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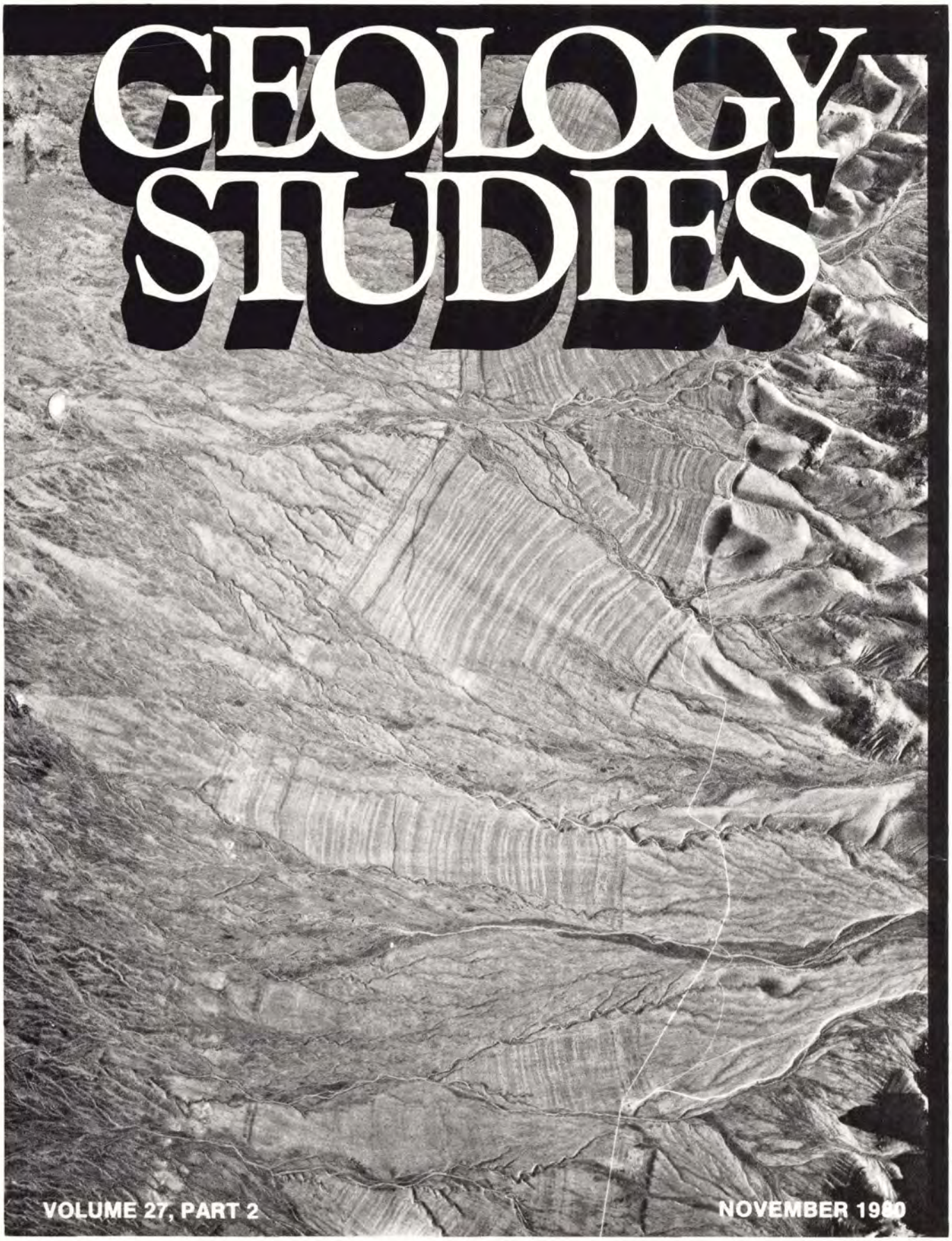

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Conodonts and Biostratigraphy of the Lower Mississippian in Western Utah and Eastern Nevada*

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ABSTRACT – Lower Mississippian rocks in western Utah and eastern Nevada are represented by the Joana Limestone, the Madison Limestone, and the combined Fitchville Formation and Gardison Limestone Great variability in formation thicknesses and the presence of unconformities make precise dating and correlation difficult

Nine sections between the Wasatch Mountains on the east and Eureka, Nevada, on the west were sampled Sections include Logan, Rock Canyon, Rattlesnake Spur, North Stansbury Mountains, Needle Range, and Confusion Range, Utah; and Wendover, Ely, and Eureka, Nevada Five Utah-Nevada zones were designated, an Upper Devonian zone, three upper Kinderhookian zones, and one Valmeyeran zone No lower or middle Kinderhookian zones were recovered The studied sections represent essentially equivalent time stratigraphic units spanning the upper third of the Kinderhookian. Exceptions to this are the Eureka and Wendover, Nevada, sections which are erosional remnants equivalent to the lowest Carboniferous rocks in the other sections In central Utah, Devonian conodont faunas are directly overlain by late Kinderhookian faunas, indicating the presence of a substantial paraconformity within the Fitchville Formation

INTRODUCTION

Lower Mississippian formations of the Great Basin have been described for more than 100 years. They contain a rather distinct coral-brachiopod fauna that led to reasonably sure recognition of an Early Mississippian age. Originally the Lower Mississippian formations were zoned and correlated on the basis of these corals and brachiopods. The fauna is easily recognized and commonly well preserved, but it does have some limitations with respect to detailed correlation. One major limitation is that most of the corals and brachiopods are not particularly time restrictive but rather tend to be more facies restricted. Since many of the Lower Mississippian rocks in the Great Basin have suffered minor to extreme secondary dolomitization, much of the macrofauna has been destroyed or rendered unrecognizable. These problems, coupled with the bounding, above and below, of many of the Lower Mississippian sections by unconformities, have made correlation within the Lower Mississippian of the Great Basin difficult and somewhat arbitrary.

Conodonts within Lower Mississippian strata have been extensively studied, and detailed zones have been determined. This fact, plus the widespread nature, ease of preservation, ability to resist destruction during dolomitization, and ease of recovery from carbonate rocks, makes conodonts potentially unsurpassed as time indicators for Lower Mississippian rocks of the study area.

The study area includes most of central Utah and east central Nevada: from the Wasatch Front on the east to Eureka, Nevada, on the west, where the Lower Mississippian carbonates essentially pinch out against the Antler uplift. Nine sections were designated for collection and study (figs. 1–10). These sections were located to give best coverage of the study area, completeness of the vertical section, and, where possible, maximum new information. Previously mapped, measured, and described sections were used in this study to insure completeness of sections and accessibility and to eliminate any potential stratigraphic or structural complications.

STRATIGRAPHY

Carbonate rock from four formations of Lower Mississippian age was collected and processed for this study. Of the four formations, the Joana Limestone, of eastern Nevada and western Utah, was selected to be the basic time stratigraphic unit of study. The other three formations, Fitchville Formation, Gardison Limestone, and the Lodgepole Limestone (basal Madison Group), are time stratigraphic equivalents to the Joana Limestone.

WESTERN UTAH AND EASTERN NEVADA

Joana Limestone

Hague (1883) proposed the name White Pine Shale for outcrops of shales and carbonate rocks in the White Pine mining district of Nevada. Hague's White Pine Shale included a lower calcareous shale, a siliceous limestone unit, and an upper black argillaceous shale. The entire sequence was assigned to the Devonian System. Spencer (1917) divided the White Pine Shale into three separate units. The lower shale was referred to as the Pilot Shale, the limestone as the Joana Limestone, and the upper shale as the Chainman Shale. He assigned the upper two units to the Mississippian System and tentatively, because of lack of fossil evidence, considered the Pilot Shale to be Mississippian also.

In 1953 the Eastern Nevada Geological Association Stratigraphic Committee (Easton and others 1953) recognized the utility of Spencer's subdivision of the White Pine Shale into the three separate formations. They, however, preferred to assign the three units the rank of members within the White Pine Shale. Nolan, Merriam, and Williams (1956) rejected the concept of the White Pine Shale in favor of giving formational rank to the Chainman Shale, Joana Limestone, and Pilot Shale because of difficulties in mapping the White Pine–Diamond Peak boundary and the extensive stratigraphic range of the shales referred to as White Pine Shale. In this paper the terminology of Nolan, Merriam, and Williams (1956) is used, and the Joana Limestone is assigned formational rank (For a complete history of stratigraphic terminology for the Lower Mississippian of eastern Nevada, see Langenheim 1960).

The Joana Limestone is a shallow to deep miogeosynclinal deposit of uniform lithologic character (Sandberg and Poole 1977). It consists largely of various limestones from micritic to coarsely crystalline textures and typically contains beds of coarse crinoidal debris and zones of chert, with small amounts of interbedded shales and siltstones.

Within the study area the Joana Limestone ranges in thickness from 1000 feet south and east of the Ely Arch to a zero edge in the area west of Eureka, Nevada, where it pinches out on the flanks of the Devonian-Mississippian Antler orogenic belt.

*This paper was submitted in 1972 in partial fulfillment of the requirements for the degree Master of Science thesis chairman, Morris S Petersen Because of a series of unforeseen events, the paper was delayed in publication

Six of the ten sections measured and collected for this study were from the Joana Limestone. Three sections were collected in Nevada: 160 feet at Ely, 80 feet at Eureka, and 24 feet at Wendover. Three sections were also collected in western Utah; 290 feet in the Confusion Range, and sections of 930 feet and 610 feet in the Needle Range. All sections produced conodont material except the Ely section.

CENTRAL UTAH

Two formations in central Utah combine to closely approximate the time stratigraphic interval represented by the Joana Limestone of Nevada and western Utah. These two formations, the Fitchville Formation and Gardison Limestone, were measured and collected as a single unit in all central Utah sections.

Fitchville Formation

The Fitchville Formation is at most localities composed of interbedded limestone and dolomite. However, dolomitization is pervasive in the Salt Lake City-Provo area of central Utah and becomes less complete to the west, north, and south. Dolomitization has largely recrystallized the shelly macrofauna of the Fitchville Formation, in most areas making identification of corals and brachiopods and precise correlation and dating difficult.

The Fitchville Formation ranges in thickness from about 100 feet in the central Wasatch Mountains to about 400 feet in the northern and southern Wasatch Mountains and west of the Wasatch Front.

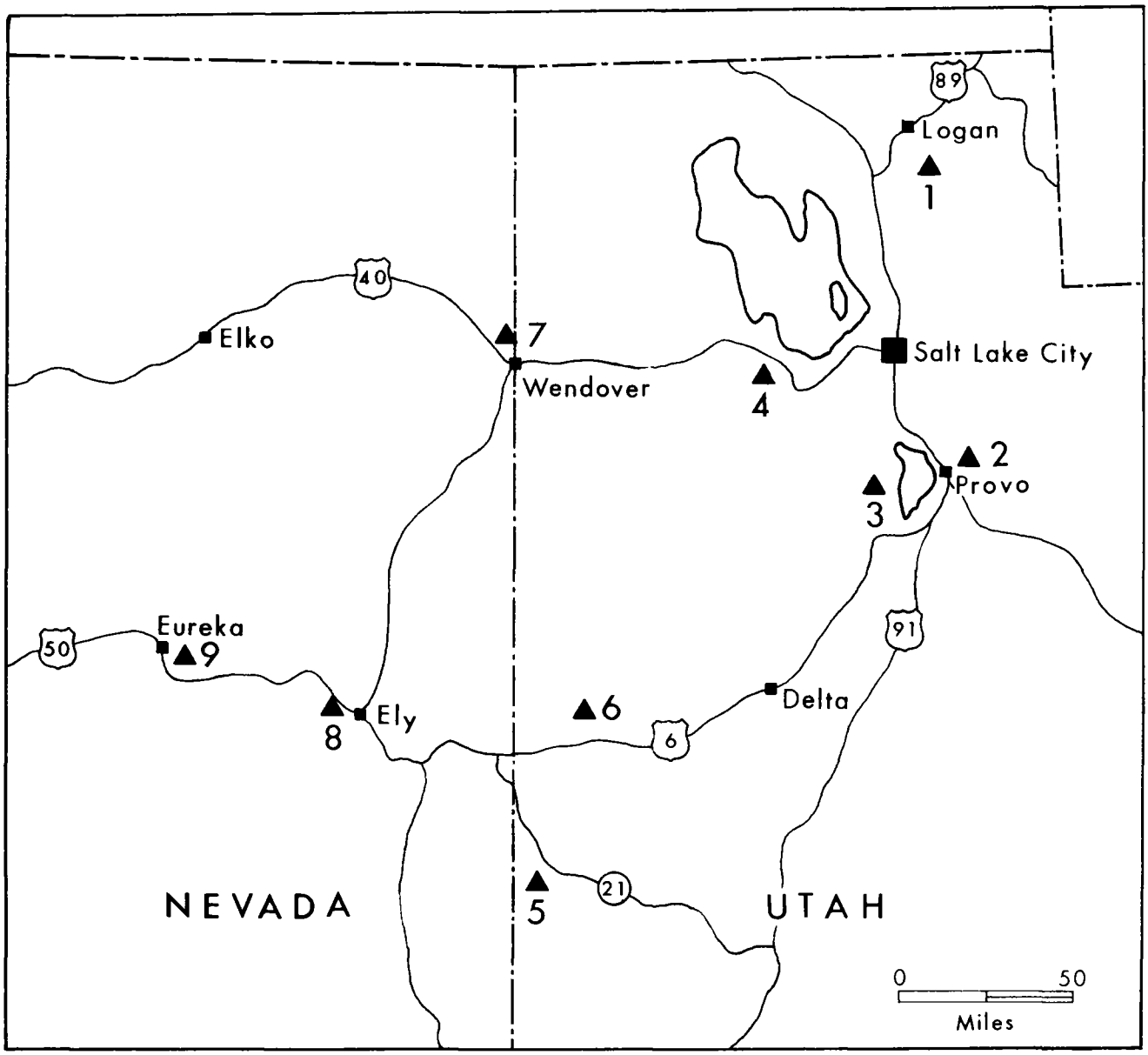

FIGURE 1.–Map showing location of sections collected during present study: 1.–Logan, Utah (see fig. 2); 2.–Rock Canyon, Utah (see fig. 3); 3.–Rattlesnake Spur, Utah (see fig. 4); 4.–North Stansbury Mtns., Utah (see fig. 5); 5.–Needle Range, Utah (see fig. 6); 6.–Confusion Range, Utah (see fig. 7); 7.–Wendover, Nevada (see fig. 8); 8.–Ely, Nevada (see fig. 9); 9.–Eureka, Nevada (see fig. 10).

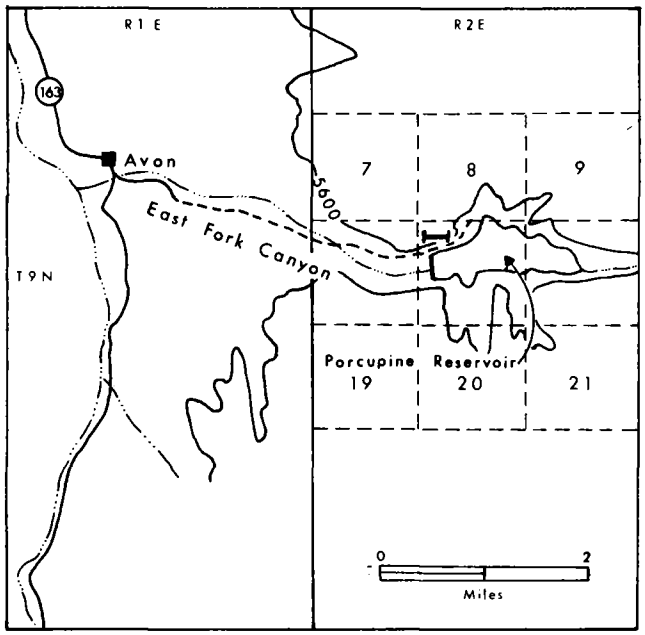

FIGURE 2.–Locality of Lodgepole Limestone section near Logan, Utah, NW¼, section 17 (unsurveyed), T. 9 N, R. 2 E, Cache County, Utah; 5600-foot contour indicated. Base from Ogden, Utah, U.S. Geological Survey Western U.S. 1:250,000 series map.

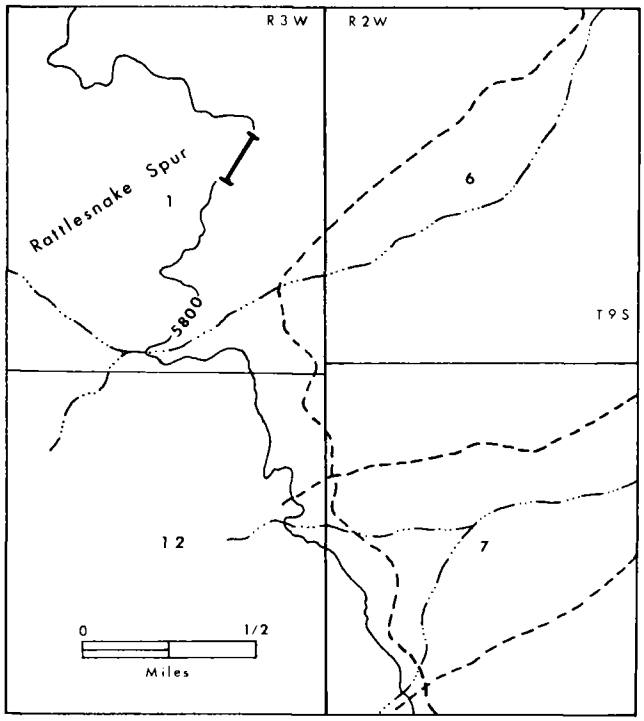

FIGURE 4.–Locality of Fitchville Formation–Gardison Limestone section at Rattlesnake Spur, NE¼, section 1, T. 9 S, R. 3 W, Utah County, Utah; 5,800-foot contour indicated; Base from Allen's Ranch and Boulter Mountains, Utah, U.S. Geological Survey 7½-minute quadrangle map.

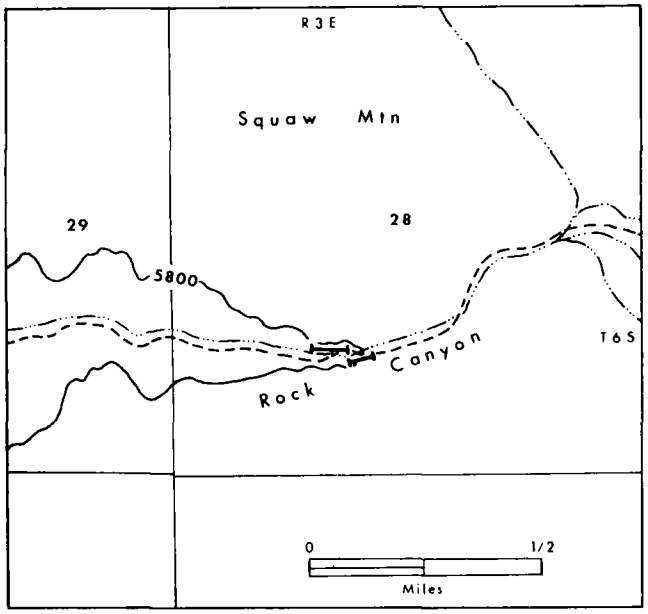

FIGURE 3.–Locality of Fitchville Formation–Gardison Limestone section in Rock Canyon, Utah, SW¼, section 28, T. 6 S, R. 3 E, Utah County, Utah; 5,800-foot contour indicated. Base from Bridal Veil Falls, Utah, U.S. Geological Survey 7½-minute quadrangle map.

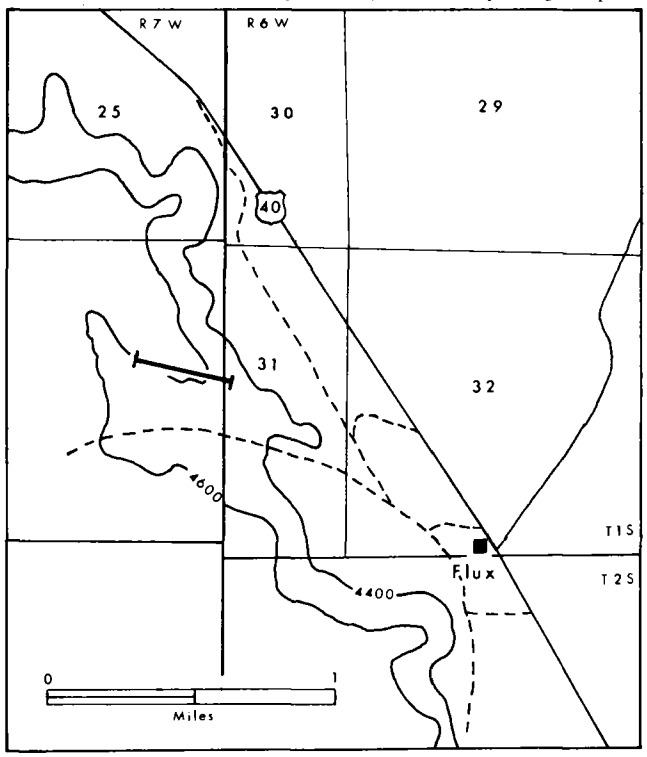

FIGURE 5.–Locality of Fitchville Formation–Gardison Limestone section in North Stansbury Mountains, section 31, T. 1 S, R. 6 W, and section 36, T. 1 s, R. 7 W, Tooele County, Utah; 4,400- and 4,600-foot contours indicated. Base from Timpie, Utah, U.S. Geological Survey 15-minute quadrangle map.

Sections were measured and sampled at three locations in central Utah: 360 feet at Rattlesnake Spur in the Tintic district, 260 feet at the North Stansbury Mountains, and 420 feet in Rock Canyon east of Provo. All sections yielded conodonts. The conodonts appear to have withstood dolomitization reasonably well although preservation becomes poorer as dolomite crystallinity becomes coarser.

Gardison Limestone

The Gardison Formation consists of a 20- to 50-feet-thick lower dolomite bed, a 200- to 250-feet-thick bed of limestone with thin dolomite partings, and an upper massive limestone unit containing abundant thin chert beds. The Gardison Limestone is approximately 450 to 500 feet thick throughout its entire exposure area.

The Gardison Limestone is typically very fossiliferous, containing abundant corals, brachiopods, and gastropods. Three sections of Gardison Limestone were measured and sampled: 420 feet at Rattlesnake Spur, 350 feet in the North Stansbury Mountains, and 320 feet in Rock Canyon. All sections yielded at least some conodonts, but, in spite of the abundance of

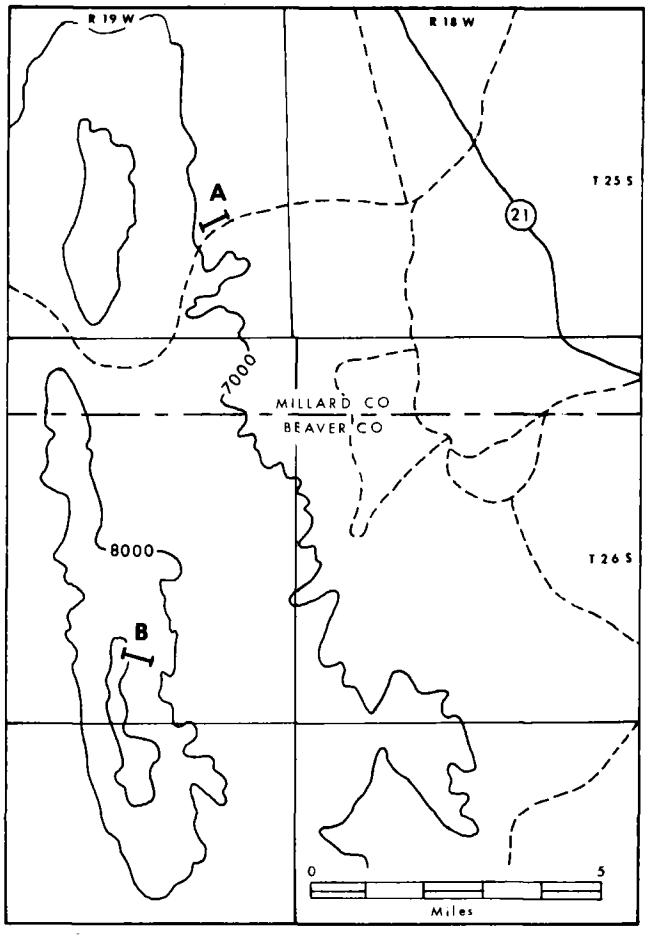

FIGURE 6.—Locality of Joana Limestone sections in the Needle Range, Millard and Beaver Counties, Utah; 7,000-, 8,000-, and 9,000-foot contours indicated. Section A, section 26 (unsurveyed), T. 25 S, R. 19 W, produced useful conodont material and is the section described as the Needle Range section in the text; section B, section 27 (unsurveyed), T. 26 S, R. 19 w, did not produce good material and is not discussed in the text. Base from Richfield, Utah, U.S. Geological Survey Western U.S. 1:250,000 series map.

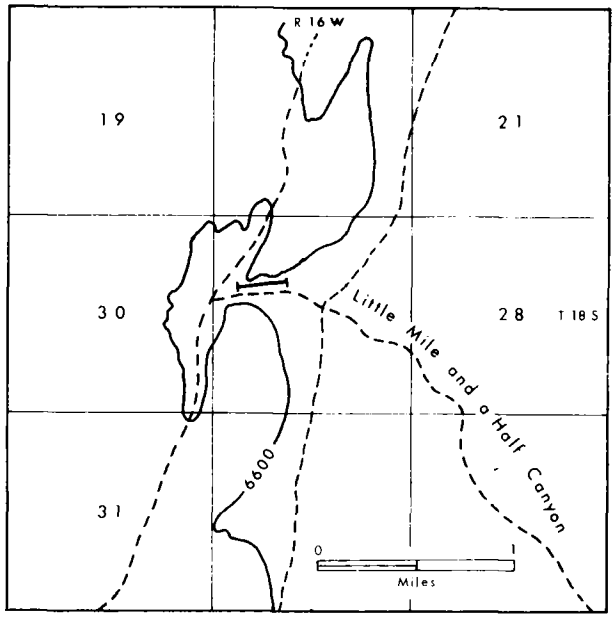

FIGURE 7.—Locality of Joana Limestone section in the Confusion Range, NW¼, section 29 (unsurveyed), T. 18 S, R. 16 W, Millard County, Utah; 6,600-foot contour indicated. Base from Conger Mountain, Utah, U.S. Geological Survey 15-minute quadrangle map.

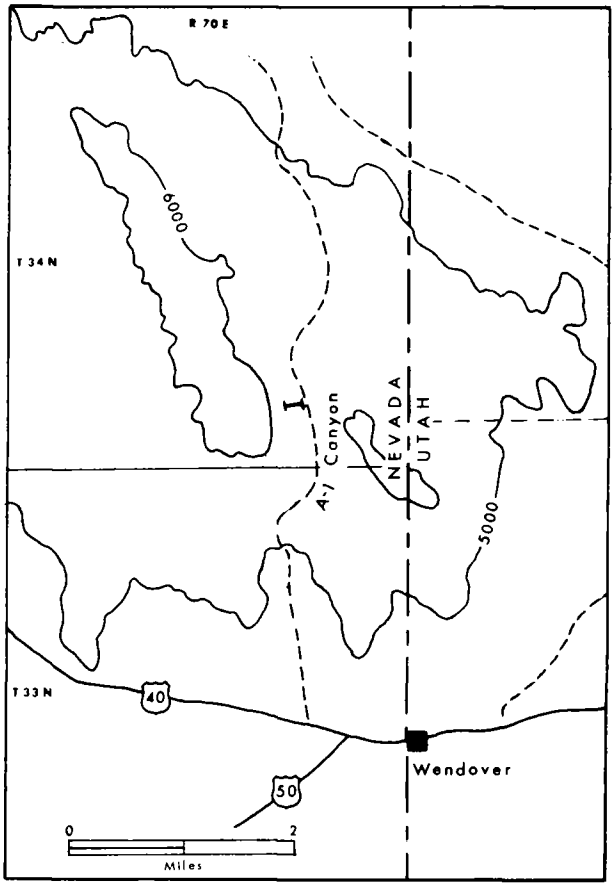

FIGURE 8.—Locality of Joana Limestone section near Wendover, T. 34 N, R. 70 E, Elko County, Nevada; 5,000- and 6,000-foot contours indicated. Base from Elko, Nevada, U.S. Geological Survey Western U.S. 1:250,000 series map.

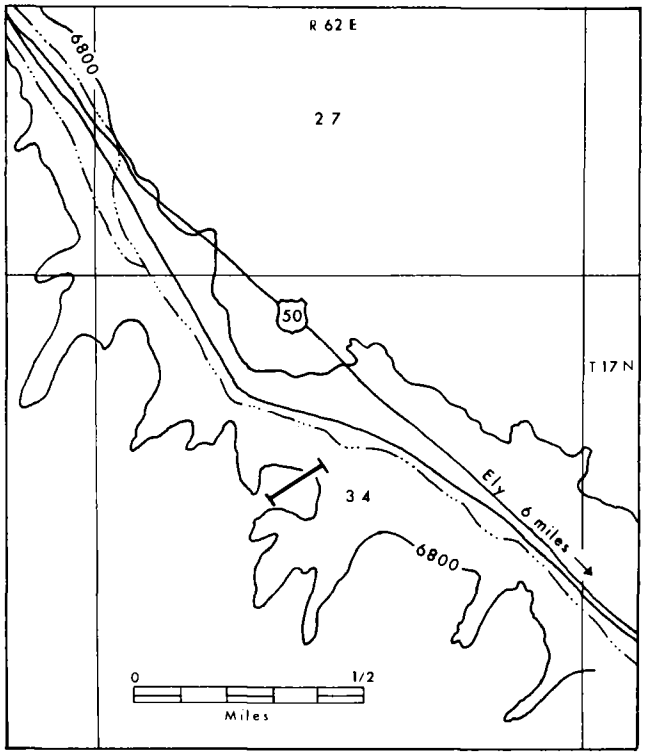

FIGURE 9.—Locality of Joana Limestone section near Ely, W½, section 34, T. 17 N, R. 62 E, White Pine County, Nevada; 6,800-foot contour indicated. Base from Ruth, Nevada, U.S. Geological Survey 7½-minute quadrangle map.

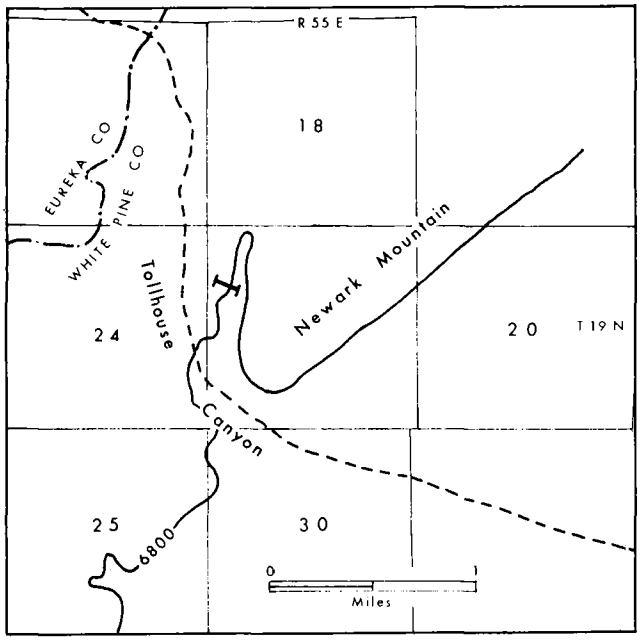

FIGURE 10.—Locality of Joana Limestone section near Eureka, NE¼, section 19, T. 19 N, R. 55 E, White Pine County, Nevada; 6,800-foot contour indicated. Base from Eureka and Pinto Summit, Nevada. U.S. Geological Survey 15-minute quadrangle maps.

macrofossils, far fewer conodonts were recovered from the Gardison sections than from the immediately underlying Fitchville sections. Sandberg and Gutschick (1978) have explained the low conodont abundances in the Gardison by the rapid rate of sedimentation.

NORTHERN UTAH

Lodgepole Limestone

The Lodgepole Formation is primarily a carbonate unit, 700 to 800 feet thick, which can be traced over most of Montana and Wyoming, and parts of Idaho, South Dakota, and Utah. Minor cherty, argillaceous, arenaceous and dolomitic carbonate interbeds occur in most sections. The Lodgepole Limestone is in part fossiliferous, containing an abundant coral-brachiopod-gastropod fauna.

The only section of Lodgepole Limestone measured and collected for this study was located at Porcupine Dam, 20 miles south of Logan, Utah, in the Bear River Range. The measured section is 590 feet thick. The section is extremely fossiliferous and yielded by far the most abundant and best preserved conodonts of any of the sections used in this study.

SYSTEMATIC PALEONTOLOGY

From the material collected and processed for the present study, specimens of 27 species and subspecies of conodonts, representing 11 genera, were recovered. Twenty-three species and subspecies of 7 stratigraphically important genera are described alphabetically and illustrated. The remaining four genera of long-ranging bars and blades:

Hibbardella
Hindeodella
Ozarkodina
Neoprioniodus

These are considered to be stratigraphically unimportant and are not studied. Under occurrence, the following frequencies are used, except where noted, in reference to the total number of specimens recovered from the combined sections:

Rare—less than 5
Frequent—6 to 25
Common—26 to 50
Abundant—more than 50

All sample numbers listed under occurrence indicate interval of the sample above the base of the collected section; for example, L-30 indicates the sample was taken 30 feet above the base of the Logan, Utah, section. Base of section does not necessarily correspond to formational boundaries. For formation boundaries refer to figure 11.

All figured specimens are reposited with the Department of Geology collections, Brigham Young University (BYU).

Genus ELICTOGNATHUS Cooper, 1939

ELICTOGNATHUS LACERATUS (Branson and Mehl)

Pl. 3, fig. 18

Description.—Narrow ridge on outer side, narrow ridge to prominent shelf on inner side slightly above aboral edge. Basal cavity elliptical, longitudinally and centrally located, with a sharp keel extending posteriorly and anteriorly. Posterior edge or blade commonly flexed inward.

Remarks.—Specimens involved in the present study have a narrow ridge (or only moderate shelf development) on the inner side. None possesses the large nodes or buttresses found below the apical dentical of many specimens within the range of variability of *E. laceratus* as defined by Klapper (1966) and Thompson and Fellows (1970).

Occurrence.—*E. laceratus* occurs commonly and is confined to the *Siphonodella cooperi* and lowermost *S. obsoleta* zones. Specimens were recovered from following samples: L-30, L-40, L-50, L-80, and L-100 (Logan); R-200 and R-210 (Rattlesnake Spur); F-70 (North Stansbury Mountains); A-Base (Needle Range); and W-24 (Wendover).

Genus GNATHODUS Pander, 1856

GNATHODUS DELICATUS Branson and Mehl

Pl. 3, figs. 13, 14

Description.—Low, broad, asymmetrical cap, ornamented with nodes or rows of nodes. A single prominent row of nodes is developed on the narrow inner side, and scattered nodes of two or more rows of nodes are developed on the wide outer side of the platform.

Remarks.—*G. delicatus* is the only *Gnathodus* species recovered in present study material, although the Lower Mississippian commonly contains several species of *Gnathodus* in the Mississippi Valley, Missouri, Texas, and elsewhere in the western United States.

Occurrence.—*Gnathodus delicatus* was found at only two localities. One specimen was recovered from sample T-80 (*Siphonodella obsoleta* Zone) in the Eureka section; the other from sample R-780 (*Polygnathus communis-Spathognathodus* Zone) in the Rattlesnake Spur section.

Genus ICRIODUS Branson and Mehl, 1938a

ICRIODUS cf. I. COSTATUS (Thomas)

Pl. 3, figs. 15, 16

Description.—Arched platform with prominent inclined posterior cusp. Nodes of lateral rows aligned with and connected by transverse ridges to nodes in the median row. The large flaring basal cavity is widest posteriorly.

Remarks.—All recovered specimens of *Icriodus* cf. *I. costatus* are very poorly preserved. Invariably, the main cusp, though present, is broken near its base, and the anterior ends of each unit are missing.

Occurrence.—*Icriodus* cf. *I. costatus* occurs in the *costatus* Zone. Only two specimens were recovered: one from sample R-150 (Rattlesnake Spur) and one from sample F-20 (North Stansbury Mountains).

Genus POLYGNATHUS Hinde, 1879

POLYGNATHUS COMMUNIS COMMUNIS Branson and Mehl

Pl. 2, figs. 12, 13, 16, 17

Description.—The lanceolate or ovate platform is quite variable in size with the free blade at least as long as the platform. Carina is nodose; platform is smooth or may have weakly developed transverse ridges anteriorly. Shallow troughs are present.

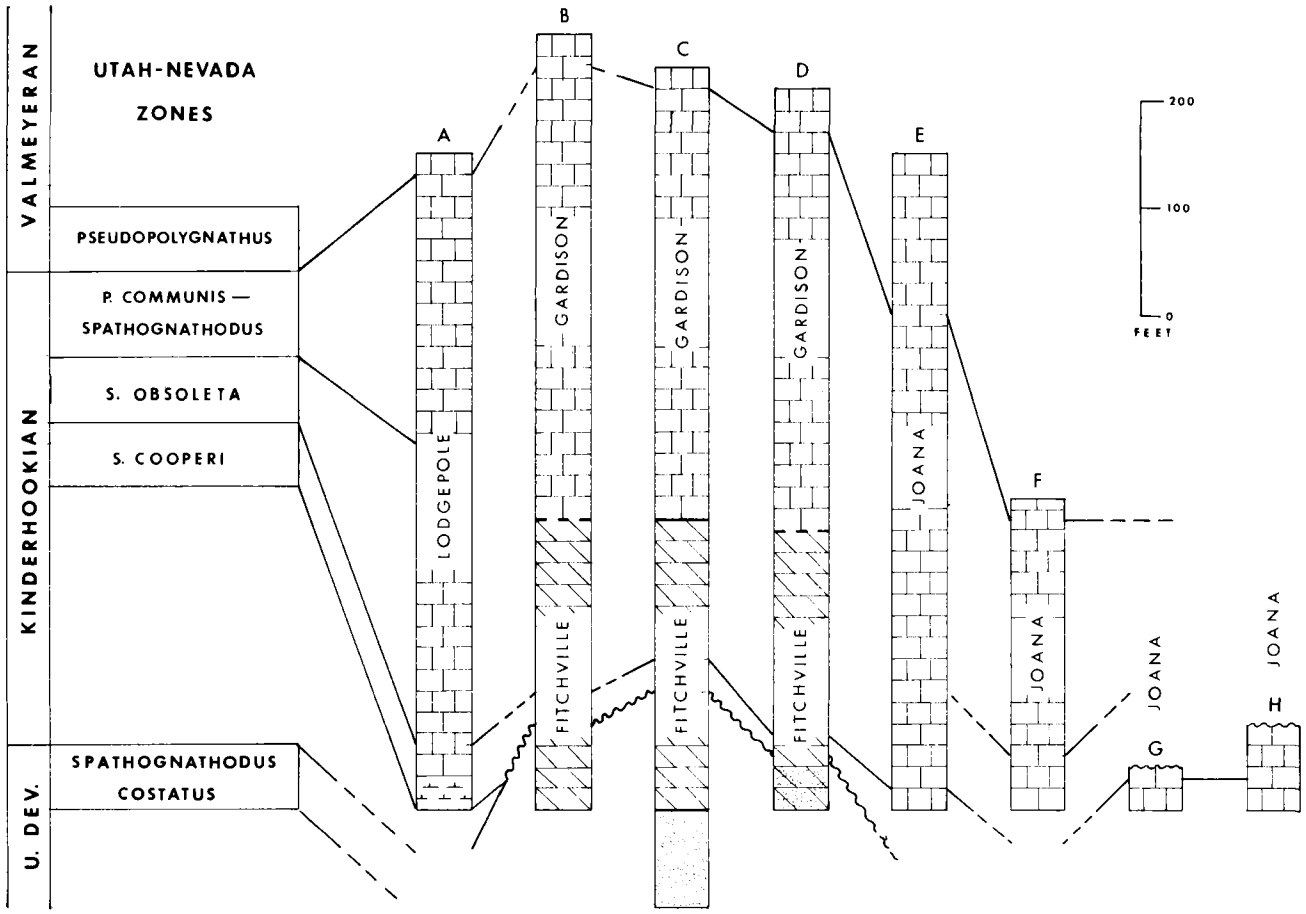

FIGURE 11.—Age of the Utah-Nevada zones and occurrence within, and correlation between, the eight study sections from which conodonts were recovered. Sections include Logan (A), Rock Canyon (B), Rattlesnake Spur (C), North Stansbury Mountains (D), Needle Range (E), and Confusion Range (F), in Utah; Wendover (G) and Eureka (H) in Nevada. Dashed correlation lines indicate that the zone was not recognized in a particular section.

The lower surface of the platform has an elliptical to subcircular pit located at the anterior end of the platform.

Remarks.—*Polygnathus communis communis* is the longest ranging platform recovered in this study. It is found almost continually in each section, and in many samples, it was the only conodont recovered. Its presence in the youngest samples in each section suggests that none of the measured sections are younger than Osagean.

Occurrence.—*Polygnathus communis communis* occurs from base to top of each studied section. It is found abundantly in the *Siphonodella cooperi* and *Pseudopolygnathus* zones but occurs frequently in all other zones.

POLYGNATHUS PERPLEXUS

Pl. 2, figs. 1, 2

Description.—Compound unit with a free blade about half as long as the platform. Platform is broadest medially and tapers toward the anterior and posterior ends. Poorly developed carina is strongly incurved posteriorly and does not extend to the posterior end of the platform. One moderately to strongly developed rostral ridge on either side of the carina. Rostral ridges angle toward but do not intersect carina. Oval surface ornamented with randomly arranged nodes. Aboral surface smooth except for prominent raised keel which is highest at anterior and posterior ends. Basal cavity is an indistinct slit located within the keel in the central part of the platform.

Remarks.—Specimens included in *Polygnathus perplexus* show moderate variability of rostral ridge development and size and abundance of nodose ornamentation.

Occurrence.—Specimens assigned to *Polygnathus perplexus* occur frequently in the *Bispathodus costatus* zone. Samples yielding specimens include: F-Base, F-10, and F-20 (North Stansbury), and R-60, R-70, and R-80 (Rattlesnake Spur).

POLYGNATHUS INORNATUS Branson

Pl. 2, figs. 7, 8

Description.—Lanceolate platform with a short, high free blade. Anterolateral edges of platform strongly upturned. Carina sinuous posteriorly and may be strongly incurved. Platform asymmetrical with a distinct sinus or constriction near its posterior lateral terminations. Both sides of platform ornamented with nodes and transverse ridges. Basal cavity relatively large, circular to ovate, usually with prominent lips, and set in the prominent raised keel.

Remarks.—Klapper (1971) discussed the problem concerning the simultaneously published *Polygnathus inornatus* types of Branson, 1934, and Branson and Mehl, 1934b. He recognized two form species and designated the specimen illustrated by E. R. Branson (1934, pl. 25, fig. 8) as lectotype of *P. inornatus*. *Polygnathus inornatus* E. R. Branson is distinguished from *P. inornatus* of Branson and Mehl as follows: the former has an asymmetrical platform, with a sinus in the posterior outer margin and a sinuous or incurved posterior carina, whereas *P. inornatus* Branson and Mehl has a virtually straight blade and carina that divide an almost bilaterally symmetrical platform.

(For a complete discussion of the *Polygnathus inornatus* problem see Klapper 1971, p. 6–7).

Occurrence.—*Polygnathus inornatus* Branson occurs commonly in samples from the *Siphonodella cooperi* Zone. Specimens were recovered from samples L-30 and L-40 (Logan); F-70 (North Stansbury); A-Base (Needle Range); T-Base (Eureka); and W-24 (Wendover).

POLYGNATHUS INORNATUS *Sensu* Branson and Mehl

Pl. 2, fig. 3, 4

Polygnathus symmetrica Branson , STRAKA, 1968, p. 35, pl. 1, figs. 11, 13 only.

Polygnathus inornatus inornatus Branson and Mehl (*sic*), RHODES et al., 1969, p. 186, pl. 10, figs. 4–6; DRUCE, 1969, p. 98, pl. 20, figs. 1–3.

Polygnathus inornata sensu Branson and Mehl, KLAPPER, 1971, p. 7, pl. 1, figs. 11, 12.

Description.—Lanceolate platform with short, high free blade. Anterolateral edges of platform strongly upturned. Carina and blade virtually straight dividing an almost bilaterally symmetrical platform. Both sides of platform ornamented with nodes and transverse ridges. Basal cavity large, circular to ovate, usually with prominent lips, and set in the raised keel.

Remarks.—See discussion under *Polygnathus inornatus* Branson. Few specimens of *Polygnathus inornatus sensu* Branson and Mehl were recovered in the present study, but *P. inornata* Branson was commonly encountered.

Occurrence.—*Polygnathus inornatus sensu* Branson and Mehl occur rarely in the *Siphonodella cooperi* Zone. Samples yielding specimens were R-200 and R-210 (Rattlesnake Spur); A-Base (Needle Range).

POLYGNATHUS LONGIPOSTICUS Branson and Mehl

Pl. 2, figs. 9, 10, 14, 15

Description.—Platform may not reach posterior end of element. Anterolateral margins of platform upturned to about the level of the carina. Platform margins transversely ridged and usually nearly straight. The basal cavity is large, circular to ovate, and set within the platform.

Remarks.—Because of the transition between *Polygnathus longiposticus* and *P. symmetricus,* assignment of some specimens to one species or the other is arbitrary. High degree of upturning of the anterolateral margins and extension of the blade beyond the posterior end of the platform were considered diagnostic of *P. longiposticus.*

Occurrence.—*Polygnathus longiposticus* occurs commonly in the *Siphonodella cooperi* Zone. Samples yielding specimens were L-30 and L-40 (Logan); R-200 and R-210 (Rattlesnake Spur); F-70 (North Stansbury); and W-24 (Wendover).

POLYGNATHUS EXTRALOBATUS Schafer

Pl. 2, figs. 11, 18

Description.—Asymmetrical platform with greatly expanded outer side, strongly incurved platform with the carina not reaching the posterior end. Posteriorly to the carina the platform is crossed by oblique, transverse ridges. Ridges are oblique to carina on the inner side of the central portion of the platform. Pit elliptical with lips.

Remarks.—In the present study *Polygnathus extralobatus* frequently occurs with *P. semicostatus,* which is similar. Because of effects of dolomitization of the enclosing rocks, carinal and transverse ridge detail is often obscured. In such cases, the broader, more posteriorly rounded specimens are placed with *P. extralobatus*; the more elongate specimens with pointed posterior ends, with *P. semicostatus.*

Occurrence.—*Polygnathus extralobatus* occurs frequently within the *Bispathodus costatus* Zone. Samples yielding specimens were: N-20 (Rock Canyon); F-50 (North Stansbury); R-70, R-110, and R-150 (Rattlesnake Spur).

POLYGNATHUS SEMICOSTATUS Branson and Mehl
Pl 2, figs 5, 6

Description.—Conodont with short blade and long, narrow to fairly wide and highly arched platform. Platform constricted medially and extends to a sharp point posteriorly. High, prominent carina originates near the constricted central portion of platform and passes anteriorly into the blade. Posterior to the carina, strong transverse ridges cross the width of the platform. Aboral surface comes to a sharp ridge with the keel indistinct as apex of ridge. Elliptical pit, with poorly developed lips, set in keel at anterior end of platform.

Occurrence.—*Polygnathus semicostatus* occurs abundantly almost continuously through the *Spathognathodus costatus* Zone. Samples yielding specimens include F-Base to F-50 (North Stansbury) and R-Base to R-100 (Rattlesnake Spur).

Genus PSEUDOPOLYGNATHUS Branson and Mehl, 1934

PSEUDOPOLYGNATHUS MARGINATUS Branson and Mehl
Pl 3, figs 7, 8, 9, 10

Description.—Lanceolate platform tapering to a sharp point near or at the posterior end of strongly nodose carina. Platform equally developed on both sides of carina and bears weak to strong transverse ridges. Prominent raised keel present throughout length of platform except where interrupted by basal cavity. Wide basal cavity nearly symmetrical with thick, flaring lips.

Remarks.—Several growth stages of *Pseudopolygnathus marginatus* are present in the study material Immature forms have basal cavities of much the same size and shape as mature specimens but have very small platforms with only very weak transverse ridges or nodose ornamentation.

Occurrence.—*Pseudopolygnathus marginatus* occurs in the *Siphonodella cooperi* Zone. Only sample L-30 (Logan) yielded material assignable to *P. marginatus.*

PSEUDOPOLYGNATHUS PRIMUS Branson and Mehl
Pl 3, figs 1, 2, 3, 4

Description.—Asymmetrical platform with lateral lobe developed on one side (right or left) only Right side of platform developed farther anteriorly. Ornamented with coarse and irregular transverse ridges or, in immature specimens, with single nodes on each side of platform. Basal cavity is large and asymmetrical and does not extend to platform margins in mature species.

Remarks.—In the present study forms assignable to *Pseudopolygnathus primus* occur in rocks as young as latest Kinderhookian or Valmeyeran. Many of these forms occupy the stratigraphic interval usually occupied by *P. multistriatus* in the midcontinent area. Many forms assigned to *P. primus* in this study may be transitional with *P. multistriatus.*

Occurrence.—In the studied faunas *Pseudopolygnathus primus* occurs commonly only in the *Pseudopolygnathus* Zone. Samples yielding specimens include L-610 (Logan), F-600 and F-610 (North Stansbury); A-445 and A-450 (Needle Range); and C-270, C-280, and C-290 (Confusion Range).

PSEUDOPOLYGNATHUS cf P MULTISTRIATUS Mehl and Thomas
Pl 3, figs 5, 6

Description.—Elongate, gently convex, doubly tapering platform extends farther anteriorly on the right side. Blade, short, carina low and nodose. Both sides of platform ornamented with coarse transverse ridges or single nodes in immature specimens. Large basal cavity subcircular, thick lipped, with short points posteriorly and anteriorly within narrow keel

Remarks.—Forms included as *Pseudopolygnathus* cf. *P. multistriatus* in this study appear to be largely immature. They occur with *P. primus* and may be juvenile forms of *P. primus.* However, the overall platform shape, and especially the shape of the basal cavity, is very similar to forms of *P. multistriatus* illustrated by Thompson (1967, pl. 4, figs. 15, 16, 19, 20).

Occurrence.—Forms assignable to *Pseudopolygnathus* cf. *P. multistriatus* occur frequently with *P. primus* in the *Pseudopolygnathus* Zone. Samples yielding specimens include L-610 (Logan); F-600 and F-610 (North Stansbury); A-445 and A-450 (Needle Range); and C-270, C-280, and C-290 (Confusion Range).

PSEUDOPOLYGNATHUS TRIANGULUS TRIANGULUS Voges
Pl. 3, figs 11, 12

Description.—Nearly symmetrical and subtriangular platform anterior margins nearly perpendicular to carina Carina and keel slightly incurved, platform ornamented by numerous small closely spaced transverse ridges. Basal cavity small, ovate, and set in keel.

Remarks.—The small basal cavity and fine ornamentation of *Pseudopolygnathus triangulus triangulus* are more similar to polygnathid forms than to most pseudopolygnathids. However, Voges (1959, p 295–296, text-fig. 5) presents phylogenetic evidence relating *P. triangulus triangulus* to *P. triangulas inaequalis,* establishing *P. triangulus triangulus* as a true pseudopolygnathid.

Occurrence.—*Pseudopolygnathus triangulus triangulus* was recovered from only two samples, both from the *Siphonodella cooperi* Zone. *P. triangulus triangulus* occurs frequently in sample L-30 (Logan) and rarely in sample F-70 (North Stansbury)

Genus SIPHONODELLA Branson and Mehl, 1944

SIPHONODELLA COOPERI Hass
Pl 1, figs 3, 4

Description.—Nodes on inner side of platform and strong transverse ridges on outer side. Two or three rostral ridges present; longest one on outer platform terminating posteriorly at outer margin of platform or forming that margin

Remarks.—*Siphonodella cooperi* is similar to and transitional with *S. quadruplicata.* Specimens recovered during the present study show all stages of development between the two species. Those forms where the longest lateral ridge on the outer platform either terminates posteriorly at the outer margin or becomes that margin are considered to be *S. cooperi.* In *S. quadruplicata* the longest rostral ridge on the outer platform terminates posteriorly in the region above the basal cavity and does not reach the lateral margin.

In agreement with Klapper (1971, p. 10) the division of *S. cooperi* into subspecies (Thompson and Fellows, 1970, p 104–105) is not considered valid as illustrated forms can be referred to either *S. obsoleta* or *S. isosticha* (see synonomies) A zone of probable equivalence to the *Siphonodella cooperi hassi* subzone of Thompson and Fellows (1970) was recognized in the present study sections, but all siphonodellids were referable to *S. obsoleta.*

Occurrence.—*Siphonodella cooperi* is the most abundant species recovered during the present study It is found abundantly over a 10-to-20-foot interval near the base of six of the studied

sections. Its presence defines the *Siphonodella cooperi* Zone. Samples from which specimens were recovered include L-30 and L-40 (Logan); R-200 and R-210 (Rattlesnake Spur); F-70 (North Stansbury); A-Base (Needle Range); W-24 (Wendover); and T-Base (Eureka).

SIPHONODELLA CRENULATA (Cooper)

Pl. 1, figs. 9, 10

Description.—Markedly asymmetrical platform; outer, strongly convex, margin may have sharp angular bend at midlength. Two, or rarely three, short rostral ridges present. Mature specimens typically ornamented with transverse ridges on the outer platform and nodes on inner platform.

Remarks.—Two mature specimens of *Siphonodella crenulata* were recovered during the study. The remaining specimens were small, immature forms with the typical *S. crenulata* platform outline but either devoid of oral ornamentation or only faintly nodose.

Occurrence.—Eight specimens that are definitely *Siphonodella crenulata* were recovered from sample L-30 (Logan). Fragments of what may be *S. crenulata* were noted in samples F-70 (North Stansbury) and T-Base (Eureka). All specimens are from the *Siphonodella cooperi* Zone.

SIPHONODELLA cf. S. ISOSTICHA (Cooper)

Pl. 1, figs. 1, 2

Description.—Representative specimens have posterior termination of the longest rostral ridge on the outer platform adjacent to the position where the carina begins to incurve and midway between the carina and margin. Long rostral ridge on inner side terminates at a comparable position. Posterior platform weakly nodose with somewhat stronger nodes on the inner side.

Remarks.—Klapper (1971, p. 10, 12), in a restudy of the holotype of *Siphonodella isosticha,* recognized a difference in the position of posterior termination of the longest outer rostral ridge of specimens assigned to *S. isosticha.* The longest outer rostral ridge of the holotype terminates at the outer margin. Specimens where the longest outer ridge terminates on the platform rather than at the outer margin are referred to as *S.* cf. *S. isosticha.*

Occurrence.—*Siphonodella* cf. *S. isosticha* occurs frequently in samples L-30 (Logan) and rarely in sample A-Base (Needle Range) and is confined to the *Siphonodella cooperi* Zone.

SIPHONODELLA LOBATA (Branson and Mehl)

Pl. 1, figs. 7, 8

Description.—Outer lateral lobe present. Transverse ridges ornament both sides of platform. Rostrum well developed. Keel atypical for *Siphonodella,* raised and continuous throughout entire length of platform, interrupted only by small, lipped, basal cavity. Secondary keel beneath outer lateral lobe joins main keel at basal cavity.

Remarks.—The prominent outer lobe and continuous raised keel distinguish *Siphonodella lobata* from other siphonodellids. The keel of *S. lobata* is similar to that of the polygnathids; however, the well-developed rostrum and very small basal cavity are typically siphonodellid.

Occurrence.—Only two specimens of *Siphonodella lobata* were recovered. Both specimens occurred in sample L-30 (Logan) within the *Siphonodella cooperi* Zone.

SIPHONODELLA OBSOLETA Hass

Pl. 1, figs. 5, 6

Description.—Relatively long narrow platform with two to four rostral ridges. Long rostral ridge extends to near posterior end of outer platform. Inner platform nodose, outer platform weakly ornamented or smooth between the long rostral ridge and carina.

Remarks.—Above the occurrence of all other siphonodellids in the studied sections, one form of *Siphonodella* persists. This form is the same *Siphonodella* that was designated *S. cooperi hassi* by Thompson and Fellows (1970, p. 104–105, pl. 6, figs. 2, 4). In agreement with Klapper (1971, p. 12) these forms are considered to be *S. obsoleta.* In the present study area, the persistence of *S. obsoleta* beyond the range of all other siphonodellids defines the *Siphonodella obsoleta* Zone.

Occurrence.—*Siphonodella obsoleta* occurs occasionally in the *Siphonodella cooperi* Zone in samples L-30 (Logan), R-210 (Rattlesnake Spur), F-70 (North Stansbury), A-Base (Needle Range), W-24 (Wendover), and T-Base (Eureka). *S. obsoleta* occurs abundantly in the *Siphonodella obsoleta* Zone. Samples yielding specimens include: L-40 to L-240 (Logan); R-220 to R-240 (Rattlesnake Spur); C-Base and C-5 (Confusion Range); and T-25 to T-80 (Eureka).

SIPHONODELLA QUADRUPLICATA (Branson and Mehl)

Pl. 1, figs. 11, 12

Description.—Posterior termination of the innermost rostral ridge on the outer platform is adjacent to the position where the carina begins to incurve and between the margin and the carina. Number of rostral ridges varies from three to five. Outer platform ornamented with transverse ridges, inner platform is nodose.

Remarks.—The distinction between *Siphonodella quadruplicata* and *S. cooperi* is based on the position of termination of the innermost rostral ridge on the outer platform, as emphasized in the diagnoses of the respective species. This division is highly artificial and within the present study material, forms representing a complete transition between the two species were recovered.

Occurrence.—*Siphonodella quadruplicata* occurs frequently within the *Siphonodella cooperi* Zone. Samples yielding specimens include: L-30 (Logan); R-200 and R-210 (Rattlesnake Spur); F-70 (North Stansbury); A-Base (Needle Range); W-24 (Wendover); and T-Base (Eureka).

BISPATHODUS (Müller, 1962)

BISPATHODUS ACULEATUS (Branson and Mehl)

Pl. 3, fig. 19

Description.—Lateral denticles developed on inner side of blade in the region of basal cavity. Development of lateral denticles does not reach posterior tip. Unit nearly straight to slightly curved. Basal cavity located at mid-length, nearly circular in shape, and wide.

Remarks.—Lateral denticles of *Bispathodus aculeatus* are usually joined to the denticles of the main row by transverse ridges. Number of lateral denticles variable but specimens from the present study usually have 4 lateral denticles. *B. aculeatus* is a slightly more robust form than most spathognathodids.

Occurrence.—*Bispathodus aculeatus* occurs frequently in the *B. costatus* Zone. Samples yielding specimens include: N-20 (Rock Canyon); R-90 (Rattlesnake Spur); and F-50 (North Stansbury).

Genus SPATHOGNATHODUS Branson and Mehl, 1941

SPATHOGNATHODUS CRASSIDENTATUS (Branson and Mehl)
Pl 3, fig 17

Description.—Dentition of blade over the platform of even length increasing in width posteriorly Two main denticles, markedly higher and wider than the others, at anterior end of blade. Basal cavity originates somewhere near mid-length. Cavity nearly symmetrical, rounded anteriorly and tapering to a point at posterior end of specimen

Remarks.—The two prominent, wide anterior denticles serve to distinguish *"Spathognathodus" crassidentatus* from other spathognathodids

Occurrence.—*"Spathognathodus" crassidentatus* occurs relatively abundantly in all the studied sections ranging from the *Bispathodus costatus* Zone through the *Pseudopolygnathus* Zone.

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TABLE 1
Distribution of Conodonts in the Logan Section

The 610-foot section was measured in 10-foot intervals. These 29 intervals yielded conodont material, 15 intervals were sampled but barren, and 18 intervals were covered and not sampled.

FORMATION	Leatham Fm.	Lodgepole Fm.																														
CONODONT ZONES	Siphonodella cooperi	Siphonodella obsoleta																										Polv. communis Spath. crassidentatus			Pseudopolygnathus	
SPECIES \ SAMPLES	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	210	220	240	250	345	360	440	460	590	600	610
Elictognathus laceratus		29	1				1																						
Polygnathus communis		23	10	3	1		2	2	2		1	1				4	2	1	1	1	1	1	1		2	1		7	
Polygnathus inornatus Branson		1	1																										
Polygnathus inornatus Branson & Mehl		5	1																										
Polygnathus longipostícus		30	6												1		1												
Polygnathus species indeterminate	3	2	1												1														
Pseudopolygnathus marginatus		12																											
Pseudopolygnathus cf. P. multistriatus		2																										2	
Pseudopolygnathus primus																												2	1
Pseudopolygnathus triangulus triangulus		14																											
Siphonodella cooperi		169	8																										
Siphonodella crenulata		18	1																										
Siphonodella cf. S. isosticha		4	25	2																									
Siphonodella lobata		6																											
Siphonodella obsoleta		60	36	7	1	1	5	3	5		1	1	1	1	2	15	9	2		2	1				1				
Siphonodella quadruplicata		8																											
Siphonodella species indeterminate		47	13	2							2																		
Spathognathodus crassidentatus		18	2			1				2		1			1	3	6			2		3	1	3		1		3	

TABLE 2
Distribution of Conodonts in the Rock Canyon Section

The 740-foot section was measured in 10-foot intervals. These 9-sample intervals yielded conodonts, 54 intervals were sampled but barren, and 8 intervals were covered and not sampled.

FORMATION	Fitchville Fm.		Gardison Ls.						
CONODONT ZONES	Spathognathodus costatus		Polv. communis Spatho. crassidentatus			Pseudopolygnathus			
SPECIES \ SAMPLES	20		420	590	620	630	650	680	690	700
Polygnathus communis	2			1	15	2		6		
Polygnathus inornatus Branson & Mehl	1									
Polygnathus obliquicostatus	5		BARREN							
Polygnathus species indeterminate										
Spathognathodus aculeatus	1									
Spathognathodus crassidentatus				2	10	2	1	3	2	3

TABLE 3
Distribution of Conodonts in the Rattlesnake Spur Section

The 780-foot section was measured in 10-foot intervals. These 25-sample intervals yielded conodonts, 26 intervals were sampled but barren, and 28 intervals were covered and not sampled.

FORMATION	Fitchville Fm.																				Gardison Ls.						
CONODONT ZONES	Spathognathodus costatus														Siphonodella cooperi		Siphonodella obsoleta				Polygnathus communis Spathognathodus crassidentatus						Pseudopolygnathus
SPECIES \ SAMPLES	BASE	10	20	30	50	60	70	80	90	110	120	130	140	150	200	210	220	230	240	360	710	730	750	760	770	780	
Elictognathus laceratus															1	2											
Icriodus cf. I. Costatus														1													
Polygnathus communis				6	2		2	1	3	4	2		3	2	9				1		4	5	2	5	1	8	
Polygnathus inornatus Branson & Mehl															2												
Polygnathus longipostícus															3	3											
Polygnathus granulosus						2	4	1																			
Polygnathus obliquicostatus								2				1		3													
Polygnathus semicostatus		3	5	2			1																				
Polygnathus species indeterminate	1		2			1																					
Pseudopolygnathus primus																										2	
Siphonodella cooperi															37	4	1			BARREN							
Siphonodella cf. S. isosticha															1												
Siphonodella lobata																1											
Siphonodella obsoleta															7	5	2	2	2								
Siphonodella quadruplicata																1											
Siphonodella species indeterminate		•													3	7	1										
Spathognathodus aculeatus		•							1																		
Spathognathodus crassidentatus	4		3	2	3		3	2		1				2	2	1					2	3	3	1	3	4	

TABLE 4

Distribution of Conodonts in the North Stansbury Mountains Section

The 650-foot section was sampled in 10-foot intervals. These 12-sample intervals yielded conodonts, 21 intervals were sampled but barren, and 33 intervals were covered and not sampled.

FORMATION	Fitchville Fm.								Gardison Ls.							
CONODONT ZONES	Spathognathodus costatus				Siphonodella cooperi				Polygnathus communis – Spathognathodus crassidentatus					Pseudopolygnathus		
SPECIES \ SAMPLES	BASE	10	20	50	70			260	405	560	570	580	590	600	610	
Elictognathus laceratus					13											
Polygnathus communis	7		5	2	31					2	25	4	14		14	26
Polygnathus inornatus Branson & Mehl					4											
Polygnathus longiposticus					9											
Polygnathus granulosus	3	2	9													
Polygnathus obliquicostatus			2													
Polygnathus semicostatus	5	6	4					BARREN								
Polygnathus species indeterminate	2			1	3											
Pseudopolygnathus cf. P. multistriatus														2	3	
Pseudopolygnathus triangulus triangulus					4											
Siphonodella cooperi					67											
Siphonodella obsoleta					18											
Siphonodella species indeterminate					16											
Spathognathodus aculeatus				2												
Spathognathodus crassidentatus	1	2	4		11				2		8	2	5	3	3	

TABLE 5

Distribution of Conodonts in the Needle Range Section

The 610-foot section was measured in 10-foot intervals. These 8 intervals yielded conodonts, 45 intervals were sampled but barren, and 9 intervals were covered and not sampled.

FORMATION	Joana Ls.								
CONODONT ZONES	Siphonodella cooperi	Poly. communis – Spatho. crassidentatus						Pseudopolygnathus	
SPECIES \ SAMPLES	BASE	380	390	400	415	420	445	450	
Elictognathus laceratus	2								
Polygnathus communis	7	5	3	5	2	3	23	5	
Polygnathus deliratulus	2								
Polygnathus inornatus Branson	1								
Polygnathus inornatus Branson & Mehl	2								
Polygnathus longiposticus	2								
Polygnathus species indeterminate	1								
Pseudopolygnathus cf. P. multistriatus							3	2	
Siphonodella cooperi	4								
Siphonodella cf. S. isosticha	1								
Siphonodella obsoleta	3								
Siphonodella quadruplicata	2								
Siphonodella species indeterminate	3								
Spathognathodus crassidentatus	4	4	2	2	1	2	3	1	

TABLE 6

Distribution of Conodonts in the Confusion Range Section

The 290-foot section was measured in 5-foot intervals. These 15 sample intervals yielded conodonts, 31 intervals were sampled but barren, and 14 intervals were covered and not sampled.

FORMATION	Joana Ls.														
CONODONT ZONES	Siphonodella obsoleta		Polygnathus communis – Spathognathodus crassidentatus						Pseudopolygnathus						
SPECIES \ SAMPLES	BASE	5	30	195	230	235	240	245	250	265	270	275	280	285	290
Polygnathus communis						1	2	3	19	24	12	20	34	2	9
Polygnathus inornatus Branson & Mehl			6												
Pseudopolygnathus cf. P. multistriatus										1	2		6		3
Pseudopolygnathus primus													1		2
Siphonodella obsoleta	1														
Siphonodella species indeterminate	1	1													
Spathognathodus crassidentatus			1					1	11	18	6	3	3	1	2

TABLE 7

DISTRIBUTION OF CONODONTS IN THE WENDOVER SECTION

THE 24-FOOT SECTION WAS MEASURED IN 2-FOOT INTERVALS. SAMPLE INTERVAL 24 YIELDED CONODONTS, 9 INTERVALS WERE SAMPLED BUT BARREN, AND 3 INTERVALS WERE COVERED AND NOT SAMPLED.

FORMATION	*Joana Ls.*									
CONODONT ZONES	*Siphonodella cooperi*									
SPECIES \ SAMPLES	BASE	2	4	6	8	10	12	16	18	24
Elictognathus laceratus										2
Polygnathus communis										3
Polygnathus inornatus Branson										3
Polygnathus inornatus Branson & Mehl									N	1
Polygnathus longiposticus								E		2
Polygnathus species indeterminate	B		A		R		R			6
Siphonodella cooperi										9
Siphonodella obsoleta										3
Siphonodella quadruplicata										4
Siphonodella species indeterminate										13
Spathognathodus crassidentatus										2

TABLE 8

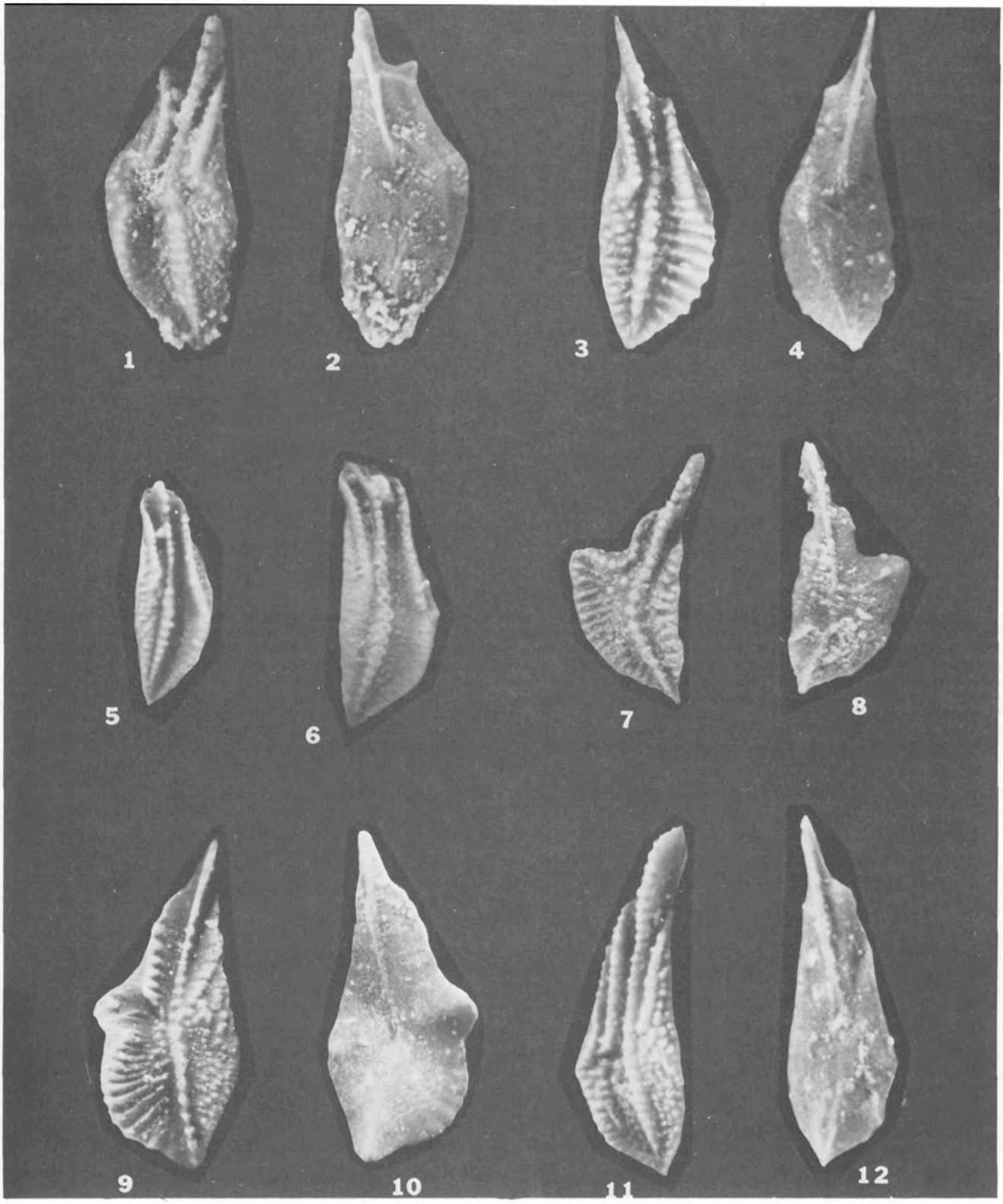
DISTRIBUTION OF CONODONTS IN THE EUREKA SECTION

THE ABOVE 4 SAMPLES REPRESENT THE ONLY OUTCROPS IN THE 80-FEET SECTION. THE REMAINDER OF THE SECTION WAS COVERED AND NOT SAMPLED.

FORMATION	*Joana Ls.*			
CONODONT ZONES	*Siphonodella cooperi*	*Siphonodella obsoleta*		
SPECIES \ SAMPLES	BASE	40	55	80
Elictognathus laceratus	4			
Gnathodus delicatus				1
Polygnathus communis	5	2		
Polygnathus inornatus Branson	1			
Polygnathus inornatus Branson & Mehl	1			
Polygnathus species indeterminate	1			
Siphonodella cooperi	16			
Siphonodella obsoleta	11	3	2	6
Siphonodella quadruplicata	2			
Siphonodella species indeterminate	14			
Spathognathodus crassidentatus	4			

EXPLANATION OF PLATE 1

All figures are unretouched photographs of coated specimens. Figures *1, 2.–Siphonodella* cf. *S. isosticha* (Cooper). Lodgepole Limestone, Logan (L-30). Oral and aboral views, hypotype, BYU-1914, X30. *3,4.–Siphonodella cooperi* Hass. Lodgepole Limestone, Logan (L-30). Oral and aboral views, hypotype, BYU-1912, X35. *5,6.–Siphonodella obsoleta* Hass. *5*, Fitchville Formation, Rattlesnake Spur (R-200). Oral view, hypotype, BYU-1909, X35. *6*, Lodgepole Limestone, Logan (L-170). Oral view, hypotype, BYU-1910, X35. *7,8.–Siphonodella lobata* (Branson and Mehl). Lodgepole Limestone, Logan (L-30). Oral and aboral views, hypotype, BYU-1915, X25 *9,10.–Siphonodella crenulata* (Cooper). Lodgepole Limestone, Logan (L-30). Oral and aboral views, hypotype, BYU-1913, X25 *11,12.–Siphonodella quadruplicata* (Branson and Mehl). Lodgepole Limestone, Logan (L-30). Oral and aboral views, hypotype, BYU-19122, X35.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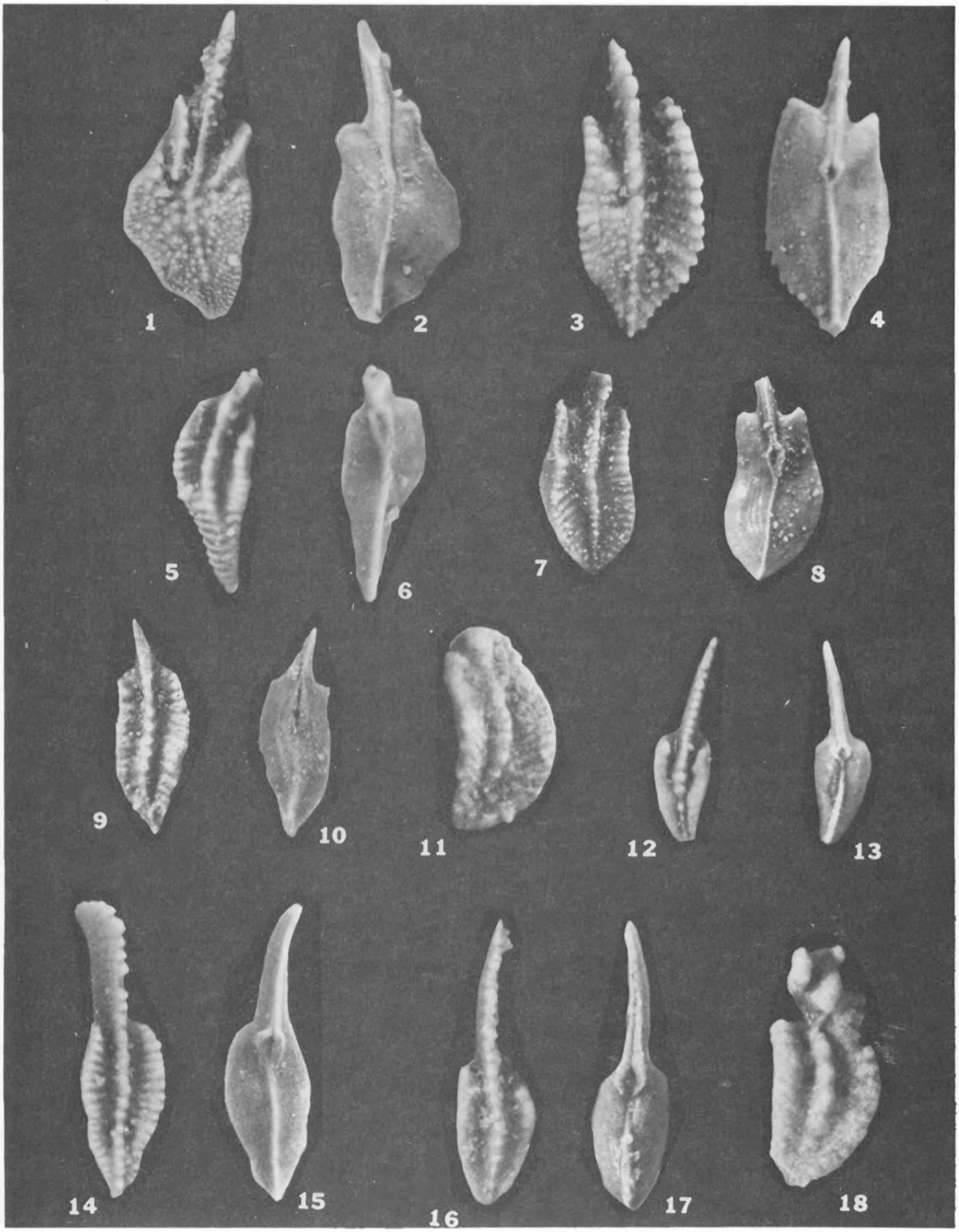
EXPLANATION OF PLATE 2

All figures are unretouched photographs of coated specimens Figures *1,2.–Polygnathus granulosus* Branson and Mehl Fitchville Formation, North Stansbury (F-Base) Oral and aboral views, hypotype, BYU-1926, X25 *3,4.–Polygnathus inornatus sensu* Branson and Mehl Joana Limestone, Needle Range (A-Base) Oral and aboral views, hypotype, BYU-1935, X35 *5,6.–Polygnathus semicostatus* Branson and Mehl Fitchville Formation, North Stansbury (F-20) Oral and aboral views, hypotype, BYU-1929, X40 *7,8.–Polygnathus inornatus* Branson Lodgepole Limestone, Logan (L-30) Oral and aboral views, hypotype, BYU-1934, X25 *9,10.–Polygnathus longiposticus* Branson and Mehl Lodgepole Limestone, Logan (L-30) Oral and aboral views, hypotype, BYU-1928, X25 *11,18.–Polygnathus extralobitus* Schafer *11,* Fitchville Formation, Rock Canyon (N-20) Oral view, hypotype, BYU-1931, X67 *18,* Fitchville Formation, Rattlesnake Spur (R-130), Oral view, hypotype, BYU-1930, X73 *12,13,16,17.–Polygnathus communis communis* Branson and Mehl *12,13,* Lodgepole Limestone, Logan (L-30) Oral and aboral views, hypotype, BYU-1932, X35 *16,17,* Joana Limestone, Confusion Range (C-280) Oral and aboral views, hypotype, BYU-1933, X35 *14,15.–Polygnathus longiposticus* Bianson and Mehl. Joana Limestone, Needle Range (A-Base) Oral and aboral views, hypotype, BYU-1927, X35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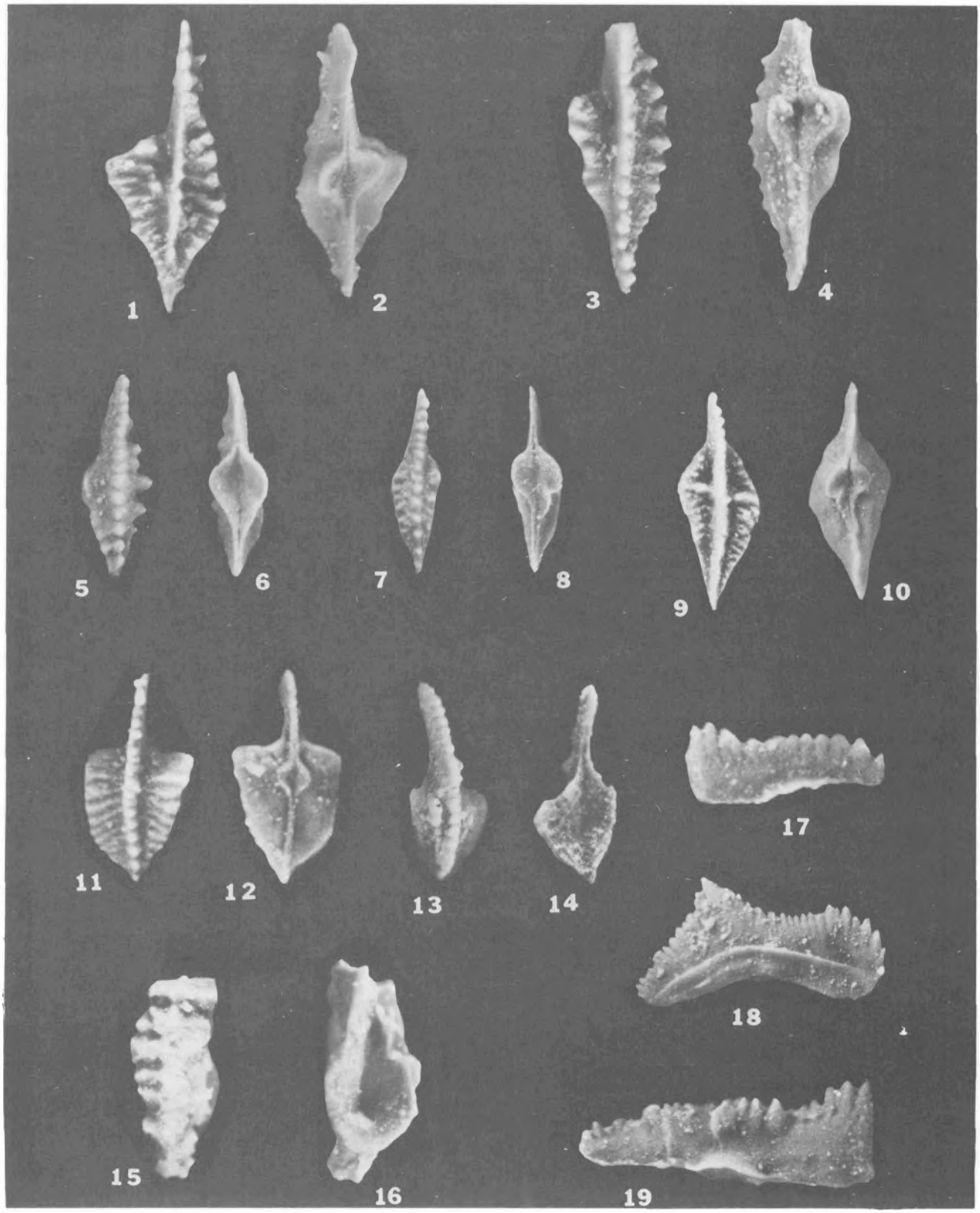
EXPLANATION OF PLATE 3

All figures are unretouched photographs of coated specimens. Figures *1,2,3,4.–Pseudopolygnathus primus* Branson and Mehl *1,2,* Lodgepole Limestone, Logan (L-610) Oral and aboral views, hypotype, BYU-1922, X25 *3,4,* Joana Limestone, Confusion Range (C-280) Oral and aboral views, hypotype, BYU-1923, X30 *5,6.–Pseudopolygnathus* cf *P. multistriatus* Mehl and Thomas Joana Limestone, Confusion Range (C-280) Oral and aboral views, hypotype, BYU-1925, X35 *7,8,9,10.–Pseudopolygnathus marginatus* (Branson and Mehl) Lodgepole Limestone, Logan (L-30) *7,8,* oral and aboral views, hypotype, BYU-1920, X35 *9,10,* oral and aboral views, hypotype, BYU-1921, X25 *11,12.–Pseudopolygnathus triangulus triangulus* Voges Lodgepole Limestone, Logan (L-30) Oral and aboral views, hypotype, BYU-1924, X35 *13,14.–Gnathodus delicatus* Branson and Mehl Joana Limestone, Eureka (T-380) Oral and aboral views, hypotype, BYU-1936, X30 *15,16.–Icriodus* cf *I costatus* (Thomas) Fitchville Formation, Rattlesnake Spur (R-150) Oral and aboral views, hypotype, BYU-1919, X35 *17 –Spathognathodus crassidentatus* (Branson and Mehl) Lodgepole Limestone, Logan (L-30). Outer lateral view, hypotype, BYU-1918, X30 *18 –Elictognathus laceratus* (Branson and Mehl) Lodgepole Limestone, Logan (L-30) Outer lateral view, hypotype, BYU-1919, X25 *19 –Spathognathodus aculeatus* (Branson and Mehl) Fitchville Formation, Rattlesnake Spur (R-90) Inner lateral view, hypotype, BYU-1916, X22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