus *dentata,* toothed, to denote the subdivision of the entire blade into denticles.

Occurrence.—This species occurs in the Antelope Valley Limestone of central Nevada (Harris and others 1979) and in the Mystic Conglomerate (Barnes and Poplawski 1973). A specimen recovered from the Deepkill Shale of New York and identified as *H. serrata* by Landing (1976) may be transitional between *H. sinuosa* and *H. holodentata,* although its age seems considerably older than the specimens reported here. Viira (1974) illustrated specimens from the subsurface of Estonia that she identified as *Spathognathodus* sp. but which probably represent the unnamed younger species (*Histiodella* n. sp. 2 of Harris and others 1979) that occurs above *H. holodentata* in the Antelope Valley Limestone; the same form has been reported under the name *Spathognathodus* in reports of early Middle Ordovician conodonts from the Lévis Formation in eastern Canada, from the island of Öland in the Baltic region of northern Europe, and from the Table Head Formation of Newfoundland (see Uyeno and Barnes 1970, Lindström 1960, Fåhraeus 1970). Dzik (1978) has reported as *H. serrata* some specimens from the Mójcza Limestone of the Holy Cross Mountains of Poland that seem close to *H. holodentata.* Bergström (1977) found *H. holodentata* in the Hølonda Limestone in Norway.

Range in the Pogonip.—The species occurs in the upper Lehman and lower Watson Ranch at Crystal Peak.

Number of specimens.—Bladelike element, 215; ? symmetrical element, 1.

Repository.—Figured bladelike elements UMC 1094–2 (holotype), 3, 4 (paratypes); figured symmetrical element UMC 1094–5 (paratype).

HISTIODELLA MINUTISERRATA Mound
Pl. 5, fig. 11

Histiodella sinuosa (Graves & Ellison). LINDSTRÖM, 1964, text-fig. 54c [bottom specimen only; top specimen is *H. sinuosa*].

Histiodella minutiserrata MOUND, 1965b, p. 21–22, Pl. 3, figs. 1–3, text-fig. 1F.

Remarks.—Mound established this name to include bladelike elements whose general outline is very similar to the elongate blades of *H. altifrons,* but which are distinct in having a minute sawtooth development along the oral margin. McHargue (1975) found numerous specimens of this type in his large collection from the Joins Formation and noted that similarly serrate elements corresponding to all but the oistodiform element of *H. altifrons* were present as well. Both Mound and McHargue inferred that these serrations represent an incipient stage in the progressive development of denticles in the blade of successive species of *Histiodella* in lower Middle Ordovician rocks. Furthermore, McHargue observed that the greatest abundance of these serrate elements is in strata higher in the Joins than those in which *H. altifrons* is dominant but beneath those characterized by numerous specimens of *Histiodella sinuosa* (Graves and Ellison), although continuous overlap exists in the ranges of each of these species.

We found only one specimen, an elongate blade, in the Kanosh that shows the distinctive sawtooth pattern of *H. minutiserrata.* This feature is so faintly developed, however, that abraded specimens likely would have lost it, so that some of the specimens we interpret as elongate blades of *H. altifrons* may belong here. We cannot evaluate the conclusion that these forms are intermediate between *H. altifrons* and *H. sinuosa* on the basis of the collections from the Pogonip because of the rarity of *H. minutiserrata.* Such forms are fairly abundant in the Antelope Valley Formation of Nevada (collections of RLE), and our observation of that material leads us to have reservation about that interpretation. In particular, the serrations are far more numerous and of much smaller dimensions than the denticles that develop in the younger species of *Histiodella.* No specimens that we have seen display a tendency for the individual teeth of the saw blade to be accentuated to form distinct denticles. Perhaps these serrate forms represent phenotypic variants of *H. altifrons* or a descendant species that is not in the same lineage with *H. sinuosa.*

Occurrence.—Serrate histiodellids occur in the Joins and Oil Creek Formations of Oklahoma (Lindström 1964, Mound 1965b, McHargue 1975) and in the Antelope Valley Formation of central Nevada (collections of RLE).

Range in the Pogonip.—Lower Kanosh at Fossil Mountain (I–K–7).

Number of specimens.—1.

Repository.—Figured hypotype UMC 1094–6.

HISTIODELLA SINUOSA (Graves & Ellison)
Pl. 5, figs. 1–3, 5–7

Bryantodus sinuosa GRAVES & ELLISON, 1941, p. 9–10, Pl. 2, fig. 13 (identified as *Bryantodina sinuosa* on p. 4 and in Plate legend).

Histiodella serrata HARRIS, 1962, p. 209, Pl. 1, fig. 3; MOUND, 1965b, p. 22–23, Pl. 3, figs. 4, 6, 7; NIEPER, 1969, Pl. O VII, fig. 12; SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 39; HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, figs. 10, 11.

Histiodella sinuosa (Graves & Ellison). LINDSTRÖM, 1964, text-fig. 54c, top specimen only (bottom specimen is *Histiodella minutiserrata*); BRADSHAW, 1969, p. 1151–1152, Pl. 137, figs. 24, 25 (*non* fig. 26, = *Histiodella altifrons*).

non Histiodella sinuosa (Graves & Ellison). BARNES & POPLAWSKI, 1973, p. 776, Pl. 1, figs. 17, 18.

Remarks.—The characters of mature elongate blades in the apparatus of *Histiodella sinuosa* were clearly established by Harris (1962) and by Mound (1965b) in their discussions of *Histiodella serrata,* under which name they described these elements. We have compared our collections, as well as the specimens described by those authors, with the single specimen of *H. sinuosa* reported by Graves and Ellison. That specimen clearly falls within the range of variations of the much larger collections from the Joins Formation.

Unlike in *H. altifrons* where the blade retains sharp outlines throughout ontogeny, denticles are clearly differentiated at an early stage in the development of elements of *H. sinuosa.* The denticles appear anterior to the peak at an earlier stage than do those located posteriorly. One immature form in our collection has seven anterior denticles but none behind the peak. Posterior denticulation seems to be confined to late stages of growth. Anterior denticles are separated by well-defined interdenticular troughs that extend from the oral margin across at least half the height of the blade, and in most specimens they reach nearly to the swollen basal region. Faint striae extend from just above this basal shoulder to the oral margin. By contrast, all specimens of *H. altifrons* available to us exhibit smooth, highly reflective surfaces at magnifications up to 100 diameters.

The elongate blades of *H. sinuosa* are similar in outline to those of *H. altifrons,* and robust specimens of the latter with coarse indentations in the oral margin may be mistaken for the former. Isolated specimens may be difficult to identify, especially if extreme variants of either one of them are represented. The ranges of the two species overlap in the Kanosh in western Utah and in the Antelope Valley Formation in Nevada, but McHargue (1975) reported them to be stratigraphically separated in the Joins Formation of Oklahoma. Specimens of *H. sinuosa* in which posterior denticulation is well developed may be difficult to distinguish from elongate blades of *Histiodella holodentata* n. sp. These species do not have common ranges in the Pogonip of western Utah, but they overlap in the Antelope Valley Formation in central Nevada (Harris and others 1979), so that again isolated specimens may offer difficulty of identification.

McHargue (1975) reported this species to have the same elemental composition in its apparatus as *H. altifrons.* We found only two specimens representing the symmetrical element which resembles that of *H. altifrons* except for the development of denticles along the oral margin. The oistodiform element of the species does not differ significantly from that of *H. altifrons,* and specimens could not be identified in the absence of more diagnostic elements of the respective apparatuses.

Occurrence.—In addition to its occurrences in the Joins Formation of southern Oklahoma (Harris 1962, Lindström 1964, Mound 1965b, McHargue 1975), this species is present also in the Everton Formation of northern Arkansas (Golden 1969), in the Fort Peña Formation of west Texas (Bradshaw 1969), and in the Antelope Valley Formation of central Nevada (Harris and others 1979). Nieper (1969) illustrated a specimen that is transitional to *H. holodentata* from the Nora Formation of Queensland, Australia. It is a characteristic element of Fauna 3 of Sweet and others (1971), who identified it as *Histiodella serrata.*

Range in the Pogonip.—Continuous through upper Kanosh at Fossil Mountain and lower Lehman at Crystal Peak; two isolated specimens found high in the Lehman.

Number of specimens.—Elongate blades, 121; symmetrical element, 2; oistodiform element, 16.

Repository.—Figured hypotypes: elongate blades UMC 1094–7, 8, 9, 10; symmetrical element UMC 1094–11; oistodiform element UMC 1094–12.

? HISTIODELLA sp.
Pl. 5, fig. 18

Remarks.—A fragmented specimen from lower Fillmore may represent a species of *Histiodella.* The specimen is thermally altered (CAI 4) but seems to have been largely albid except for the base. It is bilaterally symmetrical, thin, with a broadly swollen face and a shallowly depressed opposite face. Edges are blunt; they converge apically at an angle of about 30°; distal extremity is missing. Base has been damaged so that details are uncertain; a shallow basal cavity is suggested.

Occurrence.—Repetski (1975, and in press) found a transition series of elements, including forms like that described here, in the El Paso Group of western Texas. The same range of morphologies is represented in the conodonts of the Manitou Formation near Colorado Springs, Colorado (undescribed collection of RLE).

Range in the Pogonip.—The only specimen in our collection came from 161.5 m (530 ft) above the base of Fillmore Formation at Section C.

Number of specimens.—1.

Repository.—Figured specimen UMC 1094–13.

Genus JUANOGNATHUS Serpagli, 1974
Type species.—*Juanognathus variabilis* Serpagli, 1974.

JUANOGNATHUS JAANUSSONI Serpagli
Pl. 5, figs. 12, 13

Conodont gen. et sp. indet. UYENO & BARNES, 1970, p. 118, Pl. 22, figs. 11, 12.
Juanognathus jaanussoni SERPAGLI, 1974, p. 50–51, Pl. 11, figs. 8a–12c, Pl. 23, figs. 1a–5b, text-fig. 9.

Remarks.—Serpagli's description and illustrations are very thorough, and we find no differences between our specimens and those he reported.

The specimens from the Columbia Ice Fields section of Alberta that Serpagli included in his synonymy (*Acodus* n. sp. of Ethington and Clark 1965) belong in *Acanthodus* Furnish and not here. The form reported by Lee (1970) as a species of *Paltodus* Pander and included in the synonymy by Serpagli is less certain, but probably it does not belong in *J. jaanussoni* because it displays three keeled edges.

Occurrence.—This species is known to occur in the San Juan Limestone of Argentina (Serpagli 1974), in the El Paso Group in west Texas (Repetski 1975, and in press), and in the Lévis Formation in Quebec (Uyeno and Barnes 1970).

Range in the Pogonip.—*J. jaanussoni* was found in the Wah Wah Formation at Section J; it ranges from low in the Wah Wah through the lower Kanosh at Fossil Mountain.

Number of specimens.—66.

Repository.—Figured hypotypes UMC 1094–14, 15.

JUANOGNATHUS VARIABILIS Serpagli, 1974
Pl. 5, figs. 8–10, 17

Acodus ? sp. B IGO & KOIKE, 1967, p. 14–15, Pl. 3, figs. 15a, b, text-fig. 4K.
Acontiodus sp. B IGO & KOIKE, 1967, p. 17, Pl. 2, fig. 15, text-fig. 4.
Scolopodus staufferi (Furnish). IGO & KOIKE, 1967, p. 25, Pl. 3, fig. 13, text-fig. 6E.
Scolopodus sp. A IGO & KOIKE, 1967, p. 26, Pl. 2, figs. 7a, b, text-fig. 5I.
Paltodus sp. D ETHINGTON & CLARK, 1971, p. 67, 77, Pl. 2, fig. 7.
Protopanderodus ? sp. BARNES & POPLAWSKI, 1973, p. 785, Pl. 1, fig. 15.
Juanognathus variabilis SERPAGLI, 1974, p. 49–50, Pl. 11, figs. 1a–7c, Pl. 22, figs. 6–17, text-fig. 8.

Recurved cones with great variation among the cross sections of the elements. Most are depressed with a broadly rounded anterior face and sharp lateral edges. Posterior face has rounded median ridge which, on a few specimens, shows a shallow groove either along the midline of the ridge or slightly to one side. Ridge is flanked by flat areas to either side that terminate laterally in sharp edges. These lateral areas are very narrow near the tip of the element and on most specimens become progressively wider in the basal direction. Generally they are subequal in area, but on some specimens one is distinctly wider than the other. In such specimens there may be a fan-shaped salient to one side near the basal margin; these salients commonly suggest incipient denticulation along their free margin.

Element is twisted at about midlength; degree of torsion is variable so that some specimens approach bilateral symmetry whereas others are so strongly twisted that the lateral edges are rotated distally to almost the anterior-posterior positions. In these extreme cases the convexity of the anterior surface is greatly distorted. Basal cavity is subtriangular in cross section. In broad specimens it is shallow whereas it is considerably deeper in specimens whose width is small compared to length. The tip of the cavity reaches the general level of the element at which torsion occurs. Base is inflated in the posterior direction to accommodate lower reaches of the cavity.

Remarks.—Our material from the Pogonip compares very closely to the type collection. Serpagli (1974, p. 50) postulated that an oistodiform element might be associated with these forms, but we have not found an obvious associate in our collections. He also suggested that those forms from Korea that Lee (1970) described as *Distacodus stolus* Lindström perhaps should be assigned here also. However, the illustrations suggest elements of the type Moskalenko (1967) identified as *Distacodus baikiticus,* and we believe them to be distinct from the present species.

Occurrence.—Igo and Koike (1967) found these elements, which they reported under several form-species, in the lowest sample they processed from the Setul Limestone of Malaya. A single specimen that almost certainly belongs here was reported by Barnes and Poplawski (1973) from the Mystic Conglomerate of Quebec as *Protopanderodus?* sp. The type collection is from the San Juan Formation of Argentina (Serpagli 1974).

Range in the Pogonip.—We recovered these elements from the Fillmore Formation in Section H (210–280.7 m

[690–921 feet]) and in Section ST (73–128 m [240–420 feet]). It also occurs in the Wah Wah at Section H (samples 1–13) and near the base of Fossil Mountain (I–WW–2, 3B, 5, 6), but does not range to the top of the formation.

Number of specimens.—205.

Repository.—Figured hypotypes UMC 1094–16, 17, 18, 19; unfigured hypotypes UMC 1094–20, UMC 1095–1.

Genus JUMUDONTUS Cooper, 1981

Type species.—*Jumudontus gananda* Cooper, 1981.

Remarks.—Cooper (1981) defined *Jumudontus* to include specimens from the Horn Valley Siltstone of central Australia. As presently known, the apparatus in this genus consists wholly of bladelike, multidenticulate elements that lack a cusp. The basal portion of the blade is expanded toward one end (defined as posterior by Cooper but treated herein as anterior) to accommodate a basal cavity or a broad basal surface. Elements may be wholly hyaline or may display both albid and hyaline regions.

We have previously (1964) identified these forms with *Spathognathodus* in the form sense, but marked asymmetry of the base and a broad but only slightly excavated basal surface are not developed on any of the elements defined under that name. The type species of *Spathognathodus*, *S. primus* (Branson and Mehl), is a Silurian form which has been interpreted as an element of an apparatus for which the names *Ozarkodina* Branson & Mehl (Lindström 1970) and *Hindeodella* Bassler (Jeppsson 1969) have been used. Whatever the proper name for this apparatus, *Spathognathodus* will be suppressed. Presently we know of no other elements that would be associated in an apparatus with those considered here. Should future investigations identify a multielement apparatus including these elements, that apparatus likely would not be similar to the Silurian apparatus containing *S. primus* elements.

Cooper (1981) postulated that *Jumudontus* probably is related to *Loxodus* Furnish, 1938, but did not offer reasons to support this conclusion. As presently known, both genera have apparatuses that include only one type of element, a multidenticulate blade, but they offer only superficial similarity in form. At this stage of knowledge of these genera, relationship between the two is conjectural. Cooper also suggested affinity to *Histiodella* Harris, 1962. The apparatus of the latter species includes a variety of bladelike elements as well as oistodiform elements (McHargue 1975), whereas no corresponding elements are known to occur in association with *Jumudontus* elements. Furthermore, all elements in *Histiodella* are wholly hyaline and display longitudinal shoulders along the basal margin to either side, features that are not present in the elements of *Jumudontus*.

JUMUDONTUS GANANDA Cooper

Pl. 2, figs. 9, 10

? *Spathognathodus* n. sp. LINDSTRÖM, 1960, p. 93, text-fig. 5–3.
Spathognathodus sp. ETHINGTON & CLARK, 1965, p. 201, Pl. 2, fig. 5.
New Genus B. SWEET, ETHINGTON & BARNES, 1971, Pl. 1, fig. 34; BARNES, 1974, p. 230, Pl. 1, fig. 9; BARNES, 1977, p. 104, Pl. 1, fig. 16–18; TIPNIS CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 17.
"*Spathognathodus*" sp. SERPAGLI, 1974, p. 71–72, Pl. 19, figs. 11a, b, Pl. 29, fig. 16.
? *Loxodus asiaticus* ABAIMOVA, 1975, p. 114, Pl. 10, fig. 14, 17, text-fig. 8(38, 39).
Spathognathodus sp. LANDING, 1976, p. 640, Pl. 4, fig. 15.
Histiodella n. sp. A s.f. FÅHRAEUS & NOWLAN, 1978, p. 460–461, Pl. 3, fig. 14.
Jumudontus gananda COOPER, 1981, p. 170, 172, Pl. 31, fig. 13.

Heavy robust blades whose denticles are totally fused except at their tips. Denticles of anterior two-thirds of blade are erect and subequal in size, and all occupy the same plane. Posterior denticles are reduced progressively in size and increasingly inclined; last denticle reclined at an angle of about 20° to the aboral margin of the frontal part of the element. Posterior reaches of element are flexed and twisted so that the last denticles are turned inward from the plane occupied by the anterior part of the element. Region below denticles is of about the same thickness as the denticles themselves, so that they merge into the general surface of the blade. The element is abruptly widened at the aboral margin to form a basal flare which is stronger to one side than the other. Base is only slightly excavated; under side of element is occupied by a flat attachment surface that extends from the anterior basal corner to the base of the terminal denticle. This surface is almost bilaterally symmetrical beneath the anterior two-thirds of the blade where it becomes progressively wider in the posterior direction from the anterior extremity. At about two-thirds the length of the element, the lateral face is sharply inflected on the side toward which the posterior flexure is directed, and bilateral symmetry of the aboral surface is lost on the remainder of the blade. Opposite face is unaffected and maintains the contour of the anterior part of the element.

Remarks.—These bladelike elements occur very sparingly in the Pogonip of the Ibex area. In most samples only a single specimen was found, and commonly even these were fragmentary. All of the specimens are quite robust; they are dark but are translucent in transmitted light. By contrast, the specimen from Alberta that we (1965) reported earlier has white matter in the distal reaches of the denticles. White matter is characteristic of the type specimens from Australia (Cooper 1981) and also is present in the specimen from the Ship Point Formation of northern Canada illustrated by Barnes (1977). The other reports of occasional specimens that seem to belong here do not discuss the interal structure (e.g., Serpagli 1974, Landing 1976). The external morphology is consistent among all of the illustrated specimens, and recognition of separate species based on presence or absence of white matter probably is not warranted.

Lindström (1960, text-fig. 5–3) illustrated a specimen that he identified as a new species of *Spathognathodus* from late Arenigian or Llanvirnian strata of northern Öland. The illustration, a line drawing, suggests that this specimen may be quite similar to *J. gananda*. *Loxodus asiaticus* Abaimova (1972, 1975) resembles this form in general outline and morphology; we cannot evaluate the species adequately from the published discussion, but we agree with Cooper (1981) that it probably is congeneric with *J. gananda*.

Occurrence.—We (1965) reported this form as a possible species of *Spathognathodus* from the section near the Columbia Ice Fields of Alberta. Barnes (1974) has recorded its presence in the upper part of the Ship Point Formation on an unnamed island off the west coast of Baffin Island, Tipnis and others (1978) recovered this species from the Broken Skull and Sunblood Formations in the southern District of Franklin in Canada. Serpagli (1974) found one specimen in his collection from the San Juan Formation of Argentina and also noted that this species occurs in undescribed collections from the Lower Ordovician of Sweden where it occurs in the Zone of *Prioniodus elegans.* Fåhraeus and Nowlan (1978) reported one specimen from the Cow Head Group of Newfoundland. Landing (1976) found a single specimen in the Deepkill Formation in New York. Repetski (1975, and in press) found this species in the El Paso Group of west Texas, and Potter (1975) recovered it from near the top of the West Spring Creek Formation in southern Oklahoma. Cooper (1981) described the species from the Horn Valley Siltstone of central Australia.

Range in the Pogonip.—Scattered specimens were found in the upper 85 m (280 ft) of the Fillmore at Section H and in the Fillmore of the ST Section. Three specimens, each from a different sample, were recovered from the Wah Wah at Section J. The species is present in the Wah Wah and lower Juab near the base of the Fossil Mountain.

Number of specimens.—32.

Repository.—Figured hypotypes UMC 1088–17, 18, unfigured hypotype UMC 1088–19.

Genus LOXODUS Furnish, 1938

Type species.—*L. bransoni* Furnish, 1938.

Remarks.—*Loxodus* is unique among lowest Ordovician conodonts in having the denticles fused to form a bladelike structure. In the only associated multidenticulate forms, species of *Cordylodus* Pander, the denticles are longer, less reclined, and more clearly differentiated. *Loxodus* has a deep but narrow basal cavity, whereas cordylodiform elements have shallow cavities that are directed anteriorly to a sharp point.

Hass (1962, p. 48) included *Loxodus* in a subfamily Neoprioniodontinae together with *Neoprioniodus* Rhodes and Müller, *Leptochirognathus* Branson and Mehl, *Pachysomia* Smith and *Subprioniodus* Smith. Affinity with any of these in the form or biological sense seems unlikely. Lindström (1970) did not include *Loxodus* in any of the categories he recognized in the supergeneric classification that he presented. Sweet and Bergström (1972), p. 41) stated that the apparatus of *Loxodus* is unknown and that it seemingly does not include other types of multidenticulate elements. It does not have any obvious associates among the simple cones in our collections, although this may reflect the relatively meager numbers of *Loxodus* specimens we have found.

Müller (1962, p. 86) suggested that *Loxodus* evolved from a simple cone element through addition of secondary denticles in a posterior series. No probable progenitors have been identified, and, as noted by Lindström (1964, p. 35), no descendants have been recognized. Two specimens from the St. George Formation of Newfoundland were compared to *L. bransoni* by Barnes and Tuke (1970). Identical specimens were recovered from clays in the interval between the Jefferson City Dolomite and the St. Peter Sandstone of central Missouri by A. H. Moore (1970). They are associated there with an element that seemingly forms the eobelodiniform component in a *Belodina* type of apparatus. Comparable elements have not been reported in previous collections containing *Loxodus,* and we have not found them. Accordingly we believe that the specimens from Newfoundland should be assigned to a new genus. As observed by Cooper (1981), *Loxodus asiaticus* Abaimova (1975) likely belongs in *Jumudontus* Cooper.

LOXODUS BRANSONI Furnish

Pl. 5, fig. 15

Loxodus bransoni FURNISH, 1938, p. 339, Pl. 42, figs. 33–34, text-fig. 2A; SANDO, 1958, Pl. 2, fig. 17; HASS, 1962, p. 48, text-fig. 26(5a–c); LINDSTRÖM, 1964, p. 157, text-fig. 54a; MOUND, 1968, p. 412–413, Pl. 3, figs. 14–16; ETHINGTON & CLARK, 1971, p. 73, Pl. 1, fig. 11; ABAIMOVA, 1975, p. 112, 114, Pl. 10, figs. 12, 13, 15, text-fig. 8(35, 40, 43); REPETSKI & ETHINGTON, 1977, p. 95, Pl. 1, fig. 2.

Remarks.—Pogonip representatives of *L. bransoni* are very similar to the type material described by Furnish (1938) with one notable exception. The basal portion of the unit is much deeper than is the case with the types. Further, the element is flexed along a line just below the base of the denticle row so that the denticles lean to one side. In addition, the anterior portion of the element is curved toward the same side. In this respect, the loxodids of the Great Basin are similar to the specimen from the Stonehenge Limestone illustrated by Sando (1958). Furnish's material, in contrast, is not flexed, and the denticles lie in the same plane as the excavated basal region.

Occurrence.—*Loxodus bransoni* has been reported from the Stonehenge Limestone in the Appalachian region by Sando (1958). Recorded occurrences in central United States are in the Oneota Dolomite of the Upper Mississippi Valley (Furnish 1938), the Collier Shale of west central Arkansas (Repetski and Ethington 1977) and the McKenzie Hill Formation of southern Oklahoma (Mound 1968). Ethington and Clark (1971) reported its presence in the Manitou Formation of central Colorado, and Goodwin (1964) found it in the Grove Creek Limestone of southern Montana. Longwell and Mound (1967) included this form in a faunal list of conodonts recovered from the Monocline Valley Formation of southern Nevada, although this occurrence has not been documented further. The faunal list indicates that *Loxodus* is associated with forms otherwise known from much younger strata; this report requires verification. All of these occurrences are in rocks somewhat above the base of the Canadian Series. Abaimova (1975) reported this species from Lower Ordovician strata along the Lena River on the Siberian Platform.

Range in the Pogonip.—We found this species in the type section of the House Formation in the interval between 46 m and 24 m (150 and 80 ft) beneath the base of the overlying Fillmore Formation. Larsen recovered *L. bransoni* between 67 and 147.5 m (220 and 484 ft) in the House in the type area, in the interval between 8.4 and 90 m (27.5 and 258.5 ft) in the exposed House at

Section B of Hintze (1951), and between 73.8 and 107 m (242 and 352 ft) in the House in the Willden Hills. *Loxodus bransoni* is a minor component of the population in most samples with only one or two specimens being the normal complement, although one of Larsen's samples collected 139 m (456.5 ft) in the type area produced 20 specimens.

Number of specimens.—51.

Repository.—Figured hypotype UMC 1095–2; unfigured hypotypes UMC 1095–3, 4.

? aff. LOXODUS sp. s.f.
Pl. 5, fig. 4

Remarks.—A few specimens from the upper Lehman are reported here. In general outline they are suggestive of *Loxodus* Furnish in that they are thin blades that are flexed anteriorly. The denticles are erect anteriorly but slightly inclined posteriorly, and fused except for their apices. They are subequal in size except for the first 2–3 in the series. Commonly the second and third denticles from the anterior end are much longer than the others as well as somewhat wider. Upper part of these elements is wholly albid in contrast to a dark narrow basal band. Basal cavity is a longitudinal slit.

We doubt any biologic affinity exists between these specimens and *Loxodus*. They are much younger than any documented occurrences of that genus elsewhere and are separated stratigraphically from the highest occurrence of *L. bransoni* at Ibex by nearly 915 m (300 ft) of strata. The dark band beneath an otherwise albid element suggests possible affinity with *Histiodella*, and these elements occur together with *H. holodentata* at Ibex and in the upper Antelope Valley Limestone in central Nevada (collections of RLE). However, the forms considered here occur so sparingly in both regions in contrast to the relatively great abundance of the bladelike elements of *H. holodentata* that we are reluctant to treat them as parts of a common apparatus. Further, these elongate blades with their largest denticles located anteriorly do not correspond clearly with either the oistodiform elements or the symmetrical elements that have been included in other species of *Histiodella*.

Range in the Pogonip.—Upper Lehman Formation at Crystal Peak.

Number of specimens.—22.

Repository.—Figured specimen UMC 1095–5; unfigured specimen UMC 1095–6.

Genus MACERODUS Fåhraeus & Nowlan
Type species.—*Macerodus dianae* Fåhraeus & Nowlan.

Remarks.—This distinctive simple-cone type of element is as yet poorly known. The type collection from Bed 8 of the Cow Head Group of western Newfoundland (Fåhraeus and Nowlan 1978) includes only 13 specimens distributed among 5 samples whose total yield was 115 specimens. No other elements that could be associated in a common apparatus are present in those samples; we did not find any obvious associates in our collections either. Perhaps *Macerodus* is a conodont whose apparatus is of the sort Cooper (1975) labelled Type 4, i.e., a series of related morphotypes.

Another possible occurrence of the genus is the two specimens from the Mandal Formation of North Korea that Lee (1975) identified as *Stereoconus plenus* Branson and Mehl. The views provided by Lee suggest a more continuously recurved element than the type species; in this respect they resemble material from the El Paso Group of west Texas (Repetski 1975, and in press) that likely belongs here also and some of our specimens as well. Lee noted that the basal cavity is obscured in his specimens; their similarity to *Macerodus* may be superficial. The Mandal Formation seemingly has considerable range in age (Llanvirnian–Caradocian), and the sample from which Lee's specimens were obtained is not part of a systematic stratigraphic collection. Other conodonts from samples that Lee believes to have come from the same part of the formation (Lee, plate 1) seem more likely to represent Early Ordovician than Middle Ordovician age.

MACERODUS DIANAE Fåhraeus & Nowlan
Pl. 5, fig. 16; fig. 14

Panderodus acostatus (Branson & Mehl). MOUND, 1968, p. 415, Pl. 4, fig. 41 (*non* figs. 39, 40).
Panderodus compressus (Branson & Mehl). MOUND, 1968, p. 415–416, Pl. 4, figs. 42, 43, 47, 49 (*non* figs. 44–46, 48).
Panderodus striatus (Stauffer). MOUND, 1968, p. 416, Pl. 4, fig. 56.
Paltodus sp. C ETHINGTON & CLARK, 1971, p. 73, Pl. 2, fig. 11.
Stereoconus plenus Branson & Mehl. LEE, 1975, p. 180–181, Pl. 1, figs. 19, 20.
Macerodus dianae FÅHRAEUS & NOWLAN, 1978, p. 461, Pl. 1, figs. 26, 27.

Asymmetrical distacodontid that is somewhat twisted distally. Elements are continuously recurved so that distal third of cusp is reclined at an angle of about 120° to the trend of the basal margin, or most of the cusp is straight with the tip bent sharply at almost a right angle to the lower reaches. Both lateral faces bear shallow linear troughs located about halfway between the midline and the anterior margin. On the continuously curved forms, these troughs are quite distinct, beginning a short distance above the aboral margin and becoming progressively faint near the tip of the cusp. In those forms that are straight throughout most of their length, the troughs are very subdued and cannot be seen unless the specimens are illuminated from a very low angle. Region anterior to the groove is swollen to form a blunt or rounded anterior

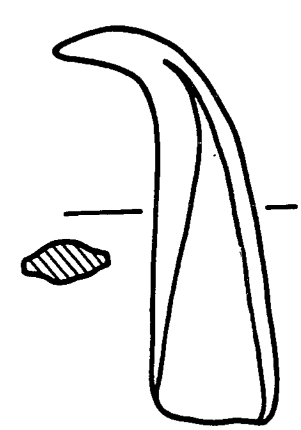

Figure 14.—*Macerodus dianae* Fåhraeus & Nowlan.

margin. Region posterior to troughs is thick, with flat sides leading to rounded posterior margin. The elongate, straight forms have a broad posterior groove above the level where the tip of the cusp is bent over. No groove is present in this position in the regularly curved specimens. Base is not expanded, either laterally or in the anterior-posterior direction. Basal cavity is a deep, tapering cone whose axis is straight, so that the sharp tip is located near the anterior margin of the curving cusp. In the regularly curved forms the tip of the cusp is about at midlength; in the straight forms it is located at the level of strongest curvature.

Remarks.—The two morphologies, curved and straight, discussed above may indicate that this group can be subdivided. Unfortunately, we have too few specimens to discuss their relative frequency and stratigraphic distribution, so we are including them under a single name. In the other occurrences of this type of distacodontid known to us (Mound 1968, Lee 1975, Repetski 1976, Fåhraeus and Nowlan 1978), either one or the other of these two morphologic types has been reported but not both.

Occurrence.—Mound (1968) assigned specimens having this general morphology from the Cool Creek Formation of Oklahoma to several species of *Panderodus* Ethington. None of these specimens shows a slit on the face of the cusp or a notch in the basal margin, features diagnostic of *Panderodus.* No panderodids are present in collections from the Cool Creek Formation provided us by Dr. Don Toomey, but *Macerodus* is present there (*Paltodus* sp. C of Ethington and Clark 1971). *Macerodus dianae* occurs in the El Paso Group in west Texas (Repetski 1975, and in press) and in undescribed collections (RLE) from the Manitou Formation at the type section in Williams Canyon near Colorado Springs, Colorado. Fåhraeus and Nowlan (1978) described the species from Bed 8 of the Cow Head Group of western Newfoundland.

Range in the Pogonip.—Fillmore Formation, Section C (350 [107 m], 430 [131 m], 435 [132.5 m], 455 [139 m], and 460 feet [140 m], respectively).

Number of specimens.—10.

Repository.—Figured hypotype UMC 1095–7; unfigured hypotypes UMC 1095–8, 9, 10.

Genus MICROZARKODINA Lindström, 1971
Type species.—*Prioniodina flabellum* Lindström, 1955.

MICROZARKODINA FLABELLUM (Lindström)
Pl. 4, fig. 2; Pl. 5, figs. 21, 22, 25, 26

Cordylodus perlongus LINDSTRÖM, 1955, p. 552, Pl. 6, figs. 36, 37; LINDSTRÖM, 1960, text-fig. 3(1); VIIRA, 1967, text-fig. 1(21); VIIRA, 1974, p. 63, Pl. 5, figs. 7, 8.

Oistodus linguatus n. sp. var. *complanatus* LINDSTRÖM, 1955, p. 578, Pl. 3, figs. 37, 38.

Prioniodina flabellum LINDSTRÖM, 1955, p. 587, Pl. 6, figs. 23–25; LINDSTRÖM, 1960, text-figs. 3(10), 4(12); LINDSTRÖM, 1964, text-fig. 10D; VIIRA, 1967, text-fig. 1(28); VIIRA, 1974, p. 112, Pl. 5, figs. 3, 4.

Trichonodella alae LINDSTRÖM, 1955, p. 599, Pl. 6, figs. 38–40; LINDSTRÖM, 1960, text-fig. 3(5); LINDSTRÖM, 1964, p. 87, text-figs. 31L, M, N; VIIRA, 1967, text-fig. 1(19); VIIRA, 1974, p. 127, Pl. 5, fig. 5.

Trichonodella? irregularis LINDSTRÖM, 1955, p. 600, Pl. 6, figs. 21, 22; LINDSTRÖM, 1960, text-fig. 3(2); VIIRA, 1967, text-fig. 1(20); VIIRA, 1974, p. 127, Pl. 5, fig. 6.

Oistodus complanatus Lindström. LINDSTRÖM, 1960, text-fig. 4(11); VIIRA, 1967, text-fig. 1(5); VIIRA, 1974, p. 96, Pl. 3, figs. 1, 2, ? Pl. 4, fig. 26.

? *Prioniodina* cf. *flabellum* Lindström. WOLSKA, 1961, p. 364–365, Pl. 4, figs. 4a, b.

Microzarkodina flabellum (Lindström). LINDSTRÖM, 1971, p. 58, Pl. 1, figs. 6–11, text-figs. 19, 20; GEDIK, 1977, p. 37, 42, Pl. 2, figs. 22–24; LÖFGREN, 1978, p. 61–62, Pl. 11, figs. 27–36, text-figs. 27A, B.

Prioniodina? flabellum Lindström? SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 12.

Oistodus sp. B SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 13.

Ozarkodina flabellum (Lindström). BARANOWSKI & URBANEK, 1972, p. 213, Pl. 1, fig. 4.

? *Oistodus lanceolatus* Pander. BARANOWSKI & URBANEK, 1972, p. 213, Pl. 2, fig. 4.

? *Microzarkodina flabellum* (Lindström). VAN WAMEL, 1974, p. 70–71, Pl. 7, figs. 19–23, ? fig. 18.

Microzarkodina flabellum parva Lindström. DZIK, 1976, text-figs. 35a–h.

Remarks.—The elements of the apparatus of *M. flabellum* were described in form-taxonomy by Lindström (1955), and the whole apparatus has been discussed in detail by Lindström (1971) and by Löfgren (1978). Our collection from the Juab includes a small number of ozarkodiniform elements that almost certainly represent this species. The denticle anterior to the cusp is less clearly differentiated than is indicated by the illustrations of this species from its type area in Sweden. Nevertheless, the specimens we found in the Juab seem to be rather variable in this respect, and a new species is not warranted. Our original collection did not yield any of the ramiform elements of the apparatus, but samples collected later from the same section produced symmetrical and asymmetrical elements which are illustrated here to document their presence. No cordylodiform elements have been found in the Ibex area to date. Oistodiform elements are more abundant by half in our collection than are the ozarkodiniform elements. This is in contract to the ratios reported by Lindström (1971) who found the frequency of the latter to be twice that of the former and by Löfgren (1978) who found them in the ratio of 5 ozarkodiniform elements to 3 oistodiform elements. The species is much more abundant in southern Sweden than in the Juab, so that this deviation in relative abundance among the elements likely reflects the small numbers recovered from the Ibex area.

Lindström (1971) reported that this species is restricted to upper Latorpian and lower Volkhovian (Arenigian) strata in southern Sweden where it occurs in the conodont zones of *Prioniodus evae* and *Baltoniodus triangularis.* By contrast, van Wamel (1974) stated that the species occurs higher in the same sequence, although this discrepancy may be the result of different taxonomic treatment. Lindström (1971) established *Microzarkodina parva* for a species whose ozarkodiniform elements are characterized by denticles less than half as long as their cusps. He recognized a zone named for this species near the top of the Arenigian in southern Sweden (uppermost Volkhovian). Judging from his illustration (1974, pl. 7, fig. 19), van Wamel may have identified such forms as *M. flabellum;* he did not discuss the relationship of these two species or refer to *M. parva* in any way. This relationship merits further examination, for Löfgren

(1978, p. 62) experienced difficulty in distinguishing species within her collections on the basis of relative lengths of cusps and denticles; she stated that a spectrum exists among the 524 ozarkodiniform elements that she examined and listed *M. parva* as a junior synonym in her treatment of *M. flabellum*.

Occurrence.—This species occurs in the Lower Ordovician of Scandinavia and the eastern Baltic region (Lindström 1971, Kohut 1972, van Wamel 1974, Viira 1974, Löfgren 1978) and in glacial erratics in Poland (?Wolska 1961, Dzik 1976). Baranowski and Urbanek (1972) found it in the Kaczawa Mountains in southwestern Poland, and Gedik (1977) has illustrated specimens from the Taurus Mountains of Turkey. McTavish and Legg (1976) listed it from undescribed collections from the Canning Basin, Western Australia.

Range in the Pogonip.—Highest Wah Wah through the lower half of the Juab at Fossil Mountain.

Number of specimens.—Ozarkodiniform element, 22; oistodiform element, 30; asymmetrical and symmetrical ramiform elements found in samples not in measured sequence.

Repository.—Figured ozarkodiniform elements UMC 1095–11, 12; figured oistodiform element UMC 1095–13; unfigured oistodiform element UMC 1095–14; figured asymmetrical element UMC 1095–15; figured symmetrical element UMC 1095–16.

"MICROZARKODINA" MARATHONENSIS (Bradshaw)
Pl. 5, figs. 14, 19, 20, 23, 24, 27

Gothodus? n. sp. ETHINGTON & CLARK, 1965, p. 193.
Cordylodus flexuosus (Branson & Mehl). MOUND, 1965b, p. 14, P. 1, fig. 26.
Gothodus communis Ethington & Clark. MOUND, 1965b, p. 20, Pl. 2, figs. 24, 25.
? *Cordylodus*? sp. HIGGINS, 1967, p. 384, text-fig. 2(6).
Gothodus marathonensis BRADSHAW, 1969, p. 1151, Pl. 137, figs. 13–15, text-figs. 3S, T, U.
Paracordylodus sp. BRADSHAW, 1969, p. 1159, Pl. 136, figs. 12, 13.
Roundya sp. BRADSHAW, 1969, p. 1160–1161, Pl. 137, fig. 17, text-fig. 3A.
? aff. *Microzarkodina adentata* MCTAVISH, 1973, p. 49–50, Pl. 3, figs. 28, 33–35, 38–40, 42–44.
? aff. *Paracordylodus gracilis* Lindström. MCTAVISH, 1973, p. 50, Pl. 3, fig. 36 (*non* fig. 41 = *P. gracilis*).
Prioniodus cf. *P.* sp. C. McTavish. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 6.
Cordylodiform ? element A TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 8.
? *Protoprioniodus yapu* COOPER, 1981, p. 178, Pl. 30, figs. 5, 9, 11, 13 (*non* figs. 3, 4, 8).

The apparatus of this species includes three kinds of elements which we identify here as ozarkodiniform, oistodiform, and ramiform.

Ozarkodiniform elements have a broad, reclined cusp with sharp edges and narrow medial lateral costae. Margins of cusp are straight to gently convex; anterior edge may be deflected to one side, particularly in the basal region. Anterior aboral region may be produced as an anticusp or continued anteriorly as an acute anterobasal region. Cusp followed by series of basally crowded, thin denticles bearing lateral costae. Inclination of denticles increases posteriorly. Narrow ledge to either side extends along base of denticles and across cusp, turning downward anterior to costae and becoming subparallel to anterior margin. Ledge is most prominent in position of costae, narrower both anteriorly and posteriorly from this position. Element thins beneath ledge to sharp aboral edge. The basal region beneath the ledge is dark, in contrast to albid cusp and denticles. In transmitted light the denticles can be seen to be continuous within the interior of the element and to extend almost to the base. Elements are excavated aborally by a narrow longitudinal slit that flares beneath the posterior half of the cusp. The elements may be flexed so that the cusp and denticles do not occupy a common plane.

Ramiform element are multidenticulate and have proclined to suberect cusps with triangular cross sections. Edges of the cusp are developed as keels, two of which are oriented posteriorly and laterally, respectively. The third edge is directed anteriorly or turned laterally. Denticles of posterior process are erect, long, fused nearly to their tips. Denticles and distal portion of cusp made of white matter. Almost all specimens available to us are broken close behind the cusp, but the most nearly complete individuals show that the process was flexed or sinuous in plan. Sinuosity of prosess decreases from maximum at tips of denticles to minimum at aboral edge. Cusp may have planar face between anterior and lateral edge or may have a longitudinal trough in this position. Lateral and anterior edges are continued aborally and posteriorly as nondenticulate free processes which are inclined downward beneath the posterior process. Narrow ledges are present to either side along base of denticles. Elements thin aborally to chisellike edge through a dark band beneath the denticles. Similar dark material is present in the fork between the two processes and in a narrow strip along their inner edges. A very narrow region along the lower margin of the posterior process suggests basal inversion. Shallow slits radiate from a pit beneath the cusp and extend along the inner edges of the anterior and lateral processes and beneath the posterior process. Traces of shallow basal funnels are present in the fork between the anterior and lateral processes on some specimens.

Oistodiform elements display a reclined cusp that consists wholly of albid matter and that bears high rounded median costae on both faces. Edges of cusp are sharp. Cusp is turned so that its leading edge is out of the plane of the posterior part of the base. Cusp is continued anteriorly and aborally as an elongate process. Posterior part of base is elongate, low; its arcuate upper margin is keeled. Aboral margin is somewhat variable. It may be arched following a smooth curve, or the anterior and posterior regions may meet at an angle of about 130°. On the convex side of the element, a shoulder extends the length of the basal region parallel to the aboral edge. Beneath this shoulder, the base is constricted, then expands again to the basal margin so that a marginal basal trough is produced. All of the element below the shoulder is dark in contrast to the albid matter of the cusp and of the keel on the posterior part of the base. Basal cavity is a shallow, asymmetrical cone whose apex is directed anteriorly beneath the cusp. Base is somewhat flared where cavity is deepest, thin anteriorly and posteriorly. Cavity may be confined to subcentral position beneath the cusp, or it may continue as a slit toward either extremity. The two ends of the base are not excavated, but have sharp aboral edges. No indication of basal inversion was observed.

Remarks.—The ramiform elements are quite variable in the development of the frontal part of the cusp and in the expression of the lateral costa. Generally the latter is high and sharp, but on some specimens it is low and rounded. On such individuals the corresponding process is reduced or absent. The anterior edge of the cusp may be directed anteriorly, or it may be turned to the side opposite the lateral costa. In some cases it is directly opposite the lateral costa so that the cusp has a flat anterior face and is bilaterally symmetrical. We did not find specimens that showed two lateral costae as well as an anterior edge, so that the transition series seems not to be complete.

McTavish (1973) illustrated a very similar group of elements from the Emanuel Formation of Western Australia and proposed the name *Microzarkodina adentata* for them. His material also has white matter in cusps and denticles above a dark basal region. He also reported the presence of a ledgelike structure on at least some of his specimens. McTavish's ramiform elements generally are similar to the ramiform elements from the Pogonip that we describe above, although we did not find as complete symmetry transition as he illustrated. The ozarkodiniform elements of the Australian species are terminated rather abruptly anterior to the cusp, and their margin is turned laterally in this region. By contrast, ozarkodiniform elements from the Pogonip are drawn out in the anterobasal region and are not deflected. The oistodiform elements from Australia are broadly similar to those from the Pogonip, but the latter have a more prominently developed rib on the cusp. The specimen that McTavish (1973, Pl. 3, fig. 36) considered to be an oistodiform element of *Paracordylodus gracilis* Lindström probably is a complete specimen of the oistodiform element of *"M." adentata;* it is much too large to belong in an apparatus with the associated specimen of *P. gracilis* that he illustrated (Pl. 3, fig. 41).

Like McTavish, we had considerable difficulty deciding what is the proper generic assignment of these elements. The concentration of white matter in the oral region above a basal shoulder is suggestive of the elements of species of *Protoprioniodus.* Further the same three general kinds of elements that we include in *P. aranda* are present here, i.e., bladelike (ozarkodiniform), ramiform, and oistodiform. However, none of the species of *Protoprioniodus* known to date has even a suggestion of denticles in any position. The lateral shoulders have not been described for any of the species of *Microzarkodina* described by Lindström (1971), and such features are lacking from topotype specimens of the ozarkodiniform element of the type species, *M. flabellum,* in our collections and from the specimens from the lower Juab that we identify under that name. Perhaps our material and that studied by McTavish should be given a new generic name, but we are reluctant to do that until the relationships and variations of the extant genera and species are clarified further. Pending development of such information, we prefer to maintain the tentative assignment made earlier by McTavish.

Occurrence.—This species is present in the Fort Peña Formation in the Marathon region (Bradshaw 1969) and in the upper half of the El Paso Group (Repetski 1975, and in press), both in west Texas. It occurs high in the West Spring Creek Formation of Oklahoma (Potter 1975) and in the overlying Joins Formation (Mound 1965, McHargue 1975). A few specimens have been found in the uppermost Jefferson City Formation of Missouri (Moore 1970; Stanley Fagerlin personal communication). Tipnis and others (1978) recovered this species from the Broken Skull Formation, southern District of Franklin, Canada. Some of the oistodiform elements from the Horn Valley Siltstone of central Australia that Cooper (1981) included in *Protoprioniodus yapu* seem identical to the oistodiform elements that we include in the apparatus of *"M." marathonensis.* He did not illustrate any of the other elements of the apparatus from that formation.

Range in the Pogonip.—Scattered specimens were found in the Fillmore in the lower part of the exposure at Section H. The species becomes common near the middle of that section and continues through the Wah Wah, Juab, and Kanosh Formations.

Number of specimens.—Oistodiform element, 217; ozarkodiniform element, 115; ramiform elements, 161.

Repository.—Figured ramiform elements, UMC 1095–17, 18, 19; unfigured ramiform elements UMC 1095–20, UMC 1096–1, 2; figured ozarkodiniform elements UMC 1096–3, 4; figured oistodiform element UMC 1096–5; unfigured oistodiform element UMC 1096–6.

Genus MULTIOISTODUS Cullison, 1938

Type species.—Multioistodus subdentatus Cullison, 1938.

Representatives of this genus were reported first in form-taxonomy from the Dutchtown Formation of southeast Missouri by Cullison (1938) who named three species based on the number of denticulate processes. Lindström (1964, p. 82, text-fig. 26F–I) recognized that these forms, plus another morphotype that Cullison did not describe, are parts of an apparatus whose members display a "Cordylodus-Roundya" transition series. Sweet and Bergström (1972, p. 42) accepted this reconstruction of the apparatus, although they (text-fig. 2b) also included species whose apparatus consists of five kinds of elements.

Both four-membered and five-membered apparatuses are represented among the forms from the Pogonip that we assigned to *Multioistodus.* They have in common the quadripartite symmetry transition identified by Lindström, but the species with five elements also has an asymmetrical (scandodiform) element. Perhaps this element is a modified cordylodiform element which has been lost or has been replaced by a more nearly symmetrical element in those species for which we can identify only four kinds of elements. As an alternative, this element may be homologous with the oistodiform element of *Pteracontiodus cryptodens,* a species that also displays a quadrimembrate transition series like that of *Multioistodus.* The relations that may exist between *Pteracontiodus* and *Multioistodus* are not clear at this time. Both have hyaline elements. *Multioistodus* has differentiated denticles or blade-shaped structures (alars) developed from the basal reaches of the edges and costae, but such features are lacking in *Pteracontiodus.* The ranges of the two genera overlap in Oklahoma and in western Utah, but neither genus is known from sufficient occurrences to establish their total ranges.

Multioistodus has been described to date only from North America. The specimen that Moskalenko (1970) identified with *M. tridens* Cullison appears to be a symmetrical element of a species of *Erismodus.* McTavish and Legg (1976) reported a species of *Multioistodus* in a faunal list of undescribed collections from the Canning Basin, Western Australia.

MULTIOISTODUS AURITUS (Harris & Harris)
Pl. 6, figs. 1–4

Multioistodus n. sp. LINDSTRÖM, 1964, text-figs. 26F–I.
Acodus auritus HARRIS & HARRIS, 1965, p. 34–35, Pl. 1, figs. 2a–c; MOUND, 1965b, p. 8, Pl. 1, figs. 1–3.
Multioistodus lateralis Cullison. MOUND, 1965b, p. 24–25, Pl. 3, figs. 14–16.
Multioistodus subdentatus Cullison. MOUND, 1965b, p. 25, Pl. 3, fig. 25, ? fig. 17, (*non* figs. 18, 20, ? = *M. subdentatus*).
Multioistodus tridens Cullison. MOUND, 1965b, p. 26, Pl. 3, figs. 24, 26, (*non* fig. 19, ? = *M. subdentatus*).
Multioistodus compressus (Harris & Harris). BRADSHAW, 1969, p. 1153–1155, Pl. 133, figs. 1–10, Pl. 136, figs. 2–4, 7–9; SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 29 (*non* figs. 36, 40 ? = *M. compressus*).
? *Acodus auritus* Harris [sic]. BARNES, 1974, Pl. 1, fig. 8.
? *Multioistodus compressus* Harris & Harris. TIPNIS, CHATTERTON & LUDVIGSEN. 1978, Pl. 4, figs. 1, 4; *non* fig. 6.
New Genus new species A TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 17.

The four kinds of elements that comprise the apparatus of this species are characterized by the development of thin, bladelike alars, typically containing white matter in all but their basal portions. In this respect they differ from the denticles of the type species which are hyaline throughout.

Cordylodiform elements display an erect, thin, sharp-edged cusp. Some specimens have marginal keels with gently swollen median regions, others are uniformly lenticular in cross section. Cusp may be somewhat twisted along its length, or it may occupy the plane of symmetry of the element. Anterior aboral angle is near 90°; commonly a low, rounded lobe projects anteriorly just above the anterior aboral corner. Posterior denticle is erect, thin; its height is up to twice its basal width. Typically the porterior margin of the cusp meets the front margin of the denticle in a sweeping continuous curve; in the younger specimens the denticle is reclined and passes over into the cusp in an arc whose radius of curvature is quite short. Basal cavity has gently arcuate upper outline, strongly curved anterior outline, with its sharp tip adjacent to the anterior margin. Base is not inflated.

Acodiform elements have cusps that are slender, proclined, with anterior and posterior keels. Slight to moderate flexure in the basal portion of the cusp produces concavo-convex element. Face of cusp on convex side of element is gently swollen. Opposite side of cusp is variable; a few forms show strongly swollen transverse section to this side, but most are gently convex. The midline to this side bears a costa that may be developed as a hairlike ridge on the swollen face of the cusp, or it may be a sharp-edged prominence that divides the face of the cusp into subplanar anterior and posterior areas. Near the basal margin the costa is broadened to form a low knob or a distinct alar. If the latter is present, it is thin, sharp-edged, and directed laterally and slightly upward. The posterior edge of the cusp is continued along an inflated basal region from which it gives rise to a posterior alar. The basal width of the alar commonly is comparable to that of the cusp, but distally the alar tapers more quickly so that it generally has no more than one-fourth the length of the cusp. The space between the alar and the cusp may have the form of a sweeping curve, or it may be occupied by an acute angle. Specimens of the latter type have unusually large alars whose width exceeds that of the cusp and whose relative length is greater than normal. Anterior keel of cusp becomes wider toward the basal margin. Robust individuals have a thickened knob in this position, although none displays an anterior alar. This feature is confined to the larger specimens and probably indicates advanced ontogeny. Basal cavity has triangular transverse section; its apex is located low in the cusp near the anterior margin. Straw-colored basal funnels are common; they project a short distance beyond the basal margin.

Distacodiform element has slender, slightly proclined cusp with sharp edges. Lateral surfaces of cusp are nearly planar except on the largest specimens where they may be slightly swollen. Hairlike costae are present on each side at the approximate midline. These costae turn somewhat posteriorly in the basal region and terminate at alars that are directed slightly laterally and upward. Posterior edge of cusp passes over through a sweeping curve into the anterior edge of a saillike posterior denticle. This denticle typically is about twice as long and its basal width; it is reclined and has a sharp tip. It may be slightly twisted relative to the rest of the element, or it may occupy a plane of symmetry. The anterior aboral region may be rounded, or it may display a thin anterior basal corner. Basal cavity is slender and directed almost horizontally beneath the posterior denticle and cusp. Its upper outline is gently arched; its lower outline is strongly curved; the sharp tip of the cavity is adjacent to the anterior margin of the element. Basal funnels project a short distance beyond the basal margin on many specimens.

The trichonodelliform element has a slender, slightly proclined cusp with a rounded anterior face and a blunt posterior edge. Low anterolateral costae turn posteriorly near the base and give rise proximally to short, upward-directed alars. Posterior edge of the cusp passes over through a sweeping curve into a large, erect, bladelike denticle. Anterior surface of cusp widens basally and turns posteriorly beneath the element where it widens significantly to form a flattened aboral surface. Basal cavity is directed horizontally with its sharp apex adjacent to the anterior margin. The upper outline of the cavity is moderately arched; the lower outline is more strongly curved. Basal funnels are present on many of the specimens in our collection.

Remarks.—Bradshaw (1969) reconstructed an apparatus from the Fort Peña Formation of western Texas that included the four kinds of elements described above. She considered the apparatus to contain a fifth element, which she described as oulodid, corresponding to *Multioistodus compressus* Harris and Harris s.f., the name she used for the entire apparatus. She noted that the latter elements are not present in her collections from the Fort Peña, and she appears to have based her reconstruction on the material from the Joins Formation described by Mound (1965b). Studies of the Joins conodonts by Mound and by McHargue (1975) show that a complex of multioistodid forms is present there, although the only published report, that of Mound, cannot be relied upon to establish their mutual stratigraphic and taxonomic relations. Neither our collection nor that of Bradshaw supports inclusion of elements of the *M. compressus* type in the apparatus that contains *Acodus auritus* s.f., and we believe that apparatus is restricted to the four-element transition series with each element homologous to one of the elements of the type species, *M. subdentatus*. McHargue (1975) placed an oistodiform element in this apparatus, but we believe that element properly belongs in the apparatus of *Scandodus sinuosus* Mound (see discussion of that species below).

Occurrence.—This species occurs in the upper West Spring Creek and Joins Formation of Oklahoma (Harris and Harris 1965, Mound 1965b, McHargue 1975) and in the Everton Formation in northern Arkansas (Golden 1969). It occurs in the Fort Peña Formation in the Marathon Region of west Texas (Bradshaw 1969) and in the Antelope Valley Formation in central Nevada (collections of RLE). It is present also in the Sunblood Formation in the southern District of Franklin, Canada (Tipnis and others 1978).

Range in the Pogonip.—This species occurs sporadically in the lower part of the Kanosh at Fossil Mountain and becomes abundant in the upper half of that formation. It may occur also near the top of the Lehman Formation at Crystal Peak (see discussion of ? *Multioistodus auritus* below).

Number of specimens.—Cordylodiform element, 48; acodiform element, 193; distacodiform element, 126; trichonodelliform element, 27.

Repository.—Figured acodiform element UMC 1096–7; figured cordylodiform element UMC 1096–8; figured distacodiform element UMC 1096–9; figured trichonodelliform element UMC 1096–10.

? MULTIOISTODUS AURITUS (Harris & Harris)
Pl. 6, figs. 5–7

? *Multioistodus subdentatus* Cullison. MOUND, 1965b, p. 25, fig. 17 (*non* figs. 18, 20, 25).
Multioistodus compressus Harris & Harris *sensu* Sweet, Ethington & Barnes. SUHM & ETHINGTON, 1975, p. 1131, 1132.

Remarks.—A sample from near the top of the Lehman Formation at Crystal Peak contains a moderate abundance of elements that resemble those of *M. auritus* in the development of alars and in having generally thin, blade-like appearance. The most significant difference is in the relation between the cusp and the posterior denticle. In typical *M. auritus* the space between these features is occupied by a sweeping curve as described above. By contrast, in the specimens from the Lehman Formation the cusp and denticle are crowded together with a deep and acute angle separating them in the oral outline of all elements. No trichonodelliform elements were found in the sample, but the other three elements of the transition series are present. This sample is separated stratigraphically from the highest occurrence of typical *M. auritus* by nearly the entire thickness of the Lehman Formation, an interval in which other species of *Multioistodus* are represented in abundance. The specimens reported here seem sufficiently different from *M. auritus* to merit recognizing them as an independent but related taxon. Nevertheless, we believe that a single sample provides insufficient basis for formally naming a new species.

Occurrence.—Suhm and Ethington (1975) reported but did not describe specimens like these from equivalents of the Simpson Group in the Beach and Baylor Mountains of west Texas. Mound (1965b) figured a specimen, identified under *M. subdentatus*, from the Joins Formation of southern Oklahoma, having the morphology reported here.

Range in the Poponip.—Recovered only from sample collected 44 m (145 ft) above base of Lehman Formation, Crystal Peak Section.

Number of specimens.—Acodiform element, 27; cordylodiform element, 17; distacodiform element, 10.

Repository.—Figured acodiform element UMC 1096–11; figured cordylodiform element UMC 1096–12; figured distacodiform element UMC 1096–13.

MULTIOISTODUS COMPRESSUS Harris & Harris
Pl. 6, figs. 8–11, 16

Neomultioistodus compressus HARRIS & HARRIS, 1965, p. 43–44, Pl. 1, figs. 7a–c.
Multioistodus compressus Harris & Harris. MOUND, 1965b, p. 24, Pl. 3, figs. 12, 13; SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, figs. 36, 40 (*non* fig. 29, = *M. auritus*); BARNES, 1974, p. 230, Pl. 1, fig. 12.
? *Multioistodus subdentatus* Cullison. MOUND, 1965b, p. 25, Pl. 3, fig. 17 (*non* figs. 18, 20, = *M. subdentatus;* fig. 25, = *M. auritus*).
non Multioistodus compressus (Harris & Harris). BRADSHAW, 1969, p. 1153–1155, Pl. 133, figs. 1–10, Pl. 136, figs. 2–4, 7–9 (= *M. auritus*).
? *Multioistodus compressus* Harris & Harris. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 6; (*non* figs. 1, 4, ? = *M. auritus*).
? *Erismodus* ? sp. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 8.
Multioistodus ? sp. C TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 17.

Cordylodiform elements have slender, erect cusps that are straight distally but regularly curved basally. Cusp is unequally biconvex in transverse section, one side uniformly and broadly curved from edge to edge and the other with a more strongly swollen midregion flanked by narrow, planar margins. Anterior aboral region is occupied typically by an anteriorly projecting, semicircular knob that may be differentiated into an alar; some specimens show this knob or alar turned toward the more strongly swollen side of the cusp, but in others it is directed stright ahead. Posterior edge of cusp passes over posteriorly into stubby, erect to slightly reclined denticle with lenticular cross section. Cusp may be somewhat twisted along its length so that the anterior edge is rotated out of the plane of the element. Basal region is short and not inflated. Specimens from the Ibex area are thermally altered, and their bases typically retain short but heavy basal funnels; as a result the outline of the basal cavity cannot be observed in reflected or transmitted light. It appears to have a nearly straight upper outline and a strongly curved lower outline with its sharp tip adjacent to the anterior margin.

Acodiform element has slightly reclined to erect cusp that is straight distally but recurved proximally. One lateral surface is gently convex transversely; the other is more strongly swollen and bears a hairline costa located at or just anterior to the midline. Edges of cusp are blunt. Posterior edge is produced proximally as a stubby denticle that is deflected toward the noncostate side of the element. Anterior edge terminates at aboral margin without modification. Costa is produced as a spikelike anterolaterally directed denticle whose length and width typically are greater than for the posterior denticle and may be up to half the corresponding dimensions of the cusp. Base is inflated posteriorly, somewhat recessed between the leading edge of the cusp and the lateral denticle, and planar to slightly swollen to the opposite side. Shape of the basal cavity cannot be discerned on the specimens at hand; heavy basal funnels are present in many specimens.

Distacodiform elements have a stout, biconvex cusp, each side of which bears a hairline cosa. Costae may be symmetrically placed at the approximate midline of their respective side, or one may be located medially and the other far posteriorly. Anterior and posterior edges of cusp are sharp. Costae and posterior edge of the cusp are produced proximally as peglike denticles, the two to each side directed outward and upward and the posterior one slightly reclined. Anterobasal region forms a thin prow beneath the cusp and ahead of the lateral denticles. Basal cavity is obscured in the material at hand; basal funnels commonly are retained.

Trichonodelliform elements resemble the distacodiform elements in lateral view except that the anterobasal prow is replaced by a broadly rounded surface. The lateral costae are always located symmetrically and opposite each other, and are separated by a rounded anterior surface of the cusp.

Scandodiform elements have an erect, unequally biconvex cusp, one face broadly convex transversely and the other strongly swollen medially with narrow planar marginal regions. Posterior edge of cusp meets leading edge of posterior denticle in an angle of 45° or less. Denticle is reclined at about that angle relative to cusp, has sharp edges and biconvex section. Base is markedly inflated to one side with greatest swelling beneath juncture of cusp and denticle. Basal cavities obscured in material at hand.

Remarks.—The cordylodiform element of this species was described in form-taxonomy by Harris and Harris (1965) from near the top of the West Spring Creek Formation of southern Oklahoma. They assigned this element to *Neomultioistodus,* one of several subgenera that they and Harris (1964a) recognized for the several elemental morphotypes then known to occur in *Multioistodus.* Reconstruction of the apparatus by Lindström (1964) established the relations between these recurring types of elements and demonstrated that the proposed subgenera were not valid.

This species differs from *Multioistodus subdentatus* and from *Multioistodus auritus,* both of which also occur in the Ibex area, in possessing a fifth element, here designated as scandodiform, in the apparatus. No elements of this type were reported from the upper West Spring Creek and Joins by Harris (1964), Harris and Harris (1965), or Mound (1965b), although the latter author may have included such forms among the specimens he identified as *Oistodus abundans* Branson and Mehl. McHargue (1975) found elements with expanded bases in the Joins and assigned them to an apparatus identical to that described here, but he considered it to represent *M. subdentatus.* That species does not display such an element in its type occurrence in the Dutchtown Formation (Cullison 1938, Repetski 1973), and we did not find it in association with the elements from the upper Lehman that we identify with *M. subdentatus.* We believe the species recognized by McHargue probably should be assigned to *M. compressus.* The phylogenetic relations among the species of *Multioistodus* are not as yet clear. Some of the elements, e.g., those labelled acodiform, distacodiform, and trichonodelliform above, appear to have been conservative and often cannot be assigned to species in the absence of the more diagnostic cordylodiform element.

Occurrence.—This species occurs in the uppermost West Spring Creek and Joins Formation of southern Oklahoma. Occurrences in the Ft. Peña Formation and in equivalents of the Simpson Group in west Texas reported by Bradshaw (1969) and by Suhm and Ethington (1975) actually represent *M. auritus.* Barnes (1974, Pl. 1, fig. 12) illustrated but did not described a specimen from the Bay Fiord Formation of Devon Island, Arctic Canada, which he identified as *M. compressus.* The illustration suggests that it is an element of the type here described as being scandodiform. Tipnis and others (1978) found this species in the Sunblood Formation in the southern District of Franklin, Canada.

Range in the Pogonip.—Upper Kanosh (above I-K-10A) through the lower 9 m (30 ft) of the Lehman Formation.

Number of specimens.—Cordylodiform element, 102; acodiform element, 232; distacodiform element, 88; trichonodelliform element, 75; scandodiform element, 184.

Repository.—Figured acodiform element UMC 1096-14; unfigured acodiform element UMC 1096-15; figured cordylodiform element UMC 1096-16; unfigured cordylodiform element UMC 1096-17; figured distacodiform element UMC 1096-18; unfigured distacodiform element UMC 1096-19; figured trichonodelliform element UMC 1096-20; unfigured trichonodelliform element UMC 1097-1; figured scandodiform element, UMC 1097-2; unfigured scandodiform element UMC 1097-3.

MULTIOISTODUS SUBDENTATUS Cullison
Pl. 6, figs 12-14

Multioistodus subdentatus CULLISON, 1938, p. 226, Pl. 29, figs. 13a, b; MEHL & MCLAUGHLIN, 1944, Pl. 9, figs. 19, 20, 21 (*non* figs. 17, 18); BRANSON & MEHL, 1944, p. 239, Pl. 93, figs. 10, 19; YOUNGQUIST & CULLISON, 1946, p. 586-587, Pl. 89, figs. 12, 17, 18, Pl. 90, figs. 2, 13; LIND-

STRÖM, 1964, text-fig. 48 (l, m); MOUND, 1965b, p. 25, Pl. 3, figs. 18, 20 (*non* figs. 17, 25, = *M. auritus* [Harris & Harris]) SWEET, ETHINGTON & BARNES, 1971, p. 174, Pl. 2, fig. 24.
Multioistodus lateralis CULLISON, 1938, p. 226–227, Pl. 29, fig. 14; MEHL & MCLAUGHLIN, 1944, p. 66, Pl. 9, figs. 2, 10, 11, 14, 15.
Multioistodus tridens CULLISON, 1938, p. 227, Pl. 29, figs. 15a, b; MEHL & MCLAUGHLIN, 1944, p. 66, Pl. 9, figs. 12, 13; YOUNGQUIST & CULLISON, 1946, p. 587, Pl. 90, figs. 10, 11, 18.
Multioistodus (*Multioistodus*) *subdentatus* (Cullison). HARRIS, 1964a, p. 111–112, Pl. 1, figs. 1, 2.
Multioistodus (*Dirhadicodus*) *lateralis* Cullison. HARRIS, 1964a, p. 115–116, Pl. 1, figs. 3, 4.
Multioistodus (*Trirhadicodus*) *tridens* (Cullison). HARRIS, 1964a, p. 117–118, Pl. 1, figs. 5, 6.
non Multioistodus lateralis Cullison. MOUND, 1965b, p. 24, Pl. 3, figs. 14–16 (= *M. auritus* [Harris & Harris]).
? *Multioistodus tridens* Cullison. MOUND, 1965b, p. 26, Pl. 3, fig. 19 (*non* figs. 24, 26, = *M. auritus* [Harris & Harris]).
non Multioistodus tridens Cullison. MOSKALENKO, 1970, p. 76, Pl. 6, fig. 4 (? = *Erismodus* sp.).

Remarks.—We compared our material directly with topotype specimens of *M. subdentatus* from the Dutchtown Formation in southeast Missouri, and found the two collections to be essentially identical. As noted previously, the acodiform, distacodiform, and trichonodelliform elements that we include in this species do not display obvious differences from the corresponding elements of *M. compressus.* The cordylodiform elements of the two species are distinct, however. Those of *M. subdentatus* do not display the anterobasal lobes or alars that are characteristic of *M. compressus.* The cusp and posterior denticle are more slender and more strongly biconvex in *M. subdentatus* than in *M. compressus;* the denticle in the former typically is erect and parallel to the distal reaches of the cusp, whereas in *M. compressus* the denticle usually is reclined. Specimens from the lower Lehman that we assign to *M. compressus* have the anterobasal lobe only faintly developed and in that respect appear to be transitional with the cordylodiform element of *M. subdentatus.* We did not find scandodiform elements in our collections of *M. subdentatus* from the Ibex area, and we have not observed them in the topotype material from the Dutchtown.

Occurrence.—This species occurs in the Dutchtown Formation in southeastern Missouri (Cullison 1938; Youngquist and Cullison 1946; Repetski 1973) and in the Everton Formation in northern Arkansas (Golden 1969). Harris (1964a) identified this species from the Oil Creek Formation and from the Burgen Sandstone of Oklahoma. It has been reported to occur in the Joins Formation of Oklahoma (Mound 1965b; McHargue 1975), but the specimens that have been illustrated are not typical representatives of the species; they may be transitional between *M. subdentatus* and the older *M. compressus.*

Range in the Pogonip.—This species is present in an interval of almost 61 m (201 ft) beginning 19 m (61 ft) above the base of the Lehman at Crystal Peak. It was not found in samples collected above 24 m (80 ft) in that formation, but a few specimens were found in a dolostone unit low in the overlying Watson Ranch Quartzite.

Number of specimens.—Cordylodiform element, 133; acodiform element, 50; distacodiform element, 54; trichonodelliform element, 29.

Repository.—Unfigured acodiform element UMC 1097–4; figured cordylodiform element UMC 1097–5; figured distacodiform element UMC 1097–6; figured trichonodelliform element UMC 1097–7.

MULTIOISTODUS sp.
Pl. 6, figs. 15, 17, 20, 21

Remarks.—We recognize these specimens as a separate species of *Multioistodus* for which we do not propose a name because they occur in only one sample in our collection. The complete transition series of elements is present. The posterior denticle, where developed, is less prominent than on most specimens that we assign to *Multioistodus compressus,* although its bladelike nature suggests affinity with that species. Cordylodiform elements have a well-defined anterobasal lobe which also suggests relationship to *M. compressus.* The acodiform elements do not have an alar at the proximal extremity of the lateral costa, and they do not display a posterior denticle. Instead, they have narrow keels developed in these positions, a feature suggesting possible affinity with species of *Pteracontiodus.* All of the elements have the basal excavation confined to a shallow, subcentral pit with striate surfaces extending away from it along the basal flanks and suggesting basal inversion in the late stages of ontogeny. All earlier described species of *Multioistodus* display clearly defined basal cavities, so that we cannot identify these elements with any of them.

We are uncertain where these forms belong in the phylogeny of *Multioistodus.* We found them to occur in only one sample that was collected near the top of the range of *M. compressus.* They may represent unusual variants of that species, although no typical specimens of *M. compressus* are included among the conodonts from that sample. They occur in sufficient numbers to support their recognition apart from *M. compressus.*

Range in the Pogonip.—We found these forms only in the sample taken at the base of the Lehman Formation at Crystal Peak.

Number of specimens.—Acodiform element, 33; cordylodiform element, 13; distacodiform element, 15; trichonodelliform element, 7.

Repository.—Figured acodiform element UMC 1097–8; figured cordylodiform element UMC 1097–9; figured distacodiform element UMC 1097–10; trichonodelliform element UMC 1097–11.

Genus OEPIKODUS Lindström, 1955
Type species.—*O. smithensis* Lindström, 1955.

Remarks.—Lindström established the name *Oepikodus* as a form-genus for elements in the Lower Ordovician of Sweden that are characterized by a suberect cusp having a denticulate posterior process and flanked by ridges or costae that may be produced as short anterolateral processes. Subsequently he (1971) and Bergström (1968) concluded that such elements are integral parts of the apparatus of multielement *Prioniodus* Pander. Some of the multielement reconstructions assigned to *Prioniodus,* e.g., *P. evae* Lindström, lack the full complement of elements of the type species, *P. elegans.* Accordingly, Bergström and Cooper (1973) recommended that such species be assigned to a separate subgenus for which they considered *Oepikodus* to be an appropriate name since the type form-species is included in the apparatus of *P. evae.* Serpagli (1974) implemented this suggestion and recognized three subgenera of *Prioniodus.* The elemental composition of the reconstructed apparatuses, as well as the nature of the individual elements, shows marked differences among the proposed subgenera. For this reason we are treating them as distinct genera.

OEPIKODUS COMMUNIS (Ethington & Clark)
Pl. 6, figs. 18, 22, 25

? *Cordylodus quadratus* GRAVES & ELLISON, 1941, p. 10–11, Pl. 1, figs. 22–25.
Gothodus communis ETHINGTON & CLARK, 1964, p. 690, 692, Pl. 114, figs. 6, 14; ETHINGTON & CLARK, 1965, p. 193, Pl. 1, fig. 21; ETHINGTON & CLARK, 1971, p. 77, Pl. 2, fig. 24; SWEET, ETHINGTON & BARNES, 1971, p. 166, Pl. 1, fig. 27; ETHINGTON, 1972, p. 24, Pl. 1, fig. 20; BARNES, 1974, Pl. 1, fig. 12.
Oepikodus equidentatus ETHINGTON & CLARK, 1964, p. 692–693, Pl. 113, figs. 6, 8, 10, 11, 14.
? *Oistodus longiramis* Lindström. ETHINGTON & CLARK, 1964, p. 693, Pl. 114, figs. 2, 7.
Subcordylodus sp. aff. *S. delicatus* (Branson & Mehl). ETHINGTON & CLARK, 1964, p. 701–702, Pl. 115, figs. 1, 5, 7, 10.
non Gothodus communis Ethington & Clark. MOUND, 1965b, p. 20, Pl. 2, figs. 24, 25 (= *"Microzarkodina" marathonensis* (Bradshaw)).
Oepikodus quadratus (Graves & Ellison). ETHINGTON & CLARK, 1965, p. 193–194, Pl. 2, fig. 9; ETHINGTON & CLARK, 1971, p. 77, Pl. 2, fig 26; ETHINGTON, 1972, p. 24, Pl. 1, figs. 24–26, ? 27.
Oistodus longiramis Lindström. ETHINGTON & CLARK, 1965, p. 195–196, Pl. 1, fig. 5; ETHINGTON & CLARK, 1971, Pl. 2, fig. 15; SWEET, ETHINGTON & BARNES, 1971, p. 166, Pl. 1, fig. 17; ETHINGTON, 1972, p. 23, Pl. 1, fig. 3.
Subcordylodus sp. ETHINGTON & CLARK, 1965, p. 201–202, Pl. 2, fig. 6.
non Oepikodus quadratus (Graves & Ellison). SWEET, ETHINGTON & BARNES, 1971, p. 166, Pl. 1, fig. 20 (= oepikodiform element of aff. *Oepikodus minutus* (McTavish)).
Prioniodus evae communis (Ethington & Clark). MCTAVISH, 1973, p. 45–46, Pl. 3, figs. 27, 29–32, 37, text-figs. 6a–e; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, figs. 1–3, 7, 10.
Prioniodus (*Oepikodus*) *intermedius* SERPAGLI, 1974, p. 53–57, Pl. 15, figs. 1a–4b, Pl. 27, figs. 1–7, Pl. 31, figs. 2a–6.

Remarks.—Ethington and Clark (1971, p. 77, Pl. 2, fig. 26) considered *"Cordylodus" quadratus* Graves and Ellison, which at present is known only from the original collection from the Marathon Limestone of Texas, to be a senior synonym of *Oepikodus equidentatus* Ethington and Clark. Bergström and Cooper (1973, p. 323) agreed with this opinion. If this is substantiated, Graves and Ellison's species name will have priority over the one used here.

The study of the conodonts of the Marathon Limestone by Graves and Elulison was a reconnaissance, and, although the species they recorded are representative of the fauna, the list likely is far from complete. Bergström and Cooper (1973, p. 319–321) subsequently demonstrated the presence in the Marathon of all the elements of *P. evae.* They tentatively equated *"Cordylodus" multidentatus* Graves and Ellison with the oepikodiform element of *P. evae* and concluded that *"C." quadratus* represents a morphologically similar element of a distinct species. The prioniodiform element of *O. communis* has not been reported to occur in the Marathon, but another of Graves and Ellison's form-species, *Acodus denticulatus,* is a prioniodiform element. It has a short posterior process, a denticulate lateral process of which only the proximal part remains, and an apparently undenticulate anterior process, also fragmentary. The element may be another part of the apparatus that includes *"O." quadratus.* It may be an unusual specimen of the prioniodiform element of *P. elegans* Pander as suggested by Lindström (1964, p. 38), or it may represent a closely similar species that has been reported from just under the Monument Springs Member of the Marathon by Bergström and Cooper (1973, p. 329, fig. 7). Until a thorough study of the conodonts of the Marathon Limestone has been made, the affinities of these elements will remain uncertain Hence we prefer not to formalize a nomenclatural revision pending such study and are retaining *O. communis* as a valid name.

Serpagli (1974) established a new species, *O. intermedius,* which he believed to have evolved from *O. evae* and possibly to have given rise in turn to *O. communis.* Principal differences were reported to be in the prioniodiform elements which were interpreted to be relativly straight anteriorly and to have an arched posterior process in the case of *O. communis* in contrast to a curved anterior margin and a posterior process that turns up distally in *O. intermedius.* The posterior processes of the oepikodiform elements were reported to differ in having denticles of uniform size in *O. communis* as compared to hindeodellid development in *O. intermedius.* The oistodiform elements were described as having more strongly reclined cusps in *O. intermedius* than in the other species. We have found that our earlier description (1964) of the elements of *O. communis* and the subsequent interpretation of that description by Serpagli are too restrictive. In the collections from western Utah and in others from other parts of North America, we have found all of the morphologic variants used by Serpagli to distinguish two species to occur together.

The posterior process of the prioniodiform elements varies from occupying the plane of the cusp and anterior aboral process to moderately flexed. The denticles may become increasingly inclined posteriorly with those farthest from the cusp leaning backward at an angle to the axis of the process. The process also may be somewhat twisted so that distally the oral edge is directed outward, and in extreme cases the denticles in this position are almost normal to the plane of the cusp. The anterior aboral process may extend downward and slightly posteriorly from the leading edge of the cusp, or it may be turned backward to subtend an angle of 45° with the posterior process. This spectrum includes the forms for which Serpagli (1974) described *Prioniodus* (*Oepikodus*) *intermedius.* The occurrence of the morphologic variants is so continuous, both stratigraphically and within samples, that no meaningful subdivision can be made; we therefore consider *P. intermedius* to be a junior synonym of *O. communis.*

Oepikodiform elements of *O. communis,* as developed in the Ibex area, show limited symmetry transition. Most specimens have the cusp and posterior process lying in a plane, although a few are slightly flexed. Typically the cusp exhibits a swollen medial region to either side with blunt anterior and posterior margins. The swollen regions are continuous aborally with lobes that project posteriorly at the basal margin. Lateral processes are not differentiated on such specimens, which are like the one from the El Paso Group that Ethington and Clark (1964) compared to *Subcordylodus delicatus* s.f. The cusps of other specimens show clearly defined lateral costae as well as anterior and posterior keels. The costae are continuous aborally with short lateral processes. In general, the specimens with clearly defined costae and lateral processes tend to be rather robust. However, these features are not a function of growth, for many of the specimens that lack lateral processes are of equal size with those that possess them. Commonly the costae and lateral proceses are unequally developed; in extreme cases only one side of the specimen shows them. Thus, the oepikodiform elements show all aspects of a Cordylodus-Roundya transition series (*sensu* Lindström, 1964, p. 80–84) except the roundyaform element.

Oepikodiform elements of *Oepikodus evae* are very similar in gross morphology to those of *O. communis,* as has been noted by Serpagli (1974, p. 72). The primary distinction that has been made is in the denticulation of the posterior process which is reported to show pronounced alternation in size of denticles in *O. evae* (Lindström 1955, definition of *O. smithensis*) in contrast to denticles of generally uniform size in *O. communis*. However, the present collections show that some oepikodiform elements from the latter species show at least occasional enlarged denticles on the posterior process; Serpagli (1974, description of *P.* (*O.*) *intermedius*) reported the same relationship among the specimens he described from Argentina. Thus oepikodiform elements seem to be somewhat generalized as presently understood, and specific assignment of isolated specimens that occur in the absence of prioniodiform elements may be impossible. This difficulty might be resolved by detailed megascopic and ultrastructural comparisons of oepikodiform elements based on large collections from numerous localities.

The specimens from the El Paso Group of Texas that we reported earlier (1964) as *Oistodus longiramis* Lindström have an arched aboral margin with the axis of the cusp making an angle of 45° or more with the posterior part of the base. The cusp shows a prominent median costa on each side. Outlines of unerupted denticles can be seen within the anterior part of the base, suggesting that at an earlier stage in ontogeny these specimens were distinctly falodiform. These specimens are unlike all of the others from western North America that we have reported under the above name as well as the oistodiform elements from the Pogonip that we include here. Probably the oistodiform elements that we described from the El Paso represent homologous parts of a related species. Their outline is suggestive of that of the oistodiform elements of *O. evae* Lindström (see Serpagli, 1974, text-fig. 1c), although that species was not found by us in the part of the El Paso that we studied. It does occur in the Marathon Limestone of Texas, however (Bergström and Cooper 1973). Repetski (1975, and in press) has found numerous oistodiform elements of *O. communis* in the El Paso.

Occurrence.—This species is present in the El Paso Group of west Texas (Ethington and Clark 1964, Repetski 1975, and in press), in the Ninemile Formation of central Nevada (Ethington 1972) and in the Columbia Ice Fields Section of Alberta (Ethington and Clark 1965). It has been found in the West Spring Creek Formation of southern Oklahoma (Potter 1975) and in clays beneath the St. Peter Sandstone in east central Missouri (Moore 1970). It also occurs in strata in northern Arkansas that have been mapped as part of the Blackrock Formation (undescribed collections of RLE). McTavish (1973) reported its occurrence in the Emanuel Formation in Australia, Serpagli (1974) found it in the San Juan Limestone of Argentina, and Barnes (1974) illustrated a specimen from the Eleanor River Formation of Devon Island, Arctic Canada. Tipnis and others (1978) illustrated this species from the Broken Skull Formation of the southern District of Franklin, Canada.

Range in the Pogonip.—This species has its lowest occurrence somewhat above the middle of the Fillmore Formation 73 m (240 ft) above the base of Section H and is common throughout the higher part of that formation and the Wah Wah at all sections where this interval was collected.

Number of specimens.—Prioniodiform element, 341; oepikodiform element, 426; oistodiform element, 201.

Repository.—Figured prioniodiform element UMC 1097–12; unfigured prioniodiform element UMC 1097–13; figured oepikodiform element UMC 1097–14; unfigured oepikodiform element UMC 1097–15; figured oistodiform element UMC 1097–16; unfigured oistodiform element UMC 1097–17.

aff. OEPIKODUS? MINUTUS (McTavish)
Pl. 6, figs. 19, 23, 24, 26–28

Haddingodus aff. *H. serra* Sweet & Bergström [sic]. MOUND, 1965b, p. 20–21, Pl. 2, figs. 21, 28.
Oepikodus quadratus (Graves & Ellison). SWEET, ETHINGTON & BARNES, 1971, Pl. 1, fig. 20.
aff. *Prioniodus elegans* Pander. ETHINGTON, 1972, p. 23, Pl. 1, fig. 1.
aff. *Baltoniodus minutus* MCTAVISH, 1973, p. 42–43, Pl. 3, figs. 3, 14, 17 (*non* fig. 8, ? = *Prioniodus* sp. nov. B McTavish, 1973).

Prioniodiform element has an erect cusp that is tapered and sharp edged. Face opposite lateral process broadly convex; face toward lateral process with median ridge that is strongly differentiated from face of cusp and carries a sharp keel in robust specimens. Costa barely differentiated from the surface of cusp on less robust specimens. Anterior margin of element forms a broad arc that coincides with leading edge of cusp and aboral process. Aboral process situated more or less directly beneath cusp; somewhat shorter and more slender than cusp. Denticles may be present along the front margin of the anterior process, or this margin may be keeled. Plane of cusp and aboral process is rotated somewhat from the plane of the posterior process. Shallow posterior process has at least six erect, crowded-to-fused denticles of nearly uniform size. Vertical dimension of the posterior process is greater than one-half but less than the length of the denticles. The process is swollen at the base of the denticles to form a narrow ledge on either side. The thickness of the process is reduced below the swollen region, then expands to the basal margin. The magnitude of the swelling appears to depend on the size of the specimens, being stronger in the larger individuals; it may be inconspicuous on small specimens. The lateral process is directed downward and laterally. As seen from the anterior direction, the angle between the lateral process and the anterior edge of the element is between 30° and 45°; viewed laterally the lateral process subtends an angle of 90° and generally of greater than 100° with the trend of the posterior process. About half of the specimens show short, crowded denticles that stand at an acute angle to the oral margin of the lateral process. The other specimens have no denticles on the lateral process, which has a blunt oral edge instead. Where denticles are present, the lateral process is swollen near their bases with the swelling to the outer side of the specimen being continuous with the one on the same side of the posterior process. The aboral surface of each process is excavated by a flaring trough which increases in depth as the position beneath the cusp is approached.

Elements that we identify as being cyrtoniodiform display a cusp that is erect proximally; the distal reaches are missing from all of the specimens at hand. Outer face regularly convex, inner face of cusp with narrow, rounded median ridge that is flanked by depressed regions. Edges sharp to blunt. Aborally the cusp is continued as an anticusp directed downward and posteriorly. Posterior process shallow, somewhat arched, and flexed laterally. At least 10 denticles on posterior process in most complete specimen; all denticles thin, crowded to fused. Those 4–5 denticles proximal to cusp are narrower than those located distally. That denticle at highest part of arch of process and near the middle of the series is larger than any of the others. Proximal denticles may be nearly erect or inclined posteriorly; those located more distally invariably are inclined somewhat to the posterior. Strongest inclination at posterior end of series. Posterior process swollen to inside at base of denticles to form a narrow shelf; outer surface shows less conspicuous swelling. Process thins aborally but flares again adjacent to basal margin. Basal cavity a shallow trough beneath posterior process but deepens as it approaches the cusp, where a sharp tip is directed anteriorly. A short trough extends from this point downward along the anticusp. Cavity flares strongly to inside in angle between anticusp and posterior process; no corresponding flare is present to outside. Basal funnel, if present, projects a short distance beyond free basal edge.

Oepikodiform elements have slender cusp that is proclined at an angle of about 60° to the vertical. Cusp typically with blunt to keeled anterior and posterior edges. One or both lateral faces with high median costa that continues aborally and laterally across basal region. Distally these costae are produced as short, stubby, posteriorly directed lateral processes. Anterior edge of cusp produced downward and posteriorly as a thin process that lies between and below the lateral processes. On robust specimens the edge along the cusp and the anterior aboral process are deflected to one side to form a lateral ridge. Posterior process long, shallow, delicate; distal portion generally lost on specimens at hand. Process may be somewhat arched and in some cases is slightly to strongly flexed and twisted. Denticles are subequal in size, proclined proximal to cusp but erect or reclined distally. Shallow troughs excavate all processes; troughs become deeper proximally and merge as an anteriorly directed basal cavity whose sharp tip is near the anterior margin.

Cusp of cordylodiform element slender, proclined at about 45°, having blunt anterior and posterior margins and gently to markedly swollen lateral faces. Anticusp continues downward and posteriorly from anterior region of cusp and subtends an angle of ca. 35–45° with the trend of the posterior process. Leading margin of element nearly straight, although it may be somewhat curved or even show a very obtuse angle at the level of the base of the cusp. All the specimens in our collection have lost the distal part of the posterior process. Judging from the portion that is retained, the process seemingly was rather long and shallow. At least 10 denticles are present; typically they are at least half as broad as they are high, erect, and crowded basally but discrete at their tips. The basal cavity is a shallow trough beneath the distal part of the posterior process and continues anteriorly into a slightly flared, spacious basal cavity enclosed by thin sheaths in the angle between the anticusp and the process. The tip of the cavity is directed almost horizontally near the anterior margin at the level of the base of the cusp. As seen in lateral view, the upper outline of the cavity is gently arched beneath the posterior process. The outline of the cavity ahead of the tip is somewhat concave toward the anticusp. Basal funnels are retained in some specimens where they protrude for a short distance beyond the lateral sheaths. The entire element is flexed in the anterior region of the posterior process.

Trichonodelliform elements have cusp proclined at about 30° to the vertical; stout, with sharp posterior and lateral costae; anterior broadly rounded. Lateral costae produced as aborolateral processes that subtend an angle of about 30° with the trend of the posterior process. Viewed from the anterior-aboral direction, the lateral processes diverge at an angle of about 15°. Edges of the lateral processes are keeled with the keels becoming more prominent distally; edges are directed outward. Posterior process is incomplete on all specimens in collection, but it seems to have been long and shallow. Thirteen denticles on most complete specimen; denticles thin, erect, at least half as broad as tall, basally fused but distally discrete. Basal troughs along aboral sides of all processes unite proximally to form an anteriorly directed basal cavity enclosed by thin sheaths. Basal funnels, if retained, project a short distance beyond free basal margin.

Cusp of oistodiform element is slender, sharp edged, reclined at an angle of about 45° to axis of base. Typically bowed along entire length of the element, which is markedly concavo-convex laterally. Cusp bears unequal longitudinal median swellings on its faces; edges are sharp. Anterior margin is gently convex to straight, posterior outline is slightly convex proximally, becoming shallowly concave toward extremity. Tip of cusp is acute. Anterobasal angle is about 45°. Base is produced posteriorly as an elongate, low, keeled blade with an arcuate upper margin. Base is expanded toward concave side of element beneath posterior half of the cusp. From this region the base narrows quickly in the anterior direction, less abruptly posteriorly. Beneath a basal shoulder that extends parallel to aboral margin, the base is somewhat constricted but may expand again at basal edge. Cavity is shallow, its deepest point beneath and behind the middle of the cusp. It is a V-shaped trough that declines in depth distally beneath posterior part of base. Anterior to its deepest point, the cavity loses depth abruptly. Zones of basal inversion may be present at the anterobasal corner and at the posterior extremity. Basal outline is convex from the anterobasal corner through the region of basal flaring; distally it is concave beneath the arched posterior region of the base. Cusp is translucent and white; base is opaque and brownish black.

Remarks.—The elements discussed here generally resemble the illustrations of McTavish's type material which came from the Emanuel Formation of Australia. The present specimens lack the needlelike denticles of anterior and lateral processes that McTavish described. The fact that his photographs do not show these denticles indicates that they are very small indeed, and the margins of the processes in question do not seem to be particularly serrate. Further, the multielement species is based on only 13 specimens representing at least four kinds of elements, all collected from a single sample in the Emanuel sequence. Thus, it is not possible to make a satisfactory comparison of the Utah material with McTavish's species although gross similarity suggests affinity.

Lindström (1971) characterized *Baltoniodus* as having denticulate prioniodiform elements, although he conceded that the type species, *B. navis,* shows irregular to sporadic denticulation. In addition, he included in multielement *Baltoniodus* other kinds of elements, including an amorphognathiform element that lacks platform ledges, ramiform elements that display a symmetry transition, and an oistodiform element. Earlier Lindström (1970), p. 435) had indicated that elements of *Baltoniodus* have much deeper basal cavities with much thinner walls than is the case in *Prioniodus.* It was this latter feature that McTavish (1973) seemingly used to determine the generic assignment of two species, *B. minutus* and *B. oepiki.*

Sweet and Bergström (1972, p. 35) considered *Baltoniodus* to be a subgenus of *Prioniodus* that is typified by two prioniodiform elements, one of which is the "amorphognathiform element" of Lindström's generic definition. Further, they disagreed with Lindström's conclusion that these two types of multielement associations have separate phylogenies. Serpagli (1974) accepted their interpretation and included in *P.* (*Baltoniodus*) species assigned to *Prioniodus* that possess distinct lobate platform elements, e.g., *P. variabilis* and *P. gerdae.*

The specimens from the Pogonip that are considered here, as well as those from the Emanuel Formation of Australia with which they are compared, do not fit the concept of *Baltoniodus* that has evolved over the past few years. Usually deep basal cavities are not displayed, despite McTavish's emphasis of this character in his discussion of the Australian specimens. Furthermore, lobate platform elements are not present in either collection, a feature that indicates a significant difference from most of the species now assigned to *Baltoniodus;* such elements seem not to be present in the type species, *B. navis,* either. McTavish reported lack of an oistodiform element as part of the apparatus of *B. minutus,* although this may not be significant because his type collection is very small. We tentatively include an oistodiform element in our interpretation as discussed above. None of the oistodiform elements illustrated by McTavish conforms to that which we believe to belong here.

We have assigned this species with questions to *Oepikodus,* primarily because the prioniodiform elements are very similar in gross outline to those of *O. communis.* In fact we originally grouped all of these elements in the form sense as *Gothodus communis sensu* Ethington and Clark, 1964. However, careful examination of our collection shows that all prioniodiform elements recovered above the upper part of the Wah Wah Formation display one or the other of the modifications of the lateral process that are described above. Finally, oistodiform elements of the type of *O. longiramis* Lindström s.f. were not found above the top of the Wah Wah. All of this suggests to us that another, but perhaps related, species has succeeded *O. communis* in an interval that begins near the top of the Wah Wah Formation and continues into lower Kanosh.

Prioniodiform elements from the Emanuel Formation of Australia figured and described by McTavish (1973) generally conform to the material reported here in the character of the cusp and of the posterior and lateral processes. The aboral process is missing from McTavish's illustrated specimen, but he stated that a denticle may have been present along its margin proximal to the cusp. This material is suggestive of the prioniodiform elements of *O. communis* (Ethington and Clark), but the latter never show denticles on the lateral processes. Further the aboral process is much longer and more clearly differentiated in the forms considered here than in *O. communis.* The presence of a swollen area beneath the denticles, particularly on the posterior process, is suggestive of prionodiform elements of *Oepikodus evae.*

Those prioniodiform elements that are lacking denticles on the lateral process are transitional to the cyrtoniodiform elements. In some cases they differ only in having a delicate costa on the face of the cusp and continuing across the basal region but not differentiated as a lateral process at the aboral margin. None of the cyrtoniodiform elements displays a costa on the cusp. Although the total ranges for the two kinds of prioniodiform elements and for the cyrtoniodiform elements are virtually the same, the frequency of occurrence of the prioniodiform elements with denticulate lateral processes is greatest in the lower half of the range, whereas the other two have their greatest abundance in the upper part of the range. Perhaps this indicates progressive transformation of the apparatus.

Oepikodiform elements from the Wah Wah Formation that we assign to this species are indistinguishable from the comparable elements of *O. communis.* They were assigned to the respective species on the basis of the characters displayed by the associated prioniodiform elements. Specimens from the Kanosh Formation typically are robust and are more likely to show flexure of the posterior process than are the older forms. Although oepikodiform elements have been reported widely from western North America (Graves and Ellison 1941; Ethington and Clark 1964, 1965, 1971; Ethington 1972), none of those described previously displays flexure or twisting of the posterior process.

Occurrence.—The species reported by McTavish (1973) with which we compare these forms from the Pogonip occurs in the Emanuel Formation in the Canning Basin, Western Australia. The form described here is present in the Ninemile Formation in the Antelope Range in central Nevada (Ethington 1972) and is present in undescribed collection representing the Vinini Formation, also from central Nevada. It has been found in the upper part of the West Spring Creek Formation of southern Oklahoma (William Mills personal communication 1979).

Range in the Pogonip.—This species is present in upper Wah Wah, Juab, and lowest Kanosh at all localities where these intervals have been sampled.

Number of specimens.—Cordylodiform element, 31; cyrtoniodiform element, 48; bicostate oepikodiform element, 93; unicostate oepikodiform element, 51; oistodiform element, 40; prioniodiform element with denticulate lateral process, 39; prioniodiform element with nondenticulate lateral process, 46; trichonodelliform element, 26.

Repository.—Figured cordylodiform element UMC 1097–18; unfigured cordylodiform element UMC 1097–19; figured cyrtoniodiform element UMC 1097–20; unfigured cyrtoniodiform element UMC 1098–1; figured oepikodiform elements UMC 1098–2 (unicostate), UMC 1098–3 (bicostate); unfigured oepikodiform element UMC 1098–4; figured oistodiform element UMC 1098–5; unfigured oistodiform element UMC 1098–6; figured prioniodiform element UMC 1098–7; unfigured prioniodiform element UMC 1098–8, 9; unfigured trichonodelliform elements UMC 1098–10–12.

Genus OISTODUS Pander, 1856
Type species.—*Oistodus lanceolatus* Pander, 1856.

OISTODUS BRANSONI Ethington & Clark, n. sp.
Pl. 7, figs. 1–3, 5, 6; fig. 17

Paltodus jeffersonensis BRANSON & MEHL, 1933, Pl. 4, fig. 18.
Distacodus? sp. MEHL & RYAN, 1944, Pl. 6, figs. 25, 26.
Oistodus sp. ETHINGTON & CLARK, 1964, p. 694, Pl. 114, fig. 21.
? *"Oistodus"?* sp. SERPAGLI, 1974, p. 41, Pl. 12, figs. 4a, b, Pl. 24, fig. 11, Pl. 30, figs. 9a, b.

Cusp of cordylodiform element is reclined at about 45° to basal margin and is broad basally but slender distally; length of cusp at least twice that of base. Outer face of cusp is uniformly convex; inner face has swollen region behind midline and is flanked on either side by thin areas that terminate in the anterior and posterior edges. The swelling continues onto the basal region to produce a flare that may project laterally as a pronounced lip. The posterior part of the base is short with a strongly arcuate oral outline. Basal margin is sinuous in lateral view with a subcentral salient and anterior and posterior reentrants. The base swells regularly beneath the cusp, then constricts abruptly somewhat above the basal edge. The surface of the element is uniformly covered with well-defined striae that are continuous from the tip of the cusp to the level where basal constriction occurs. A thin band adjacent to the basal margin is devoid of striae and instead is very smooth and highly reflective of light. Basal funnels project a short distance beyond the aboral edge on many of the specimens in our collection.

The cladognathodiform element is similar to the cordylodiform element except that its outer face has a strongly developed postmedian costa that is produced aborally as a prominent narrow salient at the aboral margin.

The trichonodelliform element has a stout cusp that is triangular in cross section with keeled corners. Anterior face has a shallow median trough extending laterally to either margin; posterolateral faces are swollen medially and depressed adjacent to the posterior and lateral keels. Distal portion of the cusp is markedly reclined and directed parallel to the basal margin; cusp is strongly curved proximally. The base maintains the triangular cross section of the cusp; posterior part of the base is short.

Distacodiform elements display a reclined, asymmetrical cusp with sharp anterior and posterior edges continuously curved throughout their length. Element is broadly flexed so that one face is slightly concave, the opposite face is correspondingly convex. High narrow keels rise to either side at the basal margin and continue to the distal tip of the cusp. Keel on the concave side of the element has its origin somewhat ahead of the midpoint of the base. Its sharp edge is turned somewhat anteriorly throughout the lower third of its length, but it is directed laterally for the rest of its extent. This costa maintains its position ahead of the midline of the cusp and approaches the anterior margin near the distal tip. It is everywhere sharply delimited from the face of the cusp and is separated from the anterior edge by a V-shaped trough. Opposite costa has its origin farther anteriorly along the basal margin; its sharp edge is directed anterolaterally along its entire length. This costa is not sharply delimited but rather merges into the general lateral surface of the cusp. The region between this costa and the anterior edge is depressed basally, but the depression becomes increasingly faint higher on the cusp, and distally this region is occupied by a narrow facet. Posterior part of base has sharp upper margin which passes over through approximately a right angle into the posterior edge of the cusp. Viewed laterally, the outline of the basal cavity is a deformed triangle whose apex has been drawn over and is directed anteriorly. A heavy growth axis leads away from the tip of the basal cavity and curves upward and posteriorly to the tip of the cusp.

Cusp of oulodiform element is blade-shaped with sharp edges; one face is regularly convex, the other has a broad median swelling. This swelling continues aborally to produce basal inflation. Element is markedly striate except for a narrow basal zone. Anterobasal angle is ca. 50°. Base is not continued posteriorly beyond cusp; posterior margin is uniformly curved from the posterior basal corner through the rear margin of the cusp.

Remarks.—Branson and Mehl (1933, Pl. 4, fig. 18) illustrated a specimen from residual clays in the upper Jefferson City Formation of east central Missouri and identified it as a new species, *Paltodus jeffersonensis.* No description of this species was provided in this or any subsequent publication of these or other authors. A second specimen collected from a similar clay in central Missouri was reported but not described by Mehl and Ryan (1944), who tentatively identified it as a species of *Distacodus*

Pander. Because Branson and Mehl did not fulfill the requirements of Article 13 of the International Code of Zoological Nomenclature when they failed to prepare a statement of the characters of their new species, *P. jeffersonensis* is not a validly established name. To avoid confusion of authorship and nomenclature, we are proposing a new name for the multielement apparatus described here which includes elements identical to the specimen illustrated by Branson and Mehl.

The apparatus of *Oistodus bransoni* generally conforms to the plan Lindström (1964, text-fig. 26A–E) reported for *Oistodus lanceolatus;* we can distinguish elements corresponding to those he identified as "oulodus," "cordylodus," "cladognathodus," and "roundya" elements, respectively. Subsequently (1974, p. 201), Lindström revised the terminology of the elements of *O. lanceolatus* to include only three types which he designated as cordylodiform, cladognathodiform, and trichonodelliform, respectively. In addition to counterparts of these three (or four) elements, we include in *O. bransoni* elements with strong lateral costae (*P. jeffersonensis* of Branson and Mehl) which perhaps are a variant of the trichonodelliform element. In his diagnosis of *Oistodus delta* (trichonodelliform element of *O. lanceolatus*), Lindström (1955, p. 573) reported the presence of a very faint median keel on the anterior face; elements of the type identified as *P. jeffersonensis* may constitute a more strongly developed form of this morphotype.

The elements of *O. bransoni* are characterized by having a very short and stubby posterior extension of the base whose oral margin is either straight or strongly arched. The surfaces of the cusps of all elements display longitudinal striae that continue to the basal region. These properties distinguish this species from the younger *Oistodus multicorrugatus* Harris in which the cordylodiform elements are much larger than in *O. bransoni,* and in which the posterior basal extension rivals the cusp in length and in which the surfaces appear smooth at magnifications up to at least 100 diameters.

The only specimen in our collection that we identify as an oulodiform element is suggestive of the form that Lindström (1964, text-fig. 26a) identified as the oulodiform element of *O. lanceolatus.* He has not included such elements in subsequent discussions (e.g., 1973, p. 201) of the apparatus of *O. lanceolatus,* and the presence of such elements in the *Oistodus* apparatus has not been demonstrated conclusively. The specimen we found seems very close to one from the San Juan Limestone of Argentina that Serpagli (1974) reported as *"Oistodus"*? sp. Principal difference between the two is that the specimen from Argentina has an angular bend in the posterior margin which serves to differentiate a short posterior extension of the base.

Derivation of new name.—In honor of the late Professor E. B. Branson of the University of Missouri and in recognition of his contributions to the study of conodonts.

Occurrence.—Branson and Mehl (1933) found this species in clays associated with the upper Jefferson City Formation in Missouri. It is present in the El Paso Group of west Texas (Ethington and Clark 1964; Repetski 1975, and in press), and it may occur also in the San Juan Limestone of Argentina (Serpagli 1974).

Range in the Pogonip.—This species is present but not abundant in the upper half of the Fillmore Formation at Section H and in the ST Section but is rare at the Mesa Section.

Number of specimens.—Cordylodiform element, 42; cladognathodiform element, 5; distacodiform element, 6; oulodiform element, 1; trichonodelliform element, 19.

Repository.—Figured cordylodiform element UMC 1098–13 (holotype); unfigured cordylodiform elements UMC 1098–14, 15; figured cladognathodiform element UMC 1098–16; figured distacodiform element UMC 1098–17; unfigured distacodiform elements UMC 1098–18, 19; figured trichonodelliform element UMC 1098–20; unfigured trichonodelliform element UMC 1099–1; figured oulodiform element UMC 1099–2.

OISTODUS CRISTATUS Ethington & Clark, n. sp.
Pl. 7, fig. 4

Cordylodiform element with short, broad, bladelike cusp. Anterior margin rises vertically from anterobasal angle, then curves sharply posteriorly and is concave to the tip of cusp. Posterior margin straight or shallowly concave. Leading edge of cusp may be deflected laterally from base through region of greatest curvature so that some elements are concavo-convex, others lie in a plane. Convex side of unit is unornamented; concave side has a swollen region beginning at basal margin beneath posterior half of cusp. This rounded ridge rises and turns posteriorly to occupy a submedial position on the cusp. Base is somewhat inflated medially, thinning both anteriorly and posteriorly from this position. Posterior region of base is short, keeled, of about the same length and form as the cusp. Angle between cusp and basal margins is 30° or slightly greater. All of the specimens are relatively opaque in the basal region so that the shape of the basal cavity cannot be observed. It appears to be shallow, extending from the posterior extremity of the basal region to just short of the anterobasal angle. A basal constriction is present on all specimens. It extends entirely around each element just above the basal margin with most pronounced development in the region of basal flaring, becoming increasingly obscure anteriorly and posteriorly from this position. Basal margin is sinuous, concave anteriorly and posteriorly, and convex medially.

Remarks.—This species is associated with and probably has close affinities with *O. multicorrugatus* Harris. The broad proximal portion of the bladelike cusp is particularly suggestive of that species. The tapered distal portion of the cusp resembles the necked extremities commonly observed on rejuvenated distacodontids, thus raising the possibility that these are pathogenic specimens. However, no indication of a fracture can be observed in transmitted light, and therefore these elements must be the result of normal growth. The basal region is very shallow and short, and no lateral costae are present. That part of the Pogonip from which we obtained these specimens contains a variety of costate oistodiform elements, all of which are assigned here to *O. multicorrugatus* Harris. It is possible that these elements represent unusual morphotypes of the cordylodiform element of that species.

Derivation of new name.—*Cristatus,* crested; to draw attention to the broad proximal portion of the cusp outline is suggestive of the crest or comb on the head of a chicken.

Occurrence.—Elements of this morphology are present in the Oil Creek Formation of southern Oklahoma (undescribed collections of RLE).

Range in the Pogonip.—Upper part of the Kanosh Formation (I-K-13A through I-K-15E), Fossil Mountain.

Number of specimens.—8.

Repository.—Figured holotype UMC 1099-3; unfigured paratype UMC 1099-4.

"OISTODUS" HUNICKENI Serpagli
Pl. 7, fig. 8

"Oistodus" hunickeni SERPAGLI, 1974, p. 54–55, Pl. 13, figs. 1a–3b, Pl. 23, figs. 6, 7.

Remarks.—Our specimens conform closely to the descriptions and illustrations provided by Serpagli on the basis of material from Argentina. By enclosing the generic citation in quotation marks when he defined the species, he expressed doubt that these forms really belong in *Oistodus.* We concur that this species cannot be assigned to that genus, for it lacks the symmetry variants of species of *Oistodus* and also has an abundance of albid matter in the cusp. Probably it is an oistodiform element of an apparatus that also contains other elements present in the fauna discussed by Serpagli and in our collections as well, e.g., *"Scandodus" robustus.* Reconstruction of an apparatus must be based on more extensive material than is available to us or than was at Serpagli's disposal, so that we retain his "functional" generic designation.

Occurrence.—Serpagli (1974) described this species from the San Juan Formation of Argentina.

Range in the Pogonip.—Wah Wah Formation at Section J and at Fossil Mountain.

Number of specimens.—19.

Repository.—Figured specimen UMC 1099-5; unfigured specimen UMC 1099-6.

"OISTODUS" INAEQUALIS Pander s.f.
Pl. 7, fig. 7; fig. 15

Oistodus sp. MEHL & RYAN, 1944, Pl. 7, figs. 5, 6.
aff. *Oistodus inaequalis* Pander. LINDSTRÖM, 1955, p. 576–577, Pl. 3, figs. 52–57; VIIRA, 1974, p. 96, Pl. 2, fig. 13.
Oistodus sp. aff. *O. forceps* Lindström. ETHINGTON & CLARK, 1964, p. 694, Pl. 113, fig. 19, Pl. 114, fig. 9.
Scandodus furnishi Lindström. ETHINGTON & CLARK, 1964, p. 698, Pl. 114, figs. 11, 24.
Oistodus inaequalis Pander. ETHINGTON & CLARK, 1965, p. 195, Pl. 1, fig. 11; BARNES & TUKE, 1970, p. 89, Pl. 20, figs. 2, 3, 7.
non Oistodus inaequalis Pander. MOUND, 1968, p. 414, Pl. 3, fig. 24; LEE, 1970, p. 327–328, Pl. 7, figs. 22, 24, Pl. 8, fig. 12; LEE, 1975, p. 87, Pl. 2, figs. 2, 3, text-figs. 4B, C.
? *Oistodus inaequalis* Pander. DRUCE & JONES, 1971, p. 76, Pl. 12, figs. 10a–13b, text-fig. 25a; VIIRA, 1974, p. 96, Pl. 2, fig. 13; LEE, 1976, p. 169–170, Pl. 1, fig. 12, text-fig. 3D.
aff. *Drepanoistodus inaequalis* (Pander). VAN WAMEL, 1974, p. 65–66, Pl. 2, fig. 7 (oistodiform element only).
aff. *Drepanoistodus inconstans* (Lindström). VAN WAMEL, 1974, p. 67, Pl. 3, fig. 11 (oistodiform element only).
aff. *Paltodus deltifer* (Lindström). LINDSTRÖM, 1977, p. 421–423, Paltodus-Pl. 1, fig. 4 (oistodiform element only).
aff. *Paltodus subaequalis* Pander. LINDSTRÖM, 1977, p. 427–428, Paltodus-Pl. 1, fig. 9 (oistodiform element only).
aff. *Paltodus inconstans* Lindström. FÅHRAEUS & NOWLAN, 1978, p. 459, Pl. 2, figs. 6, 9 (oistodiform element only).

Reclined oistodiform elements with strongly carinate inner faces and gently rounded outer faces. Anterior and posterior edges are sharp. The base is strongly swollen toward the inner side, especially in the position of the carina, whereas the base is regularly convex on the outer side. When the element is lying on the outer surface, the basal cavity opens in the inward direction. The basal cavity is shallow; many specimens retain heavy basal funnels. The cusp is long and relatively slender; its length commonly is more than twice the anterior-posterior length of the base.

Remarks.—Elements having this general shape have been interpreted as components of the apparatus of various species of *Paltodus* Pander following the interpretation of Lindström (1971, 1977). The oistodiform elements of these species have not been clearly distinguished from each other in the reports to date of their occurrence, so that they are not diagnostic of species. They are associated in the reconstructed apparatuses with costate drepanodiform elements (e.g., *Paltodus inconstans* Lindström, 1955) which are used to differentiate the species. The elements described above do not differ in any significant way from most of the reported occurrences of *O. inaequalis* Pander or of oistodiform elements of species of *Paltodus.* They have a relatively long range in the middle Pogonip and are modestly abundant, but no obviously associated drepanodiform elements can be identified from our collections. For this reason we are reporting this significant element of the Pogonip fauna under *Oistodus* in the form sense, although ultimately it will be reassigned when the apparatus to which it belongs has been established.

Occurrence.—Elements having this morpohology have been reported from northern Europe (Lindström 1955, van Wamel 1974, Löfgren 1978). We found them in the El Paso Group and in the section at the Columbia Ice Fields of Alberta (1964, 1965). Similar elements occur in the upper West Spring Creek Formation of Oklahoma

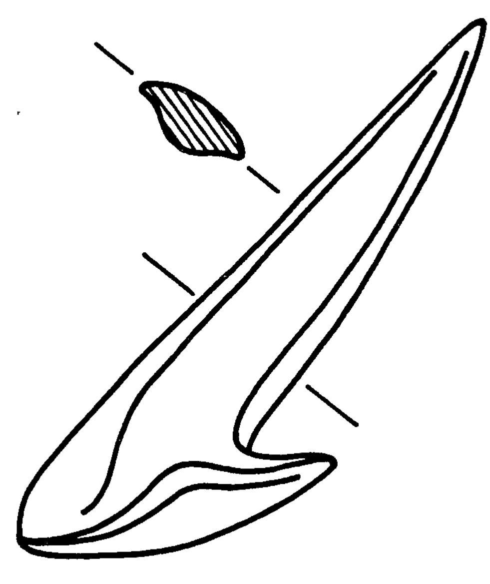

Figure 15.—*"Oistodus" inaequalis* Pander s.f.

(Potter 1975), and Fåhraeus and Nowlan have found them in the Cow Head Group of Newfoundland. Specimens from the Ninmaroo Formation of Australia that Druce and Jones (1971) reported as *O. inaequalis* seem very close to our material from the Pogonip, but the other conodonts in the Ninmaroo fauna suggest that it is older than the part of the Pogonip from which we obtained our material.

Range in the Pogonip.—These elements have their lowest occurrence in the lower part of Zone G in the Fillmore Formation (152.7 m [501 ft] in Section C) and range upward into the Wah Wah Formation (H–J–10).

Number of specimens.—215.

Repository.—Figured specimen UMC 1099–7; unfigured specimen UMC 1099–8.

aff. "OISTODUS" INAEQUALIS Pander s.f.
Pl. 7, fig. 11; fig. 16

Remarks.—These elements suggest morphologic affinity with *"O." inaequalis* s.f. in that their shallow basal cavities open to the inner side. They differ from that element in having a less prominent carina on the inner face, in having a much longer base whose anterior-posterior length is in excess of twice the width of the proximal part of the cusp, and in being drawn out at the anterobasal region.

Elements of this type are present throughout much of the range in the Pogonip of *"O." inaequalis* s.f. but are much less frequent or abundant in the occurrences in that interval. We are uncertain whether they are an extreme morphologic variant of that form or whether they are from an unrelated species.

Occurrence.—Repetski (1975, and in press) recovered the same elements from the El Paso Group of west Texas.

Range in the Pogonip.—Middle and upper Fillmore in all four section (C, H, Mesa, ST).

Number of specimens.—41.

Repository.—Figured specimen UMC 1099–9; unfigured specimen UMC 1099–10.

OISTODUS MULTICORRUGATUS Harris
Pl. 7, figs. 9, 10, 12–14, 17; fig. 17

Acontiodus sp. GRAVES & ELLISON, 1941, p. 5, 7, Pl. 2, fig. 24.
Oistodus multicorrugatus HARRIS, 1962, p. 204, Pl. 1, figs. 2a–c; MOUND, 1965b, p. 29, Pl. 3, figs. 31, 34, 35, Pl. 4, fig. 2; HIGGINS, 1967, p. 386, text-fig. 2(3); UYENO & BARNES, 1970, p. 110, Pl. 21, fig. 3; SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 32; BARNES, 1974, p. 230, Pl. 1, fig. 7; SUHM & ETHINGTON, 1975, p. 1131, 1132; BARNES, 1977, p. 103, Pl. 1, figs. 20–24.
Oistodus delta Lindström. ETHINGTON & CLARK, 1965, p. 194, Pl. 2, figs. 7, 13.
Oistodus sp. C ETHINGTON & CLARK, 1965, p. 196–197, Pl. 2, fig. 19.
Oistodus sp. D ETHINGTON & CLARK, 1965, p. 197.
Oistodus pseudomulticorrugatus MOUND, 1965b, p. 29, Pl. 4, figs. 3–5, 8, 9, text-fig. 1H; SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 33; SUHM & ETHINGTON, 1975, p. 1131, 1132.
Oistodus scalenocarinatus MOUND, 1965b, p. 30, Pl. 4, figs. 6, 7, 10–12, text-fig. 1I; BARNES, 1977, p. 103, Pl. 1, figs. 11–13.
Oistodus lanceolatus Pander. HIGGINS, 1967, text-fig. 2(1a, b); BRADSHAW, 1969, p. 1156–1157, Pl. 133, figs. 14–17; UYENO & BARNES, 1970, p. 119, Pl. 24, figs. 23, 24.
? *Oistodus multicorrugatus* Harris. SERPAGLI, 1974, p. 52–53, Pl. 23, figs. 13–16.
Oistodus cf. *O. lanceolatus* Pander. TIPNIS, CHATTERTON, & LUDVIGSEN, 1978, Pl. 2, figs. 9, 15; ? Pl. 2, figs. 10, 12.
Oistodus cf. *pseudomulticorrugatus* Mound. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 22.
Oistodus cf. *O. multicorrugatus* Harris. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 24.

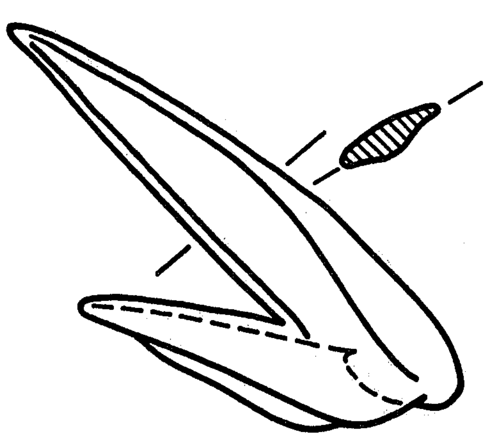

Figure 16.—aff. *"Oistodus" inaequalis* Pander s.f.

Remarks.—This species was established as a form-taxon for multicostate, robust oistodiform elements that R. W. Harris (1962) reported from "middle and upper Joins" Formation in southern Oklahoma. Other elements of the apparatus were described as form-species by Mound (1965b) who restudied the conodonts of the Joins sequence. These several elements were found by Bradshaw (1969) in her study of the conodonts of the Fort Peña Formation of west Texas. She recognized that they constituted parts of an apparatus which she believed to be that of *Oistodus lanceolatus* Pander as described by Lindström (1971). Serpagli (1974) disagreed with this assignment; he observed that the elements from northern Europe on which *O. lanceolatus* is based do not display multiple costae, nor do they have a ledge near the basal margin as is typical in *O. multicorrugatus.* The free base of elements of *O. multicorrugatus* has a high, thin keel that not uncommonly rivals the cusp in breadth and length in contrast to the regularly tapering and relatively short free base of *O. lanceolatus.* The specimens from Argentina that were considered by Serpagli do not show the free base to be as strongly developed as is typical of *O. multicorrugatus* from the Joins Formation or in the specimens from the Pogonip that we identify here. The other conodonts in the collections from Argentina reported by Serpagli occur in the Pogonip at levels generally below the range of *O. multicorrugatus.* In general morphology and in faunal associates, the specimens Serpagli identified with *O. multicorrugatus* more nearly resemble the elements from the Pogonip that we report here as *Oistodus* sp. A, a species that may be transitional between *Oistodus bransoni* and *O. multicorrugatus.*

The conodonts that Longwell and Mound (1967) reported as *Oistodus delta* Lindström, *Oistodus lanceolatus* Pander, and *Oistodus triangularis* Lindström may belong in *O. multicorrugatus.*

Noncostate cordylodiform elements that we include here are for the most part very large and are quite poorly preserved. Probably their great area as seen in lateral view resulted in their being subjected to differential stresses during compaction of the sediment in which they were buried. As a consequence of the fractures thus produced, few complete specimens were recovered. The extremely broad cusps and posterior basal regions of these elements are so distinctive that even badly fragmented individuals can be identified with confidence.

An abundance of material indicates that this element is more variable than is indicated in the original description. Mound (1965b, p. 29) considered twisting of the cusp and presence of sinuous anterior and posterior margins to be characteristic. Our collections include forms whose cusp is flexed but not twisted and with straight or convex margins as well as specimens that conform closely to the original description. The aboral groove bordering the basal margin is very variable. On most specimens it is faintly developed; some show it to be prominent, and on a few it is absent. The same variation with respect to this feature was observed in other specimens that we are identifying as other elements of this species.

The most distinguishing feature is the very large basal region which is not inflated. The posterior part of the base is strongly keeled and commonly is subequal in size to the cusp. Aboral margin is straight or slightly concave posteriorly and becomes strongly convex beneath the cusp. Anteriorly, the aboral margin rises to truncate the cusp so that on most forms an anterobasal corner is not present. Lateral faces of the cusp are unornamented, so that transverse section is narrowly biconvex. A number of specimens have faint parallel longitudinal costae that are confined to the lower reaches of the cusp. This feature may indicate a transitional relationship with the multicostate cordylodiform elements in which strong multiple costae are characteristic. The general outline of these two elements is very similar in that both have a broad cusp and an enlarged free base.

Mound (1965b) observed that the basal region on multicostate cordylodiform elements of *O. multicorrugatus* from the Joins Formation of Oklahoma is more variable than was indicated by Harris (1962). Numerous specimens from the Pogonip support Mound's observation and demonstrate the range of variability. In all cases the region directly beneath the cusp is convex downward. Generally the base is drawn out posteriorly into a bladelike region whose lower margin is gently concave. Most commonly, another but smaller embayment of the lower margin is located anteriorly. Specimens showing this configuration have the keeled leading edge of the cusp much reduced basally, and the region of the anterobasal corner is narrow. A few specimens have broad anterior keels that persist to the base of the element to produce a pronounced bladelike anterobasal corner. In such forms the anterior recess in the aboral margin may rival that located posteriorly, or the margin may be nearly straight in this area. Still other specimens have no anterior keel. These elements generally have the posterior part of the base much reduced, so that the outline of the aboral margin is continuously and strongly convex. The cusp on elements of this type is swollen medially and therefore much less bladelike than is typical of this form.

Most specimens have four to six costae to either side of the cusp, but a few individuals show only one or two. Many, but not all, have an indented band extending entirely around the base just above the aboral margin. This feature was reported by Harris (1962) who described it as a "channel" which "continues within the anterior rim of the blade." Our material does not support the latter observation. Well-preserved specimens show that this impressed region is continuous across the anterior margin from one side of the element to the other. No indication of basal inversion is seen; instead, the surface of the region is everywhere smooth and glossy. Accordingly it seems that in some specimens the later lamellae were basally constricted producing the "channel." Others, which are otherwise identical in morphology, did not experience basal constriction during growth and therefore do not display a "channel."

Cladognathodiform elements display the broad, reclined cusp and strongly keeled free base that is typical of the species. Each side of the cusp has a low, posteriorly directed costa halfway between the posterior margin and the midline of the cusp. These costae begin on the base, curve strongly at the juncture of base and cusp, and die out on the lower part of the cusp. A strong costa occupies the median position of the element on one side, beginning at the basal margin and continuing to the distal extremity. An anterobasal face ahead of this costa is markedly depressed. The opposite side of the element is broadly

Figure 17.—Lateral views of cordylodiform elements of, from left to right, *Oistodus bransoni* n. sp., *Oistodus* sp. 1, and *Oistodus multicorrugatus*.

swollen in the position corresponding to that of the median costa.

Elements of this type are much less common than the cordylodiform elements described above. Lindström (1971, p. 38) found the cordylodiform and cladognathodiform elements to occur in about equal numbers in *O. lanceolatus,* the type species

Trichonodelliform elements resemble *O. delta* Lindström s.f., which now is considered to be the trichonodelliform element of *Oistodus lanceolatus* Pander. The latter elements have a cusp with anterolaterally directed keels forming the edges of a triangular anterior face. Although a few of the individuals in our collections show an anterior face that is flat transversely, most have a longitudinal trough that extends the entire length of the anterior part of the cusp. The cusp narrows posteriorly to form a sharp to blunt median edge; cross section of the cusp is triangular with concave sides. All of the Pogonip specimens have a single costa to each side, separated from the anterolateral keel by a trough. Costae develop somewhat above the basal margin and continue to the tip of the cusp. The height of these costae is variable; most are prominent and approach the size of the anterolateral keels, but a few specimens show low, subdued costae. Basal region of the elements is strongly expanded posteriorly beneath the reclined distal portion of the cusp. The free base terminates upward in a sharp thin keel that either slopes in a straight line from its juncture with the posterior edge of the cusp to the posterobasal corner or is broadly convex through this region. The basal cavity is shallow and commonly retains a basal funnel.

General configuration of distacodiform elements is similar to that of the trichonodelliform elements described above except that the anterior region is not depressed between the anterobasal costae. Instead, this region forms a smooth face with a low, narrow median keel that is confined largely to the basal portion of the cusp. General plan of the element is suggestive of *Paltodus jeffersonensis* Branson and Mehl s.f., which is here considered to be an element of *Oistodus bransoni,* n. sp., but in the latter the anterior keel is much more prominent and continues to the tip of the cusp.

A few specimens suggest *O. multicorrugatus* in having a broad bladelike cusp with low costae on the lateral faces and a prominently keeled free base. However, the cusp is less strongly reclined, and a distinct anterobasal corner is developed. The specimens are not flexed as are typical cordylodiform elements of *O. multicorrugatus.* In lateral view they somewhat resemble elements here considered tentatively as the oulodiform element of *Oistodus bransoni* and also suggest those that Lindström (1964, p. 80) figured as the comparable element of *O. lanceolatus* Pander. Perhaps these specimens represent infrequent morphologic variants of the cordylodiform elements in each of these three species. It is possible also that those reported here as oulodiform elements of *O. bransoni* and of *O. multicorrugatus* are each representatives of other distinct species that are very poorly represented in our Pogonip collections.

Occurrence.—Oistodus multicorrugatus occurs in the upper West Spring Creek Formation and Joins Formations in Oklahoma (Potter 1975, Harris 1962, Mound 1965b, McHargue 1975). It is present in the Fort Peña Formation (Graves and Ellison 1941, Bradshaw 1969) and in equivalents of the Simpson Group in the Beach and Baylor Mountains of west Texas (Suhm and Ethington 1975). Uyeno and Barnes (1970) reported it from the Lévis Formation of Quebec, Barnes (1974, 1977) found it in the Ship Point Formation of the Canadian Arctic, and Tipnis and others (1978) illustrated specimens from the Broken Skull Formation of northern Canada.

Range in the Pogonip.—This is most common in the Kanosh and occurs sparingly throughout much of the Lehman Formation.

Number of specimens.—Noncostate cordylodiform element, 113; costate cordylodiform element, 147; cladognathodiform element, 33; trichonodelliform element, 67; ? distacodiform element, 2; ? oulodiform element, 4.

Repository.—Figured noncostate cordylodiform element UMC 1099–11; unfigured noncostate cordylodiform elements UMC 1099–12–14; figured costate cordylodiform element UMC 1099–15; unfigured costate cordylodiform elements UMC 1099–16–18; figured cladognathodiform element UMC 1099–19; unfigured cladognathodiform element UMC 1099–20; figured trichonodelliform element UMC 1100–1; unfigured trichonodelliform elements 1100–2, 3; figured ? distacodiform element UMC 1100–4; unfigured ? distacodiform element UMC 1100–5; figured ? oulodiform element UMC 1100–6; unfigured ? oulodiform element UMC 1100–7.

"OISTODUS" TRIANGULARIS Furnish
Pl. 7, figs. 15, 18, 22, 23

Oistodus? triangularis FURNISH, 1938, p. 330–331, Pl. 42, fig. 22, text-fig. 1P; ETHINGTON & CLARK, 1971, p. 72, Pl. 1, figs. 18, 22, 23.

? *Drepanodus acutus* Pander. DRUCE & JONES, 1971, p. 73, Pl. 20, figs. 5a–7c, text-fig. 24a.

? *Acodus housensis* Miller. JONES, 1971, p. 43, Pl. 3, figs. 6a–c.

? *Drepanodus tenuis* Moskalenko. JONES, 1971, p. 55, Pl. 3, figs. 3a–4b, Pl. 8, figs. 9a–c.

? aff. *Acodus firmus* VIIRA, 1974, p. 42, Pl. 1, figs. 21–23, text-fig. 2.

Remarks.—Furnish's description of the specimens from the Upper Mississippi Valley on which he based this species suggests that he was faced with considerable variation among them. Both the name and description indicate that a characteristic feature is an approximately triangular cross section. The material at hand from western Utah, as well as an abundance of well-preserved material from the Manitou Formation of central Colorado, demonstrates that the cross sections range from thin with one flattened side and one somewhat swollen side to markedly triangular with a blunt lateral edge. Typically the anterior margin is turned toward the more nearly planar side of the element. Robust specimens commonly show numerous subparallel hairlike costae on the basal region. These elements are associated in the Manitou with an erect element whose general outline is suggestive of the suberectiform element of species of *Drepanoistodus.* Although this species cannot be retained in *Oistodus* in either the form or multielement sense, we are uncertain as to its relationship to other Lower Ordovician conodonts. The specimens from the Ibex area are not sufficiently well preserved to permit thorough evaluation of the elements of the apparatus.

Lindström (1977) considered these elements to belong to the apparatus of a species he identified with *Paltodus variabilis* Furnish. However, the symmetry transition displayed by these forms here and in the Manitou argue against that assignment. The species Viira (1974) reported from the Lower Ordovician of Estonia as *Acodus firmus* appears to display at least some of the symmetry variants we found to occur in *"O." triangularis,* and the two species may be closely related. However, neither seems to contain an oistodiform element in its apparatus as presently understood, and this argues against assigning either species to *Acodus.* We will not clarify the systematic position of the species by transferring it to another genus just to remove it from *Oistodus,* and we are not as yet convinced that it deserve a new generic name of its own. For this reason we are retaining Furnish's original designation for identification only.

Occurrence.—The species occurs in the Oneota Formation in southern Minnesota (Furnish 1938), in the Manitou Formation in Colorado (Ethington and Clark 1971), and in the El Paso Group in west Texas (Repetski 1975, and in press). It probably is represented by specimens from the Ninmaroo Formation of Queensland, Australia, and from the Pander Greensand of northwestern Australia that Druce and Jones (1971) and Jones (1971) identified as *Drepanodus acutus* Pander, *Acodus housensis* Miller, and *Drepanodus tenuis* Moskalenko. A possibly related species, *Acodus firmus* Viira, has been described from the Lower Ordovician of Estonia.

Range in the Pogonip.—This species is present in all but the lower third of the House Formation at all localities where that formation was collected.

Number of specimens.—171.

Repository.—Figured specimens UMC 1101–4–7; unfigured specimen UMC 1101–8.

OISTODUS sp. 1
Pl. 7, figs. 16, 19–21; fig. 17

? *Oistodus multicorrugatus* Harris. SERPAGLI, 1974, p. 52–53, Pl. 23, figs. 13–16, text-fig. 10.
? *Oistodus lanceolatus* Pander. FÅHRAEUS & NOWLAN, 1978, p. 467, Pl. 2, figs. 15, 16.

Remarks.—A small number of elements from the Wah Wah and Juab Formations are generally similar to *Oistodus multicorrugatus* in possessing a broad bladelike cusp that is strongly reclined. They differ from the elements of the latter species in that the posterior basal extension is relatively short, perhaps only half the length of the cusp, and has a regularly curved oral margin instead of a high, thin keel. In this respect, these elements are intermediate between *O. bransoni* and *O. multicorrugatus.* Perhaps they represent an extreme in the morphologic spectrum of one or the other of these species; the portion of the Pogonip from which they were recovered is high in the range of the former and in the lower part of the range of the latter.

The elements from the San Juan Formation of Argentina that Serpagli (1974) identified with *O. multicorrugatus* seem nearly identical to those reported here.

Almost all of the specimens that we place here are cordylodiform elements of which only a few show faint costae on the faces. The cladognathodiform element and trichonodelliform element are represented by only one specimen each.

Range in the Pogonip.—Wah Wah Formation at Section J and Wah Wah and Juab Formations near Fossil Mountain.

Number of specimens.—Cordylodiform element, 38; cladognathodiform element, 3; trichonodelliform element, 1.

Repository.—Figured noncostate cordylodiform element UMC 1100–8; unfigured noncostate cordylodiform element UMC 1100–9; figured costate cordylodiform element UMC 1100–10; figured cladognathodiform element UMC 1100–11; figured trichonodelliform element UMC 1100–12.

"OISTODUS" sp. 2 s.f.
Pl. 8, fig. 1; fig. 18

A distinctive oistodiform element with a strongly reclined cusp and very reduced base. Cusp is recurved through more than 90° so that axis of cusp and a line normal to the basal margin subtend less than a right angle. One face of the cusp is gently convex, the other has a strong longitudinal costa near the front margin with the rest of the face nearly planar. Posterior edge of the cusp is sharp, the anterior edge is blunt. Posterior edge of the cusp is tangential proximally with the short posterior edge of the base. The basal cavity is large but not inflated; its tip is located near the anterior margin at the level of maximum curvature.

Remarks.—This unique element has not been reported previously, although it occurs in undescribed collections (D. J. Kennedy personal communication). Because the general outline is that of an oistodiform element, we are listing it here under the genus *Oistodus.* However, the portion of the cusp posterior to the costa contains at least some albid matter, which is not consistent with Lindström's (1971) redefinition of *Oistodus* Pander. We found only a few specimens, so that we cannot evaluate the range in morphology that might occur. Perhaps a new genus is represented.

Range in the Pogonip.—Specimens were recovered from the Fillmore Formation at 155 m (510 ft) and 183 m (600 ft) of Section H.

Number of specimens.—3.

Repository.—Figured specimen UMC 1100–13.

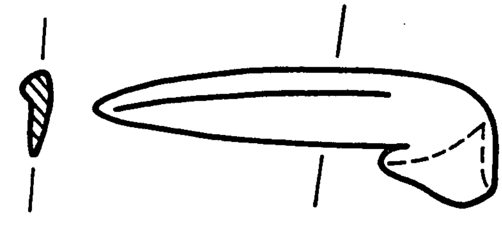

Figure 18.—*"Oistodus"* sp. 2 s. f.

"OISTODUS" sp. 3 s.f.
Pl. 8, fig. 2

Squat cone with short, strongly reclined cusp that is recumbent on the base throughout its length. Tip of cusp just above or slightly ahead of posterior extremity of base. Base deep, broad anteriorly, and tapering posteriorly so that basal outline in plan view is triangular with rounded corners. Anterior surface is broadly curved near the basal margin but narrows to a blunt edge as the base merges into the cusp. In lateral view the anterobasal angle is about 90°, anterior outline of the element is straight proximally but becomes strongly curved through the lower part of the cusp. The cusp tapers rapidly as it approaches the tip so that it has a spatulate distal outline. Basal cavity is obscured by thermal alteration; probably it is deep and spacious.

Remarks.—Initially, we dismissed this unusual specimen as a rejuvenated element because of the abrupt taper of the distal part of the cusp. If this interpretation were correct, the heavy basal region should indicate to which of the associated species it properly belongs. No other specimens show a base having this configuration, however, and we were inclined to dismiss the specimen as too uncertain to be identified. Recently Brand (1976) recovered identical elements in the interval between 82 and 366 m (270 and 1200 ft) above the base of the Kindblade Formation of Oklahoma. Although not a dominant component of the fauna of the Kindblade, these elements occur there in sufficient numbers and at enough stratigraphic levels to indicate that they are not aberrant or pathogenic specimens. Study of collections from units in which they are more abundant than seems to be the case with the Fillmore will be needed to establish where they belong.

Range in the Pogonip.—Fillmore Formation, 210 m (690 ft) above the base of Section H.

Number of specimens.—1.

Repository.—Figured specimen UMC 1100–14.

"OISTODUS" sp. 4, s.f.
Pl. 8, fig. 3

Cusp strongly reclined, sharp edged to keeled; with lenticular cross section. Lateral ridges may be present but are poorly defined. Leading edge of cusp somewhat convex in outline proximal to base; distally nearly straight. Posterior margin is convex proximally. Distal portion has been lost from all specimens, but most complete individuals suggest that in its outer reaches the posterior margin becomes concave and that the cusp had a slender extremity leading to a sharp point. Base is low; broadly flared, particularly posteriorly. Anterobasal angle drawn out, generally about 45°. Posterior basal extension is very short; up to half the length of its low keel is in contact with or fused to the rear edge of the cusp. Distally these two edges diverge at an angle of 30°. Viewed from the outer side, the aboral margin is straight from the anterobasal corner to the point of greatest basal flare, then curves sharply upward to intersect the posterior margin at an angle between 45° and 60°. In a few specimens the aboral outline, viewed from the inner side of the element, is gently convex to almost straight. Base is completely excavated; cavity is shallow with its apex beneath and posterior to the center of the cusp.

Remarks.—The low basal region of this form is suggestive of the oistodiform element of species of *Histiodella,* but we did not identify obvious histiodelliform elements that might be associated with it. It may belong to a species of *Drepanoistodus,* but we could not relate it to obvious drepanodiform associates.

Occurrence.—McHargue (1975) found this form to occur in abundance in the Joins Formation but was not able to assign it to an apparatus.

Range in the Pogonip.—Middle and upper Kanosh at the Fossil Mountain section.

Number of specimens.—7.

Repository.—Figured specimen UMC 1100–15.

"OISTODUS" sp. 5 s.f.
Pl. 8, fig. 8

A variable oistodiform with slender, reclined cusp that consists wholly of albid matter. Leading edge generally blunt and rounded, but may be sharp. Anterior margin strongly curved in basal region, becoming nearly straight along cusp. Posterior edge sharp; marginal outline sinuous, straight, or somewhat concave distally and convex proximally. This margin joins the free upper edge of the base, and the two are fused for one-third the length of the base. Some specimens are clearly flexed, others only barely so. Inner face of cusp may have a clearly defined costa located ahead of the midline, or this face may be uniformly swollen transversely. Outer face never shows a costa but may have a median crest from which the surface slopes to either edge. Angle between axes of cusp and base varies from 15° to 30°, although the smaller angle is more common. Base is very shallow, its depth one-fifth the length of the cusp or less. It is expanded anteriorly, particularly to the inner side, but narrow posteriorly. Free portion of base represents about one-half basal length. Its upper edge is blunt; in outline it is gently convex proximally and strongly so distally where it curves back anteriorly to meet the lower margin in an obtuse angle. Lower margin sinuous, convex anteriorly but straight or gently concave in the rear two-thirds of its length. Basal cavity shallow, its apex directed anteriorly and upward at about one-sixth the length of the base behind the anterior margin.

Remarks.—This distinctive oistodiform element cannot be related to any of the other elements in our collection so that we report it in the form sense.

Range in the Pogonip.—Larsen recovered this element from the House Formation in the collections from Section B of Hintze (1951) and from the type area.

Number of specimens.—19.

Repository.—Figured specimen UMC 1100–16.

"OISTODUS" sp. 6 s.f.
Pl. 8, fig. 4

? *Oistodus inaequalis* Pander. DRUCE & JONES, 1971, p. 76, Pl. 12, figs. 10a–13b, text-fig. 25a.

Oistodiform element with broad cusp having sharp edges; outer surface is broadly convex transversely, inner surface has linear swollen region occupying most of posterior half of surface. Anterobasal corner is drawn out sharply and has an apical angle of ca. 30°. Posterior basal extension is very short; the length of its straight to arched upper margin is about one-half the transverse width of the cusp. Base is strongly flared to inside beneath posterior half of the cusp but is thin anteriorly. Basal cavity is shallow.

Remarks.—We have so few specimens of this form that we are uncertain where they should be assigned. They may be extreme variants of the oistodiform element of New Genus 3 herein, in which the anterobasal region is continued far anteriorly.

Occurrence.—The specimens from the Ninmaroo Formation of Australia that Druce and Jones (1971) identified with *O. inaequalis* are all broken to some degree. Overall, they seem to be quite close to the forms reported above.

Range in the Pogonip.—These elements were found by Larsen in the uppermost House Limestone in the type area; he also found one specimen in upper House at Hintze's (1951) Section B.

Number of specimens.—11.

Repository.—Figured specimen UMC 1100–17; unfigured speciment UMC 1100–18.

Genus ONEOTODUS Lindström, 1955

Type species.—Distacodus ? simplex Furnish, 1938.

Remarks.—Oneotodus was proposed originally as a form-genus to include simple cone elements with circular cross sections and unornamented cusps (Lindström 1955, p. 581). Subsequently nearly 20 form-species have been described most of them from Lower and Middle Ordovician strata. The majority of these form-species have been recorded from only their type collections, although a few have been reported widely. The only common character has been the absence of ridges or grooves on the cusp; perhaps some of these species are based on juvenile individuals.

We have examined the type specimens of *D. ? simplex* (SUI 1274) and a topotype specimen that Furnish donated to the University of Missouri conodont collection (UMC 550–2). These three specimens have characteristics not reported by Furnish (1938, p. 328) and not considered by Lindström in the definition of *Oneotodus.* In all three specimens all but the region surrounding the basal cavity consists wholly of white matter. Cross section is not consistent among the three specimens; both cotypes have subcircular section but are flattened posteriorly, whereas the topotype has a recess along the posterior margin. None has an expanded base; basal cavities are shallow but broad and have their apices adjacent to the anterior margins of the respective specimens. At highest magnification available to us, faint surface striae are suggested.

Numerous specimens from Lower Ordovician deposits of central United States have been compared by us with the types of *D. ? simplex;* this comparison shows that the latter specimens represent only one aspect of a variety of forms that resemble them in similar development of white matter and in the form of the basal cavity. The other forms are distinguished by varying development of sharp-edged costae on the lateral portions of the cusp; typically, the anterior region is rounded and not costate. The elements collectively must constitute an apparatus consisting wholly of simple cones. The costate forms have been identified previously by authors including ourselves with *Scolopodus cornutiformis* Branson and Mehl. The latter species includes wholly hyaline elements that typically are laterally compressed. The costae in *S. cornutiformis* are narrow, low, and blunt with broad areas between them; in contrast, the costae in costate representatives of the form identified here as aff. *O. simplex* are broad, relatively sharp, and asymmetrical with steep posterior faces and sloping anterior faces that terminate anteriorly at the base of the next anterior costa. The basal cavity is relatively deeper in *S. coruntiformis* than in aff. *O. simplex,* and the former seems to achieve greater overall size. The two species are associated in deposits in central Missouri like those from which Branson and Mehl (1933) recovered their "Jefferson City" collections.

Our collections contain too few specimens to allow a satisfactory definition of the apparatus of the species as aff. *O. simplex.* Dr. Uwe Brand has studied numerous specimens of this form from the Kindblade Formation in Oklahoma where it is more abundant and better preserved than in its occurrences in the Ibex area. These specimens are the basis of a manuscript (Ethington & Brand, in press) that discusses the concept of *Oneotodus* as a multielement taxon and the validity of species assigned to that genus by various authors. A thorough description of aff. *O. simplex* appears there, and most of the form-species identified with *Oneotodus* over the post two decades are removed from the genus.

aff. ONEOTODUS SIMPLEX (Furnish)

Pl. 8, fig. 7

aff. *Distacodus? simplex* FURNISH, 1938, p. 328, Pl. 42, figs. 24, 25, text-fig. 1(O).

Scolopodus n. sp. MEHL & RYAN, 1944, p. 45, Pl. 6, figs. 41–45 (*non* figs. 40, 47, = *Scolopodus cornutiformis*).

Scolopodus cornutiformis Branson & Mehl. ETHINGTON & CLARK, 1964, p. 698–699, Pl. 114, figs. 16, 23; BARNES & TUKE, 1970, p. 91, Pl. 18, figs. 1, 4; BARNES, 1974, p. 227, Pl. 1, fig. 1; BARNES & SLACK, 1975, p. 4, figs. 1A–F.

Remarks.—Most of the specimens from the Pogonip that we assign here are fragmented. Many appear to be partially rejuvenated, and others have been broken during processing or prior to extraction from the rock matrix.

All of the specimens in our collection are costate. Number and height of the costae vary among the specimens, but in all cases the costae show a steep posterior face and a broad sloping anterior face that terminates anteriorly at the base of the posterior face of the costa ahead. In almost all of the samples from which it was recovered it is represented by single specimens.

Occurrence.—This species is present in pre-St. Peter clays in central Missouri (Moore 1970) and in the Kindblade and West Spring Creek Formations of southern Oklahoma (Potter 1975, Brand 1976). Some of the specimens that Mound (1968b) assigned to several species of *Scolopodus* Pander clearly belong here, but restudy of the conodonts of that formation will be necessary to delimit their occurrence there. The species occurs in the El Paso Group in west Texas (Ethington and Clark 1964, Repetski 1975, and in press) and in the St. George Formation of western Newfoundland (Barnes and Tuke 1970).

Range in the Pogonip.—We found this species to be present but sporadic in its occurrence in the Fillmore Formation in the upper half of the Mesa Section (170 through 315 m [559 through 1035 ft] and throughout the ST Section. Range in Section H is from 67 through 265 m (220 through 870 ft). Occasional specimens were found in Section C in the interval from 130 through 284 m (425 through 931 ft).

Number of specimens.—75.

Repository.—Figured specimen UMC 1100–19; unfigured specimens UMC 1100–20, 1101–1.

ONEOTODUS NAKAMURAI Nogami
Pl. 8, figs. 14, 19

Oneotodus sp. a. MÜLLER, 1959, p. 458, Pl. 13, fig. 17.
Oneotodus sp. indet. MÜLLER, 1959, p. 458, Pl. 13, fig. 1.
Oneotodus nakamurai NOGAMI, 1967, p. 216–217, Pl. 1, figs. 9–13, text-figs. 3A–E; MILLER, 1969, p. 435–436, Pl. 63, figs. 1–10, text-fig. 5E; DRUCE & JONES, 1971, p. 82–83, Pl. 10, figs. 1–8b, text-fig. 26i, j.
? *Oneotodus datsonensis* DRUCE & JONES, 1971, p. 80, Pl. 14, figs. 1a–4c, text-fig. 26c; JONES, 1971, p. 56–57, Pl. 3, figs. 5a–7c.
? *Oneotodus nakamurai* Nogami. JONES, 1971, p. 58, Pl. 4, figs. 1a–c.

Remarks.—This simple, generalized element is common throughout the House Limestone at all sections where it was studied. Generally the elements are strongly recurved above the base so that the cusp is parallel to the basal margin throughout its length. Some specimens show slight bowing of the distal reaches of the cusp; others are straight. As noted by Nogami (1967), the cusp consists almost wholly of albid material, although the distal tip appears to be hyaline. The base is little inflated; the basal cavity is a shallow cone. Faint striae are revealed at high magnification (see Pl. 8, fig. 19).

Occurrence.—The type collection came from Upper Cambrian rocks (Yencho Beds) collected in northeastern China (Nogami 1967). The species is present in the Signal Mountain Limestone in Oklahoma (Müller 1959) and probably also in the Ninmaroo Formation and Pander Greensand in Australia (Druce and Jones 1971; Jones 1971). Miller (1969) reported its occurrence in the Notch Peak Formation which underlies the Pogonip in the Ibex region.

Range in the Pogonip.—House Limestone at all sampled sections.

Number of specimens.—273.

Repository.—Figured specimen UMC 1101–2; unfigured specimen UMC 1101–3.

Genus PALTODUS Pander, 1856
Type species.—*Paltodus subaequalis* Pander, 1856.

"PALTODUS" BASSLERI Furnish
Pl. 8, figs. 11, 12

Paltodus bassleri FURNISH, 1938, p. 331, Pl. 42, fig. 1; ETHINGTON & CLARK, 1971, p. 72, Pl. 2, figs. 2, 4, 6; REPETSKI & ETHINGTON, 1977, p. 95, Pl. 1, fig. 1.
Paltodus variabilis FURNISH, 1938, p. 331, Pl. 42, figs. 9, 10, text-fig. 1E; ETHINGTON & CLARK, 1965, p. 197–198; LINDSTRÖM, 1977, p. 429–431, Paltodus–Plate 1, figs. 10, 11 (*non* figs. 12–16).
non Paltodus variabilis Furnish. GRAVES & ELLISON, 1941, p. 5, Pl. 2, fig. 17; SERGEEVA, 1963, p. 99–100, Pl. 7, figs. 10–12, text-fig. 5; MOUND, 1965b, p. 31, Pl. 4, figs. 13, 14; MOUND, 1968, p. 415, Pl. 4, figs. 18–38; LEE, 1970, p. 331, Pl. 7, fig. 31.
Scolopodus asymmetricus DRUCE & JONES, 1971, p. 89–91, Pl. 19, figs. 3a–7c, text-fig. 30a; JONES, 1971, p. 61–62, Pl. 5, figs. 1a–2c.
Scolopodus bassleri (Furnish). DRUCE & JONES, 1971, p. 91–92, Pl. 17, figs. 1a–4d, text-fig. 30b; JONES, 1971, p. 62–63, Pl. 5, figs. 3a–c, 6a–c, Pl. 9, figs. 2a–c, 3a–c.
Paltodus (?) *bassieri* [sic] Furnish. ABAIMOVA, 1975, p. 88–89, Pl. 7, figs. 14, 15, 17–19, text-fig. 7(41, 42, 44–46).
Paltodus (?) *variabilis* Furnish. ABAIMOVA, 1975, p. 92–93, Pl. 7, figs. 12, 16, text-fig. 8(2, 3).
? *Scolopodus bassleri* (Furnish). FÅHRAEUS & NOWLAN, 1978, p. 468, Pl. 1, figs. 18, 19.

Remarks.—Sweet and Bergström (1972, p. 32) suggested that the form-taxa that Furnish (1938) described under the names *Acodus oneotensis, Oistodus? triangularis,* and *Paltodus bassleri,* respectively, constitute parts of the apparatus of one species. As noted previously herein in the discussion of *"A." oneotensis* and *"O." triangularis,* Furnish did not describe the ranges of morphology that are displayed by any of these groups, each of which has a symmetry transition of its own. We consider it unlikely that they are parts of a common apparatus; but, if this should be substantiated, it will be the most complicated apparatus recognized to date.

Lindström (1977) interpreted *Paltodus bassleri, Paltodus variabilis* Furnish, *Acodus oneotensis* Furnish, *Oistodus? triangularis* Furnish, and *Oistodus inclinatus* Branson and Mehl *sensu* Furnish, all of which were reported from the Oneota Dolomite of the Upper Mississippi Valley by Furnish (1938), as the elements of the apparatus of a species which he recognized under the name *P. variabilis.* As stated above, we believe that *"A." oneotensis* and *"O." triangularis* represent independent species and cannot be parts of a common apparatus, and that neither is related to *P. bassleri.* Large collections from the Manitou Formation of Colorado (assembled by RLE) have an abundance of material that supports the interpretation of *P. bassleri* and *P. variabilis* as extremes in a transition series. The valid name, however, is *"P." bassleri* which was selected by Druce and Jones (1971) who considered these two form-species to be synonyms. Further, the collections from the Manitou do not contain any oistodiform elements like those that Furnish compared with *Oistodus inclinatus* Branson and Mehl s.f. *"Paltodus" bassleri* seemingly has an apparatus of the monoelemental type (see Sweet and Bergström 1972, p. 32) that is characterized by a spectrum of variants on a single theme.

The material from the lower Pogonip displays wide variance in cross section, ranging from near bilateral symmetry to marked asymmetry. Some specimens are robust with subround transverse section, others are slender and flattened. One lateral groove is always present, although in some of the flattened forms it is only a depressed region adjacent to the anterior margin. Another groove varies from posterior in position to lateral, in which case it is located to the opposite side and somewhat more posteriorly than the other groove. Some specimens do not have a clearly defined second groove. All of the variations are completely intergradational, and we cannot identify distinct groups within the spectrum. Striae are present posteriorly on the cusp but visible only at high magnification (see Pl. 8, fig. 12).

Occurrence.—This species is present in the Oneota Formation in the Upper Mississippi Valley region (Furnish 1938) and in the El Paso Group of west Texas (Repetski 1975, and in press). We earlier (1971) reported its occurrence in the Manitou Formation in central Colorado. Although the fauna of the McKenzie Hill Formation of southern Oklahoma includes species elsewhere associated with *"P." bassleri,* the specimens Mound (1968) illustrated under that name seem to be identified incorrectly. It has been reported from the Collier Formation in Arkansas and Oklahoma. (Repetski and Ethington 1977). Druce and Jones (1971) found this species in the Ninmaroo Formation in Queensland, and Jones recovered it from the Pander Greensand, Ooloo Limestone, and Jinduckin Formation in northwestern Australia. Abaimova (1975) described the species from Lower Ordovician rocks of the Siberian platform. The specimen from the Cow Head Group of Newfoundland that Fåhraeus and Nowlan (1978) illustrated is not a typical morphotype of this species. The conodonts that they reported to be associated with that specimen are forms that occur higher in the Ibex section than *"P." bassleri.* We believe that the specimen from the Cow Head does not belong in this species.

Range in the Pogonip.—*"Paltodus" bassleri* occurs in middle and upper House Limestone at all of the sampled sections.

Number of specimens.—202.

Repository.—Figured specimen UMC 1101–9; unfigured specimens UMC 1101–10, 11.

aff. PALTODUS? JEMTLANDICUS Löfgren
Pl. 8, fig. 10; fig. 19

aff. *Paltodus? jemtlandicus* LÖFGREN, 1978, p. 65, Pl. 4, figs. 1–3, 6.

Small elements with broad cusps whose proximal width is ca. 80% of the anterior-posterior length of the base. Base is very shallow with the cavity opening somewhat inward. Cusp has a poorly defined median carina on the inner face and is gently rounded on the outer side. Anterobasal angle ca. 80°, posterobasal angle about 30°.

Remarks.—These specimens are suggestive of those discussed elsewhere in this report under the name *"Oistodus" inaequalis* Pander s.f., but are distinct in having less well-defined carinae, and cusps whose width is greater relative to basal length. In addition, they typically are much smaller than those forms.

The elements described above resemble the oistodiform elements of *P. ? jemtlandicus* which Löfgren (1978) described from Llanvirnian strata of Jämtland, Sweden. The specimens from Sweden have a larger angle between the posterior edge of the cusp and the base than is shown here, and the anterobasal angle is somewhat less in those specimens. The outline of the cusp, the vaguely defined carina, and the shape of the basal cavity are very similar in the two collections. We did not find drepanodiform elements of the kind that she included in her reconstruction of the species. Her specimens are much younger than those reported here which come from late Tremadocian or early Arenigian strata. We are tentatively considering our material to represent a species of *Paltodus* whose other elements are not clearly indicated in our collections.

Range in the Pogonip.—Lower Fillmore in the C Section between 46 and 39 m (150 and 455 ft).

Number of specimens.—29.

Repository.—Figured specimen UMC 1101–12.

aff. PALTODUS SEXPLICATUS (Jones) *sensu* Abaimova, 1975
Pl. 8, figs. 5, 6; fig. 20

? aff. *Paltodus quinquecostatus* MÜLLER, 1964, p. 98, Pl. 12, figs. 4a, b, Pl. 13, figs. 2a, b.
? aff. *Paltodus sexplicatus* (Jones). ABAIMOVA, 1975, p. 91–92, Pl. 7, figs. 1, 2, text-fig. 7(31, 39).

Remarks.—We include here two kinds of elements that occur through a short interval in the Fillmore. Both are characterized by strong costae that begin just above the base and continue orally; costae are not symmetrically arranged on the cusp on either type of specimen. The larger and heavier elements, which constitute about one-third of the available material, have up to six costae, whereas the smaller individuals have only four. Possibly these two sizes and configurations represent different growth stages of a single kind of element, for the plan of the smaller elements is present in the larger ones but obscured by more strongly developed and more numerous costae. Arguing against this interpretation is the shape of the basal cavity whose apex is drawn over in the anterior direction (see fig. 20) in the smaller forms but which is essentially a tapering cone in the larger specimens.

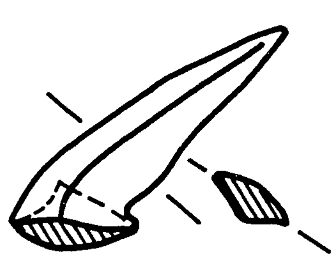

Figure 19.—aff. *Paltodus? jemtlandicus* Löfgren (oistodiform element).

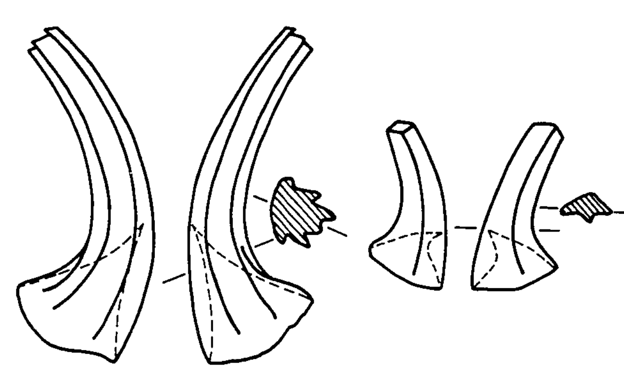

Figure 20.—Opposite views of large and small elements of aff. *Paltodus sexplicatus* (Jones) *sensu* Abaimova.

Because both types share the same limited range in the Fillmore, we believe they came from the same apparatus. This apparatus also may include the forms reported here as ?*Scandodus* sp. 2 s.f.; the latter elements occur through a greater interval in the lower Fillmore but have their highest occurrence near the top of the range of the elements considered here. Further, they display considerable variation in the symmetry arrangement of their heavy costae so that some of the specimens that we have included there may belong here.

The heavy costae and the considerable variation that exists in their distribution about the cusp among our specimens are suggestive of *P. quinquecostatus* Müller and of *P. sexplicatus* (Jones) of Abaimova (1975), but the descriptions and illustrations of those species are not adequate for evaluation of possible affinity. The specimens that Abaimova identified as *P. sexplicatus* seem very close to the small specimens considered above. The smaller specimens also resemble *Paltodus inconstans* Lindström (= drepanodiform element of *Paltodus subaequalis* Pander according to Lindström 1977), but oistodiform elements like those of the apparatus of that species do not occur in the part of the Pogonip from which we obtained our material.

The only common feature between these elements and those that Jones described from the Pander Greensand of Australia as *Scolopodus sexplicatus* is the presence of multiple heavy costae. A new specific name is required, but neither our collection nor that of Abaimova is adequate to properly define the limits of a named species.

Occurrence.—The specimens with which we compare these elements were reported from Lower Ordovician rocks of South Korea (Müller 1964) and from Lower Ordovician exposures along the middle reaches of the Lena River on the Siberian Platform (Abaimova 1975).

Range in the Pogonip.—Fillmore Formation, Section C in the interval from 128 through 140 m (420 through 460 ft).

Number of specimens.—Large specimens, 18; small specimens, 37.

Repository.—Figured specimens UMC 1101–13, 14.

"PALTODUS" SPURIUS Ethington & Clark
Pl. 8, figs. 9, 13

Paltodus spurius ETHINGTON & CLARK, 1964, p. 695, Pl. 114, figs. 3, 10, text-fig. 28; ETHINGTON & CLARK, 1965, p. 197.
Paltodus variabilis Furnish. LEE, 1970, p. 331, Pl. 7, fig. 31.

Remarks.—A complete growth series can be reconstructed from among the specimens at hand. It shows that the lateral groove becomes increasingly less prominent with growth. At the same time the rounded ridge posterior to the groove swells correspondingly, so that it is the dominant feature on gerontic individuals.

Lindström (1977) recently emended the diagnosis of *Paltodus* Pander to provide for an apparatus with prioniodiform, ramiform, and oistodiform elements. The distinctive specimens that we (1964) described as *P. spurius* do not correspond clearly to any of these three kinds of elements; almost certainly this form does not belong to a species of *Paltodus*. We cannot, however, establish with certainty to what kind of apparatus it belongs from the specimens available to us.

Occurrence.—The species was first reported on the basis of several specimens obtained from strata in the Chiricahua Mountains of southeastern Arizona (Ethington and Clark 1964). Subsequently, we found it in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965), in the Opohonga Formation of central Utah, and in the Manitou Formation of central Colorado (undescribed collections of RLE). It has been reported (Longwell and Mound 1967) to be present in the Monocline Valley Formation in southern Nevada. Repetski (1975, and in press) found it in the El Paso Group of west Texas. Lee (1970) reported its presence in the Dumogol Beds of South Korea and in the Mandal Beds in North Korea.

Range in the Pogonip.—This species occurs in the upper half of the House Limestone; it was recovered from all of the sampled sections.

Number of specimens.—227.

Repository.—Figured specimens UMC 1101–15, 16.

Genus PANDERODUS Ethington, 1959
Type species.—*Paltodus unicostatus* Branson & Mehl, 1933.

PANDERODUS sp.
Pl. 8, figs. 15, 16

Remarks.—Specimens of *Panderodus* in the Crystal Peak Dolomite fall into two generalized groups. One consists of rather slender elements whose variable cross sections suggest a transition series. Typically they have one rounded side which bears the longitudinal slit and a flat to gently convex opposite side. The anterior margin commonly is deflected toward the flattened side. The other group consists of broad, relatively thin elements whose cross sections are lenticular. In general, these forms resemble some of the specimens of *Panderodus* that Ethington and Schumacher found in the Copenhagen Formation in central Nevada. These two kinds of elements probably represent the components of the apparatus of a single species. Sweet and Bergström (1972, p. 32, 41, text-fig. 2N) reconstructed the apparatus of *Panderodus* to include two kinds of elements.

Range in the Crystal Peak.—*Panderodus* ranges through the upper 12 m (40 ft) of the Crystal Peak Dolomite at the type section but is not present in any of the samples collected lower in the formation at that locality. A specimen that may belong in *Panderodus* also was recovered from near the base of the Watson Ranch Quartzite at the same locality.

Number of specimens.—23.

Repository.—Figured specimens UMC 1101–17, 18.

? PANDERODUS sp.
Pl. 8, figs. 17, 18

Remarks.—Two specimens from the Lehman Formation are assigned with question to *Panderodus* because of the presence of a hairline slit located posteriorly in the plane of symmetry. This slit extends to the basal margin where it is slightly widened. Elements are bilaterally symmetrical with a rounded anterior surface and posterolateral shoulders. Posterior surface is depressed adjacent to these shoulders on each side, then swells slightly before being recessed again near the slit. Elements are only slightly recurved along their length. Base is somewhat swollen posteriorly so that the outline of the basal margin as seen from beneath is nearly circular. The surfaces of both specimens are dull; they appear to bear longitudinal striae whose size and spacing are near the limits of resolution of the optical microscope at magnification of ca. 100 diameters, but which are clearly defined by the SEM.

These specimens differ from typical representatives of *Panderodus* in being bilaterally symmetrical and in having the slit located posteriorly rather than laterally. They may be related to older forms such as *"Scolopodus" gracilis* and *"Scolopodus" emarginatus,* both of which have posterior slits or grooves and which tend to be striate.

Occurrence.—These specimens came from the Lehman Formation at 44 m (145 ft) above the base in the Crystal Peak Section.

Number of specimens.—2.

Repository.—Figured specimens UMC 1101–19, 20.

Genus PARAPRIONIODUS Ethington & Clark, n. gen.
Type species.—Tetraprioniodus costatus Mound, 1965b.

Apparatus consists of largely hyaline elements and includes two kinds of prioniodiform elements and a transition series of ramiform elements. White matter, if present, is confined to the denticles on the processes. An oistodiform element is not part of the apparatus.

Remarks.—The presence of two kinds of prioniodiform elements and of a transition series of ramiform elements is similar to the arrangement of the apparatus of *Prioniodus* Pander as that genus has been interpreted recently (see, e.g., Sweet and Bergström 1972, text-fig. 2A; Löfgren 1978, p. 78). However, the elements of that genus are dominantly albid, and an oistodiform element invariably is present, so that the several elements considered here do not conform individually or collectively to the characters of *Prioniodus.* We cannot identify these elements under any other extant genus among Ordovician conodonts, so that a new name is necessary.

PARAPRIONIODUS COSTATUS (Mound)
Pl. 8, figs. 20–26

Cordylodus delicatus Branson & Mehl. MOUND, 1965b, p. 14, Pl. 1, figs. 25, 28, 30.
Dichognathus extensa Branson & Mehl. MOUND, 1965b, p. 15, Pl. 1, fig. 27.
Dichognathus typica Branson & Mehl. MOUND, 1965b, p. 15–16, Pl. 1, fig. 29.
Ozarkodina delecta Stauffer. MOUND, 1965b, p. 30–31, Pl. 4, fig. 15.
Prioniodus evae Lindström. MOUND, 1965b, p. 32–33, Pl. 4, figs. 17, 18.
Tetraprioniodus costatus MOUND, 1965b, p. 34–35, Pl. 4, figs. 19, 25, 31, text-fig. 1K.
Cyrtoniodus sp. A SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 2, fig. 22.
Prioniodina? sp. A SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 37.
Prioniodus sp. A SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 26.
Prioniodus sp. B SWEET, ETHINGTON & BARNES, 1971, p. 169, P. 1, fig. 28; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 11.
Tetraprioniodus sp. A SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 30; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 21.
? *Dichognathus* sp. A TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 12.
Cordylodus sp. A TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, fig. 22.
"Prioniodus" sp. HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 1, figs. 13–15.

The apparatus of this species includes two kinds of prioniodiform elements, one with two of its processes arranged horzontially to either side of the cusp and the other with the processes extending downward away from the base of the cusp, and a transition series of ramiform elements including forms here designated as being cordylodiform, cyrtoniodiform, oepikodiform, and trichonodelliform.

Cusp of one prioniodiform element slender, elongate, somewhat reclined; edges sharp, outer face gently swollen and opposite face strongly so. Inner face of cusp with prominent costa ahead of midline; costa branches from face of cusp as lateral process. Posterior process, which is a continuation of the posterior edge of the cusp, is shallow and of moderate thickness. It may be twisted toward the distal extremity. It bears up to six discrete denticles separated from each other by narrow gaps whose width is of the order of one-third that of the adjoining denticles. Cross sections of denticles are circular to elliptical. Lateral process is shorter and may be deeper than posterior process. The former carries five to six denticles which decrease in size away from the cusp. Proximal denticles of this process tend to be fused, whereas the outer two are discrete. Axis of lateral process is nearly aligned with that on the posterior process, i.e., they have a common axis or form a slight arch. In addition they almost occupy a common plane so that, seen from above, the element shows only slight flexing. Anterior edge of cusp turns laterally away from lateral process and is produced as a downward and/or outward directed anterior process. This process is much shallower and shorter than the other two. One or two denticles are poorly differentiated from the oral margin of the anterior process and grow at a low angle to its axis. Under side is completely excavated by subprocess troughs that merge in a subcentral basal cavity beneath the cusp. Gerontic specimens show a broad but shallow trough beneath the processes.

Cusp of other prioniodiform element stout, slightly reclined; outer face medially swollen with keeled edges. Inner face with prominent costa somewhat ahead of midline. Cusp is depressed between keels and costa. Keels and costae of cusp produced basally as denticulate processes located posteriorly, anterobasally, and aborolaterally, respectively. Posterior process is shallow; it may be somewhat arched and slightly twisted. Denticles are discrete pegs separated by spaces comparable to their own width. Those closest to the cusp are suberect, but those toward the extremity are more strongly reclined. Most specimens show five denticles on this process, but a few have six. Viewed from the posterior direction, the lateral process forms about a 135° angle with the axis of the cusp. This process is thin and moderately deep, with about four discrete but closely spaced denticles. The process terminates in a blunt point beyond the farthest denticle. Anterior aboral process is directed downward and outward from the base of the cusp. It is flexed toward the side opposite the lateral process, and so does not occupy the same plane as the cusp. Denticles are few, only two or three in number, discrete, and set approximately normal to the oral margin. Shallow grooves occupy entire underside of each process and merge in a basal cavity beneath cusp. Cavity flares to produce aboral lips in the areas between the posterior process and the other two processes. That lip in the outer lateral position is always quite distinct; the other may be subdued. On large, presumably gerontic, specimens the ornamentation of the cusp is very pronounced. These specimens have thick processes which aborally show broad striated surfaces of basal inversion without a clearly defined groove. The centrally located cavity, however, is present in these forms.

Cordylodiform elements are dominated by a very large cusp whose length is of the order of three times that of the largest succeeding denticle. Cusp is vertical to slightly reclined, with sharp anterior and posterior edges. Both inner and outer surfaces of cusp show median longitudinal swelling flanked by broad keels. Keels consist of white matter which shows prismatic structures oriented approximately normal to edge of cusp, whereas axial region of cusp is dark but translucent. Leading edge of cusp is continued downward and anteriorly as a short process with two or three stubby denticles that typically are fused throughout much of their length. Posterior process is long, shallow, and broad. Denticles of arched posterior process are discrete or basally fused; that one closest to cusp is reclined at an angle of about 75° to the axis of the posterior process. Succeeding denticles are more strongly inclined, those farthest posterior at about 45°. All denticles consist of white matter. Aborally excavated by a broad but shallow trough that extends to the extremities; trough is deepest beneath the cusp. A thin lobate lip is almost always present in the aboral margin on the inner side beneath the cusp. A comparable, although generally smaller, lip is present in some specimens on the outer side, but many lack this feature.

Cyrtoniodiform element is very similar to cordylodiform element in overall morphology but differs in having a strong inner flare to the basal cavity situated beneath the posterior half of the cusp. The flared region is continuous with the swollen medial region of the cusp, which is more strongly developed in these elements than in the cordylodiform elements.

Tetraprioniodiform element has slender cusp that is slightly curved throughout its length and has quadrangular cross section. Anterior and posterior margins of cusp are keeled; lateral surfaces bear strong costae. Costae merge anteriorly into surface of cusp but have distinct, posteriorly directed faces. One costa follows approximate midline of cusp, and anterior keel is deflected toward that side. Opposite costa is about halfway between midline of cusp and posterior margin. Keeled margins and costae are produced basally from the cusp as unequal processes. Posterior process is somewhat arched, narrow, shallow; bears 5–6 widely separated, peglike denticles of which the larger are near the middle of the series with smaller ones anteriorly and posteriorly. Inclination of denticles increases posteriorly in the series away from the cusp. The process leading from the centrally located costa is directed anterolaterally and downward. Viewed from the posterior direction, it makes an angle of about 120° with the cusp; in oral view it subtends an angle of ca. 110° with the posterior process. This process tends to be twisted and/or flexed. It is somewhat deeper at its middle than proximal to the cusp or distally. Denticles number about 5; they are widely spaced and set normal to the oral margin of the process. The process branching from the asymmetrically located costa extends posteriorly and downward. Viewed laterally it forms an angle of ca. 130° with the cusp; in oral view the angle between this process and the posterior process is no more than 30°. This process is shallower than the others but is the longest of the processes. Denticles on this process are widely spaced and peglike, and they increase in length progressively away from the cusp. Anterior process is a downward continuation of the leading edge of the cusp. Its length is of the order of one-third of the length of the cusp. The anteriorly directed edge has several poorly defined denticles. All of the processes are excavated by broad troughs that merge into a shallow subcentral cavity. Under sides of the proceses of large (?gerontic) specimens are nearly flat.

Cusp of trichonodelliform element is erect distally and curved basally. It is slender, broadly rounded anteriorly between two lateral costae. These costae, which occupy the lateral midlines, have posterior facing facets that are markedly set off from the face of the cusp. Posterior edge of cusp is keeled. Keel and costae give rise to denticulate processes that branch away from the base of the cusp. Posterior process is moderately deep and thin and slightly arched and bears 5–6 denticles. The denticles are discrete but crowded; those located anteriorly are fused to each other, and the leading denticle is fused to the cusp. Inclination and size of denticles increase somewhat in the posterior direction. Lateral processes are symmetrically distributed relative to the plane occupied by the cusp and posterior process. Arch between lateral processes is about 60–70° as seen from the posterior direction; angle subtended by cusp and lateral processes as seen in lateral view is about 120°; posterior process intersects each lateral process proximal to the cusp to subtend an angle of somewhat more than 45° as seen from above. Lateral processes may be flexed distally; they each carry up to 7 discrete to crowded denticles whose orientation is normal to the oral margin of the process. Proximal denticles are smaller than those located farther away from the cusp. Most specimens have thin processes with shallow aboral troughs. Heavy and presumably gerontic forms have thick processes with broad, relatively planar lower surfaces. A lobate and swollen aboral lip commonly is present anteriorly between the two lateral processes. Basal cavity is anteriorly directed, conical excavation in the base of the cusp, from which the troughs lead out beneath the three processes.

Occurrence.—This species occurs in the Joins Formation in southern Oklahoma (Mound 1965b), where it is restricted to the upper half of the formation and continues into the overlying Oil Creek Formation (McHargue 1975). It is present also in the Everton Formation of northern Arkansas (Golden 1969). Suhm and Ethington (1975) recorded its presence in equivalents of the Simpson Group in the Beach Mountains of west Texas. It occurs also in the upper Antelope Valley Limestone in central Nevada (Harris and others 1979). Tipnis and others (1978) found it in the Sunblood Formation in the southern District of Franklin, Canada.

Range in the Pogonip.—This species is an abundant component of the conodont fauna of the Lehman Formation at Crystal Peak beginning 12 m (40 ft) from the base of the formation. It is present also in carbonate units low in the Watson Ranch Quartzite at that locality.

Number of specimens.—Extended prioniodiform element, 146; pendant prioniodiform element, 160; cordylodiform element, 220; cyrtoniodiform element, 166; tetraprioniodiform element, 344; trichonodelliform element, 60.

Repository.—Figured extended prioniodiform element UMC 1102–1; unfigured extended prioniodiform element UMC 1102–2; figured pendant prioniodiform element UMC 1102–3; unfigured pendant prioniodiform elements UMC 1102–4; figured cordylodiform element UMC 1102–5; unfigured cordylodiform element UMC 1102–6; figured cyrtoniodiform element UMC 1102–7; unfigured cyrtoniodiform element UMC 1102–8; figured tetraprioniodiform element UMC 1102–9; unfigured tetraprioniodiform element UMC 1102–10; figured trichonodelliform element UMC 1101–11; unfigured trichonodelliform element 1102–12.

Genus PAROISTODUS Lindström, 1971
Type species.—*Oistodus parallelus* Pander, 1856.

PAROISTODUS PARALLELUS (Pander)
Pl. 9, fig. 1

Oistodus parallelus PANDER, 1856, p. 27, Pl. 2, fig. 40; LINDSTRÖM, 1955, p. 579–580, Pl. 4, figs. 26, 30, 31, text-fig. 3-0 (*non* Pl. 4, figs. 27–29, 41, text-fig. 3N); LINDSTRÖM, 1960, text-fig. 1(II–6); WOLSKA, 1961, p. 352, Pl. 3, fig. 4; ETHINGTON, 1972, p. 23, Pl. 1, fig. 21.
Acodus expansus GRAVES & ELLISON, 1941, p. 8, Pl. 1, fig. 6.
Distacodus expansus (Graves & Ellison). LINDSTRÖM, 1955, p. 555, Pl. 3, figs. 13–17, text-figs. 2g, i; LINDSTRÖM, 1960, text-fig. 2(10); WOLSKA, 1961, p. 347, Pl. 1, fig. 4; ETHINGTON, 1972, p. 23, Pl. 1, fig. 23; VIIRA, 1974, p. 64, text-figs. 15k–m, 61.
Paroistodus parallelus (Pander). LINDSTRÖM, 1971, p. 47–48, text-figs. 8, 11; LINDSTRÖM, 1973, p. 329–330, Paroistodus Pl. 1, figs. 1–4; SERPAGLI, 1974, p. 61–62, Pl. 14, figs. 8–12b, Pl. 25, figs. 1–6, Pl. 30, fig. 5; VAN WAMEL, 1974, p. 79–80, Pl. 7, figs. 12–17; LANDING, 1976, p. 635, Pl. 3, figs. 1, 2; DZIK, 1976, text-fig. 3; FÅHRAEUS & NOWLAN, 1978, p. 460, Pl. 2, fig. 12 (*non* fig. 13, = *Drepanodus* sp. 2 herein); LÖFGREN, 1978, p. 68–69, Pl. 1, figs. 18–21.

Remarks.—Scattered specimens in the Fillmore have costate faces, twisted cusps, and shallow basal cavities; they correspond closely to the drepanodiform elements of *P. parallelus.* We were not able to identify oistodiform elements of this species in the samples from which these drepanodiforms were recovered or from the general range within the Pogonip of these specimens. The oistodiform elements may have been included among those we here compare with *Drepanoistodus forceps* and/or *Drepanoistodus basiovalis.*

Occurrence.—This species is widespread in Lower Ordovician rocks in North America and northern Europe and has been reported from Argentina and Australia also. Löfgren (1978) has summarized its numerous previously reported occurrences. In addition to those listed by her, it has also been reported from the Cow Head Group of western Newfoundland (Fåhraeus and Nowlan 1978), and it has been found in the El Paso Group of west Texas (Repetski 1975, and in press) and in the Kindblade Formation of southern Oklahoma (Brand 1976).

Range in the Pogonip.—Scattered specimens were found in the Fillmore beginning 161.6 m (530 ft) above the base of the formation and continuing upward; one specimen was found in the lowest Wah Wah at Section J.

Number of specimens.—27.

Repository.—Figured specimen UMC 1102–13; unfigured specimens UMC 1102–14, 15.

Genus PHRAGMODUS Branson & Mehl, 1933
Type species.—*Phragmodus primus* Branson & Mehl, 1933.

? PHRAGMODUS FLEXUOSUS Moskalenko
Pl. 9, figs. 2–7

? *Acodus anceps* MOSKALENKO, 1970, p. 40–41, Pl. 1, fig. 1.
Oistodus cf. *abundans* Branson & Mehl. MOSKALENKO, 1970, p. 47, Pl. 1, fig. 2.
Dichognathus brevis Branson & Mehl. MOSKALENKO, 1970, p. 64–65, Pl. 1, figs. 7a, b.
Phragmodus sp. MOSKALENKO, 1970, p. 81, Pl. 12, fig. 5.
Subcordylodus sinuatus Stauffer. MOSKALENKO, 1970, p. 88–89, Pl. 13, fig. 4; MOSKALENKO, 1973a, p. 80–81, Pl. 12, figs. 7–9a, b; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 7.
Phragmodus sp. nov. MOSKALENKO, 1972, p. 48–50, text-fig. 1, Table 2.
Acodus anceps Moskalenko, MOSKALENKO, 1973a, p. 29, Pl. 1, figs. 1, 2; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 1.
Oistodus abundans Branson & Mehl. MOSKALENKO, 1973a, p. 35–36, Pl. 1, figs. 8, 9; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 2.
? *Dichognathus brevis* Branson & Mehl. MOSKALENKO, 1973a, p. 66, Pl. 16, fig. 1.
Dichognathus decipiens Branson & Mehl. MOSKALENKO, 1973a, p. 66–67, Pl. 15, figs. 7a, b, 8–12a, b; MOSKALENKO, 1973b, p. 89, Pl. 18, figs. 8a, b.
? *Dichognathus typica* Branson & Mehl. MOSKALENKO, 1973a, p. 67, Pl. 16, fig. 2.
Dichognathus sp. MOSKALENKO, 1973a, Pl. 16, fig. 3; MOSKALENKO, 1973b, Pl. 18, fig. 10.
Gothodus evengiensis MOSKALENKO, 1973a, p. 67–68, Pl. 11, figs. 1–3a, b; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 5.
Phragmodus flexuosus MOSKALENKO, 1973a, p. 73–74, Pl. 11, figs. 4–6; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 6.
? *Plectodina glenwoodensis* Stauffer. MOSKALENKO, 1973a, p. 76, Pl. 11, figs. 7–9; MOSKALENKO, 1973b, p. 89, Pl. 18, fig. 8.
Oistodus subabundans NASSEDKINA, 1975, p. 119, Pl. 6, figs. 1, 2.
Dichognathus typica Branson & Mehl. NASSEDKINA, 1975, p. 124, Pl. 6, fig. 12.
Phragmodus borealis NASSEDKINA, 1975, p. 124–125, Pl. 6, figs. 13, 14.
Subcordylodus aff. *plattynnensis* [sic] Branson & Mehl. NASSEDKINA, 1975, p. 125–126, Pl. 6, figs. 7, 8.
Subcordylodus sp. NASSEDKINA, 1975, p. 124–125, Pl. 6, figs. 13, 14.
Cordylodus sp. nov. NASSEDKINA, 1975, Pl. 6, figs. 5, 6, 10.
non Phragmodus flexuosus Moskalenko. HARRIS, BERGSTRÖM, ETHINGTON & ROSS, 1979, Pl. 2, figs. 1–4.

Phragmodiform elements have a proclined to suberect cusp followed by a shallowly arched process that displays pronounced undulations and twisting. Oral margin of the process is turned to the side in positions of maximum flexing so that the denticles in such places are directed laterally, and in extreme cases they extend almost horizontally at their apices. The first three to four denticles occupy the region where the process emerges from the posterior margin of the cusp. They are erect, discrete but basally crowded, and relatively short and slender when compared with those that follow them in the series. The next three denticles are progressively longer and heavier; the first two of these are erect, but the third is curved to become reclined above its base. The latter denticle is the largest of the entire series, although it is not greatly longer or heavier than those adjacent to it. Two to three denticles following are turned strongly to the side as already mentioned and become progressively smaller as part of the gradual decline in size of denticles to the posterior extremity. The remaining denticles are increasingly inclined to the tip of the process. The process bears a shallow aboral trough on most specimens. Some robust (gerontic?) individuals show a flat to convex aboral surface beneath the distal part of the process suggesting that basal inversion has occurred in this region. This surface continues into a shallow trough beneath and anterior to the position of the largest denticle. The trough is continuous anteriorly with the basal cavity whose axis is nearly horizontal, its apex located near the anterior margin.

The phragmodiform elements are divided into three groups based on the ornamentation of the cusp and basal region. The most numerous forms have a keeled anterior margin and lateral costae as well as the posterior keel and process. Generally the anterior keel is deflected laterally, particularly near the base. Lateral costae are poorly defined distally where they occupy the midline to either side of the cusp. Basally they become more clearly differentiated; one costa generally is much stronger than the other. On many specimens the two lateral costae occupy different positions on their respective sides of the cusp; one is posterior whereas the other lies along the midline of the cusp. Less numerous are elements lacking one of the lateral costae. These really represent one extreme in the variable development of one of the costae. The third type of phragmodiform element has a rounded anterior face instead of an anterior keel; the lateral costae are equally developed and opposite each other so that these elements are bilaterally symmetrical except for the flexing of the posterior process.

Dichognathiform elements have their denticulate limbs diverging at an angle of about 120° from the base of the cusp when viewed from above. The sharp-edged denticles are discrete but basally contiguous; those of the posterior limb are increasingly inclined with position away from the cusp; the denticles of the other limb are approximately normal to the oral margin. Stout cusp is erect with sharp edges and convex outer lateral face. Inner face of cusp bears prominent costa which is a continuation of the oral edge of the smaller limb. This costa is medial near the base of the cusp but somewhat anterior to the midline distally. The face of the cusp is depressed anterior to the costa and particularly so near the base. The region posterior to the costa is planar distally and somewhat inflated with marginal troughs near the base. Anterior margin of the cusp is curved throughout its length, strongly so toward the basal margin. Aboral surface is continuously excavated by a broad trough which is deepened to a sharp apex beneath the cusp and which extends from one extremity to the other. In gerontic forms the trough is very broad, so that the under sides of the limbs are nearly flat.

Subcordylodiform elements have slender, erect cusps whose anterior and posterior edges are keeled. The anterior keel typically is deflected to one side. Posterior process is shallow but thick. Denticles are crowded and may be fused basally; they are sharp edged with lenticular cross sections. Anterior denticles may be small, nearly erect, and more closely crowded than those that follow. Succeeding denticles may increase slightly in size with the largest near the end of the series, although generally they are of subequal size. Inclination of the denticles increases posteriorly within the series, and the last denticles may lean backward at an angle of less than 45° to the oral margin of the process. The process is straight to somewhat sinuous in plan, whereas the series of denticles along its oral margin is strongly sinuous. The denticles alternate in groups of about three between those leaning to the left relative to the process and those leaning to the right. The basal surface of the process is excavated by a broad trough that is continued anteriorly into a basal cavity in the cusp. The anterior margin of the cusp is produced basally as an anticusp that curves backward beneath the basal cavity. A few specimens have a narrow, hairlike costa that begins at about midlength of the cusp on the outer side and continues aborally onto the anticusp.

The cusp of the oistodiform element is about twice the length of the anterior-posterior dimension of the base. Edges of the cusp are keeled; outer surface is regularly convex transversely; inner surface has a broad, rounded central region that increases in prominence basally and continues across the inflated part of the base. Anterior margin of these elements is regularly curved through midlength of the cusp and straight distally. Posterior margin of the cusps sinuous; it is tangential with the keeled upper margin of the base. Base is markedly inflated to one side to enclose the basal cavity. Basal cavity has subtriangular outline in lateral view; its sharp tip is turned over anteriorly and located ahead of the midline of the cusp.

Remarks.—Elements of *Phragmodus flexuosus* were reported in open nomenclature by Moskalenko (1970) in a report on conodonts from sections along the Moiero River on the Siberian Platform. Her initial collection of these elements was meager, each being represented by only one specimen; all but one element came from the same sample. In a later paper (Moskalenko 1972) she defined the apparatus on the basis of more extensive collections from lower Middle Ordovician strata (Volginskian) along the Podkamennaya Tunguska River, also on the Siberian Platform. Her reconstruction involved nine kinds of elements which she illustrated by line drawings and which she designated as phragmodiform, cordylodiform, gothodiform, two kinds of plectodiniform and of dichognathiform, oistodiform, and acodiform elements, respectively. The new species was left in open nomenclature, although some of the elements were compared with previously described form-taxa, e.g., *Oistodus abundans* Branson and Mehl for the oistodiform element.

The conodonts from the sections along the Podkamennaya Tunguska were described in detail in a paper that appeared subsequently (Moskalenko 1973a), and the name *Phragmodus flexuosus* was introduced as a form-species. Another new name, *Gothodus evenkiensis,* was advanced for bilaterally symmetrical elements that she interpreted as being gothodiform. The other elements also were identified in form-taxonomy under established names: *Acodus anceps* Moskalenko, *Dichognathus decipiens* Branson and Mehl, *Oistodus abundans* Branson and Mehl, *Plectodina glenwoodensis* Stauffer, and *Subcordylodus sinuatus* Stauffer.

Comparison of the photographs in the 1973 publication with the earlier line drawings illustrating the apparatus indicates to us that fewer than nine kinds of elements should be included in the apparatus. The photographs of the specimens identified as *Acodus anceps* (Moskalenko 1973a, Pl. 1, figs. 1, 2) appear to depict oistodiform elements that are not greatly different from those that were identified with *Oistodus abundans.* Moskalenko did not identify any specimens from the sections along the Podkamennaya Tunguska as *Cyrtoniodus flexuosus* in her 1973 paper, but the elements she reported as *Plectodina glenwoodensis* (see her Pl. 11, figs. 7, 8) include specimens that might be identified under the former name. Hence we believe that no more than one plectodiniform element is involved in the apparatus. According to text-figure 3 in the 1973 paper, the forms Moskalenko identified as *Dichognathus typicus* Branson and Mehl, and which she considered to be one of the two dichognathiform elements of *P. flexuosus,* do not occur below the top of the range of the nominate elements so that they are unlikely components of the apparatus. The holotype of *P. flexuosus* came from unit 4 in her section PT–IV, and is associated there with the elements she identified as *Gothodus evenkiensis* (gothodiform), *Subcordylodus sinuatus* (cordylodiform), *Plectodina glenwoodensis* (plectodiniform), *Dichognathus decipiens* (dichognathodiform), *Acodus anceps* and *Oistodus abundans* (oistodiform); this allows for a maximum of six kinds of elements. The same basic apparatus seems to occur in the collections from west flank of the Urals from which Nassedkina (1975) described *Phragmodus borealis* which probably is a junior synonym of *P. flexuosus.*

Phragmodus flexuosus has been reported by Bergström and Carnes (1976) from the Holston Formation of eastern Tennessee in strata of the *Pygodus anserinus* Zone. These conodonts were described in Carnes's unpublished Ph.D. dissertation (1975) in which the apparatus is reported to include phragmodiform and subcordylodiform, elements with undulatory processes together with dichognathodiform and cyrtoniodiform elements. Carnes rejected Moskalenko's inclusion of oistodiform elements in the apparatus of *P. flexuosus* because he did not find such elements in his collections and others available to him containing the distinctive phragmodiform elements of the species, and because Sweet and Bergström (1972) had concluded that oistodiform elements appear late in the evolution of *Phragmodus* and as a replacement for cyrtoniodiform elements. Carnes agreed with Votaw (1971) that the unnamed species of *Phragmodus* that had been reported from the McLish Formation of Oklahoma (see Sweet, Ethington and Barnes 1971, Pl. 2, figs. 3–6; Sweet and Bergström 1972, text-fig. 4B) also represents *Phragmodus flexuosus* as they interpreted that species.

We can see no objective differences between the phragmodiform, dichognathiform, and subcordylodiform elements that we found in the Crystal Peak Dolomite and those that Carnes and Moskalenko reported in their respective interpretations of *Phragmodus flexuosus,* but we cannot duplicate either of their reconstructed apparatuses. We did not find cyrtoniodiform elements in any of our samples. This lack cannot be dismissed as the result of inadequate samples or abundance or an artifact of sorting, for the other elements are abundant in most of the samples; indeed, these elements are the dominant components of the conodont population of the Crystal Peak. In addition, an oistodiform element must be part of the apparatus of the species of *Phragmodus* in the Crystal Peak samples. Oistodiform elements invariably co-occur with the other elements and are quite abundant. No other elements in the samples are present in such numbers as to make them candidates for another apparatus that would include these oistodiform elements. Either the oistodiform elements belong with the phragmodiform elements, or they belong in an apparatus of which they are the sole component. The latter interpretation is inconsistent with what is known of conodont apparatuses in the lower Middle Ordovician.

It is clear at this point that two species of *Phragmodus* with strongly undulatory processes occur in North America, one with oistodiform elements which we describe above and the other with cyrtoniodiform elements. Anita Harris (personal communication 1979) has found both of these species in central Nevada, in some cases occurring in stratigraphic sequence. The species with oistodiform elements occurs in association with conodonts of the *Eoplacognathus suecicus* Subzone (Harris and others 1979, fig. 13), whereas the other species occurs with indices of the younger *Eoplacognathus foliaceus* Subzone. In no case have oistodiform and cyrtoniodiform elements been found in the same sample. On this basis the two species offer promise for precise stratigraphic resolution in the lower Middle Ordovician of North America if this stratigraphic relationship is substantiated in future studies.

Only one of these species can be identified with *P. flexuosus,* and the other requires a new name. The definition of the species and the interpretation of its apparatus advanced by Moskalenko (1972, 1973a) are ambiguous for resolution of this taxonomic question. She included both cyrtoniodiform and oistodiform elements in her reconstruction, and both kinds of elements are present in the sample from which she selected the holotype. If the ranges of the two species overlap, her samples may have come from within the common range and contain both of them. Unless diagnostic differences between the phragmodiform elements of the two species can be established, it will be impossible to identify the holotype of *P. flexuosus* with either of them with certainty. Another possible explanation is that an ancestor-descendant relationship exists between the two species and that the replacement of oistodiform elements by cyrtoniodiform elements in the lineage was not instantaneous so that at one stage in the evolution either or both kinds of elements might be possessed by individual organisms. We cannot resolve this dilemma with the material at hand; further studies from the type area in Siberia will be required before any of the possible explanations can be evaluated.

These two species also demonstrate that oistodiform elements were not introduced in the evolution of *Phragmodus* in the transition from *P. cognitus* to *P. typicus* as shown by Sweet and Bergström (1972, p. 36, text-fig. 4). Rather they were present early in the phylogeny, were lost, and then reappeared.

Occurrence.—The species with cyrtoniodiform elements has been reported from the McLish, Tulip Creek, and lower Bromide Formations of southern Oklahoma (Sweet and Bergström 1973), from the Chazy Group of New York and Vermont (Raring 1972), from the Tumbez, Elway, Eidson, Hogskin, and Holston Formations of Tennessee (Carnes 1975), and from the Pinesburg Station Dolomite, Row Park Limestone, New Market Formation, and Chambersburg Limestone of the central Appalachians (Boger 1976). Anita Harris (personal communication 1979) has found this species in the Antelope Valley Limestone at the north end of Martin Ridge in the Monitor Range and in the Antelope Range, both localities in central Nevada.

Barnes (1974) illustrated a specimen from the Ship Point Formation of the arctic islands of Canada that resembles the phragmodiform elements discussed here. In the absence of the critical oistodiform and cyrtoniodiform elements, this specimen cannot be assigned to either of the species under consideration.

The species with oistodiform elements occurs in the Antelope Valley Formation at Meiklejohn Peak and in the upper Pogonip of the Steptoe Section, Egan Range, Nevada (Anita Harris personal communication 1979).

Range in the Crystal Peak.—?*Phragmodus flexuosus* occurs in all of the samples collected in the type section of the Crystal Peak Domolite except the highest one which was obtained just below the base of the Eureka Quartzite.

Number of specimens.—Phragmodiform element with two lateral costae, 47; phragmodiform element with one lateral costa, 31; symmetrical phragmodiform element with rounded anterior face, 15; dichognathodiform element, 88; oistodiform element, 144; subcordylodiform element, 104.

Repository.—Figured bicostate phragmodiform element UMC 1102–16; figured symmetrical phragmodiform element UMC 1102–17; unfigured phragmodiform elements UMC 1102–18; figured dichognathodiform element UMC 1102–19; unfigured dichognathodiform element UMC 1102–20; figured noncostate subcordylodiform elements UMC 1103–1; unfigured noncostate subcordylodiform element UMC 1103–2; figured costate subcordylodiform element UMC 1103–3; figured oistodiform element UMC 1103–4; unifgured oistodiform element UMC 1103–5.

Genus PLECTODINA Stauffer, 1935

Type species.—*Prioniodus aculeatus* Stauffer, 1930.

Remarks.—*Plectodina* was established in form-taxonomy by Stauffer (1935) who assigned to it elongate, denticulate bars with prominent anterior cusps. Bergström and Sweet (1966) determined that this is the senior name among the elements of an apparatus which they reconstructed and which they found to have significant range in the Middle and Upper Ordovician of the North American Midcontinent faunal province. These authors expanded their concept of the apparatus of *Plectodina* in subsequent papers (1970, 1972) to include up to seven kinds of elements which constitute an elaborate symmetry transition. They noted similarity between some of these elements and elements that occur in the reconstructed apparatus of *Oulodus* Branson and Mehl and inferred that *Plectodina* is the ancestor of the latter. Later Sweet and Schönlaub (1975), in a study of species of *Oulodus,* reaffirmed the similarity of the elements of the two genera but concluded that they are not related closely to each other. They recognized six basic elements in the apparatuses, some of which display consistent variants leading to earlier reconstructions with as many as seven elements. Symbols were assigned to designate the several elements: P (pectinate) for blade-shaped element with two variants, P_a and P_b, commonly present; M (makelliform) for pick-shaped elements; and a transition series with three morphologic norms designated S_a, S_b, and S_c, respectively.

?PLECTODINA sp.

Pl. 9, figs. 8, 9, 13

Remarks.—The specimens considered here seem to belong to the transition series of a species of *Plectodina.* All of them are broken; most have lost at least the greater part of one limb. Two of them have one short limb surmounted by a rather large, bladelike denticle and an opposite limb that is more slender, longer, and set with numerous subequal denticles. These elements correspond to the S_b elements (zygognathiform) in the apparatus of *Plectodina.* One specimen has a slender, erect cusp that is produced basally as a denticulate bar, most of which is missing. The opposite edge of the cusp bears a short satellite denticle that is largely fused to the leading edge. This specimen probably represents the S_c (cordylodiform) element of the apparatus. The remaining four specimens are subsymmetrical and represent S_a (trichonodelliform) elements; their largest denticle is flanked to each side by subequal processes that diverge at an acute angle. Denticles are lenticular in section and seem to be subequal judging from the stubs of them that remain; those adjacent to the principal denticle are approximately parallel to it, but those located farther away are directed nearly normal to the edges of their respective processes. The basal cavity is noticeably swollen in the posterior direction beneath the principal denticle but not to the opposite side. The lower surfaces of the processes are expanded as broad basal troughs.

These elements correspond in general symmetry to those of other species of *Plectodina,* but they differ in detail. The lower surfaces of the processes are considerably more expanded than in the species reported previously. However, we have so few specimens with such poor preservation that we cannot compare them adequately with other species.

Range in the Crystal Peak.—These elements occur only in the basal sample collected just above the Watson Ranch Quartzite at the type section.

Number of specimens.—13.

Repository.—Figured S_a element UMC 1103–6; unfigured S_a elements UMC 1103–7, 8; figured S_b element UMC 1103–9; unfigured S_b element UMC 1103–10; figured S_c element UMC 1103–11.

Genus PROTOPANDERODUS Lindström, 1971
Type species.—Acontiodus rectus Lindström, 1971.

PROTOPANDERODUS aff. P. ARCUATUS (Lindström)
Pl. 9, fig. 10

? *Acontiodus arcuatus* LINDSTRÖM, 1955, p. 547, Pl. 2, figs. 1–4.

Remarks.—The specimens considered here have a compressed, saggitate cross section of the cusp, with blunt anterior edge and an equally blunt posterior keel flanked by a prominent shoulder to each side. The lateral shoulders begin just above the basal margin and continue toward the distal extremity, where they become progressively well defined. The base is not markedly expanded. Aboral outline is gently convex aborally with a slight recess near the anterior margin when viewed laterally. Large basal funnels are retained by some specimens.

Lindström emphasized the strongly curved form of the basal cavity as a diagnostic feature of the elements he assigned to *Acontiodus arcuatus.* Unfortunately, our specimens all are opaque so that we cannot determine the shape of the basal cavity, and therefore we cannot identify them with Lindström's species with certainty. As noted by Serpagli (1974, p. 37), laterally compressed forms of the type Lindström (1955) assigned to *Acontiodus* Pander likely will be reassigned to *Protopanderodus.* An important distinguishing character of *Protopanderodus* is the presence of longitudinal striations (Lindström 1971, p. 50) which may be resolved only at very high magnification. The specimens we consider here do not show striae under light microscopy. We compare them to *A. arcuatus* Lindström on the basis of gross external morphology, and particularly to the specimen he illustrated (1955) on Plate 2, figure 3.

Lindström described the apparatus of *Protopanderodus* as containing both symmetrical and asymmetrical elements based on his reconstruction of the type species, *P. rectus.* No *Protopanderodus* apparatus has been described to include elements identified with *A. arcuatus,* and we are unable to propose other elements for the apparatus from the collection at hand. Van Wamel (1974) included *A. arcuatus* in the apparatus of *Drepanodus arcuatus* Pander in which he considered it to be a rare and unusual element.

Range in the Pogonip.—This form was found in the upper Fillmore at Section H (198, 216 m [650, 710 ft]).

Number of specimens.—6.

Repository.—Figured specimen UMC 1103–12.

PROTOPANDERODUS? ASYMMETRICUS
Barnes & Poplawski, 1973
Pl. 9, figs. 11, 12, 14, 19

Paltodus sp. A SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 1, fig. 14.
Protopanderodus asymmetricus BARNES & POPLAWSKI, 1973, p. 781–782, Pl. 1, figs. 12, 12a, 14, 16, text-fig. 2A.
Juanognathus asymmetricus (Barnes & Poplawski). BERGSTRÖM, 1979, p. 303, fig. 4E, ? fig. 4C.

A flattened, tongue-shaped simple-cone element that is flexed and twisted. Flexure may be evenly distributed along length of element, or it may be concentrated in the basal region with the distal reaches straight. Convex side of element is broadly rounded between the lateral edges. Opposite side has a low, broad swelling extending from basal margin to distal extremity and located off the midline. This swollen region is flanked by more nearly flat areas of unequal size. The broader of these lateral regions is on the side of the element that has the convex lateral margin. The narrow flanking area is terminated laterally at an edge that is straight or shallowly concave. Edges of element are sharp distally but are blunt or rounded near the basal margin. Base is unexpanded. Viewed from beneath, the base is narrowest near the convex lateral margin. From this position the base widens gradually almost to the opposite margin before narrowing again. Basal cavity is a shallow inclined cone whose apex is submedial in position and directed somewhat to one side. Surface of the element bears faint longitudinal striations. No trace of white matter was observed in any of the specimens; all are translucent except in the basal region, which is opaque owing to presence of foreign matter in the basal cavity.

Remarks.—Our specimens conform very closely to those described and illustrated by Barnes and Poplawski (1973), and we are certain that they are conspecific. We are less confident about the generic assignment. Lindström (1971) established *Protopanderodus* to include elements he earlier (1955) had described as *Acontiodus rectus* and *Scandodus rectus.* His generic diagnosis is quite generalized but stipulates an apparatus with symmetrical and asymmetrical elements of varying cross sections and with cusps characterized by longitudinal striations that may be inconspicuous except at very high magnification. Barnes and Poplawski seem to have given the last character greatest weight in the generic assignment of this species. We have observed striae on a variety of elements from the higher part of the Lower Ordovician and from low Middle Ordovician strata as well. These elements are so diverse in morphology that the presence of striae alone probably is insufficient basis for generic identification; Barnes and Poplawski acknowledged that future studies likely would require reassignment of some species of *Protopanderodus.* Lindström and Ziegler (1971, p. 12) amended the generic definition by restricting it to forms which, like the type species, display inverted basal cavities on some elements. Our collections and those of Barnes and Poplawski do not contain elements that show basal inversion and have symmetrical cross sections and which therefore could represent the symmetrical (acontiodiform) element of the *Protopanderodus* apparatus.

Bergström (1979) reassigned this species to *Juanognathus* Serpagli and postulated that its apparatus includes a costate, subsymmetrical element. The latter elements are similar to the forms we identify here as *Scolopodus paracornuformis* n. sp. and which occur in the same general interval as "*P.*" ? *asymmetricus,* although the absolute ranges of the two do not correspond in our collecteions. Because neither type of element is a dominant component of any sample in which they are found, this lack of concordant occurrence does not preclude considering them to be parts of the same apparatus.

Occurrence.—Barnes and Poplawski (1973) found the species in boulders in the Mystic Formation of southern Quebec. It occurs there with forms—e.g., *Histiodella* *sinuosa* and "*Cordylodus*" *horridus*—that are restricted in the Pogonip to strata higher than the beds from which we recovered *P.* ? *asymmetricus*.

Range in the Pogonip.—Occasional specimens were found in the upper Fillmore in the interval between 6 and 124 m (20 and 405 ft) in the ST Section; another was found near the top of Section H (265 m [870 ft]). This species is present but not abundant in the Wah Wah at Section J and the Wah Wah and Juab at Fossil Mountain.

Number of specimens.—23.

Repository.—Figured specimens UMC 1103–13–15.

PROTOPANDERODUS ELONGATUS Serpagli
Pl. 9, fig. 15

Protopanderodus elongatus SERPAGLI, 1974, p. 73–76, Pl. 16, figs. 8a–11c, Pl. 25, figs. 13–16, Pl. 30, fig. 4, text-fig. 16.

Remarks.—A small number of specimens from high in the Fillmore and in the lower Juab strongly resemble some of the elements that Serpagli identified as *P. elognatus*. All of the specimens from the Poponip are relatively small and laterally compressed with blunt anterior edges. The anterior edge typically is flexed somewhat to one side, a feature that is indicated in Serpagli's text-figure and in his photographs (Pl. 25, figs. 13–15). Our specimens consist of white matter except for the region surrounding the basal cavity; Serpagli noted that the type collection displayed considerable white matter.

We did not find elements corresponding to the "*Scandodus*"-like forms reported by Serpagli to be part of the apparatus of *P. elongatus*.

Occurrence.—This species is known to date only from the San Juan Formation of Argentina.

Range in the Pogonip.—This species is restricted to the highest Fillmore of Section H (229–281 m [750–921 ft]) and the ST section (99–125 m [326–410 ft]) and to the lowest Wah Wah (H–J–1, 2).

Number of specimens.—49.

Repository.—Figured specimen UMC 1103–16; unfigured specimen UMC 1103–17.

PROTOPANDERODUS GRADATUS Serpagli
Pl. 9, figs. 16, 17, 20, 21

? *Cordylodus simplex* Branson & Mehl. GRAVES & ELLISON, 1941, p. 3, Pl. 1, fig. 11 (*non* Pl. 1, fig. 4).
Acontiodus rectus sulcatus Lindström. ETHINGTON & CLARK, 1965, p. 188, Pl. 1, fig. 15.
? *Paltodus variabilis* Furnish. LEE, 1970, p. 331, Pl. 7, fig. 31.
Protopanderodus gradatus SERPAGLI, 1974, p. 75–77, Pl. 15, figs. 5a–8b, Pl. 26, figs. 1a, b, text-fig. 17.

Remarks.—Our collection includes elements having the same symmetry transition reported by Serpagli. Clearly scandodiform elements are relatively uncommon; however, some specimens are twisted somewhat near midlength and have only a poorly developed posterolateral shoulder on the side opposite that with the longitudinal groove. The latter specimens are intermediate between typical scandodiform elements and the subsymmetrical elements ("*Scolopodus*"-like elements of Serpagli). Thus the scandodiform elements are part of the symmetry transition and not distinctly set apart as Serpagli concluded (1974, p. 76).

In the lower part of the range of this species in the Pogonip, only one lateral face is grooved on the subsymmetrical element, but near the top of the range both faces are grooved on some, but not all, of the specimens. The presence of the groove is suggestive of *Acontiodus rectus sulcatus* which Lindström (1955) reported from strata in Sweden that also produced the type species of *Protopanderodus, P. rectus.* (Lindström). Lindström did not include *A. rectus sulcatus* in the apparatus of *P. rectus* which he considered to consist of symmetrical (*A. rectus*) and asymmetrical (*Scandodus rectus*) elements. Van Wamel (1974, p. 93) concluded that grooved, asymmetrical elements belong in the apparatus of *P. rectus* in addition to the two forms assigned there by Lindström.

Serpagli (1974, p. 75) suggested that some of the elements he included in his interpretation of the apparatus of *P. gradatus* are almost symmetrical, although his illustrations (see Serpagli, text-fig. 17) indicate that a lateral groove is universal. Thus the apparatus of *P. gradatus* differs from that of *P. rectus* in lacking a symmetrical element, the counterpart of the *Acontiodus rectus* element of the latter. Such elements are present in *P. leonardii* whose reported apparatus (Serpagli 1974, p. 77) does not contain a grooved element. Many of the forms in our collection that we have identified with *P. leonardii* are very similar in some characters to the grooved elements that we consider here. Particularly noteworthy are similarities in the shape of the basal cavities, in amount of curvature, in general size, and in surface texture. We suspect that these may constitute parts of a single apparatus. However, *P. leonardii* ranges somewhat lower in the sequence from which Serpagli's material was obtained than does *P. gradatus;* both forms have the same upper limit in that section. We found both of these forms to start at about the same level in the Pogonip, but the grooved elements terminate upward in the upper Lehman whereas the symmetrical forms were not found higher than the middle of the Kanosh. Until these differences in stratigraphic distribution can be evaluated, we will follow Serpagli and keep these elements as two distinct species.

Occurrence.—In addition to its occurrence in the San Juan Formation of Argentina, this species is present in the El Paso Formation of west Texas (Repetski 1975) and in the Columbia Ice Fields of Alberta (Ethington and Clark 1965). It also has been found in the upper part of the West Spring Creek Formation of southern Oklahoma (Potter 1975). One of the specimens from the Marathon Limestone of Texas that Graves and Ellison identified with *Cordylodus simplex* Branson and Mehl probably belongs here also.

Range in the Pogonip.—We found the lowest occurrence to be in the upper Fillmore at Section H (198 m [650 ft]); the species is common throughout the higher Fillmore of Section H and the ST section. It ranges throughout the Wah Wah at Section J and the Wah Wah, Juab, and Kanosh at Fossil Mountain. A few specimens were found in the Lehman at Crystal Peak where its highest occurrence is 44 m (145 ft) above the base of the formation.

Number of specimens.—415.

Repository.—Figured grooved specimens UMC 1103–

18, 19; figured nongrooved specimen UMC 1103–20; figured scandodiform element UMC 1104–1; unfigured specimens UMC 1104–2–6.

PROTOPANDERODUS LEONARDII Serpagli
Pl. 9, figs. 18, 22, 23

Acontiodus gracilis Pander. ETHINGTON & CLARK, 1964, p. 687, Pl. 113, figs. 1, 2.
Acontiodus rectus rectus Lindström. ETHINGTON & CLARK, 1965, p. 188, Pl. 2, fig. 12.
Acontiodus coniformis Fåhraeus. SWEET, ETHINGTON & BARNES, 1971, p. 166, Pl. 2, fig. 20.
Protopanderodus leonardii SERPAGLI, 1974, p. 77–79, Pl. 16, figs. 1a–4c, Pl. 27, figs. 12–16, text-fig. 18.

Remarks.—Our specimens conform closely to those elements that Serpagli included in the apparatus of this species. The same symmetry transition in the development of posterolateral costae from moderately asymmetrical to virtually bilaterally symmetrical arrangement occurs within our collection. In asymmetrical forms, the blunt anterior edge is turned to one side as is shown in Serpagli's text-figure 18. Both strongly recurved and essentially erect specimens are present in our collections, although the latter are quite uncommon. Like Serpagli, we were unable to identify a scandodiform element among the associated elements in the samples from which we recovered this species.

Occurrence.—This species is known so far only from the type collection from the San Juan Limestone of Argentina and from the El Paso Group of west Texas (Repetski 1975).

Range in the Pogonip.—This species is present in the upper Fillmore of Section H (232–281 m [760–921 ft]) and the ST section (0–128 m [0–420 ft]). It ranges throughout the Wah Wah at Section J and is present in the Wah Wah, Juab, and lower Kanosh (through I–K–10B) at Fossil Mountain.

Number of specimens.—222.

Repository.—Figured specimens UMC 1104–7–9; unfigured specimens UMC 1104–10, 11.

Genus PROTOPRIONIODUS McTavish, 1973

Type species.— *Protoprioniodus simplicissimus* McTavish, 1973.

New genus and species ETHINGTON & CLARK, 1965, p. 196, Pl. 2, fig. 11.
New genus A SWEET, ETHINGTON & BARNES, 1971, p. 168, 170, Pl. 1, figs. 19, 22.
Mehlodus ETHINGTON & CLARK, 1972, p. 393 (= *nomen nudum*).
? Genus nov. B n. sp. 1 SERPAGLI, 1974, p. 93, Pl. 19, figs. 4a, b, Pl. 29, figs. 4, 5, text-fig. 26.

Remarks.—McTavish based this multielement genus on a collection of 39 specimens from the Emanuel Formation of western Australia. As he interpreted it, the apparatus consists of prioniodiform elements, ramiform elements that display a *Cordylodus-Roundya* transition series, and oistodiform elements. Only the roundyaform element was included in his type collection, and the other elements of the transition series were inferred. He noted (p. 49) that the cusp and processes of all elements of the type species consist of white matter, but he did not include that as part of the generic diagnosis. Our material also shows the cusp and processes of all elements to be wholly albid, and we would add this as an essential character of the elements of the apparatus. Further, all of the specimens that we assign to the genus show a flangelike shoulder, in some instances quite broad, which is subparallel to the aboral margin and which cuts across the lower part of the cusp. The region beneath this flange is thinner and dark in contrast to the white matter above the flange. McTavish did not mention a flange in his discussion of *Protoprioniodus simplicissimus,* and he did not report a basal region that is dark and does not consist of white matter. The latter is shown clearly on his three figured elements (Pl. 2, figs. 6, 8, 9), however, and a flange seems to be indicated on the illustrated holotype (fig. 6). Accordingly we regard these basal characters as diagnostic.

McTavish observed that specimens from the Ordovician of western North America that have been reported in open nomenclature as species of *Oistodus* or as new genera (e.g., Ethington and Clark 1965, Pl. 2, figs. 11, 17; Sweet, Ethington, and Barnes 1971, Pl. 2, figs. 19, 22) seem similar to but distinct from *P. simplicissimus;* Cooper (1981) described the same forms as a new species, *P. aranda.* We had earlier (1972) used the name *Mehlodus* for these specimens, but since the genus was not formally established under the terms of the International Code, this name is an invalid *nomen nudum.*

We cannot distinguish prioniodiform and ramiform types among those forms in our collections that have cusps and posterior processes; instead we find a transition series in which the principal variation is in the cross section of the cusp. This ranges from symmetrical with laterally directed edges and a flat front face, or with anterolaterally directed edges and a concave front face, to asymmetrical with one edge directed anterolaterally and one posteriorly. In some cases the posterolateral edge is much reduced.

Serpagli (1974, p. 93) reported material from Argentina (2 specimens) and Sweden (1 specimen) which he identified as a species of an unnamed new genus. All of these specimens show a flange that is subparallel to the aboral margin, a prominent rib on the cusp, and a bladelike oral portion of the posterior process. Van Wamel (1974) included similar specimens from the Ordovician of Öland in a new species of *Oistodus, O. papiliosus.* He noted that his specimens consist wholly of white matter. The physical characteristics of these specimens conform to our concept of ramiform elements of *Protoprioniodus.* Further, the ages of the strata in Sweden and in Argentina that produced this material are not greatly different from the ages of the Emanuel Formation and Horn Valley Siltstone of Australia and of the part of the Pogonip which yielded typical species of *Protoprioniodus.* For this reason we believe that *O. papiliosus* should be considered a species of *Protoprioniodus. Oelandodus costatus* van Wamel (1964) almost certainly is a species of *Protoprioniodus* also, but the type species of the former genus, *O. elongatus* (Lindström), appears to lack the criteria that we consider to be diagnostic of *Protoprioniodus.* If that is a correct interpretation of *O. elongatus, Oelandodus* is not a junior symonym of *Protoprioniodus* as inferred by Cooper (1981).

PROTOPRIONIODUS ARANDA Cooper
Pl. 9, figs. 24–30

Oistodus triangularis Lindström. ETHINGTON & CLARK, 1964, p. 694, Pl. 114, fig. 4.
Oistodus sp. B ETHINGTON & CLARK, 1965, p. 196, Pl. 2, fig. 11.
New genus and species ETHINGTON & CLARK, 1965, p. 203, Pl. 2, fig. 17.
New Genus A SWEET, ETHINGTON & BARNES, 1971, p. 168, 170, Pl. 1, figs. 19, 22; BARNES, 1974, p. 231, Pl. 1, fig. 5 (*non* fig. 4); TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, figs. 12–14.
? *Oistodus lanceolatus* Pander. BARNES & POPLAWSKI, 1973, p. 777, Pl. 47, fig. 11 (*non* figs. 5–7, 10).
? *Protoprioniodus* cf. *simplicissimus* McTavish. LÖFGREN, 1978, p. 95–96, Pl. 9, figs. 12–14.
Protoprioniodus aranda COOPER, 1981, p. 175–176, Pl. 30, figs. 1, 6, 7, 10, 12.
? *Protoprioniodus nyinti* COOPER, 1981, p. 176–178, Pl. 29, figs. 1–8, 11, 12.

A species of *Protoprioniodus* whose apparatus includes ramiform, bladelike, and oistodiform elements. The ramiform elements have an erect cusp with triangular cross section and one of the three edges located posteriorly; the other two edges of the cusp may be directed anterolaterally flanking an anterior face, or one of them may be anterolateral and the other posterolateral. The posterior process bears an arcuate, thin, bladelike keel. The bladelike elements are somewhat flexed and nondenticulate, and they have an arched oral margin. In a general way they resemble the posterior process of the ramiform elements but have no vestige of a cusp. The most distinctive of the oistodiform elements has a large reclined cusp with heavy median ribs to either side. Some specimens are strongly flexed, whereas others show almost no flexure.

All elements consist of white matter in their upper portions, including the entire cusp if a cusp is present. The region of white matter is terminated aborally at a shoulder or flange beneath which the basal part of the element is dark or translucent.

Ramiform element has a proclined to suberect cusp with subtriangular transverse section. Cusp has posterior keel that is higher proximally than distally. Anterolateral keels typically are directed laterally or are turned somewhat anteriorly to create a V-shaped trough along the front of the cusp. On some specimens one of the lateral keels is turned posteriorly to give the cross section of the cusp marked asymmetry. Both lateral keels continue aborally to form a pair of short nondenticulate processes. The posterior process carries a high thin blade that is tangential proximal to the lower part of the posterior edge of the cusp. The oral margin of the blade is variable: in some specimens it is regularly arched; in others it is strongly curved anteriorly and more nearly straight posteriorly. Oral edge is sharp. The blade may be flexed or it may lie in a plane. A distinct shelf is present to either side and subparallel to the lower margin of the posterior process. This shelf is broadest beneath the center of the blade and becomes obscure as the cusp is approached. The cusp and the blade consist wholly of white matter; in contrast the region beneath the shelf is dark brown to black. Although the shelf terminates anteriorly at the cusp, this darkened area continues beyond it to form a band parallel to the lower margin of the two anterior processes. The basal region of the posterior process narrows beneath the shelf to form a chisel edge at the aboral margin. Narrow slits beneath blade and anterior processes coalesce beneath the cusp to form a pit.

Cusp of oistodiform elements typically is reclined, bladelike, with high blunt to rounded costae on both faces in slightly postmedian positions. Edges of cusp are sharp and may be straight or somewhat sinuous in outline. Base about equal in length to cusp; axis of base forms angle of about 45° with trend of costae. Base bears arcuate sharp-edged posterior blade whose proximal portion is fused to the basal reaches of the posterior edge of the cusp. Element is markedly expanded to both sides at the bottom of the cusp and blade to form a shelf which is widest adjacent to the costae and which narrows from that position to either end of the element. Basal region swollen laterally beneath costae, and narrowed anteriorly and posteriorly from that position. Posterior to the costae the base thins markedly beneath the shelf, then widens to the basal margin, thus forming a longitudinal groove on each side that extends from the posterior extremity to midlength. Anterior to the costae the base thins regularly beneath the shelf without forming a groove. Lower margin is sinuous, straight anteriorly and posteriorly with a rounded median salient beneath the region of the costae. Anterior margin of the cusp normally meets the basal margin at an angle of about 45°, although a few specimens are produced anteriorly in this region so that the anterobasal angle is considerably smaller. The basal cavity is a narrow, shallow slit that occupies the entire length of the base and flares slightly at the position of the costae. The basal region beneath the shelf is dark in contrast to the white matter of the cusp and blade.

Nondenticulate blade is bowed in the middle so that the two halves are arranged at an angle of about 150° when seen from below. Blade is thin, consists of white matter; its upper edge is sharp to blunt. Edge of blade is turned inward so that, in vertical section, concave and convex surfaces are observed. Viewed laterally, the upper edge follows a broad arch which generally intersects the lower margin at either end in an acute angle. Basal portion of element is approximately half as deep as the blade and is brown to black. Element swells to form a shelf along the base of the blade. Shelf is wider on the inner side where it may approximate development of a platform; on the outer side the shelf is a narrow flange except at midlength where it may be somewhat produced laterally. Beneath the shelf the element tapers to the basal margin. Basal cavity is a trough which extends the entire length. Trough increases in depth from either end toward the center where it is markedly widened.

Remarks.—About half of the oistodiform elements in our collection show pronounced flexure, particularly in the basal region. In such specimens the angle between costae and basal margin is of the order of 30° instead of 45°. They have a broad basal trough rather than a narrow slit, and the length of the cusp is only about three-fourth the basal length instead of subequal to it. The basal margin does not have a salient as a continuation of the costae; instead the basal margin is straight or slightly arched from end to end. The costae are subequally developed, the one on the concave side of the element is subdued whereas the opposite costa is pronounced. A few specimens have the cusp suberect and somewhat slender with the median ribs occupying half of the lateral faces. Such forms may show a tendency toward development of a basal blade anterior to the cusp as well as posterior to it.

We considered that these oistodiform variants might represent distinct elements within the apparatus. However, the form with the suberect cusp is so rare in the collection that it could not have been a consistently present element. The flexed elements occur in about equal abundance as those that are subplanar; magnitude of flexure varies from slight to strong. Thus a spectrum of variation seems to exist within the oistodiform elements, and we conclude that a subdivision on the basis of any of these features would not be meaningful.

The nondenticulate blades show considerable variation in the development of two characters. The shelf on the inner side may be narrow and only slightly wider than the outer shelf, the condition that obtains with most specimens. A few individuals have the inner shelf more strongly developed so that it largely fills the angle between the two halves of the blade, and the element resembles such "platform elements" as *Ambalodus* Branson and Mehl s.f. Generally the outer shelf is produced as a small node at midlength. Several specimens have this node greatly enlarged, and in one case a lateral process bearing a blade is developed in this position. Some of this variance may be attributed to ontogeny, although specimens of comparable side do not show the extreme development of the individual described above. Perhaps the lateral process of this specimen is a pathogenic feature.

Nondenticulate blades have the same range in the Pogonip of the Ibex area as the other elements that we include in *P. aranda.* Furthermore, they show the same distribution of white matter in the blade coupled with a dark area along the base that is typical of these other elements. Presence of a shelf subparallel to the basal margin and beneath the region of white matter also is suggestive of the ramiform and oistodiform elements of *P. aranda.* Nevertheless, the small numbers of nondenticulate elements and their sporadic occurrence in our collections suggest that they must have been very minor constituents in the apparatus, or that, like "wisdom teeth" in humans, they did not occur in all individuals.

Cooper (1981), in his discussion of conodonts from the Horn Valley Siltstone of central Australia, discussed and illustrated the same spectrum of elements that we discussed above. He recognized two species, *P. aranda* and *P. nyinti,* within this plexus of morphotypes. He identified the former as having flattened oistodiform (M) elements and ramiform (S) elements in which the posterior process bears an arched blade that meets the posterior keel of the cusp in a sharp reentrant in the oral margin. The apparatus of *P. nyinti* was described as comprising robust and flexed oistodiform (M) elements and ramiform (S) elements in which the oral margin of the posterior process is nearly a straight line and continuous with the posterior keel of the cusp. He assigned a bladelike (P) element to *P. nyinti* but was unable to identify a corresponding element for the apparatus of *P. aranda* with confidence. We find this range of morphotypes to co-occur in the Pogonip and in the Garden City Formation in northern Utah (collection of RLE) and cannot justify two species on the basis of the collections available to us. Accordingly we treat these elements as components of the apparatus of a species which we identify as *P. aranda* Cooper and whose elements we believe to display a broad spectrum of morphologic variation.

Cooper recognized a third species, *Protoprioniodus yapu,* some of whose elements resemble those we consider to be the oistodiform elements of *"Microzarkodina" marathonensis.*

Occurrence.—This species occurs in the El Paso Group in west Texas (Ethington and Clark 1964; Repetski 1975, and in press) and in the uppermost part of the West Spring Creek Formation of southern Oklahoma (Potter 1975). It is present in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965), in the Broken Skull and Sunblood Formations in the southern District of Franklin, Canada (Tipnis and others 1978), and in the upper part of the Eleanor River Formation on Devon Island, Arctic Canada (Barnes 1974). It may be represented by a specimen from the Mystic Conglomerate of Quebec that Barnes and Poplawski (1973) identified with *Oistodus lanceolatus* Pander. Löfgren (1978) illustrated ramiform elements of a species of *Protoprioniodus* from Arenigian strata of west central Sweden; these elements cannot be distinguished from our material on the basis of her published photographs. This species is present in the San Juan Formation of Argentina (collection of RLE), in the Horn Valley Siltstone in central Australia (Cooper 1981), and in northwest New South Wales (Kennedy 1976).

Range in the Pogonip.—*Protoprioniodus aranda* ranges throughout much of the Wah Wah and Juab Formations.

Number of specimens.—Ramiform elements, 194; oistodiform elements, 271; nondenticulate blades, 25.

Repository.—Figured ramiform elements UMC 1104–12, 13; unfigured ramiform element UMC 1014–14; figured nondenticulate blades UMC 1104–15, 16; figured oistodiform elements UMC 1014–17–19; unfigured oistodiform elements UMC 1014–20, UMC 1015–1.

PROTOPRIONIODUS PAPILIOSUS (van Wamel)
Pl. 10, fig. 5

Oistodus papiliosus VAN WAMEL, 1974, p. 76–77, Pl. 1, figs. 18–20.

Gen. nov. B n. sp. 1 SERPAGLI, 1974, p. 93, Pl. 19, figs. 4a, b, Pl. 29, figs. 4, 5, text-fig. 26.

Remarks.—Our specimens are identical in all respects to those from the San Juan Formation of Argentina and from the "Balticus Beds" of Sweden that were illustrated by Serpagli (1974). The cusp and triangular posterior process consist wholly of white matter, whereas the basal region is dark and shows basal inversion. A prominent lateral ridge on the cusp is produced aborolaterally as a short process. The specimens conform to the "triangulariform element" of *Oistodus papiliosus* van Wamel (1974), although the dominance of albid matter should preclude assignment to that genus. Neither our collections nor those of Serpagli contain specimens like those that van Wamel identified as oistodiform and deltaform parts of the apparatus of his species. Although he did not provide absolute abundance data in his report, he commented that he based the species on specimens that occur only rarely in samples from Öland, Sweden, that are abundantly productive of other conodonts.

The abundance of white matter, the inverted basal region, and the general outline of our specimen and of those figured by van Wamel and by Serpagli are very similar to the ramiform elements of *Protoprioniodus aranda* discussed herein. This morphology may be a relatively uncommon variant thereof, in which case van Wamel's deltaform and oistodiform elements belong to another apparatus. Because none of the known occurrences of this kind of element includes a significant number of specimens, we retain van Wamel's specific name until adequate material becomes available for study. Should these elements prove to be morphotypes of the ramiform element of *P. aranda,* van Wamel's name will have priority as the senior synonym.

Occurrence.—In addition to the specimens from the San Juan Limestone of Argentina and from Lower Ordovician rocks of southern Sweden cited above, this element has been found in the Kindblade Formation of southern Oklahoma (Brand 1976).

Range in the Pogonip.—Our specimens came from samples collected in the middle Wah Wah and in the lower Juab (about 20 m [65 ft] above the *Hesperonomiella* Bed) at Section J.

Number of specimens.—2.

Repository.—Figured specimen UMC 1105–2; unfigured specimen UMC 1105–3.

Genus PTERACONTIODUS Harris & Harris, 1965

Type species.—*Pteracontiodus aquilatus* Harris & Harris, 1965.

Eoneoprioniodus MOUND, 1965.

Remarks.—This genus is characterized by elements that display a symmetry transition including cordylodiform, acodiform, distacodiform, trichonodelliform, and oistodiform elements, respectively. The edges and costae of the cusp tend to be produced proximally as keeled processes; denticles or alars generally are not developed on these processes. The elements consist largely of hyaline matter, but the keeled edges of the stubby basal processes commonly are albid.

Mound (1965a, b) reported the cordylodiform element of *P. cryptodens* in form-taxonomy as the type species of *Eoneoprioniodus* in his study of the conodonts of the Joins Formation and assigned the other elements to form-species of *Acodus, Acontiodus, Tetraprioniodus,* and *Oistodus.* Sweet, Ethington, and Barnes (1971) recognized that these several form-elements constitute parts of a common apparatus which they identified as *Multioistodus cryptodens* (Mound) on the basis of the similarity in structure and symmetry to elements of the latter genus. Barnes (1977) recognized five elements in the apparatus corresponding to those indicated above, although he used somewhat different nomenclature to identify them. He resurrected Mound's generic name, *Eoneoprioniodus,* and seemed to conclude (p. 102) that this genus was the precursor of *Multioistodus* Cullison.

Lindström (1977, p. 2) suggested that *Pteracontiodus,* a genus previously cited only in a sketchy discussion (Harris and Harris 1965) of conodonts from the upper West Spring Creek Formation, is close to *Acodus* Pander in the components of its apparatus. He did not discuss *Pteracontiodus* in detail, but he reassigned *Eoneoprioniodus cryptodens* Mound to the genus and also recognized the type species, *P. aquilatus,* in an evaluation of species that had been recognized previously under *Acodus.*

The generic definition provided for *Pteracontiodus* by Harris and Harris (1965) indicates that they considered a partial symmetry transition to be represented by the material they were studying. It particularly notes that the proximal parts of the cusp are produced as "distinct, flaring, terminally rounded to subacute processes (not denticles)." Clearly this represents an apparatus like that to which the type material of *Eoneoprioniodus* Mound belongs. *Pteracontiodus* has priority since Harris and Harris published their paper in February of 1965, whereas Mound's note in which he defined *Eoneoprioniodus* carries the date of October 1965.

PTERACONTIODUS CRYPTODENS (Mound)
Pl. 10, figs. 1–4, 6–10

Eoneoprioniodus cryptodens MOUND, 1965a, p. 197–198, text-figs. 1, 2, 12, 13; MOUND, 1965b, p. 19.
Acodus tripterolobus MOUND, 1965b, p. 10, Pl. 1, figs. 9–13; HIGGINS, 1967, p. 384, text-fig. 2(4).
Acontiodus bialatus MOUND, 1965b, p. 11, Pl. 1, figs. 16–18, 24, text-fig. 1C.
Paltodus variabilis Furnish. MOUND, 1965b, p. 31, Pl. 4, figs. 13, 14.
Tetraprioniodus robustus? Lindström. MOUND, 1965b, p. 35–36, Pl. 4, figs. 28, 29, 33.
? *Oistodus abundans* Branson & Mehl. HIGGINS, 1967, p. 384, text-fig. 2(2).
Roundya n. sp. HIGGINS, 1967, p. 384, text-fig. 2(8).
Multioistodus cryptodens (Mound). SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 2, figs. 17A–C.
Oistodus linguatus bilongatus Harris. SWEET, ETHINGTON & BARNES, 1971, p. 169, Pl. 1, fig. 23.
Eoneoprioniodus bialatus (Mound). BARNES, 1977, p. 102, Pl. 2, figs. 20–29.
Eoneoprioniodus bilongatus (Harris). BARNES, 1977, p. 102, Pl. 10, figs. 10–19.

Cordylodiform elements have slender recurved cusps with sharp anterior and posterior keels and smooth faces. Cusp is bent and somewhat twisted; anterior keel is deflected laterally on basal half of many specimens. Faces of cusp are unequally convex; that on the concave ("inner") side is more strongly swollen. Section of cusp is subcircular in some specimens, narrowly compressed in others, with all gradations between these extremes. Base of cusp is produced anteriorly and posteriorly as thin processes; anterior process is commonly bent inward and is relatively short whereas posterior process is straight, long, and deep. Upper edge of posterior process is sharp and in a few specimens bears a single, thin, high denticle. Robust individuals may show incipient denticulation of this region. These denticles are not clearly differentiated on any of the larger specimens in the collection and are expressed only as minor serrations of the upper edge and as constrictions on the flanks of the posterior process of these large individuals. Basal region between the processes is somewhat swollen, particularly on the inner side. Basal margin is straight along the undersides of the processes with a pronounced aborally directed lobe situated beneath the cusp. Cavity is a compressed cone whose apex is turned forward terminating in submarginal position. Large basal funnels generally are present. Some specimens in the middle to upper Kanosh show the surface ornamented by coarse longitudinal ridges that are separated by deep, narrow troughs. Ridges do not reach base of element so that a smooth strip extends around the basal part of each specimen.

We compared the acodiform elements directly with Mound's type material of *Acodus tripterolobus* and found the two collections to be identical in range of morphology. The original description is quite thorough, but several generalizations should be added. Although many specimens do show strong curvature in the lower part of the cusp as cited by Mound (1965b), p. 10), nearly as many are almost straight so that the anterior margin is only slightly convex throughout the entire length. Most specimens have a smoothly swollen, acostate outer face, but a few, perhaps gerontic individuals are fluted or ribbed opposite the major costa. The lower portion of the anterior keel (anticusp of Mound's terminology) is turned toward the acostate side of the cusp. The posterior keel in the basal region tends to be widened and to develop a serrate margin suggestive of incipient and irregular denticulation. Similar development of the anterior keel is suggested near the basal margin of a few specimens, but on most this keel remains thin with a straight edge as does the basal portion of the lateral costa. Rarely, a single bladelike denticle is present on the costa near the basal margin. Broadly flaring, shallow basal funnels are common.

Asymmetrical distacodiform element is slender; compressed cusp is basally curved, distally straight, and anteriorly and posteriorly keeled; anterior keel may be deflected laterally. Lateral faces show strong costae which are not located opposite each other; generally one costa is approximately medial in position, and the other is displaced anteriorly or posteriorly from the midline. Regions between keels and costae may be somewhat inflated, although most commonly they are depressed. Typically, the surfaces are smooth except for the costae, but some large specimens, particularly from sample I–K–10B in the Kanosh at Fossil Mountain, show additional fluting or ribbing. Keels and costae are produced basally as short processes which may display irregular pseudodenticulation. Anterior aboral process is least well developed and may be absent. Basal cavity is a curved, compressed cone with its apex located anteriorly near the level of greatest curvature of the cusp. Base is little expanded and has rhomboid outline. Deep basal funnels are common.

Cusp of trichonodelliform element sharply recurved at about one-third its length above basal margin, distally straight. Bilaterally symmetrical; gently rounded anteriorly between two sharp, laterally directed costae which are located at or just ahead of the midline on the distal two-thirds of the cusp. Prominent posterior median costa has flanks sloping to either side and merging laterally with narrow posterior facing facets on the rear of the lateral costae. These lateral costae are regularly curved whereas the axis of the cusp is sharply bent; hence below region of cusp curvature the costae change their position, as seen in lateral view, and occupy an increasingly anterior position. At basal margin they are anterolateral. The configuration of the region between the costae is also modified basally from the gentle convexity of the distal region. In the region of curvature of the cusp it is subangular, then flattens to form an acutely subtriangular anterior basal facet. Base is only slightly inflated if at all. Basal outline in aboral view is triangular. Cavity is a curved slender cone of triangular cross section whose apex is near the anterior margin in the region of greatest curvature of the cusp. All three costae are produced as bladelike processes. Posterior process is short and straight, in some specimens bearing a single thin but high denticle. Lateral processes are directed downward and laterally; their free edges are twisted posteriorly. Large, and presumably gerontic, individuals show the lateral processes becoming much deeper following their emergence from the base of the cusp. Such processes have a convex free edge which shows irregularly spaced constrictions suggestive of incipient denticulation. Basal funnels are almost invariably present. They are spacious and triangular in section and occupy the region beneath the base of the cusp and between the three processes to which they are firmly affixed in aboral grooves.

Oistodiform elements have reclined, slender cusp that is unequally biconvex in cross section with keeled edges. Cusp is somewhat flexed and twisted. Anterobasal angle is ca. 45°. Base is strongly swollen from anterobasal corner to beneath midpoint of cusp and thin posteriorly. Length of posterior basal extension is up to twice the width of the lower part of the cusp; it is keeled along the arcuate oral margin. Oral keel of base meets posterior edge of cusp in acute to nearly right angle. Basal funnels are common. Outer surface of some specimens from sample I–K–10B bears several prominent linear costae; most specimens are smooth on both inner and outer surfaces.

Occurrence.—*Pteracontiodus cryptodens* occurs in the Joins Formation in southern Oklahoma (Mound 1965a, b; McHargue 1975), and a similar form is present in the Everton Formation in northern Arkansas (Golden 1969). Barnes (1977) reported this species from the Ship Point Formation on Melville Peninsula in the Canadian Arctic region, and Higgins (1967) illustrated but did not describe elements that seem to represent this species from the Durness Limestone of northernmost Scotland.

Range in the Pogonip.—This species is present and abundant throughout the entire Kanosh Formation at Fossil Mountain.

Number of specimens.—Cordylodiform element, 454; acodiform element, 444; distacodiform element, 377; trichonodelliform element, 96; oistodiform element, 212.

Repository.—Figured cordylodiform elements UMC 1105–4, 5; unfigured cordylodiform element UMC 1105–6; figured acodiform elements UMC 1105–7, 8; unfigured acodiform element UMC 1105–9; figured distacodiform elements UMC 1105–10, 11; unfigured distacodiform element UMC 1105–12; figured trichonodelliform element UMC 1105–13; unfigured trichonodelliform element UMC 1105–14; figured oistodiform elements UMC 1105–15, 16.

PTERACONTIODUS GRACILIS, n. sp.
Pl. 10, figs. 11–13, 17

Cordylodiform element has slender, continuously curved cusp with unequally biconvex transverse section. Cusp is slightly twisted and flexed along its length; the more strongly swollen surface has narrow, planar facets along the anterior and posterior edges. Anterior margin of the element is regularly curved from the tip of the cusp through the level of the tip of the basal cavity, beneath which it displays a shallow recess. Base is only slightly inflated laterally; it is not extended posteriorly but rather continues the contour of the posterior margin of the cusp. Basal cavity has strongly curved anterior outline and gently arched posterior outline; its sharp tip is directed anteriorly upward at the anterior margin.

Distacodiform element resembles cordylodiform element in general outline and in configuration of basal cavity as seen in lateral view. Lateral surfaces of cusp have median costae; that to one side continues aborally across the base somewhat behind the midline, whereas the other reaches the basal margin just ahead of the midline.

Trichonodelliform element is slender, uniformly curved along length. It is narrow from side to side with the anterolateral edges barely differentiated. Outline of basal cavity is like that of the cordylodiform and distacodiform elements.

Oistodiform element has slender cusp that is unequally biconvex with keeled edges. Anterior keel is turned to one side along the cusp but flexed back to an anterior position in the basal region where it also is somewhat broadened. The base is modestly inflated to one side. Posterior basal extension has a low keel that passes over into the posterior edge of the cusp through a sharp curve to subtend an angle of about 90°.

Remarks.—These elements are wholly hyaline except for the oistodiform element which may display a thin plume of albid matter along the growth axis of the cusp and also in the widened basal portion of the anterior keel. The oistodiform element has a distinctive morphology, and for this reason one of these specimens was selected as the holotype for this species (UMC 1015–19). The other elements are sufficiently similar to the corresponding elements of *P. cryptodens* that they might be mistaken for juveniles of that species.

We did not find acodiform elements in the collection from which the specimens assigned to *P. gracilis* were recovered. The other elements are present in sufficient abundance that we are confident that the entire apparatus of the species is represented by the collections. Perhaps the elements that we designated as being oistodiform are homologous to the acodiform element of other species of *Pteracontiodus,* e.g., *P. cryptodens,* but that would leave the apparatus without an oistodiform element unless that element is represented by the falodiform specimens mentioned previously herein. However interpreted, the elements of the apparatus of this species do not correspond exactly to the one that generally has been accepted for this genus (see, e.g., Barnes 1977, discussion of *Eoneoprioniodus*). Nevertheless, the general similarity of the cordylodiform and distacodiform elements reported here to those of *P. cryptodens* leads us to treat this as a species of *Pteracontiodus* despite the differences in apparatus.

Derivation of new name.—Latin *gracilis,* slender.

Range in the Pogonip.—This species occurs in the interval between 19 and 41 m (61 and 135 ft) above the base of the Lehman Formation at Crystal Peak.

Number of specimens.—Cordylodiform element, 35; distacodiform element, 40; trichonodelliform element, 6; oistodiform element, 51.

Repository.—Figured cordylodiform element UMC 1105–17; figured distacodiform element UMC 1105–18; figured oistodiform element (holotype) UMC 1105–19; figured trichonodelliform element UMC 1105–20.

Genus REUTTERODUS Serpagli, 1974

Type species.—*R. andinus* Serpagli, 1974.

Discussion.—This multielement genus was described by Serpagli (1974) on the basis of collections from the San Juan Formation of Argentina. He reconstructed the apparatus to include three kinds of elements: those that are conelike without denticulate processes, those with a single denticulate process, and those having two denticulate processes and a reduced cusp. Although we have recovered specimens from the Pogonip that are identical to the conelike elements reported by Serpagli and also have found denticulate forms that are suggestive of the uni- and bi-branched elements that he described, we cannot recognize his apparatus in our collections. The conelike elements occur in the upper 107 m (350 ft) of the Fillmore Formation and in the Wah Wah Formation. They are not associated with denticulate elements of the type that Serpagli assigned to *Reutterodus.* The denticulate elements that we believe to be similar to those of *Reutterodus andinus* were found only in the Fillmore in Section H at a level 134 m (440 ft) stratigraphically lower than the lowest occurrence of the conelike elements in that section. We have found these denticulate elements in the Ninemile Formation in central Nevada, where they also occur in the absence of anything resembling the conelike elements.

The denticulate elements from the Fillmore and Ninemile show much greater symmetry variation than was reported by Serpagli for the type material of *Reutterodus,* and they possess a distinct posterior process which the latter seems to lack. That portion of the uni-branched and bi-branched elements that Serpagli described as a posterior process is situated to one side of the portion of greatest basal thickness. The cusp on such specimens has a broad swollen costa that occupies a median position between the lateral process and the posterior edge or process as defined by Serpagli. This costa terminates aborally in a lip at the basal margin.

Reutterodus was found in 8 of the 17 samples in the collection from the San Juan Formation. Although Serpagli did not provide a tabular listing of the distribution of the various kinds of elements among the samples, he acknowledged that the conelike element occurred in some samples without accompanying denticulate elements. He attributed this finding to the small size of the collection and possibly to sorting. Such considerations cannot account for the occurrences of the conelike elements in our collections in the upper Fillmore and Wah Wah without any of the multidenticulate elements in the same part of the section.

Two alternative interpretations can be advanced to explain this discrepancy. One possibility is that the multidenticulate elements are not developed in all species of *Reutterodus* but that the conelike elements are invariably present and show little variation. The other is that the conelike elements constitute a monoelemental apparatus in the sense of Sweet and Bergström (1972). We believe this interpretation is supported by the lack of an obvious associate of the conelike elements in that part of the Fillmore in which we found them.

If the conelike elements are not part of *Reutterodus,* it will be necessary to revise the concept of that apparatus. Assuming that the denticulate elements from middle Fillmore represent *Reutterodus* despite the presence of a posterior process, they suggest an alternative to the model advanced by Serpagli. We include prioniodiform elements, ramiform elements showing a symmetry transition (perhaps the counterpart of Serpagli's bi-branched elements), cyrtoniodform elements (equivalent to Serpagli's uni-branched elements), and oistodiform elements. This apparatus can be reconstructed from among the conodonts of the Ninemile Formation of Nevada also. It generally conforms to the apparatus of *Prioniodus* Pander as developed by Lindström (1971), but the individual elements differ greatly in detail from any of the species currently assigned to the latter genus.

We are not making any change in nomenclature at this time because of our uncertainty about the relations of the denticulate elements in our collections to type *Reutterodus.* The denticulate elements are described as a new species of *Reutterodus,* and the conelike elements are referred with question to *R. andinus.* If subsequent studies confirm Serpagli's original interpretation of the apparatus of *Reutterodus,* a new genus will be necessary for the prioniodus-like apparatus that we described above. If our interpretation is supported in the future, a new generic name will be required for the conelike elements, because the holotype of *R. andinus* is a uni-branched element *sensu* Serpagli.

?REUTTERODUS ANDINUS Serpagli, 1974
Pl. 10, fig. 18

? *Reutterodus andinus* SERPAGLI, 1974, p. 79–81, Pl. 17, figs. 7a, b, 8a–d (*non* figs. 4a–6b, 8a–c, = uni- and bi-branched elements), Pl. 28, figs. 4, 8 (*non* figs. 1–3b, 5–7, 9a, b, uni- and bi-branched elements), text-figs. 19 (part), 20 (part).

Bladelike cusp is strongly curved near base, distally straight. Blade thickens steadily from sharp posterior edge reaching greatest thickness just behind anterior margin, then thinning abruptly. Anterior edge is sharp, deflected strongly to one side to border a narrow marginal groove. Groove is shallow along front of cusp; but in basal region the folded edge is markedly widened, and the groove is deep and somewhat broadened. Base is slightly inflated to the side bearing the groove and encloses a shallow basal cavity. Element is gently flexed above the basal cavity so that cusp and base do not occupy a common plane.

Remarks.—Serpagli's illustrations of the "conelike" elements that he assigned to *R. andius* are particularly definitive. Without question the specimens from the high Fillmore and Wah Wah which are described above conform entirely to the specimens from Argentina which he studied. As stated earlier, we are listing these specimens under *R. andinus,* although we doubt that they are part of the apparatus of *Reutterodus.* We did not find any denticulate elements in association with these elements in any of the four sections where they occur. Further, the conelike elements are moderately abundant in the El Paso Group at the type section in the Franklin Mountains of west Texas, where they also occur without associated denticulate elements (John Repetski personal communication 1974).

Serpagli (1974, p. 81) suggested that one of the specimens from the Marathon Limestone that Graves and Ellison (1941, Pl. 1, figs. 1, 7, 23) reported as *Drepanodus arcuatus* Branson and Mehl, 1933 (*non* Pander, 1856) may belong here. We examined all three of the specimens illustrated by Graves and Ellison and found all of them to be drepanodiforms, although none belong in the species to which they assigned them.

Occurrence.—Upper part of El Paso Group, Franklin Mountains, west Texas.

Range in the Pogonip.—We found these elements in the upper 70 m (231 ft) of Fillmore at Section H, throughout the Fillmore of the ST Section, and in the Wah Wah at Section J and near the base of Fossil Mountain.

Number of Specimens.—53.

Repository.—Figured specimen UMC 1106–3; unfigured specimen UMC 1106–4.

? REUTTERODUS sp.
Pl. 10, figs. 14–16, 19

Apparatus consists of prioniodiform, ramiform, cyrtoniodiform, and oistodiform elements. Cusps are broad and thin, with sharp edges. All processes are denticulate; denticles are slender, wholly fused except at their tips. Like the cusps, they consist almost wholly of white matter. Oistodiform element flexed, base drawn out anteriorly into acute anterobasal region which bears a series of short nodes or denticles along its upper surface. Under side of all processes excavated by narrow and shallow troughs that radiate from slender cavity beneath cusp. Basal funnels may be present.

Cusp of prioniodiform element slender and erect, having triangular cross section. Blunt edges produced as denticulate processes. Cusp and denticles consist largely of white matter; lower part of element is dark. Two of the processes, arbitrarily designated posterior and anterolateral, form bulk of element. Viewed from the posterolateral direction, they unite to form a concave surface at the base of the cusp. On the convex anterior surface, the denticles of these two processes are completely fused, and their position is indicated only by their free tips which define a serrate outline for the processes. The fusion of the denticles is less complete on the opposite surface where linear depressions separate each adjacent pair of denticles to a level of about midheight of the processes. The denticles are subequal in size, parallel, and relatively slender. The third edge of the cusp is directed laterally and produced aborally as a process that hugs the posterior process. This lateral process also bears fused, slender denticles oriented normal to its oral edge. Under surface is excavated by a narrow trough that may retain a basal funnel.

Cusp of ramiform elements broad but thin, tapering to acute tip. Cross section triangular with each edge produced aborally as a denticulate process. Denticles slender, fused, subparallel, oriented at a high angle to the trend of each process but not normal to it. Cusp and denticles consist of white matter; basal reaches of element are dark by comparison. Lateral processes diverge downward at an angle of 30–45° from base of cusp; posterior process inclined downward at acute angle from posterior midline of cusp. Denticles of posterior process heavier and more clearly defined than those of lateral processes. Narrow troughs beneath each process coalesce in a moderately deep basal cavity beneath cusp.

Cusp of cyrtoniodiform element thin, somewhat proclined. Edges of cusp are blunt. One face of cusp uniformly convex from edge to edge; the other with a prominent median costa. One edge is produced as a well-defined process bearing crowded to fused denticles of subequal size. Opposite edge forms a shorter process that may be somewhat flexed toward the costate side of the cusp. This process may bear a few poorly defined denticles located distally along the oral margin. Cusp and processes consist of white matter; basal reaches of the element are dark. Basal surface excavated by a narrow trough leading to basal cavity beneath cusp. Median costa of cusp continues aborally onto prominent lateral flare; opposite side of element does not show corresponding inflation of basal cavity.

Cusp of oistodiform element slender, elongate, sharp-edged with regularly convex outer face; inner face with rounded median costa. Anterobasal region extended so that it rivals the cusp in length. Posterior portion of base very reduced in both length and height. Oral edge arcuate, tangential to posterior margin of cusp. Anterior portion of base flexed inward and somewhat twisted; its oral edge broken into a succession of low crowded denticles. Denticulation extends up onto leading edge of cusp. Basal excavation begins at anterobasal corner as a narrow trough that continues posteriorly to beneath cusp, where it flares prominently to inside of element, then narrows quickly to posterior extremity.

Remarks.—These elements are assigned to *Reutterodus* with reservation. Although the almost total fusion of the denticles and their arrangement and orientation is suggestive of the denticles on uni- and bi-branched elements of *R. andinus,* the symmetry variations among the ramiform elements are different from those reported by Serpagli (1974). All of the elements have posterior processes, whereas only a posterior (lateral in Serpagli's description) costa terminating aborally in a basal flare is present on the type species. Serpagli did not mention white matter in his discussion; his illustrations are SEM micrographs and do not, therefore, differentiate areas of white matter if they are present in the type specimens. Some of the elements we include here may be homeomorphs of elements of *R. andinus,* and the two species perhaps are not related.

Two principal ramiform variants are present in our collection. One is bilaterally symmetrical with the posterior process occupying the plane of symmetry. The lateral processes diverge opposite each other from the anterolateral corners of the cusp. Although the collection has insufficient numbers to demonstrate conclusively, there is the suggestion that these symmetrical forms fall into two subgroups. In one the angle of divergence of the lateral processes and the apical angle of the cusp are 30° or less so that the element is quite slender when viewed from the anterior perspective. The other group has an angle of divergence closer to 45° and hence appears relatively broad in the same view. In addition to the symmetrical forms, we have a group of ramiform elements that are asymmetrical with one lateral process directed anterolaterally and the other posterolaterally. Such forms have a nearly flat anterior face which extends from high on the cusp to the basal region; in contrast, symmetrical forms characteristically are broadly rounded on the front of the cusp and in the region where the two lateral processes fork.

Occurrence.—Repetski (1975, and in press) found this species in the El Paso Group of west Texas; a name will be proposed for it in his forthcoming publication on the conodonts from that unit.

Range in the Pogonip.—This species was found only in samples collected at 64, 76, and 104 m(210, 250, and 300 ft) in the Fillmore of Section H.

Number of specimens.—Prioniodiform element, 3; ramiform elements, 9; cyrtoniodiform element, 6; oistodiform element, 5.

Repository.—Figured prioniodiform element UMC 1106–5; figured cyrtoniodiform element UMC 1106–6; figured ramiform element UMC 1106–7; unfigured ramiform elements UMC 1106–8, 9; figured oistodiform element UMC 1106–10.

Genus SCALPELLODUS Dzik

Type species.—Protopanderodus latus van Wamel, 1974.

SCALPELLODUS STRIATUS n. sp.

Pl. 10, figs. 23, 24

Elements included here constitute a symmetry transition of striate, recurved simple cones. Major symmetry variance is in the degree to which the cusp is twisted. At one extreme are nearly bilaterally symmetrical forms with equally convex lateral surfaces, blunt edges, and uninflated bases. This plan is modified by a spectrum of torsion of the cusp which is distributed through the majority of specimens. In twisted forms, that side toward which the basal region is rotated is more strongly convex than the opposite face, and the base is slightly swollen toward that side. In such specimens the proximal segment of the anterior margin forms a heavy, blunt keel that commonly is rotated laterally. The basal cavity is a deep, tapered cone whose apex approaches the anterior margin. Heavy basal funnels commonly protrude for a short distance beyond the aboral margin. Surfaces of the elements are covered with fine, linear striae.

Remarks.—The symmetry transition shown by these elements and their striate surfaces conform to Löfgren's (1978) emended definition of *Scalpellodus.* We did not find strongly flexed elements like those Löfgren (1978, Pl. 3, figs. 6, 10) interpreted as the scandodiform elements of *S. gracilis* and of *S. latus,* respectively. Indeed, our specimens show almost continuous morphologic variation as outlined above, so that we are unable to divide them consistently into drepanodiform vs. scandodiform elements as has been done for previously described species.

The same morphologic transitions as those reported here are displayed by the elements we compare with question to *Walliserodus ethingtoni* (Fåhraeus) *sensu* Löfgren. The latter elements are characterized by the development of sharply defined costae, although striae like those described here are present on their surfaces also.

Derivation of name.—In recognition of the numerous, closely crowded linear striae that are the principle feature of the elements of this species, *striatus*.

Occurrence.—*Scalpellodus* has been identified with certainty to date only from northern Europe (Dzik 1976, Löfgren 1978). *Drepanodus cavus* Webers, which occurs in the Platteville through upper Galena of the Upper Mississippi Valley, was placed in this genus by Dzik (1976) but does not display the striate surface that characterizes the genus according to Löfgren's emended definition, and therefore probably does not belong here.

Range in the Pogonip.—This species is most abundant in Zones G_1 and G_2 of the Fillmore Formation, but occasional specimens were found higher in that formation.

Number of specimens.—362.

Repository.—Figured specimens UMC 1106–11 (holotype), 12; unfigured specimens UMC 1106–13, 14.

Genus SCANDODUS Lindström, 1955

Type species.—*Scandodus furnishi* Lindström, 1955.

aff. "SCANDODUS" FLEXUOSUS Barnes & Poplawski s.f.

Pl. 10, figs. 20–22; fig. 21

Scandodus sp. ETHINGTON & CLARK, 1965, p. 199.
? *Scandodus furnishi* Lindström. MOUND, 1968, p. 417, Pl. 4, figs. 58–62.
? *Scandodus cf. S. pipa* Lindström. MOUND, 1968, p. 417, Pl. 4, figs. 63, 64.
Scandodus furnishi Lindström. ETHINGTON & CLARK, 1971, p. 73, Pl. 2, fig. 27; ETHINGTON, 1972, p. 22, Pl. 1, fig. 6; ABAIMOVA, 1975, p. 95–96, Pl. 9, figs. 1, 2, text-fig. 8(10, 15).
aff. *Scandodus flexuosus* BARNES & POPLAWSKI, 1973, p. 785–786, Pl. 2, figs. 1–4, text-fig. 2L.
? aff. *Scandodus mysticus* BARNES & POPLAWSKI, 1973, p. 786, Pl. 4, figs. 1, 2, text-fig. 2K.
? *Drepanodus toomeyi* Ethington & Clark. LEE, 1976, p. 164–165, Pl. 1, fig. 8, text-fig. 2H.
? *Paltodus inconstans* Lindström. GEDIK, 1977, p. 43, Pl. 1, fig. 10 (oistodiform element only).
? *Protoponderodus* aff. *gradatus* Serpagli. GEDIK, 1977, p. 44, Pl. 1, fig. 3.
aff. *Paltodus*? cf. *mysticus* (Barnes & Poplawski). LÖFGREN, 1978, p. 64–65, Pl. 4, figs. 4, 5, 11.

Remarks.—Lindström (1955) established the name *Scandodus* for simple-cone elements whose cusps are twisted so that the basal region is turned inward. Subsequently he redefined this genus to include hyaline elements of this morphology and an apparatus that also contains drepanodiform elements. Nonhyaline scandodiform elements thereby excluded from *Scandodus* were reassigned to *Drepanodus* Pander and to *Protopanderodus* Lindström. Recently Löfgren (1978) has recognized similar elements as components of the apparatuses of species of *Paltodus* Pander. It is apparent that the scandodiform morphologic plan is a common one in several genera of Lower Ordovician conodonts, and that in most cases general identity is uncertain for isolated scandodiform specimens unless the apparatus to which they belong can be established.

We have reported the elements treated here as *S. furnishi* Lindström in an earlier report (1971), but Lindström's restriction of that name to a hyaline species negates that identification. We can see little objective difference between our material and that which Barnes and Poplawski (1973) described as *S. flexuosus*. Some of the specimens that we have studied show a few widely spaced, low, narrow costae on the inner face of the cusp. Such costae usually are confined to the region ahead of the midline. Costae were not reported by Barnes and Poplawski, but they found only 4 specimens of *S. flexuosus*, and costate specimens might not be represented in a collection of that size.

Löfgren (1978) reassigned *S. flexuosus* to *Paltodus* Pander emend. Lindström, and considered it to occupy the oistodiform position in the apparatus. She believed the drepanodiform elements of the same species were represented by *Scandodus mysticus* Barnes and Poplawski. We found few specimens in our collection whose bases are strongly expanded in the posterior region as is typical of *S. mysticus;* in virtually all of the specimens we found the greatest width of the flared base to be located centrally. Accordingly we cannot substantiate the interpretation of Löfgren that these two kinds of elements are parts of one apparatus. Neither can we identify any other elements in our collections whose abundance and range make them obvious associates of the elements that we compare with *S. flexuosus.* Therefore we are reporting them under *Scandodus* in the form sense.

Occurrence.—This form certainly occurs in the El Paso Group of west Texas (Repetski 1975, and in press), in the Ninemile Formation of Nevada (Ethington 1972), in the Manitou Formation of east central Colorado (Ethington and Clark 1971), and in the Columbia Ice Fields Section

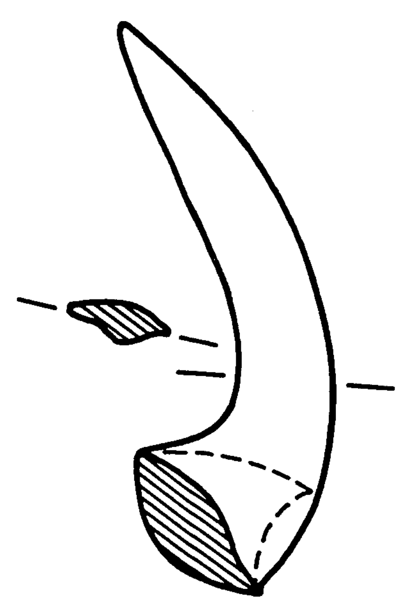

Figure 21.—aff. "*Scandodus*" *flexuosus* Barnes & Poplawski s.f.

in Alberta (Ethington and Clark 1965). Specimens that are similar morphologically to those reported here have been illustrated from the Cool Creek Formation of Oklahoma (Mound 1968), from the Mystic Conglomerate of Quebec (Barnes and Poplawski 1973), from Arenigian strata of Jämtland, Sweden (Löfgren 1978), from the Taurus Mountains of southern Turkey (Gedik 1977), from the Maggol Formation of South Korea (Lee 1976), and from along the Lena River in Siberia(Abaimova 1975).

Range in the Pogonip.—These elements range throughout the entire Fillmore Formation; they were recovered from all sections where the Fillmore was sampled.

Number of specimens.—231.

Repository.—Figured specimens UMC 1106–15–17; unfigured specimens UMC 1106–18, 19.

"SCANDODUS" ROBUSTUS Serpagli
Pl. 10, figs. 25–27

Scandodus sp. HÜNICKEN & GALLINO, 1970, Pl. 1, fig. 2; HÜNICKEN, 1971, p. 46, Pl. 1, figs. 11a, b, 12, 13, Pl. 3, figs. 16–18.
"Scandodus" robustus SERPAGLI, 1974, p. 69, Pl. 18, figs. 3a–4d, Pl. 28, figs. 12, 13.

Remarks.—Serpagli (1974) provided an excellent description and illustrations to which most of our specimens conform very closely. They show variation from his description in the way in which the posterior edge of the cusp passes over into the base. A small part of the collection has a smooth, continuous curve in this region; most specimens show an angle which may be as small as about 45° in contrast to the nearly right angle that Serpagli reported. The cusp consists wholly of albid matter whereas the base is largely hyaline.

Our collections include another morphotype that we believe to be part of the same apparatus as those considered above. It resembles the scandodiform elements just described in having a relatively broad, albid cusp whose anterior margin is extended downward and twisted to one side to form the "anticusp" that Serpagli described. The basal cavity has similar outline, and the basal region is markedly inflated to one side in both morphotypes. The second form is distinct, however, in bearing a well-defined but narrow ridge that begins on the swollen medial part of the cusp and continues across the inflated part of the base to the aboral margin. The basal outline of such elements is distinctly triangular. Some of the scandodiform elements approach this configuration, and we suspect that a larger collection might show almost complete transition between these forms.

The costate forms may be transitional also with another of Serpagli's species, *Paltodus? sweeti.* His discussion and illustrations suggest that the latter form has a relatively high and narrow costa that is restricted to the base and is most prominent adjacent to the aboral margin. In their general outline, development of a wide, bladelike cusp, somewhat twisted proximal portion of the anterior margin, and shape of the basal cavity, these forms are very like *"S." robustus.*

Serpagli's collections show that the ranges of *P. sweeti* and *"S." robustus* overlap slightly in the San Juan Limestone. However, he did not find large numbers of either of these forms, so that this stratigraphic relationship may not be conclusive. Lindström (1977, p. 19–20) accepted Serpagli's suggestion that *P. sweeti* and *"S." americanus* Serpagli are parts of a common apparatus and assigned them to *Acodus* Pander; he concluded that the apparatus also includes those forms that Serpagli identified under *Walliserodus australis.* These elements all have identical ranges in Serpagli's collections from the San Juan Limestone, but it is apparent from our material from the Pogonip that the *Walliserodus* apparatus is distinct and must be excluded from that of *P. sweeti.* One of us (RLE) has found *P. sweeti* and *"S." americanus* to co-occur in the Ninemile Formation of central Nevada and in strata in Whiterock Canyon in the Monitor Range. central Nevada. They are succeeded in higher strata at the latter locality by an abundance of *"S." robustus.* This suggests the possibility of an ancestor-descendant relationship between these two groups of elements. If such a relation exists, a question is raised as to whether the two morphotypes of *"S." robustus* described here are homologous to the *P. sweeti* and *"S." americanus* elements of the postulated ancestor. Another possibility is that the *P. sweeti* element diversified by descent to the two morphotypes above, and that another oistodiform element, e.g., *"O." hunickeni,* occupied the *"S." americanus* position in the apparatus.

Whatever the case, relationship of any of these elements to *Acodus* is conjectural. No counterparts of the ramiform transition series that generally has been considered an integral part of the apparatus of that genus is indicated by any of the collections containing *P. sweeti, "S." americanus,* and *"S." robustus* that are known to us. Clearly, these specimens do not represent *Scandodus* either, but pending collection of adequate material for evaluation of the uncertainties of their relation to other elements we retain Serpagli's form-generic identification.

Occurrence.—*"S." robustus* has been found in the San Juan Limestone of Argentina (Serpagli 1974) and in the Antelope Valley Formation (*Orthidiella* Zone) at the narrows of Whiterock Canyon, Monitor Range, central Nevada (undescribed collections of RLE).

Range in the Pogonip.—Upper Wah Wah and lower Juab at Section J and at Fossil Mountain.

Number of specimens.—Acodiform element, 12; scandodiform element, 36.

Repository.—Figured acodiform element UMC 1106–20; unfigured acodiform element UMC 1107–1; figured scandodiform elements UMC 1107–2, 3; unfigured scandodiform elements UMC 1107–4, 5.

SCANDODUS SINUOSUS Mound
Pl. 11, figs. 1–5

Acodus campanula MOUND, 1965b, p. 8–9, Pl. 1, figs. 4–6.
Acontiodus curvatus MOUND, 1965b, p. 11–12, Pl. 1, figs. 19–21, text-fig. 1D; SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 2, fig. 35.
Distacodus symmetricus MOUND, 1965b, p. 16, Pl. 2, figs. 1–3, text-fig. 1E; SWEET, ETHINGTON & BARNES, 1971, p. 168, Pl. 2, fig. 34.
Oistodus abundans Branson & Mehl. MOUND, 1965b, p. 26, Pl. 3, fig. 23 (*non* figs. 21, 22, 29).
Scandodus sinuosus MOUND, 1965b, p. 33–34, Pl. 4, figs. 21, 22, 24, text-fig. 1J.

? *Acontiodus reclinatus* Lindström. BRADSHAW, 1969, p. 1148, Pl. 131, figs. 6, 9.
? *Distacodus expansus* (Graves & Ellison). BRADSHAW, 1969, p. 1149, Pl. 131, figs. 11, 12.
? *Oistodus inclinatus* Branson & Mehl. BRADSHAW, 1969, p. 1156, Pl. 133, figs. 11–13.
? *Scandodus biconvexus* BRADSHAW, 1969, p. 1161, Pl. 134, figs. 16–18.
? *Scandodus dubius* BRADSHAW, 1969, p. 1161, Pl. 134, figs. 19–21.
non Scandodus sinuosus Mound. NIEPER, 1969, Pl. O VII, figs. 7, 8.
? *Protopanderodus* n. sp. BARNES & POPLAWSKI, 1973, p. 784–785, Pl. 2, figs. 5, 6, 6a, 12, 12a, text-figs. 2C, D (*non* Pl. 3, fig. 10)
? *Protopanderodus?* n. sp. BARNES & POPLAWSKI, 1973, p. 785, Pl. 2, fig. 9.
? *Oistodus akpatokensis* BARNES, 1976, p. 173, 175, Pl. 4, figs. 8–12.
? *Scandodus ungavensis* BARNES, 1976, p. 175–176, Pl. 4, figs. 13–18.
Distacodus ? sp. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 4, figs. 14, 18.

This species is interpreted to have an apparatus that is comprised of acodiform, scandodiform, trichonodelliform, oistodiform, and, in some instances, distacodiform elements. All elements are hyaline.

Acodiform elements are strongly recurved, robust distacodontids with prominently keeled anterior and posterior edges and pronounced lateral costae. Linear concavities are present flanking the keeled edges on the costate side of the cusp. Anterior keel stops short of anterobasal angle, whereas posterior keel, although faint in the basal region, reaches the aboral margin. Anterolateral and posterolateral faces nearly planar between costa and keels, becoming moderately convex on somewhat inflated base. Opposite side of element is strongly convex. The costa is a thin, sharp ridge extending from distal extremity to basal margin. Although located about midway between the keels, it appears in lateral view to be posterior owing to slight twisting of the element above the basal region. Curvature of the cusp is strong at about one-third the length from the basal margin. Distal reaches are nearly normal to the axis of the basal region and approximately parallel to the basal outline. On some specimens the basal outline is nearly straight as seen in lateral view whereas on others it is sinuous, concave aborally near the anterior margin, and broadly convex posteriorly. Most of the specimens in the collection are opaque, so that the basal cavity cannot be observed. Smaller forms show a conical cavity which is directed orally and anteriorly with its apex just behind the leading edge of the cusp at the level of maximum curvature of the element. Posterior outline of cavity is straight; anterior outline is recessed. Many individuals have a basal funnel that extends slightly beyond the aboral edge. Dextral and sinistral specimens are approximately equal in number.

Scandodiform elements have sharp edges and a recurved cusp. Edges are oriented anteriorly and posteriorly in the basal region, but the cusp is twisted at about one-third its length above the base. Amount of rotation of distal part of cusp is variable, ranging from slight to a quarter turn. In cases of extreme torsion, the edges are rotated from anterior-posterior position of base to lateral position near end of cusp. Edges of cusp are keeled in basal reaches, but keels become progressively less prominent higher on the cusp. Cusp may be continuously recurved along its length, or, less frequently, curvature is confined to the lower part of the element. Inner face of cusp is strongly swollen between marginal flanges of the keeled edges; outer face is less strongly but regularly convex between edges. Base is strongly inflated to inner side; basal region is circular to elliptical in cross section. Cavity is a moderately deep cone whose apex is near the anterior margin at about the level where twisting of the cusp begins. Basal funnels commonly are retained in the cavities.

The trichonodelliform elements have three keeled edges arranged in the posterior and anterolateral positions so that the cross section of the element is triangular. Posterolateral faces are planar; anterior face is transversely convex. Elements are gently to strongly recurved. The basal region is moderately swollen, the cavity anteriorly inclined with its apex near the front surface.

Oistodiform elements have relatively small basal regions in comparison to the length of the cusp. Inner face of cusp broadly swollen with marginal shoulders produced by keeled edges, outer face uniformly swollen transversely. Base is swollen to inside in continuation of swollen region of the cusp; anterobasal region is thin.

Distacodiform elements are strongly curved distacodontids in which the distal two-thirds of the cusp is turned in a direction parallel to the basal margin. Anterior and posterior edges sharp, anterior keel commonly present. Transverse section of cusp rhombic. Lateral costae prominent, continuous from basal margin to broken ends of all specimens annd presumably to tip of cusp. Anterior side of costa merges with anterobasal region of element, posterior side of costa forms a narrow posteriorly facing strip which is almost normal to posterolateral region of cusp. Costae are uniformly developed throughout their length, although on some specimens they are less prominent near the base than higher. The regions between the costae and the edges of the cusp may be depressed, or they may be slightly inflated. Basal region is laterally compressed but somewhat expanded posteriorly to produce a narrow, ellipsoidal cross section. The basal margin, as seen in lateral view, is quite variable. In some cases it is regularly convex, whereas other specimens show an anterior reentrant extending half the distance from the anterior margin to the lateral costa and followed by a convexity that continues to the posterior. Not uncommonly the convex region is in the position of the costa with concavities both anteriorly and posteriorly from it. Basal cavity is a curving, rapidly tapering cone whose apex is near the anterior margin in the region where curvature of the element is greatest. Many specimens have basal funnels projecting aborally from the cavity.

Remarks.—Mound (1965b) described all of the elements that we consider here in form taxonomy in his paper on the Joins fauna. We are assigning this species tentatively to *Scandodus* Lindström because all of the elements are hyaline and because a symmetry transition suggestive of that of *S. brevibasis* (Sergeeva) is represented. However, many of the elements are very suggestive in their overall morphology to hyaline elements that have been assigned to *Multioistodus, Eoneoprioniodus* or *Pteracontio-*

dus by various authors. None of the elements that we consider above show any traces of auxiliary denticles or alate projections associated with the basal reaches of their costae or edges, so that they would be atypical representatives of any of those genera.

We are hesitant about the generic assignment because of uncertainty about two of the elements that we considered above. In particular, the distacodiform elements are present throughout much of the range of the others in the Kanosh but were not found in the Lehman or Watson Ranch. In the same vein, the oistodiform elements are common in the Kanosh but occur in small numbers and rather sporadically in the Lehman, whereas the acodiform, scandodiform, and trichonodelliform elements have their greatest abundance in the latter formation. McHargue (1975) assembled a very large collection of conodonts from the Joins Formation of Oklahoma and concluded that the acodiform elements, trichonodelliform elements, scandodiform elements, and distacodiform elements are parts of a single apparatus, although he noted that the distacodiform elements were not present in all of the samples from which he recovered the others. He did not include an oistodiform element in his reconstruction of the apparatus; elements like the oistodiforms considered above were assigned instead to other hyaline apparatuses in the Joins fauna.

Cooper (1981) described an apparatus similar to that of *S. sinuosus* from the Horn Valley Siltstone of central Australia. He identified one of the elements of that apparatus with *Oistodus larapintinensis* Crespin s.f. and assigned the species to *Trigonodus* Nieper. The latter genus was established in form-taxonomy in a brief summary of Ordovician conodonts from Queensland, Australia (Nieper 1969) that were discussed at greater length in 1970 in Nieper's unpublished Ph.D. dissertation. The only illustrated element of the type species, *T. triangularis,* is an acontiodiform element. Such elements, in our experience, occur in the apparatus of many genera, and commonly they lack diagnostic morphologic characters that indicate which of the several possible genera they represent. In the absence of information as to the possible associated elements of *T. triangularis,* we cannot evaluate this genus, Accordingly we assign *T. larapintinensis* (Crespin) to *Scandodus* Lindström pending a thorough evaluation of the apparatus of the type species of the latter genus, *S. furnishi.* The apparatus that Cooper discusses for the species conforms element for element with the apparatus that Lindström (1971) discussed in defining multielement *Scandodus;* it must be noted, however, that that apparatus seems to be based on *S. brevibasis* (Sergeeva) rather than on the type species. Whatever the proper generic assignment, the apparatuses of *S. larapintinensis* and of *S. sinuosus* are very similar. The conodints associated with the former species indicate that it is the older of the two species.

Occurrence.—This species occurs in the Joins Formation in southern Oklahoma (Mound 1965b, McHargue 1975). It probably is represented by some of the elements from the Fort Peña Formation of west Texas that Bradshaw (1969) described as species of *Acontiodus, Distacodus,* and *Scandodus,* respectively (see synonymy). It may also be represented among the conodonts of the Mystic Conglomerate of Quebec (Barnes and Poplawski 1973), and probably also in the Ordovician sequence of Akpatok Island in Ungava Bay, District of Franklin, Canada (Barnes 1976). Tipnis and others (1978) found it in the Sunblood Formation in the southern District of Franklin.

Range in the Pogonip.—All of the elements range from lower Kanosh (I–K–4) through the lower part of the Watson Ranch Quartzite except for the distacodiform element which was found only in the Kanosh.

Number of specimens.—Acodiform element, 802; scandodiform element, 2132; trichonodelliform element, 201; oistodiform element, 450; distacodiform element, 73.

Repository.—Figured acodiform element UMC 1107–6; unfigured acodiform element UMC 1107–7; figured distacodiform element UMC 1107–8; unfigured distacodiform element UMC 1107–9; figured oistodiform element UMC 1107–10; unfigured oistodiform element UMC 1107–11; figured scandodiform element UMC 1107–12; unfigured scandodiform element UMC 1107–13; figured trichonodelliform element UMC 1107–14; unfigured trichonodelliform element UMC 1107–15.

"SCANDODUS" sp. 1. s.f.
Pl. 11, figs. 6, 7; fig. 22

? *Distomodus kentuckyensis* Branson & Branson. LEE, 1970, p. 317, Pl. 7, figs. 11, 12.
? *"Drepanodus"* sp. 4 SERPAGLI, 1974, p. 45, Pl. 13, figs. 11a–c.
? *Acodus deltatus* Lindström. VIIRA, 1974, p. 41, Pl. 2, fig. 28.
Triangulodus sp. B TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, figs. 18, 20.

Robust cone whose heavy cusp has a broadly swollen median ridge flanked by flat marginal regions on one side and a uniformly rounded surface on the opposite side. Base is strongly swollen to one side in a continuation of the median ridge. Anterior and posterior edges of the cusp are sharp; anterobasal region deflected inward from about level where basal swelling begins. Posterior margin subtends angle of 90° or somewhat less. Sharp tip of basal cavity lies near anterior margin of element; anterior outline of basal cavity strongly arcuate, posterior outline nearly straight. Specimens are altered thermally (CAI 3–4); albid matter is suggested throughout the cusp.

Remarks.—These elements are reported under the name *Scandodus* in the form sense; they probably have no affinity to the type species, *S. furnishi* Lindström. That species (Lindström 1971, p. 39) is comprised of hyaline scandodiform and drepanodiform elements, so that the

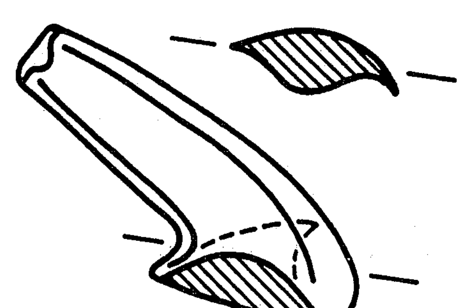

Figure 22.—*"Scandodus"* sp. 1 s.f.

apparent abundance of albid matter in the elements considered here argues against their assignment to *Scandodus*. They are moderately abundant in the higher Fillmore, but we have not been able to establish with which, if any, other elements they are apparatal associates. We cannot, therefore, assign them to any of the multielement species that have been reconstructed to date.

Occurrence.—Lee (1970) illustrated material, which he identified with *Distomodus kentuckyensis*, from the Dumogol Formation of South Korea that is very similar in external morphology to the specimens reported here. A specimen from the San Juan Limestone of Argentina that Serpagli (1974) described as *"Drepanodus"* sp. 4 has the anterobasal region deflected markedly inward in similar fashion to these elements from the Pogonip, but the cusp is continuously curved and rather slender in the former in contrast to relatively straight above the base and broad in the latter. Viira (1974, Pl. 2, fig. 28) illustrated a specimen from northern Estonia which she identified with *Acodus deltatus* Lindström. The specimen seems to lack a sharply angulate costa as is typical in that species. The illustration suggests a rounded median ridge and deflected anterobasal region similar to the characters of the specimens reported here. Tipnis and others (1978) found this form in the Sunblood and Broken Skull Formations in the southern District of Franklin, Canada.

Range in the Pogonip.—Common in the upper Fillmore at Section H (81 through 281 m [266 through 921 ft]) and the ST Section (11 through 125 m [35 ft through 410 ft]); not found in equivalent strata in the Mesa Section.

Number of specimens.—143.

Repository.—Figured specimens UMC 1107–16, 17.

"SCANDODUS" sp. 2 s.f.

Pl. 11, figs. 8, 9; fig. 23

Robust, multicostate cones whose cusps are recurved and twisted so that the basal cavity opens to one side. The basic symmetry of the cusp is dominated by four edges. The two most prominent of them are arranged opposite each other and extend orally from opposite ends of the greatest dimension of the base. It is not possible to apply the conventional designations of anterior-posterior or lateral to the positions of these edges. Somewhat less prominent costae begin at a flare in the basal margin and continue orally, closely spaced and nearly parallel to each other, separated from each other proximal to the base by a prominent trough that shallows to a flat surface on the distal part of the cusp. Surface opposite these costae is flat, convex, or swollen, depending on which specimen is examined. Areas between the prominent edges and the two secondary costae are deeply depressed by broad troughs proximal to the base; these troughs die out orally into sloping surfaces. Symmetry varies considerably among these specimens from forms whose cusps are nearly bilaterally symmetrical in their distal region about a plane centered between the two secondary costae to forms that are markedly asymmetrical in the same region. Basal cavity is obscured by thermal alteration (CAI 4) but seems to be spacious and relatively deep when viewed from the aboral direction. Many specimens retain a basal funnel that projects a short distance beyond their basal margin.

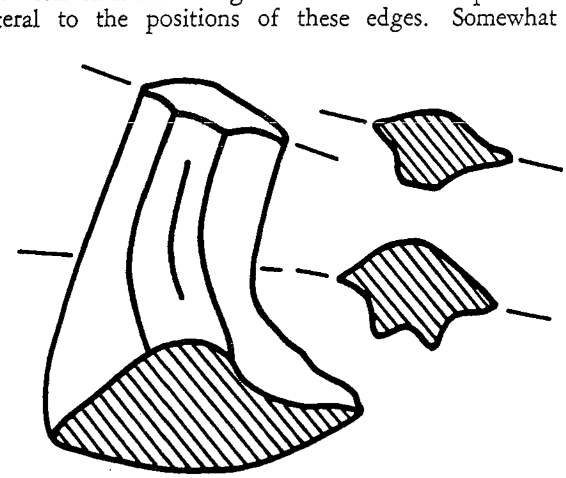

Figure 23.—*"Scandodus"* sp. 2 s.f.

Remarks.—These specimens may represent parts of an apparatus that also includes the forms reported here as *"Acontiodus"* aff. *A. latus* Pander s.f. and *Paltodus* aff. *P. sexplicatus* (Jones) s.f., based on generally common ranges in the lower Fillmore and on the similarity of the costae and ridges among the several form elements. Because this interpretation is tentative, we are reporting these elements independently and in the form sense.

Range in the Pogonip.—Fillmore Formation, 50–136 m (165–446 ft) in Section C.

Number of specimens.—21.

Repository.—Figured specimens UMC 1107–18, 19.

"SCANDODUS" sp. 3 s.f.

Pl. 11, fig. 10; fig. 24

Remarks.—The forms included here are slender, delicate, regularly curved elements that are twisted below midlength so that they do not lie in a plane of symmetry. Edges are blunt; lateral faces are unequally convex with that side toward which the base is twisted being more strongly so. The cusp contains abundant albid material; the base is dark. Basal cavity is a rapidly tapering cone whose distal tip turns to a direction parallel to the axis of the cusp. The base is moderately inflated.

Elements having this general appearance were found in a 46-m (150-ft) interval in lower Fillmore and also in another interval of about 18 m (60 ft) that is 122 m (400 ft) higher in the formation. They are not common in either interval. Their small size may mean that they

Figure 24.—*"Scandodus"* sp 3 s.f.

are juveniles, and perhaps not all of them come from the same species.

Range in the Pogonip.—Fillmore Formation, Section C between 107 and 186 m (350 and 610 ft); Mesa Section at 186, 189, and 205 m (610, 620, and 672 ft).

Number of specimens.—18.

Repository.—Figured specimen UMC 1107–20.

"SCANDODUS" sp. 4 s.f.
Pl. 11, fig. 11

? *Scandodus?* n. sp. ETHINGTON & CLARK, 1965, p. 199, Pl. 1, fig. 6.
Oistodus abundans Branson & Mehl: MOUND, 1965b, p. 26, Pl. 3, fig. 21 (*non* figs. 22, 23, 29).

Strongly asymmetrical distacodontids having keeled, recurved cusp whose base shows pronounced inflation on inner side. Cusp unequally bi-convex, inner face more strongly swollen than outer. Anterior keel better developed than that along posterior margin. Both keels continue to base of element. Anterior keel may be broadest across basal region and deflected slightly to outside. Outer face of base generally is slightly convex or nearly flat, but a few specimens are somewhat depressed in this region. A continuous curve is present in the posterior margin in the region of transition from cusp to base. Distal margin of cusp is directed normal to trend of posterior basal keel. Basal cavity is deep, its apex near the anterior margin. Basal funnels protrude a short distance beyond the free edge on many specimens. A few individuals have faint costae on either inner or outer faces at about midheight.

Remarks.—McHargue (1975) concluded that this element is part of the apparatus of a new genus which he believes also included drepanodiform, roundyaform, and oistodiform elements. We compared our specimens with those he identified as scandodiform elements of the purported new genus and found them to be identical in every respect. We are unable, however, to identify the other three types of elements in the limited range within the Pogonip where we found our specimens.

The specimen from the Columbia Ice Fields that we (1965) tentatively identified with *Scandodus* is very similar to the elements described above. The occurrence in Canada is associated with conodonts that are representative of the upper part of the Fillmore in Utah, so that considerable stratigraphic difference is indicated for that specimen relative to the specimens reported here.

Occurrence.—This element is present in the Joins Formation of southern Oklahoma (Mound 1965b, McHargue 1975) and may occur also in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965).

Range in the Pogonip.—Although recovered from a limited range in the lower to middle Kanosh at Fossil Mountain, all but three of the elements in our collection came from one sample (I–K–10B).

Number of specimens.—31.

Repository.—Figured specimen UMC 1108–1; unfigured specimen UMC 1108–2.

"SCANDODUS" sp. 5 s.f.
Pl. 11, fig. 12

Compressed, bladelike distacodontid which is gently recurved and broadly flexed. Posterior edge sharp, anterior margin blunt. A faint ridge, subparallel to the anterior margin, is generally present well ahead of the midline on the concave face of the blade. Near the tip of the unit this ridge assumes a more nearly central position. Opposite side normally smooth. Basal region does not influence margins whose curvature is continuous from base to tip. Moderately inflated in posterior half of base to enclose basal cavity, a flattened, distorted cone whose apex is drawn over toward anterior margin. Region surrounding cavity is dark brown or black and contrasts strongly with white matter of blade.

Remarks.—These scandodiform elements occur in the same general interval in the House Limestone as the forms reported below as New Genus 3 and those compared with New Genus 3 with question. The concentration of albid matter in the cusp is similar to the development of the elements of that apparatus. However, scandodiform elements like those described above have not been found in large collections from the Manitou Formation of Colorado in which New Genus 3 is represented by abundant and well-preserved specimens. For this reason we report these scandodiform elements separately and in form-taxonomy. All of the specimens at hand are relatively delicate so that they may represent juveniles which would have adopted diagnostic features at later growth stages.

Range in the Pogonip.—Upper half of the House Formation at all localities.

Number of specimens.—72.

Repository.—Figured specimen UMC 1108–3; unfigured specimen UMC 1108–4.

"SCANDODUS" sp. 6 s.f.
Pl. 11, figs. 17, 18

Elements whose cusp is flexed and twisted so that the base opens to one side. Anterior and posterior edges of cusp are rounded. One side of cusp is regularly convex; the other side bears a median longitudinal swelling that is most prominent near the base but dies out above midlength. Base flares strongly to one side in the position of the swelling on the face of the cusp. Basal outline is subtriangular in section with rounded corners. Basal cavity is shallow but broad.

Remarks.—All of the specimens included here are rather heavy individuals. They may be gerontic specimens of forms which, in typical representatives, have been assigned elsewhere.

Range in the Pogonip.—Upper House Limestone at the type area and Hintze's (1951) Section B; lower Fillmore in Section C.

Number of specimens.—43.

Repository.—Figured specimens UMC 1108–5, 6; unfigured specimen UMC 1108–7.

Genus SCOLOPODUS Pander, 1856
Type species.—*Scolopodus sublaevis* Pander, 1856.

Remarks.—*Scolopodus* was redefined by Lindström (1971) to include only conodonts whose apparatus consists of hyaline elements that occur as symmetrical and asymmetrical forms, respectively. The flanks of the cusp display costae. Lindström emphasized that this interpretation is based on *S. rex* Lindström, which has been reported to occur widely in the Lower Ordovician of the Baltic region, and not on the type species. Pander's figures are diagrammatic and subject to interpretation. Unless his collection is located, this concept will remain the operational basis for *Scolopodus*. Likely many of the species that have been assigned to the genus, e.g., *S. quadraplicatus* Branson and Mehl, ultimately will be reassigned to other genera as their apparatuses are established.

SCOLOPODUS CORNUTIFORMIS Branson & Mehl
Pl 11, figs. 13, 14

Scolopodus cornutiformis BRANSON & MEHL, 1933, p. 62, Pl. 4, fig. 23.
non Scolopodus cornutiformis Branson & Mehl. ETHINGTON & CLARK, 1964, p. 698–699, Pl. 114, figs. 16, 23; ETHINGTON & CLARK, 1965, p. 200, Pl. 1, figs. 10, 12; BARNES & TUKE, 1970, p. 91, Pl. 18, figs. 1, 4, text-fig. 6B; ETHINGTON & CLARK, 1971, p. 76, Pl. 2, figs. 21, 22; LEE, 1976, p. 172, Pl. 2, fig. 18, text-fig. 3I.
? *Scolopodus cornutiformis* Branson & Mehl. MOUND, 1968, p. 418, Pl. 5, figs. 66, 67, 69, 70 (*non* figs. 14, 15, 17–19, 22–24, 26, 27, 32).

Remarks.—The few specimens treated here include nearly symmetrical and scandodiform elements with strong linear costae that begin somewhat above the basal margin and continue orally. The costae are strongest toward the base and attenuate distally, some disappearing at about midlength, whereas others continue toward the distal reaches of the cusp. Costae are not present anteriorly, but they are rather uniformly distributed elsewhere. Faint secondary costae are present basally between some of the primary costae.

We compared our limited collection with the type specimen of *S. cornutiformis* and found no significant differences. The costae are somewhat more prominent on our material, and the type specimen does not show secondary costae. Further, the type is compressed laterally whereas our symmetrical elements have nearly circular sections. Undescribed collections from the Jefferson City Dolomite (Stan Fagerlin personal communication) contain numerous specimens of *S. cornutiformis* which show that elements of this species are variable in section and include forms such as those we report here. Asymmetrical elements are present in these collections also, so that the apparatus is in agreement with that reconstructed for *Scolopodus* by Lindström (1971). The specimens are hyaline throughout and thus conform to his redefinition of *Scolopodus.*

Occurrence.—This species has been reported from numerous localities in North America over the past decade. Restudy of the specimens from those places shows that they properly belong in *Oneotodus* or represent *Scolopodus* aff. *S. rex* Lindström. The only published report of specimens that can be identified with this species without question is the original discussion of Branson and Mehl in their paper on the Jefferson City Dolomite of Missouri. Specimens from the upper Cool Creek Formation of Oklahoma that Mound (1968) identified under this name may belong here, but the forms from the McKenzie Hill Formation that he placed here certainly do not represent this species. Brand (1976) found this species to be present, although rare, in the lower Kindblade Formation of Oklahoma.

Range in the Pogonip.—Lowermost Fillmore, Section C at 1.5, 3, and 5 m (5, 10, and 17 ft).

Number of specimens.—Symmetrical elements, 8; asymmetrical element, 1.

Repository.—Figured specimens UMC 1108–8, 9.

"SCOLOPODUS" EMARGINATUS Barnes & Tuke
Pl. 11, figs. 15, 16

Paltodus n. sp. MEHL & RYAN, 1944, p. 52, Pl. 7, figs. 17, 18.
Scolopodus emarginatus BARNES & TUKE, 1970, p. 91–92, Pl. 18, figs. 2, 6–8, text-fig. 6C.

Remarks.—Barnes and Tuke (1970, p. 91) indicated in their diagnosis that this species is characterized by smooth faces. Subsequently (p. 92), they stated that they had reservations about the generic assignment because the forms available to them "cannot be termed multicostate." The few specimens that we assign to this species show low, thin, widely spaced costae on the lateral faces; the costae are clearly defined at the basal margin and become increasingly subdued higher on the cusp. General agreement with the type collection exists for other important features, including degree of asymmetry and the presence of broad but shallow troughs on the lateral surfaces.

We examined the holotype and paratypes of "*S.*" *emarginatus* through the courtesy of Dr. T. E. Bolton of the Geological Survey of Canada and agree with Barnes and Tuke that no costae are present on these specimens. They do, however, show numerous faint longitudinal striae on their surfaces which thus are not absolutely smooth. Similar striae, and in some cases weak costae, are present on specimens from the Arbuckle Group of southern Oklahoma reported by Potter (1975) and Brand (1976) that otherwise conform to the general morphology of "*S.*" *emarginatus.* The specimen from the Jefferson City Formation of central Missouri figured by Mehl and Ryan (1944) has faint costae near the base, but the distal reaches of the cusp are quite smooth. Thus far no large collections of "*S.*" *emarginatus* have been described, so that adequate evaluation of variation in surface ornament cannot be made. Our experience with other scolopodiform elements (e.g., "*S.*" *gracilis* Ethington and Clark) has shown considerable variation in the development of surface features similar to that discussed here. This supports assignment of specimens from the Pogonip with distinct costae to "*S.*" *emarginatus* as one extreme in range of variants which also includes relatively smooth elements like the type collection.

Occurrence.—Barnes and Tuke described the species from the St. George Formation of northern Newfoundland. It also occure in the Jefferson City Formation of Missouri (Mehl and Ryan 1944, Moore 1970) and in the Kindblade and West Spring Creek Formations of southern Oklahoma (Brand 1976, Potter 1975). John Repetski (1975) found "*S.*" *emarginatus* in the upper 152 m (500 ft) of the El Paso sequence of the Franklin Mountains, west Texas.

Range in the Pogonip.—This species was recovered from several scattered samples from the middle and upper Fillmore Formation in Section H (79, 138, 265 m [260, 452, 870 ft]), at the top of Section C (960), and in the ST section (79, 84, 95, 116, 125 m [260, 275, 310, 381, 410 ft]). One specimen was found in the lower Wah Wah at Section J.

Number of specimens.—14.

Repository.—Figured specimens UMC 1108–10, 11.

"SCOLOPODUS" FILOSUS Ethington & Clark
Pl. 11, fig. 22

Scolopodus filosus ETHINGTON & CLARK, 1964, p. 699, Pl. 114, figs. 12, 17, 18, 19, text-fig. 2E; ETHINGTON & CLARK, 1964, p. 200; FÅHRAEUS & NOWLAN, 1978, p. 468, Pl. 1, figs. 16, 17.

non Scolopodus filosus Ethington & Clark. MOUND, 1965b, p. 34, Pl. 4, figs. 27, 32.

? *Scolopodus filosus* Ethington & Clark. MOUND, 1968, p. 418, Pl. 5, figs. 16, 20, 25, 28, 33, 39, 45, 46, 59; JONES, 1971, p. 63, Pl. 5, figs. 9a–c, 10a–c, Pl. 6, figs. 1a–c.

Remarks.—A few specimens scattered among the Fillmore conodonts have cusps with subcircular sections and striate faces and thereby generally conform to the definition of *"S." filosus,* a form-species that we earlier (1964) described from the El Paso Group.

The specimens listed here, as well as those recognized elsewhere, may be elements of the apparatus of *"S." gracilis* that are distinct in lacking longitudinal grooves. All of the known occurrences of *"S." filosus* are in faunas that also contain that species. If this interpretation is correct, these elements are infrequently occurring morphologic variants because they have not been recognized as widely as the other elements of the postulated apparatus and because they occur in such small numbers in our collections from the Pogonip in contrast to the much greater abundance of the graciliform and triangulariform elements.

The fine, longitudinal striae are suggestive of elements of *Scalpellodus* Dzik *sensu* Löfgren (1978). She interpreted the apparatus of that genus as comprised of scandodiform and drepanodiform elements, and *"S." filosus* does not fit either category.

Occurrence.—The form-species occurs in the El Paso Group in west Texas (Ethington and Clark 1964) and in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965). Fåhraeus and Nowlan (1978) found it in the Cow Head Group of western Newfoundland. Reported occurrences in the Arbuckle Group of Oklahoma (Mound 1968) and in the Pander Greensand of Australia (Jones 1971) need verification.

Range in the Pogonip.—We found these elements to occur sporadically in the C, H, and ST Sections in the Fillmore Formation. Lowest occurrence was 14 m (45 ft) above the base of the formation, and the highest at about 55 m (180 ft) beneath the top. Only one specimen was present in most of the samples in which we found it.

Number of specimens.—23.

Repository.—Figured specimen UMC 1108–12.

? "SCOLOPODUS" aff. "S." FILOSUS Ethington & Clark
Pl. 11, figs. 23, 25, 29

Remarks.—The specimens listed here are characterized by numerous, closely spaced striae that cover their entire surfaces. Two morphologies are represented. One type has a long, slender cusp with nearly circular section; the element is straight through the greater part of its length but has its distal extremity strongly reclined so that it is almost normal to the lower reaches. Basal cavity is deep. The other morphotype is a squat element with a short, nearly recumbent cusp. These specimens are compressed laterally so that a transverse section is ovate; basal cavity is shallow.

We did not find the two morphotypes described above in the same sample, but they occur within a limited stratigraphic interval. They are combined here primarily because of the strong similarity of the striae. The surfaces of these elements resemble *"S." filosus,* but that species does not show the diversity of morphology we report here. The type specimens of *"S." filosus* are wholly hyaline, whereas the distal reaches of the elements described above contain at least some albid material. The resemblance to *"S." filosus* may be superficial; we found so few specimens of this type that we cannot make a thorough interpretation of them.

Range in the Pogonip.—Fillmore Formation, Section H (64 through 110 m [210 through 360 ft]).

Number of specimens.—Slender element, 4; squat element, 6.

Repository.—Figured specimens UMC 1108–13–15.

"SCOLOPODUS" GRACILIS Ethington & Clark
P. 11, figs. 27, 28

Drepanodus striatus GRAVES & ELLISON, 1941, p. 11, Pl. 1, figs. 3, 12.

Scolopodus gracilis ETHINGTON & CLARK, 1964, p. 699, Pl. 115, figs. 2–4, 8, 9; ETHINGTON & CLARK, 1965, p. 200; BARNES & TUKE, 1970, p. 92, Pl. 18, figs. 11, 12, text-fig. 6E; UYENO & BARNES, 1970, p. 116, Pl. 22, figs. 9, 10; ETHINGTON & CLARK, 1971, p. 76, Pl. 2, figs. 3, 9; BARNES & POPLAWSKI, 1973, p. 786–787, Pl .3, figs. 6, 6a, 7, 7a, 8, 8a, text-figs. 2G, H; BARNES, 1974, p. 227, 228, Pl. 1, fig. 2; SUHM & ETHINGTON, 1975, p. 1131, 1132; BARNES, 1977, p. 99, Pl. 1, figs. 14, 15; WORKUM, BOLTON & BARNES, 1976, p. 116, Pl. 4, fig. 6; REPETSKI & ETHINGTON, 1977, p. 96; FÅHRAEUS & NOWLAN, 1978, p. 468, Pl 1, figs. 10, 11.

Scolopodus triangularis ETHINGTON & CLARK, 1964, p. 700, Pl. 115, figs. 6, 11, 13, 17, text-fig. 21; ETHINGTON & CLARK, 1965, p. 201; ABAIMOVA, 1975, p. 104–105, Pl. 9, fig. 16; REPETSKI & ETHINGTON, 1977, p. 96.

Scolopodus filosus Ethington & Clark. MOUND, 1965b, p. 34, Pl. 4, figs. 27, 32.

Scolopodus quadraplicatus Branson & Mehl. MOUND, 1965b, p. 34, Pl. 4, figs. 26, 30.

Scolopodus striolatus HARRIS & HARRIS, 1965, p. 38–39, Pl. 1, figs. 6a–c.

? *Scolopodus gracilis* Ethington & Clark. MOUND, 1968, p. 418, Pl. 5, figs. 29–31, 34–38, 40, 42–44, 52–53.

? *Scolopodus triangularis* Ethington & Clark. MOUND, 1968, p. 420, Pl. 6, figs. 30–38, 40.

Scolopodus cf. *S. quadraplicatus* Branson & Mehl. BRADSHAW, 1969, p. 1163, Pl. 132, figs. 8, 9.

non Scolopodus gracilis Ethington & Clark. DRUCE & JONES, 1971, p. 92, Pl. 17, figs. 5a–7d, Pl. 18, figs. 5a–d, text-fig. 30C; JONES, 1971, p. 63–64, Pl. 6, figs. 2a–c.

Scolopodus? aff. gracilis Ethington & Clark. LÖFGREN, 1978, p. 110, Pl. 8, figs. 10A, B.

? *"Scolopodus"* sp. BERGSTRÖM, 1979, p. 302–303, figs. 4B, D.

Remarks.—The holotype and paratype of *Drepanodus striatus* Graves and Ellison both have subcircular transverse section modified by a deep posterior groove. Bases are not expanded and are excavated by deep conical cavities. These features preclude retention in *Drepanodus* Pander; they correspond entirely with the morphology of *"Scolopodus" gracilis* as defined by Ethington and Clark (1964). Although the specific name of Graves and Ellison has 23 years priority over that of Ethington and Clark, it is preoccupied by *Scolopodus striatus* Pander, 1856. Accordingly, the only available name for the species is *"S." gracilis,* so long as it is retained in *Scolopodus;* if, as seems certain, it is reassigned to another genus the specific name *striatus* will have priority.

Barnes and Poplawski (1973) concluded that *"S." gracilis* and *"S." triangularis* Ethington and Clark represent two elements of an apparatus that they identified under the former name. Elements of these two types have essentially identical ranges in the Pogonip, and therefore we accept this interpretation. They also observed that their specimens were characterized by fine longitudinal striae, a feature not included in the diagnosis of the species. Striae also are present on specimens from the Joins Formation of Oklahoma (Mound 1965b) and are characteristic of the material in our Pogonip collections. We restudied the types of both *"S." gracilis* and *"S." triangularis* but could not detect striae on their surfaces. However, these specimens show considerable frosting or pitting of their surfaces, as do most conodonts from the El Paso Group, so that the striae likely would be obliterated or obscured if they were present originally.

Löfgren (1978) found a few specimens among her large collection of Arenigian and Llanvirnian conodonts from central Sweden that have the general conformation of the graciliform element of *"S." gracilis.* She concluded that these specimens probably do not belong there, however, because she did not find associated triangulariform elements. Her illustrations are of specimens that are virtually identical to most of those in our collections, and we do not hesitate to include the material from Sweden in *"S." gracilis.* Almost all of Löfgren's specimens came from one sample; if further collections from Sweden affirm the absence there of triangulariform elements, the co-occurrence of these elements in a common apparatus with graciliform elements will be placed in doubt.

The graciliform elements from the Pogonip generally appear to be hyaline throughout, whereas some of the triangulariform elements are cloudy above the basal region, suggesting the presence of albid material in the cusp. The latter may be an artifact of thermal alteration, however. Presence of albid material as a fundamental character would not be in agreement with Lindström's (1971) emended definition of *Scolopodus* which he based on *S. rex,* whose elements are hyaline throughout. The apparatus of *S. rex* and that of *S. cornutiformis* Branson and Mehl contain two kinds of elements, one relatively symmetrical and the other markedly asymmetrical. By contrast, both kinds of elements that have been included in the apparatus of *"S." gracilis* are essentially bilaterally symmetrical, so that homology with the elements of *S. rex* is not demonstrated clearly. We are not willing to propose a new generic name until the relationships and apparatuses of Lower Ordovicion cones are clearer than is the case at this time, but we believe that ultimatedy *"S." gracilis* will be removed from *Scolopodus.*

Occurrence.—Except for the report of its occurrence in Sweden (Löfgren 1978), Norway (Bergström 1979), and Siberia (Abaimova 1975), this species is restricted to North America. The conodonts from Australia identified under this name by Jones and Druce (1971) and by Jones (1971) do not belong in *"S." gracilis.* The species is very widespread in North America. It is known to occur in the Marathon and Ft. Peña Formations (Graves and Ellison 1941, Bradshaw 1969) of the Marathon Basin and in the El Paso Group (Repetski 1975, and in press) and Simpson Group equivalents (Suhm and Ethington 1975), all in western Texas. It has been found in the West Spring Creek and Joins Formation of southern Oklahoma (Harris and Harris 1965, Mound 1965b, Potter 1975) and in the "Lukfata Formation" of the western Ouachita Mountains (Repetski and Ethington 1977). The species also may be present in the Cool Creek Formation of Oklahoma as well (Mound 1968). Ethington and Clark (1965) recorded its presence in the Ordovician of the Rocky Mountains of Canada, and it has been found in the St. George, Cowhead, Mystic, and Lévis Formations of eastern Canada (Barnes and Tuke 1970, Fåhraeus and Nowlan 1978, Barnes and Poplawski 1973, Uyeno and Barnes 1970); Barnes (1974, 1977) has reported it from the Ordovician of the Canadian Arctic.

Range in the Pogonip.—This is one of the longest ranging forms in the Pogonip Group. It is present in the Fillmore, beginning 61 m (200 ft) above the base in section C, and continues upward through the Wah, Wah, Juab, and Kanosh Formations. A few specimens were recovered from the Lehman at Crystal Peak, and a specimen resembling a triangulariform element was found in the Crystal Peak Dolomite at the same locality.

Number of specimens.—Graciliform element, 311; triangulariform element, 213.

Repository.—Figured graciliform element UMC 1108–16; unfigured graciliform element UMC 1108–17; figured triangulariform element UMC 1108–18.

SCOLOPODUS MULTICOSTATUS Barnes & Tuke
Pl. 11, figs. 19, 20

Scolopodus n. sp. MEHL & RYAN, 1944, Pl. 6, figs. 27–30.
Scolopodus multicostatus BARNES & TUKE, 1970, p. 92–93, Pl. 18, figs. 5, 9, 15, 16, text-fig. 6D.

Remarks.—We compared our specimens with the type material of Barnes and Tuke and found general agreement. Our collection is of such small numbers that we cannot expand upon their description except to note that strongly asymmetrical (paltodiform) elements are present as well as those with more nearly circular transverse sections. This indicates that this species has the same elemental association as *S. rex* and *S. cornutiformis,* to which it may be closely related. It differs from these two species in that the costae are more numerous but not so strongly developed.

Occurrence.—The species is present in the St. George Formation of northern Newfoundland (Barnes and Tuke 1970) and in the Jefferson City Formation of central Missouri (Mehl and Rryan 1944).

Range in the Pogonip.—Middle Fillmore (Zone G_2) in Sections C (268 through 294 m [880 through 965 ft] and H (81 through 122 m [266 through 400 ft]).

Number of specimens.—17.

Repository.—Figured specimens UMC 1108–19, 20; unfigured specimens UMC 1109–1, 2.

SCOLOPODUS PARACORNUFORMIS n. sp
Pl. 11, fig. 21; fig. 25

Depressed hyaline elements whose anterior faces are broad and gently convex to straight transversely. The posterior view is dominated by a rounded, median ridge that is flanked by lateral shoulders, each of which is about one-third the width of the median ridge at any level along the cusp. Shoulders continue to the base of the element, although they become quite subdued at the aboral extremity and are not expressed in the basal outline. The surfaces of the shoulders slope somewhat toward the median ridge, so that they define shallow troughs whose greatest depth is proximal to the ridge. The cusp is gently recurved as seen in lateral view. The posterior surface displays numerous narrow, closely spaced striae that begin near the base and continue orally to the tip of the cusp. Striae can be observed on the blunt lateral edges where the posterior shoulders merge with the anterior face; anterior surface seems to be nonstriate. Base is moderately swollen posteriorly. Basal cavity was not observed owing to moderate thermal alteration.

Remarks.—Dzik (1976, Pl. 41, figs. 4, 7, text-figs. 13g–1, t, u) and Löfgren (1978, p. 105–107, Pl. 7, figs. 1–6, 9–12, Pl. 8, figs. 1, 2, 4–6) revised the definition of *Scolopodus cornuformis* Sergeeva to include a symmetry series of striate cones. The specimens described above are similar in transverse section to the "cornuform elements" in the terminology of Löfgren; they are not associated in the Pogonip with the variety of "scandodontiform elements" that she considered part of the apparatus of *S. cornuformis.* Although Löfgren noted considerable variation among the cornuform elements, she did not describe or illustrate any variants that are depressed in the anterior-posterior dimension. Our specimens are much less strongly recurved than are the types illustrated by Sergeeva (1963) or the elements figured by Dzik. Löfgren mentioned considerable variation in this character in the collections she described from Sweden; our material is closest to the specimens from late Arenigian strata that she described as *S. cornuformis* but is quite distinct from the Llanvirnian forms that she included under that name.

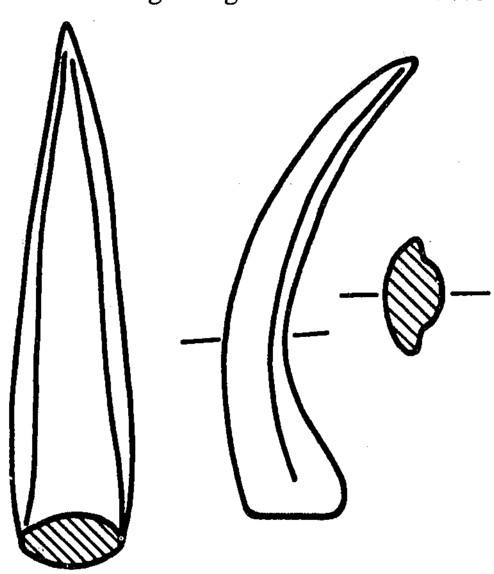

Figure 25.—Posterior and lateral views of *Scolopodus paracornuformis* n. sp.

Löfgren did not discuss the distribution of the striae on the surface of *S. cornuformis,* but one of her illustrations (Pl. 1, fig. 1A, B) suggests that the anterior face is smooth in that species except for narrow regions along the periphery to either side. In this respect the cornuform elements of *S. cornuformis* are very similar to our specimens from the Pogonip. According to Löfgren, specimens of *S. cornuformis* from Öland are opaque, and those she obtained from Jämtland are "of a darker colour than non-hyaline elements in general." Although altered thermally, all of our specimens unquestionably are hyaline throughout.

We have seen this element in our collections from youngest Canadian strata and believe it will prove to be widespread in rocks of that age in North America. In none of these occurrences did we observe the other elements of the reported apparatus of *S. cornuformis,* so that we believe a new specific name is justified.

Derivation of new name.—*Para* (near to) plus *cornuformis,* to recognize the general similarity of these elements to the cornuform element of *Scolopodus cornuformis.*

Range in the Pogonip.—This species ranges throughout almost the entire Wah Wah Formation at Section J; we found it to be rare in the interval from upper Wah Wah through basal Kanosh at Fossil Mountain.

Number of specimens.—13.

Repository.—Figured holotype UMC 1109–3; unfigured paratype UMC 1109–4.

"SCOLOPODUS" PESELEPHANTIS Lindström
Pl. 11, fig. 26

Scolopodus peselephantis LINDSTRÖM, 1955, p. 595, Pl. 2, figs. 19, 20, text-fig. 3Q; VAN WAMEL, 1974, p. 95, Pl. 8, figs. 20–24; VIIRA, 1974, p. 124, text-fig. 162.
? *Scolopodus peselephantis* Lindström. VIIRA, 1967, text-fig. 1(22).

Remarks.—We have compared our specimen with an abundant collection of *"S." peselephantis* from Horns Udde on the island of Öland. The latter show that this species is much more variable than was indicated by Lindström in his description of the types. Variation occurs particularly in the cross section of the cusp which ranges from compressed and bladelike to ovate among the several specimens and in the development of posterolateral grooves to each side of the cusp. Some specimens are strongly recurved near the base; others are nearly straight. In all cases the cusp is constructed wholly of white matter whereas the invariably shallow basal region is hyaline. Our specimen is strongly recurved and has clearly developed posterolateral grooves; it is virtually identical to specimens in our collection from the Baltic.

Occurrence.—Lindström (1955) and van Wamel

(1974) recorded the occurrence of this species in the Lower Ordovician of southern Sweden and of Öland, respectively. Sergeeva (1974) has reported its presence in the *Prioniodus evae* Zone of the Leningrad region, and Viira (1974, p. 124) reported its occurrence in Tremadocian through Caradocian strata of the eastern Baltic region.

Range in the Pogonip.—This species was found only in one sample collected in the Fillmore Formation at 244 m (800 ft) in Section H.

Number of specimens.—1.

Repository.—Figured specimen UMC 1109–5.

"SCOLOPODUS" QUADRAPLICATUS Branson & Mehl
Pl. 11, figs. 24, 30

Scolopodus quadraplicatus BRANSON & MEHL, 1933, p. 63, Pl. 4, figs. 14, 15; FURNISH, 1938, p. 332, Pl. 41, figs. 1–12; MEHL & RYAN, 1944, Pl. 6, figs. 31–37; SANDO, 1958, p. 849, Pl. 2, fig. 21; ETHINGTON & CLARK, 1964, p. 699–700, Pl. 115, figs. 12, 25; LINDSTRÖM, 1964, p. 32, text-fig. 10F; ETHINGTON & CLARK, 1965, p. 201; MERRILL, 1965, p. 394, Pl. 1, figs. 4, 5; LOCHMAN, 1966, p. 535, Pl. 65, fig. 22; MOSKALENKO, 1967, p. 114–115, Pl. 25, figs. 3–5, text-fig. 16; BARNES & TUKE, 1970, p. 93, Pl. 18, figs. 13, 14, 17, text-fig. 6F; CLARK & MILLER, 1971, p. 14; ETHINGTON & CLARK, 1971, p. 73, Pl. 2, fig. 5; ABAIMOVA, 1975, p. 103, Pl. 9, fig. 11, 14; REPETSKI & ETHINGTON, 1977, p. 97, Pl. 2, fig. 15.

Scolopodus quadriplicatus [sic] Branson & Mehl. GRAVES & ELLISON, 1941, p. 4, Pl. 1, fig. 10; GREGGS & BOND, 1971, p. 1468–1469, Pl. 2, figs. 3–6.

Scolopodus quadruplicatus [sic] Branson & Mehl. BRANSON & MEHL, 1944, p. 240, Pl. 93, figs. 38, 39.

Scolopodus triplicatus ETHINGTON & CLARK, 1964, p. 700–701, Pl. 115, figs. 20, 22–24, ETHINGTON & CLARK, 1965, p. 201; MOUND, 1968, p. 420, Pl. 6, figs. 39, 41–60, 63–65; GREGGS & BOND, 1971, p. 1469, Pl. 2, figs. 7–9.

non Scolopodus quadraplicatus Branson & Mehl. MOUND, 1965b, p. 34, Pl. 4, figs. 26, 30; FÅHRAEUS & NOWLAN, 1978, p. 468, Pl. 1, figs. 28, 30.

non Scolopodus quadraplicatus hemisphaericus MOUND, 1968, p. 418–419, Pl. 5, figs. 41, 47, 50, 51, 58.

Scolopodus quadraplicatus quadraplicatus Branson & Mehl. MOUND, 1968, p. 419, Pl. 5, figs. 48, 49, 54–57, 60–65, 68, Pl. 6, figs. 1–12, 15, 16, 76, 77.

non Scolopodus quadraplicatus Branson & Mehl. DRUCE & JONES, 1971, p. 93–94, Pl. 18, figs. 6, 7, text-fig. 30f; JONES, 1971, p. 65, Pl. 6, fig. 6.

non Scolopodus triplicatus Ethington & Clark. DRUCE & JONES, 1971, p. 96, Pl. 18, figs. 1–4, text-fig. 30i, j; JONES, 1971, p. 68, Pl. 7, figs. 1–3, Pl. 9, fig. 7.

? *Scolopodus quadraplicatus* Branson & Mehl. MOSKALENKO, 1972, Table, fig. 31.

non Scolopodus quadriplicatus [sic] Branson & Mehl. JAKOVLEV, 1973, p. 218, text-fig. 38(17).

Scolopodus aff. *S. quadraplicatus* Branson & Mehl. BARNES & POPLAWSKI, 1973, p. 787, Pl. 1, fig. 11.

? *Scolopodus* aff. *S. quadraplicatus* Branson & Mehl. COOPER & DRUCE, 1975, p. 578, fig. 25.

? *Scolopodus nogamii* Lee. LEE, 1975, p. 89, Pl. 2, figs. 11, 14.

Remarks.—The specimens included here are quite variable in the cross sections of their cusps and in their basal regions. All possess a distinct posterior groove and at least one well-defined lateral groove. The opposite lateral surface may display a distinct groove also, in which case the transverse section shows the four rounded ridges at the anterolateral and posterolateral positions for which the species was named. Many specimens, however, show only a faint groove to one side, and some have no trace of a groove on one face. We described (1964) such forms as *Scolopodus triplicatus* based on a study of a modest collection from the El Paso Group in which we contrasted this morphology with that of the type specimens of *S. quadraplicatus*. The much greater number of specimens available to us here, as well as those in undescribed collections from the El Paso and Arbuckle Groups, demonstrates that this is an artificial and excessively restrictive distinction. A continuous range in morphology exists between the quadricostate and tricostate morphology. In addition to the variation in cross sections of the cusps, the specimens also vary in degree of inflation of their bases and in the amount of torsion of the cusps. Some specimens show fine, longitudinal striae, but this feature is not correlated with any other morphologic character. Certainly this spectrum of morphologies must represent elements from a common apparatus, and only one name is warranted.

"Scolopodus" quadraplicatus is comprised of hyaline elements, and in this respect conforms to Lindström's (1971) emended diagnosis of *Scolopodus* Pander. It includes essentially symmetrical (quadricostate) and asymmetrical (tricostate) elements, as does *S. rex* Lindström on which the revised generic definition is based. We are unsure whether these elements constitute the entire apparatus of *"S." quadraplicatus,* however. If the elements traditionally identified in form-taxonomy as *Drepanodus subarcuatus* Furnish, which are almost invariable associates of *"S." quadraplicatus,* also belong in the apparatus, the species will not fit the generic definition, and a new genus will be necessary.

Occurrence.—*"S." quadraplicatus* is an almost universal component of middle and late Canadian conodont faunas in the Midcontinent Faunal Province. Branson and Mehl (1933) found it in the "Jefferson City" beds of Missouri, and Furnish (1938) reported its presence in the Prairie du Chien of the upper Mississippi Valley. It occurs in the El Paso Group (Ethington and Clark 1964; Repetski 1975, and in press) and Marathon Limestone (Graves and Ellison 1941) of west Texas, in the Kindblade and West Spring Creek Formations of Oklahoma (Mound 1968, Brand 1075), and in the Mazarn Shale of Arkansas (Repetski and Ethington 1977). Sando (1958) found it in the Rockdale Run Formation of southern Pennsylvania. We (1965) found the species at the Columbia Ice Fields Section in Alberta, and Barnes and Tuke (1970) recovered it from the St. George Formation of western Newfoundland. The only unquestionable reports of *"S." quadraplicatus* from outside North America are those of Moskalenko (1967) and of Abaimova (1975), who found this species in faunas from the Siberian Platform that are dominated by conodonts of Midcontinent aspect. The forms from Australia reported under this name by Druce and Jones (1971) and by Jones (1971) do not belong here. Some of the specimens from the Dumogol Limestone of South Korea that Lee (1975) identified as *Scolopodus nogamii* may represent *"S." quadraplicatus.*

Range in the Pogonip.—This species ranges throughout almost the entire Fillmore Formation. Lowest certain occurrence is at 23 m (75 ft) in Section C; the samples taken lower in the formation did not yield well-preserved conodonts, so that the lower limit of the range could be even nearer the base of the unit. The species is a component of the conodont population at many levels in the Fillmore, but at most of them it is not a dominant element. Many samples did not yield this species. The highest specimens were collected about 3 m (10 ft) above the base of the Wah Wah Formation at Section J.

Number of specimens.—451.

Repository.—Figured specimens UMC 1109–6, 7.

aff. SCOLOPODUS REX Lindström
Pl. 12, figs. 1, 2

aff. *Scolopodus rex* LINDSTRÖM, 1955, p. 595–596, Pl. 3, fig. 32.
aff. *Scolopodus rex* var. *paltodiformis* LINDSTRÖM, 1955, p. 596, Pl. 3, figs. 33, 34.
? *Paltodus inconstans* Lindström. ETHINGTON & CLARK, 1964, p. 695, Pl. 114, fig. 15.
Scolopodus cornutiformis Branson & Mehl. ETHINGTON & CLARK, 1955, p. 200, Pl. 1, fig. 1; ETHINGTON & CLARK, 1971, p. 73, Pl. 2, figs. 21, 22.
Scolopodus rex Lindström. SEDDON, 1970, p. 8, 16, 41, Pl. 1, figs. 12, 13; LEE, 1970, p. 334, Pl. 8, figs. 8, 9; ETHINGTON, 1972, p. 22, Pl. 1, fig. 17; BERGSTRÖM, EPSTEIN & EPSTEIN, 1972, fig. 1b; SERPAGLI, 1974, p. 86–87, Pl. 17, figs. 1a–3b, Pl. 28, fig. 10; ABAIMOVA, 1975, p. 104, Pl. 9, figs. 15, 21 (? figs. 17, 19, 20; *non* fig. 12); LEE, 1975, p. 89, Pl. 2, fig. 13.
Scolopodus rex paltodiformis Lindström. ETHINGTON, 1972, p. 22, Pl. 1, fig. 18.
? *Scolopodus* aff. *S. cornutiformis* Branson & Mehl. BARNES & POPLAWSKI, 1973, p. 786, Pl. 1, figs. 9, 10.
Scolopodus sp. ABAIMOVA, 1975, p. 106–107, Pl. 9, figs. 13, 18.
Scolopodus cf. *S. cornutiformis* Branson & Mehl *sensu* Ethington & Clark. TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 2, figs. 14, 16.

Scolopodiform elements have circular to ellipsoidal cross sections, and are broadly recurved at about one-third the length above the base with the distal portion and the basal region subtending an angle of about 130°. The most prominent characteristic is sharp-edged costae that extend the entire length of the element. Costae have posterior face that is normal to the surface near the basal margin and on the distal portion of the cusp. In the region of curvature the posterior face of the costa slopes anteriorly so that the edge overhangs in the posterior direction. Costae are highest in the region of curvature and decline in strength both basally and distally from this position. Anterior face of each costa slopes gently to base of next forward costa except in the basal region. There the costae are more subdued than higher, and they are separated by flat intercostal areas. A low costa is present along the front face of the element with smoothly rounded areas to either side; a more prominent costa occupies the corresponding posterior position but does not have similar flanking areas. Base is somewhat expanded in the posterior direction but is not flared laterally.

Paltodiform elements are strongly recurved, asymmetrical; cusp with lenticular cross section, base is circular in outline. Base turned to one side so that basal cavity is directed laterally from plane of cusp. Basal region low, representing only one-fifth of length of element. Element recurved above base with cusp subtending an angle of slightly more than 90° with axis of base. Narrow costae originate at or just above the basal margin and continue orally for varying distances. Costae on the outer surface and the posterior two-thirds of the inner face generally are confined to the basal region with the cusp smooth in these areas. Occasional specimens show a few longer costae on the outer face. By contrast a costa in a forward anterolateral position extends the entire length of the preserved portion of all specimens in our collection. Unfortunately, all have lost the tip of the cusp, and we cannot confirm that this costa reaches to the distal extremity. The next posterior costa rivals this principal costa in height in the basal region but dies out on the higher part of the cusp. These two costae and one or two shorter ones immediately posterior to them are more prominent than any of the others on the larger (more mature?) specimens in our collections; on the smaller and more slender individuals (juveniles?) only the two anterolateral costae are developed, and the elements have smooth surfaces at all other positions.

Remarks.—We have compared these specimens directly with collections from the Baltic region that contain *Scolopodus rex* Lindström. In the specimens of *S. rex* examined by us, the number of costae seems to be less, and their height is lower than in the forms from the Pogonip. None shows the overhanging edges of costae that we report here. Further, short costae that are confined to the basal region are intercalated between the main costae in *S. rex,* whereas our material shows only one order of costae. None of the specimens of *S. rex* shows an anterior costa; instead, all of them have a smoothly rounded anterior face as reported by Lindström (1955). The paltodiform elements of *S. rex* are less strongly recurved than are the corresponding elements from the Fillmore, and the base is less strongly inflated in the former. None of the paltodiform elements in the collections from Sweden show costae on the outer face, and the costae on the inner face generally extend higher on the cusp than is characteristic of the Fillmore material.

Scolopodus rex consists of hyaline elements with traces of white matter along the growth axis. Our specimens from the Pogonip have been altered, presumably thermally, and are gray to black and opaque. We cannot establish to what extent white matter was present prior to alteration, nor can we determine the configuration of the basal cavity. Nevertheless, general form is quite similar to *S. rex,* although significant differences exist in morphology as noted above. Perhaps two species are represented, but a thorough evaluation of variation within *S. rex* is needed before erection of a new species can be defended.

Occurrence.—This form is present in the El Paso Formation in the Franklin Mountains (Ethington and Clark 1964), where it occurs in the interval from 30 to 274 m (100 to 900 ft) above the base of the unit (Repetski 1975). It also occurs in the Ordovician sequence of the Rocky Mountains of Alberta (Ethington and Clark 1965) and probably in the Lower Ordovician collection that Barnes and Poplawski (1973) recovered from the Mystic Conglomerate of Quebec. Bergström and others (1972) found it in the Hamburg Klippe in Pennsylvania, and Ethington (1972) recorded its occurrence in the Ninemile Formation of central Nevada. Serpagli (1974) reported similar forms from the San Juan Formation of Argentina. Lee (1970, 1975) recovered similar material from the Lower Ordovician of Korea, and Abaimova (1975) found comparable forms in the Lower Ordovician rocks along the Lena River in Siberia. Most recently, Tipnis and others (1978) illustrated this species from the Broken Skull Formation of the southern District of Mackenzie, Canada.

Range in the Pogonip.—This species has a long range in the Fillmore, beginning 30 m (100 ft) above the base of Section C and continuing to the top of that section. It also is present throughout all but the upper 15 m (50 ft) of the Mesa section.

Number of specimens.—Scolopodiform elements, 570; paltodiform elements, 92.

Repository.—Figured scolopodiform element UMC 1109–8; unfigured scolopodiform element UMC 1109–9; figured paltodiform element UMC 1109–10; unfigured paltodiform elements UMC 1109–11, 12.

? "SCOLOPODUS" SEXPLICATUS Jones
Pl. 12, figs. 3, 4

? *Paltodus* sp. A SANDO, 1958, Pl. 2, fig. 18.
? *Scolopodus sexplicatus* JONES, 1971, p. 65–67, Pl. 5, figs. 4a–c, 5a–c, 7a–c, 8a–c, Pl. 9, figs. 4a–c, text-figs. 16a–c.
non Paltodus sexplicatus (Jones). ABAIMOVA, 1971, p. 91–92, Pl. 8, figs. 1, 2, text-fig. 7(31, 39).

Stout, asymmetrical, heavily costate distacodontid elements whose bases are slightly expanded. Anterior and posterior edges of cusp are blunt to sharp. Cusp bent to one side toward tip; may be somewhat twisted above base. One face is dominated by a stout linear ridge that occupies the midline or is slightly ahead of it. This ridge commonly is fluted by a narrow longitudinal groove. Low secondary ridges may be present to either side of the main ridge. The opposite face bears a varying number of low costae. Basal cavity is obscured by thermal alteration of the specimens; probably it is a shallow cone.

Remarks.—The specimens that we group here are quite variable in the number of ridges on their surfaces and in the degree to which the cusp is twisted relative to the base. The simplest forms have only a major linear costa to one side and faint ridges on the opposite side; such forms do not depart far from the symmetry of *"Acodus" oneotensis,* although they are much more robust than typical specimens that we identify with that species. The more strongly costate forms are suggestive of *"Scolopodus" sexplicatus* Jones. The cross sections that Jones (1971, text-fig. 16) prepared from the type collection of that species suggest that he included there a considerable range of variation in morphology. The associated conodonts in his collection indicate an age that presumably is approximately the same as that of the upper part of the House Limestone from which our specimens were obtained.

No affinity with the conodonts from the Fillmore that we discuss here under the name *Paltodus sexplicatus* (Jones) *sensu* Abaimova can be demonstrated. Intermediate forms do not exist in the stratigraphic interval between the ranges of the two forms, and the apparatuses of the two species are not the same. A new specific name for the latter species will be necessary when sufficient specimens become available to define one.

Occurrence.—A specimen from the Upper Member of the Stonehenge Limestone of Pennsylvania (Sando 1958) appears to fall within the range of variation of the material described above. Jones's collection came from the Pander Greensand and the Jinduckin Formation of Northwestern Australia.

Range in the Pogonip.—We found this species in the upper part of the House Limestone in our initial collecting at the type section (H–H–20 through H–H–24). Larsen found it between 77 and 153 m (253 and 501 ft) in his section there, between 35.2 and 87 m (115.5 and 286 ft) in Section B of Hintze (1951), and between 74 and 114 m (242 and 374 ft) in the section in the Willden Hills.

Number of specimens.—75.

Repository.—Figured specimens UMC 1109–13, 14.

SCOLOPODUS aff. S. STRIATUS Pander
Pl. 12, figs. 5, 6

aff. *Scolopodus striatus* PANDER, 1856, p. 26, Pl. 2, fig. 8.

Remarks.—The specimens assigned here are distinct from *S.* aff. *S. rex* in having costae whose origin is well above the basal edge. The region below the costae commonly is thickened. The anterior region is smoothly rounded and lacks the median costa that characterizes the scolopodiform element of *S.* aff. *S. rex.* The costae of the scolopodiform element of *S.* aff. *S. striatus* are more closely spaced and are not as high as in *S.* aff. *S. rex.* The paltodiform element is twisted basally but is not strongly recurved as in *S.* aff. *S. rex,* and the costae on the inner face are more numerous and longer than in that species. Outer face has multiple costae.

Scolopodus striatus has not been recognized other than in the original collection. Pander's description is inadequate to define the species, and the illustrations probably are diagrammatic. Nevertheless, they suggest a basal band beneath the costae like that on the specimens considered here.

Serpagli (1974, p. 86) suggested possible affinity of *S. rex* and *S. striatus* but confessed inability to evaluate their relationship because the latter is so poorly known. *Scolopodus* aff. *S. striatus* occurs in a restricted portion of the upper Fillmore above the range in that formation of *S.* aff. *S. rex*—perhaps an indication of an ancestor-descendant relationship, but other occurrences would be required to substantiate it.

Occurrence.—Hart (1963) found specimens like those reported here in faunas from clays low in the St. Peter Formation at Marquette, Iowa.

Range in the Pogonip.—These forms occur in the Fillmore in the ST section between 40 and 80 m (130 and 260 ft) and in Section H between 180 and 200 m (590 and 660 ft).

Number of specimens.—Scolopodiform elements, 20; paltodiform elements, 15.

Repository.—Figured scolopodiform element UMC 1109–15; unfigured scolopodiform element UMC 1109–16; figured paltodiform element UMC 1109–17; unfigured paltodiform element UMC 1109–18.

"SCOLOPODUS" SULCATUS Furnish
Pl. 12, figs. 7, 8; fig. 26

Scolopodus sulcatus FURNISH, 1938, p. 334, Pl. 41, figs. 14, 15, text-fig. 1I.

Remarks.—The specimens that we identify with *S. culcatus* were compared directly with Furnish's types. They are very close in their respective cross sections and in the degree of curvature of the cusp. The basal regions are comparable. We did not observe the anterior median costa, which Furnish reported to be present in the type collection, on any of our specimens; indeed, we were unable to recognize it on the types.

Occurrence.—The only previous report of this species is in the Oneota Dolomite of Minnesota (Furnish 1938) in which it occurs sparingly.

Range in the Pogonip.—The species is rare in the House Limestone. We found it in only four samples in our collection from that formation; Larsen recovered it in the interval from 60 through 146 m (198 ft through 479 ft) at the type section of the House, between 11.7 and 87 m (38.5 ft and 286 ft) at Section B of Hintze (1951), and at 85.5 and 92.2 m (280.5 and 302.5 ft) in the Willden Hills. The few occurrences in the Fillmore are at 107, 111, and 222.5 m (345, 365, and 730 ft) in Hintze's Section C and at 154.5 and 193 m (507 and 633 ft) in the Mesa Section.

Number of specimens.—48.

Repository.—Figured specimens UMC 1109–19, 20.

? SCOLOPODUS sp.
Pl. 12, figs. 9–11

Remarks.—A small number of multicostate elements of varying symmetry from the upper Fillmore Formation may be parts of a common apparatus. Affinity is suggested by generally uniform size, similar development of the basal regions of the specimens, and particularly by similarity in the surface ornamentaion. So few specimens were found that it is not possible to evaluate mutual occurrence other than to say that all come from the same general part of the formation.

The costae typically begin somewhat above the basal margin and are clearly defined throughout the preserved length of the cusp. Costae are distributed across the entire surface on most specimens, but several have broad areas lacking costae. Intercostal troughs are broad and shallow; costae are narrow, sharp ridges. Elements swell at the base of the costae, then shrink somewhat to the basal margin. All of the specimens in the collection have been altered, presumably thermally, and are dark gray so that presence of hyaline versus albid material cannot be determined. Symmetry variants include forms with asymmetrical, subsymmetrical, and acodiform cross sections, respectively. Because the collection is so small, we cannot determine whether this is a reasonable representation of the variation in morphology.

Range in the Pogonip.—Specimens were found in the upper Fillmore at Section H (210, 216, 268, 271 m [690, 710, 880, 890 ft]) and in the ST section (26, 44, 59.4, 126.5 m [85, 145, 195, 415 ft]).

Number of specimens.—Asymmetrical elements, 4; subsymmetrical elements, 5; acodiform element, 1.

Repository.—Figured acodiform element UMC 1110–1; figured asymmetrical element UMC 1110–2; figured subsymmetrical element UMC 1110–3.

SCOLOPODIFORM A
Pl. 12, fig. 12; fig. 27

Robust simple cones having a sharp posterior costa on a cusp with ellipsoidal cross section. Basal edge subcircular in plan; does not reflect posterior costa. Surface of cusp and costa bear distinct, closely spaced striae. Striae from opposite sides converge apically toward the median plane of symmetry on the anterior face and toward the edge of the costa on the posterior. Lower portion of element, just above the basal region, is not striate. Basal cavity appears to be shallow when viewed from the aboral direction; specimens have been rendered opaque by thermal alteration so that the shape of the cavity cannot be observed in transmitted light.

Range in the Pogonip.—Forms of this type were found in an interval of 61 m (200 ft) in the Fillmore beginning 70 m (230 ft) above the base in Section C.

Number of specimens—.6.

Repository.—Figured specimen UMC 1110–4.

SCOLOPODIFORM B
Pl. 12, fig. 13; fig. 28

? *Scolopodus* n. sp. 1 SERPAGLI, 1974, p. 87, Pl. 18, figs. 8a–d, Pl. 28, fig. 11.

Stout, short cones; essentially bilaterally symmetrical. Posterior median costa separated by marked troughs from

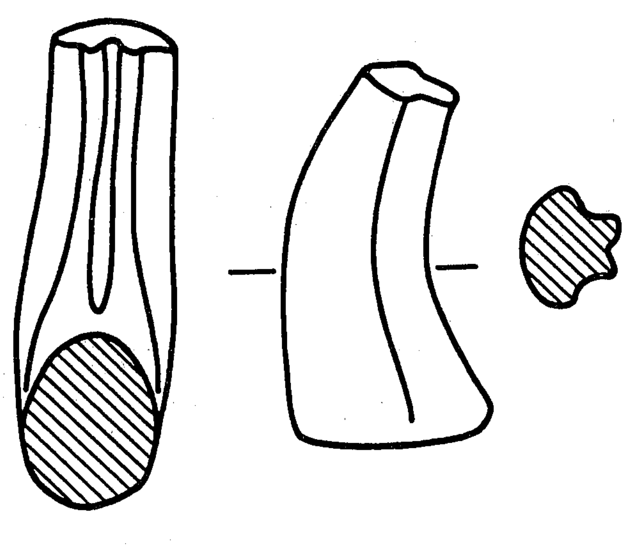

Figure 26.—Posterior and lateral views of "*Scolopodus*" *sulcatus* Furnish.

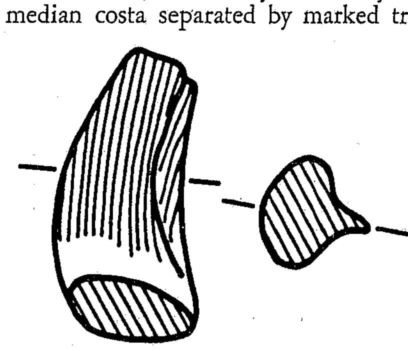

Figure 27.—Scolopodiform A.

posterolateral costae, flanked in turn by anterolateral ridges. Anterior surface broadly rounded to flattened. Costae and ridges do not reach aboral margin. Basal outline is subcircular in plan view.

Remarks.—The four specimens from the San Juan Limestone of Argentina that Serpagli (1974) reported as *Scolopodus* n. sp. 1 have transverse sections that are broadly similar to those of the specimens described above. The conodonts associated with the forms from Argentina include species that occur in the same part of the Fillmore Formation as Scolopodiform B so that similarity of age is probable. Like Serpagli, we found too few specimens to allow us to do more with them than note their presence.

Range in the Pogonip.—The specimens were found in the upper half of the Fillmore Formation at Section H (76.2 through 219.5 m [250 through 720 ft]) and the ST Section (49, 73 m [160, 240 ft]).

Number of specimens.—9.

Repository.—Figured specimen UMC 1110–5.

SCOLOPODIFORM C
Pl. 12, fig. 4; fig. 29

Acontiodus staufferi Furnish. ETHINGTON & CLARK, 1964, p. 687, Pl. 113, figs. 4, 9.

Hyaline, bilaterally symmetrical, stout, moderately curved cone. Anterior face broadly rounded. Posterior side of cusp flattened; central half of face occupied by high, swollen ridge. Median position of ridge excavated distally by a narrow slit that widens to a flaring trough in basal third of element. Basal cavity is shallow.

Range in the Pogonip.—Fillmore Formation, Section C (99, 100.5 m [325, 330 ft], Section H (168 m [510 ft]), ST Section (26 m [85 ft]).

Number of specimens.—5.

Repository.—Figured specimen UMC 1110–6.

SCOLOPODIFORM D
Pl. 12, figs. 15–17, 23; fig. 30

Hyaline, bilaterally symmetrical, moderately curved cone. Anterior face broadly rounded; posterior face flattened with heavy ridge occupying median region. A narrow slit extends along the midline of the ridge from the distal region to just below midlength. Basal cavity is shallow.

Remarks.—Three specimens from lower Wah Wah at Section J are identical in general morphology to the forms described above, but do not possess a slit on the posterior ridge. In addition the specimens from the Wah Wah show faint longitudinal striae, whereas the more numerous specimens from the Fillmore are smooth.

Range in the Pogonip.—Section C (189.3 through 294 m [621 through 965 ft]), upper half of the Mesa Section (170.4 through 327.7 m [559 through 1075 ft]), ST Section (10.7 through 77.7 m [35 through 255 ft]), and Section H (210 through 271 m [690 through 890 ft]) in the Fillmore Formation; basal Wah Wah of Section J.

Number of specimens.—62.

Repository.—Figured specimens UMC 1110–7–9; unfigured specimen UMC 1110–10.

SCOLOPODIFORM E
Pl. 12, fig. 18; fig. 31

Acontiodus iowensis Furnish. ETHINGTON & CLARK, 1964, p. 687, Pl. 113, fig. 3.

Small cones with flat front faces; moderately recurved distally. Basal margin ovate in plan view, cavity shallow.

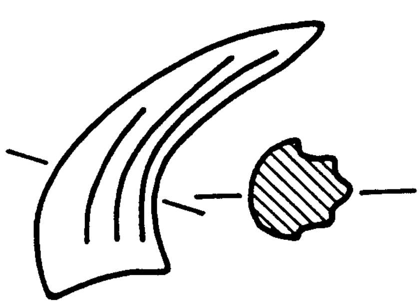

Figure 28.—Scolopodiform B.

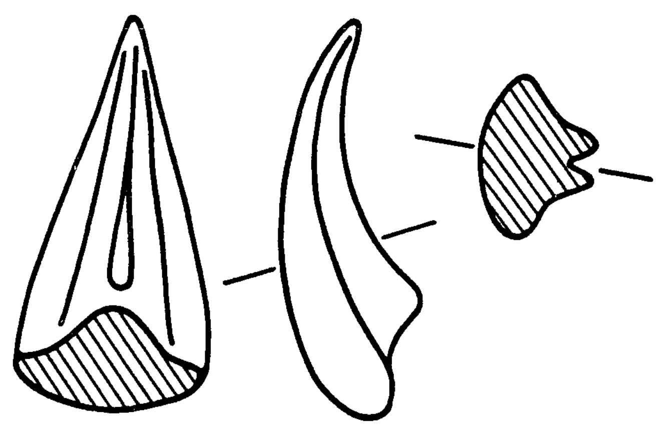

Figure 29.—Posterior and lateral views of Scolopodiform C.

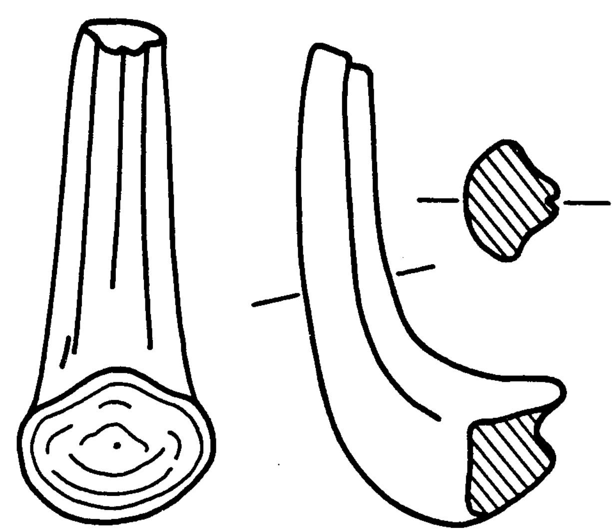

Figure 30.—Posterior and lateral views of Scolopodiform D.

Lateral flanges flank rounded posterior median ridge. Flanges begin somewhat above basal margin and expand to their greatest width in region of curvature of element, then narrow so that they are not clearly differentiated distally where cross section of cusp becomes subcircular.

Remarks.—Although moderately thermally altered, these specimens are cloudy and gray except in the basal region. This coloration is probably related to the distribution of albid matter in the cusp.

Range in the Pogonip.—Rare in the upper half of the Fillmore Formation at the Mesa Section (163.4, 247.5, 271 m [536, 812, 890 ft]) and in the ST Section (through 116 m [381 ft]).

Number of specimens.—19.

Repository.—Figured specimen UMC 1110–11.

SCOLOPODIFORM F
Pl. 12, figs. 19, 20, 26; fig. 32

Strongly curved, hyaline cones whose distal extremities are subparallel to their basal margins. Anterior faces rounded; posterior faces with heavy median ridges flanked by flattened facets. Facets begin above base, are widest in region of curvature, and attenuate distally; they merge laterally into anterior face through rounded lateral costae.

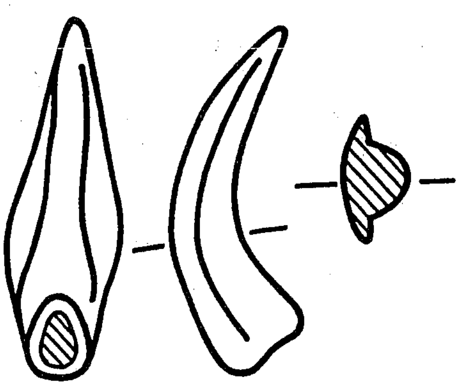

Figure 31.—Posterior and lateral views of Scolopodiform E.

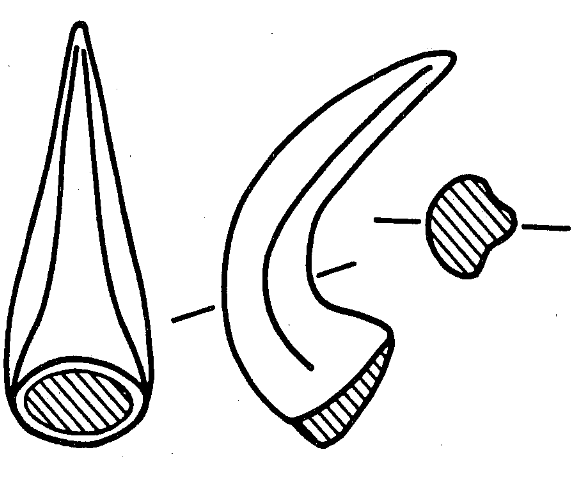

Figure 32.—Posterior and lateral views of Scolopodiform F.

Basal cavity shallow, commonly retaining heavy basal funnels. Basal margin is subcircular in plan.

Remarks.—These elements resemble the symmetrical elements of *Scolopodus cornuformis* Sergeeva (*sensu* Dzik 1976, Löfgren 1978), but the striae that Löfgren shows to be distinctly developed in that species are visible here only at high magnification (see Pl. 12, figs. 19, 20).

Range in the Pogonip.—Sporadic occurrence in Fillmore Formation in all studied sections, and in the Juab near Fossil Mountain.

Number of specimens.—25.

Repository.—Figured specimens UMC 1110–12, 13.

Genus STOLODUS Lindström, 1971
Type species.—*Distacodus stola* Lindström, 1955.

STOLODUS STOLA (Lindström)
Pl. 12, fig. 21

Distacodus stola LINDSTRÖM, 1955, p. 556–557, Pl. 3, figs 43–49; LINDSTRÖM, 1957, p. 164; LINDSTRÖM, 1960, text-fig. 2(2); WOLSKA, 1961, p. 348, Pl. 2, fig. 4; BEDNARCZYK, 1969, Pl. 1, fig. 12; VIIRA, 1974, Pl. 3, fig. 17.
Distacodus stola latus LINDSTRÖM, 1955, p. 557, Pl. 3, figs. 50, 51.
Coelocerodontus stola (Lindström). LINDSTRÖM, 1964, p. 84, text-fig. 29.
non Distacodus stola stola Lindström. ETHINGTON & CLARK, 1965, p. 189, Pl. 1, figs. 1, 2; MOUND, 1968, p. 410, Pl. 2, figs. 12–14.
non Distacodus stolus stolus Lindström. LEE, 1970, p. 316, Pl. 7, fig. 10.
Stolodus stola (Lindström). LINDSTRÖM, 1971, p. 51; VAN WAMEL, 1974, p. 95–96, Pl. 8, figs. 20–24; LINDSTRÖM, 1977, p. 539–540, Rhodesognathus-Pl. 1, figs. 10–12.
non Distacodus stola Lindström. ETHINGTON & CLARK, 1971, p. 76, Pl. 2, fig. 16.
non Stolodus stola (Lindström). ETHINGTON, 1972, p. 23, Pl. 1, fig. 13.
? *Distacodus stola* Lindström. JAKOVLEV, 1973, p. 213, text-fig. 38(6).
Distacodus latus Lindström. VIIRA, 1974, Pl. 3, fig. 16.
non Distacodus stolus Lindström. LEE, 1975, p. 84, Pl. 1, figs. 9–11, text-fig. 3H, I.
Stolodus stola stola (Lindström). LÖFGREN, 1978, p. 111–112, Pl. 9, figs. 18, 19.
Stolodus stola latus (Lindström). LÖFGREN, 1978, p. 112, Pl. 9, figs. 20–23.

Remarks.—We incluude here specimens that conform to the general definition of *Distacodus stola* (Lindström 1955) as to shape of cusp, development of keels, and nature of basal cavity. Further, they show extensive development of albid matter, which Lindström (1971) subsequently added to the diagnosis. We did not find squat, strongly curved elements like those that Lindström (1955) identified as *D. stola latus* and to which he (1977) apparently refers as "oistodiform (or prioniodiform)" elements in his discussion of *Stolodus* in the *Catalogue of Conodonts.* He noted that these elements are less abundant components of the apparatus of *Stolodus* than are the ramiform elements, so that their lack of representation among the meager collection of elements of *Stolodus* recovered from the Pogonip is not significant.

The specimens that we identified previously (1965, 1971) under the name *Distacodus stola* are distacodiform elements of species of *Acodus* and are treated as such elsewhere in this report.

Occurrence.—This species is characteristic of the North Atlantic Faunal Province in northern Europe. It has been reported previously only from the Baltic area (Sweden, Estonia, Poland) and from the Hamburg Klippe in eastern Pennsylvania (Bergström, Epstein, and Epstein 1972).

Range in the Pogonip.—Upper Fillmore of the ST Section (114 m [375 ft]) and lower Wah Wah at Section J (through 3.7 m [12 ft]).

Number of specimens.—7.

Repository.—Figured specimen UMC 1110–14.

Genus TRIPODUS Bradshaw, 1969
Type species.—*Tripodus laevis* Bradshaw, 1969.

Triangulodus VAN WAMEL, 1974, p. 96.

Remarks.—This genus was established in form-taxonomy by Bradshaw (1969) whose collection consisted of only three specimens from the Fort Peña Formation of the Marathon region, west Texas. Her description and illustration of the type species indicate that her specimens were the asymmetrical, multicostate forms referred to below as paltodiform elements.

We have a small number of elements from the Pogonip of western Utah that clearly are conspecific with Bradshaw's types. They are associated in the Pogonip occurrences with a variety of other elements whose stratigraphic ranges, gross similarity in the development of their costae, and shapes of their basal cavities indicate that these elements are parts of a common apparatus. Better preserved and more numerous specimens from the Antelope Valley Formation in central Nevada collected by one of us (RLE) have permitted reconstruction of this apparatus in detail, and our interpretation of the genus and the several elements of its apparatus is based on these collections.

The apparatus of *Tripodus* includes drepanodiform (no lateral costae), distacodiform (lateral costae to each side; symmetrical to moderately asymmetrical), paltodiform (multiple costae to one side), trichonodelliform (lateral and posterior edges but not anterior), and oistodiform elements. Basal cavities have their apices turned over in the anterior direction and situated far anteriorly except in the oistodiform element which has a cavity with a submedian tip and which shows basal inversion anteriorly. Cusps of all elements are albid.

Parts of this apparatus are very similar in form to elements assigned to species of other genera. For example, the paltodiform elements in our collection bear some resemblance to comptiform elements of *Walliserodus comptus,* and poorly preserved or fragmented specimens would be difficult to identify. The apparatuses of the two species are different, however, in that an oistodiform element has not been recognized in *Walliserodus,* so that the similarity in form is homeomorphic and does not indicate close affinity between the two forms.

One of us (Ethington 1972) earlier reported the similarity of *Paltodus volchovensis* Sergeeva s.f. to multicostate elements from the Ninemile Formation of Nevada that in turn are very similar to the paltodiform elements reported here. Lindström (1971) assigned *P. volchovensis* to the apparatus of *Scandodus brevibasis* (Sergeeva), an interpretation accepted by Serpagli (1974) and Löfgren (1978). This reconstruction admits only hyaline elements to the apparatus. Van Wamel (1974) reconstructed the apparatus containing *P. volchovensis* in a somewhat different way and established a new genus for it, *Triangulodus,* to which he (p. 96) brought both hyaline and albid species. Dzik (1976, p. 404–405, text-fig. 20) accepted *Triangulodus* and concluded that it probably evolved from *Acodus deltatus* Lindström. He did not discuss its relationship to *Scandodus,* although he expressed his opinion that the hyaline versus albid state "cannot be regarded as of any greater importance for taxonomy."

In summary, two groups of conodonts have been reported to contain elements resembling those of *Tripodus.* One, which has been recognized in Scandinavia and in Argentina, is characterized by hyaline elements. The other, which occurs in western North America and perhaps, judging from the reports of van Wamel and of Dzik, in northern Europe as well, has albid elements. At least some of the elements of the two groups are morphologic counterparts of each other. *Scandodus* Lindström as emended (Lindström 1971) belongs in the former group, whereas *Triangulodus* as defined by van Wamel includes both groups. If a hyaline versus albid nature of elements is significant for taxonomy, the latter name is not available for the albid species because its type species, *P. volchovensis,* is part of the apparatus of a hyaline form according to Lindström (1971) and Löfgren (1978). *Tripodus* Bradshaw has five years priority over *Triangulodus* and is based on albid material; it is the proper name for the second of the groups of conodonts described above.

Lindström (1970) suggested a supergeneric classification of conodonts based on similarities in reconstructed apparatuses but also taking into consideration other features, including whether or not the elements contain albid material. *Scandodus* was assigned to the Family Oistodontidae together with other forms whose elements essentially are hyaline, e.g., *Oistodus* Pander and *Scolopodus* Pander. Their apparatus consists of a symmetry transition plus an oistodiform element (*Scolopodus* appears to lack the latter element). *Tripodus* fits this description if the paltodiform element is considered to be part of the symmetry transition; elements that appear to be nearly identical in external morphology (*P. volchovensis*) are accepted as part of the transition series of *Scandodus brevibasis.* Dzik (1976, p. 404–405) interpreted *Triangulodus* (= *Tripodus*) in this way.

However, *Tripodus* can be considered to be a representative of the Prioniodontidae, a family whose members are characterized by a transition series, an oistodiform element, and at least one prioniodiform element to which the paltodiform elements described here might correspond. All of the elements of the Prioniodontidae contain notable amounts of albid matter. Interpreted in this fashion, *Tripodus* has the same basic suite of elements as *Acodus deltatus, Oepikodus communis* and *Oepikodus evae,* to which it may have closer affinity therefore than to *S. brevibasis.* The phylogenetic relationships of these Lower Ordovician conodonts are as yet poorly understood. To resolve their relationships will require further evalution of the significance of presence versus absence of albid matter in conodont elements, as well as the meaning of homemorphic elements in apparatuses that in other respects are quite different from each other.

TRIPODUS LAEVIS Bradshaw
Pl. 12, figs. 24, 25, 27–29; fig. 33

Scolopodus alatus BRADSHAW, 1969, p. 1162, Pl. 132, fig. 4.
Tripodus laevis BRADSHAW, 1969, p. 1164, Pl. 135, figs. 9, 10.
? *Oistodus elongatus* Lindström. VIIRA, 1974, Pl. 3, fig. 25 (*non* fig. 18).

The apparatus consists of a paltodiform element, an oistodiform element, and a transition series including drepanodiform, distacodiform, and trichonodelliform elements.

The paltodiform element is continuously curved; most specimens are rather gently so, but a minority of them are strongly bent. Three keeled edges are present: anterior, posterior, and lateral. The anterior edge is deflected toward the side opposite the lateral edge. As a consequence, the latter surface is somewhat dished transversely, although commonly it bears a faint, rounded ridge located medially and beginning well above the base and continuing distally. Lateral edge is located behind the midline and directed posterolaterally in most cases, although in some elements it is submedial and directed almost laterally. It increases in prominence basally and is produced as a short lateral process. At least one low costa is located approximately midway between the anterior and lateral edges; this costa begins near the base and attenuates orally so that it is not clearly developed on the distal reaches of the cusp. Some specimens show additional faint ridges flanking this central one. The cusp is twisted relative to the base, and some forms approach bilateral symmetry in the basal region with the anterior costa rotated so as to be almost opposite the lateral costa. Base is not inflated; the cavity is deep and anteriorly inclined, with its apex near the front margin.

Drepanodiform elements have sharp anterior and posterior edges and swollen lateral surfaces but lack distinct costae. They are transitional in this respect with the distacodiform elements described below. Cusp is twisted relative to the base. Basal cavity is deep, base is modestly inflated.

Distacodiform elements have sharp anterior and posterior edges and blunt lateral costae. Typically one side has the costa well behind the midline whereas the opposite costa is medial. Posterior edge is drawn out basally as a slender process, the anterior edge less prominetly so. The median costa is produced as a short, aborally directed lappet. The basal margin is slightly recessed between the posterobasal corner and the lappet and strongly so just anterior to the lappet to produce a distinct anterior recess in the lower outline of the element. The other costa is not expressed in the basal margin, and the basal outline to that side rises from the posterobasal corner to a position anterior to the midline, then drops steeply to the anterobasal corner. The base is not inflated; the cavity is inclined anteriorly with its sharp tip near the front margin.

Trichonodelliform elements have a planar to rounded front face forming the base of the triangular cross section. Posterolateral surfaces are depressed between anterolateral keeled edges and the keeled posterior edge. Element is moderately curved along its entire length. The front face of the element may display weakly defined longitudinal ridges: if present, that ridge along the midline is strongest with weaker ones to either side. Basal cavity is deep.

Oistodiform element has a reclined cusp that is drawn out in the anterobasal region. Edges are sharp; one surface of the cusp is uniformly convex transversely, but the other has a median longitudinal swelling. Anterior edge may be turned toward the latter side in the region where the cusp passes over into the base. Base has a posterolaterally directed inflated region beneath and continuous with the swollen midregion of the cusp. Posterior part of the base is elongate, shallow, and keeled along its upper margin. It is of approximately the same size as the anterobasal region of the element. Basal cavity is shallow, its tip directed anteriorly and located beneath the front half of the cusp. Basal outline on swollen side of base rises from the posterolateral corner to a lobate salient where the base is swollen, then descends to the anterobasal corner. On the opposite side, the basal outline rises to a position just ahead of and beneath the tip of the basal cavity, then descends to the anterobasal corner. This sharp reentrant in the basal outline is a characteristic feature that distinguishes these elements from numerous other oistodiform elements that occur in the same stratigraphic interval. Basal inversion is displayed in the anterior region on this side only.

Remarks.—Bradshaw's illustrations of *Scolopodus alatus* suggest that she included under this name asymmetrical elements like those we have described as paltodiform elements of *Tripodus laevis* (see illustration of holotype of *S. alatus* in Bradshaw, 1969, Pl. 132, figs. 2, 3). She also considered more nearly symmetrical forms like those we regard as the trichonodelliform elements of the latter species (see her illustrations of the paratype of *S. alatus,* Pl. 132, figs. 1, 4). Only six specimens were included in the collection on which she based *S. alatus.* She did not illustrate specimens that we would interpret as drepanodiform, oistodiform, or distacodiform elements of *T. laevis,* but this likely is not significant since she had so few specimens of the elements she illustrated.

Viira (1974, Pl 3, fig. 25) illustrated but did not describe a specimen that she identified with *Oistodus elongatus* Lindström s.f. The overall outline of this specimen, and particularly of the basal region which displays a distinct anterior aboral reentrant, suggests that it is very similar to the specimens we consider to be the distacodiform elements of *T. laevis.* None of the other elements that she figured seem close to parts of the apparatus of *T. laevis,* with the possible exception of that one she identified with *Acontiodus latus* Pander (see her Pl. 2, fig. 23) which somewhat resembles the trichonodelliform element. This is a rather generalized kind of element that is represented in the apparatus of several species, e.g., *Acodus deltatus,* so that its identity cannot be established independently.

Occurrence.—Bradshaw's type material was obtained from the Fort Peña Formation of west Texas. The species also occurs in the lower Antelope Valley Limestone in the Monitor Range, central Nevada (undescribed collections of RLE).

Range in the Pogonip.—Upper Wah Wah and Juab at Fossil Mountain, basal Juab at Section J.

Number of specimens.—Paltodiform element, 21; drepanodiform element, 1; distacodiform element, 4; trichonodelliform element, 4; oistodiform element, 16.

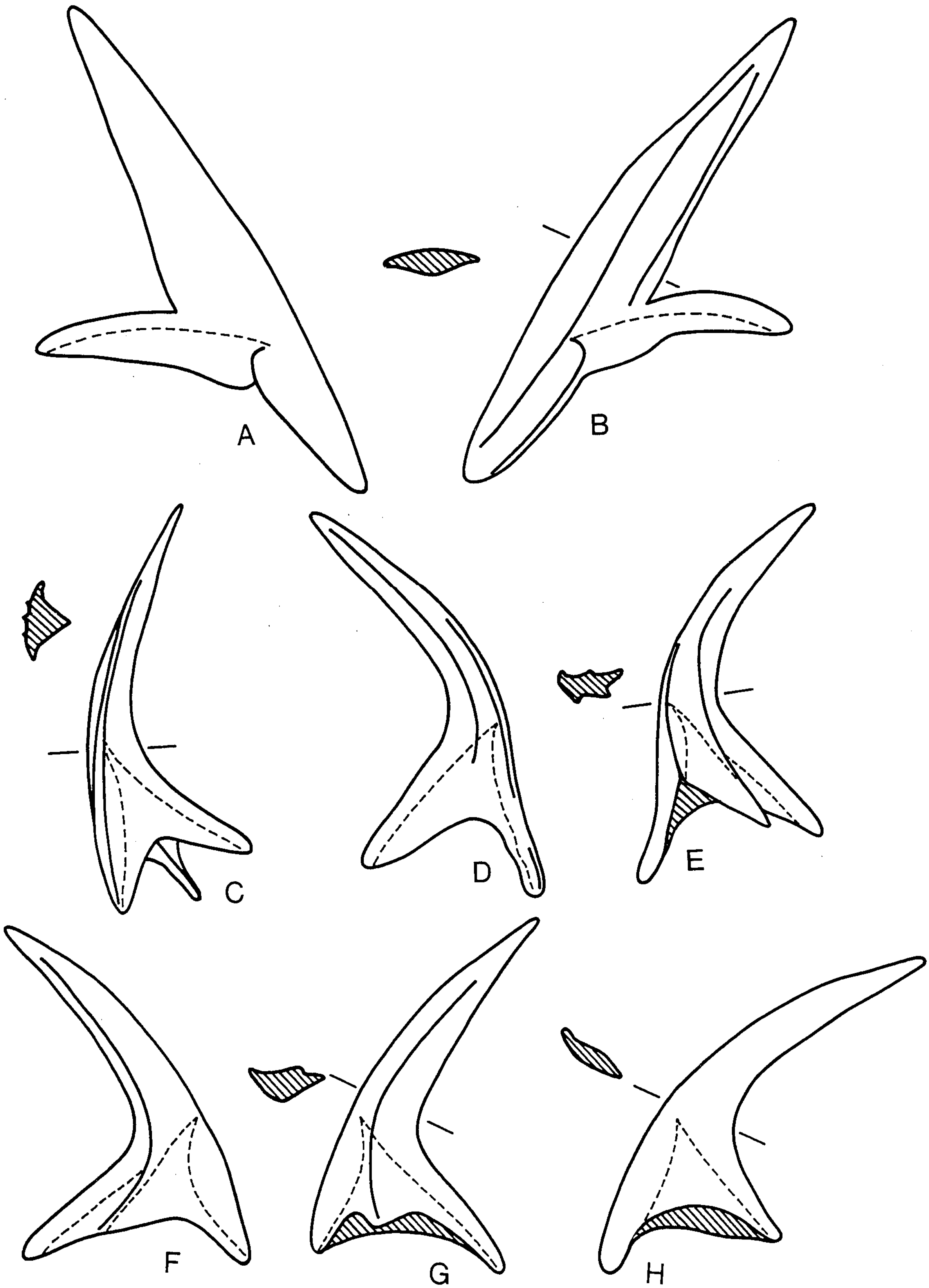

Figure 33.—*Tripodus laevis* Bradshaw. *A, B,* opposite sides of oistodiform element; *C,* lateral view of trichonodelliform element; *D, E,* opposite sides of paltodiform element; *F, G,* opposite sides of distacodiform element; *H,* drepanodiform element.

Repository.—Figured distacodiform element UMC 1110–15; unfigured distacodiform element UMC 1110–16; figured drepanodiform element UMC 1110–17; unfigured drepanodiform element UMC 1110–18; figured oistodiform element UMC 1110–19; unfigured oistodiform element UMC 1110–20; figured paltodiform element UMC 1111–1; unfigured paltodiform element UMC 1111–2; figured trichonodelliform element UMC 1111–3; unfigured trichonodelliform element UMC 1111–4.

Genus ULRICHODINA Furnish, 1938

Type species.—*Acontiodus abnormalis* Branson & Mehl, 1933.

Remarks.—Lindström (1964, p. 176) interpreted Furnish's designated type species of *Ulrichodina* as a junior synonym of *Acontiodus abnormalis* Branson and Mehl. Furnish (1938, p. 335), in his discussion of *U. prima,* noted the similarity of its cross section with that of *A. abnormalis,* but he considered them to be distinct species because the latter did not display the deflection of the basal margin that is characteristic of species of *Ulrichodina.* Branson and Mehl (1933) based *A. abnormalis* on a specimen from a residual clay deposit that lies between the Jefferson City and St. Peter Formations near Warrenton, Missouri. The base of this specimen has been partially lost, probably owing to abrasion during reworking. Lindström is correct in his interpretation, and the proper name for the type species is *U. abnormalis* (Branson and Mehl, 1933).

Thus far *Ulrichodina* is known with certainty only from North America and from Australia. The specimen from the Setul Limestone of Malaya that Igo and Koike (1967) compared with *U. wisconsinensis* is of uncertain affinity. Although still rather poorly understood, the genus seems to be largely restricted to strata of middle and late Canadian age; it is known to occur in lower Whiterockian rocks in eastern United States (John Repetski personal communication 1980). The specimen from the Fort Peña Formation (Middle Ordovician) that Graves and Ellison (1941) assigned to *Urichodina* is a fragment of a species of *Multioistodus.*

Sweet and Bergström (1972, p. 32) included *Ulrichodina* in the group of conodonts they described as having monoelemental simple-cone apparatuses. Subsequently in the same paper (p. 42) they observed that the total apparatus is unknown and indicated some reservation about their conclusion that the apparatus consists of ulrichodiniform elements. We have found specimens of several *Ulrichodina* species in Canadian rocks at numerous localities in the western United States as well as in Oklahoma, Texas, and Missouri. We have not found any obvious association of ulrichodinid elements with other conodonts in those collections and believe that Sweet and Bergström probably are correct in their assumption.

We have observed considerable variation among the elements that we assign to *Ulrichodina.* Unfortunately, these elements are relatively minor constituents of the conodont populations of the samples where we have found them; frequently only one or two elements are present despite abundance of other kinds of conodonts. Accordingly we recognize several basic morphologies, some of them already defined by Furnish, and treat them *sensu formo.* Perhaps they all are variants of a single kind of element and all belong to one apparatus. However, their occurrences are so sporadic in our collections and the numbers so small that we are unable to evaluate them satisfactorily.

ULRICHODINA ABNORMALIS (Branson & Mehl)

Pl. 12, fig. 31

Acontiodus abnormalis BRANSON & MEHL, 1933, p. 57, Pl. 4, figs. 24, 25; MEHL & RYAN, 1944, Pl. 6, figs. 4–8.

Ulrichodina prima FURNISH, 1938, p. 335, Pl. 41, figs. 21, 22; BARNES & TUKE, 1970, p. 94, Pl. 20, figs. 5, 6, 12, text-fig. 6G.

? *Ulrichodina prima* Furnish. MOUND, 1968, p. 421, Pl. 6, figs. 67, 68, 72.

Ulrichodina sp. ETHINGTON & CLARK, 1971, Pl. 2, fig. 25 (*non* fig. 18, = *U. cristata* Harris & Harris).

Remarks.—We have compared our specimens, all of which have lost the distal region, with the type specimens of Branson and Mehl and of Furnish. They correspond almost entirely. In particular some, but not all, of our specimens show the faint longitudinal striae that Furnish observed on some of his material.

Mound (1968) reported this form from the Cool Creek Formation of southern Oklahoma. His illustrations are at such small magnification and of such poor quality that interpretation of them is difficult. At least some of the elements that he identified with species of *Ulrichodina* appear to belong there, but the specific identity cannot be verified from the illustrations. It is clear that ulrichodiniform elements are figured on his Plate 6 but identified with species of *Scolopodus* (e.g., Pl. 6, fig. 37). It seems obvious to us that the lower Arbuckle sequence must be restudied on the basis of new collections in order to properly evaluate these conodonts.

Occurrence.—*Ulrichodina abnormalis* occurs in the residual clays between the Jefferson City dolomites and the St. Peter Sandstone in east central Missouri (Branson and Mehl 1933, Mehl and Ryan 1944) and in the Shakopee Formation of the Upper Mississippi Valley (Furnish 1938). We have found it in undescribed collections (donated by D. F. Toomey) from the Cool Creek and Kindblade Formations of Oklahoma, the El Paso Group of west Texas (also see Repetski 1975), and the Monument Springs Member of the Marathon Formation.

Range in the Pogonip.—The lowest occurrence is at 290 m (951 ft) above the base of the Fillmore at Section C. Specimens were found in the Fillmore at 64 m (210 ft) and at 103.6 m (340 ft) in Section H.

Number of specimens.—4.

Repository.—Figured specimen UMC 1111–5.

ULRICHODINA CRISTATA Harris & Harris

Pl. 12, figs. 22, 30

Ulrichodina cristata HARRIS & HARRIS, 1965, p. 40–41, Pl. 1, figs. 5a–d.

Ulrichodina sp. ETHINGTON & CLARK, 1971, Pl. 2, fig. 18 (*non* fig. 25, = *U. abnormalis*).

Remarks.—Our specimens conform closely to the description and illustrations provided by Harris and Harris with one exception. We find faint traces of longitudinal striation on some specimens, particularly in the basal region. Such striation is not displayed by all of our specimens and therefore is not a significant difference from the type collection.

Occurrence.—Harris and Harris (1965) reported the species from the West Spring Creek Formation at the famous Highway 77 section in southern Oklahoma. Unfortunately, they did not specify from which part of the formation they obtained their collection, although the introduction to their paper implies that they dealt only with the upper half of the formation. We previously (1971) figured a specimen from the Kindblade Formation, also from southern Oklahoma.

Range in the Pogonip.—The lowest occurrence in our collection is at 290 m (951 ft) above the base of the Fillmore at Section C. One specimen was found at 216.7 m (711 ft) in the Mesa Section and others at 115.8 and 271.3 m (380 and 890 ft) in Section H. We found the species to occur sporadically in the Fillmore at the ST Section.

Number of specimens.—10.

Repository.—Figured specimens UMC 111–6, 7.

ULRICHODINA DEFLEXA Furnish
Pl. 13, figs. 1, 2

Ulrichodina? deflexus Furnish, 1938, p. 335–336, Pl. 41, figs. 23, 24.

Remarks.—Furnish based his species on a single specimen. He characterized it as having a rounded cross section of its cusp that is modified by broad but shallow longitudinal furrows. We have compared our specimens with the holotype and have found that all have an additional character not reported by Furnishh. A well-developed posterior groove, narrower and deeper than the longitudinal troughs, is present on all specimens including the holotype. In addition some of our specimens have ellipsoidal instead of circular cross sections, and some of them show prominent longitudinal striation. We, therefore, emend Furnish's diagnosis to include a diagnostic posterior groove, circular to ellipsoidal cross section, and the possibility of striae.

Occurrence.—The holotype from the Shakopee Dolomite of southern Minnesota is the only previously known specimen. Mound (1968) compared three specimens from the uppermost Cool Creek Formation of Oklahoma with *U. deflexa,* but they certainly are not ulrichodiniforms. Two specimens from the Pander Greensand of northern Australia which Jones (1971) compared with *U. deflexa* have the same slender outline in lateral view as the holotype, but they are described as having sharp anterior and posterior edges. Probably they represent a distinct species.

Range in the Pogonip.—We found these forms at 141.7, 161.6, and 183 m. (465, 530, and 600 ft), respectively, of the Fillmore in Section C. They also occur in the Fillmore in the interval from 158 to 180 m (519 to 590 ft) of the Mesa Section.

Number of specimens.—7.

Repository.—Figured specimens UMC 1111–8, 9.

ULRICHODINA? SIMPLEX, n. sp.
Pl. 13, figs. 3, 4, 9

? *"Drepanodus"* sp. 3 SERPAGLI, 1974, p. 45, Pl. 10, figs. 7a, b, Pl. 21, fig. 15.

Cusp is a knife-shaped blade with sharp anterior and posterior edges and sharp tip. Lateral surfaces smooth; greatest thickness slightly ahead of midline. Base widely flared, shallowly excavated, continued posteriorly slightly beyond posterior edge of cusp. Basal margin has a prominent sinus on each side beginning just behind anterobasal corner and occupying about a third of the length of the basal margin as seen in lateral view.

Remarks.—These forms are close to *U. cristata* Harris and Harris in the shape of their cusps. However, they do not have the ulrichodinid deflection of the anterobasal region. The sinuses in the basal margin are suggestive of incipient development of such a feature, but the specimens are so robust that they likely are not juveniles on which the deflection had not yet developed to its full extent. Such sinuses could be produced if the deflected portion of the base of a typical ulrichodiniform element were everted. As this morphology could be derived from a typical representative of *Ulrichodina,* we believe it best to consider these specimens to have affinity with, if not actual, membership in that genus.

One of the specimens that Jones (1971) identified as *Acodus oneotensis* Furnish seems very similar to *U.? simplex;* its aboral outline is suggestive of an unspecialized form of *Ulrichodina* rather than of Furnish's species. Jones's specimen was collected from the Pander Greensand of northern Australia, where it is associated with other elements that seem to indicate an older age than the material described here. A specimen from the San Juan Limestone of Argentina, identified with *Drepanodus* Pander by Serpagli (1974), may belong here.

Occurrence in the Pogonip.—Specimens were collected in the Fillmore Formation at 268 m (880 ft) in Section C, at 235 and 271 m (770 and 890 ft) in Section H, and at 99.4 m (326 ft) in the ST Section.

Number of specimens.—4.

Repository.—Figured holotype UMC 1111–10; figured paratypes UMC 1111–11, 12.

? ULRICHODINA WISCONSINENSIS Furnish
Pl. 13, fig. 15

? *Ulrichodina wisconsinensis* FURNISH, 1938, p. 335, Pl. 41, figs. 19, 20; ETHINGTON & CLARK, 1964, p. 702; JONES, 1971, p. 71, Pl. 7, figs. 11a, b, 12a, b.

Remarks.—Our specimens agree with the holotype in having a knifelike posterior edge and a rounded anterior margin. They differ, however, in showing a typical ulrichodinid deflection of the anterobasal region. We examined the holotype carefully and found a slight depression in this area. Further, the basal region shows a scalloped edge, indicating that at least some of the specimen has been broken away. In addition, our specimens are much larger than the holotype which may indicate ontogentic differences.

Range in the Pogonip.—Specimens were found at 183, 228.6, and 238 m (600, 750, and 780 ft) above the base of the Fillmore Formation at Section C. Others were recovered 160, 163.4, 205, 206.7, and 270 m (525, 536, 672, 711, and 885 ft) in the Mesa Section and at 76, 79, and 103.6 m (250, 260, and 340 ft) in Section H.

Number of specimens.—12.

Repository.—Figured specimen UMC 1111–13.

? ULRICHODINA sp.
Pl. 13, fig. 8

Remarks.—Three robust specimens from lower Fillmore have flared bases and striate lateral faces. The cusp swells anteriorly from a blunt posterior edge to its thickest development near the anterior margin. A broad anterior trough is most pronounced near the base where it forms a minor reentrant. These specimens are similar to forms from the Cool Creek Formation of Oklahoma which Mound (1968, p. 412, Pl. 6, figs. 61, 62, 69) described as *Ulrichodina cristata.* At least one of his illustrated specimens (Pl. 6, fig. 29) seems to be a representative of *Scolopodus quadraplicatus* Branson and Mehl; the generic assignment is tenuous. Pending a careful restudy of the conodonts of the lower Arbuckle, we believe it best to note this similarity but to leave the generic identification in question.

Range in the Pogonip.—We found these forms only in a sample collected 26 m (85 ft) above the base of the Pogonip at Section C.

Number of specimens.—3.

Repository.—Figured specimen UMC 1111–14.

Genus WALLISERODUS Serpagli, 1967

Type species.—*Acodus curvatus* Branson & Branson, 1947.

As interpreted by Serpagli (1967, 1974), this conodont genus has an apparatus consisting of simple-cone elements that display a symmetry variation in the number of strongly developed costae that ornament their margins and faces. His original collections consisted of material from the Upper Ordovician of the Carnic Alps which he identified with *Paltodus debolti* Rexroad, 1967, previously known only from the Silurian Brassfield Formation of Ohio and Kentucky, and which he established as the type species. Rexroad and Craig (1971, p. 695) insisted that Serpagli's specimens are distinct from any of the form-species earlier reported from the Brassfield and thereby placed in question the validity of *Walliserodus.* Cooper (1975) agreed that the material from the Carnic Alps is not the same as the specimens from the Brassfield but concluded that the former collection represents a somewhat more primitive species. He retained *Walliserodus* as a multielement genus and believed that the element in the apparatus of the type species having nomenclatorial priority is *A. curvatus* Branson and Mehl. Cooper further characterized the apparatus as consisting of "an acodontiform and a suite of costate paltodontiform elements in an intergrading morphological series."

Serpagli (1974, p. 89) compared *Walliserodus* with *Coelocerodontus* Ethington, 1959, and with *Stolodus* Lindström, 1971, which he considered to be related genera because each includes costate simple cones in its apparatus. Lindström (1971, p. 51) and van Wamel (1974, p. 95) characterized *Stolodus* as having white matter widely distributed throughout the elements, and both authors stressed that the keels and costae are very thin and delicate in *Stolodus* elements. A symmetry transition series among the elements of *Stolodus* has been reported. Discussions indicate that all elements possess four principal costae whose relative spacing varies; they may be deflected or twisted from fundamental anterior, posterior, and lateral positions. Short costae may be intercalated between the principal costae. Thus far only the type species, *S. stola* (Lindström), has been recognized. *Coelocerodontus* is based on completely hollow cones having polygonal cross sections with keeled edges. The apparatus of *Coelocerodontus* has not been established with certainty, although Webers (1966) and Sweet and Bergström (1972) suggested at least two elements are present in the type species. As the three genera are understood at this time, affinity among them is speculative.

The elements that Serpagli (1974) included in *Walliserodus australis* have morphologic counterparts in apparatuses reported under other generic names. Thus tricostate elements of *W. australis* are similar to acodiform and paltodiform elements of *Triangulodus* van Wamel, to gothodiform and prioniodiform elements of *Acodus deltatus* Lindström *sensu* McTavish (1973), to belodiform and acodiform elements of *Acodus russoi* Serpagli (1974), and to gothodiform and prioniodiform elements of *Prioniodus deltatus* (Lindström) *sensu* van Wamel (1974). In the same way the asymmetrical elements with four costae resemble tetraprioniodiform elements of *Acodus* as interpreted by McTavish and Serpagli and trapezognathiform elements of *Prioniodus deltatus* of van Wamel. Symmetrical quadricostate elements are similar to oepikodiform elements identified as part of the apparatus of species of *Acodus* by Serpagli and of *Prioniodus deltatus* by van Wamel.

Each of the genera listed above as possessing elements resembling those of *Walliserodus australis* also has an oistodiform element as an integral part of its apparatus. Serpagli did not include an oistodiform element in his concept of *Walliserodus,* and Cooper did not recognize an oistodiform element as part of the apparatus of the genus. None of the numerous oistodiform elements in our collection seems appropriate to *Walliserodus,* either from stratigraphic distribution or general morphologic appearance. For this reason we are assigning forms from the middle Pogonip to *Walliserodus* even though individual elements, particularly those that are somewhat fragmented or that have been etched during diagenesis, are not readily distinguished from elements others have assigned elsewhere as noted above. We are uncertain about the affinity of our material with the Silurian forms that constitute the types for *Walliserodus curvatus.*

WALLISERODUS COMPTUS (Branson & Mehl)
Pl. 13, figs. 6, 7, 11–13; fig. 34

Paltodus comptus BRANSON & MEHL, 1933, p. 61, Pl. 4, fig. 9.
Scolopodus pseudoquadratus BRANSON & MEHL, 1933, p. 63, Pl. 4, fig. 19.
Paltodus sp. A ETHINGTON & CLARK, 1971, p. 73, Pl. 2, fig. 12.
? *Scolopodus sexplicatus* Jones. COOPER & DRUCE, 1975, p. 578–579, fig. 29.
? *Scolopodus* cf. *S. cornutiformis* Branson & Mehl. COOPER & DRUCE, 1975, p. 576, fig. 33.

Remarks.—The conodonts that we are including here conform generally to the symmetry variations that Serpagli reported for *Walliserodus australis*, but on most of our specimens the costae are less prominent than he indicated in his text-figures. We compared our specimens directly with collections from the Jefferson City Formation of Missouri and with the type specimens of "Jefferson City" conodonts reported by Branson and Mehl (1933). We have specimens in our collections that clearly are identical to the types of *Paltodus comptus* and of *Scolopodus pseudoquadratus*. Large collections from the Jefferson City and associated clays of central and eastern Missouri show that these type specimens represent only one aspect of a range of morphology that is quite variable in the strength, arrangement, and number of costae. The more strongly costate elements in the Jefferson City collections encompass forms like those described as *Walliserodus australis*. Serpagli (1974, p. 91) earlier noted the similarity of *P. comptus* to elements of *W. australis* but, because of inadequate information, declined to evaluate their possible affinity.

Elements similar to those of *W. comptus* have been reported previously. Lindström (1955) described as *Scolopodus* n. sp. a form with pentagonal symmetry that is suggestive of the symmetrical element with five costae. McTavish (1973) illustrated a somewhat similar form as the "trichonodelliform" elements of *Acodus transitans*. Sergeeva (1963, text-figs. 5, 6) prepared cross sections of *Paltodus variabilis* and of *Paltodus volchovensis* that suggest similarity to multicostate elements of *W. comptus*, but she did not report any of the other morphologic types considered here. *P. volchovensis* has been interpreted as part of the apparatus of *Scandodus brevibasis* (Sergeeva) by Lindström (1971) (= *Triangulodus brevibasis* (Sergeeva) of van Wamel (1974)). Serpagli (1974) noted the similarity between *Paltodus* sp. and *Scolopodus* n. sp. 1 of Uyeno and Barnes (1970) and some of the multicostate elements of *W. comptus*. The former are from part of the Lévis Formation of Quebec that has been correlated on the basis of trilobites with the upper Kanosh and Lehman (Uyeno and Barnes 1970), so that if a related species is present there, it is younger than *W. comptus*.

Occurrence.—These forms occur in clays at the top of the Jefferson City sequence in central and eastern Missouri and in the higher part of the Jefferson City proper. Serpagli found them in the lower part of the San Juan Limestone sequence of Argentina. Repetski (1975, and in press) found some of the elements in the upper part of the El Paso Formation in the Franklin Mountains, west Texas.

Range in the Pogonip.—Symmetrical pentacostate elements are present in many samples in the upper 91.4 m (300 ft) of the Fillmore at the H, ST, and Mesa sections. Several specimens that may belong here were found much lower (Mesa 525 [160 m], H 250 [76 m], H 420 [128 m]. This element is also present in the base of the Wah Wah at Section J.

Quadricostate elements occur sporadically in the middle and upper Fillmore of the Mesa Section (195.7–321.6 m [642–1055 ft]); they occur through the upper Fillmore at Section H (186–280.8 m [610–921 ft]), and occasional specimens were found lower in that section (64, 76.2, 81, 128 m [210, 250, 266, 420 ft]); they are present throughout the ST section. Specimens were found in the lower Wah Wah at Section J.

Multicostate elements like the holotype, the *comptus* element, are present in many samples in the upper Fillmore at Section H (192–271.3 m [630–890 ft] but are less common in the ST section. They also occur in the lower Wah Wah at Section J. Another distinctive multicostate element having five asymmetrically distributed costae occurs in the upper 60 m (200 ft) of the Fillmore at Section H and in the ST section; it is present in the basal Wah Wah at Section J.

Tricostate forms occur in the upper Fillmore at Section H (186–271.3 m [610–890 ft]) and throughout the ST section.

Number of specimens.—Symmetrical elements with five costae, 46; quadricostate elements, 83; comptiform elements, 39; asymmetrical multicostate elements, 39; tricostate elements, 36.

Repository.—Figured asymmetrical multicostate element UMC 1111–15; unfigured asymmetrical multicostate element UMC 1111–16; figured comptiform element UMC 1111–17; unfigured comptiform elements UMC 1111–18, 19; figured quadricostate element UMC 1111–20; un-

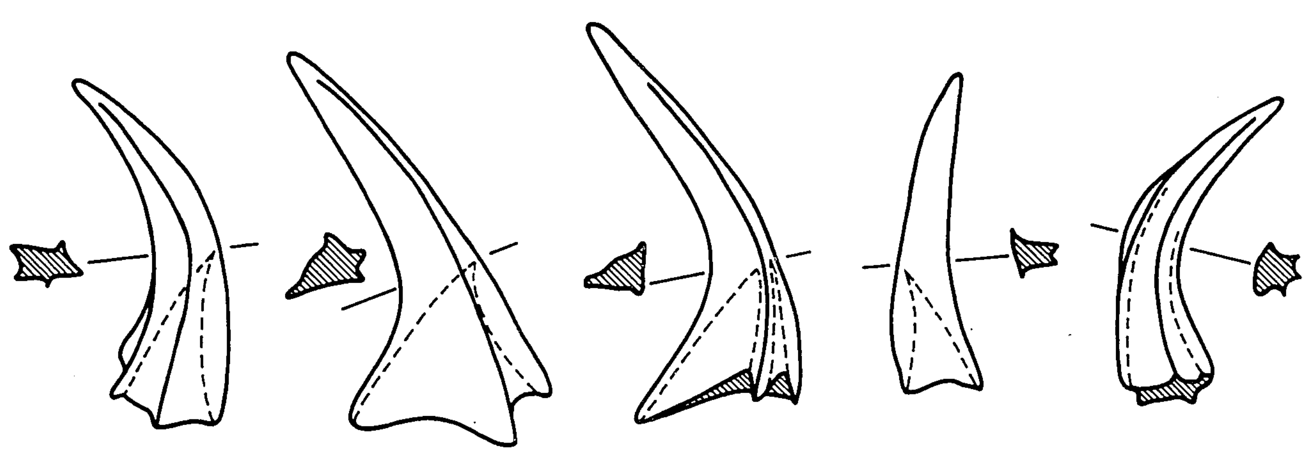

Figure 34.—Elements of the apparatus of *Walliserodus comptus* (Branson & Mehl); from left to right: comptiform, asymmetrical multicostate, tricostate, quadricostate, and symmetrical elements.

figured quadricostate element UMC 1112–1; figured symmetrical element UMC 1112–2; unifgured symmetrical element UMC 1112–3; figured tricostate element UMC 1112–4; unfigured tricostate element UMC 1112–5.

? WALLISERODUS ETHINGTONI (Fåhraeus) SENSU Löfgren
Pl. 13, figs. 10, 14–16; fig. 35

? *Panderodus ethingtoni* FÅHRAEUS, 1966, p. 26, Pl. 3, figs. 5a, b.
? *Walliserodus ethingtoni* (Fåhraeus). BERGSTRÖM, RIVA & KAY, 1974, Pl. 1, fig. 12; DZIK, 1976, text-fig. 14(o, p); REPETSKI & ETHINGTON, 1977, Pl. 1, fig. 9, Table 2; LÖFGREN, 1978, p. 114–116, Pl. 4, figs. 27–35, text-fig. 33.

Two kinds of eluements are considered here. One is a transition series of costate, continuously curved cones that typically display two low, posteriorly directed costae to one side and approximately four to the opposite side. The variation in symmetry ranges from compressed specimens with a convex anterolateral face on the bicostate side to subsymmetrical forms with a broadly convex anterior surface. Basal cavity is a shallow tapering cone whose apex is near the anterior margin; heavy basal funnels are retained in many specimens.

The other kind of element has a twisted, recurved, asymmetrical cusp and a basal region that is moderately inflated to one side. A faint ridge rises along the cusp above the swollen part of the base and bears up to three low costae. The opposite face of the cusp is regularly rounded. Faint longitudinal striae are present on the surface in addition to the costae. Basal cavity is a squat, anteriorly directed cone; basal funnels may be present.

Remarks.—This association of elements suggests the apparatus of *Scolopodus* as it was interpreted by Lindström (1971). The range in symmetry reflected by the multicostate elements is greater than has been reported for species of *Scolopodus,* although we noted herein that the cross sections of elements of *S.* aff. *S. rex* range from circular to flattened ellipsoidal. Similar variation exists in *S. cornutiformis,* but neither of these species achieves the marked asymmetry observed here.

Our specimens seem very close to those from central Sweden that Löfgren assigned to *Walliserodus ethingtoni.* She noted broad ranges in symmetry, primarily in terms of the relative numbers of costae on opposite sides of the elements, in her collections, but she did not comment on the range in cross sections that she found. Her illustrations (see Löfgren 1978, Pl. 4, figs. 27–35) suggest that both fat and flat specimens are included, and those she described as strongly asymmetrical (see her Pl. 4, fig. 32) may correspond to our specimens that have a noncostate side.

Occurrence.—*Walliserodus ethingtoni* was reported initially from Middle Ordovician (Viruan) rocks in southern Sweden (Fåhraeus 1966). Bergström, Riva, and Kay

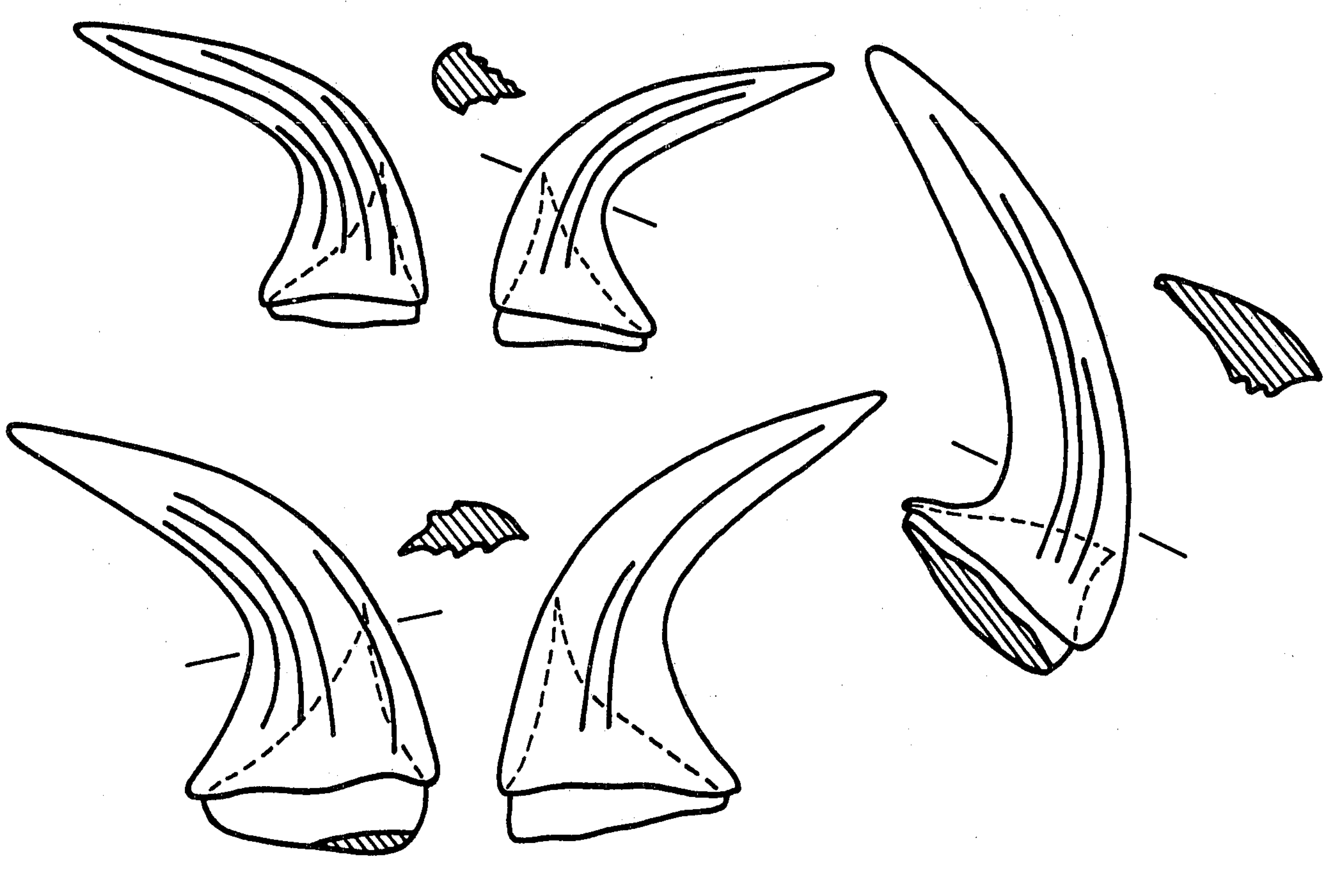

Figure 35.—Elements of the apparatus of *Walliserodus ethingtoni* (Fåhraeus) *sensu* Löfgren (1978).

(1974) found it in the Cobbs Arm Limestone (Chazyan) of north central Newfoundland, and Fåhraeus (1970) listed this species among the conodonts that he found in the Table Head Formation of western Newfoundland. Repetski and Ethington (1977) found a few specimens in the Womble Shale of west central Arkansas. Löfgren (1978) recovered it from Lower Ordovician (Kundan) strata of central Sweden, and Dzik obtained it from erratic boulders in Poland. By contrast our forms are restricted to rocks of Canadian age, so that the species is a long ranging one if our specimens prove to be conspecific with those reported previously.

Range in the Pogonip.—Fillmore Formation, lowest occurrence at 240.8 m (790 ft) in section C and continuing to near the top of the formation.

Number of specimens.—Symmetry variants, 266; asymmetrical elements, 59.

Repository.—Figured asymmetrical elements UMC 1112–6, 7; unfigured asymmetrical element UMC 1112–8; figured scandodiform element UMC 1112–9; unfigured scandodiform element UMC 1112–10; figured subsymmetrical element UMC 1112–11.

? New Genus 1
Pl. 13, fig. 17

? *Acodus* sp. MÜLLER, 1964, p. 96, Pl. 12, figs. 2a, b, 9.
Drepanodus acutus Pander. DRUCE & JONES, 1971, p. 73, Pl. 20, figs. 5a–7c, text-fig. 24a.
Drepanodus tenuis Moskalenko. JONES, 1971, p. 65, Pl. 3, figs. 3a–4b, Pl. 8, figs. 9a–c.
? *Drepanodus tenuis* Moskalenko. MÜLLER, 1973a, p. 38, Pl. 6, figs. 1a–3b, 5t–c, 6.

Stout, continuously curved elements whose cusp is ellipsoidal in cross section. A prominent linear ridge interrupts the smooth surface toward the front of the element. Posterior face of ridge is normal to surface of element; anterior to the blunt crest of the ridge the surface of the cusp maintains its normal contour. Ridge begins near base, attains greatest prominence in region where cusp is most strongly curved, and attenuates distally. Basal region is modestly inflated; basal funnels project far beyond basal margins in those specimens which retain them. Basal cavity is obscured by thermal alteration, and its form could not be established.

Remarks.—These specimens appear to be identical to those from the Ordovician of Australia that Jones (1971) and Druce and Jones (1971) identified with the above-listed species of *Drepanodus*. They do not correspond to *Drepanodus* Pander in the morphologic (form-generic) sense in which these species were defined, nor do they stand close to any of the elements in the multielement interpretation of that genus (Lindström 1971, 1973). We cannot reassign them to any other Ordovician genus with confidence, however. They are distinctive elements among the conodonts of the lower Fillmore, but our collections are too meager to permit a thorough assessment of them.

Müller's (1973a) collections from northern Iran include specimens that may belong here also, although the associated species indicate somewhat greater age than that part of the Pogonip from which we obtained our material.

Occurrence.—Druce and Jones (1971) reported elements of this kind from the Ninmaroo Formation of Queensland, Australia, and Jones (1971) found them in the Pander Greensand, the Jinduckin Formation and the Ooloo Limestone, all from northwestern Australia. Müller (1964, 1973) illustrated specimens that may belong here in his study of Lower Ordovician conodonts from South Korea and also in his work on conodonts from northern Iran.

Range in the Pogonip.—Lower Fillmore, Section C (19.8 through 36.6 m [65 through 120 ft]; ? at 84.7 m [278 ft]).

Number of specimens.—12.

Repository.—Figured specimen UMC 1112–12.

New Genus 2
Pl. 13, figs. 18–20, 24

? *Rhipidognathus* sp. ETHINGTON & CLARK, 1964, p. 695–698.

A few blade-shaped specimens from the upper half of the Fillmore Formation are unlike any previously named conodont elements. Several morphologies are included, but none is represented by more than a few specimens so that they cannot be evaluated satisfactorily. The most common type is characterized by a reclined, poorly differentiated cusp with one flat face and one strongly carinate face. Edges of the cusp are blunt; they are produced anteriorly and posteriorly to develop the blade-like outline, which varies considerably among the few specimens available. In some cases the oral margin is serrate, suggesting incipient denticulation, whereas in one specimen the oral margin is blunt and unmodified. Lateral surfaces of the elements display faint striae that begin well above the basal margin and continue to the distal edge. The region between the origin of the striae and the basal margin is depressed to form a longitudinal basal trough. Basal cavity is shallow; commonly a heavy basal funnel protrudes far beyond the basal margin of the element.

Remarks.—These specimens probably represent a new genus, but we do not have enough of them to define a genus satisfactorily. We are uncertain, even, whether all of the specimens we considered here belong together.

Occurrence.—The specimen (see Pl. 13, fig. 18) from the El Paso Group that we previously (1964) identified with question as a species of *Rhipidognathus* almost certainly is congeneric with some of the specimens reported here. It is less robust than our material from the Pogonip, does not show striae, and is more clearly bladelike. However, the overall shape of the element, particularly the basal region, supports affinity. Such elements must be uncommon in the El Paso also, for Repetski (1975) did not encounter them in a systematic study of the El Paso Group. Brand (1976) found these forms in the Kindblade Formation of Oklahoma where they also are rare.

Range in the Pogonip.—These elements occur in the Fillmore Formation in the interval between 76.2 and 237.7 m (250 and 780 ft) above the base at Section H.

Number of specimens.—7.

Repository.—Figured specimens UMC 1112–13–15; unfigured specimens UMC 1112–16, 17.

New Genus 3
Pl. 13, figs. 21, 23, 25–27

Acodus oneotensis Furnish. MÜLLER, 1964, p. 95–96, Pl. 13, figs. 1a, b, 8; DRUCE & JONES, 1971, p. 56–57, Pl. 12, figs. 3a–7c, text-fig. 20; JONES, 1971, p. 44, Pl. 1, figs. 6a–7c, (*non* fig. 5, Pl. 8, figs. 1a–c; MÜLLER, 1973a, p. 26–27, Pl. 7, figs. 1, 3–8.
Oistodus sp. ETHINGTON & CLARK, 1971, p. 69, Pl. 1, fig. 2.
? *Oistodus inaequalis* Pander. DRUCE & JONES, 1971, p. 76, Pl. 12, figs. 10a–13b, text-fig. 25a.
? *Oistodus lanceolatus* Pander. DRUCE & JONES, 1971, p. 77–78, Pl. 6, figs. 6a–8c, text-fig. 25b; MÜLLER, 1973a, p. 40–41, Pl. 8, figs. 3–5.
? *Acodina euryptera* ABAIMOVA, 1975, p. 33–34, Pl. 1, figs. 7–9, text-fig. 6(7, 8).
? *Acodina lirata* Stauffer. ABAIMOVA, 1975, p. 34–35, Pl. 1, figs. 11, 12, text-fig. 6(4).
? *Acodina lanceolata* Stauffer. ABAIMOVA, 1975, p. 35–36, Pl. 1, fig. 13, text-fig. 6(9).
? *Acodina navicula* ABAIMOVA, 1975, p. 36–37, Pl. 1, figs. 15, 16, text-fig. 6(5, 6).
? *Acodus aliformis* Abaimova. ABAIMOVA, 1975, p. 41–42, Pl. 2, fig. 2 (*non* figs. 1, 3).
Acodus ? sp. MOUND, 1968, p. 407, Pl. 1, figs. 16, 28.
Acontiodus bicurvatus (Stauffer). MOUND, 1968, p. 407, Pl. 1, figs. 17, 18, 29–31, 33, 34.
New genus REPETSKI & ETHINGTON, 1977, p. 95, Pl. 1, fig. 6.

This species includes a symmetry transition of bladelike elements and an oistodiform element. All of the elements have the cusp constructed wholly of albid matter.

Anterior and posterior edges of bladelike elements generally are sharp, but the largest individuals have blunt edges. Basal region is bent inward from the plane of the cusp and may be somewhat twisted. The base is strongly expanded inward; outer basal flare may be of comparable magnitude, or it may be very slight. Basal cavity is of moderate depth; the deeper part is drawn out into a slender cone whose sharp apex is directed anteriorly upward toward the leading edge of the cusp. Outer face of cusp bears prominent median costa that extends from the basal margin to the apex of the cusp. Costa is most prominent basally and dies away distally to a median convexity. Position of costa is medial on distal part of cusp, but it may be displaced to either side of the midline toward the base. Commonly the anterior edge is deflected inward near the base, and the area between this edge and the costa on such specimens forms an inward directed face. In many individuals the basal margin is concave between the edges and the costa. Most commonly the inner face of the cusp is gently convex transversely, but it may bear a faint median ridge.

The oistodiform elements have a flexed, bladelike cusp whose inner (concave) face has a narrow, low, rounded costa that is sharply defined and located approximately along the midline. This costa is increasingly well developed distally but is obscure near the base. The opposite face of the cusp is transversely convex; some specimens show a faint suggestion of a ridge in corresponding position to the costa, but it is never differentiated clearly. Edges of cusp are sharp. Leading margin is continuously curved along length, perhaps with slightly shorter radius of curvature basally than distally. Other margin is sinuous, distally concave, and proximally convex. Rear edge abuts proximally against upper margin of base. Basal region is low and relatively short as compared to length of cusp; the free upper margin of the basal region is about one-fourth the length of the posterior edge of the cusp. Base is swollen to the inside at about midlength, but with no corresponding swelling to opposite side. Swollen region is continued upward into area where costa becomes differentiated on the cusp. The basal cavity is shallow, its apex directed anteriorly and upward to a point somewhat ahead of the middle of the base. Anteriorly from this point it is extremely shallow whereas posteriorly it remains somewhat deeper. Basal margin is sinuous, concave anteriorly and posteriorly with a subcentral lobe in the position of the basal swelling. Anterior basal angle is variable, but for most specimens it is less than 45°.

Remarks.—The bladelike elements show a transition from drepanodiform elements that have sharp anterior and posterior edges and lie in a plane through elements that are flexed and bowed along their length so that the edges are laterally directed and the element is almost symmetrical.

This form has been identified previously with "*Acodus*" *oneotensis* Furnish (see, e.g., Müller 1964, 1973a). Although these two species occur together in the Pogonip and in the Manitou Formation of Colorado (undescribed collection of RLE), they are not closely related. Their apparatuses are wholly different from each other. Further, Furnish did not find specimens of N. Gen. 3 in his collections from the Prairie du Chien beds of the Upper Mississippi Valley from which "*A.*" *oneotensis* was reported for the first time.

A name for this genus will be provided in a paper by Repetski and Ethington (in preparation) based on abundant and well-preserved material from other collections. Most of the specimens from the Pogonip are quite fragmentary and inadequate for clearly defining the range of morphologies of a species.

Occurrence.—This species is present in the Manitou Formation of Colorado (Ethington and Clark 1971), in the El Paso Group in its type area in west Texas (Repetski 1975, and in press), and in the Collier Formation in Arkansas (Repetski and Ethington 1977). Specimens from the McKenzie Hill Formation of Oklahoma that Mound reported as *Acodus?* sp. and *Acontiodus bicurvatus* (Stauffer) probably are bladelike elements of this species. Druce and Jones (1971) found this species in the Ninmaroo Formation of Queensland, and Jones (1971) reported it from the Pander Greensand and Jinduckin Formation of Northwestern Australia. Müller (1964, 1973a) reported it from the Shirgesht Formation of northern Iran and from Lower Ordovician strata of South Korea. Several form-species from the Lower Ordovician rocks along the middle reaches of the Lena River on the Siberian Platform reported by Abaimova (1975) seem to consist largely of white matter and to have similar general appearance to some of the bladelike elements.

Range in the Pogonip.—We found this species in the upper House at the type section (H–H–18 through H–H–25). Larsen found it between 60.4 and 159.3 m (198 and 522.5 ft) in the type House, between 6.7 and 102.3 m (22 and 335.5 ft) at Section B of Hintze (1951), and between 70.4 and 122.4 m (231 and 401.5 ft) in the Willden Hills.

Number of specimens.—Bladelike elements, 361; oistodiform elements, 138.

Repository.—Figured bladelike elements UMC 1112–18–20; UMC 1113–1; figured oistodiform element UMC 1113–2; unfigured oistodiform element UMC 1113–3.

? New Genus 3
Pl. 3, fig. 26

? *Acodus aliformis* ABAIMOVA, 1971, p. 76–77, Pl. 10. fig. 5; ABAIMOVA, 1975, p. 41–42, Pl. 2, figs. 1, 3 (*non* fig. 2).

Bladelike distacodontid, nearly bilaterally symmetrical, with continuously curved posterior margin developed as sharp edge. Anterior margin blunt or rounded; may be continuously curved but commonly has straight basal reach and gently curved distal region. In the latter case, the change from straight to curved margin is reflected as a hump in the anterior outline. A faint, rounded ridge extends along either face adjacent to the anterior margin and is continuous from near the base to near the tip. Base sometimes inflated anteriorly. Basal outline has shape of teardrop. Cavity is a shallow asymmetrical cone which tapers markedly toward the anteriorly located tip. Region about the basal cavity is dark; remainder of element is albid.

Remarks.—The element described above closely resembles the illustration that Abaimova (1971, 1975) prepared for the holotype of *"Acodus" aliformis,* as well as that of one of the other illustrated specimens that she identified with that species. The third specimen that she figured seems clearly to belong in the transition series discussed previously under New Genus 3.

This form occurs in well-preserved material from the Manitou Formation of Colorado where it is associated with elements that we consider without question to belong in the apparatus of New Genus 3, and the same association occurs in the House Limestone as well as in the collections of Abaimova. We are uncertain whether this association reflects a common apparatus, however. If it does, these simple elements must be present in that apparatus in relatively small numbers in comparison to the elements of the transition series and the oistodiform element. The albid cusp and shallow basal cavity are consistent with assignment to New Genus 3. However, these elements also occur in the same part of the section in the Manitou and in the House as *Clavohamulus densus* Furnish, a species that also is typified by being almost exclusively albid except for the shallow basal region. Some of the specimens in the Manitou collection show the lower anterior portion of the blade markedly swollen, with the remainder of the blade being thin. This configuration suggests possible affinity to *Clavohamulus* with the swollen region analogous to the bulb on *C. densus* and the thin part of the blade corresponding to the cusp of that species.

Occurrence.—Elements of this type are present in the lower Manitou Formation in east central Colorado and probably are present in Abaimova's (1971, 1975) collections from Lower Ordovician strata in the middle reaches of the Lena River on the Siberian Platform.

Range in the Pogonip.—Larsen recovered elements of this type in the upper half of the House Limestone in the type area; he found it to have the same general range at Section B of Hintze (1951) and in the Willden Hills.

Number of specimens.—50.

Repository.—Figured specimens UMC 1113–4; unfigured specimens UMC 1113–5, 6.

? New Genus 4
Pl. 14, figs. 1–3

? *Erismodus* sp. BRADSHAW, 1969, p. 1150, Pl. 136, fig. 1, text-fig. 3G.

Apparatus consists of acodiform, cordylodiform, and trichonodelliform elements. Cusps contain variable amounts of white matter; auxiliary denticles are broad and stubby and consist wholly of albid material. Basal regions are strongly inflated.

Acodiform element has stubby cusp whose cross section is nearly circular. An anterior costa is located at the midline distally but diverges to one side basally. Costa is asymmetrical; that side toward which it is displaced basally is nearly normal to adjacent surface; opposite side is not differentiated from general surface of element. Each side of the cusp has a planar, posteriorly facing shoulder that widens as it approaches the base. Each shoulder gives rise basally to a single posterolateral denticle. Denticles are broad and short and have unequally biconvex sections. Base of element is strongly flared in the posterior direction to encompass a spacious conical basal cavity.

Cusp of cordylodiform element is erect, unequally biconvex; outer face is gently swollen transversely, inner surface with strongly rounded median ridge flanked by linear depressions near edges. Edges are blunt to sharp. Anterior edge is turned toward more convex (inner) side of cusp and becomes quite broad basally. It may display a faint knob, sometimes with white matter, suggesting an anterior denticle, although no clearly differentiated denticles are present in this position on any of the specimens at hand. Posterior denticle is stubby to slender, sharp-edged, and biconvex in section; it consists wholly of white matter. Cusp and denticle subtend an angle of ca. 30–40°; they may lie in a common plane, or the denticle may be inclined outward relative to the cusp. Base is strongly inflated to inside; basal cavity is shallow cone.

Trichonodelliform element is generally similar to acodiform element but lacks anterior costa and is bilaterally symmetrical. Anterior surface of cusp is broadly rounded, posterior surface is more strongly rounded and may carry an obscure, median, hairlike ridge. Basal cavity flares posteriorly around plane of symmetry but thins toward both extremities.

Remarks.—The elements of this species are suggestive of some of the elements of *Multioistodus auritus* in the tendency toward development of stubby auxiliary denticles consisting of white matter. The apparatus is lacking an element with quadrilateral (distacodiform) symmetry, however, if it is based on the specimens in our present collections; and this lack precludes identifying this species with *Multioistodus* should it be substantiated by further collecting. Lack of distacodiform elements and of oistodiform elements, together with the development of clearly differentiated denticles, rules against assignment to *Pteracontiodus.* The apparatus of *Tricladiodus clypeus* Mound has not been reconstructed as yet, but work in progress by William Mills (personal communication) on material from the upper part of the West Spring Creek Formation indicates that a symmetry transition of elements with blade-shaped denticles is present. That material is wholly hyaline, however, and the denticles are much more prominent than in the forms reported here.

Golden (1969) found elements that are very similar in overall morphology to the elements described above in his study of conodonts from the Everton Formation of northern Arkansas. He reported them as a species of *Multioistodus* in which he included four kinds of elements, one of which is very close to the ones we here interpret as the acodiform element of *M. auritus*. The other elements in Golden's species correspond closely, although differing in detail, to the three elements we combine here. Our specimens are not associated with forms that resemble the fourth element of Golden's species. Although all of our collection comes from one sample in the Lehman Formation, all of the elements are sufficiently abundant there that probability must be small that the absence of the fourth element is due to sampling inadequacy. We are tempted, therefore, to conclude that Golden's reconstruction of the apparatus is incorrect. However, McHargue (1975) independently reconstructed from among the conodonts of the Joins Formation the same basic apparatus as that recognized by Golden but considered it to represent a species of *Tricladiodus*. This leaves us uncertain what to do with our collection; we list it tentatively as a new genus since the apparatus seems not to correspond to that of any of the genera with elements like these. Nevertheless, the morphologic elements among the largely hyaline conodonts such as *Multioistodus, Pteracontiodus,* and *Tricladiodus* seem to us to show greater variability than is typical of genera with largely albid elements, so that further research may prove that our interpretation of those genera has been too restrictive. In that event, this species may be shown to fall within the limits of one of these genera.

Occurrence.—In addition to the possibly related forms from the Everton and Joins Formations mentioned in the discussion above, Bradshaw (1969) illustrated a specimen from the lower Fort Peña Formation of west Texas that resembles the cordylodiform element.

Range in the Pogonip.—We found these elements only in the sample collected 9 m (30 ft) above the base of the Lehman Formation at Crystal Peak.

Number of specimens.—Acodiform element, 25; cordylodiform element, 77; trichonodelliform element, 13.

Repository.—Figured acodiform element UMC 1113–7; unfigured acodiform element UMC 1113–8; figured cordylodiform element UMC 1113–9; unfigured cordylodiform element UMC 1113–10; figured trichonodelliform element UMC 1113–11; unfigured trichonodelliform element UMC 1113–12.

New Genus 5
Pl. 4, figs. 4, 8

Two specimens, both with the basal extremity missing, cannot be identified with any previously described elements. Their overall morphology is suggestive of the leading end of a ski. They are broad and have one generally flattened surface; edges are sharp and curled away from the flattened surface. Margins of the specimens are subparallel over most of length but distally taper abruptly to a blunt point which is turned away from the flattened surface (like the tip of a ski). Edges and distal extremity are albid, medial region is hyaline. Posterior surface (upper in terms of morphologic analogy to ski) has median ridge that rises markedly in the basal direction and carries a hairlike costa at the plane of symmetry. A deep basal cavity penetrates to level at which distal end begin to turn posteriorly.

Range at Ibex.—These specimens came from a sample collected 4 m (13 ft) below the *Eofletcheria* Bed in the Crystal Peak Dolomite at Crystal Peaw.

Number of specimens.—2.

Repository.—Figured specimens UMC 1113–13, 14.

ASSOCIATED MICROFOSSILS

Genus ASTRASPIS Walcott, 1892

Type species.—*Astraspis desiderata* Walcott, 1892.

? ASTRASPIS sp.
Pl. 14, fig. 6

Astraspis? tubercle NITECKI, GUTSCHICK & REPETSKI, 1975, p. 4, fig. 7.

Remarks.—The fossils considered here are of uncertain affinity, although, as noted by Nitecki and others (1975), they show similarity to ossicles from *Astraspis,* an ostracoderm. They are like the specimen from the Oil Creek Formation figured by those authors in having a flattened base that seemingly is devoid of fractured margins that would indicate removal from a larger and more continuous sheet or body of mineralized tissue. Overall shape is that of a flattened cone with fluted sides. Many specimens appear to be worn distally with the ridges subdued or missing over the top of the studlike fossil. Some of them show local differentiation of albid matter in contrast to hyaline or translucent material in adjacent areas. In this respect they resemble conodonts.

Occurrence.—Joins Formation (McHargue 1975) and Oil Creek Formation (Nitecki and others 1975) of Oklahoma.

Range in the Pogonip.—Upper Kanosh at Fossil Mountain, abundant in those samples that contain them.

Number of specimens.—156.

Repository.—Figured specimen UMC 1113–18.

Genus MILACULUM Müller, 1973b

Type species.—*Milaculum ruttneri* Müller, 1973b.

Remarks.—Müller (1973b, p. 217–218) suggested that these phosphatic microfossils might be related to conodonts and provide insight into the evolution of that group of fossils. Although they commonly occur with conodonts, no affinity seems evident. They do not resemble conodonts, in either internal structure or external morphology. Nevertheless, a variety of morphologies developed within *Milaculum* during Early and Middle Ordovician time, so that, when better documented, these forms should be valuable for biostratigraphy despite their uncertain affinity.

MILACULUM aff. M. ETHINCLARKI Müller
Pl. 14, fig. 5

Form B ETHINGTON & CLARK, 1965, p. 204, Pl. 1, fig. 20.
aff. *Milaculum ethinclarki* MÜLLER, 1973b, p. 223–224, Pl. 34, figs. 5, 6, 8.

Remarks.—Müller (1973b, Pl. 34, fig. 5) selected as the holotype of *M. ethinclarki* a specimen from the Middle Ordovician Kirkfield Formation of southeastern Ontario. He noted, but did not emphasize in his definition, that this specimen is shaped like a "dog biscuit," i.e., broadest at the spatulate ends but slightly narrower in the middle. The lower surface is characterized by pits set in rows that intersect to form a quadrate pattern, with the pits in adjacent pairs of rows set at opposite corners of a square. The upper surface is covered with closely crowded, but randomly arranged, conical nodes.

Müller also assigned to *M. ethinclarki* the specimens from the Columbia Ice Fields section of Alberta that we (1965, p. 204) identified as inconspicuously as possible as Form B. They show the same sort of randomly arranged external nodes and a comparable pattern of pits on the underside as the holotype of *M. ethinclarki.* However, the specimens from Alberta as well as identical forms in our collections from the Pogonip are invariably ovate in outline and shallowly arched, both longitudinally and transversely. Further, they have been found only in strata of late Early Ordovician age and thus are considerably older than the type specimen of Müller's species. It seems best at present, to separate these two forms until more conclusive data can be gathered regarding the stratigraphic and geographic distributions of these morphotypes.

Occurrence.—Lower Ordovician (Arenigian) strata of the Columbia Ice Fields Section, Alberta (Ethington and Clark 1965).

Range in the Pogonip.—Wah Wah through lower Kanosh at Fossil Mountain.

Number of specimens.—14.

Repository.—Figured specimen UMC 1113–19.

MILACULUM MUELLERI n. sp.
Pl. 14, figs. 7, 9

Helmet-shaped representative of *Milaculum* dominated at one end of the longitudinal axis by a high, slender, subcylindrical region that is reclined at an angle of about 30° to the basal margin. This cylinder is terminated abruptly at the lower margin in the direction toward which it is reclined; in the opposite direction its basal reaches are drawn out into a brim which distally is turned upward. Mammillary nodes are distributed over the entire outer surface. Overall, the nodes show no preferred arrangements relative to each other, but locally, e.g., on the surface of the brim or on the flanks of the cylinder, they may show alignment. The nodes are closely crowded basally. They increase in size progressively from the base upward; the heaviest nodes form an irregular "crown of thorns" near the top of the cylinder. These forms are wholly hollow. The inner surface at magnification of ca. 100 diameters seems to have faint relief, but no geometric pattern of pits or elevations can be discerned.

Remarks.—The external shape and the upward increase in size of the nodes differentiate this form from any of the species reported by Müller and from any of the other species of *Milaculum* that occur in the Pogonip. The shape is somewhat like that of a specimen from the Oil Creek Formation of Oklahoma that Nitecki, Gutschick, and Repetski (1975) illustrated as an unnamed species of *Milaculum.* That form seems to have a globular region to one end of its longitudinal axis that is transitional into a widened brim. The subspherical main region has heavy but irregularly spaced nodes that resemble those near the top of the cylindrical portion of *M. muelleri.* The brim of the specimen from Oklahoma does not bear nodes, but shows poorly defined but parallel ridges oriented at an angle of ca. 45° to the longitudinal axis of the specimen. One of our specimens of *M. muelleri* has alignments of nodes on the brim that are oriented at about 30° to the longitudinal axis. The form from the Oil Creek and *M. muelleri* have closer affinity with each other than either has to any other known species of *Milaculum,* but they probably are not conspecific.

Derivation of name.—For Dr. Klaus. J. Müller of Bonn University who first described and named species of *Milaculum.*

Range in the Pogonip.—Juab through basal Kanosh (I–K–4) at Fossil Mountain.

Number of specimens.—21.

Repository.—Figured specimens UMC 1113–20 (holotype), UMC 1114–1 (paratype).

MILACULUM RETICULATUM n. sp.
Pl. 14, figs. 14–17

Helmet-shaped species of *Milaculum* whose aboral margin, as seen in lateral view, is shallowly concave. Oral outline rises at an angle of 30–35° to aboral margin to highest point, descends steeply and then more gently to form the brim of the helmet. Sides are nearly normal to the basal plane but somewhat constricted near the center. Surface bears subparallel ridges in two series that extend across the surface from opposite sides and intersect each other to form a netlike surface ornament. Near the base they intersect at about 60° to enclose rhombic pits; on the flattened crown and brim they intersect nearly at a right angle so that the pits are approximately square. The under surface is completely excavated. Poorly defined nodes are suggested in the lumen at magnifications of ca. 100 diameters; no preferred orientation of these low nodes was observed.

Remarks.—This form is very similar to *M. spinoreticulatum* n. sp. defined below. However, no trace of external spines or nodes is to be found on any of the specimens of *M. reticulatum* available to us. They do not co-occur with *M. spinoreticulatum* in the samples from which they were obtained, but those samples came from within the stratigraphic range of that form. The two may be closely related.

Derivation of name.—To draw attention to the netlike sculpture of the external surface.

Range in the Pogonip.—Upper Fillmore (244 and 247 m [800 and 810 ft] in Section H).

Number of specimens.—12.

Repository.—Figured specimens UMC 1114–2 (holotype), 3 (paratype).

MILACULUM ROSSI n. sp.
Pl. 14, figs. 12, 13

Helmet-shaped species of *Milaculum.* Aboral margin is straight when viewed from side. Upper outline is sinuous; arched at one end, then descending in nearly straight line to opposite extremity. Sides are nearly parallel and normal to plane of base. Viewed from above, one end is rounded, the other spatulate. Mammillary nodes are aligned in rows that trend subparallel to aboral margin. They are not rigorously restricted to these rows, however, so that in many areas on the surface, and particularly at the highest point, random arrangement seems to occur. Nodes are crowded but are not contiguous. Under side is totally excavated. No pits or elevated features are visible within the lumen at ca. 100 diameters magnification.

Remarks.—The gross lateral form of this species resembles that of *M. reticulatum* and of *M. spinoreticulatum* described here. They are distinct, however, in that they display nodes or ridges aligned in two series rather than only one as is the case in *M. rossi.* They show no regions where the nodes are randomly arranged, whereas such distribution occurs particularly at the crown of *M. rossi.*

Derivation of name.—For. Dr. R. J. Ross, Jr., in recognition of his contributions to the geology and paleontology of the Ordovician of the Great Basin

Range in the Pgonip.—Wah Wah and lower Juab at Fossil Mountain.

Number of specimens.—15.

Repository.—Figured holotype UMC 1114–4.

MILACULUM SPINORETICULATUM n. sp.
Pl. 14, figs. 10, 11

Form A ETHINGTON & CLARK, 1965, p. 204, Pl. 1, fig. 17.

Helmet-shaped or cap-shaped representatives of *Milaculum,* depending on whether or not a brim is present at one end of the longitudinal axis. Both ends are rounded, sides are parallel and essentially vertical. Basal outline is shallowly concave when viewed from the side. Nodes cover the external surface; they are aligned in two series. One consists of alignments along the sides and subparallel to the lower margin. The other has the nodes aligned in rows beginning at the basal margin on one side and extending transversely across the specimen to the basal margin on the opposite side. Further these latter rows are arranged radially, with those toward each end nearly recumbent and those near the center almost vertical. Along the midline these two series intersect each other so that several subparallel longitudinal rows of nodes are produced. The nodes near the lower margin of this form are smaller than those toward the crown. Specimens are totally hollow and seem to have faint nodes in the lumen when viewed at high magnification (ca. 100 diameters).

Remarks.—This form is suggestive of *M. reticulatum* in having the ornament of the surface distributed in rows or ridges that cross each other.

Derivation of name.—In recognition of the reticlulate pattern subtended by the two series of aligned nodes.

Occurrence.—Lower Ordovician (Arenigian) of the Columbia Ice Fields Section, Alberta (Ethington and Clark 1965).

Range in the Pogonip.—Common in the upper 94 m (300 ft) of the Fillmore; one specimen found 44.5 m (146 ft) above the base of the unit in Section C.

Number of specimens.—61.

Repository.—Figured specimens UMC 1114–5 (holotype), UMC 1114–6 (paratype); unfigured specimen UMC 114–7 (paratype).

Genus PTILONCODUS Harris, 1962
Type species.—*Ptiloncodus simplex* Harris, 1962.

PTILONCODUS SIMPLEX Harris
Pl. 14, figs. 18–20

Ptiloncodus simplex HARRIS, 1962, p. 206–207, Pl. 1, figs. 5a–c, 6; MOUND, 1965b, p. 33, Pl. 4, fig. 20; ETHINGTON & CLARK, 1965, p. 203–204, Pl. 1, fig. 8; BARNES & POPLAWSKI, 1973, p. 785; TIPNIS, CHATTERTON & LUDVIGSEN, 1978, Pl. 3, fig. 30; TIPNIS, 1979, p. 51–54, Pl. 8.1.

Remarks.—The comments we made earlier (1965) regarding the affinities and significance of these fishhook-shaped fossils still obtain. Most authors who have discussed these fossils have concluded that they are not conodonts despite their assignment to that group of fossils by Harris (1962). Notable exceptions are Mound (1965b) and Bordeau (1972), both of whom argued for conodont affinities on the basis of presumed structural and compositional similarity to unquestioned conodonts. Mound (1965b) claimed that petrographic examination demonstrated that the substance of *Ptiloncodus simplex* is apatite in the form of numerous crystallites arranged in fibers. Bordeau (1972) observed that specimens of *Ptiloncodus harrisi* from the Viola Formation display the "characteristic amber and white appearance of conodonts." Specimens here assigned to *P. simplex* typically seem to be largely comprised of albid matter surrounded by a relatively thin region of hyaline material. We are not convinced, however, that development of white matter is sufficient grounds for assigning these specimens to the conodonts. We have observed white matter in generally hyaline fossils from Pennsylvanian strata that normally are interpreted as representing fish remains, e.g., *Cooperella* Gunnell, *Cooleyella* Gunnell. Without evidence for centrifugal growth of lamellae and of a basal cavity or pit, none of which has been demonstrated for *Ptiloncodus,* relationship to conodonts is conjectural. Further the "Mickey Mouse ears" that are present at the opposite end of the shaft from the hook on complete specimens seem not to have counterparts on any known conodonts. Examination of the distal part of the shaft with SEM has shown no clearly defined attachment scar such as was reported by Harris (1962), nor is a pit or cavity present there into which the ears might have been fit as a bizarre basal funnel type of structure.

Some of the specimens in our collection have the shaft cylindrical to the distal end. Others show the development of small knobs to either side to which the ears were affixed. A younger species, *P. harrisi,* reported from the Viola Limestone, has these knobs greatly accentuated.

Occurrence.—This species is known to occur in the Joins Formation in southern Oklahoma (Harris 1962, McHargue 1975), in the section at the Columbia Ice Fields in Alberta (Ethington and Clark 1965), in the

Mystic Conglomerate in Quebec (Barnes and Poplawski 1973), and in the Broken Skull Formation in the southern District of Franklin, Canada (Tipnis and others 1978). Tipnis (1979) described fused clusters of *P. simplex* specimens from low in the Antelope Valley Formation in the Monitor Range of central Nevada.

Range in the Pogonip.—We recovered *P. simplex* in the interval from low in the Wah Wah through the middle of the Kanosh at Fossil Mountain.

Number of specimens.—38.

Repository.—Figured specimens UMC 1114–8–10.

Genus UTAHPHOSPHA Müller & Miller, 1976

Type species.—*Utahphospha sequina* Müller & Miller, 1976.

UTAHPHOSPHA sp.

Pl. 14, figs. 21, 22

Remarks.—We found an almost complete specimen of a species of*Utahphospha* in the upper Fillmore, but unfortunately this specimen was lost while being studied. It resembled the type species in having a conical shape with an apical opening. The surface was set with widely spaced, circular ossicles that were of an amber color in contrast to the pale gray-brown of the tent-shaped body to which they were affixed. Whereas the ossicles of *U. sequina* are almost in contact, those of the form from the Fillmore were separated by spaces of the order of size of their own diameter. Further, they were generally flat rather than depressed like those of *U. sequina,* and each of them bore five or six short slender spines oriented at high angles to its surface.

The type species was obtained from Upper Cambrian rocks in the same general region from which we collected our Pogonip material. Although we cannot establish a new specific name on the basis of the fragment remaining in our collection, we note this occurrence to demonstrate that *Utahphospha* ranges into the Ordovician and that evolution seemingly resulted in modification of the surficial ossicles.

Range in the Pogonip.—The specimen, now lost, came from 244 m (800 ft) in Section H in the Fillmore Formation.

Number of specimens.—1 plus a fragment.

Repository.—Figured specimen UMC 1114–11.

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EXPLANATION OF PLATE 1

FIGURES *1–6.*—*Acodus deltatus* Lindström. *1,* oistodiform element, UMC 1086-17 (Mesa 6), X140; *2,* drepanodiform element, UMC 1086-9 (Mesa 610), X100; *3,* prioniodiform element, UMC 1086-6 (Mesa 610), X100; *4,* gothodiform element, UMC 1086-13 (Mesa 610), X120; *5,* distacodiform element, UMC 1086-11 (C 750), X80; *6,* trichonodelliform element, UMC 1086-15 (C 750), X120.

7.—*Acanthodus lineatus* (Furnish), UMC 1086-2 (Type House 462), X65.

8.—*Acanthodus uncinatus* Furnish, UMC 1086-4 (Willden Hills 308), X55.

9–13.—*Acodus* ? aff. *A. emanuelensis* McTavish. *9,* cordylodiform element, UMC 1087-5 (H 250), X70; *10,* gothodiform element, UMC 1087-4 (H 210), X130; *11,* drepanodiform element, UMC 1087-2 (H 210), X130; *12,* trichonodelliform element, UMC 1087-6 (H 210), X90; *13,* prioniodiform element, UMC 1087-1 (H 250), X90.

14.—aff. *Acodus gladiatus* Lindström s.f., UMC 1087-8 (Type House 369), X100.

15.—"*Acontiodus*" *iowensis* Furnish s.f., UMC 1088-2 (H-H-14), X125.

16.—"*Acodus*" *oneotensis* Furnish, UMC 1087-11 (Willden Hills 313.5), X130.

17.—*Acodus* sp. 1 s.f., UMC 1087-13 (C 120), X100.

18.—"*Acontiodus*" aff. "*A.*" *latus* Pander s.f., UMC 1088-4 (C 365), X100.

19,20.—? *Acodus* sp. 2 s.f. *19,* distacodiform element, UMC 1087-17 (C305), X115; *20,* acodiform element, UMC 1087-15 (C325), X115.

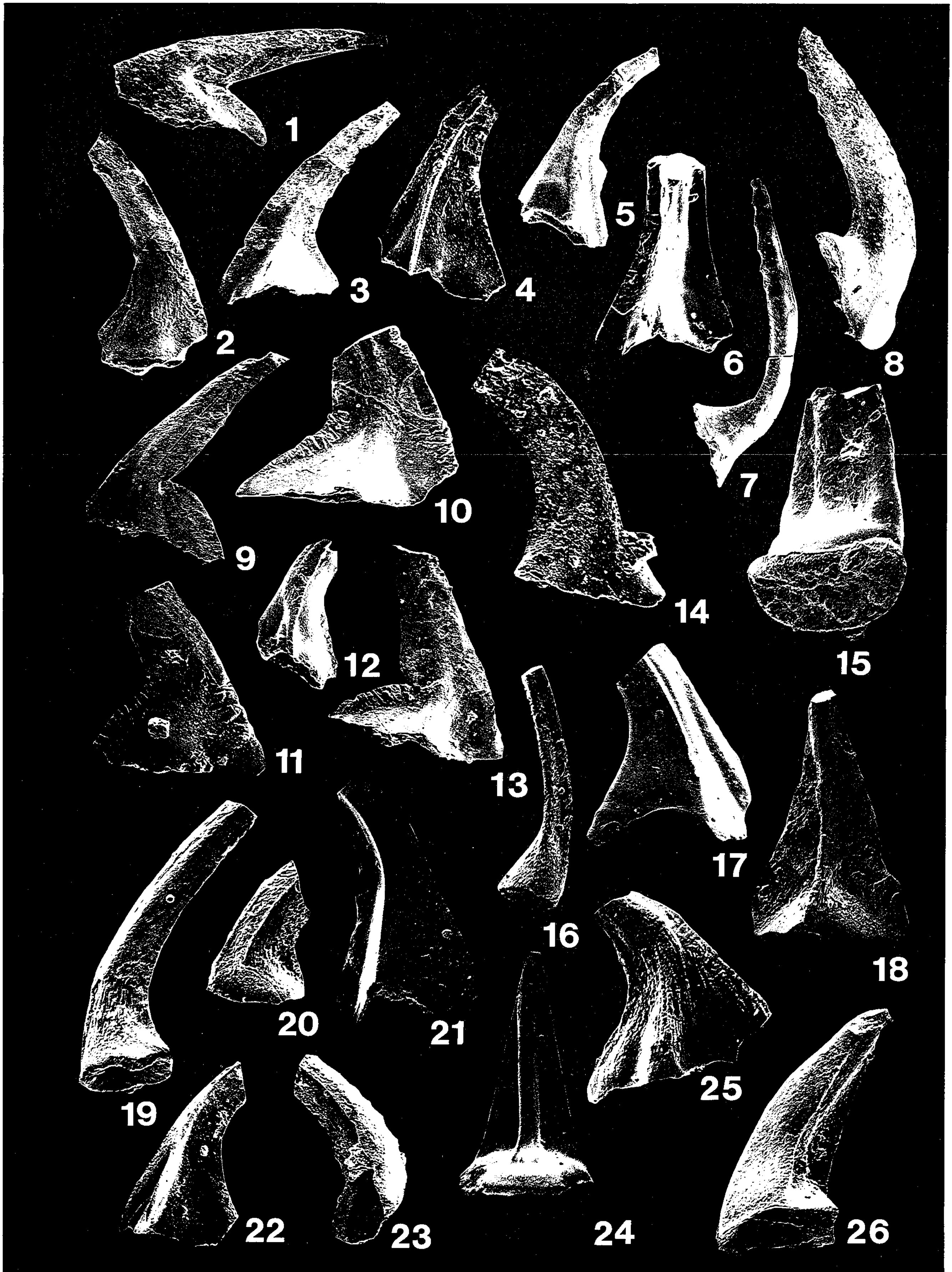
21.—"*Acontiodus*" sp. s.f., UMC 1088-9 (C 951), X115.

22,23.—? *Acodus* sp. 3. *22,* asymmetrical element, UMC 1087-19 (C 730), X85; *23,* symmetrical element, UMC 1087-18 (C 951), X115.

24.—"*Acontiodus*" *staufferi* Furnish s.f., UMC 1088-7 (H-H-20), X55.

25.—*Acodus* sp. 4, UMC 1087-20 (Type House 506), X225.

26.—"*Acontiodus*" *propinquus* Furnish s.f., UMC 1088-5 (H-H-10B), X100.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EXPLANATION OF PLATE 2

FIGURES *1-4.*—*Belodella robusta* n. sp. *1,* holotype, triangulariform element, UMC 1088-10 (CP-CP-4), X90; *2,* plano-convex element, UMC 1088-12 (CP-CP-4), X90; *3,* oistodiform element, UMC 1088-14 (CP-CP-5), X90; *4,* biconvex element UMC 1088-13 (CP-CP-5), X90.

5.—? aff. *Belodina* sp., UMC 1088-15 (CP-CP-4), X100.

6.—? aff. *Bryantodina* sp., UMC 1088-16 (CP-CP-8), X125.

7.—*Chirognathus* sp., UMC 1088-20 (CP-CP-7), X70.

8,11.—*Chosonodina rigbyi* n. sp. *8,* holotype, UMC 1089-3 (CP-L-11), X85; *11,* paratype, UMC 1089-4 (CP-L-12), X70.

9,10.—*Jumudontus gananda* Cooper. *9,* UMC 1088-8 (ST 195), X80; *10,* UMC 1088-7 (I-WW-7C), X110.

12.—*Chosonodina herfurthi* Müller, UMC 1089-2 (House, horizon unknown), X150.

13,14.—*Cordylodus prion* Lindström s.f., UMC 1089-18 (H-H-10A), 19 (H-H-9), X80 and X60, respectively.

16,17.—*Cordylodus intermedius* Furnish. *16,* subangulatus element, UMC 1089-16 (Section B 38.5), X60; *17,* intermedius element, UMC 1089-14 (Section B 27.5),

18,19.—*Cordylodus proavus* Müller. *18,* oklahomensis element, UMC 1090-2 (Type House 99); *19,* proavus element, UMC 1089-20 (H-H-7), X60.

20.—*Clavohamulus primitus* Miller, UMC 1089-9 (Type House, base) X150.

21.—*Clavohamulus densus* Furnish, UMC 1089-5 (H-H-9) X250.

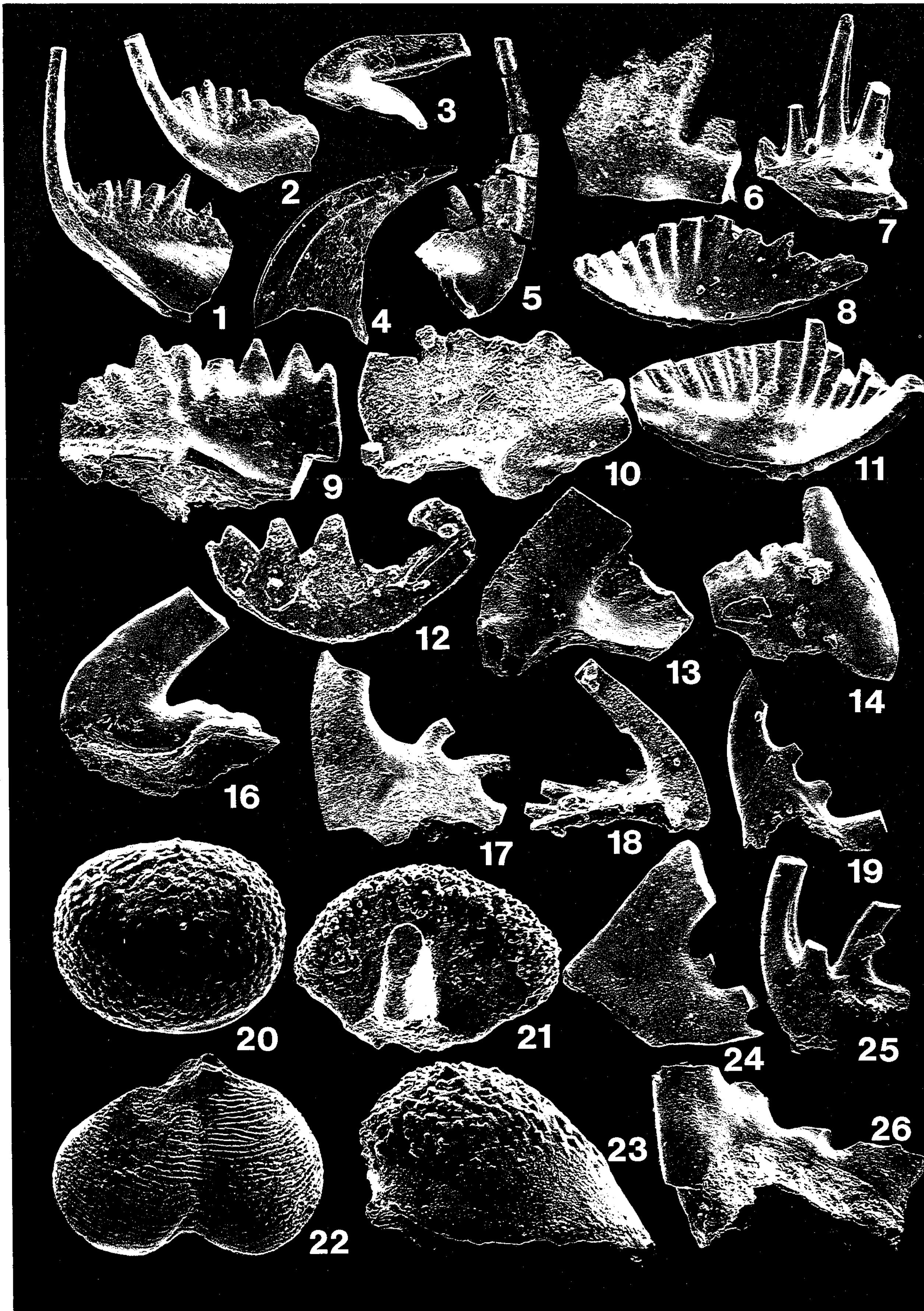
22.—*Clavohamulus* n. sp., UMC 1089-10 (Mesa 570), X175.

23.—*Clavohamulus elongatus* Miller, UMC 1089-7 (Notch Peak, 22 feet below top, House type locality), X200.

24.—*Cordylodus angulatus* Pander, angulatus element, UMC 1090-4 (H-H-19), X100.

25.—? *Cordylodus caseyi* Druce & Jones s.f., UMC 1089-12 (H-H-9), X55.

26.—*Cordylodus* sp. A s.f., UMC 1090-6 (H-H-9), X90.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EXPLANATION OF PLATE 3

FIGURE *1*.–*Dapsilodus ? nevadensis* (Ethington & Schumacher), UMC 1090-8 (CP-CP-4), X110.

2,3.–*Dischidognathus primus*, n. gen, n. sp. *2*, holotype, UMC 1090-11 (CP-L-10), X100; *3*, paratype, UMC 1090-12 (CP-L-11), X100.

4–6,12.–? *Drepanodus arcuatus* Pander. *4*, arcuatiform element, UMC 1090-15 (H 250), X90; *5*, oistodiform element, UMC 1090-18 (Mesa 610), X55; *6*, cf. arcuatiform element, UMC 1090-16 (H 750), X90; *12*, sculponeaform element, UMC 1090-17 (H 750), X55.

7.–*Drepanodus gracilis* (Branson & Mehl) s.f. *sensu* Lindström, UMC 1091-8 (H 890), X55.

8.–"*Drepanodus*" *parallelus* Branson & Mehl, UMC 1091-10 (C 800), X60.

9.–"*Drepanodus*" *simplex* Branson & Mehl *sensu* Druce & Jones, UMC 1106-1 (H-H-15), X50.

10,15.–Drepanodiform 1, UMC 1091-18 (Type House 292), X100 and X310, respectively.

11.–"*Drepanodus*" *toomeyi* Ethington & Clark, UMC 1091-14 (ST 115), X70.

13.–*Drepanodus* sp. 1, UMC 1091-15 (C 115), X90.

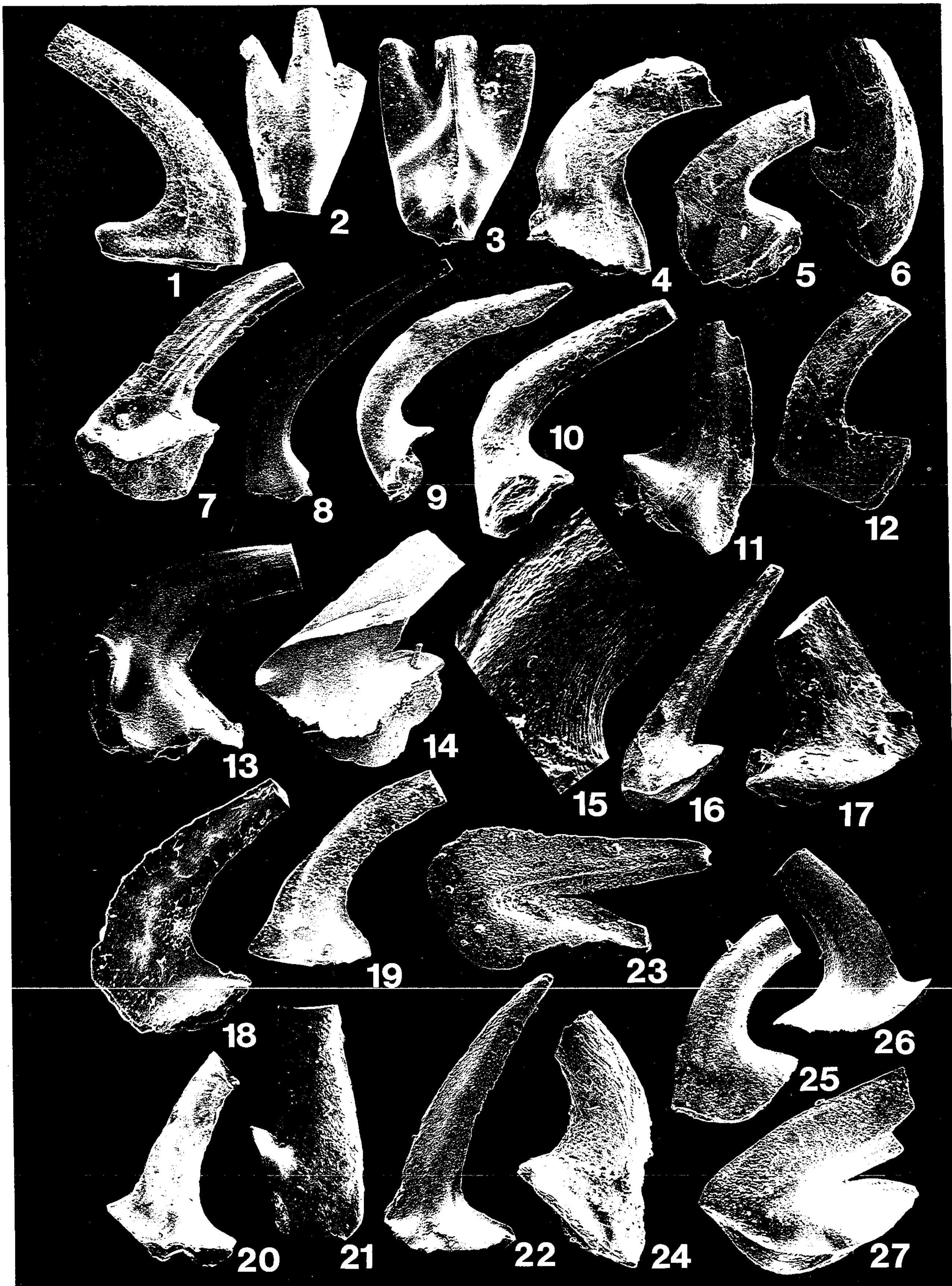
14.–*Drepanodus* ? sp. 2, UMC 1096-16 (ST 310), X80; bright streak across surface of specimen is an artifact.

16–17.–? *Drepanoistodus angulensis* (Harris). *16*, oistodiform element, UMC 1092-9 (CP-CP-8), X80; *17*, suberectiform element, UMC 1092-10 (CP-CP-3), X55.

18–21.–*Drepanoistodus angulensis* (Harris). *18*, scandodiform element, UMC 1092-1 (CP-L-7), X90; *19*, homocurvatiform element, UMC 1091-20 (CP-L-7); *20*, suberectiform element, UMC 1092-2 (CP-L-7), X60; *21*, oistodiform element, UMC 1092-3 (CP-L-7), X50.

22–24.–*Drepanoistodus* aff. *D. forceps* (Lindström). *22*, suberectiform element, UMC 1092-19 (H 750), X60; *23*, oistodiform element, UMC 1092-18 (Mesa 850), X125; *24*, homocurvatiform element, UMC 1092-17 (H 750), X80.

25–27.–*Drepanoistodus* aff. *D. basiovalis* (Sergeeva). *25*, homocurvatiform element, UMC 1092-13 (C 475), X70; *26*, suberectiform element, UMC 1092-15 (C 475), X80; *27*, oistodiform element, UMC 1092-14 (C 475), X110.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EXPLANATION OF PLATE 4

FIGURES *1,3,4,16.*—*Histiodella holodentata* n. sp. *1,* bladelike element, paratype, UMC 1094-4 (CP-L-13), X100; *3,* bladelike element, holotype, UMC 1094-2 (CP-L-15), X90; *4,* bladelike element, paratype, UMC 1094-3 (CP-L-13), X100; *16,* symmetrical element, paratype, UMC 1094-5 (CP-L-13), X150.

2.—*Microzarkodina flabellum* (Lindström), asymmetrical element, UMC 1095-15 (Juab Formation, horizon unknown), X150.

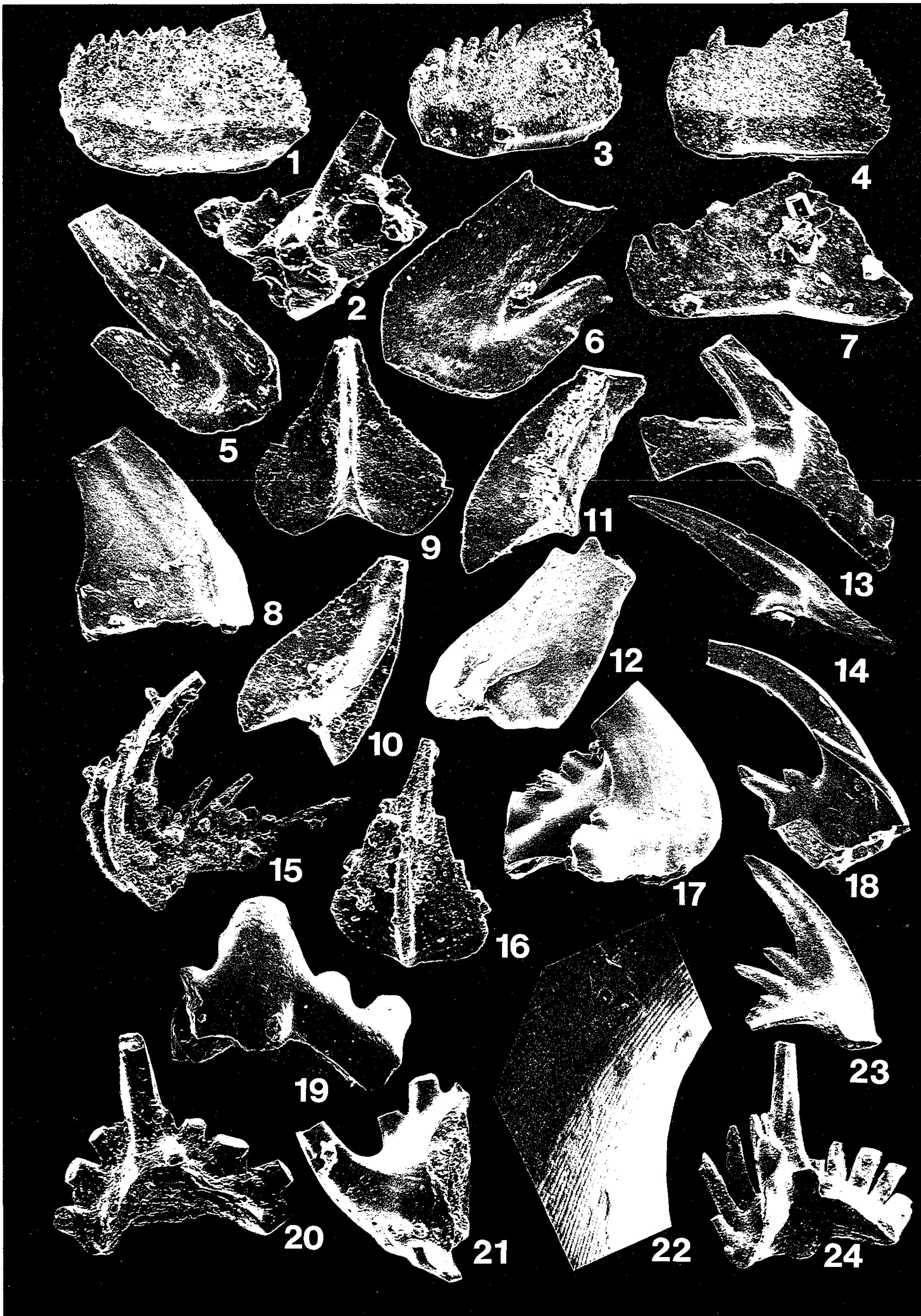
5–12.—*Histiodella altifrons* Harris. *5,6,* oistodiform elements, UMC 1093-20 (I-K-8), UMC 1094-1 (I-K-6), X150 and X125, respectively; *7,* elongate blade, UMC 1093-14 (I-K-9), X65; *8,* short blade, UMC 1093-15 (I-K-3A), X150; *9,* symmetrical element, UMC 1093-19 (I-K-9), X150; *10,11,* asymmetrical elements, UMC 1093-18 (I-K-7A), UMC 1093-17 (I-K-10C), X125 and X140, respectively; *12,* twisted blade, UMC 1093-16 (I-K-10C), X200.

13,14.—*Falodus* sp. s.f., UMC 1113-15 (CP-L-4), UMC 1113-16 (CP-L-7), X75 and X40, respectively.

15,17,23,24.—*Erraticodon* aff. *E. balticus* Dzik. *15,* trichonodelliform element, UMC 1093-12 (CP-CP-2), X60; *17,* hindeodelliform element, UMC 1093-9 (CP-WR-C), X70; *23,* neoprioniodiform element, UMC 1093-10 (CP-CP-7), X70; *24,* plectospathodiform element, UMC 1093-11 (CP-L-15), X35.

18.—? *Erraticodon* sp., UMC 1114-12 (CP-L-1), X40.

19–22.—*Erismodus asymmetricus* (Branson & Mehl). *19,* symmetrical element, UMC 1093-4 (CP-CP-1), X100; *20,* moderately asymmetrical element, UMC 1093-5 (CP-CP-1), X50; *21,22,* strongly symmetrical element, UMC 1093-6 (CP-CP-1), X50 and X500, respectively.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EXPLANATION OF PLATE 5

FIGURES 1–3,5–7.–*Histiodella sinuosa* (Graves & Ellison). *1,3,5,7,* elongate blades, UMC 1094-9 (I-K-13A), X150; UMC 1094-10 (I-K-13C), X75; UMC 1094-7 (CP-L-1), X100; UMC 1094-8 (I-K-13A), X60; *2,* symmetrical element, UMC 1094-11 (CP-L-1), X100; *6,* oistodiform element, UMC 1094-12 (CP-L-5), X100.

4.–? aff. *Loxodus* sp. s.f., UMC 1095-5 (CP-L-13), X125.

8–10,17.–*Juanognathus variabilis* Serpagli; UMC 1094-16 (H-J-2), X80; UMC 1094-17 (H 750), X80; UMC 1094-18 (H 724), X80; UMC 1094-19 (H 710), X65.

11.–*Histiodella minutiserrata* Mound, UMC 1094-6 (I-K-7), X100.

12,13.–*Juanognathus jaanussoni* Serpagli; UMC 1094-14 (H-J-2), UMC 1094-15 (H-J-14), both X80.

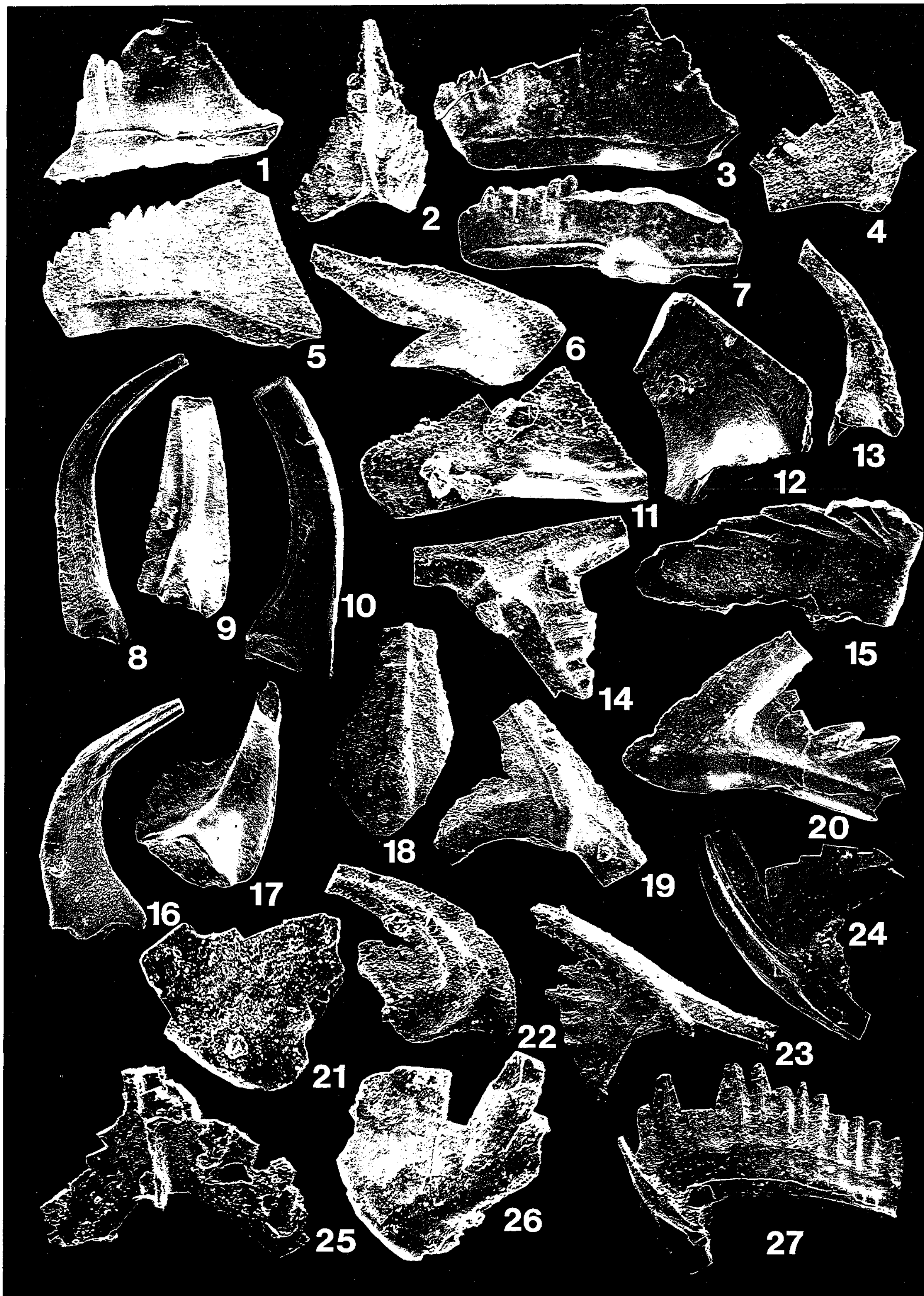
14,19,20,23,24,27.–"*Microzarkodina*" *marathonensis* (Bradshaw). *14,20,* ozarkodiniform element, UMC 1096-3 (H 610), UMC 1096-4 (I-K-7A), both X90; *19,* oistodiform element, UMC 1096-5 (I-J-3), X90; *23,24,27,* ramiform elements; UMC 1095-17 (H 600), X90; UMC 1095-18 (I-K-7A), X130; UMC 1095-19 (I-K-7), X90.

15.–*Loxodus bransoni* Furnish, UMC 1095-2 (H-H-18), X115.

16.–*Macerodus dianae* Fåhraeus & Nowlan, UMC 1095-7 (C 350), X125.

18.–?*Histiodella* sp., UMC 1094-13 (C 530), X115.

21,22,25,26.–*Microzarkodina flabellum* (Lindström). *21,26,* ozarkodiniform element; UMC 1095-12 (I-J-3), X200; UMC 1095-11 (I-J-2B), X150; *22,* oistodiform element, UMC 1095-13 (I-J-2A), X150; *25,* symmetrical element, UMC 1095-16 (Juab Formation, horizon unknown), X150.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EXPLANATION OF PLATE 6

FIGURES *1-4.*—*Multioistodus auritus* (Harris & Harris). *1,* cordylodiform element, UMC 1096-8 (I-K-10A), X75; *2,* distacodiform element, UMC 1096-9 (I-K-10B), X100; *3,* acodiform element, UMC 1096-7 (I-K-10B), X50; *4,* trichonodelliform element, UMC 1096-10 (I-K-15C), X90.

5-7.—? *Multioistodus auritus* (Harris & Harris). *5,* acodiform element, UMC 1096-11 (CP-L-13), X150; *6,* cordylodiform element, UMC 1096-12 (CP-L-13), X90; *7,* distacodiform element, UMC 1096-13 (CP-L-13), X125.

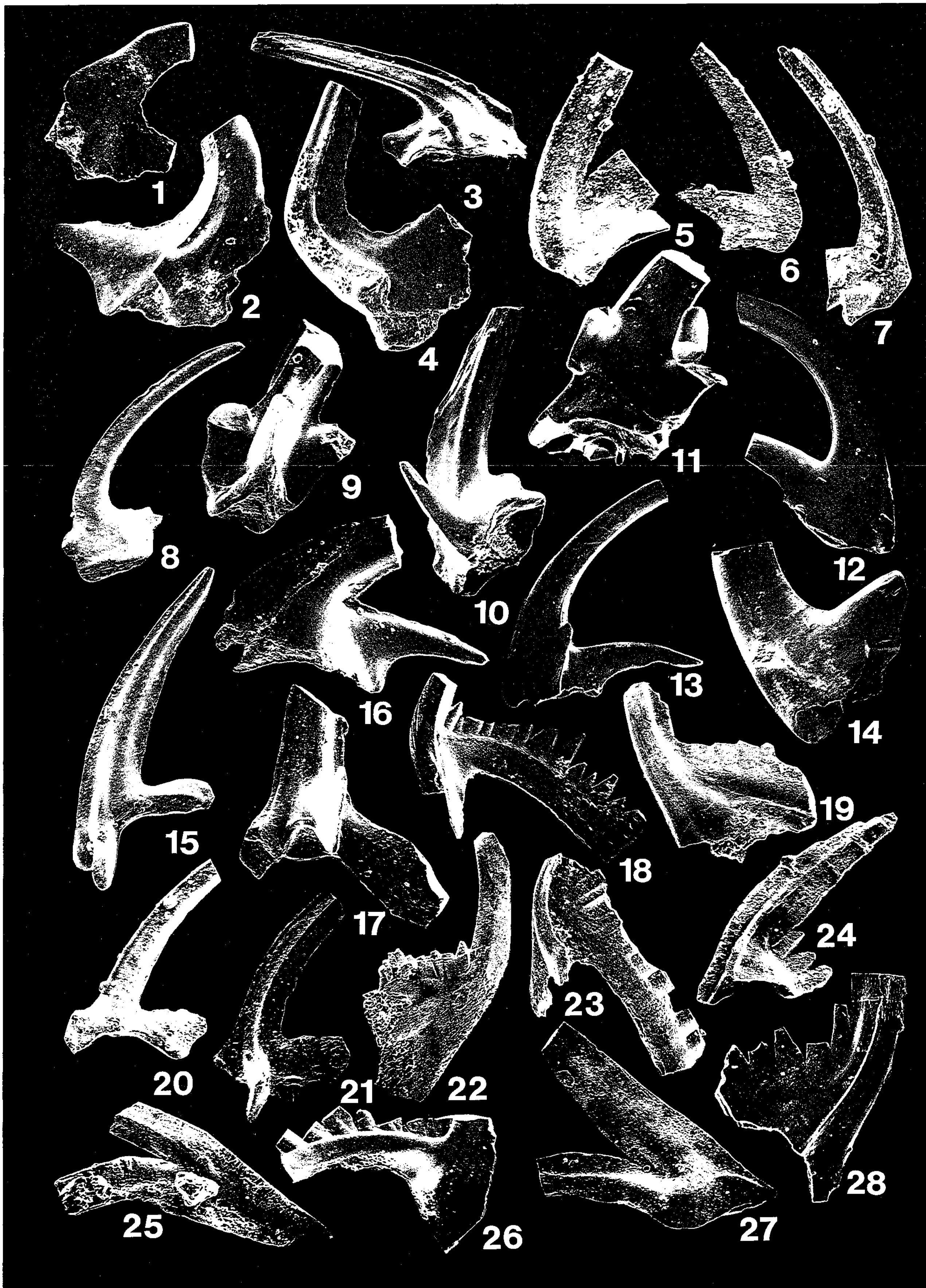
8-11,16.—*Multioistodus compressus* Harris & Harris. *8,* cordylodiform element, UMC 1096-16 (I-K-10B), X30; *9,* distacodiform element, UMC 1096-18 (I-K-14E), X60; *10,* acodiform element, UMC 1096-14 (I-K-13A), X70; *11,* trichonodelliform element, UMC 1096-20 (I-K-4), X50; *16,* scandodiform element, UMC 1097-2 (I-K-13A), X80.

12-14.—*Multioistodus subdentatus* Cullison. *12,* cordylodiform element, UMC 1097-5 (CP-L-9), X50; *13,* distacodiform element, UMC 1097-6 (CP-L-9), X40; *14,* trichonodelliform element, UMC 1097-7 (CP-L-9), X45.

15,17,20,21.—*Multioistodus* sp. *15,* acodiform element, UMC 1097-8 (CP-L-1), X40; *17,* trichonodelliform element, UMC 1097-11 (CP-L-1), X80; *20,* cordylodiform element, UMC 1097-9 (CP-L-1), X60; *21,* distacodiform element, UMC 1097-10 (CP-L-1), X75.

18,22,25.—*Oepikodus communis* (Ethington & Clark). *18,* prioniodiform element, UMC 1097-12 (H-J-2), X160; *22,* oepikodiform element, UMC 1097-14 (H 440), X90; *25,* oistodiform element, UMC 1097-16 (ST 410), X80.

19,23,24,26-28.—aff. *Oepikodus ? minutus* (McTavish). *19,* cordylodiform element, UMC 1097-18 (I-J-8A), X90; *23,* bicostate oepikodiform element, UMC 1098-3 (I-K-1A), X90; *24,* prioniodiform element, UMC 1098-7 (I-J-2A), X90; *26,* cyrtoniodiform element, UMC 1097-20 (I-K-5), X90; *27,* oistodiform element, UMC 1098-5 (I-J-2B), X90; *28,* unicostate oepikodiform element, UMC 1098-2 (I-WW-7C), X40.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EXPLANATION OF PLATE 7

FIGURES *1–3,5,6.*—*Oistodus bransoni* n. sp. *1,* holotype, cordylodiform element, UMC 1098-13 (H 590), X90; *2,* cladognathodiform element, UMC 1098-16 (ST 255), X90; *3,* distacodiform element, UMC 1098-17 (H 640), X60; *5,* oulodiform element, UMC 1099-2 (ST 260), X60; *6,* trichonodelliform element, UMC 1098-20 (H 590), X90.

4.—*Oistodus cristatus* n. sp., holotype, UMC 1099-3 (I-K-15B), X50.

7.—"*Oistodus*" *inaequalis* Pander s.f., UMC 1099-7 (Mesa 850), X70.

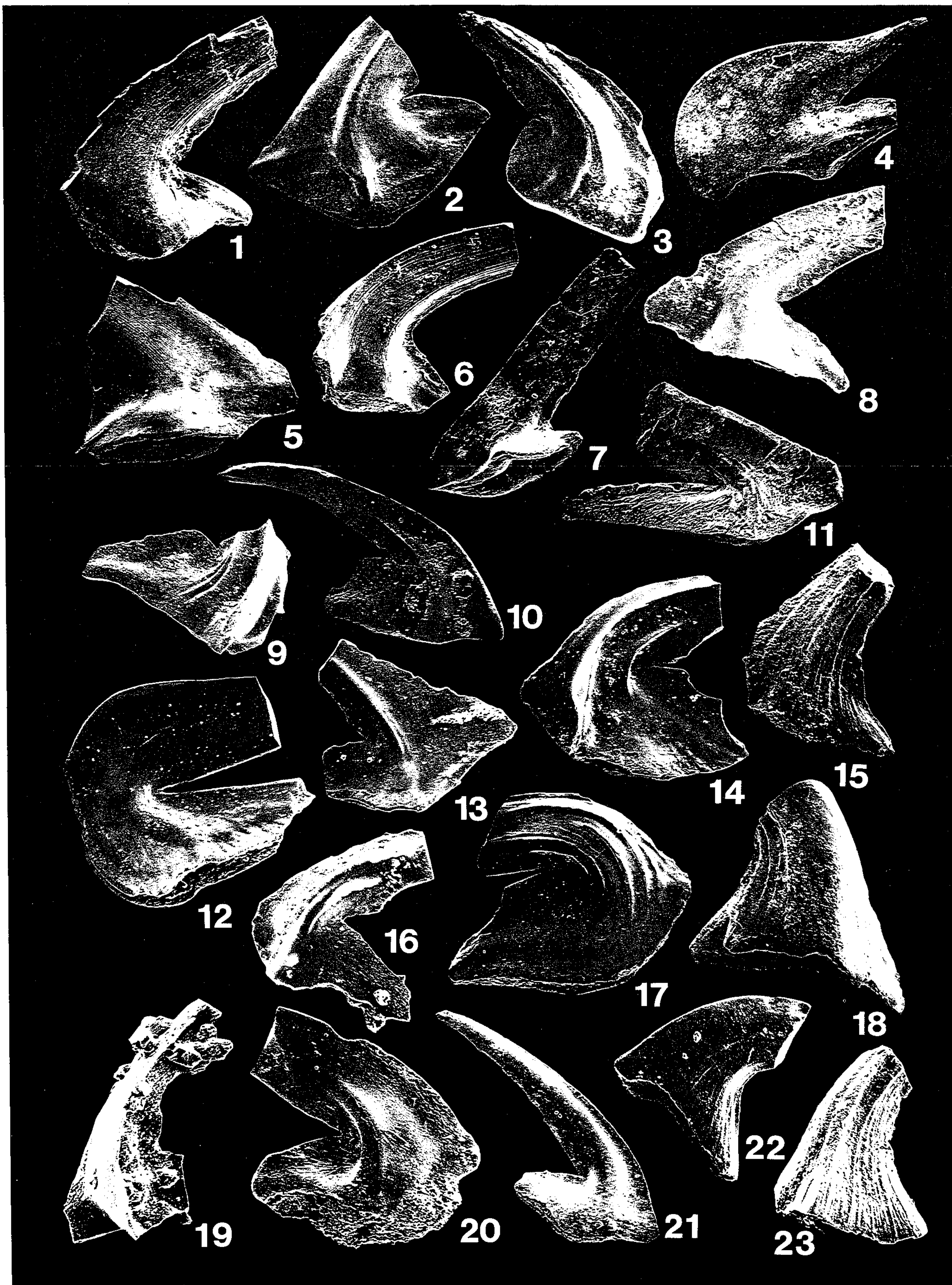
8.—"*Oistodus*" *hunickeni* Serpagli, UMC 1099-5 (H-J-1), X150.

9,10,12–14,17.—*Oistodus multicorrugatus* Harris. *9,* trichonodelliform element, UMC 1100-1 (H-J-4), X75; *10,* ? distacodiform element, UMC 1100-4 (ST 410), X55; *12,* noncostate cordylodiform element, UMC 1099-11 (I-K-3), X55; *13,* oulodiform element, UMC 1100-6 (H 890), X55; *14,* cladognathodiform element, UMC 1099-19 (I-K-10), X75; *17,* costate cordylodiform element, UMC 1099-15 (I-WW-9), X100.

11.—aff. "*Oistodus*" *inaequalis* Pander s.f., UMC 1099-9 (C 365), X100.

15,18,22,23.—"*Oistodus*" *triangularis* Furnish. Representative specimens showing varying development of surface ornament and different degrees of convexity of lateral surface; UMC 1101-4 (Type House 220); UMC 1101-5-7 (Willden Hills 396); X80, X70, X70, and X100, respectively.

16,19–21.—*Oistodus* sp. 1. *16,* cladognathodiform element, UMC 1100-11 (H-J-4), X90; *19,* trichonodelliform element, UMC 1100-12 (I-J-5), X90; *20,* costate cordylodiform element, UMC 1100-10 (H-J-3), X60; *21,* noncostate cordylodiform element, UMC 1100-8 (I-J-3), X60.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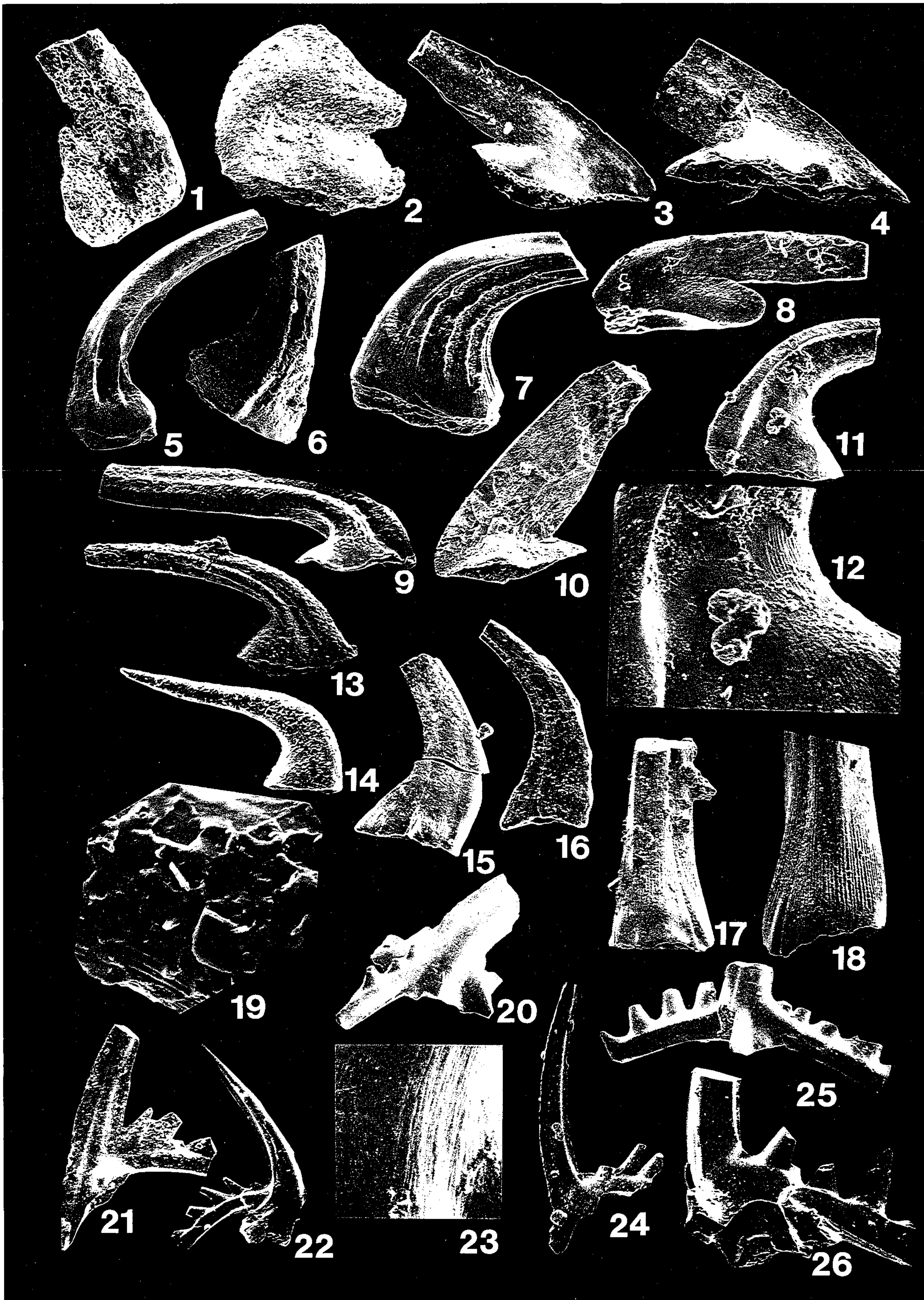
EXPLANATION OF PLATE 8

FIGURE *1.*—"*Oistodus*" sp. 2 s.f., UMC 1100-13 (H 510), X150.
2.—"*Oistodus*" sp. 3 s.f., UMC 1100-14 (H 690), X150.
3.—"*Oistodus*" sp. 4 s.f., UMC 1100-15 (I-K-7A), X75.
4.—"*Oistodus*" sp. 6 s.f., UMC 1100-17 (Type House 462), X70.
5,6.—aff. *Paltodus sexplicatus* (Jones) *sensu* Abaimova. *5,* large element, UMC 1101-13 (C 435), X60; *6,* small element, UMC 1101-14 (C 435), X115.
7.—aff. *Oneotodus simplex* (Furnish), UMC 1100-19 (ST 260), X150.
8.—"*Oistodus*" sp. 5 s.f., UMC 1100-16 (B 55), X200.
9,13.—"*Paltodus*" *spurius* Ethington & Clark, UMC 1101-15 (Type House 301), X150; UMC 1101-16 (Type House 385), X110.
10.—aff. *Paltodus ? jemtlandicus* Löfgren, UMC 1101-12 (C 365), X150.
11,12.—"*Paltodus*" *bassleri* Furnish. *11,* UMC 1101-9 (H-H-21B), X90; *12,* detail of same specimen showing closely spaced ridges on posterolateral region of cusp, X250.
14,19.—*Oneotodus nakamurai* Nogami. *14,* UMC 1101-2 (Type House base), X125; *19,* detail of surface showing narrow linear ridges on posterolateral region, X900.
15,16.—*Panderodus* sp., UMC 1107-17 (CP-CP-4), X80; UMC 1107-18 (CP-CP-4), X125.
17,18.—? *Panderodus* sp., UMC 1101-19 (CP-L-13), X90; UMC 1101-20 (CP-L-13), X150.
20–26.—*Paraprioniodus costatus* (Mound). *20,* pendant prioniodiform element, UMC 1102-3 (CP-L-9), X75; *21,* cyrtoniodiform element, UMC 1102-7 (CP-L-13) X45; *22,* tetraprioniodiform element, UMC 1102-9 (CP-L-9), X45; *23,* detail specimen of figure 20, showing faint ridges in lower reaches of cusp, X375; *24,* cordylodiform element, UMC 1102-5 (CP-L-6), X40; *25,* extended prioniodiform element, UMC 1102-1 (CP-L-9), X60; *26,* trichonodelliform element, UMC 1102-11 (CP-L-9), X100.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EXPLANATION OF PLATE 9

FIGURE *1.*—*Paroistodus parallelus* (Pander), drepanodiform element, UMC 1102-13 (C 790), X400.

2–7.—? *Phragmodus flexuosus* Moskalenko. *2,* bicostate phragmodiform element, UMC 1102-16 (CP-CP-4), X40; *3,* subcordylodiform element, UMC 1103-1 (CP-CP-4), X55; *4,* oistodiform element, UMC 1103-4 (CP-CP-4), X60; *5,* dichognathiform element, UMC 1102-19 (CP-CP-4), X50; *6,* symmetrical phragmodiform element, UMC 1102-17 (CP-CP-4), X60; *7,* costate subcordylodiform element, UMC 1103-3 (CP-CP-4), X60.

8,9,13.—? *Plectodina* sp. *8,* S_a element, UMC 1103-6 (CP-CP-8), X70; *9,* S_c element, UMC 1103-11 (CP-CP-8), X80; *13,* S_b element, UMC 1103-9 (CP-P-8), X125.

10.—*Protopanderodus* aff. *P. arcuatus* (Lindström), specimen showing basal funnel, UMC 1103-12 (H 650), X40.

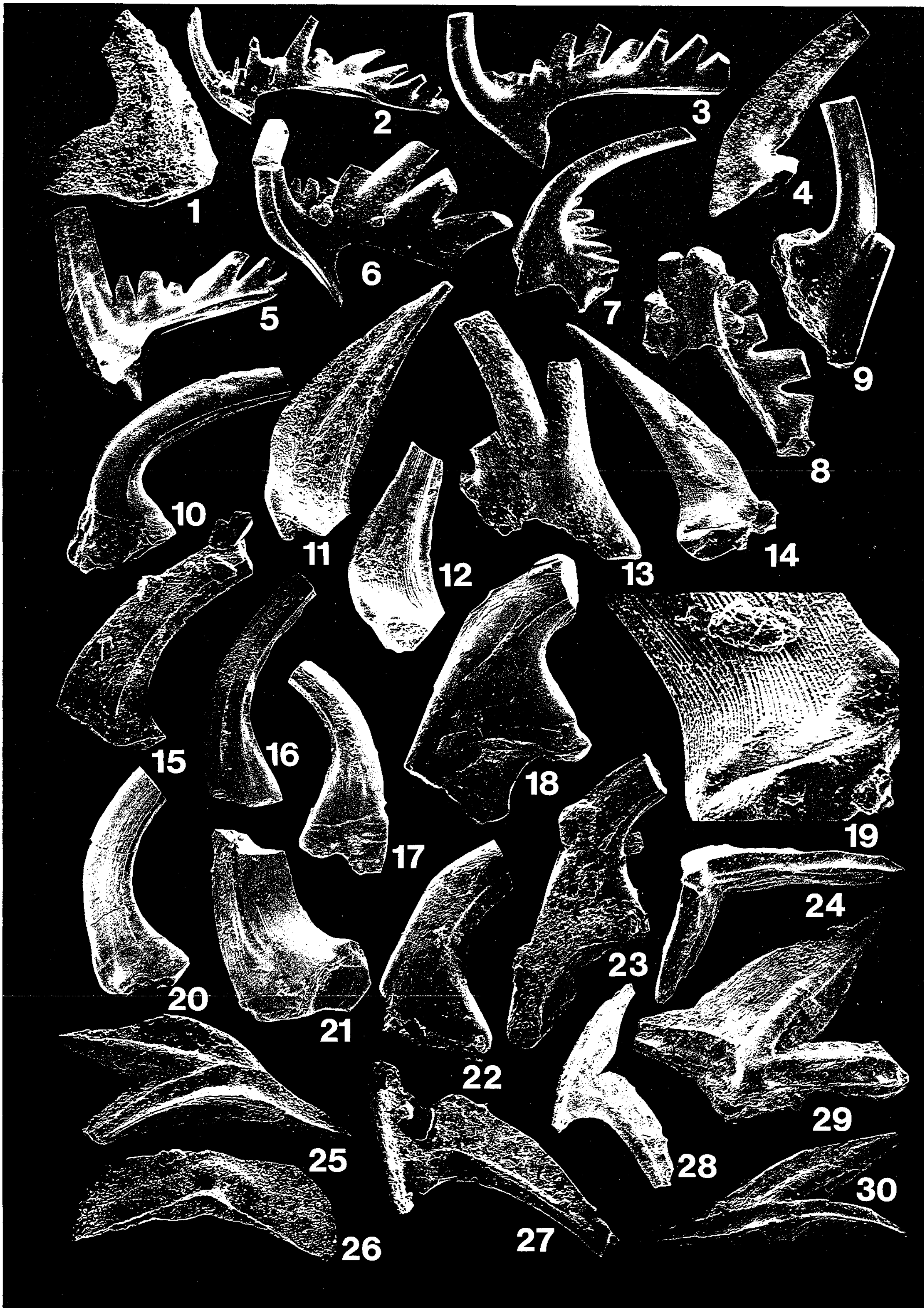
11,12,14,19.—*Protopanderodus* ? *asymmetricus* Barnes & Poplawski. *11,12,14,* UMC 1103-13 (ST 405), 14 (I-J-3), 15 (I-WW-7A), X110, X130, X70, respectively; *19,* detail of UMC 1103-15 showing surface ornament, X200.

15.—*Protopanderodus elongatus* Serpagli, UMC 1103-16 (H-J-2), X110.

16,17,20,21.—*Protopanderodus gradatus* Serpagli. *16,17,* elements with grooved lateral surfaces, UMC 1103-18 (I-K-10B), X70, UMC 1103-19 (ST 130), X90; *20,* element without lateral groove, UMC 1103-20 (ST 385), X70; *21,* scandodiform element, UMC 1104-1 (ST 410), X90.

18,22,23.—*Protopanderodus leonardii* Serpagli, UMC 1104-7 (ST 0), UMC 1104-8 (I-K-4A), UMC 1104-9 (ST 390), each X75.

24–30.—*Protoprioniodus aranda* Cooper. *24,* bladelike element, aboral view, UMC 1104-15 (I-J-5), X75; *25,29,30,* oistodiform elements, UMC 1104-17 (H-J-5), X110, UMC 1104-18 (I-J-3), X80, UMC 1104-19 (I-J-8), X80; *26,* lateral view of bladelike element, crest of blade lost, UMC 1104-16 (H-J-5), X125; *27,28,* ramiform elements, UMC 1104-13 (I-J-2A), UMC 1104-12 (I-WW-7B), both X100.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EXPLANATION OF PLATE 10

FIGURES *1–4,6,10.*–*Pteracontiodus cryptodens* (Mound). *1,* costate distacodiform element, UMC 1105-11 (I-K-10B), X60; *2,* distacodiform element, UMC 1105-10 (I-K-3A), X25; *3,* cordylodiform element, UMC 1105-4 (I-K-10B), X60; *6,* costate acodiform element, UMC 1105-8 (I-K-10B), X60; *7,* oistodiform element, UMC 1105-15 (I-K-10B), X40; *8,* trichonodelliform element, UMC 1105-13 (I-K-10B); *9,* acodiform element, UMC 1105-7 (I-K-10B), X45; *10,* costate oistodiform element, UMC 1105-16 (I-K-10B), X45.

5.–*Protoprioniodus papiliosus* (van Wamel), ramiform element, UMC 1105-2 (H-J-17), X140.

11–13,17.–*Pterocontiodus gracilis* n. sp. *11,* trichonodelliform element, UMC 1105-20 (CP-L-7), X60; *12,* cordylodiform element, UMC 1105-17 (CP-L-7), X60; *13,* distacodiform element, UMC 1105-18 (CP-L-7), X60; *17,* holotype, oistodiform element, UMC 1105-19 (CP-L-7), X60.

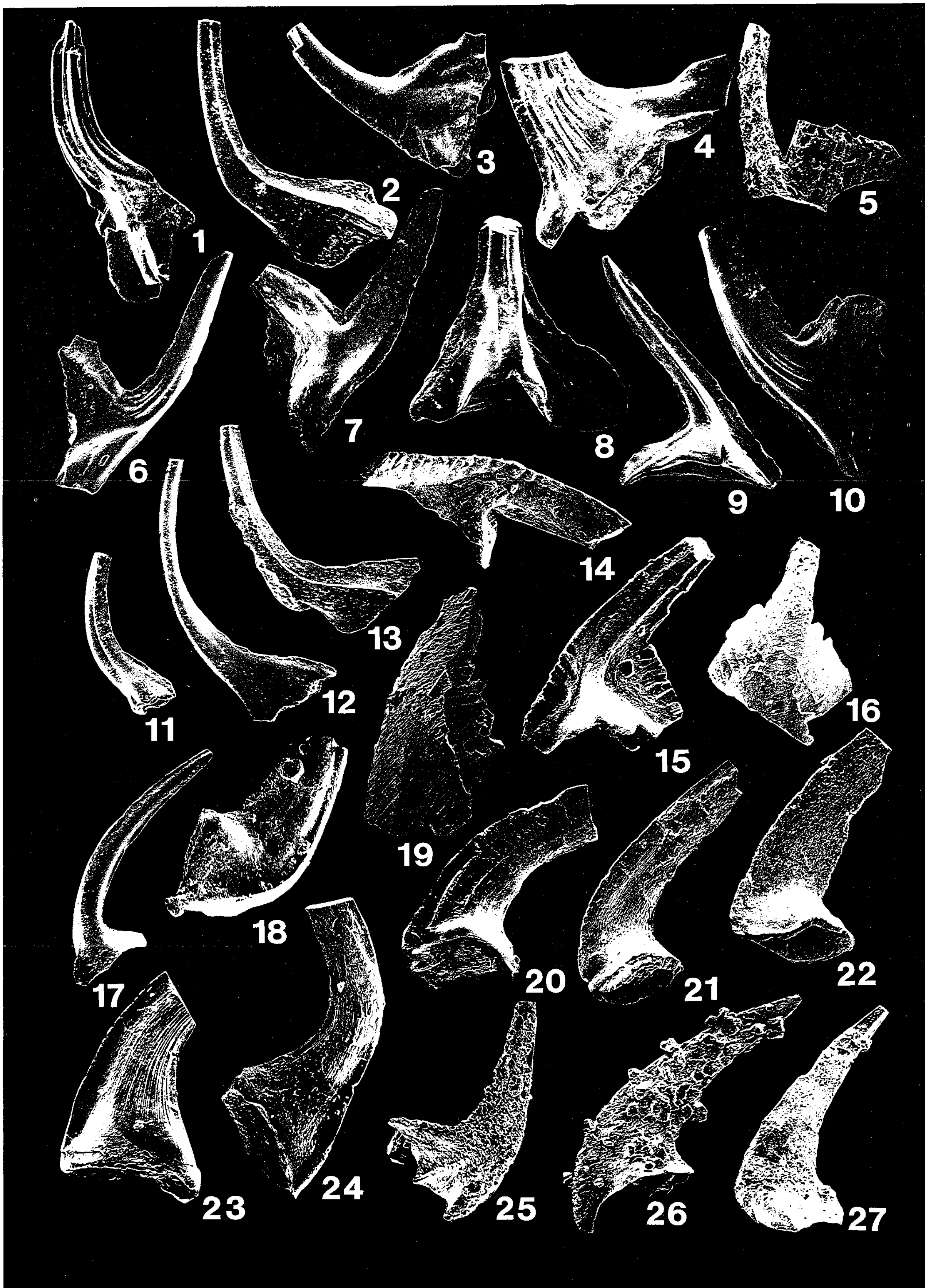
14–16,19.–? *Reutterodus* sp. *14,* oistodiform element, UMC 1106-10 (H 250), X100; *15,* cyrtoniodiform element, UMC 1106-6 (H 210); *16,* prioniodiform element, UMC 1106-5 (H 250), X110; *19,* ramiform element, UMC 1106-7 (H 250), X125.

18.–? *Reutterodus andinus* Serpagli, "conelike" element, UMC 1106-3 (H-J-2), X125.

20–22.–aff. "*Scandodus*" *flexuosus* Barnes & Poplawski s.f.; UMC 1106-15 (C 800), X70; UMC 1106-16 (H 640), X70; UMC 1106-17 (C 430), X125.

23,24.–*Scalpellodus striatus* n. sp.; UMC 1106-11 (holotype; C 485), X100; UMC 1106-12 (Mesa 610), X90.

25–27.–"*Scandodus*" *robustus* Serpagli. *25,* acodiform element, UMC 1106-20 (I-WW-7B), X90; *26,27,* scandodiform elements, UMC 1107-2 (I-J-2), UMC 1107-3 (I-J-2), both X70.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EXPLANATION OF PLATE 11

FIGURES *1–5.*–*Scandodus sinuosus* Mound. *1,* acodiform element, UMC 1107-6 (I-K-11A), X45; *2,* trichonodelliform element, UMC 1107-14 (I-K-9A), X45; *3,* distacodiform element, UMC 1107-8 (I-K-7), X70; *4,* scandodiform element, UMC 1107-12 (CP-L-6), X45; *5,* oistodiform element, UMC 1107-10 (CP-L-6), X70.

6,7.–"*Scandodus*" sp. 1 s.f., UMC 1107-16 (H 850), UMC 1106-17 (H 750), both X50.

8,9.–"*Scandodus*" sp. 2 s.f.; UMC 1107-18 (C 160), X60; UMC 1107-19 (C 220), X50.

10.–"*Scandodus*" sp. 3 s.f., UMC 1107-20 (Mesa 610), X150.

11.–"*Scandodus*" sp. 4 s.f., UMC 1108-1 (I-K-10B), X75.

12.–"*Scandodus*" sp. 5 s.f., UMC 1108-3 (Type House 264), X225.

13,14.–*Scolopodus cornutiformis* Branson & Mehl, UMC 1108-8 (C 10), UMC 1108-9 (C 10), X80 and X60, respectively.

15, 16.–"*Scolopodus*" *emarginatus* Barnes & Tuke; UMC 1108-10, 11, X40 and X90, respectively.

17,18.–"*Scandodus*" sp. 6 s.f.; UMC 1108-5 (H-H-19), X80; UMC 1108-6 (C 45), X45.

19,20.–*Scolopodus multicostatus* Barnes & Tuke; UMC 1108-19 (C 120), X40; UMC 1108-20 (H 266), X90.

21.–*Scolopodus paracornuformis* n. sp., holotype, UMC 1109-3 (H-J-2), X75.

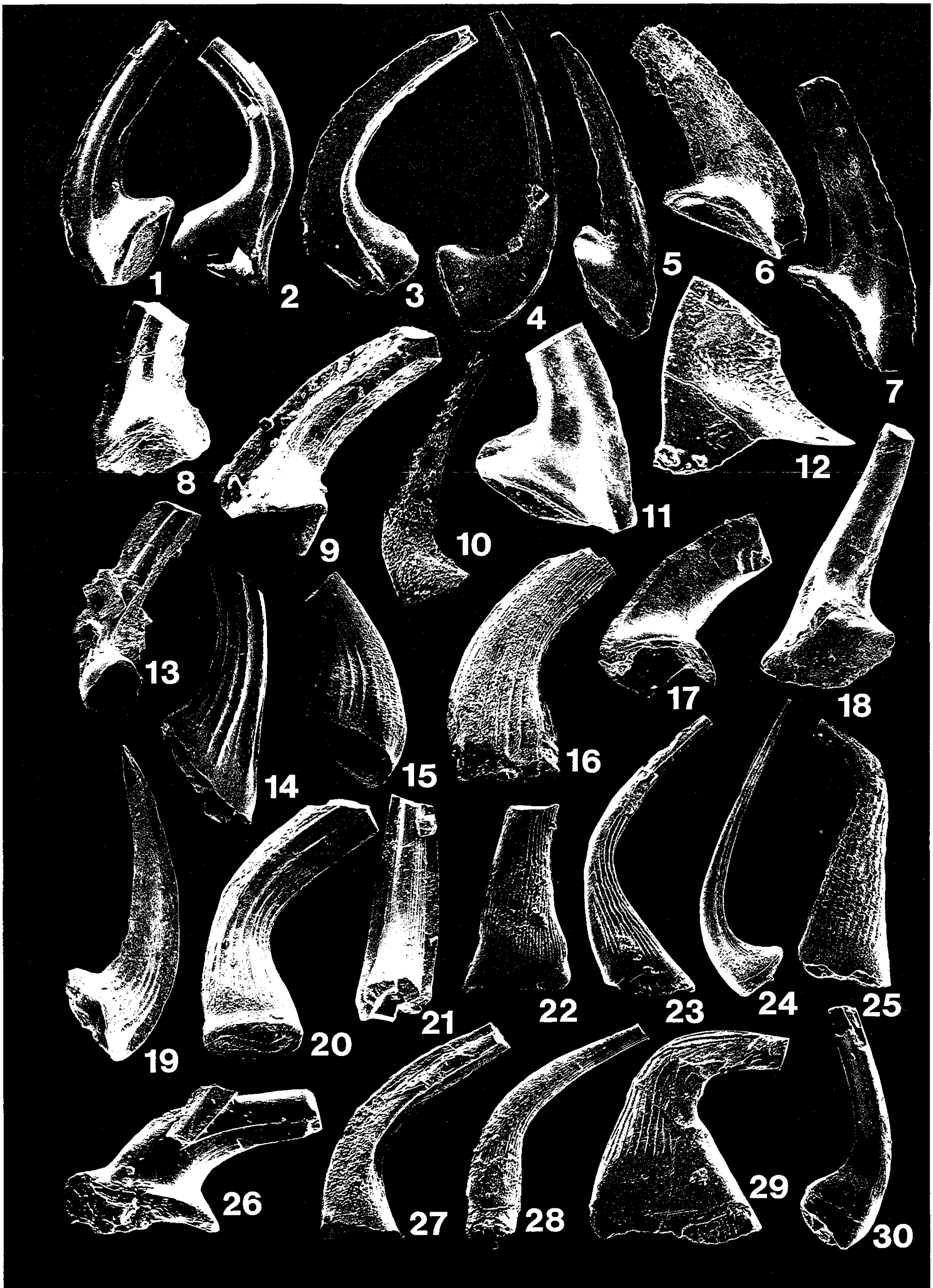
22.–"*Scolopodus*" *filosus* Ethington & Clark, UMC 1108-12 (ST 280), X150.

23,25,29.–? "*Scolopodus*" aff. "*S.*" *filosus* Ethington & Clark; UMC 1108-13 (H 210), X110; UMC 1108-14 (H 250), X125; UMC 1108-15 (H 340), X60.

24,30.–"*Scolopodus*" *quadraplicatus* Branson & Mehl; UMC 1109-6 (ST 395), X70; UMC 1109-7 (C 530), X75.

26.–"*Scolopodus*" *peselephantis* Lindström, UMC 1109-5 (H 800), X150.

27,28.–"*Scolopodus*" *gracilis* Ethington & Clark. *27,* triangulariform element, UMC 1108-18 (H 250), X100; *28,* graciliform element, UMC 1108-16 (ST 410), X100.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EXPLANATION OF PLATE 12

FIGURES *1,2.*–aff. *Scolopodus rex* Lindström. *1,* paltodiform element, UMC 1109-10 (C 640); *2,* scolopodiform element, UMC 1109-8 (C 250), X60.

3,4.–? "*Scolopodus*" *sexplicatus* Jones, UMC 1109-13 (H-H-22), UMC 1109-14 (H-H-20), both X50.

5,6.–*Scolopodus* aff. *S. striatus* Pander. *5,* paltodiform element, UMC 1109-17 (ST 130), X60; *6,* scolopodiform element, UMC 1109-15 (ST 130), X55.

7,8.–"*Scolopodus*" *sulcatus* Furnish; UMC 1109-19 (H 210), X70; UMC 1109-20 (C 345), X75.

9–11.–? *Scolopodus* sp. *9,* acodiform element, UMC 1110-1 (H 710), X125; *10,* asymmetrical element, UMC 1110-2 (H 690), X70; *11,* subsymmetrical element, UMC 1110-3 (ST 195), X70.

12.–Scolopodiform A, UMC 1110-4 (C 425), X100.

13.–Scolopodiform B, UMC 1110-5 (H 260), X100.

14.–Scolopodiform C, UMC 1110-6 (H 510), X90.

15–17,23.–Scolopodiform D. *15,* detail of specimen of figure 16 showing striae, X150. *16,* lateral view of UMC 1110-7 (Mesa 850), X50; *17,* lateral view of UMC 1110-9 (ST 255), X65; *23,* posterior view of UMC 1110-8 (H 890), X70.

18.–Scolopodiform E, UMC 1110-11 (ST 0), X120.

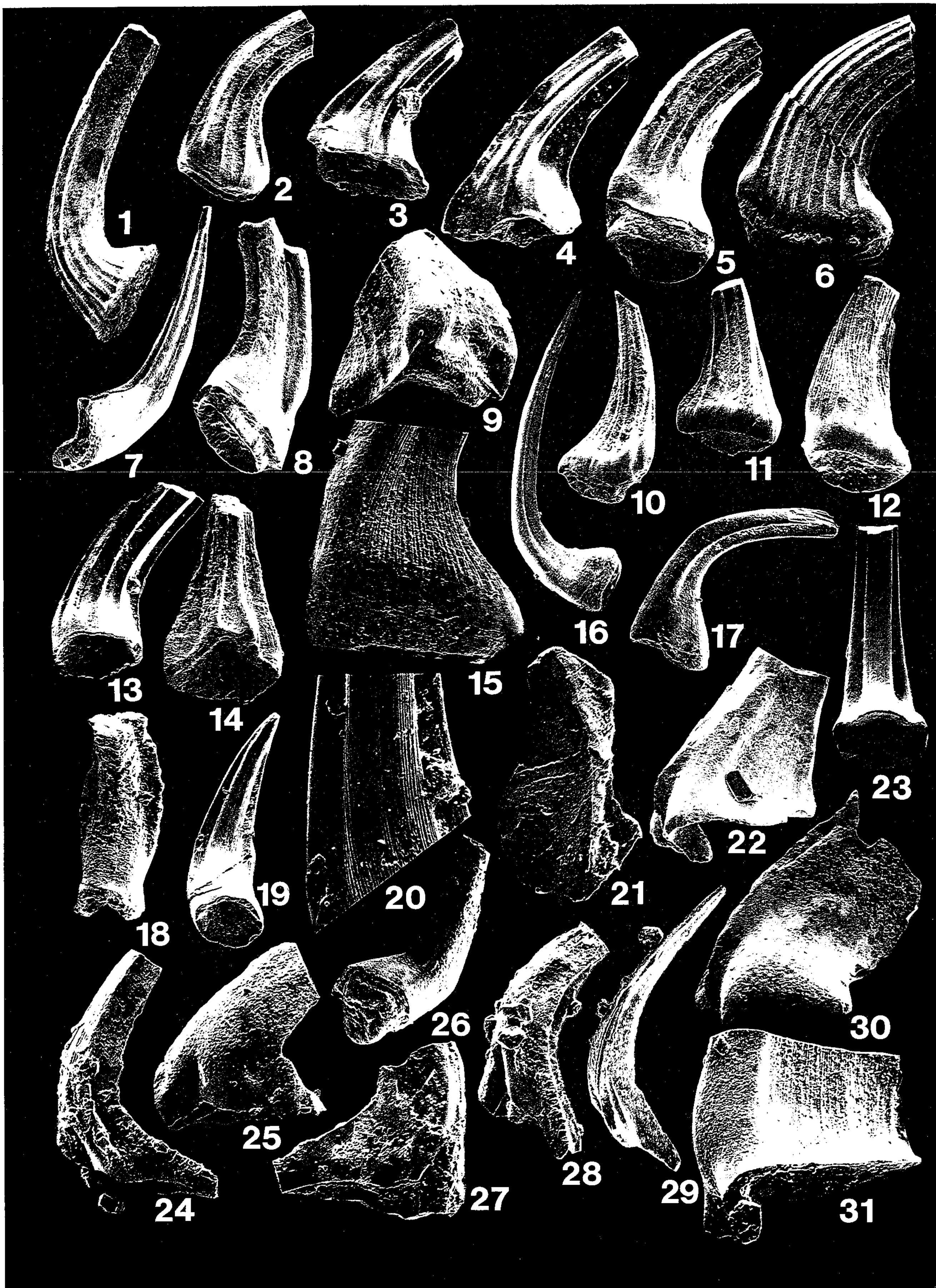
19,20,26.–Scolopodiform F. *19,* UMC 1110-12 (H 850), X75; *20,* specimen of figure 19 showing details of striae, X225; *26,* lateral view of UMC 1110-13 (C 185), X70.

21.–*Stolodus stola* (Lindström), UMC 1110-14 (H-J-2), X200.

22,30.–*Ulrichodina cristata* Harris & Harris, *22,* UMC 1111-6 (ST 75), X75; *30,* UMC 1111-7 (H 380), X70.

24,25,27–29.–*Tripodus laevis* Bradshaw. *24,* distacodiform element, UMC 1110-15 (I-J-2A), X100; *25,* oistodiform element, UMC 1110-19 (I-WW-7C), X100; *27,* drepanodiform element, UMC 1110-17 (I-J-2B), X100; *28,* paltodiform element, UMC 1111-1 (I-J-2A), X100; *29,* trichonodelliform element, UMC 1111-3 (I-J-3), X80.

31.–*Ulrichodina abnormalis* (Branson & Mehl), UMC 1111-5 (C 951), X225.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EXPLANATION OF PLATE 13

FIGURES *1,2.*—*Ulrichodina deflexa* Furnish. *1,* UMC 1111-8 (Mesa 570), X125; *2,* UMC 1111-9 (Mesa 590), X150.

3,4,9.—*Ulrichodina ? simplex* n. sp. *3,* posterior view of paratype, UMC 1111-11 (H 890), X75; *4,* lateral view of paratype, UMC 1111-12 (H 770), X80; *9,* lateral view of holotype, UMC 1111-10 (ST 326), X40.

5.—*? Ulrichodina wisconsinensis* Furnish, UMC 1111-13 (Mesa 536), X50.

6,7,11–13.—*Walliserodus comptus* (Branson & Mehl). *6,* asymmetrical multicostate element, UMC 1111-15 (H 724), X60; *7,* tricostate element, UMC 1112-4 (H 710), X60; *11,* comptiform element, UMC 1111-17 (H 690), X70; *12,* quadricostate element, UMC 1111-20 (H 760), X60; *13,* symmetrical element, UMC 1112-2 (H 890), X55.

8.—*? Ulrichodina* sp., UMC 1111-14 (C 85), X75.

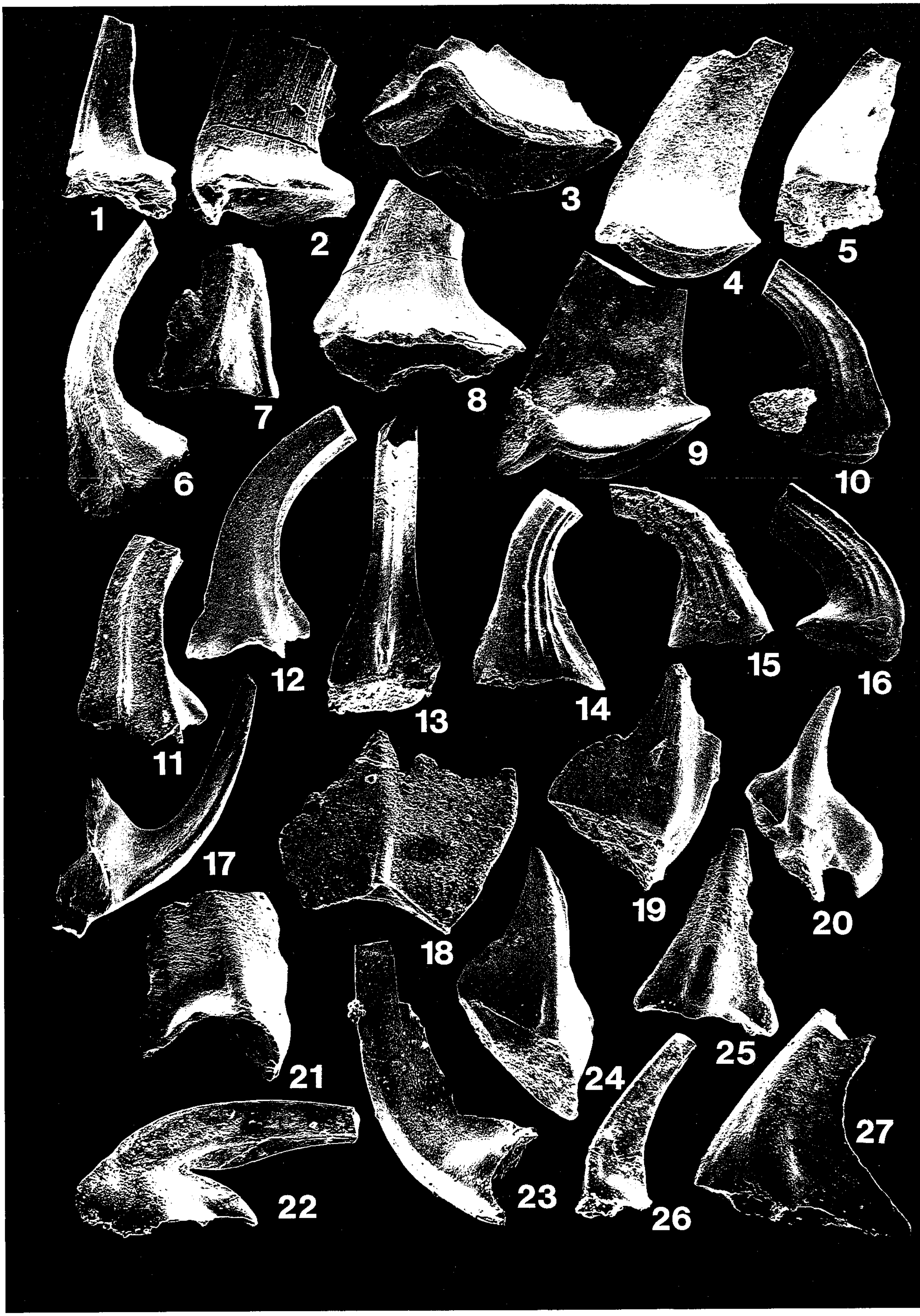
10,14–16.—*? Walliserodus ethingtoni* (Fåhraeus) *sensu* Löfgren. *10,14*; asymmetrical elements, UMC 1112-7 (H 610), X60; UMC 1112-6 (H 250), X100; *15,* subsymmetrical element, UMC 1112-11 (C 800), X80; *16,* scandodiform element, UMC 1112-9 (H 640), X60.

17.—? New Genus 1, UMC 1112-12 (C 85), X50.

18–20,24.—New Genus 2. *18,* BYU 912, X110; *19,* UMC 1112-13 (H 250), X110; *20,* UMC 1112-14 (H 780), X70; *24,* UMC 1112-15 (H 610), X80.

21–23,25,27.—New Genus 3. *21,* outer lateral view of flexed bladelike element, UMC 1112-18 (H-H-20), X90; *22,* oistodiform element, UMC 1113-2 (Type House 462), X120; *23,* inner lateral view of flexed bladelike element, UMC 1112-19 (H-H-20), X90; *25,* symmetrical bladelike element, UMC 1112-20 (H-H-20), X90; *27,* planar bladelike element, UMC 1113-1 (H-H-20), X90.

26.—? New Genus 3, UMC 1113-4 (Type House 264), X90.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EXPLANATION OF PLATE 14

FIGURES *1-3.*—? New Genus 4. *1,* acodiform element, UMC 1113-7 (CP-L-4), X125; *2,* trichonodelliform element, UMC 1113-11 (CP-L-4), X150; *3,* cordylodiform element, UMC 1113-9 (CP-L-4), X150.

4,8.—New Genus 5. *4,* UMC 1113-13 (CP-CP-4), X80; *8,* UMC 1113-14 (CP-CP-4), X130.

5.—*Milaculum* aff. *M. ethinclarki* Müller, UMC 1113-19 (I-K-4), X125.

6.—? *Astraspis* sp., UMC 1113-18 (I-K-15C), X225.

7,9.—*Milaculum muelleri* n. sp. 7, upper view of holotype, UMC 1113-20 (I-J-8), X125; *9,* lateral view of paratype, UMC 1114-1 (I-J-6C), X125.

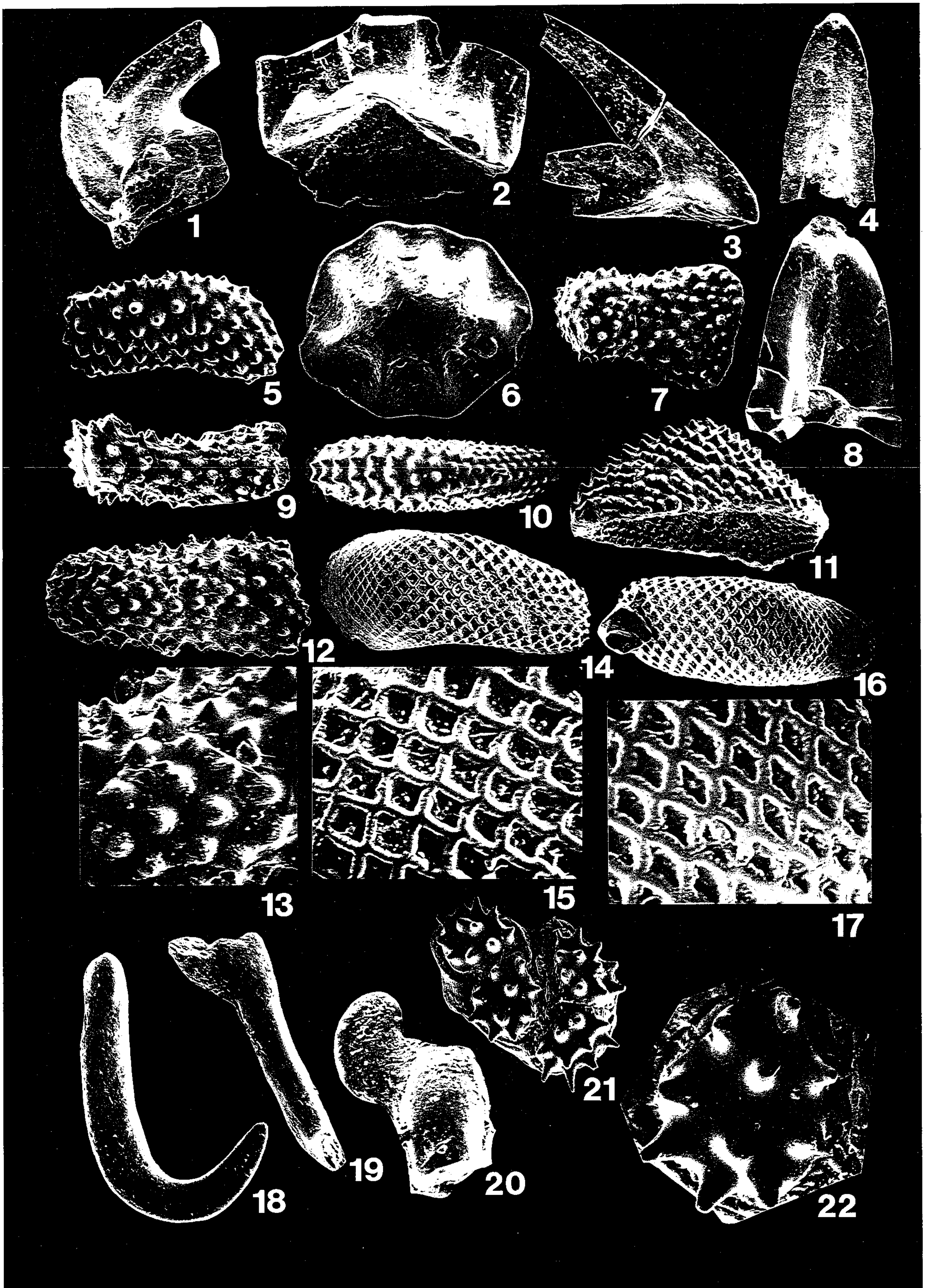
10,11.—*Milaculum spinoreticulatum* n. sp. *10,* upper view of holotype, UMC 1114-5 (H 800), X150; *11,* aborolateral view of paratype, UMC 1114-6 (H 800), X150.

12,13.—*Milaculum rossi* n. sp. *12,* upper view of holotype, UMC 1114-4 (I-WW-7B), X160; *13,* detail of nodes on upper surface, X400.

14-17.—*Milaculum reticulatum* n. sp. *14,15,* upper view and detail of upper surface of paratype, UMC 1114-3 (H 800), X125 and X400; *16,17,* upper view and detail of upper surface of holotype, UMC 1114-2 (H 800), X125 and X400.

18-20.—*Ptiloncodus simplex* Harris. *18,* lateral view of specimen lacking "ears" at distal end of shaft, UMC 1114-9 (I-J-8A), X175; *19,* front view of specimen with left "ear" still attached, UMC 1114-10 (I-K-10B), X100; *20,* distal end of shaft showing attached "ear," UMC 1114-8 (I-WW-6), X200.

21,22.—*Utahphospha* sp. *21,* fragment showing four plates studded on substrate, UMC 1114-11 (H 800), X150; *22,* detail of single plate, X425.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Maps

Preliminary geologic map of the Cricket Mountains, Millard County, Utah, by L. F. Hintze, 1959, scale 1" equals 4,000 ft., ozalid print 36" x 48".
Preliminary geologic camp of the Burbank Hills and Northern Needle Range, Millard County, Utah, by L. F. Hintze, 1960, scale 1" equals 4,000 ft., ozalid print.
Geology of the southern Wasatch Mountains and vicinity, by L. F. Hintze (from vol. 9, pt. 1), two colors, 20" x 32".
Preliminary geologic map of the Y mountain area, east of Provo, Utah, by L. F. Hintze, 1969, scale 1" equals 2,000 ft.

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Hintze, L. F., 8½ x 11" colored geological map of Utah with roads.

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Utah geological highway map, scale 1" equals 15 miles. Full color with seven stratigraphic sections, seven cross-sections, ERTS photomosaic of Utah and a summary of Utah's geologic history.

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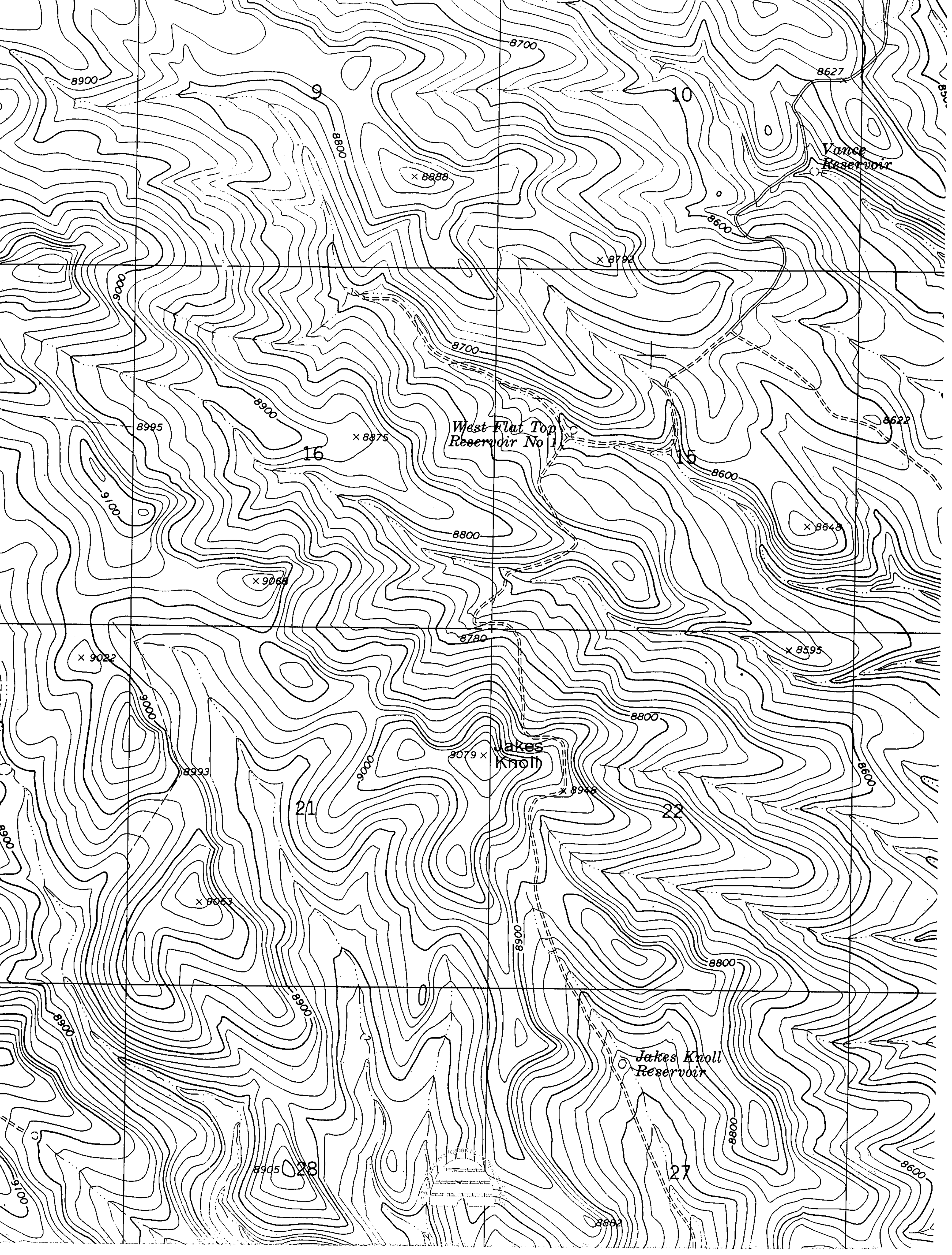
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