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Late Devonian and Early Mississippian Biostratigraphy of Central Utah*

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ABSTRACT.—From the Pinyon Peak Limestone and Gardner Formation of central Utah, the writer has obtained 36 species of 14 conodont genera. Species of *Palmatolepis* and *Polygnathus* can be used in refined Devonian zonation, similarly *Siphonodella* is useful in Lower Mississippian zonation.

Three distinct conodont assemblage zones designated C, D, and E have been determined in the Late Devonian-Early Mississippian rock sequences of central Utah. Zone C is of uppermost *Cheiloceras* age (III-IV), Zone D is of *Wocklumeria* (V-VI), and Zone E is of *Gattendorfia* to lower *Pericyclus* (Cu I-Cu II α). These zones are useful in detailed biostratigraphic determinations and are correlated with the standard stages based on ammonoid genera in Europe.

Zone C and D, present in the upper Pinyon Peak Limestone and lower Gardner Formation can be correlated with the lower part of the Double Horn Shale Member of the Houy Formation in Texas and the Grassy Creek, Saverton, Louisiana, and possibly, the lower part of the Glen Park Formation of the Upper Mississippi Valley.

Zone E, present in the Gardner Formation, can be correlated with the upper part of the Double Horn Shale and Chappel Limestone of central Texas, the upper part of the Glen Park Limestone, all of the Hannibal Shale, and the lower part of the Chouteau Limestone of the Upper Mississippi Valley.

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*A thesis submitted to the Faculty of the Department of Geology, Brigham Young University in partial fulfillment of the requirements for the degree Master of Science.

INTRODUCTION

Results of work by Clark & Becker (1960) concerning Late Devonian biostratigraphy in eastern Nevada and western Utah prompted the writer to use conodonts for Late Devonian-Early Mississippian correlations in central Utah.

Conodonts have world-wide use as index fossils and have been particularly useful in Late Devonian-Early Mississippian studies. Certain species of *Polygnathus* (Ziegler, 1958) and *Palmatolepis* (Youngquist, 1947; Bischoff & Ziegler, 1956; Lys & Serre, 1957; Clark & Becker, 1960) are indicative of the Devonian and species of *Siphonodella* (Scott, 1958, *ms.*; Branson & Mehl, 1934a) are a good key to rocks of Mississippian age. Species of these genera were encountered in the rocks of central Utah and are of value in correlating the middle Paleozoic sequence and in definition of the Devonian-Mississippian time boundary.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the assistance of Dr. David L. Clark for supervision of the problem, counsel, and aid in identification and editing the manuscript.

Thanks are extended to Dr. J. R. Bushman for help and suggestions pertaining to the study, also Michael Steed and William Tidwell for assistance in the field.

STATEMENT OF PROBLEM

Principle objective of this study was the use of conodonts in the Late Devonian-Early Mississippian sequence of central Utah in an attempt to define biostratigraphic zones of the strata and to determine as closely as possible the physical location of the Devonian-Mississippian time boundary.

The lithologic similarity of the Upper Devonian and Lower Mississippian sequence in central Utah (Brooks, 1959, p. 56; Morris, 1957, p. 14; Rigby, 1952, p. 33) and paucity of a critical fauna (Lindgren & Loughlin, 1919, p. 35; Peterson, 1956, p. 25; Morris, 1957, p. 13) previously have made biostratigraphic work difficult.

TECHNIQUES

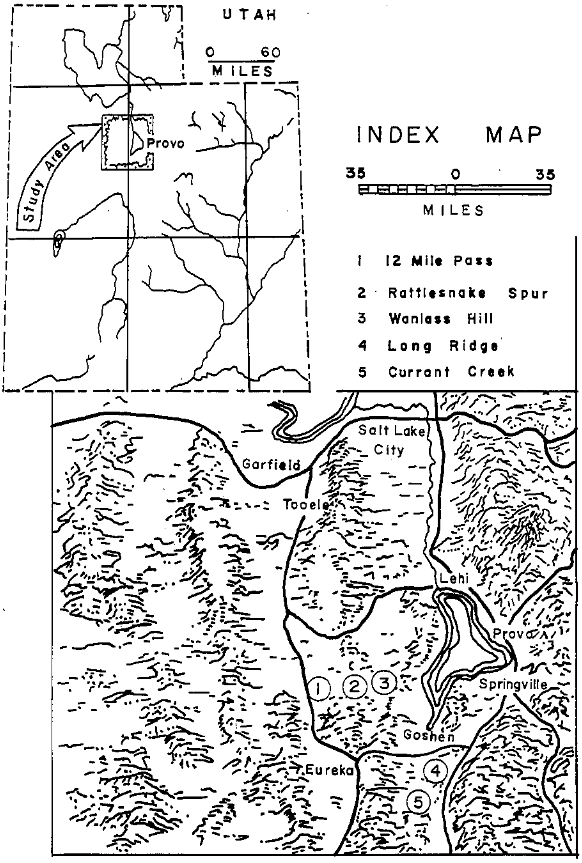
Field Procedure

Samples of the Pinyon Peak Limestone and lower Gardner Formation were taken from one to ten foot intervals on the Rattlesnake Spur and Currant Creek sections (Text-fig. 1). Sample numbers were painted on the outcrop and the distance between samples was measured by means of a 100 foot steel tape and Brunton Compass.

Samples from Wanlass Hill, Long Ridge, Rock Canyon, and the east side of 12 Mile Pass were taken at random intervals to determine the lateral distribution of zone species.

Laboratory Procedure

Samples were crushed into pieces about half an inch in diameter and 250 grams dissolved in 15 percent glacial acetic acid. The residues were washed, sieved, and the material retained on the 60 and 120 mesh screens examined on a modified Triebel tray. This tray is made from a light metal and painted with black paint, which should fill all corners and angles smoothly. The bottom of



TEXT-FIGURE 1.—Index map and section locations.

1. One and one-half miles northwest of Allen's Ranch and three miles west is located the small ridge (south side of road) which was sampled at 12 Mile Pass.

2. Rattlesnake Spur is located two and one-half miles due west of Allen's Ranch. The measured and sampled section is on the crest of the ridge.

3. Wanlass Hill is reached by going north from Elberta across the railroad tracks and cross under the power line, then turn west at the first intersection and travel two and three-fourth miles. The sampled section is on the east side of Wanlass Hill.

4. The Long Ridge section is located on the northern part of Long Ridge, one-half mile south of Warm Springs Mountain (about two and one-half miles southeast of Goshen).

5. Currant Creek is located 4.1 miles south of Goshen. There is a small pumphouse directly opposite (west) of the sampled and measured section.

the tray is divided by yellow lines into squares ten millimeters in width. A hole is then punched from below through every intersection of the yellow lines and the microfossils are dropped through these holes as they appear in the field of view. These fossils fall into a centered slide, resting underneath the tray in a space cut out of plywood and fastened to the stage of the microscope. This method is particularly useful in picking microfossils because it is rapid, easy, and reduces the danger of losing microfossils during transferal from tray to slide. Further details of this method are discussed by Glaessner (1948, p. 42-43).

STRATIGRAPHY

General

Lower Mississippian rocks in central Utah are represented by the lower Gardner Formation while Upper Devonian rocks in this same area include the upper part of the Victoria Quartzite, the Pinyon Peak Limestone and the lower beds of the Gardner Formation.

The Pinyon Peak Limestone and the lower Gardner Formation were measured and sampled at various localities in central Utah (Text-fig. 1). Samples collected were taken in quantity to provide sufficient material for investigation.

In addition, a thin unit of possible Late Devonian age was sampled in Rock Canyon but no microfossils were obtained.

Tectonic relationships of the Upper Devonian in this part of Utah are discussed by Rigby (1959).

Pinyon Peak Limestone

The Pinyon Peak Limestone was named for exposures on the east side of Pinyon Peak in the Tintic district, Utah, by Lindgren & Loughlin (1919, p. 36). Stratigraphic position of this limestone was confused at the time of its description but is now known to lie stratigraphically above the Victoria Quartzite (Lovering *et al.*, 1959, p. 1505-1506).

The Pinyon Peak Limestone consists of gray, thin- to medium-bedded limestones and dolomites. Outcrop pattern is variable and the lower beds are relatively soft in comparison to the adjacent beds. The upper part of this formation has a mottled appearance due to irregular intercalation of argillaceous material within limestone lenses (Peterson, 1956, p. 26). Thickness of this formation varies from 98 feet at Currant Creek (Peterson, 1953, *ms.*, p. 25) and Rattlesnake Spur to 200 feet at Wanlass Hill (Rigby, 1952).

Initial dating of the Pinyon Peak was done by Edwin Kirk (Lindgren & Loughlin, 1919) who indicated that the fauna was not sufficient to make a precise age determination.

The following fossils were identified by Kirk:

Pleurotomaria sp., *Cyathophyllum* sp., *Rhombopora* sp., *Spirifer* sp.

Later work by Peterson (1956) with the Pinyon Peak Limestone produced identification of the following:

Spirifer argentarius (?) Meek, *Atrypa* cf. *montanensis* Kindle, *Cyrtospirifer whitneyi* (Hall), *Cyrtospirifer* cf. *portal* (?) Merriam, *Cyathophyllum* (?) sp.

Measured and sampled sections of the Pinyon Peak Limestone are indicated on Text-fig. 1.

Devonian? Calcarenite

A bed of unknown age, located stratigraphically between the top of the Cambrian and base of the Mississippian is exposed at various localities along the western face of the Wasatch Mountains (Gaines, 1950 *ms.;* Rhodes, 1955; Peterson, 1956; Woodland, 1958; Rigby, 1959).

This unit varies from three to eight feet thick and contains some quartz grit and small pebbles which are held together with a cement of calcareous dolomite (Gaines, 1950).

Brooks (1959, fig. 2) has used lithology as a means of correlating this unit with the Victoria Quartzite and the overlying rocks with the Pinyon Peak Limestone.

Samples were taken from this unit and the overlying formation (possible Pinyon Peak) in Rock Canyon from Sec. 28, T. 6 S., R. 3 E. (Woodland, 1958) but no microfossils were obtained.

Gardner Formation

The Gardner Formation was named by Lindgren & Loughlin (1919, p. 39-40) from outcrops in Gardner Canyon in the Tintic district, Utah.

The Gardner Formation consists of a series of thin- to massive-bedded limestones which have been affected by varying degrees of dolomitization (Clark, 1954). In the middle part of this formation is an algal biostrome known locally as the "curley bed" (Proctor & Clark, 1956). This unit was used as the upper boundary of the present study.

Below this "curley bed", the Gardner Formation consists of a lower dolomite member and an upper limestone member which total 237 feet thick. Color of the lower unit varies from dark gray to light somber gray and becomes darker in color where alteration due to dolomitization is prominent. The limestone is dark blue-gray on a fresh surface, becoming almost black in some places; it is much lighter and has a "meringue" appearance on a weathered surface (Clark, 1954, p. 20).

The writer sampled up to the "curley bed", however, systematic work in the laboratory indicated a definite Mississippian fauna approximately 100 feet below this distinctive unit. Since further investigations were not needed to determine the Mississippian boundary, this remaining 100 foot section was not studied.

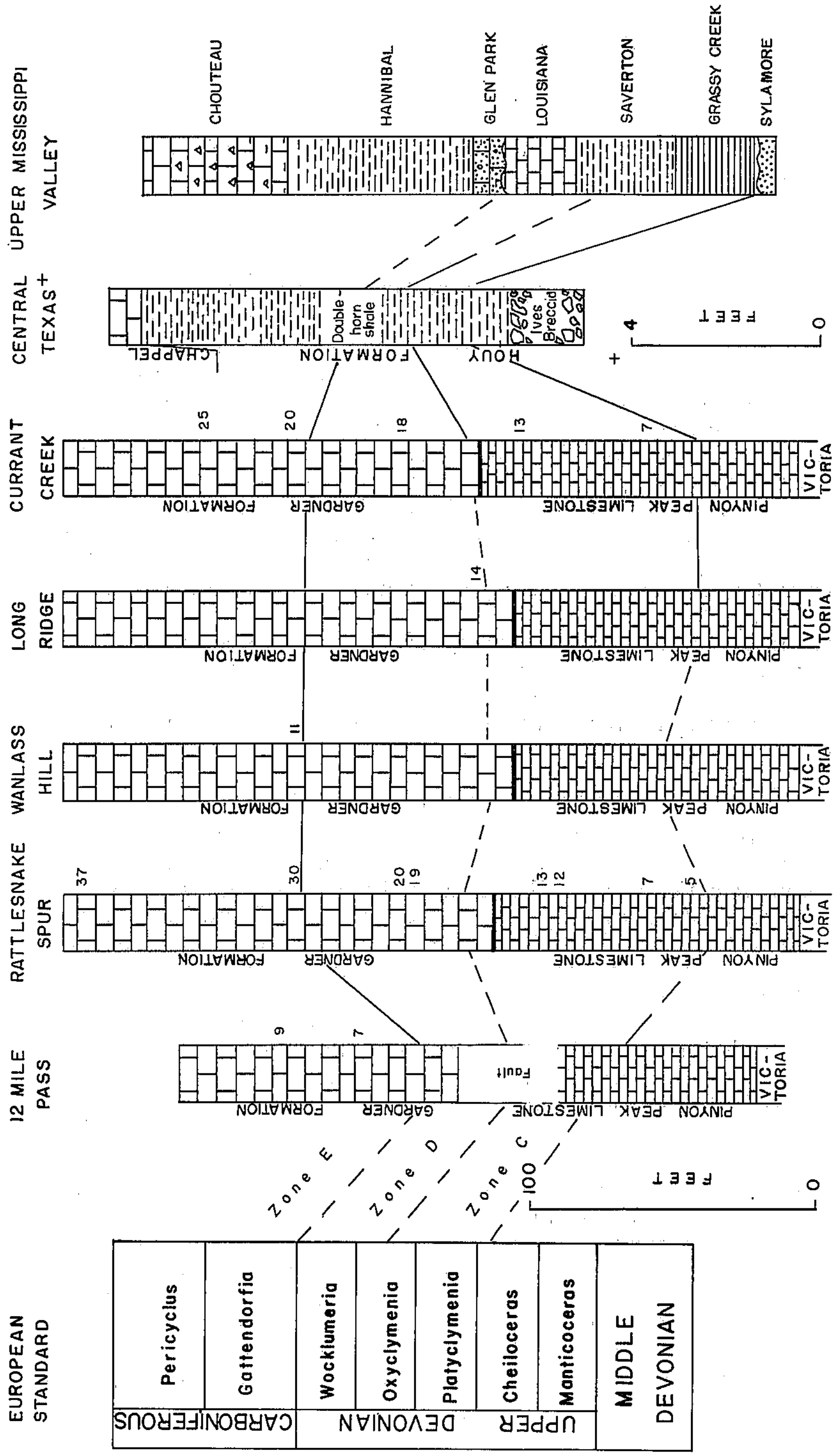
CONODONT ASSEMBLAGE ZONES

Clark & Becker (1960) established three conodont assemblage zones, Zone A, B, and C, for the Late Devonian Pilot Shale and Devils Gate Limestone sequence in Utah and Nevada. The youngest of their zones (C) was recognized by the writer on Rattlesnake Spur and correlation was effected with the other sections in central Utah (Text-fig. 2). Two younger zones, one of uppermost Devonian age (V-VI of the European standard) and one of lowermost Mississippian (Kinderhookian or Lower Tournaisian) have been encountered and are here designated as Zone D and Zone E. Thus five conodont zones ranging in age from early-Late Devonian (*Manticoceras*) through Early Mississippian (Kinderhookian or Lower Tournaisian) are now recognized in the western Utah-central Utah Paleozoic sequence.

Zone C

The oldest zone encountered is characterized by one species of *Palmatolepis, P. (P.) rugosa* Branson & Mehl, three species of *Polygnathus, P. nodocostata* Branson & Mehl, *P. granulosa* Branson & Mehl, *P. semicostata* Branson & Mehl, and one species of *Hibberdella, Hibberdella telum* Huddle. The designation of this interval as Zone C is in accord with the recognition of this same zone by Clark & Becker (1960) in eastern Nevada and western Utah.

Although these species of *Polygnathus* have not yet been used in precise correlations, they all have been recognized as occurring only in Upper De-



TEXT-FIGURE 2.—Conodont zones C, D, and E and correlations of the Late Devonian-Early Mississippian sections in central Utah and North America.

vonian. They are, therefore, useful in Central Utah because they are associated with *P. (P.) rugosa* to define Zone C. Similar use of *H. telum* is not possible because Huddle (1934) indicates a range of Middle? Devonian to possible Lower Mississippian for this species.

Zone C was recognized at Rattlesnake Spur, Currant Creek, and the Long Ridge sections in central Utah. At Rattlesnake Spur, this zone occurs from units 30-80 feet above the base of the Pinyon Peak Limestone and upon further investigation, was found at approximately the same stratigraphic distance at each of the other two sections.

Zone D

This zone is characterized by one species of *Polygnathus, P. styriaca* Ziegler plus numerous unidentifiable species of *Ligonodina, Hindeodella,* and *Spathognathodus.* Flügel & Ziegler (1957) indicate a definite range of *Oxyclymenia* through *Wocklumeria* (V-VI) for *P. styriaca* in Europe.

The bar and blade types of this zone range from Upper Ordovician to Lower Permian and are presently of no value in determining stratigraphic correlations. However, *P. styriaca* is stratigraphically restricted as indicated above and is useful in identifying Zone D.

Specimens were collected from a zone 10 feet above the base of the Gardner Formation at Rattlesnake Spur.

It is not possible to determine whether this zone is Upper *Platyclymenia* or *Oxyclymenia* due to the range of *P. styriaca,* but limitation can be set to zones V-VI of the European Devonian standard.

Zone E

The youngest conodont zone determined in central Utah is characterized by three species of *Siphonodella; S cooperi* Hass, *S. duplicata* (Branson & Mehl) and *S. quadruplicata* (Branson & Mehl). They range through Late Kinderhookian (Gutschick, 1960, p. 119; Hass, 1956, 1959; Cloud *et al.,* 1957, p. 813) in North America and into the Visean of Europe (Voges, 1959; Bischoff, 1957, p. 12-13; Serre & Lys, 1960, p. 39).

This zone has been identified at Rattlesnake Spur and 12 Mile Pass in central Utah. At Rattlesnake Spur, this zone occurs from 70-137 feet above the base of the Gardner Formation while at 12 Mile Pass it occurs 40-62 feet above the base of this same unit.The difference in thickness of the 12 Mile Pass section is due in part to faulting.

Species of *Siphonodella* are apparently restricted to rocks of Kinderhookian age in North America (Gutschick, 1960, p. 119; Branson & Mehl, 1934b; Hass, 1959). Possibly *S. obsoleta,* which Hass (1959, p. 393) mentions as ranging throughout the Chappel Limestone in Texas, may range above the Kinderhookion into Lower Osagian (Hass, 1959, p. 366; Gutschick, 1960, p. 115). However, in Europe, Serre & Lys (1960, p. 39) indicate species (*S. duplicata & S. quadruplicata*) of *Siphonodella* range through the Tournaisian into the Visean.

If the European Tournaisian is equivalent to the North American Kinderhookian and Osagian as indicated by Weller (1948, chart 5), Gutschick (1960, p. 115), and Kummel (1961, p. 562-563, etc.), then *Siphonodella* has a longer stratigraphic range in Europe than in this country. This is curious because most species of platform conodonts (*Palmatolepis,* etc.) have quite restricted ranges which are identical and correlative between Europe and North America (Müller, 1956; Clark & Becker, 1960).

CORRELATIONS

Zone C was recognized in the lower part of the Pinyon Peak Limestone on Rattlesnake Spur in central Utah. In addition to the *Palmatolepis* fauna, Zone C is characterized by species of *Polygnathus* which are common in Zone C age rock in other parts of the country.

P. (P.) rugosa and species of *Polygnathus* can be correlated with species in the uppermost bed of the Devils Gate Limestone of eastern Nevada and in the middle and upper-middle part of the Pilot Shale of western Utah (Clark & Becker, 1960), the middle and upper Grassy Creek Shale of Illinois (Scott, 1958 *ms., P. (P.) Polylophodonta* zone), almost all of the Perrysburg Formation of western New York and northeastern Pennsylvania (Hass, 1958), Zone III of the Houy Formation in central Texas (Cloud *et al.,* 1957), part of the Gassaway member of the Chattanooga Shale in central Tennessee (Hass, 1956), the Huron member of the Ohio Shale of Ohio and Kentucky (Hass, 1947, 1958), the upper part of the lower Blackiston Formation of southern Indiana (Campbell, 1946), and the Upper *Cheiloceras* or Lower *Platyclymenia* of the European standard (III-IV).

Late Devonian rocks equivalent to Zone D are not well known in this country (Clark & Becker, 1960, p. 1667). Klapper (1958) has described a fauna from the Darby Formation of the Wind River Mountains, Wyoming, which he considered *Oxyclymenia* (V) of the European standard based on the occurrence of *P. (P.) gonioclymenia* Müller. Other correlations of Zone D include the lower part of the Double Horn Shale of the Houy Formation (Cloud *et al.,* 1957), and the Grassy Creek, Saverton, Louisiana and part of the Glen Park Limestone of the Upper Mississippi Valley (Scott, 1958, *ms.*). Thus a partial correlation can be made with Zone D (bearing *P. styriaca,* V-VI) and Klapper's Darby Formation (bearing *P. (P.) gonioclymenia,* V).

Zone E was recognized in the medial-lower Gardner Limestone at Rattlesnake Spur and 12 Mile Pass, Tintict district, Utah.

On the basis of *Siphonodella,* the key fossil in Zone E, correlations with other sections in North America include the Bushberg Sandstone of southern Missouri (Branson & Mehl, 1934a), Prospect Hill Sandstone of Iowa (Youngquist & Patterson, 1949), English River and McCraney units of southeast Iowa (Thomas, 1949), the Maury Formation of Kentucky and Tennessee (Hass, 1956), the upper part of the Glen Park Limestone, all of the Hannibal Shale, and the lower part of the Chouteau Limestone (Scott, 1958 *ms.*), and the upper part of the Houy Formation and the Chappel Limestone of Texas (Hass, 1959).

Correlations can be made with Cu I-Cu II α in the Lower Carboniferous of the European standard (Bischoff, 1957, p. 13; Voges, 1959, p. 269).

SYSTEMATIC PALEONTOLOGY

The fauna here described includes a description of the first Lower Mississippian conodonts reported from the Great Basin.

Approximately 800 conodonts representing 36 species of 14 genera were obtained from samples taken from the Pinyon Peak Limestone and portions of the lower Gardner Formation in central Utah. The fauna was in general, poorly preserved with only a limited number of specimens suitable for study.

Genus SIPHONODELLA (Branson & Mehl), 1934

Species of this genus are distinguished from one another by the number of secondary carina present at the anterior end and the presence of nodes or transverse ridges on the inner side.

The usefulness of species of *Siphonodella* in the Lower Mississippian is well known. Knechtel & Hass (1938) indicate *S. duplicata* and *S. quadruplicata* occur only in formations of Kinderhookian age in North America. More recently Hass (1959) considers *S. cooperi* chiefly of Late Kinderhookian and possibly Lower Osagian. In Europe, Voges (1959) shows zonation of the Tournaisian and Lower Visean (Lower *Pericyclus*) by means of three *Siphonodella* species.

The correlation problem between North America and Europe is discussed under Conodont Assemblage Zones.

Siphonodella quadruplicata (Branson & Mehl)

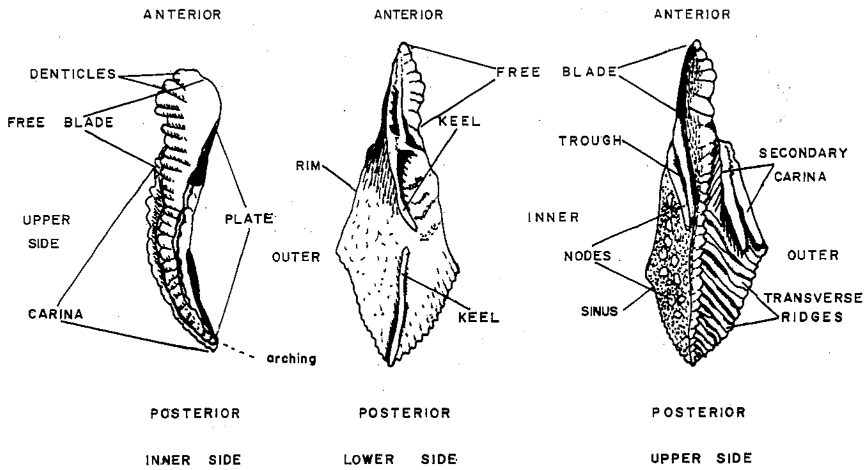
pl. 6 figs. 9, 13, 14.

Siphonognathus quadruplicata BRANSON & MEHL, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 295, pl. 24, figs. 18-21.

Siphonodella quadruplicata YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 57, 70, pl. 16, fig. 11; HASS, 1959, U.S. Geol. Survey Pro. Paper 294-J, p. 370, 371, pl. 49, fig. 28.

Description.—Margin of specimen nearly straight on outer side and convex on inner; pointed at posterior end, carina decreases in height abruptly from free blade and is made up of transverse ridges, inner side with nodes. On plate are two secondary carina on each side of main carina with narrow depressions between them. All ridges increase in height toward the anterior end. The keel is indistinct at anterior and small on rostrum. Escutcheon faintly visible.

Discussion.—*S. quadruplicata* is easily separated from other species of this genus by means of two secondary carina on each side of the main carina (Text-fig. 3). Youngquist



TEXT-FIGURE 3.—Morphology of *Siphonodella.*

& Patterson (1949) list a rather complete synonymy of *S. quadruplicata.*

Occurrence.—This species occurs throughout a 12 foot zone 125 feet from the base of the Gardner Formation on Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and in a 22 foot interval, 64 feet from the base of the Gardner Formation on the east side of 12 Mile Pass, Sec. 36, T. 8 S., R. 3 W.

Repository.—BYU 1101, 1102.

Siphonodella duplicata (Branson & Mehl)
pl. 6 figs. 5, 7.

Siphonognathus duplicata BRANSON & MEHL, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 295-297, pl. 24, figs. 16, 17.
Siphonodella duplicata YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 69, pl. 16, figs. 7-10; HASS, 1959, U.S. Geol. Survey Pro. Paper 294-J, pl. 49, figs. 17, 18, 25.

Description.—Lateral margins convex, posterior end pointed. Plate strongly arched, low carina. Upper surface on both outer and inner margin ornamented by transverse ridges. One secondary carina on each side of the main carina. Lower surface is smooth with distinctive keel present only at posterior end. The escutcheon is faintly visible.
Discussion.—*S. duplicata* differs from *S. quadruplicata* by the presence of one secondary carina on each side of the main carina and transverse ridges on both inner and outer margins. Youngquist & Patterson (1949) list a rather complete synonymy.
Occurrence.—This species occurs in samples 30-37 in a 65 foot zone 70-135 feet from the base of the Gardner Formation on Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and in a 22 foot interval 64 feet above the base of the Gardner Formation on the east side of 12 Mile Pass, Sec. 36, T. 8 S., R. 3 W.
Repository.—BYU 1103, 1104.

Siphonodella cooperi Hass
pl. 6, figs. 8, 10, 11.

Siphonognathus duplicata BRANSON & MEHL, 1938, Univ. Missouri Studies, v. 13, no. 4, p. 148, pl. 34, figs. 34, 35.
Siphonognathus quadruplicata COOPER, 1939, Jour. Paleontology, v. 13, p. 409, pl. 41, figs. 44-45.
Siphonodella duplicata var. B. HASS, 1951, Amer. Assoc. Petrol. Geol. Bull., v. 34, p. 2539, pl. 1, fig. 7.
Siphonodella cooperi HASS, 1959, U.S. Geol. Survey Pro. Paper 294-J, p. 392, pl. 48, figs. 35-36.

Description.—Lateral margins convex, posterior end pointed. Plate strongly arched when viewed from either upper or lower surface. Carina and inner margin approximately same height with nodes on carina exceptionally distinct. Upper surface on outer margin ornamented by transverse ridges, inner margin by faint nodes. Lower surface has a distinct keel at both posterior and anterior. A smooth ridge runs essentially parallel to outer margin and median line. Escutcheon located as a slit at the crest of the arching.
Discussion.—*S. cooperi* differs from *S. duplicata* in several characteristics. *S. cooperi* has nodes instead of transverse ridges on inner platform and is more elongate with the curved ridge of its outer platform terminating at the margin of platform anterior to pulp cavity instead of being nearly straight and terminating on platform near the pulp cavity. The presence of transverse ridges on the outer margin of *S. cooperi* rather than small nodes as on *S. obsoleta* Hass differentiates the two.
Occurrence.—This species occurs with *S. quadruplicata* in a 12 foot zone 125 feet from the base of the Gardner Formation on Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and in a 22 foot interval 64 feet above the base of the Gardner Formation on the east side of 12 Mile Pass, Sec. 36, T. 8 S., R. 3 W.
Repository.—BYU 1105, 1106, 1107.

Genus POLYGNATHUS Hinde, 1879

Polygnathus semicostata Branson & Mehl
pl. 5, figs. 9, 10.

Polygnathus semicostata BRANSON & MEHL, 1934b, Univ. Missouri Studies, v. 8, no. 3, p. 247-248, pl. 21, figs. 1, 2; THOMAS, 1949, Geol. Soc. Amer. Bull., v. 60, p. 407-408, pl. 1, fig. 23.
Polygnathus semicostatus COOPER, 1939, Jour. Paleontology, v. 13, p. 403-404, 420, pl. 39, figs. 27-28.

Description.—Plate narrow, more than twice as long as wide, inner margin convex slightly, outer margin slightly concave. The posterior end long and narrow, pointed in some specimens. Carina originates about middle of the plate and passes into the blade.. Approximately ten transverse ridges on the posterior end join the outer margin with the inner margin. Lower surface is a sharp ridge which becomes rounded in the middle. The escutcheon is only a depression. Blade does not show as an extension in front of plate from lower view (Text-fig. 4).

Discussion.—*P. semicostata* is a very distinct species of *Polygnathus* but because of ornamentation on the posterior it could be confused with *P. linguiformis*. However, *P. linguiformis* has a "shoulder" like extension on the outer margin midway to the posterior end.

Occurrence.—Sample 7, 35 feet from the base of Pinyon Peak Limestone at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and Sample 7, 35 feet from the base of Pinyon Peak Limestone at Currant Creek, Sec. 36, T. 10 S., R. 1 W.

Repository.—BYU 1109, 1110.

Polygnathus nodocostata Branson & Mehl

pl. 5, fig. 14.

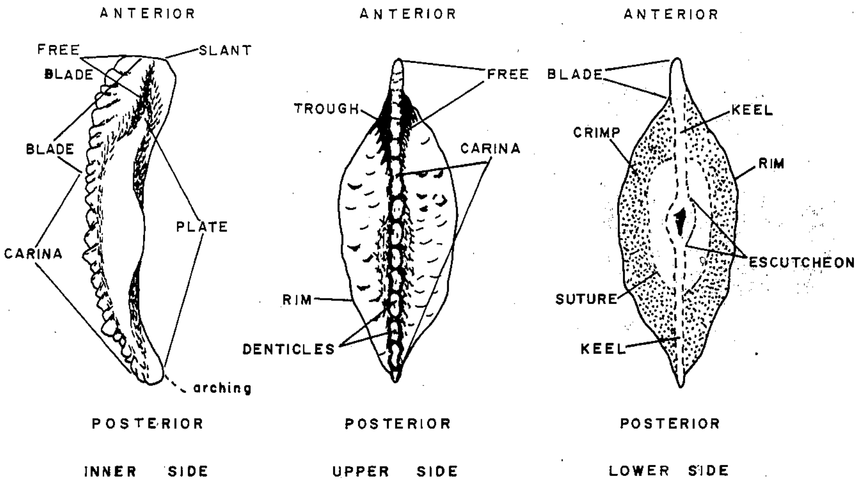
Polygnathus nodocostata BRANSON & MEHL, 1934b, Missouri Studies, v. 8, no. 3, p. 246-247, pl. 20, figs. 9-13; BOND, 1947, Ohio Jour. Sci., v. 47, p. 21, 33, pl. 2, fig. 22.

Description.—Plate rhombiodal to elliptical in outline, ornamented with five rows of nodes which run tangent to carina. Carina straight, composed of five nodes on anterior end, and extends full length of the specimen. Free blade comprises one-third of specimen. Lower surface has distinct keel running length of specimen, more highly developed at posterior end, point of mergence with free blade at anterior end. Escutcheon not distinct.

Discussion.—This species resembles *P. rhomboidea* (Ulrich & Bassler, 1926) but differs in that the carina does reach the posterior end and the distance between nodes is greater. The alignment of nodes on thé upper surface of *P. nodocostata* is the principal means of differentiating this species from *P. granulosa.*

Occurrence.—*P. nodocostata* occurs in Sample 5, 30 feet above the base of the Pinyon Peak Limestone at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and Sample 7, 35 feet above the base of the Pinyon Peak Limestone at Currant Creek, Sec. 36, T. 10 S., R.

Repository.—BYU 1117.



TEXT-FIGURE 4.—Morphology of *Polygnathus* (after Müller & Müller, 1957).

Polygnathus inornata Branson

pl. 5, figs. 8, 13.

Polygnathus inornata BRANSON, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 293, pl. 24, figs. 5-7; YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 64, pl. 17, figs. 4, 5, 9, 13; VOGES, 1959, Paläont. Zeit., 33, p. 291, t. 34, figs. 12-20.

Description.—Plate small, axis curved laterally; free margins bent nearly vertical on antetrior half of plate producing deep median cavity, posterior half strongly concave and somewhat sinusoidal, sharp posterior end beyond the plate caused by carina and keel. Outer margin higher than inner, well defined transverse ridges at the free margins;

carina high, broad, with individual nodes distinguishable. Lower surface has small escutchon near anterior and sharp keel toward the posterior end.
Discussion.—According to Youngquist & Patterson, "This species has been rather broadly interpreted," (1949, p. 64). The strong arching of the plate and sinusoidal wanderings of the whole posterior end should help somewhat in the identification.
Occurrence.—Sample 37, 135 feet above the base of the Gardner Formation at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.
Repository—BYU 1115.

Polygnathus longipostica Branson & Mehl
pl. 5 figs. 3, 6, 7.

Polygnathus longpostica BRANSON & MEHL, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 294, pl. 24, figs. 8-11; YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 65, pl. 15, fig. 16-20; THOMAS, Geol. Soc. Amer. Bull., v. 60, p. 409, 411, 417, pl. 3, fig. 38; HASS, 1956, U.S. Geol. Survey Prof. Paper 286, p. 25, pl. 2.
Description.—Plate nearly bilaterally symmetrical, median line straight, margins nearly straight with transverse ridges and low, distinct nodes near posterior. Carina composed of low nodes along middle of plate with one larger than others near back end of plate. Blade high, sharp, thin, denticles. Lower surface has concentric growth ridges; keel is sharp on blade and high at posterior. Escutcheon exceptionally large.
Discussion.—Specimens in Utah material are of various sizes but have the same general characteristics as defined by Branson & Mehl for *P. longipostica.*
Occurrence.—Unit 37, 135 feet above the base of the Gardner Formation at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.
Repository.—BYU 1111, 1112.

Polygnathus granulosa Branson & Mehl
pl. 5 fig. 15.

Polygnathus granulosa BRANSON & MEHL, 1934b, Univ. Missouri Studies, v. 8, no. 3, p. 246, pl. 20, figs. 21, 23; THOMAS, 1949, Geol. Soc. Amer. Bull., v. 60, p. 408, 418, pl. 1, figs. 33-34.
Description.—Plate thick, slightly twisted, and divided evenly by carina. Carina low and extends almost to the back of the plate, carina appears as single ridge due to coalescing of nodes. Carina much thinner on anterior, upper surface slightly convex ornamented with nodes with no definite arrangement. Nodes or granules approximately same size on all parts of the specimen. Lower surface smooth except for sharp keel which is highest at anterior and posterior ends. Escutcheon small and slit shaped, located approximately in the center of the lower surface.
Discussion.—*P. granulosa* could possibly be confused with *P. nodocostata. P. granulosa* lacks node arrangement, however.
Occurrence.—Sample 5, 25 feet above the base of Pinyon Peak Limestone at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W., and Sample 7, 35 feet above base of Pinyon Peak Limestone at Long Ridge, Sec. 20, T. 10 S., R. 1 E.
Repository.—BYU 1114.

Polygnathus sp. aff. *permarginata* Branson
pl. 5 fig. 5.

Polygnathus permarginata BRANSON, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 312, pl. 25, fig. 19; THOMAS, 1949, Geol. Soc. Amer. Bull., v. 60, p. 408, 411, pl. 3, fig. 39.
Description.—Plate long and thick with straight axis nearly bilaterally symmetrical, free margins bent upward the complete length of the plate. Median cavity of the plate deep on both sides of carina. The margins are each marked by 14 short transverse ridges. Carina and blade on the Utah material not distinct due to weathering. Lower surface gently curved with small escutcheon present near the anterior end and a sharp keel running the length of the plate.
Discussion.—The specimen here referred to as *P. permarginata* has most of the characteristics of *P. permarginata,* but due to breakage and weathering it would not be correct to identify this definitely.
Occurrence.—Sample 37, 135 feet above the base of Gardner Formation, at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.
Repository.—BYU 1122.

Polygnathus perplana Branson
pl. 5 fig. 4.

Polygnathus perplana BRANSON, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 309, pl. 25, fig. 7; THOMAS, 1949, Geol. Soc. Amer. Bull., v. 60, p. 408, 411, pl. 3, fig. 35.

Description.—Plate small, medium thickness with thin margins almost bilaterally symmetrical with straight axis. Free margins turned up to about height of carina. Carina strong, composed of coalesced nodes. Lower surface arched with escutcheon near anterior of plate and a sharp keel reaching the posterior. Blade very thin, longer than deep, composed of about eight denticles.

Discussion.—Specimens are small, usually slender and blade has eight or nine confluent denticles.

Occurrence.—Sample 7, 40 feet above the base of the Gardner Formation east side of 12 Mile Pass, Sec. 36, T. 8 S., R. 3 W.

Repository.—BYU 1120, 1121.

Polygnathus communis Branson & Mehl
pl. 6 figs. 1-4.

Polygnathus communis BRANSON & MEHL, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 293, pl. 24, figs. 1-4; YOUNGQUIST & PATTERSON, 1949, Jour. Paleontology, v. 23, p. 62, pl. 15, figs. 7, 8; VOGES, 1959, Paläont. Zeit., bd. 33, p. 288, t. 38, figs. 1-7.

Description.—Specimens very small, plate thick for size of specimen, smooth on upper surface, much longer than wide. Carina composed of small indistinct nodes which grade into high denticles of blade. Blade approximately same length as plate and has about ten denticles. Lower surface smooth with sharp keel on blade decreasing in height toward the escutcheon. Keel starts again from the posterior end of the escutcheon and rises rapidly to the posterior end of the plate.

Discussion.—As Youngquist & Patterson (1949) have indicated, some of the figured specimens in the literature do not resemble the species as described by Branson & Mehl (1934). Voges (1959) has some specimens figured which although are not nearly oval in outline, resemble the Utah specimens. Specimens were broken during preparation for photography.

Occurrence.—Sample 11 found in Wanlass Hill, Sec. 35, T. 8 S., R. 2 W.; Sample 25 in Currant Creek, Sec. 36, T. 10 S., R. 1 W.; Sample 20-27 in Sec. 1, T. 9 S., R. 3 W., Rattlesnake Spur, Tintic district, Utah.

Repository.—BYU 1118.

Polygnathus styriaca Ziegler
pl. 5 figs. 11, 12.

Polygnathus styriaca FLUGEL & ZIEGLER, 1957, Mit. Naturw. Ver. Steiermark, bd. 87, p. 47-48, pl. 1, figs. 11-13;
Polygnathus cf. *styriaca* VOGES, 1959, Paläontol. Zeit., bd. 33, p. 294, pl. 34, figs. 36-41.

Description.—Plant comprises two-thirds of specimen, nearly bilaterally symmetrical, with axis very slightly curved laterally; platform highly convex upward, and ornamented with small nodes of no specific arrangement. Free margins essentially flat-lying, with slight serrations. Carina low of irregular height and extends to the back of the plate; blade is high, bent laterally and made up of about four distinct denticles. The lower surface smooth except for a sharp keel which is highest at anterior and posterior ends and is divided near the anterior end to provide a shallow, wide, escutcheon.

Discussion.—*P. styriaca* is distinctive because of its small size, convexity of plate, and bent blade. The specimen shown from its lower view (pl. 5 fig. 12) looks as if it has a very deep escutcheon. However, this is caused by a quantity of quartz crystals adhering to the lower surface.

Occurrence.—Sample 20, 120 feet above base of Pinyon Peak Limestone, Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.

Repository.—BYU 1119.

Polygnathus normalis Miller & Youngquist
pl. 6 fig. 6

Polygnathus normalis MILLER & YOUNGQUIST, 1947, Jour. Paleontology, v. 21, p. 515, pl. 74, figs. 4, 5; YOUNGQUIST & MILLER, Jour. Paleontology, 1948, v. 22, p. 448-449, pl. 68, fig. 11.

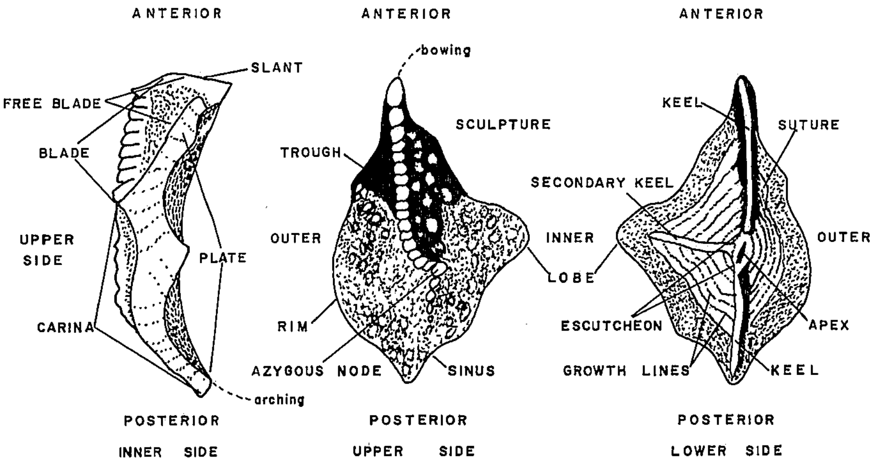
Description.—Plate about one-half of the length of specimen, and the blade most distinc-

tive part of the unit. The sides of the plate separated by the carina are narrow and rather short transverse ridges provide ornamentation on the upper surface. Carina extends back of the plate, in front of the plate the blade is high and made up of nine denticles which are confluent nearly to their apices. Lower surface is very sharp on the blade and a median keel is easily discernable. Escutcheon is of medium size located at the junction of free blade and plate.
Discussion.—The specimen from Utah is very similar to the specimen described by Miller & Youngquist (1947) including nine denticles and blade being strongly arched on the posterior end of the plate.
Occurrence.—Samples 7, 12, 37, at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.
Repository.—BYU 1113.

Genus PALMATOLEPIS Ulrich & Bassler, 1926
Subgenus PALMATOLEPIS (PALMATOLEPIS) Müller, 1956
Palmatolepis (*Palmatolepis*) *rugosa* Branson & Mehl
pl. 5, fig. 16

Palmatolepis rugosa BRANSON & MEHL, 1934b, Univ. Missouri Studies, v. 8, no. 3, p. 236, pl. 18, figs. 15, 16, 18, 19; KLAPPER, 1958, Jour. Paleontology, v. 32, no. 6, p. 1088, pl. 142, fig. 12; HASS, 1959, U.S. Geol. Survey Prof. Paper 294-J, pl. 50, fig. 17.

Description.—Plate sigmoidally curved, increases in width from front to back. Carina on back lobe is distinct only by azygous node, increases in height in front of azygous node. A row of nodes bisects side lobe; on narrow side of plate are a number of short ridges normal to carina. Row of large nodes parallels carina in front of side lobe. Lower surface irregular due to ridges and furrows normal to keel (Text-fig. 5).



TEXT-FIGURE 5.—Morphology of *Palmatolepis* (after Müller & Müller, 1957).

Discussion.—*P. rugosa* is similar to *P. quadrantinodosa* but can be distinguished by ridges on outer side, and nodes on inner side.
Occurrence.—Sample 5, 25 feet above base of Pinyon Peak Limestone at Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.
Repository.—BYU 1108.

Genus HIBBERDELLA Ulrich & Bassler, 1926
Hibberdella telum Huddle

Hibberdella telum HUDDLE, 1934, Amer. Paleont. Bull., 72, v. 21, p. 79-80, pl. 3, figs. 10-12.

Description.—Bar heavy, exceptionally wide, convex upward, bilaterally symmetrical. Short, central, broad, erect cusp gradually tapering to apex. Denticles rounded, thick, distinctly separate. Approximately eight denticles on each side of main cusp. No escutcheon.

Discussion.—A very distinctive specimen which can be easily distinguished from other species of *Hibberdella* by its broad, short cusp, and exceptionally wide bar.

Occurrence.—Sample 13, 65 feet above the base of the Pinyon Peak Limestone, Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.; Sample 16, 70 feet above the base of the same limestone, Long Ridge, Sec. 20, T. 10 S., R. 1 E.; and Sample 12, 60 feet above the Pinyon Peak at Currant Creek, Sec. 36, T. 10 S., R. 1 W.

Repository.—BYU 1126.

Genus SOLENODELLA (Branson & Mehl), 1934
Solenodella costata (Branson & Mehl)
pl. 5 fig. 1.

Solenognathus costata BRANSON & MEHL, 1934a, Univ. Missouri Studies, v. 8, no. 4, p. 332, pl. 27, fig. 7.

Solenodella costata BRANSON, 1944, Univ. Missouri Studies, v,. 19, no. 3, p. 181, 222, pl. 32, fig. 12.

Description.—Blade curved with slight flexure of lower corner, about three times as long as deep. Outer side smooth with little evidence of number of denticles. Inner side shows outline of denticles very well. Upper edge crenulate with denticles rising evenly from front to apical denticle one-third length of blade from back then sloping to back of blade. Denticles of front number 14, denticles of back 12. Those of the back series are similar to those of front except shorter and thinner. Inner and outer basal ridge prominent throughout length of blade. Escutcheon very small, rounded, with front and back groves short distance from escutcheon.

Discussion.—Only a single specimen of this genus was found.

Occurrence.—Sample 37, 135 feet above the base of the Gardner Formation, Rattlesnake Spur, Sec. 1, T. 9 S., R. 3 W.

Repository.—BYU 1123.

REFERENCES CITED

Bischoff, G., 1957, Die Conodonten-Stratigraphie des Reno Herzynischen Unterkarbons mit Berucksichtigung der *Wocklumeria*-Stufe und der Devon/Karbon-Grenze: Hess. Landesamt Bodenf., Abh. no. 19, 64 p.

———, & Ziegler, W., 1956, Das Alter der "Ufer Schichten" in Marberger Hinterland nach Conodonten: Hess. Landesamt Bodenf. Notizblatt, bd. 84, p. 138-169.

Bond, R. H., 1947, Ohio shale conodonts: Ohio Jour. Sci., v. 47, no. 1, p. 21-37, 2 pls.

Branson, E. B., 1944, The Geology of Missouri: Univ. Missouri Studies, v. 19, no. 3, 535 p., 46 pls.

———, & Mehl, M. G., 1934a, Conodonts from the Bushberg sandstone: Univ. Missouri Studies, v. 8, no. 4, p. 265-299.

———, 1934b, Conodonts from the Grassy Creek Shale of Missouri: Univ. Missouri Studies, v. 8, no. 3, 260 p., 21 pls.

———, 1938, Conodonts from the Lower Mississippian of Missouri: Univ. Missouri Studies, v. 13, no. 4, 260 p., 2 pls.

Brooks, J. E., 1959, Devonian regional stratigraphy in northcentral Utah: Intermountain Assoc. Petrol. Geol. 10th Annual Field Conf., Geol. of the Wasatch and Uinta Mountains, p. 54-59.

Campbell, Guy, 1946, New Albany Shale: Geol. Soc. Amer. Bull., v. 57, p. 829-908.

Clark, D. L., 1954, Stratigraphy and sedimentation of the Gardner Formation in central Utah: Brigham Young Univ. Research Studies, Geol. Series, v. 1, no. 1, 60 p.

———, & Becker, J. H., 1960, Upper Devonian correlations in western Utah and eastern Nevada: Geol. Soc. Amer. Bull., v. 71, p. 1661-1674, 2 pls.

Cloud, P. E., Jr., Barnes, V. E., & Hass, W. H., 1957, Devonian Mississippian transition in central Texas: Geol. Soc. Amer. Bull., v. 68, p. 807-816, 5 pls.

Cooper, C. L., 1939, Conodonts from a Bushberg-Hannibal horizon in Oklahoma: Jour. Paleontology, v. 13, p. 379-422, pls. 39-47.

Flügel, H., & Ziegler, W., 1957, Die Gliederung des Oberdevons und Unterkarbons am Steinberg westlich von Graz mit Conodonten: Mitteilungen Naturw. Ver. Steiermark, bd. 87, p. 25-60, pls. 1-5.

Gaines, P. W., 1950 *ms.*, Stratigraphy and structure of the Provo Canyon-Rock Canyon area, south-central Wasatch Mountains, Utah: unpublished M.S. Thesis, Brigham Young University.

Glaessner, M. F., 1948, Principles of micropaleontology: Melbourne Univ. Press, 296 p.

Gutschick, R. C., 1960, Early Carboniferous (Lower Carboniferous-Tournaisian) micropaleontology in the United States: XXI International Geol. Congress, pt. VI, p. 114-119.

Hass, W. H., 1947, Conodont zones in Upper Devonian and Lower Mississippian formations of Ohio: Jour. Paleontology, v. 21, p. 131-141.

———, 1951, Age of Arkansas novaculite: Amer. Assoc. Petrol. Geol. Bull., v. 35, p. 2526-2541, 1 pl., 2 tab.

———, 1956, Age and correlation of the Chattanooga Shale and Maury Formation: U.S. Geol. Survey Prof. Paper 286, 47 p., 5 pls.

———, 1958, Upper Devonian conodonts of New York, Pennsylvania, and interior states: Jour. Paleontology, v. 32, p. 765-769.

———, 1959, Conodonts from the Chappel Limestone of Texas: U.S. Geol. Survey Prof. Paper 294-J, p. 365-396, pls. 46-50.

Huddle, J. W., 1934, Conodonts from the New Albany Shale of Indiana: Bull. of Amer. Paleontology, v. 21, no. 72, 136 p., 12 pl.

Klapper, Gilbert, 1958, An Upper Devonian conodont fauna from the Darby Formation of the Wind River Mountains, Wyoming: Jour. Paleontology, v. 32, p. 1082-1093, pls. 141-142.

Knechtel, M. M., & Hass, W. H., 1938, Kinderhook conodonts from Little Rocky Mountains, northern Montana: Jour. Paleontology, v. 12, p. 518-520.

Kummell, Bernhard, 1961, History of the Earth: W. H. Freeman & Co., San Francisco, 610 p.

Lindgren, W., & Loughlin, G. F., 1919, Geology and ore deposits of the Tintic Mining District, Utah: U.S. Geol. Survey Prof. Paper 107, 282 p.

Lovering, T. S., Morris, H. T., Proctor, P. D., & Lemish, John, 1951, Upper Ordovician, Silurian, and Devonian stratigraphy of the Tintic Mountains, Utah: (Abstract) Geol. Soc. Amer. Bull., v. 62, p. 1505-06.

Lys, M. M., & Serre, B., 1957, Présence de conodonts dans le Paléozöique du Sahara (région d'Adrar-Tranezrouft): L'Acad. Sci. Comptes Rendus, v. 244, no. 7, p. 916-918.

Miller, A. K., & Youngquist, W., 1947, Conodonts from the type section of the Sweetland Creek Shale in Iowa: Jour. Paleontology, v. 21, no. 6, p. 501-517, pls. 72-75.

Morris, H. T., 1957, General geology of the East Tintic Mountains, Utah: Guidebook to the Geology of Utah, no. 12, Geol. East Tintic Mountains and ore deposits Tintic mining district, p. 1-57.

Müller, K. J., 1956, Zur Kenntnis der Conodonten-Fauna des eropiäschen Devons; 1. Die Gattung *Palmatolepis*: Senck. Naturf. Gesell. Abh. 494, 68 p., 11 pls.

———, & Müller, E. M., 1957, Early Upper Devonian (Independence) conodonts from Iowa; Part I: Jour. Paleontology, v. 31, no. 6, p. 1069-1108, pl. 135-142.

Peterson, H. N., 1953 *ms.*, Structure and Paleozoic stratigraphy of the Currant Creek area near Goshen, Utah: Unpublished M. S. Thesis, Brigham Young University.

Peterson, M. S., 1956, Devonian strata of central Utah: Brigham Young Univ. Research Studies, Geol. Series, v. 3, no. 3, 37 p.

Proctor, P. D., & Clark, D. L., 1956, The Curley Limestone—an unusual biostrome in central Utah: Jour. Sed. Pet., v. 26, p. 313-321.

Rhodes, J. A., 1955, Stratigraphy and structural geology of the Buckley Mountain area, south-central Wasatch Mountains, Utah: Brigham Young Univ. Research Studies, Geol. Series, v. 2, no. 4, 57 p.

Rigby, J. K., 1952, Geology of the Selma Hills: Utah Geol. Mineral Survey Bull. 45, 107 p.

———, 1959, Upper Devonian unconformity in central Utah: Geol. Soc. Amer. Bull., v. 70, p. 207-218.

Scott, A. J., 1958, *ms.*, Late Devonian and Early Mississippian faunas of the Upper Mississippi Valley: Unpublished Ph.D. Thesis, Univ. Illinois.

Serre, B., & Lys, M. M., 1960, Repartition de Quelques conodonts dans le Dévonian et le Carbonifére Inférieur de France et de Belgique: XXI International Congress, pt. VI, p. 35-40.
Thomas, L. A., 1949, Devonian-Mississippian formations of south-east Iowa: Geol. Soc. Amer. Bull., v. 60, p. 403-437, 4 pl.
Ulrich, E. O., & Bassler, R. S., 1926, A classification of the toothlike fossils, conodonts, with descriptions of American Devonian and Mississippian species: U.S. Nat. Mus. Proc., v. 68, art. 12, 63 p., 11 pl.
Voges, A., 1959, Conodonten aus dem Unterkarbon I and II (*Gattendorfia*- und *Pericyclus*-Stufe) des Sauerlandes: Palaont. Zeit., bd. 33, p. 266-314.
Weller, J. M., *et al.,* 1948, Correlation of the Mississippian formations of North America: Geol. Soc. Amer. Bull., v. 59, p. 91-196.
Woodland, R. B., 1958, Stratigraphic significance of Mississippian endothyrid Foraminifera in central Utah: Jour. Paleontology, v. 32, p. 791-814, 6 pl.
Youngquist, Walter, 1947, A new Upper Devonian conodont fauna from Iowa: Jour. Paleontology, v. 21, p. 95-112, pls. 24-26.
———, & Miller, A. K., 1948, Additional conodonts from the Sweetland Creek Shale of Iowa: Jour. Paleontology, v. 22, no. 4, p. 440-450, pl. 67-68.
———, & Patterson, S. H., 1949, Conodonts from the Lower Mississippian Prospect Hill sandstone of Iowa: Jour. Paleontology, v. 23, p. 57-73, pl. 15-17.
Ziegler, W., 1958, Conodontenfeinstratigraphische Unterschungen an der Grenze Mittledevon/Oberdevon und in der Adorf-Stufe: Hess. Landesant Bodenf., Notizbl., bd. 87, p. 7-77, 12 pl.

EXPLANATION OF PLATE 5

All figures x 32

FIG. 1.—*Solenognathus costata* Branson & Mehl. Sample 37, Rattlesnake Spur; Zone E; BYU 1123.
FIG. 2.—*Polygnathus perplana* Branson. Sample 7, 12 Mile Pass; Zone E; BYU 1121.
FIG. 3.—*Polygnathus longipostica* Branson & Mehl. Sample 37, Rattlesnake Spur; Zone E; BYU 1111.
FIG. 4.—*Polygnathus perplana* Branson. Sample 7, 12 Mile Pass; Zone E; BYU 1120.
FIG. 5—*Polygnathus* sp. aff. *permarginata* Branson. Sample 37, Rattlesnake Spur; Zone E; BYU 1122.
FIG. 6, 7—*Polygnathus longipostica* Branson & Mehl. 6, upper view, 7, lower view; Sample 37, Rattlesnake Spur; Zone E; BYU 1112.
FIG. 8—*Polygnathus inornata* Branson. Sample 37, Rattlesnake Spur; Zone E; BYU 1115.
FIG. 9—*Polygnathus semicostata* Branson & Mehl. Sample 8, Rattlesnake Spur; Zone C; BYU 1110.
FIG. 10—*Polygnathus semicostata* Branson & Mehl. Sample 7, Currant Creek; Zone C; BYU 1109.
FIG. 11, 12—*Polygnathus styriaca* Ziegler. 11, upper view, 12, lower view; Sample 20, Rattlesnake Spur; Zone D; BYU 1119.
FIG. 13—*Polygnathus inornata* Branson. Sample 37, Rattlesnake Spur; Zone E; BYU 1116.
FIG. 14—*Polygnathus nodocostata* Branson & Mehl. Sample 5, Rattlesnake Spur; Zone C; BYU 1117.
FIG. 15—*Polygnathus granulosa* Branson & Mehl. Sample 5, Rattlesnake Spur; Zone C; BYU 1114.
FIG. 16—*Palmatolepis* (*Palmatolepis*) *rugosa* Branson & Mehl. Sample 5, Rattlesnake Spur; Zone C; BYU 1108.

EXPLANATION OF PLATE 6

All figures x 32

FIG. 1—*Polygnathus communis* Branson & Mehl. Sample 11, Wanlass Hill; Zone E; BYU 1118.
FIG. 2—*Polygnathus communis* Branson & Mehl, Sample 25, Currant Creek; Zone E; BYU 1125.
FIG. 3, 4—*Polygnathus communis* Branson & Mehl. 3, lower view, 4, upper view; Sample 25, Rattlesnake Spur, Zone E; BYU 1124.
FIG. 5, 7—*Siphonodella duplicata* (Branson & Mehl). 5, upper view, 7, lateral view; Sample 37; Rattlesnake Spur; Zone E; BYU 1104.
FIG. 6—*Polygnathus normalis* Miller & Youngquist. Sample 7, Rattlesnake Spur; Zone C; BYU 1113.
FIG. 8—*Siphonodella cooperi* Hass. Sample 7, 12 Mile Pass; Zone E; BYU 1106.
FIG. 9—*Siphonodella quadruplicata* (Branson & Mehl). Sample 37, Rattlesnake Spur, Zone E; BYU 1127.
FIG. 10—*Siphonodella cooperi* Hass. Sample 37, Rattlesnake Spur; Zone E; BYU 1107.
FIG. 11—*Siphonodella cooperi* Hass. Sample 35, Rattlesnake Spur; Zone E; BYU 1105.
FIG. 12—*Siphonodella duplicata* (Branson & Mehl). Sample 37, Rattlesnake Spur; Zone E; BYU 1103.
FIG. 13—*Siphonodella quadruplicata* (Branson & Mehl). Sample 37, Rattlesnake Spur; Zone E; BYU 1101.
FIG. 14—*Siphonodella quadruplicata* (Branson & Mehl). Sample 7, 12 Mile Pass; Zone E; BYU 1102.

PLATE 5

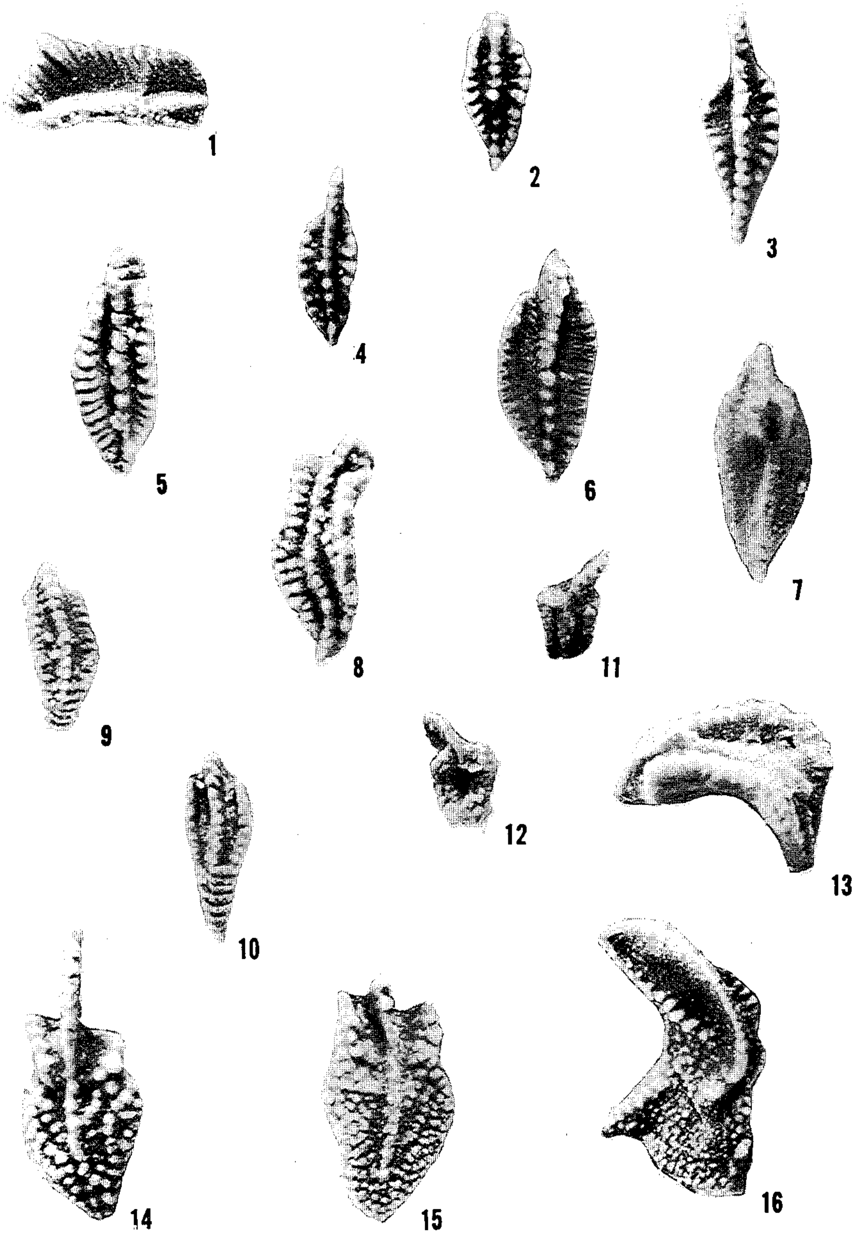


PLATE 6