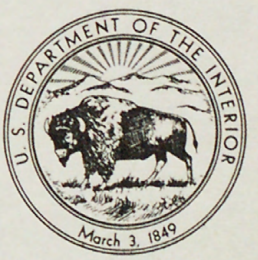
Conodonts from the Chappel Limestone of Texas

By WILBERT H. HASS

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

GEOLOGICAL SURVEY PROFESSIONAL PAPER 294-J

Division of the formation into three faunal zones, description of species, and presentation of utilitarian classification of disjunct conodonts



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SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

CONODONTS FROM THE CHAPPEL LIMESTONE OF TEXAS

By WILBERT H. HASS

ABSTRACT

The Chappel limestone of Early Mississippian (late Kinderhook and probably partly early Osage) age crops out in the Llano region of Texas where it is as much as 45 feet thick. It contains three conodont faunal zones which, from youngest to oldest, are herein designated: (1) the *Bactrognathus communis* zone of probable early Osage age; (2) the *Gnathodus punctatus* zone of late Kinderhook (Chouteau) age—this zone ranges throughout the greater thickness of the Chappel; and (3) the *Siphonodella cooperi* zone, also of late Kinderhook (Chouteau) age. This zonation is based on an examination of the disjunct conodonts in more than 150 collections, as well as on a study of the frequency distribution of species in 68 collections. These 68 collections contain 22,946 identifiable specimens, some representing reworked material derived from Ordovician, Devonian, and lowermost Mississippian sources. Four generic names, *Dollymae*, *Branmehla*, *Hindeodina*, and *Pandorinellina*, are new; the last named replaces *Pandorina* Stauffer, 1940, which is preoccupied.

A new classification of disjunct conodonts is presented. This classification, utilitarian rather than biologic, is based on the fact that each individual conodont was built up by the accretion of lamellae about the apex of the pulp cavity. This cavity is used as the point of reference for all other parts of the conodont structure. Separation of the lamellae from one another, along one or more growth axes and in one or more directions, resulted in the development of fanglike structures without denticles (Distacodontidae); fanglike structures with denticles (Belodontidae); denticulated blades and bars (Coleodontidae, Prioniodinidae, and Prioniodontidae); platelike structures with platforms (Polygnathidae); and platelike structures with greatly expanded pulp cavities (Idiognathodontidae).

INTRODUCTION

This paper is concerned with some conodonts from the Chappel limestone—a thin formation of Early Mississippian age that crops out in the Llano region of Texas. It contains three conodont faunal zones; the upper one ranges throughout beds herein considered to be of probable early Osage age, and the middle and lower ones throughout beds herein considered to be of late Kinderhook (Chouteau) age.

The conclusions of the paper are based on the examination of many conodont specimens in more than 150 collections; 82 of these, containing approximately 25,000 specimens, are listed in the locality register (p. 374). Almost all of these collections are from known intervals of measured sections. Figure 121 shows the localities at which conodonts were collected (the notation C–13 on the map represents, for example, conodont locality 13). Table 1 records the number of specimens of each species recognized in the examined material of 68 collections; these collections contain 22,946 identifiable specimens, some of which represent reworked material derived from the weathering of the Ordovician, Devonian, and lowermost Mississippian rocks of the Llano region. Chart 1 gives the relative abundance of species in each of the three faunal zones of the Chappel, based on the data of table 1.

This report does not consider the entire conodont fauna of the Chappel limestone; only species that, in the author's opinion, are sufficiently distinctive to have stratigraphic value are included. Such species, together with others believed to have been reworked into the Chappel limestone, are illustrated on plates 46–50.

Fieldwork was done in the summer of 1938, August 1942, June and July 1945, July 1950, and March 1956. Most of the conodont collections were made either in 1945 or 1956. In 1945, the author spent 2 days in Blanco and Burnet Counties with V. E. Barnes of the Texas Bureau of Economic Geology and 8 days elsewhere in the Llano region with P. E. Cloud, Jr. of the U. S. Geological Survey; and in 1956, 13 days were spent with Cloud and Barnes investigating the Chappel limestone and other formations in the Llano region. Some of the material collected by the writer in 1945 was destroyed while in transit to Washington; fortunately, Barnes and Cloud were able to replace most of the lost material with new collections in October and December 1945.

AGE AND STRATIGRAPHIC LIMITS OF THE CHAPPEL LIMESTONE

The Chappel limestone is one of several thin units that crop out in the Llano region between the Barnett formation of Late Mississippian age and the Ellenburger group of Early Ordovician age. The named

units recognized within this stratigraphic interval are listed below:

Chappel limestone:
Early Mississippian (chiefly late Kinderhook but probably in part early Osage).
Houy formation:
Early Late (and probably late Middle) Devonian to Early Mississippian (early Kinderhook). Includes the Doublehorn shale member and the Ives breccia member; also the abandoned Zesch formation, which is equivalent to a part of the Ives.
Bear Spring formation:
Early Middle Devonian.
Stribling formation:
Early or Middle Devonian.
Pillar Bluff formation:
Early Devonian.
Burnam limestone:
Late Ordovician.

The Chappel limestone and the Houy formation are exposed at many places along the east, north, and west margins of the Llano uplift, but the rest of the above-listed formations appear to have a more restricted distribution. In outcrop, the Chappel ranges from a featheredge to 45 feet in thickness; and "underground to the north and west of the Llano uplift" it is either absent or ranges "from a thin stratum to 150 feet" (Sellards, 1932, p. 92). The Houy is less than 17 feet thick in outcrop, but is probably much thicker in the subsurface as it is the central Texas representative of the widespread Upper Devonian and Lower Mississippian black-shale sequence. The Houy contains several distinct conodont faunas. Because of their excellent state of preservation, specimens from this older formation were selected to illustrate the obviously reworked material in the Chappel.

Opinions differ as to the age and stratigraphic limits of the Chappel. The formation was named by Sellards (1932, p. 91, 92) who stated that the Chappel formation is of Boone or Osage age; he designated an outcrop 3 miles southeast of San Saba as the type locality. Girty (1926, p. 3, 24–43) and Roundy (1926, p. 6–8) described a part of the fauna; they believed their fossils came from rocks of Boone age. These fossils were collected by P. V. Roundy and K. C. Heald on April 20, 1919, and, according to Roundy (1926, p. 2), came from "a gray, medium-hard, somewhat crinoidal limestone exposed so far as I am aware, only along the road to Chappel about three [2.4] miles southeast of the courthouse at San Saba. This limestone . . . is only about a foot thick."

Weller and others (1948, p. 143, 144; pl. 2, col. 54) were of the opinion that the Chappel limestone "contains both Late Kinderhookian and Osagean species and probably differs in age from place to place"; to them it appeared that "some of the limestone, locally identified as Chappel, is equivalent to the lower part of the Barnett as distinguished at other places."

According to Plummer (1950, p. 30) the Chappel formation probably ranges in age from the early Kinderhook through the Burlington. Plummer (1950, p. 26–28) subdivided the Chappel formation into the following four members:

Whites Crossing coquina (youngest): a pelmatozoan detritus found locally in structural sinks and depressions in Lower Ordovician rocks. This coquina, according to Plummer, is as much as 60 feet thick and contains megafossils that strongly suggest a Burlington age.

Espey Creek limestone: a widespread pelmatozoan-bearing unit. At some of Plummer's localities this member consists of several thin beds of hard crystalline limestone, but at other places it is a single layer of somewhat loosely cemented pelmatozoan debris. At most outcrops the thickness of the Espey Creek, according to Plummer, is between 8 and 12 inches, although he found it to be much thicker at some places, especially in structural sinks.

Ives conglomerate: a hard siliceous rock consisting of chert pebbles and cobbles embedded in silica sand and cemented by silica. The Ives, according to Plummer, commonly ranges from 6 to 14 inches in thickness.

King Creek marl (oldest): "a dark-gray, collodial, nonlaminated, fossiliferous, lumpy, partially cemented hard marl, which fills depressions, cavities, and holes in the Ellenburger surface" (Plummer, 1950, p. 26). Plummer stated that this member is commonly less than one foot thick, is erratic in its distribution, and contains fossils of early Kinderhook age.

The Chappel limestone as conceived by Cloud and Barnes (1948, p. 49–52) is equivalent to Plummer's Espey Creek limestone, with the exception of approximately the basal 1.5 feet of the member at its type site on Espey Creek (locality C–22). This basal part of the Chappel limestone was assigned to the Houy formation by Cloud, Barnes, and Hass (1957) because it contains pre-Chappel conodonts. According to Cloud and Barnes (1948) megafossil evidence indicates that the Chappel limestone is chiefly of late Kinderhook (Chouteau) age and probably partly of early Osage (Fern Glen) age. The age and stratigraphic limits of Plummer's member given in the present paper agree with the determinations of Cloud and Barnes.

The Whites Crossing coquina member is classed (Hass, 1953, p. 69–71) as late Osage (Keokuk) age and placed in the lower part of the Barnett formation. The Ives conglomerate member—herein called the Ives breccia member—is considered a part of the Houy formation as described by Cloud, Barnes, and Hass (1957). The Ives is classified as Late Devonian but it is not the same age throughout its extent. At some localities it is

definitely of early Late Devonian, and possibly of late Middle Devonian, age but at other localities, including the type area of the Ives in western San Saba County and the exposures along King Stream in the vicinity of locality C–21 of the present paper (fig. 121), it is of younger Late Devonian age. The author considers Plummer's King Creek marl member, at its type site on King Stream near locality C–21, to be a small, local, cavity filling that washed under or leaked through the Ives breccia member. Its conodont fauna contains many Mississippian (early Kinderhook) species and, therefore, must be younger than the overlying Ives breccia member of Late Devonian age. Cloud, Barnes, and Hass (1957) placed the King Creek marl member of Plummer's Chappel formation in the Houy formation.

CONODONT FAUNAL ZONES

Megafossils are not too common in the Chappel limestone, especially in the eastern part of the Llano region. Conodonts, on the other hand, are common or even abundant in the formation at most outcrops. Some conodont species range throughout the Chappel, whereas others are restricted to a part of that formation. Some of the species are also found in the pre-Chappel rocks of the Llano region. It is the author's opinion that most of the conodonts in this last-named group represent reworked material.

Table 1 is a distribution chart in which the conodont species recognized in the Chappel limestone are divided into two groups: (1) species which, in the Llano region, have not been found in pre-Chappel rocks; and (2) species which, in that region, are present in pre-Chappel rocks. Species listed under the second heading are further subdivided on the basis of their first appearance in some of the better known stratigraphic successions of the United States; that is, the division depends on whether a species first appeared in the Ordovician, Devonian, or Mississippian (lower Kinderhook). Table 1 gives the number of specimens of each species recognized in the examined material of the listed collections. A direct numerical comparison, however, cannot be made between the specimens of a given species in one collection and those of the same species in any other collection because the amount of material examined differed from sample to sample. However, the data in table 1 do show that there are abrupt variations in the frequency of certain species. Moreover, a study of the conodonts in serial collections from 37 localities showed that some of these frequency variations have an invariable stratigraphic relationship with each other. This fact is borne out by the serial collections listed in table 1 and is the basis for recognizing three conodont faunal zones in the Chappel limestone. Each of these zones has been named after one of its characteristic conodont species. These zones, from youngest to oldest, are:

Bactrognathus communis zone; probably lower Osage:
Restricted to the topmost beds of the Chappel.

Gnathodus punctatus zone; Upper Kinderhook (Chouteau):
The greater thickness of the Chappel limestone belongs to this zone. However, all three zones have been recognized at some localities even where the Chappel limestone is quite thin; as, for example, at locality C–1 (fig. 121) where the formation is 2.5 feet thick.

Siphonodella cooperi zone; Upper Kinderhook (Chouteau):
Present in the lowermost beds of the Chappel at some localities.

Chart 1 records the relative abundance of conodont species in each of the three faunal zones of the Chappel limestone; it also illustrates the changes in faunal composition that occur from the lowermost to the topmost beds of that formation. The 68 collections used to compile this chart are those listed in table 1. On the chart, frequency-distribution data for each zone are recorded in histogram form in accordance with the percentage scale given in the chart. Each solid column records the abundance of a species relative to those species in a given zone that are not found in the pre-Chappel rocks of the Llano region. Each open column shows the abundance of a species relative to all species recognized in the same faunal zone.

Some of the Mississippian species listed in table 1 and chart 1 from pre-Chappel rocks may also occur naturally in the Chappel limestone; it is impossible to determine what proportion of the specimens of such species are reworked. *Polygnathus communis* and *Elictognathus lacerata*, for example, fall in this category, as each has been found at many localities throughout the United States in rocks of both early and late Kinderhook age. Nevertheless, it is the author's opinion that all of the Ordovician and Devonian conodont species, and most of the Mississippian pre-Chappel species listed in the chart and table have been reworked into the Chappel limestone. His observations during the past 20 years—which include a study of the conodonts in the standard Upper Devonian succession of North America in New York and northwestern Pennsylvania (Hass, 1951, 1956, 1958; Cloud, Barnes, and Hass, 1957), as well as observations of others, including Branson and Mehl (1933b, 1941a), give strong support to this view. However, all of the species recognized in the collections detailed in table 1 are listed because some stratigraphers believe that current knowledge of the stratigraphic ranges of conodont genera and species is too insufficient to allow the conodont specialist to determine which specimens in a collection are the reworked ones. To a certain extent this is a valid argument, although it is not nearly as effective today as it was when less was known about the ranges of

conodonts. Nevertheless, even if it were granted that all of the species recorded in table 1 and chart 1 did occur naturally in the Chappel, those which first appear in the Ordovician or Devonian would be of no stratigraphic value in Chappel studies, because they would then have an extremely long stratigraphic range. As would be expected, table 1 shows that the basal beds of the Chappel limestone contain the greatest number of specimens considered to have been reworked. Had table 1 included more collections, additional Ordovician species, such as *Ulrichodina* sp. and *Paltodus* sp., and Devonian species, such as *Neoprioniodus alatus* (Hinde), would have been recorded. However, since these unrecorded species are scarce, even had they been included, the relative abundance of species as shown in chart 1, would not have been changed.

In 1947, the author (Hass, 1947, p. 1190) stated in an abstract that the Chappel limestone included all of the beds between the Barnett formation and the Ives breccia—which at that time he classed as a distinct formation of Late Devonian age. The following five conodont faunas were then recognized in the Chappel:

Pre-Burlington fauna
Pre-Welden fauna of Oklahoma
Branson and Mehl's Chouteau fauna of Missouri
Bushberg and Hannibal faunas of Missouri
Grassy Creek fauna of Missouri

The pre-Burlington fauna of the 1947 abstract is the fauna of the *Bactrognathus communis* zone of the present paper; the pre-Welden fauna of Oklahoma is the fauna of the *Gnathodus punctatus* zone; and Branson and Mehl's Chouteau fauna of Missouri is the fauna of the *Siphonodella cooperi* zone. Rocks containing the remaining two faunas are no longer considered to be a part of the Chappel limestone because Cloud and Barnes (1948) have demonstrated that the Chappel, as conceived by them, is a mappable unit that correlates chiefly with the Chouteau and probably in part also with the Fern Glen portions of the standard Mississippian succession. Rocks having the lower two faunas are now placed in the Houy formation by Cloud, Barnes, and Hass (1957).

BACTROGNATHUS COMMUNIS ZONE

The *Bactrognathus communis* zone is restricted to the topmost beds of the Chappel limestone. Specimens of species of *Bactrognathus*, *Doliognathus*, *Scaliognathus*, *Staurognathus*, and *Neoprioniodus lanceolatus* are especially characteristic of the zone, for with the exception of a few specimens of *Bactrognathus*, they have not been recognized in the underlying faunal zones of the Chappel. Several other species, including *Gnathodus delicatus*, *Pseudopolygnathus lanceolata*, *Roundya* sp. B, and *Neoprioniodus oligus*, are relatively more abundant in the *Bactrognathus communis* zone than in the other two zones. On the other hand, the *B. communis* zone contains only a few specimens, or none at all, of the species that typify the *Gnathodus punctatus* and *Siphonodella cooperi* zones.

Rocks of the *Bactrognathus communis* zone are probably of early Osage age. *Bactrognathus* is present in Missouri in the Fern Glen limestone of earliest Osage age (Mehl and Thomas, 1947). According to Branson and Mehl (1941b, p. 98) "*Doliognathus* and *Scaliognathus* and the first of the typical representatives of *Bactrognathus*" appear in the Mississippian succession of southwestern Missouri in a very thin calcareous shale. They assigned this shale to the overlying Pierson limestone, which, according to C. P. Kaiser (see Weller and others, 1948, p. 147), is a lithologic variant of the St. Joe limestone of earliest Osage age. Branson (1944, p. 184), on the other hand, placed the Fern Glen, Pierson, and St. Joe limestones of Missouri in the lower Mississippian (Kinderhook), and this assignment may in part explain why Ellison (1946, figs. 1, 2; p. 108, 110) recorded the ranges of *Bactrognathus* and *Doliognathus* as "lower and middle Mississippian" (Kinderhook and Osage) and that of *Scaliognathus* and *Staurognathus* as "lower Mississippian" (Kinderhook).

Branson and Mehl (1941b) reported specimens of *Bactrognathus*, *Doliognathus*, and *Staurognathus* from the basal beds of the so-called Sycamore limestone of Pontotoc County, Okla. These authors, however, did not intend to imply a correlation of the beds they identified as Sycamore with the type Sycamore limestone of south-central Oklahoma; rather, they were using the name in a sense common in petroleum exploration. The Sycamore of Pontotoc County, according to Branson and Mehl, "was designated as within the Mayes by Hyatt (1936) and some writers would describe it as the lower part of the Mississippian Caney." *Bactrognathus inornata* is one of the species Branson and Mehl (1941b, p. 100) found in the basal beds of the so-called Sycamore of Pontotoc County. It is the author's opinion that this species is conspecific with *Geniculatus claviger* (Roundy), a species characteristic of the lower part of the Caney shale of Oklahoma and the upper conodont faunal zone of the Barnett formation of Texas. The association of this species with species of *Bactrognathus*, *Doliognathus*, and *Staurognathus* would suggest a naturally mixed fauna (Hass, 1953, p. 78) although it is also possible that Branson and Mehl (1941b) could have included too great a thickness of beds in their collection from the basal part of the so-called Sycamore of Pontotoc County.

C. L. Cooper (1948, p. 362) considered the Pierson limestone of Missouri and the limy shale above the Welden limestone (Branson and Mehl's Sycamore limestone of Pontotoc County) to be in the Osage because

in Indiana he found a conodont fauna with many new forms, including six species of *Bactrognathus* and *Doliognathus*, in the shale directly on top of the Rockford limestone. He believed the Rockford limestone to be the youngest formation of Kinderhook age in that area.

GNATHODUS PUNCTATUS ZONE

The *Gnathodus punctatus* zone appears to range throughout most of the Chappel limestone wherever that formation is very thick. Specimens of *Gnathodus punctatus* are commonly very abundant in collections from this zone; and this species together with *Polygnathus communis* var. *carina*, *Ozarkodina* sp. A, and *Siphonodella obsoleta* form a distinctive association. *Dollymae sagittula* is scarce, but appears to be restricted to this zone.

Rocks of the *Gnathodus punctatus* zone are herein considered to be of late Kinderhook (Chouteau) age. This age designation is in accord with that of Cloud and Barnes (1948, p. 50) who collected Chouteau megafossils from the Chappel limestone of the western part of the Llano region. For example, conodont collection 9360 (locality C–20 on fig. 121) obtained from the comminuted material of Cloud's megafossil collection TF–406 (Cloud and Barnes, 1948, p. 50), contains the following identifiable conodonts: *Gnathodus punctatus* (418 specimens), *Gnathodus delicatus*, *Hindeodella fragilis*, *Hindeodina uncata*, *Ligonodina singularis*, *Ozarkodina* sp. A, *Neoprioniodus oligus*, *Roundya* sp. A, *Siphonodella obsoleta*, and one specimen each of *Panderodella distorta*,[1] *Panderodella gracilis*, and *Palmatolepis* sp. All of these species, with the exception of the two panderodellids and the one palmatolepid, are representative of the *Gnathodus punctatus* zone. Conodonts have also been recovered from the comminuted material of Carboniferous collection 2623, from the type Chappel limestone (locality C–1). Most of the minute megafossils which Girty (1926) described are from this collection. In addition to *Gnathodus punctatus*, lot 2623 contains one or more specimens of *Siphonodella obsoleta*, *Roundya* sp. A, *Polygnathus communis*, and *Gnathodus delicatus;* some fragments, including five palmatolepids, are also present. With the exception of the palmatolepids, the identified material in collection 2623 is typical of the *Gnathodus punctatus* zone. This collection thus provides a faunal link between that part of the type succession of the Chappel limestone from which Girty's minute megafossils came and some beds in the western part of the Llano region that contain typical Chouteau megafossils.

The Chappel limestone has been correlated with the Welden limestone of Oklahoma. According to C. L. Cooper (1939, p. 381), he and Girty "collected a considerable megafauna from the Welden at its type locality in 1929. On the basis of these fossils Girty (unpublished manuscript) correlated the Welden with the crinoidal limestone of Boone age (Chappel formation of Sellards, 1932). . . . He concluded that, although the two faunas are similar to each other, they are not closely related to any known Mississippian faunas of outlying regions." On the other hand, some investigators have correlated the Welden with the Chouteau of the Mississippi Valley area. According to Weller and others (1948, p. 144), the Welden limestone "contains trilobites of Upper Kinderhookian type, suggesting its correlation with the Chouteau or higher beds [apparently the Sedalia or Gillmore City]"; and C. L. Cooper (oral communication, September 1955) is now also of the opinion that the Welden is a Chouteau correlative, although formerly he (1939, p. 381, 384) considered it to be younger than the Kinderhook.

The Welden is approximately 4 feet thick at its type locality in the SE¼SW¼NE¼ sec. 27, T. 3 N., R. 6 E., of Pontotoc County, Okla. The author's collections from the top 3.3 feet of the type Welden did not contain recognizable conodonts, but two collections (15586 and 15587) from intervals in the basal 0.7 foot of the Welden, as well as one (15588) from the topmost 0.2 foot of the underlying pre-Welden shale of Cooper, contain conodonts like those in the *Gnathodus punctatus* zone of the Chappel limestone. The conodonts in these three collections, together with the conodonts *Bactrognathus*, *Doliognathus*, and *Staurognathus*, in the limy shale that directly overlies the Welden (Cooper, 1948, p. 362; Branson and Mehl, 1941b), permit the Welden to be correlated with that part of the Chappel limestone which is assigned to the *Gnathodus punctatus* zone. The significant species recognized in the above-mentioned collections are listed below:

Collection 15586.—Welden limestone, type locality;

[1] Certain species heretofore considered as belonging to the genus *Palmatolepis* Ulrich and Bassler, 1926, are herein assigned to the genus *Panderodella* Bassler, 1925, whose type species, *Panderodella truncata*, was described and illustrated by Ulrich and Bassler (1926, p. 52, pl. 9, figs. 15–17). Müller (1956, p. 16) designated the lectotype of *Panderodella* as the specimen Ulrich and Bassler (1926) illustrated as fig. 15 on pl. 9. The writer has examined this lectotype; it is not a *Polygnathus* as stated by Müller, but rather is conspecific with Ulrich and Bassler's (1926, p. 51, pl. 9, figs. 18–20) *Palmatolepis glabra*. Both species were described in the same publication and were founded on material collected from the basal sandstone of the Chattanooga shale near Mount Pleasant, Maury County, Tenn. The correct name of the species is *Panderodella glabra* (Ulrich and Bassler).

Panderodella Bassler, 1925, has priority over *Palmatolepis* Ulrich and Bassler, 1926. *Palmatolepis*, however, is a well-known name that—if possible—should be preserved. The writer, therefore, proposes that *Palmatolepis*, whose type species is *Palmatolepis perlobata* Ulrich and Bassler, be reserved for those asymmetric platelike conodonts whose axis is commonly sigmoid in oral view and whose blade is somewhat concave toward the inner platform. In addition, this inner platform is distinctly lobed adjacent to the azygous node; with the lobe so formed commonly built up about a secondary carina and a secondary keel. *Panderodella* resembles *Palmatolepis*, but its species tend to be narrower and they also lack a distinct lobe on the inner platform. The author considers *Manticolepis* Müller (1956, p. 16; type species, *Palmatolepis subrecta* Miller and Youngquist, 1947) to be a junior synonym of *Palmatolepis;* and *Deflectolepis* Müller, (1956, p. 16; type species, *Palmatolepis deflectens* Müller, 1956) to be a junior synonym of *Panderodella*.

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a small collection from 0.3–0.7 foot above the base of the formation.

Gnathodus punctatus (Cooper)
Polygnathus communis Branson and Mehl
Polygnathus communis Branson and Mehl var. *carina* Hass

Collection 15587.—Welden limestone, type locality; a small collection from 0–0.3 foot above the base of the formation.

Gnathodus punctatus (Cooper)
Polygnathus communis Branson and Mehl
Neoprioniodus oligus (Cooper)
Siphonodella obsoleta Hass

Collection 15588.—From the topmost 0.2 foot of C. L. Cooper's pre-Welden shale at the type locality of the Welden limestone.

Gnathodus punctatus (Cooper)
Polygnathus allocota (Cooper)
Polygnathus communis Branson and Mehl
Neoprioniodus oligus (Cooper)
Siphonodella cooperi Hass
Siphonodella obsoleta Hass

Gnathodus punctatus has also been collected in the interval between 11.5–17.5 feet below the top of the middle division of the Arkansas novaculite at Caddo Gap, Montgomery County, Ark., in beds classified as Mississippian (Chouteau) by the U. S. Geological Survey (Hass, 1951, p. 2539).

SIPHONODELLA COOPERI ZONE

The *Siphonodella cooperi* zone is restricted to the basal beds of the Chappel limestone and contains numerous specimens of *Siphonodella cooperi* as well as a relatively large number of specimens of *Polygnathus allocota*. *Polygnathus radina*, though not abundant, is more commonly found in these lower beds than in the higher beds of the Chappel. *Spathognathodus cooperi* and *Spathognathodus longus*, as far as known, are restricted to the *Siphonodella cooperi* zone.

The *Siphonodella cooperi* zone is herein considered to be of late Kinderhook (Chouteau) age because its conodont fauna more closely resembles that of the overlying *Gnathodus punctatus* zone than that in rocks of older Kinderhook age. Moreover, the comminuted material of P. E. Cloud's (Cloud and Barnes, 1948, p. 50) Chouteau megafossil collections TF–385a and 389b, from the Chappel limestone, contains conodonts of the *Siphonodella cooperi* zone. Significant species in these two collections are listed below:

Collection 15533.—From comminuted material of Cloud collection TF–385a (see Cloud and Barnes, 1948, p. 50). Locality C–19, in borrow pit on the east side of U. S. Highway 87, 6.7 miles south-southeast of Brady, McCulloch County, Tex.

Elictognathus lacerata (Branson and Mehl)
Gnathodus delicatus Branson and Mehl
Polygnathus allocota (Cooper)
Polygnathus communis Branson and Mehl
Polygnathus radina Cooper
Siphonodella cooperi Hass
Spathognathodus longus Hass

Collection 15534.—From comminuted material of Cloud collection TF–389b (see Cloud and Barnes, 1948, p. 50). Locality C–19, in field southwest of U. S. Highway 87, 6.7 miles south-southeast of the courthouse at Brady, McCulloch County, Tex.

Elictognathus lacerata (Branson and Mehl)
Gnathodus delicatus Branson and Mehl
Ligonodina singularis Hass
Polygnathus allocota (Cooper)
Polygnathus communis Branson and Mehl
Polygnathus radina Cooper
Siphonodella cooperi Hass

Additional support for the view that the *Siphonodella cooperi* zone is a Chouteau correlative is found in the fact that a few of its conodont species are like those reported from the Chouteau limestone of Missouri (Branson and Mehl, 1938). These species include *Gnathodus delicatus*, *Siphonodella cooperi* (identified as *Siphonodella duplicata* by Branson and Mehl), and *Subbryantodus radians*. The *Siphonodella cooperi* zone also has some species in common with the greater part of Cooper's (1939) pre-Welden shale of Pontotoc County, Okla. This shale is 1.45 feet thick at the type locality of the Welden limestone where, from its basal 1.25 feet, the author made two collections containing the following species:

Collection 15589.—Pre-Welden shale of Cooper (1939) at type locality of Welden limestone, Pontotoc County, Okla. From 0.2–0.85 foot below top of shale.

Dinodus fragosus (E. R. Branson)
Elictognathus lacerata (Branson and Mehl)
Gnathodus punctatus (Cooper) (one specimen)
Nodognathus spicata Cooper
Polygnathus allocota (Cooper)
Polygnathus inornata E. R. Branson
Pseudopolygnathus asymmetrica Cooper
Siphonodella cooperi Hass
Siphonodella quadruplicata (Branson and Mehl)

Collection 15590.—Same locality as collection 15589. From 0.85–1.45 feet below the top of the pre-Welden shale of Cooper (1939).

Dinodus fragosus (E. R. Branson)
Elictognathus lacerata (Branson and Mehl)
Elictognathus bialata (Branson and Mehl)
Polygnathus allocota (Cooper)
Polygnathus inornata (E. R. Branson)
Polygnathus communis Branson and Mehl
Pseudopolygnathus asymmetrica Cooper
Siphonodella cooperi Hass

Siphonodella lobata (Branson and Mehl)
Siphonodella quadruplicata (Branson and Mehl)
Siphonodella sexplicata (Branson and Mehl)

It is the author's opinion that the Welden limestone and the pre-Welden shale of Cooper (1939) are of late Kinderhook (Chouteau) age; that the Welden and the topmost 0.2 foot of the pre-Welden shale are correlative with the *Gnathodus punctatus* zone of the Chappel limestone, and that the remainder of the pre-Welden shale is a correlative of the *Siphonodella cooperi* zone. C. L. Cooper (oral communication, September 1955) identifies the Welden with Chouteau rocks; and in 1948 (Cooper, 1948, p. 359–360) correlated the pre-Welden shale with the Jacobs Chapel shale of Indiana. According to Weller and others (1948, chart 5, col. 76), the Jacobs Chapel, which underlies the Rockford limestone, is a Chouteau correlative.

Conversely, Branson and Mehl (1941a, p. 204, 205, 208, 209) believed that the Welden limestone might be as young as "Middle Mississippian" (Osage and Meramec) and that the pre-Welden shale is the same age as the Welden, since, according to them, typical Welden conodonts are in the lowermost part of the pre-Welden shale. As indicated in the foregoing paragraphs, the author's observations differ from those of Branson and Mehl and, therefore, he disagrees with their age determinations as well as with their statement that typical Welden conodonts are in the lowermost bed of the pre-Welden shale. He also believes that a part of the conodont fauna of Cooper's (1939) pre-Welden shale cannot be cited as supporting Branson and Mehl's (1941a, p. 208, 209) concept of a "phantom formation." The Bushberg-Hannibal conodonts which they recognized in Cooper's pre-Welden shale could range naturally into that Lower Mississippian (Chouteau) unit or, if reworked, they could have been derived from the youngest beds of the underlying Woodford shale. It is the author's opinion that these conodonts were reworked, because in Pontotoc County, Okla., the youngest beds of the Woodford shale are of Early Mississippian (early Kinderhook) age; these beds contain conodonts like those in the Bushberg sandstone member of the Sulphur Springs formation and the Hannibal shale of Missouri.

MEASURED SECTIONS

Almost all of the material on which the zonation of the Chappel limestone is based came from known intervals of measured sections. Nine of these sections are described below; their locations are shown in figure 121.

Locality C–1, section 1; type locality of the Chappel limestone

[Southeast 2.4 miles from courthouse at San Saba, San Saba County, Tex., on San Saba to Chappel road in cut high on side of hill. About 150 feet west of original type site of Chappel limestone. Except for top 0.4 foot of Chappel limestone, measurements and descriptions of units after P. E. Cloud, Jr., November 1945 and March 20, 1956]

	Feet
Barnett formation: Shale; olive-gray where freshly exposed but yellowish-gray and yellowish-brown where weathered; a few thin limestone beds, mostly near top of formation; basal 0.5 ft locally contains glauconite	50
Chappel limestone:	
Limestone, light-olive-gray, argillaceous; contains pelmatozoan columnals; easily separated from underlying bed along an uneven surface	.4
Limestone, bedded, medium- to dark-gray, coarse- to medium-grained; contains pelmatozoan columnals; phosphatic pellets rare in basal 0.25 ft	2.1

Collection No.	*Distance below top, in feet*
11124	0–0.3
11130	.3– .4
15555	.4– .7
15556	1.0–1.3
15557	1.3–1.65
15558	1.65–2.25
15559	2.25–2.5

Houy formation:	
Limestone, gray, medium- to coarse-grained; contains phosphatic pellets	0.08–0.4
Chert breccia with matrix of glauconite and phosphatic limestone (probably Ives breccia member)	.22– .5
Limestone, greenish-gray, medium-grained; contains chert fragments and greenish shale	.1
Total	52.9–53.5

Honeycut formation.

In July 1950, the writer made a preliminary set of collections along the face of the outcrop at locality C–1, section 1. Two of those collections (11124, from the top 0.3 foot of the Chappel and 11130, from 0.3 to 0.4 foot below the top) contain conodonts of the *Bactrognathus communis* zone. The limestone bed from which these collections came is easily separated from the underlying bed along an uneven surface. Apparently, this youngest bed of the Chappel is not present everywhere along the face of the outcrop; as the topmost bed of the Chappel where Cloud measured his section is 0.9 foot thick and contains representatives of the *Gnathodus punctatus* faunal zone.

Section 2 was measured at locality C–1 at the original type site of the Chappel limestone, 2.4 miles southeast of the courthouse at San Saba, San Saba County, Tex., on the old San Saba to Chappel road, downhill from a right angle turn on that road, and high on the side of a hill. This exposure was mostly covered in 1950 by fill for the bed of the new road.

Four conodont collections from this site are listed in table 1. Three are from a measured section and the fourth is from the comminuted material of collection 2623, from which most of Girty's (1926, p. 3, 24–43) minute megafossils came. According to Cloud and

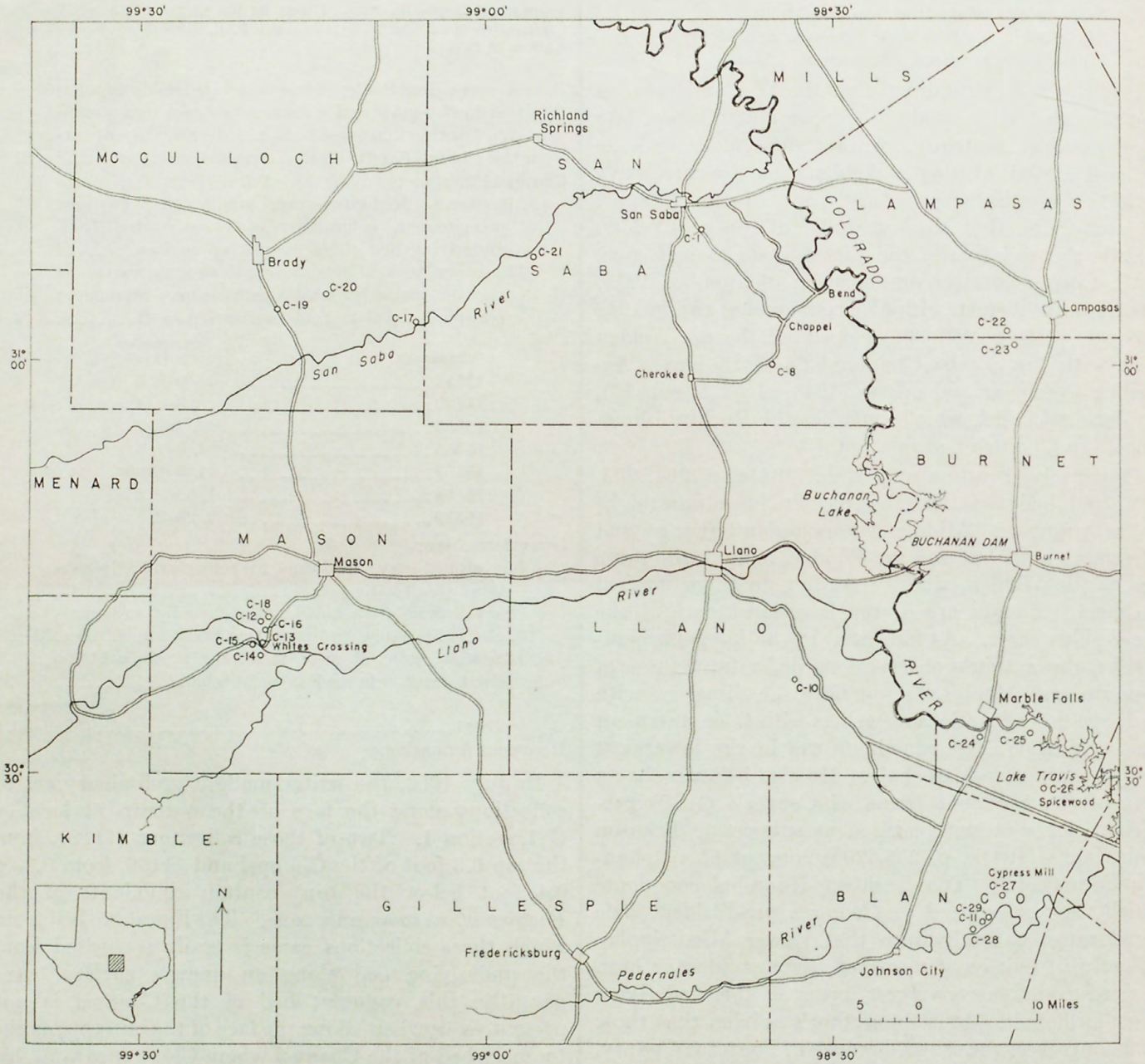

FIGURE 121.—Map showing localities at which conodonts were collected from the Chappel limestone.

Barnes (1948, p. 49) the Chappel limestone at the original type site is approximately 2 feet thick. They stated that the upper 10 to 11 inches of the Chappel "is a tough, medium to rather dark gray rock with a brownish, olive, or bluish cast"; and that the lower 13 to 14 inches of the formation has "been leached to a marly appearance and lighter yellowish color, presumably by the movement of ground water along the Chappel-Honeycut contact." The author's conodont collections from this section of the Chappel (see table 1) are from intervals in the uppermost of Cloud and Barnes' two divisions. The top 0.2 foot of the upper division contains the fauna of the *Bactrognathus communis* zone and the remaining 0.6 foot, the fauna of the *Gnathodus punctatus* zone. A very few conodonts suggestive of the *Siphonodella cooperi* zone have been recognized in collections 8653 and 9008 from Cloud and Barnes' lower division, found by the author to be as much as 1.7 feet thick. However, practically all of the conodont specimens in this lower division belong to species characteristic of either an early Kinderhook age or a Late Devonian age and, in the author's opinion, the rocks of this lower division should be included in the underlying Houy formation.

Locality C–13, Whites Crossing section

[Just northwest of Whites Crossing, a crossing on the Llano River, 8.3 miles (airline) southwest of the courthouse at Mason, Mason County, Tex., along the northeast bank of the Llano River. Measurements and description of Barnett formation after P. E. Cloud, Jr., November 1945]

	Feet
Barnett formation:	
Limestone, off-white to light-gray, fine-grained to sublithographic	2
Limesand, very light gray to yellowish-gray where freshly exposed; reddish-orange and reddish-brown where weathered; very coarse grained except for a few sublithographic beds; pelmatozoan columnals extremely abundant	11
Chappel limestone: Limestone, pale-red to pale-yellowish-brown, fine- to medium-grained	1. 7

Collection No.	Distance below top, in feet
15561	0 –0. 33
9303	1. 2–1. 7

Total	14. 7

Base of Chappel limestone covered.

Locality C–16, Barnett Trench section

[About 2,100 feet due west of the point at which Honey Creek intersects the road from Mason to Whites Crossing, Mason County, Tex. Measurements and description of Barnett formation after P. E. Cloud, Jr., July 4, 1945]

	Feet
Barnett formation (lower beds only):	
Limestone, off-white to very light gray, fine-grained	1. 5
Limestone, off-white to very light gray, coarse-grained	9. 5
Limestone, off-white, very fine grained to sublithographic	1
Limestone, off-white to very light gray, fine-grained	10
Chappel limestone: Limestone, pale-red to pale-yellowish-brown fine- to medium-grained	19

Collection No.	Distance below top, in feet
9384	0– 1. 0
9383	14. 0–15. 0
9314	14. 0–15. 0
9300	18. 0–19. 0

Total	41

Gorman formation.

Locality C–20, section 2, Bald Ridge area

[About 6.2 miles (airline) S. 33° E. of courthouse at Brady, about 3,000 feet N. 35° W. of peak of Bald Ridge, and about 250 feet northeast of southeast corner of collapsed inlier of Mississippian rocks, McCulloch County, Tex.]

Barnett formation.

	Feet
Chappel limestone: Limestone, pale-red to light-brown, fine- to medium-grained, crinoidal	20

Collection No.	Distance below top, in feet
9351	0–1. 0
9350	about 5. 0
9349	about 10. 0
9348	about 15. 0
9347	19. 0–20. 0

Gorman formation.

Locality C–21, King Spring area

[Along west bank of King Stream, about 400 feet north of King Spring, 0.85 mile (airline) south of a bridge over San Saba River, and 9.6 miles (airline) S. 10° E. of Richland Springs, San Saba County, Tex. After notes by P. E. Cloud, Jr., November 1945]

Covered.

	Feet
Chappel limestone:	
Limestone, brownish-gray, crinoidal	0. 45
Limestone, crinoidal, cherty	0. 1– . 2
Limestone, gray, crinoidal	. 35

Collection No.	Distance above base, in feet
9355	0. 55–1. 0
9354	0–0. 3

Total	0. 9–1. 0

Gorman formation.

Locality C–22, Espey Creek

[Along west bank of Espey Creek, about 400 feet S. 40° E. of J. R. Walker ranch house (formerly Hollenbeck ranch), and 5 miles (airline) west-southwest of the center of Lampasas, Lampasas County, Tex. Type site of Plummer's (1950, p. 22, 23) Espey Creek limestone member of Chappel formation. Measurements and descriptions after P. E. Cloud, Jr., March 19, 1956]

	Feet
Quaternary gravel: To the northeast, in the immediate vicinity of this section, are outcrops of the Marble Falls limestone of Pennsylvanian age and the Barnett formation of Mississippian age	11
Chappel limestone:	
Limestone, medium-gray, compact, fine-grained to subaphantic; pelmatozoan columnals throughout	. 85
Limestone, yellowish-gray, marly, silty, fine- to medium-grained; pelmatozoan columnals throughout	. 9
Limestone, gray, fine-grained; pelmatozoan columnals abundant	. 6
Shale, yellowish-gray; calcareous, with silty, 0.1-foot thick limestone bed in middle	. 38
Limestone, gray, fine-grained; with scattering of pelmatozoan columnals	. 25
Shale, yellowish-gray; calcareous; with thin layers of silty limestone	. 46
Limestone, light-gray; with numerous pelmatozoan columnals	. 35
Limestone, greenish-gray, silty; with pelmatozoan columnals	. 26

Collection No.	Distance in feet, above base
15563	3. 90–4. 05
15564	2. 40–2. 60
15565	2. 00–2. 30
15566	1. 07–1. 32
15567	0– . 26

Houy formation:	
Limestone, yellowish-gray, silty; pelmatozoan columnals common; phosphatic nodules and lenses as much as 0.4 ft long and 0.1 ft thick on outcrop face	0.4–. 7
Phosphatic pellet bed with bone fragments, gray-brown	. 14
Phosphorite, olive-gray	. 27
Chert, greenish-gray; weathers white to greenish-white	. 12
Shale, olive-gray	. 4
Sandstone, grayish-brown; consists of phosphatic pellets, bone fragments, quartz sand, and conodonts; many black phosphatic pebbles on upper surface	.05– . 15
Total	16. 17–16. 83

Honeycut formation.

Locality C–23, Pillar Bluff area

[In wash on north side of Pillar Bluff Creek, about 2,000 feet N. 77° E., of Pillar Bluff 900 feet N. 5° W. of F. M. Bodenhamer ranch house, and 4.5 miles southwest of Lampasas in northern Burnet County, Tex. (See Barnes, Cloud, and Warren, 1945, fig. 43; or Barnes, Cloud, and Warren, 1947, fig. 3)]

Recent soil and rubble.

Chappel limestone:

	Feet
Limestone, olive-gray to yellowish-brown, fine- to medium-grained; few pelmatozoan columnals	0. 85
Limestone, light-gray to dusky-yellow, medium-grained; few pelmatozoan columnals	. 35
Limestone, light-olive-gray, medium-grained; pelmatozoan columnals common, standing in relief on weathered surfaces	. 8
Limestone, yellowish-gray to light-olive-gray, fine-grained; few pelmatozoan columnals	. 5
Limestone, yellowish-gray, fine- to medium-grained; very few pelmatozoan columnals	. 5
Covered	1

Collection No.	Distance above base, in feet
15568	3. 15–4. 00
15569	2. 80–3. 15
15570	2. 00–2. 80
15571	1. 50–2. 00
15572	1. 00–1. 50

Total	4

Honeycut formation.

Locality C–26, Spicewood area

[In bed of branch of Little Cypress Creek, about 3 miles due west of Spicewood, Burnet County, Tex. Texas Bureau of Economic Geology locality 27T–6–37A. Measurements and descriptions after P. E. Cloud, Jr., March 19, 1956]

Barnett formation:

	Feet
Shale with inch-thick chert beds: partly covered	10

Chappel limestone:

Limestone, medium-dark-gray to olive-gray, very fine-grained to granular; in beds as much as 1 foot thick; scattered to abundant pelmatozoan columnals	3. 5

Collection No.	Distance below top, in feet
15579	0–0. 1
15580	1. 6–1. 85
15581	3. 2–3. 5

Houy formation:

	Feet
Clay, yellow-brown, gritty, somewhat plastic; with phosphatic pebbles and nodules measuring as much as 0.1 by 0.25 by 0.7 ft	0. 9
Total	14. 4

Ives breccia member.

Locality C–28, Johnson City area

[In bed of Pedernales River near north bank, 0.25 mile west of mouth of Miller Creek and 1.9 miles northeast of type site of Stribling formation at Honeycut Bend, Blanco County, Tex. (See Cloud and Barnes, 1948, pl. 3). Measurements and descriptions by P. E. Cloud, Jr., March 19, 1956]

Barnett formation.

Chappel limestone:

	Feet
Limestone, gray to brownish-gray, medium- to coarse-grained; contains pelmatozoan columnals	3. 5
Limestone, pinkish-gray with greenish tinge, hard; contains pelmatozoan columnals	1
Limestone, greenish and yellowish, silty, friable to hard; contains pelmatozoan columnals	1

Collection No.	Distance above base, in feet
15583	5. 4–5. 5
15584	2. 0–2. 4
15585	0 –0. 3

Total	5. 5

Houy formation.

LOCALITY REGISTER

Data pertinent to the 82 numbered collections mentioned in this report are contained in the following table. Most of these collections are from known intervals in the Chappel limestone. Four collections are from the underlying Houy formation and 1 is from the basal 0.5 foot of the overlying Barnett formation. The table also includes 5 collections from Pontotoc County, Okla.; 3 of these are from the pre-Welden shale of Cooper (1939) and the other 2 are from the overlying Welden limestone.

Collection and locality data

USGS Carboniferous catalog	Collector	Date of collection	Formation (from Chappel limestone unless otherwise noted)	Stratigraphic position in formation	No. on fig. 121	Description of locality
2623	P. V. Roundy and K. C. Heald.	Apr. 20, 1919	*Gnathodus punctatus* zone	(Comminuted material of collection from which almost all of Girty's (1926) minute megafossils came).	1	Southeast 2.4 miles from courthouse at San Saba, San Saba County, Tex., on old San Saba to Chappel Road, downhill from right angle turn in road, and high on side of hill. This exposure was mostly covered in 1950 by fill for bed of new road.
8653	W. H. Hass	June 10, 1938	Houy formation	Entire unit, 1.7 ft thick	1	Same as collection 2623.
9008	do	Aug. 7, 1942	do	Basal 0.2 ft	1	Do.
9028	do	Aug. 10, 1942	Barnett formation	Basal 0.5 ft; contains many reworked conodonts.	1	Do.
9053	do	Aug. 23, 1942	*Gnathodus punctatus* zone	(Not from measured section)	25	Doublehorn Creek area, about 4 miles (airline) southeast of north end of bridge over Colorado River at Marble Falls, Blanco County, Tex., and about 0.2 mile southwest of site of collection 15576.
9264	V. E. Barnes and L. E. Warren.	August 1944	Houy formation	(Comminuted material of Early Mississippian megafossil collection).	29	Johnson City area, about 5 miles (airline) south-southwest of Cypress Mill and 0.75 mile northeast of Elm Pool, Blanco County, Tex.[1]
9266[2]	P. E. Cloud	Feb. 13, 1945	do	(Thin yellowish to brownish sandy limestone containing bone fragments and other phosphatic material. Cloud's collection TF-294).	23	Pillar Bluff area, 4.2 miles by cyclometer west-southwest from junction of Naruma road with U. S. Highway 281, just south of Lampasas River, on north side of Pillar Bluff Creek about 1,900 ft N. 77° E. of Pillar Bluff and 850 ft N. 11° W. of the F. M. Bodenhamer ranch house, northern Burnet County, Tex.[3]

See footnotes at end of table.

Collection and locality data—Continued

USGS Carboniferous catalog	Collector	Date of collection	Formation (from Chappel limestone unless otherwise noted)	Stratigraphic position in formation	No. on fig. 121	Description of locality
9300	W. H. Hass	July 4, 1945	*Siphonodella cooperi* zone	18–19 ft below top	16	Barnett Trench section, about 2,100 ft due west of point at which Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex.
9301	do	July 6, 1945	*Gnathodus punctatus* zone	8–9 ft below top	15	Barton Ranch section 2, about 2,500 ft N. 88° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex.
9302	do	do	*Siphonodella cooperi* zone	11–12 ft below top	12	Zesch Ranch section, about 5,000 ft N. 60° W. of point at which Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex.
9303	do	July 5, 1945	*Bactrognathus communis* zone	1.2–1.7 ft below top	13	Whites Crossing section, along northeast bank of Llano River just northwest of Whites Crossing and 8.3 miles (airline) southwest of the courthouse at Mason, Mason County, Tex.
9304	do	July 6, 1945	do	3.5–4.0 ft below top	18	Honey Creek section 1, at base of bluff along east bank of Honey Creek, about 2,800 ft N. 24° W. of intersection of Honey Creek and road from Mason to Whites Crossing, Mason County, Tex.
9305	do	July 5, 1945	do	Topmost 0.3 ft	14	Barton ranch section 1, about 3,200 ft S. 14° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex.
9306	do	July 4, 1945	do	0–1.0 ft below top	18	Honey Creek section 2, on north-facing hillside approximately 500 ft east of Honey Creek and about 2,600 ft N. 20° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex.
9307	P. E. Cloud and V. E. Barnes.	Dec. 4, 1945	*Gnathodus punctatus* zone	0.2–0.5 ft below top	1	Same as collection 2623.
9314	W. H. Hass	July 4, 1945	do	14–15 ft below top	16	Same as collection 9300.
9347	P. E. Cloud and V. E. Barnes.	Dec. 5, 1945	*Siphonodella cooperi* zone	19–20 ft below top	20	Bald Ridge area, about 6.2 miles (airline) S. 33° E. of courthouse at Brady, about 3,000 ft N. 35° W. of peak of Bald Ridge, and about 250 ft northeast of southeast corner of collapsed inlier of Mississippian rocks, McCulloch County, Tex.
9348	do	do	*Gnathodus punctatus* zone	About 15 ft below top	20	Same as collection 9347.
9349	do	do	do	About 10 ft below top	20	Do.
9350	do	do	*Bactrognathus communis* zone	About 5 ft below top	20	Do.
9351	do	do	do	0–1.0 ft below top	20	Do.
9353	do	do	do	0–0.5 ft below top	17	Lost Creek area, about 1.7 miles N. 60° E. of mouth of Lost Creek (which empties into San Saba River just east of slab crossing of San Saba River on Voca to Long Valley road), about 100 ft north of river, and near mouth of Jim Davis Hollow, southeastern McCulloch County, Tex.
9354	do	Dec. 4, 1945	*Siphonodella cooperi* zone	0–0.3 ft above base	21	King Spring area, along west bank of King Stream, about 400 ft north of King Spring, 0.85 mile (airline) south of bridge over San Saba River, and 9.6 miles (airline) S. 10° E. of Richland Springs, San Saba County, Tex.
9355	do	do	*Gnathodus punctatus* zone	0.55–1.0 ft above base	21	Same as collection 9354.
9357	do	do	*Bactrognathus communis* zone	0–0.2 ft below top	1	Same as collection 2623.
9358	do	do	*Gnathodus punctatus* zone	0.5–0.8 ft below top	1	Do.
9359	do	Dec. 3, 1945	do	0–0.2 ft above base	8	Davis Creek area, in wash, about 3.6 miles south of Chappel, 50 ft south and 100 ft east of third crossing of Davis Creek on Chappel to Cherokee road, San Saba County, Tex.
9360	P. E. Cloud	Apr. 18, 1945	do	(From comminuted material of Cloud's megafossil collection TF–406.) [4]	20	Bald Ridge area, about 6.2 miles (airline) S. 33° E. of courthouse at Brady, about 2,900 ft N. 39° W. of peak of Bald Ridge, and at southeast corner of collapsed inlier of Mississippian rocks, McCulloch County, Tex.
9361	P. E. Cloud and V. E. Barnes.	Dec. 7, 1945	do	0–0.5 ft above base	10	Moore Hollow area of Riley Mountains, about 1,900 ft due west of Llano-Click road, 1.9 miles south of point where that road crosses Honey Creek, Llano County Tex.
9362	do	do	do	1.0–2.0 ft above base	10	Same as collection 9361.
9367	V. E. Barnes	Oct. 30, 1945	*Bactrognathus communis* zone	0–0.4 ft below top	11	Elm Pool, Johnson City area, about 5.2 miles (airline) south-southwest of Cypress Mill, 4,000 ft north of mouth of Miller Creek, and about 3 miles northeast of Honeycut Bend on Pedernales River, Blanco County, Tex.[4a]
9368	do	do	do	2.0–2.5 ft below top	11	Same as collection 9367.
9369	do	do	*Gnathodus punctatus* zone	4.5–5.0 ft below top	11	Do.
9377	V. E. Barnes and P. E. Cloud.	Dec. 2, 1945	do	0.05–0.4 ft above base	27	Johnson City area, about 2 miles south-southwest of Cypress Mill, 6,000 ft northwest of foot of Pedernales Falls, 1 mile southeast of Voyle's ranch turnoff from Cypress Mill–Johnson City road, 800 ft north-northeast of depression, 200 ft south of dry wash, and 100 ft west of crooked fence, Blanco County, Tex.
9378	do	do	do	2.5–3.0 ft above base	27	Same as collection 9377.
9379	W. H. Hass	July 6, 1945	*Bactrognathus communis* zone	0–1.0 ft below top	15	Same as collection 9301.
9380	do	do	*Siphonodella cooperi* zone	12–14 ft below top	12	Same as collection 9302.
9381	do	do	*Gnathodus punctatus* zone	About 8 ft below top	12	Do.
9382	do	July 5, 1945	do	About 3 ft below top	14	Same as collection 9305.
9383	do	July 4, 1945	do	14–15 ft below top	16	Same as collection 9300.
9384	do	do	*Bactrognathus communis* zone	Top 1 ft	16	Do.

See footnotes at end of table.

Collection and locality data—Continued

USGS Carboniferous catalog	Collector	Date of collection	Formation (from Chappel limestone unless otherwise noted)	Stratigraphic position in formation	No. on fig. 121	Description of locality
9393	W. H. Hass	July 6, 1945	*Bactrognathus communis* zone	Top 1 ft	12	Same as collection 9302.
11124	do	do	do	Top 0.3 ft	1	Type locality of Chappel limestone, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex., on San Saba to Chappel road, in cut high on side of hill, about 150 ft west of original type site of Chappel limestone, which was mostly covered in 1950 by fill for bed of new road.
11130	do	do	do	0.3–0.4 ft below top	1	Same as collection 11124.
15533	P. E. Cloud	Apr. 11, 1945	*Siphonodella cooperi* zone	(From comminuted material of Cloud's collection TF–385a)[4].	19	In borrow pit on east side of U. S. Highway 87, 6.7 miles south-southeast of Brady, McCulloch County, Tex.
15534	do	do	do	(From comminuted material of Cloud's collection TF–389b)[4].	19	In field southwest of U. S. Highway 87, 6.7 miles south-southeast of Brady, McCulloch County, Tex.
15555	W. H. Hass	Mar. 20, 1956	*Gnathodus punctatus* zone	0.4–0.7 ft below top	1	Same as collection 11124.
15556	do	do	do	1.0–1.3 ft below top	1	Do.
15557	do	do	do	1.3–1.65 ft below top	1	Do.
15558	do	do	*Siphonodella cooperi* zone	1.65–2.25 ft below top	1	Do.
15559	do	do	do	2.25–2.5 ft below top	1	Do.
15560	do	July 6, 1945	*Bactrognathus communis* zone	About 5 ft below top	12	Same as collection 9302.
15561	do	July 5, 1945	do	Top 0.33 ft	13	Same as collection 9303.
15562	do	July 4, 1945	*Gnathodus punctatus* zone	7.5–8.0 ft below top	18	Same as collection 9306.
15563	do	Mar. 19, 1956	*Bactrognathus communis* zone	3.9–4.05 ft above base	22	Espey Creek area, along west bank of Espey Creek, about 400 ft S. 40° E. of J. R. Walker ranch house (formerly Hollenbeck ranch), and 5 miles (airline) west-southwest of the center of Lampasas, Lampasas County, Tex. Type site of Plummer's[5] Espey Creek limestone member of Chappel formation.
15564	do	do	do	2.4–2.6 ft above base	22	Same as collection 15563.
15565	do	do	do	2.0–2.3 ft above base	22	Do.
15566	do	do	*Gnathodus punctatus* zone	1.07–1.32 ft above base	22	Do.
15567	do	do	*Siphonodella cooperi* zone	Basal 0.26 ft	22	Do.
15568	do	June 29, 1945	*Bactrognathus communis* zone	3.15–4.0 ft above base	23	Pillar Bluff area, in wash on north side of Pillar Bluff Creek, about 2,000 ft N. 77° E. of Pillar Bluff, 900 ft N. 5° W. of F. M. Bodenhamer ranch house, and 4.5 miles southwest of Lampasas in northern Burnet County, Tex.[6]
15569	do	do	*Gnathodus punctatus* zone	2.8–3.15 ft above base	23	Same as collection 15568.
15570	do	do	do	2.0–2.8 ft above base	23	Do.
15571	do	do	do	1.5–2.0 ft above base	23	Do.
15572	do	do	*Siphonodella cooperi* zone	1.0–1.5 ft above base	23	Do.
15573	do	Mar. 11, 1956	*Bactrognathus communis* zone	Top 0.3 ft	24	Marble Falls area, 1.4 miles S. 13° W. of north end of bridge over Colorado River at Marble Falls, Burnet County, Tex., along side of road at southwestern edge of road-material pit in Carboniferous outlier.[7]
15574	do	do	*Siphonodella cooperi* zone	0.4–0.7 ft below top	24	Same as collection 15573.
15575	do	do	do	0.7–1.0 ft below top	24	Do.
15576	V. E. Barnes, P. E. Cloud, and others.	May 1, 1951	*Bactrognathus communis* zone	Top 1 ft	25	Doublehorn Creek area, Burnet County, Tex., about 4.2 miles (airline) south-southeast of Marble Falls on E. D. Fowler ranch, 2,400 ft N. 77° W. of Fowler ranch house, 900 ft N. 30° E. of cattle guard on main ranch road at west boundary of Fowler ranch, and in prominent drain at head of earth tank.
15577	do	do	*Gnathodus punctatus* zone	1.0–2.0 ft below top	25	Same as collection 15576.
15578	do	do	do	2.0–3.0 ft below top	25	Do.
15579	W. H. Hass	Mar. 19, 1956	*Bactrognathus communis* zone	Top 0.1 ft	26	Spicewood area in bed of branch of Little Cypress Creek, about 3 miles due west of Spicewood, Burnet County, Tex. (Texas Bureau of Economic Geology locality 27T–6–37A).
15580	do	do	do	1.6–1.85 ft below top	26	Same as collection 15579.
15581	do	do	*Gnathodus punctatus* zone	3.2–3.5 below top	26	Do.
15582	do	Mar. 9, 1956	*Bactrognathus communis* zone	About 5 ft above base	27	Same as collection 9377.
15583	do	do	do	5.4–5.5 ft above base	28	Johnson City area, in bed of Pedernales River near north bank, 0.25 mile west of mouth of Miller Creek and 1.9 miles northeast of type site of Stribling formation at Honeycut Bend, Blanco County, Tex.[8]
15584	do	do	*Gnathodus punctatus* zone	2.0–2.4 ft above base	28	Same as collection 15583.
15585	do	do	*Siphonodella cooperi* zone	Basal 0.3 ft	28	Do.
15586	do	Apr. 12, 1949	Welden limestone	0.3–0.7 ft above base		Cut on abandoned railroad right of way SE¼SW¼NE¼ sec. 27, T. 3 N., R. 6 E., about 6 miles south of Ada, Pontotoc County, Okla.
15587	do	do	do	Basal 0.3 ft		Same as collection 15586.
15588	do	do	Pre-Welden Shale of C. L. Cooper (1939).	Top 0.2 ft		Do.
15589	do	do	do	0.2–0.85 ft below top		Do.
15590	do	do	do	0.85–1.45 ft below top		Do.

[1] See Barnes, Cloud, and Warren, 1945, p. 174–176 and Cloud and Barnes, 1948, pl. 3.
[2] This number in the Carboniferous catalog refers to the same collection as 9340 in the Silurian-Devonian catalog.
[3] See Barnes, Cloud, and Warren, 1947, fig. 3, loc. TF–294.
[4] See Cloud and Barnes, 1948, p. 50.
[4a] See Cloud and Barnes, 1948, p. 316.
[5] Plummer, F. B., 1950, p. 22, 23.
[6] See Barnes, Cloud, and Warren, 1945, fig. 43.
[7] Barnes, 1954, fig. 1.
[8] Cloud and Barnes, 1948, pl. 3.

CLASSIFICATION OF DISJUNCT CONODONTS

Conodonts are the microscopic toothlike and platelike structures of a monophyletic group of extinct marine animals, which presumably were bilaterally symmetrical, soft bodied, and pelagic. They are laminated, composed primarily of calcium phosphate, and usually are either grayish black or light brown. Conodonts are an extremely useful tool of the stratigraphic paleontologist. They definitely range from the Lower Ordovician into the Middle Triassic and possibly range from the Upper Cambrian into the Upper Cretaceous.

At the present time a natural classification cannot be devised, partly because the zoological position of the animal that bore conodonts is unknown and partly because conodont assemblages are extremely scarce and difficult to interpret (an assemblage consists of several different kinds of discrete conodonts presumed to represent parts of one animal). On the other hand, a utilitarian classification based on disjunct specimens is feasible; and several such classifications have been published (Bassler, 1925; Ulrich and Bassler, 1926; Huddle, 1934; and Branson and Mehl, 1944).

The classification herein proposed was first suggested by the author in 1941 (Hass, 1941, p. 80, 81). It is based on the fact that the individual conodont was built up through the accretion of lamellae about the apex or tip of the pulp cavity. Each of these lamellae is open toward the aboral side of the structure, where its free edge is commonly evident as a faint line that encloses the free edges of all previously accreted lamellae. The lamellae, therefore, merely record stages in the development of the conodont structure; and, as seen, all except the aboral side of a complete specimen is merely the exposed surface of the last lamella accreted to the structure before death overtook the conodont-bearing animal. There are many different forms of disjunct conodonts. Individual conodonts having the same general form are commonly grouped together into species, similar species into genera, and like genera into families. This is done within the framework of the Rules of Zoological Nomenclature, although such species, genera, and families are not true biologic categories, in the sense that those terms are used in the classification of most other groups of animals—such as the gastropods, brachiopods, and corals. In time, perhaps, a clear distinction will be made between the terms used in a biologic classification and those used in a utilitarian one.

In the classification herein proposed, the pulp cavity is used as the point of reference for all other parts of a conodont structure, because it represents the area about which the structure was built, and also because it is a visible feature of all true conodonts. The classification, therefore, is concerned with a related group of structures, devoid of all extrinsic fossil fragments; moreover, the classification lends itself to the inclusion of additional categories as more information is accumulated. Inasmuch as all true conodonts have a laminated structure, the suborder Neurodontiformes Branson and Mehl (1944) (proposed for conodonts with a fibrous structure) is not recognized. Conodonts formerly placed in that suborder are herein considered to be specimens whose original lamellar structure has been obscured through alteration.

The many different forms of disjunct conodonts now recognized developed because the lamellae in any conodont were separated from each other along one or more growth axes and in one or more directions (Hass, 1941). This separation of lamellae resulted in the development of fanglike structures (Distacodontidae); fanglike structures with denticles (Belodontidae); denticulated blades and bars (Coleodontidae, Prioniodinidae, and Prioniodontidae); platelike structures with platforms (Polygnathidae); and platelike structures with greatly expanded pulp cavities (Idiognathodontidae). The classification follows:

Order Conodontophorida Eichenberg, 1930

Family Distacodontidae Bassler, 1925

Pulp cavity surmounted by a single, straight or curved, undenticulated fanglike cusp. Lower Ordovician to Upper Silurian, Devonian(?) and Carboniferous(?). Includes *Distacodus* Hinde; *Acodus*, *Acontiodus*, *Drepanodus*, *Oistodus*, *Paltodus*, *Scolopodus*, all of Pander; *Mixoconus* Sweet; *Scandodus* Lindström; *Stereoconus* Branson and Mehl; and *Ulrichodina* Furnish.

Family Belodontidae Huddle, 1934

Pulp cavity surmounted by a single, straight or curved, denticulated, fanglike cusp whose base may be greatly enlarged. Lower Ordovician to Upper Silurian. Includes *Belodus*, *Cordylodus*, both of Pander; *Acanthodus* Furnish; *Microcoelodus* Branson and Mehl; *Ptiloconus* Sweet; and *Strachanognathus* Rhodes.

Family Coleodontidae Branson and Mehl, 1944

Pulp cavity beneath main cusp at or near the anterior end of denticulated bladelike or barlike unit. Lower Ordovician to Middle Triassic.

Subfamily Coleodontinae Branson and Mehl, 1944

Main cusp indistinct, not terminal; anterior bar or blade short. Middle Ordovician to Lower Mississippian (Osage). Includes *Coleodus*, *Bactrognathus*, *Trucherognathus*,

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all of Branson and Mehl; *Arcugnathus* Cooper; *Pravognathus* Stauffer; *Branmehla* Hass, nom. nov. (p. 381) and *Hindeodina* Hass, nom. nov. (p. 382).

Subfamily Hindeodellinae Hass, nov.

Main cusp distinct, not terminal; anterior blade or bar short. Lower(?) Silurian and Upper Silurian to Middle Triassic. Includes *Hindeodella* Bassler; *Cervicornoides* Stauffer; *Kladognathus* Rexroad; *Tripodellus* Sannemann; and *Metaprioniodus* Huddle.

Subfamily Neoprioniodontinae Hass, nov.

Main cusp terminal. Aboral side of posterior bar may be deeply grooved but is not expanded into a concavity. Anticusp, if present, commonly undenticulated but may support nearly or completely fused denticles. Upper Ordovician to Middle Triassic. Includes *Neoprioniodus* Rhodes and Müller, *Leptochirognathus* Branson and Mehl, *Loxodus* Furnish, and *Pachysomia* and *Subprioniodus*, both of Smith.

Subfamily Cyrtoniodontinae Hass, nov.

Main cusp terminal. Aboral side of posterior bar partly or wholly expanded into a concavity. Anticusp, if present, may be denticulated. Ordovician. Includes *Cyrtoniodus*, *Plectodina*, both of Stauffer; *Gothodus*, *Paracordylodus*, both of Lindström; *Holodontus*, *Keislognathus* both of Rhodes; *Phragmodus*, *Zygognathus*, both of Branson and Mehl; and *Periodon* Hadding.

Subfamily Ligonodininae Hass, nov.

Main cusp terminal. Posterior bar or blade may be grooved but is not excavated. Anticusp present, denticulated, well-formed. Middle Ordovician to Lower Triassic. Includes *Ligonodina*, *Euprioniodina*, *Synprioniodina*, all of Bassler; *Hindeodelloides* Huddle; and *Loxognathus* Graves and Ellison.

Subfamily Hibbardellinae Müller, 1956

Main cusp terminal, at apex of denticulated anterior arch. Posterior bar present. Lower Ordovician to Middle Triassic. Includes *Hibbardella*, *Diplododella*, both of Bassler; *Elsonella* Youngquist; *Roundya* Hass; *Tetraprioniodus* Lindström; and *Avignathus* Lys and Serre.

Subfamily Chirognathinae Branson and Mehl, 1944

Main cusp at apex of denticulated arch. Unit tends to be palmate. Middle Ordovician to Upper Devonian. Includes *Chirognathus* Branson and Mehl; *Rhipidognathus* Branson, Mehl, and Branson; and *Scutula* Sannemann.

Subfamily Lonchodininae Hass, nov.

Main cusp at apex of denticulated arch. Unit is not palmate. Lower Ordovician to Middle Triassic. Includes *Lonchodina* Bassler; and *Apatognathus*, *Curtognathus*, *Erismodus*, *Trichonodella*, all of Branson and Mehl.

Family Prioniodinidae Bassler, 1925

Pulp cavity beneath main cusp at or near the posterior end of a denticulated bladelike or barlike unit. Lower Ordovician to Upper Pennsylvanian. Includes *Prioniodina*, *Palmatodella*, *Polygnathellus*, all of Bassler; *Falodus* Lindström; *Gyrognathus* Stauffer; *Metalonchodina*, *Oulodus*, *Subbryantodus*, all of Branson and Mehl; and *Pelekysgnathus* Thomas.

Family Prioniodontidae Bassler, 1925

Pulp cavity in middle third of bladelike or barlike unit. Lower Ordovician to Middle Triassic.

Subfamily Prioniodontinae Bassler, 1925

Main cusp larger than denticles of blade or bar. Denticulated lateral process may be present. Unit is not palmate. Lower Ordovician to Middle Triassic. Includes *Prioniodus* Pander; *Angulodus* Huddle; *Bryantodus* Bassler; *Cardiodella*, *Dichognathus*, *Ozarkodina*, *Plectospathodus*, all of Branson and Mehl; *Geniculatus* Hass; and *Tortoniodus* Stauffer.

Subfamily Spathognathodontinae Hass, nov.

Main cusp inconspicuous or but slightly larger than denticles of either the blade or the bar. Unit is not palmate. Lower Ordovician to Lower Triassic. Includes *Spathognathodus*, *Centrognathodus*, *Pinacognathus*, all of Branson and Mehl; *Aphelognathus* Branson, Mehl, and Branson; *Bryantodina* Stauffer; *Dinodus*, *Elictognathus*, *Nodognathus*, *Oligodus*, all of Cooper; *Falcodus* Huddle; and *Pandorinellina* Hass, nom. nov., herein [for

Pandorina Stauffer, 1940 (not Bory de St. Vincent, 1827; Scacchi, 1833), type species, *Pandorina insita* Stauffer, 1940, and *Lambdaynathus* Rexroad.

Family Polygnathidae Bassler, 1925

Pulp cavity greatly restricted; platforms flank part or all of axis. Middle Ordovician to Middle Triassic. Includes *Polygnathus* Hinde; *Ambalodus, Amorphognathus, Ancyrognathus, Doliognathus, Nothognathella, Polygnathoides, Polylophodonta, Pseudopolygnathus, Scaliognathus, Siphonodella, Staurognathus*, all of Branson and Mehl; *Ancyrodella, Palmatolepis*, both of Ulrich and Bassler; *Gnathodella* Matern; *Gondolella* Stauffer and Plummer; *Panderodella* Bassler; *Scyphiodus* Stauffer; *Ctenopolygnathus* Müller and Müller; and *Mestognathus* Bischoff.

Family Idiognathodontidae Harris and Hollingsworth, 1933

Pulp cavity not greatly restricted, so that aboral side of unit is partly or entirely opened up into a large concavity; platforms may flank part or all of axis. Upper Ordovician to Middle Permian.

Subfamily Idiognathodontinae Harris and Hollingsworth, 1933

Blade present, denticulated, well-formed; expanded pulp cavity restricted, more or less, to the anterior end of the unit. Middle Silurian to Middle Permian. Includes *Idiognathodus* Gunnell; *Cavusgnathus, Idiognathoides*, both of Harris and Hollingsworth; *Gnathodus* Pander; *Streptognathodus* Stauffer and Plummer; *Taphrognathus* Branson and Mehl; *Kockelella* Walliser; and *Dollymae* Hass, nom. nov. (p. 394).

Subfamily Balognathinae Hass, nov.

Blade present; aboral side excavated. Upper Ordovician. Includes *Balognathus, Icriodella*, both of Rhodes.

Subfamily Icriodontinae Müller and Müller, 1957

Blade poorly developed or entirely absent; aboral side excavated or nearly so. Lower Silurian to Upper Devonian. Includes *Icriodus* Branson and Mehl; and *Icriodina* Branson and Branson.

Incertae sedis

Genera included in this division are not classified as to family because, being based on inadequate material, their relationships are indeterminable. Lower Ordovician to Middle Triassic. Includes *Cornuramia* Smith; *Distamodus* Branson and Branson; *Lonchodus* Pander; *Neocoleodus, Polycaulodus*, both of Branson and Mehl; *Nericodus, Trapezognathus*, both of Lindström; *Ptilognathus* Elias; *Sagittodontus* Rhodes; and *Scotlandia* Cossmann.

INVALID GENERIC NAMES AND JUNIOR SYNONYMS OF DISJUNCT CONODONTS

Acodina Stauffer, 1940 [=*Acontiodus* Pander, 1856].

Ancyroides Miller and Youngquist, 1947 [=*Ancyrognathus* Branson and Mehl, 1934].

Ancyropenta Müller and Müller, 1957 [=*Ancyrodella* Ulrich and Bassler, 1926].

Barbarodina Stauffer, 1935 [=*Cyrtoniodus* Stauffer, 1935].

Cardiodus Branson and Mehl, 1933 [not *Cardiodus* Trouessart, 1881] [=*Cardiodella* Branson and Mehl, 1944].

Centrodus Pander, 1856 [not *Centrodus* Giebel, 1847; McCoy, 1848] [=*Lonchodus* Pander, 1856].

Centrognathus Branson and Mehl, 1933 [not *Centrognathus* Guérin-Méneville, 1840] [=*Centrognathodus* Branson and Mehl, 1944].

Cladognathus Rexroad, 1956 [not *Cladognathus* Burmeister, 1847] [=*Kladognathus* Rexroad, 1958].

Ctenognathus Pander, 1856 [not *Ctenognathus* Fairmaire, 1843] [=*Spathognathodus* Branson and Mehl, 1941].

Deflectolepis Müller, 1956 [=*Panderodella* Bassler, 1925].

Dryphenotus Cooper, 1939 [=*Gnathodus* Pander, 1856].

Ellisonia Müller, 1956 [=*Hibbardella* Bassler, 1925].

Eoligonodina Branson, Mehl, and Branson, 1951 [=*Zygognathus* Branson, Mehl, and Branson, 1951].

Hamulosodina Cooper, 1931 [=*Ligonodina* Bassler, 1925].

Heterognathus Stauffer, 1935 [not *Heterognathus* Girard, 1854; Schmarda, 1859; King, 1864; Rey, 1888] [=*Pravognathus* Stauffer, 1936].

Idioprioniodus Gunnell, 1933 [=*Ligonodina* Bassler, 1925].

Ligonodinoides Stauffer, 1938 [=*Palmatodella* Bassler, 1925].

Machairodia Smith, 1907 [=*Distacodus* Hinde, 1879, objective].

Machairodus Pander, 1856 [not *Machairodus* Kaup, 1833] [=*Distacodus* Hinde, 1879].

Macropolygnathus Cooper, 1939 [=*Polygnathus* Hinde, 1879].

Manticolepis Müller, 1956 [=*Palmatolepis* Ulrich and Bassler, 1926].

Mehlina Youngquist, 1945 [=*Spathognathodus* Branson and Mehl, 1941].

Multioistodus Cullison, 1938 [=*Belodus* Pander, 1856].

Neocordylodus Cooper, 1939 [=*Ligonodina* Bassler, 1925].

Oepikodus Lindström, 1954 [=*Tetraprioniodus* Lindström, 1954].

Oneotodus Lindström, 1954 [=*Drepanodus* Pander, 1856].

Pandorina Stauffer, 1940 [not *Pandorina* Bory de St. Vincent, 1827; Scacchi, 1833] [=*Pandorinellina* Hass, nov. nom. (p. 378)].

Pinacodus Branson and Mehl, 1934 [not *Pinacodus* Davis, 1883] [=*Pinacognathus* Branson and Mehl, 1944].

Polygnathodella Harlton, 1933 [=*Idiognathoides* Harris and Hollingsworth, 1933].

Polyplacognathus Stauffer, 1935 [=*Amorphognathus* Branson and Mehl, 1933].

Prioniodella Bassler, 1925 [=*Prioniodina* Bassler, 1925].

Pteroconus Branson and Mehl, 1933 [not *Pteroconus* Hinde *in* Fox, 1900] [=*Ptiloconus* Sweet, 1955].

Rosagnathus Rhodes, 1955 [=*Tetraprioniodus* Lindström, 1954].

Siphonognathus Branson and Mehl, 1934 [not *Siphonognathus* Richardson, 1858] [=*Siphonodella* Branson and Mehl, 1944].

Solenodella Branson and Mehl, 1944 [=*Elictognathus* Cooper, 1939].

Solenognathus Branson and Mehl, 1934 [not *Solenognathus* Agassiz, 1846; Bleeker, 1856–57; Pictet and Humbert, 1866] [=*Elictognathus* Cooper, 1939].

Spathodus Branson and Mehl, 1933 [not *Spathodus* Boulenger, 1900] [=*Spathognathodus* Branson and Mehl, 1941].

Subcordylodus Stauffer, 1935 [=*Plectodina* Stauffer, 1935].

Telumodina Cooper, 1931 [=*Palmatodella* Bassler, 1925].

Trichognathus Branson and Mehl, 1933 [not *Trichognathus* Berthold, 1827; Gemminger and Harold, 1868] [=*Trichonodella* Branson and Mehl, 1948].

Valentia Smith, 1907 [not *Valentia* Stöl, 1856; Smith, 1901] [=*Scotlandia* Cossmann, 1909].

Below are listed the type species of three genera proposed by Bassler in 1925, together with their lectotypes:

Bryantodus Bassler, 1925; type species, *Bryantodus typicus* Ulrich and Bassler, 1926; lectotype, the specimen figured by Ulrich and Bassler, 1926, as figure 11 on plate 6.

Euprioniodina Bassler, 1925; type species, *Euprioniodina deflecta* Ulrich and Bassler, 1926; lectotype, the specimen figured by Ulrich and Bassler, 1926, as figure 11 on plate 3.

Polygnathellus Bassler, 1925; type species, *Polygnathellus typicalis* Ulrich and Bassler, 1926; lectotype, the specimen figured by Ulrich and Bassler, 1926, as figure 1 on plate 1.

SYSTEMATIC DESCRIPTIONS

In the following descriptions, the blade of a platelike conodont is considered as being posterior to the pulp cavity and the carina as being anterior to the same structure. This orientation is contrary to that in general use, but is followed herein because the blade of a platelike conodont appears to have evolved out of the posterior blade, bar, or limb of a compound conodont, whereas the carina appears to have evolved out of the anterior blade, bar, or limb. For example, the blade and carina of *Polygnathus* compare favorably with the posterior and anterior blades respectively of *Spathognathodus*, and the blade and carina of *Staurognathus* resemble the posterior and anterior bars respectively of *Bactrognathus* and *Hindeodella*.

The specimens described and illustrated in this paper have been deposited in the U. S. National Museum.

Family COLEODONTIDAE Branson and Mehl, 1944

Subfamily COLEODONTINAE Branson and Mehl, 1944

Genus BACTROGNATHUS Branson and Mehl, 1941

1941. *Bactrognathus* Branson and Mehl, Jour. Paleontology, v. 15, p. 98.

Type species, by original designation, *Bactrognathus hamata* Branson and Mehl, 1941.

Bactrognathus communis Hass, n. sp.

Plate 46, figures 20, 25–27, 30, 31

Holotype.—USNM 115051.

Paratypes.—USNM 115048, 115049, 115050, 115052, 115053.

Locality.—C–18, at base of bluff on Honey Creek, about 2,800 feet N. 24° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9304.

Oral view.—Posterior bar generally twice as long as anterior bar, compressed, erect, straight, and thickest along or just below midline of lateral sides. Denticles of posterior bar partly or entirely fused. Anterior bar resembles posterior bar, but flexed inward as much as 90° just anterior to pulp cavity. Anterior bar of some specimens concave toward outer side of fossil and twisted so that inner side is inclined toward posterior end of fossil. Outer lateral expansion of pulp cavity commonly larger than inner one, somewhat asymmetric, and directed slightly toward posterior end of fossil. Oral surface of each lateral expansion with one or more nodes; with several nodes common alinement is along midline of expansion.

Lateral view.—Aboral edge curved downward at distal end of posterior bar. Summit line of fossil even or toothed, and highest at anterior and posterior extremities.

Aboral view.—Groove along midline of fossil gradually widens toward pulp cavity. Surface of lateral expansions of pulp cavity concave but not grooved along midline.

Bactrognathus communis is a common and characteristic fossil of the upper faunal zone of the Chappel limestone to which it therefore lends its name. The species is distinguished from *Bactrognathus excavata* Branson and Mehl through the ornamentation of the lateral expansions of the pulp cavity. According to Branson and Mehl (1941b, p. 99) their species has one "sharp node on the inner [outer] side close to the blade" whereas *B. communis* has one or more nodes on the inner as well as on the outer expansion.

A few specimens of *Bactrognathus communis* have been found in collections from the *Gnathodus punctatus* zone.

Bactrognathus penehamata Hass, n. sp.

Plate 46, figures 22, 23, 29

Holotype.—USNM 115055.

Paratypes.—USNM 115054, 115056.

Locality.—C–13, Whites Crossing, approximately 8.3 miles (airline) southwest of courthouse at Mason, Mason County, Tex. Collection 9303.

Oral view.—Posterior bar generally twice as long as anterior bar, erect, straight to slightly bowed outward, and thickest at or just below midline of lateral sides. Lateral sides may flare adjacent to aboral side. Some denticles of posterior bar completely fused but most have sharp-edged tips. Anterior bar resembles posterior bar but is less massive and flexed inward approximately 45° just anterior to pulp cavity. Lips of pulp cavity very small.

Lateral view.—Aboral edge curved downward at distal end of posterior bar. Summit line of fossil uneven; highest above pulp cavity.

Aboral view.—Groove along midline of posterior bar gradually widens toward pulp cavity, but that of anterior bar quite narrow.

Bactrognathus penehamata is a characteristic fossil of the *Bactrognathus communis* faunal zone; a few specimens of this species, however, have been found in the underlying *Gnathodus punctatus* zone. *B. penehamata* is distinguished from *B. hamata* Branson and Mehl through the characteristics of the aboral side of the anterior bar. According to Branson and Mehl (1941b, p. 99) the "posterior-lateral flexure" [anterior bar] of *B. hamata* has a "wide shallow trough" whereas the anterior bar of *B. penehamata* has a very narrow groove.

Genus BRANMEHLA Hass, n. gen.

Type species, here designated, *Spathodus inornatus* Branson and Mehl, 1934.

Bladelike unit whose pulp cavity is near anterior end of unit. Main cusp indistinct; denticles of blade closely set. Anterior end of unit may be flexed inward slightly. Aboral side narrow. Lips of pulp cavity may be prominent.

Branmehla differs from *Spathognathodus* in that the pulp cavity is near the anterior end of the unit instead of being more or less equidistant from the anterior and posterior extremities.

Two species of *Branmehla*—*B. inornata* (Branson and Mehl) and *B. disparilis* (Branson and Mehl)—have been recognized in collections from the Chappel limestone. Both of these species, which were formerly assigned to the genus *Spathognathodus*, are considered to have been reworked into the Chappel, as the natural stratigraphic range of *B. inornata* is believed to be high Upper Devonian to lowermost Mississippian; and that of *B. disparilis* to be high Upper Devonian. Other species assigned to the new genus were formerly called: *Spathognathodus flexus* Thomas, *Spathognathodus mediocris* (Branson and Mehl), and *Spathognathodus praelongus* Cooper.

Branmehla inornata (Branson and Mehl)

Plate 50, figure 3

1934. *Spathodus inornatus* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 3, p. 185, pl. 17, fig. 23. Grassy Creek shale, Marion County, Mo. (Date of imprint, 1933.)

1934. *Spathodus fissilis* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 3, p. 185, pl. 17, fig. 10. Grassy Creek shale, Marion County, Mo. (Date of imprint, 1933.)

1934. *Spathodus rectus* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 3, p. 186, pl. 17, fig. 24. Grassy Creek shale, Callaway County, Mo. [Date of im print, 1933.]

1943. *Spathodus inornatus* Branson and Mehl. Cooper, *in* Cooper and Sloss, Jour. Paleontology, v. 17, p. 175, pl. 28, fig. 9. Core from Steveville Oil field, Alberta, Canada.

1956. [Not] *Spathognathodus inornatus* (Hass). Elias, *in* Petroleum Geology of southern Oklahoma, p. 119, pl. 3, figs. 37–39(=*Gnathodus inornatus* Hass).

1956. [Not] *Spathognathodus* cf. *S. inornatus* (Hass). Elias, *in* Petroleum Geology of southern Oklahoma, p. 119, pl. 3, figs. 41, 42, 62, 63 (=?*Gnathodus* sp.)

1956. *Spathognathodus inornatus* (Branson and Mehl). Hass, U. S. Geol. Survey Prof. Paper 286, pl. 3, figs. 22–24. Upper faunal zone of Gassaway member of Chattanooga shale, central Tennessee.

1956. *Spathognathodus inornatus* (Branson and Mehl). Bischoff and Ziegler, Notizblatt hessisch. Landesamtes f. Bodenforsch. zu Wiesbaden, v. 84, p. 166, pl. 13, figs. 4–6, 12. Zone to V- to VI, Germany.

1957. *Spathognathodus inornatus* (Branson and Mehl). Cloud, Barnes, and Hass, Geol. Soc. America Bull., v. 68, pl. 5, fig. 2. Houy formation, Texas.

Hypotype.—USNM 115120.

Locality.—C–29, Johnson City area, about 5 miles (airline) south-southwest of Cypress Mill, and 0.75 mile northeast of Elm Pool, Blanco County, Tex. Collection 9264.

Oral view.—Elongate bladelike unit; tends to be bowed inward slightly; thickest along midline of lateral sides and broadest adjacent to pulp cavity from where it tapers toward extremities. Posterior blade approximately three times longer than anterior blade; its denticles increase in height anteriorly, appressed nearly to their sharp-edged tips, biconvex in horizontal section, with outer side of each denticle slightly thicker than inner. Each lateral expansion of pulp cavity small, semicircular in outline, with smooth oral surface. Denticles of anterior blade resemble those of posterior blade; decreasing in height toward distal end of unit. Main cusp similar to adjacent denticles of blade.

Lateral view.—Summit line of unit dentate and somewhat arched above pulp cavity.

Aboral view.—Aboral side narrow, grooved along midline. Pulp cavity elliptical in outline with longer direction transverse to midline of fossil; outer lip of pulp cavity slightly larger than inner one.

Genus HINDEODINA Hass, n. gen.

Type species, here designated, *Hindeodina simplaria* Hass, n. sp.

Elongate bladelike or barlike unit; anterior bar may be flexed inward. Main cusp aborted, indistinct, distinguished from bar denticles only through position above pulp cavity. Bar denticles may be of more than of one size. Greater part of aboral side sharp edged. Lips of pulp cavity either absent or extremely small.

Hindeodina differs from *Hindeodella* and *Cervicornoides* in having an aborted main cusp instead of a large, well-developed one. It is more elongate than either *Branmehla* or *Coleodus*; and is distinguished from *Bactrognathus* in having a sharp-edged aboral side and, at most, only extremely small lips for its pulp cavity.

Two species of *Hindeodina*—*H. simplaria* and *H. uncata*—have been found in the author's collections from the Chappel limestone. Both of these species appear to range throughout the Chappel, although neither one is represented in the collections by many specimens. Other species assigned to the new genus were formerly called: *Hindeodella compressa* Huddle, and *Hindeodella elongata* Huddle.

Hindeodina simplaria Hass, n. sp.

Plate 48, figure 17

Holotype.—USNM 115010.

Locality.—C–16, about 2,100 feet due west of point at which Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Compressed ribbonlike unit with posterior bar even more than five time longer than anterior bar. Posterior bar bowed inward.

Lateral view.—Denticles of posterior bar directed posteriorly, closely set, and of two sizes. Larger sized denticles curved inward, pointed, and biconvex in horizontal section with inner side of each denticle thickened so that it appears offset toward inner side of smaller sized denticles. Smaller sized denticles needlelike; two to four of them separate adjacent larger sized denticles. Main cusp aborted, distinguished from larger sized denticles only through its position above pulp cavity. Anterior bar flexed inward and directed downward with reference to posterior bar. Its denticles resemble the larger sized ones of the posterior bar but are less thick on inner side.

Aboral view.—Aboral side sharp edged except adjacent to pulp cavity where midline is grooved. Pulp cavity small.

The aborted main cusp distinguishes *Hindeodina simplaria* from all species of *Hindeodella*. The species here described is more compressed than *Hindeodina uncata*; its anterior bar, also, is not flexed inward nearly so much as is the anterior bar of that species.

Hindeodina simplaria ranges throughout the Chappel limestone but is not a common species.

Hindeodina uncata Hass, n. sp.

Plate 47, figure 6

Holotype.—USNM 115006.

Locality.—C–15, about 2,500 feet N. 88° W. of southwest bank of Llano River, at Whites Crossing, Mason County, Tex. Collection 9301.

Oral view.—Barlike unit with anterior bar angled inward approximately 90°. Posterior bar as much as five times longer than anterior bar, straight or slightly bowed inward, broadest near main cusp, and tapered to compressed posterior end.

Lateral view.—Denticles of posterior bar closely set, directed posteriorly, and of two sizes. Larger sized denticles compressed, curved inward, pointed, and biconvex in horizontal section with inner side thicker than outer side. Generally, several smaller sized needlelike denticles present between adjacent larger sized denticles. Main cusp aborted, distinguished from larger sized denticles only by its position above pulp cavity. Anterior bar compressed, less massive than posterior bar; some of its denticles tend to be directed toward distal end of anterior bar but in other respects resemble those of posterior bar.

Aboral view.—Aboral side sharp edged except at anterior end of posterior bar of large specimen where midline is grooved. Pulp cavity small.

The aborted main cusp distinguishes *Hindeodina uncata* from those species of *Hindeodella* whose anterior bar is angled inward approximately 90°.

Hindeodina uncata ranges throughout the Chappel limestone; the species is not common.

Subfamily HINDEODELLINAE Hass, nov. (p. 378)

Genus HINDEODELLA Bassler, 1925

1925. *Hindeodella* Bassler, Geol. Soc. America Bull., v. 36, p. 219.

1926. *Hindeodella* Bassler. Ulrich and Bassler, U. S. Natl. Mus. Proc., v. 68, art. 12, p. 17, 38, 39.

Type species, by original designation, *Hindeodella subtilis* Ulrich and Bassler, 1926; lectotype, specimen figured by Ulrich and Bassler, 1926, as figure 17 on plate 8.

Hindeodella fragilis Hass, n. sp.

Plate 48, figures 18, 21, 26

Holotype.—USNM 115023.

Paratypes.—USNM 115024, 115025.

Localities.—Holotype, and paratype 115025: C–15, about 2,500 feet N. 88° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex. Collection 9301. Paratype 115024: C–16, about 2,100 feet due west of point at which Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Fragile barlike unit with part of anterior bar flexed inward approximately 90°. Posterior bar may be more than 10 times longer than anterior bar; straight to slightly curved inward, higher than wide, elliptical in transverse section and tapered toward compressed posterior end.

Lateral view.—Denticles of posterior bar closely set, directed posteriorly, and of two sizes. Larger sized denticles curved inward, pointed and biconvex in horizontal section. Generally 2 to 4 smaller sized, needlelike denticles separate adjacent larger sized ones. Main cusp several times larger but in other respects similar to larger sized denticles. Anterior bar produced into pointed extremity below remainder of fossil; angled downward just anterior to main cusp with inward flexure of bar located a short distance beyond main cusp. Denticles of anterior bar erect, discrete, and pointed; decrease in size anteriorly on inwardly flexed portion of bar.

Aboral view.—Aboral side sharp edged except by pulp cavity where it is grooved. Pulp cavity small.

Hindeodella fragilis ranges throughout the Chappel limestone. The characteristics of the anterior bar distinguish *H. fragilis* from other species of the genus.

Subfamily NEOPRIONIODONTINAE Hass, nov. (p. 378)

Genus NEOPRIONIODUS Rhodes and Müller, 1956

1956. *Neoprioniodus* Rhodes and Müller, Jour. Paleontology, V. 30, p. 698, 699.

Type species, by original designation, *Prioniodus conjunctus* Gunnell.

Neoprioniodus insolitus Hass, n. sp.

Plate 48, figures 19, 22

Holotype.—USNM 115020.

Paratype.—USNM 115019.

Locality.—C–16, about 2,100 feet due west of point at which Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Posterior bar straight or curved inward except at distal end where it is flexed outward; bar of young specimen compressed but that of mature specimen greatly thickened on inner side.

Lateral view.—Basal portion of inner side of posterior bar beveled. Bar denticles either erect or directed slightly toward posterior or anterior end; denticles closely set, biconvex in horizontal section with inner side thicker than outer. Main cusp directed forward, pointed, biconvex in horizontal section with inner side expanded, especially in basal part. Anticusp short, rounded, and flexed outward slightly.

Aboral view.—Aboral side sharp edged except adjacent to pulp cavity where it may be faintly grooved. Pulp cavity small, located mainly on inner side of midline of fossil.

Specimens of *Neoprioniodus insolitus* have been found in all three faunal zones of the Chappel limestone.

Neoprioniodus lanceolatus Hass, n. sp.

Plate 46, figures 1, 2, 8

Holotype.—USNM 115040.

Paratypes.—USNM 115039, 115041.

Localities.—Holotype: C–12, about 5,000 feet N. 60° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9393. Paratypes: C–14, about 3,200 feet S. 14° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex. Collection 9305.

Oral view.—Posterior bar compressed, bladelike, straight.

Lateral view.—Denticles of posterior bar needlelike, directed slightly forward, appressed to near their pointed tips. Main cusp pointed, very slender, and biconvex in horizontal section, with inner side somewhat enlarged adjacent to posterior bar. Main cusp directed forward with reference to posterior bar; anticusp located beneath anterior end of posterior bar; main cusp also bowed inward slightly at tip and outward slightly at pointed extremity of anticusp.

Aboral view.—Aboral side of unit grooved, broadly so beneath anticusp. Pulp cavity small.

This species resembles *Neoprioniodus corniger* (E. R. Branson) from the Hannibal shale of Missouri. However, the outer side of the posterior bar of the species from Missouri extends below the level of the inner side of the bar, a characteristic that is not present in *Neoprioniodus lanceolatus*. *N. lanceolatus* differs from *Neoprioniodus singularis* (Hass) from the Barnett formation of Texas in having the aboral side of the anticusp broadly grooved instead of beveled.

Neoprioniodus lanceolatus appears to be restricted to the *Bactrognathus communis* zone of the Chappel limestone.

Neoprioniodus oligus (Cooper)

Plate 47, figure 3

1939. *Prioniodus oligus* Cooper, Jour. Paleontology, v. 13, p. 405, pl. 46, figs. 9–11, 63, 71; pl. 47, figs. 20, 21. Pre-Welden shale interval of Cooper (1939), Pontotoc County, Okla.

1957. *Prioniodina oliga* (Cooper). Bischoff, Abh. hessisch. Landesamtes f. Bodenforsch. zu Wiesbaden., v. 19, p. 47, 48. Zone cu III, Germany.

Hypotype.—USNM 115159.

Locality.—C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. Collection 9307.

Oral view.—Posterior bar widest along aboral side and thicker on inner side of midline of unit than on outer side.

Lateral view.—Denticles normal to posterior bar, curved inward, compressed, and may be completely fused into ribbonlike structure that merges into main cusp. Large main cusp directed slightly forward with reference to posterior bar; its extremities pointed and anterior and posterior sides sharp edged. Basal part of inner side of main cusp enlarged adjacent to posterior bar.

Aboral view.—Pulp cavity large; apex adjacent to posterior bar.

Cooper (1939, p. 405) has placed *Prioniodus* sp. B of Roundy, 1926, from the Barnett formation of Texas, in synonymy with his *Neoprioniodus oligus* but the present author would place Roundy's species in *Neoprioniodus roundyi* (Hass). According to the author (Hass, 1953, p. 88), *N. roundyi* "differs from *P. oligus* [*N. oligus*] as follows: the anterior side of the cusp of *P. roundyi* [*N. roundyi*] is faintly sigmoid in lateral view and its inner side is not greatly enlarged adjacent to the posterior bar, whereas the anterior side of the cusp of *P. oligus* [*N. oligus*] is commonly convex in lateral view and its inner side is enlarged adjacent to the posterior bar."

Neoprioniodus oligus has been found in collections from the *Bactrognathus communis* and *Gnathodus punctatus* zones.

Subfamily LIGONODININAE Hass, nov. (p. 378)

Genus LIGONODINA Bassler, 1925

1925. *Ligonodina* Bassler, Geol. Soc. America Bull., v. 36, p. 218.

1926. *Ligonodina* Bassler. Ulrich and Bassler, U. S. Natl. Mus. Proc., v. 68, art. 12, p. 8, 12, 13.

1933. *Idioprioniodus* Gunnell, Jour. Paleontology, v. 7, p. 265.

Type species, by original designation, *Ligonodina pectinata* Ulrich and Bassler, 1926; lectotype, specimen figured by Ulrich and Bassler, 1926, as figure 10 on plate 2.

Ligonodina singularis Hass, n. sp.

Plate 46, figures 14–17

Holotype.—USNM 115154.

Paratypes.—USNM 115152, 115153, 115155.

Localities.—Holotype: C–16, about 2,100 feet due west of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9314. Paratypes: C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. Specimens 115152 and 115155 from collection 9357; specimen 115153 from collection 9307.

Oral view.—Posterior bar emerges without offset from main cusp.

Lateral view.—Denticles of posterior bar either erect or directed posteriorly. Base of main cusp of large specimen may be expanded. Two sharp edges—one anterior, one posterior—divide cusp into larger outer side and smaller inner one. Anterior sharp edge, at tip of main cusp, located along front side of unit but toward base of cusp; anterior sharp edge, located along inner side. Behind this sharp edge, inner side may be grooved. Anticusp approximately half as long as main cusp and directed downward about 90° with reference to posterior bar. Viewed from inner side, anticusp has linguiform outline and flares along aboral side. Anticusp supports 3 to 5 discrete denticles; denticles directed upward and backward, biconvex in horizontal section with inner side of each slightly thicker than outer side.

Anterior view.—Anticusp distinctly set off from basal portion of main cusp.

Aboral view.—Aboral side of posterior bar tends to be even; that of anticusp either even or rounded. Pulp cavity large, occupying entire underside of main cusp.

Ligonodina singularis ranges throughout the Chappel limestone but is most abundant in the *Bactrognathus communis* and *Gnathodus punctatus* faunal zones.

Subfamily HIBBARDELLINAE Müller, 1956

Genus ROUNDYA Hass, 1953

1953. *Roundya* Hass, U. S. Geol. Survey Prof. Paper 243–F, p. 88, 89.

Type species, by original designation, *Roundya barnettana* Hass, 1953.

Roundya sp. A

Plate 46, figures 9, 10

Hypotypes.—USNM 115037, 115038.

Localities.—C–18, at base of bluff on Honey Creek, about 2,800 feet N. 24° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Specimen 115037 from collection 9304. C–14, about 3,200 feet S. 14° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex. Specimen 115038 from collection 9305.

Roundya sp. A is based on fragmentary specimens. Main cusp divided by sharp-edged lateral ridges into smaller anterior side and larger posterior side. Main cusp flexed posteriorly just above base and slightly rounded adjacent to posterior bar. Limbs of anterior arch trend slightly to anterior of main cusp. Aboral side of each limb, even with faint groove along midline. Denticles of anterior arch discrete, curved upward and backward, circular to elliptical in horizontal section. Pulp cavity occupies entire underside of main cusp.

Roundya sp. A ranges throughout the Chappel limestone.

Roundya sp. B

Plate 46, figure 11

Hypotype.—USNM 115046.

Locality.—C–18, at base of bluff on Honey Creek, about 2,800 feet N. 24° W. of point at which Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9304.

Main cusp pointed, curved posteriorly, compressed. Anterior arch small, fragile, joined to base of anterior side of main cusp. Each limb of arch short, higher than wide, tapered to pointed extremity, and curved slightly toward posterior end of unit. Denticles of anterior arch small, discrete, pointed, directed upward and curved backward. Posterior bar emerges from main cusp without offset; higher than wide in transverse section. Aboral side of fossil broadly grooved. Pulp cavity occupies underside of main cusp with apex near anterior end of concavity.

Roundya sp. B has been found in collections from the *Bactrognathus communis* and *Gnathodus punctatus* zones.

Family PRIONIODINIDAE Bassler, 1925

Genus SUBBRYANTODUS Branson and Mehl, 1934

1934. *Subbryantodus* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 4, p. 285. (Date of imprint, 1933.)

Type species, by original designation, *Subbryantodus arcuatus* Branson and Mehl, 1934.

Subbryantodus radians Branson and Mehl

Plate 48, figures 25, 29

1938. *Subbryantodus radians* Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 141, pl. 34, figs. 22, 23. Chouteau limestone, Montgomery County, Mo.

1939. *Subbryantodus angulatus* Cooper, Jour. Paleontology, v. 13, p. 416, pl. 45, figs. 11, 12, 15, 16. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1947. [Not] *Subbryantodus radians* Branson and Mehl. Bond, Ohio Jour. Sci., v. 47, no. 1, p. 36, pl. 2, fig. 13. Huron member of the Ohio shale, Franklin County, Ohio.

Hypotypes.—USNM 115008, 115009.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Unit compressed, broadest adjacent to pulp cavity; tapering from there toward extremities of fossil. Anterior and posterior blades straight to slightly curved inward.

Lateral view.—Posterior blade shorter than anterior blade which is commonly angled downward more than 45° with reference to posterior blade. Denticles of posterior blade short, normal to blade, curved inward

slightly, closely set, pointed, biconvex in horizontal section; denticles of anterior blade resembling those of posterior blade but larger and commonly curved throughout their length. Apical denticle pointed, compressed, curved posteriorly, and biconvex in horizontal section.

Aboral view.—Aboral side broadly grooved along midline of unit. Pulp cavity prominent, elliptical in horizontal section with longer direction making an acute angle with inner side of posterior blade.

Subbryantodus radians ranges throughout the Chappel limestone; it is quite rare.

Family PRIONIODONTIDAE Bassler, 1925

Subfamily PRIONIODONTINAE Bassler, 1925

Genus OZARKODINA Branson and Mehl, 1933

1933. *Ozarkodina* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 1, p. 51.

Type species, by original designation, *Ozarkodina typica* Branson and Mehl, 1933.

Ozarkodina, sp. A

Plate 47, figures 4, 5

Hypotypes.—USNM 115160, 115161.

Locality.—C–15, about 2,500 feet N. 88° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex. Collection 9301.

Oral view.—Unit bowed inward slightly, thickest adjacent to pulp cavity, tapering from there to extremities.

Lateral view.—Anterior limb longer than posterior limb and directed downward with reference to it. Both limbs thickest near oral side. Denticles of posterior limb erect or directed backward slightly, closely set, subequal in size, pointed, biconvex in horizontal section. Denticles of anterior limb resembling those of posterior limb but tending to be slightly larger. Apical denticle larger but in other respects similar to limb denticles. Restoration and suppression of denticles common. Small lips flank pulp cavity.

Aboral view.—Unit broadest adjacent to pulp cavity and grooved along midline.

Ozarkodina sp. A is rather common in the *Gnathodus punctatus* faunal zone; it is less common in the *Bactrognathus communis* zone, and extremely scarce in the *Siphonodella cooperi* zone.

Subfamily SPATHOGNATHODONTINAE Hass, nov. (p. 378)

Genus ELICTOGNATHUS Cooper, 1939

1934. *Solenognathus* Branson and Mehl [not Agassiz, 1846; Bleeker, 1856–1857; Pictet and Humbert, 1866], Missouri Univ. Studies, v. 8, no. 4, p. 270, 271. [Date of imprint, 1933.]

1939. *Elictognathus* Cooper, Jour. Paleontology, v. 13, p. 386, 387.

1944. *Solenodella* Branson and Mehl, *in* Shimer and Shrock, Index fossils of North America, p. 244.

1948. *Solenodella* Branson and Mehl. Branson and Mehl, Jour. Paleontology, v. 22, p. 527.

Type species, by original designation, *Solenognathus bialata* Branson and Mehl, 1934.

Elictognathus lacerata (Branson and Mehl)

Plate 49, figures 1-8, 12

1934. *Solenognathus lacerata* E. B. Branson and Mehl, Missouri Univ. Studies, v. 8, no. 4, p. 271, pl. 22, figs. 5, 6. [Date of imprint, 1933.] Bushberg sandstone member of the Sulphur Springs formation, Ste. Genevieve County, Mo.

1934. *Solenognathus costata* E. R. Branson, Missouri Univ. Studies, v. 8, no. 4, p. 332, pl. 27, fig. 7. [Date of imprint, 1933.] Hannibal shale, Marion County, Mo.

1934. *Solenognathus tenera* E. R. Branson, Missouri Univ. Studies, v. 8, no. 4, p. 332, 333, pl. 27, fig. 8. [Date of imprint, 1933.] Hannibal shale, Marion County, Mo.

1934. *Bryantodus camurus* Huddle, Bull. Am. Paleontology, v. 21, no. 72, p. 68, 69, pl. 2, figs. 6–9. Upper part of New Albany shale [considered by author of present paper to have come either from Campbell's (1946) Henryville formation or from Campbell's Falling Run member of his Sanderson formation], southern Indiana.

1934. *Bryantodus microdens* Huddle, Bull. Am. Paleontology, v. 21, no. 72, p. 69, pl. 2, fig. 10. Upper part of New Albany shale [considered by author of present paper to have come either from Campbell's (1946) Henryville formation or from Campbell's Falling Run member of his Sanderson formation], southern Indiana.

1938. *Solenognathus lacerata* E. B. Branson and Mehl. Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 131, pl. 33, fig. 27. Bushberg sandstone member of the Sulphur Springs formation, Ste. Genevieve County, Mo.

1938. *Solenognathus tenera* E. R. Branson. E. B. Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 140, pl. 34, fig. 14. Chouteau limestone, Montgomery County, Mo.

1939. *Solenognathus amphelicta* Cooper, Jour. Paleontology, v. 13, p. 410, pl. 44, figs. 10–12. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus anida* Cooper, Jour. Paleontology, v. 13, p. 410, pl. 44, figs. 46–48. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus anomala* Cooper, Jour. Paleontology, v. 13, p. 410, pl. 44, figs. 15–17. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus anomaloda* Cooper, Jour. Paleontology, v. 13, p. 410, pl. 44, figs. 27–29. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus araia* Cooper, Jour. Paleontology, v. 13, p. 410, pl. 44, figs. 31, 32. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus costata* E. R. Branson. Cooper, Jour. Paleontology, v. 13, p. 410, 411, pl. 44, figs. 33–35. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus eura* Cooper, Jour. Paleontology, v. 13, p. 411, pl. 44, figs. 7–9. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus lacerata* Branson and Mehl. Cooper, Jour. Paleontology, v. 13, p. 411, pl. 44, fig. 30. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus macra* Cooper, Jour. Paleontology, v. 13, p. 411, 412, pl. 44, figs. 13, 14. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Solenognathus tenera* E. R. Branson. Cooper, Jour. Paleontology, v. 13, p. 412, pl. 44, figs. 36, 37. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1941. *Solenognathus* sp. Hass, Jour. Paleontology, v. 15, pl. 13, figs. 3, 4, 7. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1949. *Pinacognathus? deflecta* Youngquist and Patterson, Jour. Paleontology, v. 23, p. 60, pl. 15, fig. 5. Prospect Hill sandstone, Washington County, Iowa.

1949. *Solenodella tenera* (E. R. Branson). Thomas, Geol. Soc. America Bull., v. 60, pl. 3, figs. 18, 20. English River siltstone, Washington County, Iowa.

1951. *Solenodella tenera* (E. R. Branson)? Youngquist and Downs, Jour. Paleontology, v. 25, p. 790, 791, pl. 111, fig. 3. Wassonville limestone, Washington County, Iowa.

1951. *Elictognathus lacerata* (Branson and Mehl). Hass, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 2538, 2539, pl. 1, fig. 3. Faunal zone in upper part of middle division of Arkansas novaculite, Montgomery County, Ark.

1956. *Elictognathus lacerata* (Branson and Mehl). Hass, U. S. Geol. Survey Prof. Paper 286, pl. 2, figs. 21, 22. Maury formation, Sumner County, Tenn.

1956. *Solenodella costata* (E. R. Branson). Bischoff and Ziegler, Notizblatt. hessisch. Landesamtes f. Bodenforsch. zu Wiesbaden, v. 84, p. 166, pl. 12, figs. 18, 19. Zone cu II, Germany.

Hypotypes.—USNM 114953, 114954, 114955, 114956, 114957, 114958, 114959, 114960, 114961.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Lateral view.—Unit compressed, approximately twice as long as high. Basal portion of posterior blade commonly flexed inward; basal portion of anterior blade flexed outward slightly. Denticles appressed to near their pointed sharp-edged tips. Suppression and restoration of parts common. Anterior blade directed downward slightly with reference to posterior blade. Summit line of fossil toothed, uneven; most specimens with two high points along summit line: one located above apical denticle and another about six to ten denticles from anterior end of fossil. Apical denticle varying in size and shape invariably compressed. Denticles of anterior blade, for the most part larger than those of posterior blade. Lateral ridge along outer side of fossil narrow, but that on inner side commonly wide and shelflike on posterior two-thirds of fossil.

Aboral view.—Unit slightly sinuous in anterior-posterior direction, grooved along midline except at anterior and posterior extremities of fossil. Pulp cavity and its lips small.

Because of effects produced by suppression or restoration of parts, specimens assigned to *Elictognathus lacerata* may differ in detail from one another; see, for example, figures 1–8, 12, on plate 49; all illustrations are of specimens that come from the same collection.

E. lacerata ranges throughout the Chappel limestone but is most abundant in the *Siphonodella cooperi* zone.

Genus NODOGNATHUS Cooper, 1939

1939. *Nodognathus* Cooper, Jour. Paleontology, v. 13, p. 397.

Type species, by original designation, *Nodognathus spicata* Cooper, 1939.

Nodognathus spicata Cooper

Plate 48, figures 23, 24

1939. *Nodognathus spicata* Cooper, Jour. Paleontology, v. 13, p. 397, pl. 40, figs. 32–34. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

Hypotypes.—USNM 114982, 114983.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Nodognathus spicata has many characteristics of a spathognathodid or an immature pseudopolygnathid. Lips of pulp cavity well-formed; each of them commonly supports spinelike process or transverse ridge on its oral side. Pulp cavity a more or less cone-shaped pit.

This species is scarce in the *Gnathodus punctatus* and *Siphonodella cooperi* zones.

Genus SPATHOGNATHODUS Branson and Mehl, 1941

1933. *Spathodus* Branson and Mehl [not Boulenger, 1900], Missouri Univ. Studies, v. 8, no. 1, p. 46.

1941. *Spathognathodus* Branson and Mehl, Jour. Paleontology, v. 15, p. 98.

Type species, by original designation, *Spathodus primus* Branson and Mehl, 1933.

Spathognathodus cooperi Hass, n. sp.

Plate 48, figures 16, 20

Holotype.—USNM 115014.

Paratype.—USNM 115015.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Unit bladelike, slightly bowed inward, thickest along midline of lateral sides, broadest adjacent to base of apical denticle. Anterior blade 2 to 3 times longer than posterior blade.

Lateral view.—Denticles large, closely set, erect or directed slightly toward posterior end. Apical denticle larger than blade denticles, directed posteriorly; its base expanded to form prominent lips for pulp cavity. Anterior blade directed downward with reference to aboral side of posterior blade. Summit line of fossil toothed.

Aboral view.—Aboral side narrow but distinctly grooved along midline. Pulp cavity prominent, elliptical in horizontal section with longer dimension alined with midline.

Spathognathodus cooperi resembles *Spathognathodus abnormis* (Branson and Mehl) from the Bushberg sandstone member of the Sulphur Springs formation of Missouri. The new species is distinguished by its larger blade denticles, larger apical denticle, and more prominent lips of the pulp cavity.

Spathognathodus cooperi appears to be restricted to the *Siphonodella cooperi* zone.

Spathognathodus longus Hass, n. sp.

Plate 48, figures 9, 13, 14

Holotype.—USNM 115017.

Paratypes.—USNM 115016, 115018.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Elongate bladelike unit with posterior extremity flexed inward slightly; thickest along midline of lateral sides and broadest at base of apical denticle. Anterior blade as much as twice length of posterior blade.

Lateral view.—Denticles closely set, erect or directed slightly toward posterior end. Denticles of some specimens differ greatly in size and shape owing to suppression and restoration of parts. Apical denticle similar to and only slightly larger than blade denticles. Aboral side of fossil straight to broadly concave, but may be angled downward near anterior end. Summit line of unit toothed and irregular but lacking distinctive high point.

Aboral view.—Aboral side narrow but grooved along midline. Pulp cavity in horizontal section elongate in direction of midline of fossil; asymmetric, with lip on outer side of pulp cavity a bit longer and broader than lip on inner side.

Spathognathodus longus resembles *Spathognathodus abnormis* (Branson and Mehl) from the Bushberg sandstone member of the Sulphur Springs formation of Missouri. The new species, however, lacks a distinctive high point along the summit line and, commonly, the distal end of its anterior blade is angled downward. It is more elongate and its apical denticle is less well developed than in *Spathognathus cooperi.*

Spathognathodus longus is not abundant in the Chappel limestone; it appears to be restricted to the *Siphonodella cooperi* zone.

Family POLYGNATHIDAE Bassler, 1925

Genus DOLIOGNATHUS Branson and Mehl, 1941

1941. *Doliognathus* Branson and Mehl, Jour. Paleontology, v. 15, p. 100.

Type species, by original designation, *Doliognathus lata* Branson and Mehl, 1941.

Doliognathus excavata Branson and Mehl

Plate 46, figures 28, 32

1941. *Doliognathus excavata* Branson and Mehl, Jour. Paleontology, v. 15, p. 101, pl. 19, figs. 20, 21. Pierson limestone, Barry County, Mo.

Hypotypes.—USNM 115047, 128001.

Locality.—C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. USNM 115047 from collection 9028; USNM 128001 from collection 11124.

Oral view.—Arched asymmetric platelike unit broadest in vicinity of pulp cavity, tapering from there to three pointed extremities. Axis angled inward just anterior to pulp cavity. Main carina low; its denticles commonly nodelike. Blade two to three times as long as main carina; its denticles partly or entirely fused into low ridge. Axis divides plate into narrow, unequally sized, more or less smooth-margined platforms. Adjacent to pulp cavity, outer platform has lobe; secondary carina of this lobe joins axis at junction point of blade and main carina. Denticles of secondary carina partly or entirely fused into low noded ridge. Surface of both platforms may be ornamented with granules, nodes, and transverse ridges.

Lateral view.—Unit arched about pulp cavity. Summit line of axis low and uneven except near distal end of blade where summit line may be toothed.

Aboral view.—Midline of axis and lobe of outer platform keeled except adjacent to pulp cavity, which is large, triangular in horizontal section, with flaring sides.

Doliognathus excavata is present only in the *Bactrognathus communis* zone of the Chappel limestone.

Genus POLYGNATHUS Hinde, 1879

1879. *Polygnathus* Hinde, Geol. Soc. London Quart. Jour., v. 35, p. 361.

1889. *Polygnathus* Hinde. Miller, North American Geology and Paleontology, p. 520.
1926. *Polygnathus* Hinde. Roundy, U. S. Geol. Survey Prof. Paper, 146, p. 13.
1939. *Macropolygnathus* Cooper, Jour. Paleontology, v. 13, p. 392.

Type species, by subsequent designation of Miller, 1889, *Polygnathus dubia* Hinde, 1879. The type of *Polygnathus dubia* designated by Roundy, 1926, as fig. 17 on pl. 16 of Hinde's 1879 publication.

Polygnathus allocota (Cooper)

Plate 48, figures 27, 28, 30–34

1939. *Macropolygnathus allocota* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 53, 54. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus itha* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 4–6. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus anameda* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 28–30. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus anodosa* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 17–19. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus anomala* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 1–3. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus bela* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 20–22. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus diamesa* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 69, 70; pl. 43, figs. 1, 2. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus idia* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 67, 68. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus isa* Cooper, Jour. Paleontology, v. 13, p. 393, pl. 42, figs. 36–38. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus campsa* Cooper, Jour. Paleontology, v. 13, p. 394, pl. 42, figs. 14–16. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus curta* Cooper, Jour. Paleontology, v. 13, p. 394, pl. 43, figs. 5–7. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus leyra* Cooper, Jour. Paleontology, v. 13, p. 394, pl. 42, figs. 39–41. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus lita* Cooper, Jour. Paleontology, v. 13, p. 394, 395, pl. 43, figs. 8, 9. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus nodus* Cooper, Jour. Paleontology, v. 13, p. 395, pl. 42, figs. 57, 58. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus olca* Cooper, Jour. Paleontology, v. 13, p. 395, pl. 42, figs. 31–33. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus platys* Cooper, Jour. Paleontology, v. 13, p. 395, pl. 42, figs. 25–27. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus radina* Cooper, Jour. Paleontology, v. 13, p. 395, 396, pl. 42, figs. 7–9. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus stena* Cooper, Jour. Paleontology, v. 13, p. 396, pl. 42, figs. 51, 52; pl. 43, figs. 3, 4. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Macropolygnathus tetrodus* Cooper, Jour. Paleontology, v. 13, p. 396, pl. 42, figs. 55, 56. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Polygnathus dystacta* Cooper, Jour. Paleontology, v. 13, p. 400, pl. 39, figs. 41, 42. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Polygnathus exodus* Cooper, Jour. Paleontology, v. 13, p. 400, pl. 42, figs. 42–44. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1939. *Pseudopolygnathus cyclotelum* Cooper, Jour. Paleontology, v. 13, p. 407, pl. 39, figs. 61, 62. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.
1956. *Polygnathus allocota* (Cooper). Hass, U. S. Geol. Survey Prof. Paper 286, pl. 2, fig. 18. Maury formation, Sumner County, Tenn.

Hypotypes.—USNM 114989, 114990, 114991, 114992, 114993, 114994, 114995.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Oral view.—Unit four to five times longer than broad. Margin of plate may be entire. Carina straight or slightly curved inward, compressed, ridgelike; its denticles discrete or completely fused. Blade commonly longer than carina, ridgelike. Denticles of blade range from partly fused to entirely fused; each partly fused denticle biconvex in horizontal section and has sharp-edged tip. Axis of fossil divides plate into narrow subequally sized platforms that flank carina and most of blade. Outer platform may be slightly longer than inner one; both platforms merge into thickest portion of blade. Surface of platforms generally pitch slightly toward axis; they commonly bear nodes or transverse ridges.

Lateral view.—Summit line of axis toothed or irregular, located above level of platforms. In general, anterior two-thirds of summit line arched about pulp cavity; that of posterior third rises above remainder of fossil. Fossil is angled downward slightly, with reference to aboral side of blade, just anterior to pulp cavity.

Aboral view.—Well-formed keel sharp edged except adjacent to pulp cavity where it splits and merges into lips of pulp cavity. Pulp cavity large, pitlike, more or less elliptical in horizontal section; its longer dimension aligned with midline of fossil.

Cooper (1939, p. 392) proposed the genus *Macropolygnathus* for some fusiform conodonts whose narrow platforms flank the carina and most of the blade. These characteristics are herein considered as having only specific value; and Cooper's genus is regarded as being congeneric with *Polygnathus*. The 19 species of *Macro-*

polygnathus that Cooper named and described, together with several other of his species, are herein placed in a single category, *Polygnathus allocota* (Cooper) because the characteristics that distinguish Cooper's species are considered to be too minute to have specific value.

Polygnathus allocota ranges throughout the Chappel limestone but is especially abundant in the *Siphonodella cooperi* zone.

Polygnathus communis Branson and Mehl

Plate 49, figures 9–11, 13

1934. *Polygnathus communis* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 4, p. 293, pl. 24, figs. 2–4. [Date of imprint, 1933] Bushberg sandstone member of the Sulphur Springs formation, Ste. Genevieve County, Mo.

1934. *Polygnathus communis* Branson and Mehl. E. R. Branson, Missouri Univ. Studies, v. 8, no. 4, p. 308, pl. 25, figs. 5, 6. [Date of imprint, 1933] Hannibal shale, Marion County, Mo.

1938. *Polygnathus communis* Branson and Mehl. Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 145, pl. 34, figs. 39–41. Chouteau limestone, Montgomery County, Mo.

1939. *Polygnathus communis* Branson and Mehl. Cooper, Jour. Paleontology, v. 13, p. 399, pl. 39, figs. 1, 2, 9, 10, 23, 24. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Polygnathus adola* Cooper, Jour. Paleontology, v. 13, p. 399, pl. 39, figs. 33–36. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1941. *Polygnathus* sp. Hass, Jour. Paleontology, v. 15, pl. 13, figs. 2, 2a. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1947. *Polygnathus communis* Branson and Mehl. Mehl and Thomas, Denison Univ., Bull. Sci. Lab., v. 47, p. 15, pl. 1, fig. 37. Fern Glen limestone, St. Louis County, Mo.

1949. *Polygnathus communis* Branson and Mehl. Youngquist and Patterson, Jour. Paleontology, v. 23, p. 62, pl. 15, figs. 7, 8. Prospect Hill sandstone, Des Moines County, Iowa.

1949. *Polygnathus communis* Branson and Mehl. Thomas, Geol. Soc. America Bull., v. 60, pl. 3, fig. 37. Prospect Hill sandstone, Des Moines County, Iowa.

1951. *Polygnathus communis* Branson and Mehl. Youngquist and Downs, Jour. Paleontology, v. 25, p. 787, pl. 111, figs. 4, 5, 19, 20. Wassonville limestone, Washington County, Iowa.

1951. *Polygnathus communis* Branson and Mehl. Hass, Amer. Assoc. Petroleum Geologists Bull., v. 35, p. 2538, 2539, pl. 1, fig. 10. Faunal zone in the upper part of the middle division of the Arkansas novaculite, Montgomery County, Ark.

1956. *Polygnathus communis* Branson and Mehl. Hass, U. S. Geol. Survey Prof. Paper 286, pl. 2, figs. 2–5. Maury formation, Sumner and Hamilton Counties, Tenn.

1957. *Polygnathus communis* Branson and Mehl. Bischoff, Abh. hessisch. Landesamtes f. Bodenforsch. zu Wiesbaden, v. 19, p. 42, pl. 2, figs. 23–27. Germany.

Hypotypes.—USNM 114928, 114929, 114931, 114933.

Localities.—C–15, about 2,500 feet N. 88° W. of southwest bank of Llano River at Whites Crossing, Mason County, Tex. USNM 114928; collection 9301. C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. USNM 114929, 114931, 114933; collection 9300.

Oral view.—Axis straight to slightly angled inward just anterior to pulp cavity. Plate lanceolate, widest adjacent to pulp cavity where each platform may support a small node; margin of plate generally smooth. Posterior to pulp cavity, plate is depressed and merges into thickest portion of blade. Carina consisting of nodes or completely fused denticles; some of these nodes near anterior end may be indistinct. Blade slightly longer than carina, most massive adjacent to plate, thickest just above aboral side. Denticles of blade generally increase in size posteriorly, compressed; each denticle with sharp-edged tip. Narrow platforms flank carina and as much as one-third of blade. Oral surface of platforms minutely pitted and may pitch toward axis.

Lateral view.—Plate is angled downward anterior to the pulp cavity with reference to aboral side of blade. Summit line of axis toothed or irregular. Blade increases slightly in height posteriorly.

Aboral view.—Midline of plate strongly keeled except just anterior to pulp cavity. Blade split adjacent to pulp cavity. Pulp cavity pitlike, elliptical in horizontal section; its longer dimension aligned with midline of fossil.

Polygnathus communis is a characteristic Lower Mississippian fossil. In formations of early Kinderhook age, the plate of this species, in oral view, tends to be ovate, but in formations of late Kinderhook and earliest Osage age, the plate, in oral view, is lanceolate. The species ranges throughout the Chappel limestone.

Polygnathus communis Branson and Mehl bifurcata Hass n. var.[2]

Plate 48, figures 11, 12

Holotype.—USNM 114930.

Paratype.—USNM 114932.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

This variety is distinguished from *Polygnathus communis* s. s. by having a secondary carina near anterior end of outer platform. Well-formed secondary keel is located beneath the secondary carina.

A few specimens of *P. communis* var. *bifurcata* have been found in collections from the *Siphonodella cooperi* and *Gnathodus punctatus* zones of the Chappel limestone.

[2] This variety is a subspecies.

Polygnathus communis Branson and Mehl carina Hass n. var.[3]

Plate 47, figures 8, 9

Holotype.—USNM 115157.

Paratype.—USNM 115158.

Locality.—C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. Collection 9307.

This variety differs from *Polygnathus communis* s. s. by having a noded ridge on each platform. Each ridge trends from junction point of blade and carina to posterior margin of platform on which it is located. Secondary keels not present beneath these ridges.

The variety is quite common in the *Gnathodus punctatus* zone; a few specimens have been recognized in the *Bactrognathus communis* zone.

Polygnathus radina Cooper

Plate 48, figures 6, 7, 10

1939. *Polygnathus radina* Cooper, Jour. Paleontology, v. 13, p. 403, pl. 39, figs. 5, 6. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Polygnathus delicatula* Ulrich and Bassler. Cooper, Jour. Paleontology, v. 13, p. 400, pl. 40, figs. 37, 38. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1951. *Polygnathus radina* Cooper. Hass, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 2539, pl. 1, figs. 5, 6. Faunal zone in the upper part of the middle division of the Arkansas novaculite, Montgomery County, Ark.

Hypotypes.—USNM 114979, 114980, 114981.

Localities.—C–12, about 5,000 feet N. 60° W. of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. USNM 114979; collection 9302. C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. USNM 114980 and 114981; collection 9300.

Oral view.—Unit fragile, approximately 3 times longer than broad, arched and angled inward slightly just anterior to pulp cavity. Plate ovate, slightly asymmetric, depressed at posterior end, and merged into thickest portion of blade. Margin of plate entire. Carina composed of nodelike denticles decreasing in size anteriorly. Blade may be slightly longer than carina, compressed. Denticles of blade fused except at their sharp-edged tips; slightly larger at posterior end. Axis divides plate into subequally sized platforms that flank carina and anteriormost portion of blade. Surface of platforms slightly convex, pustulose.

Lateral view.—Plate, anterior to pulp cavity, is angled downward approximately 45° with reference to aboral side of blade. Summit line of axis toothed; increasing in height toward posterior end.

Aboral view.—Keel well developed, angled inward slightly just anterior to pulp cavity, split adjacent to pulp cavity; sides of keel merging into prominent lips of pulp cavity, which enclose shallow elliptical area with longer direction transverse of keel. Outer lip of pulp cavity larger than inner.

Polygnathus radina is distinguished by the pustular ornamentation of the platforms and by the prominent lips of the pulp cavity. The specimen from Oklahoma that Cooper (1939, p. 400) identified as *Polygnathus delicatula* Ulrich and Bassler is herein identified as *Polygnathus radina.* Ulrich and Bassler's species differs from *Polygnathus radina* in many features including a lanceolate plate and transversely ridged platforms.

P. radina ranges throughout the Chappel limestone but is most common in the *Siphonodella cooperi* zone.

Genus PSEUDOPOLYGNATHUS Branson and Mehl, 1934

1934. *Pseudopolygnathus* Branson and Mehl, Missouri Univ. Studies, v. 8, no. 4, p. 297, 298. (Date of imprint, 1933.)

Type species, by original designation, *Pseudopolygnathus prima* Branson and Mehl, 1934.

Pseudopolygnathus lanceolata Hass, n. sp.

Plate 47, figures 19–26

Holotype.—USNM 115000.

Paratypes.—USNM 114996, 114997, 114998, 114999, 115001, 115002, 115003.

Localities.—C–18, base of bluff on Honey Creek, about 2,800 feet N. 24° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. USNM 115000, 115001, 115002, and 115003; collection 9304. C–13, Whites Crossing, approximately 8.3 miles (airline) southwest of courthouse at Mason, Mason County, Tex. USNM 114996, 114997, 114998, and 114999; collection 9303.

Oral view.—Axis straight to slightly sinuous. In young specimens a few distinct nodes flank axis; in older specimens, narrow platforms flank carina and part of blade to form lanceolate plate with irregular margin. Denticles of carina may be completely fused. Blade approximately as long as carina, erect, thickest at or below midline of its lateral sides. Denticles of blade compressed, almost even on outer side; adjacent to pulp cavity denticles may be fused into low sharp-edged ridge, but toward posterior end of blade, they are large, high, and have sharp-edged tips. Inner platform shorter than outer platform, ornamented with nodes and prominent transverse ridges, but smooth and slightly depressed immediately adjacent to blade.

[3] This variety is a subspecies.

Outer platform not depressed adjacent to blade; otherwise features like those of inner platform.

Lateral view.—Aboral side of plate angled downward with reference to aboral side of blade. Summit line of axis smooth or toothed; remaining below level of platforms except at posterior end of blade.

Aboral view.—Midline of fossil keeled, but split adjacent to pulp cavity; its sides merge into lips of pulp cavity, which is grooved along midline and somewhat elliptical in horizontal section, with longer direction aligned with midline of fossil.

Pseudopolygnathus lanceolata is a common species of the *Bactrognathus communis* zone; a few specimens have also been found in the *Gnathodus punctatus* zone.

Genus SCALIOGNATHUS Branson and Mehl, 1941

1941. *Scaliognathus* Branson and Mehl, Jour. Paleontology, v. 15, p. 101, 102.

Type species, by original designation, *Scaliognathus anchoralis* Branson and Mehl, 1941.

Scaliognathus anchoralis Branson and Mehl

Plate 46, figures 18, 19

1941. *Scaliognathus anchoralis* Branson and Mehl, Jour. Paleontology, v. 15, p. 102, pl. 19, figs. 29–32. Pierson limestone, Barry County, Mo.

1957. *Scaliognathus anchoralis* Branson and Mehl. Bischoff, Abh. hessisch. Landesamtes f. Bodenforsch. zu Wiesbaden, v. 19, p. 53, 54, pl. 1, figs. 8–14. Subzone cu II_γ, Germany.

Hypotypes.—USNM 127999, 128000.

Locality.—C–26, Spicewood area, bed of branch of Little Cypress Creek, about 3 miles due west of Spicewood, Burnet County, Tex. Collection 15579.

Oral view.—Unit slightly asymmetric, somewhat anchor-shaped. Blade straight to slightly bowed inward; with short compressed denticles. Main cusp located at anterior end of unit, small, resembles blade denticles. Outer platform slightly larger than inner. Anteriorly each platform resembles arm of anchor, supports secondary carina. Denticles of secondary carina of outer platform directed forward, small but distinct. Platforms narrow in posterior half of unit; flank blade to its posterior end. Oral surface covered with small nodes and ridges.

Lateral view.—Unit thin. Posterior half of unit curved downward slightly with reference to its anterior half.

Aboral view.—Keels beneath blade and secondary carinae strongly developed; each keel faintly grooved along midline. Pulp cavity small.

Scaliognathus anchoralis appears to be restricted to the *Bactrognathus communis* zone of the Chappel limestone.

Genus SIPHONODELLA Branson and Mehl, 1944

1934. *Siphonognathus* Branson and Mehl [not Richardson, 1858], Missouri Univ. Studies, v. 8, no. 4, p. 295. (Date of imprint, 1933.)

1944. *Siphonodella* Branson and Mehl, *in* Shimer and Shrock, Index fossils of North America, p. 245.

1948. *Siphonodella* Branson and Mehl. Branson and Mehl, Jour. Paleontology, v. 22, p. 528.

Type species, by original designation, *Siphonognathus duplicata* Branson and Mehl, 1934.

Siphonodella cooperi Hass, n. sp.

Plate 48, figures 35, 36

1938. *Siphonognathus duplicata* Branson and Mehl. Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 148, pl. 34, figs. 34, 35. Chouteau limestone, Montgomery County, Mo.

1939. *Siphonognathus quadruplicata* Branson and Mehl. Cooper, Jour. Paleontology, v. 13, p. 409, pl. 41, figs. 44, 45. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1951. *Siphonodella duplicata* (Branson and Mehl) var. B of Hass, Am. Assoc. Petroleum Geologists Bull., v. 34, p. 2539, pl. 1, fig. 7. Faunal zone in upper part of the middle division of the Arkansas novaculite, Montgomery County, Ark.

Holotype.—USNM 114987.

Paratype.—USNM 114988.

Locality.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. Collection 9300.

Siphonodella cooperi has two or three rostral ridges. It differs from type specimens of *Siphonodella duplicata* (Branson and Mehl) in having nodes instead of transverse ridges on inner platform. Some specimens identified in literature as *Siphonodella duplicata* do have nodes on inner platform, but *S. cooperi* differs from them in being more elongate and in having the curved rostral ridge of its outer platform terminate at margin of platform anterior to pulp cavity instead of being nearly straight and terminating on platform near pulp cavity. The presence of transverse ridges on outer platform distinguishes *S. cooperi* from *Siphonodella obsoleta* Hass.

Siphonodella cooperi is a common and characteristic fossil of the lower faunal zone of the Chappel limestone to which it therefore lends its name. The species is represented by relatively few specimens in the overlying *Gnathodus punctatus* and *Bactrognathus communis* faunal zones.

Siphonodella obsoleta Hass, n. sp.

Plate 47, figures 1, 2

Holotype.—USNM 115162.

Paratype.—USNM 115163.

Locality.—C–15, about 2,500 feet N. 88° W. of the southwest bank of the Llano River at Whites Crossing, Mason County, Tex. Collection 9301.

Siphonodella obsoleta has one rostral ridge on each platform. Rostral ridge on inner platform is restricted to posterior end of plate, whereas that on outer platform continues anteriorly as upturned margin of plate. Inner platform bears closely spaced nodes; outer platform, in addition to granules, may have a few nodes at anterior end as well as along free margin.

Siphonodella obsoleta resembles those specimens of *S. duplicata* (Branson and Mehl) and *S. cooperi* Hass that have two rostral ridges; *S. obsoleta*, however, differs in having granules rather than strong transverse ridges on the outer platform.

Siphonodella obsoleta is a characteristic fossil of the *Gnathodus punctatus* faunal zone. The species, however, ranges throughout the Chappel limestone.

Genus STAUROGNATHUS Branson and Mehl, 1941

1941. *Staurognathus* Branson and Mehl, Jour. Paleontology, v. 15, p. 102.

Type species, by original designation and by monotypy, *Staurognathus cruciformis* Branson and Mehl, 1941.

Staurognathus anchoraria Hass, n. sp.

Plate 46, figures 12, 13, 21

Holotype.—USNM 115043.

Paratypes.—USNM 115042, 115044.

Locality.—C–18, at base of bluff on Honey Creek, about 2,800 feet N. 24° W. of point where Honey Creek crosses road from Mason to Whites Crossing, Mason County, Tex. Collection 9304.

Oral view.—Unit depressed, with smooth or but slightly roughened margin. Blade and main carina flanked by narrow platforms. Oral surface of unit covered with granules and nodes. Blade nearly twice as long as main carina; its platforms broadest anteriorly, and thickest at or near oral side. Denticles of blade commonly small and nodelike although they may be larger and more distinct at posterior end of blade. Main carina angled inward, consisting of minute denticles or nodes. Blade flanked by lateral lobes. Each lobe joins axis at junction point of blade and main carina; generally, each lobe longer than main carina, supporting a faint secondary carina along its midline.

Lateral view.—Main carina is angled downward slightly with reference to aboral side of blade. Oral surface of fossil nearly parallel with aboral side. Summit line of axis may be toothed near posterior end of blade.

Aboral view.—Aboral side set off from remainder of fossil by sharp-edged flange; this side broadly grooved except in distal portions of blade and carina.

Staurognathus anchoraria differs from *Staurognathus cruciformis* Branson and Mehl (see pl. 46, fig. 24) in the ornamentation of the oral surface and in the orientation and size of the lateral lobes.

Staurognathus anchoraria is not too common in the Chappel limestone; it appears to be restricted to the *Bactrognathus communis* zone.

Staurognathus cruciformis Branson and Mehl

Plate 46, figure 24

1941. *Staurognathus cruciformis* Branson and Mehl, Jour. Paleontology, v. 15, p. 102, pl. 19, figs. 25, 36. Sycamore limestone of some geologists, Pontotoc County, Okla.

Hypotype.—USNM 115045.

Locality.—C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. Collection 9357.

Oral view.—Asymmetric unit, with smooth to slightly roughened margin, bearing a faint resemblance to a Latin cross. Blade is more than twice as long as carina; denticles of blade may be fused to adjacent nodes of narrow platforms thereby forming series of transverse ridges, although, generally, denticles of blade are so minute that blade is depressed. Carina curved inward; its denticles nodelike, its narrow platforms smooth. Lateral lobes join axis at junction point of blade and carina; larger outer lateral lobe more or less at right angles to axis, whereas smaller inner lateral lobe is directed toward posterior end of fossil. Each lobe commonly supports noded secondary carina although on some specimens midline of lobe may be depressed.

Lateral view.—Oral surface of fossil nearly parallel with aboral side. Summit line toothed.

Aboral view.—Aboral side set off from remainder of fossil by sharp-edged flange; broadly grooved adjacent to pulp cavity.

Staurognathus cruciformis differs from *Staurognathus anchoraria* (see pl. 46, figs. 12, 13, 21) in the ornamentation of the oral side and in the orientation and size of the lateral lobes.

Staurognathus cruciformis is not too common in the Chappel limestone; it appears to be restricted to the *Bactrognathus communis* zone.

Family IDIOGNATHODONTIDAE Harris and Hollingsworth, 1933

Subfamily IDIOGNATHODONTINAE Harris and Hollingsworth, 1933

Genus DOLLYMAE Hass, n. gen.

Type species, here designated, *Dollymae sagittula* Hass.

Sagittate unit consisting of blade, terminal main cusp, and both inner and outer secondary carinae. Each secondary carina joined to main cusp and flanks a lateral side of blade. Pulp cavity very large; its apex located very near anterior end of unit.

Dollymae has a superficial resemblance to *Ancyrodella* Ulrich and Bassler. It differs in lacking a main carina and a plate, as well as in having its pulp cavity located very near the anterior end of the unit instead of approximately equidistant from the anterior and posterior ends of the unit. The large expanded pulp cavity distinguishes *Dollymae* from *Scaliognathus*. The genus is named for the author's daughter.

Dollymae sagittula Hass, n. sp.

Plate 47, figures 7, 10

Holotype.—USNM 128003.

Paratype.—USNM 128002.

Locality.—C–1, type locality of Chappel limestone, along San Saba to Chappel road, 2.4 miles southeast of courthouse at San Saba, San Saba County, Tex. Collection 9307.

Oral view.—Unit somewhat asymmetric. Blade straight to slightly bowed inward; its denticles short, compressed, and either erect or directed forward. Main cusp directed anteriorly, nodelike. Inner secondary carina nearly straight; its denticles short, compressed, curved away from midline of unit, and fused nearly to their pointed tips. Outer secondary carina resembles inner one. Area between anterior half to two-thirds of blade and adjacent portions of each secondary carina smooth and troughlike.

Lateral view.—Aboral side curved downward anterior to pulp cavity with reference to the toothed summit line of fossil. Troughlike areas between blade and secondary carinae extend below aboral side of blade.

Aboral view.—Grooves along midline of blade and each secondary carina are well formed; joined at apex of enlarged pulp cavity. That part of expanded pulp cavity located between blade and each secondary carina broadly arched. Area anterior to grooves of secondary carinae rather thick in vicinity of apex of pulp cavity.

Dollymae sagittula is typical of the *Gnathodus punctatus* faunal zone.

Genus GNATHODUS Pander, 1856

1856. *Gnathodus* Pander, Monographie der fossilen Fische des silurischen Systems der russisch-baltischen Gouvernements, p. 33, 34.

1939. *Dryphenotus* Cooper, Jour. Paleontology, v. 13, p. 386.

Type species, by monotypy, *Gnathodus mosquensis* Pander, 1856.

Gnathodus delicatus Branson and Mehl

Plate 46, figures 3–7; plate 48, figures 1–5, 8

1938. *Gnathodus delicatus* Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 145, pl. 34, figs. 25–27. Chouteau limestone, Montgomery County, Mo.

1938. *Gnathodus perplexus* Branson and Mehl, Missouri Univ. Studies, v. 13, no. 4, p. 145, pl. 34, fig. 24. Chouteau limestone, Montgomery County, Mo.

1939. *Gnathodus mosquensis* Pander. Cooper, Jour. Paleontology, v. 13, p. 388, pl. 41, figs. 23–25, 30–32; pl. 42, figs. 75, 76. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Gnathodus perplexus* Branson and Mehl. Cooper, Jour. Paleontology, v. 13, p. 388, pl. 42, figs. 47–50. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1947. *Gnathodus perplexus* Branson and Mehl. Mehl and Thomas, Denison Univ., Bull. Sci. Lab., v. 40, art. 2, p. 10, pl. 1, fig. 4. Fern Glen limestone, St. Louis County, Mo.

1951. *Gnathodus delicatus* Branson and Mehl. Hass, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 2539, pl. 1, fig. 4. Faunal zone in the upper part of the middle division of the Arkansas novaculite, Montgomery County, Ark.

Hypotypes.—USNM 115026, 115027, 115028, 115029, 115030, 115031, 115032, 115033, 115034, 115035, 115036.

Localities.—C–16, about 2,100 feet due west of point where Honey Creek intersects road from Mason to Whites Crossing, Mason County, Tex. USNM 115026 through 115031; collection 9300. C–13, Whites Crossing, 8.3 miles (airline) southwest of courthouse at Mason, Mason County, Tex. USNM 115032 through 115036; collection 9303.

Oral view.—Axis straight or slightly angled inward at junction of blade and main carina. Generally, carina is a noded or sharp-edged ridge but its down-curved anterior third may be modified into a series of transverse ridges, formed through fusion of denticles of carina with adjacent nodes on inner and outer sides of cup. Cup elongate, asymmetric, widest posteriorly and pointed anteriorly; its oral surface noded except for smooth marginal band. Inner side of cup longer and narrower than outer. Nodes on posterior one-half to three-quarters of inner side of cup generally fused into ridge paralleling carina. Blade may be as much as twice as long as carina; thickest along or just below midline of lateral sides. Size of blade denticles in-

creases slightly toward posterior end; denticles compressed and fused nearly to their pointed sharp-edged tips.

Lateral view.—Summit line of fossil toothed and downcurved near anterior end.

Aboral view.—Blade mostly sharp edged, but split anteriorly; its sides merge into those of expanded pulp cavity, or cup. Pulp cavity grooved along midline; apex located near posterior end of concavity.

Gnathodus delicatus ranges throughout the Chappel limestone but is most common in the *Bactrognathus communis* zone.

Gnathodus punctatus (Cooper)

Plate 47, figures 11–18

1939. *Dryphenotus punctatus* Cooper, Jour. Paleontology, v. 13, p. 386, pl. 41, figs. 42, 43; pl. 42, figs. 10, 11. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Dryphenotus litus* Cooper, Jour. Paleontology, v. 13, p. 386, pl. 42, figs. 34, 35. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Dryphenotus macrolobus* Cooper, Jour. Paleontology, v. 13, p. 386, pl. 41, figs. 48, 49; pl. 42, figs. 45, 46. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1939. *Dryphenotus oxys* Cooper, Jour. Paleontology, v. 13, p. 386, pl. 42, figs. 12, 13. Pre-Welden shale of Cooper (1939), Pontotoc County, Okla.

1944. *Gnathodus* (*Dryphenotus*) *macrolobatus* Cooper. Branson and Mehl, *in* Shimer and Shrock, Index fossils of North America, p. 245, pl. 94, fig. 69.

1951. *Gnathodus punctatus* (Cooper). Hass, Am. Assoc. Petroleum Geologists Bull., v. 35, p. 2539, pl. 1, fig. 2. Faunal zone in upper part of middle division of Arkansas novaculite, Montgomery County, Ark.

Hypotypes.—USNM 115164, 115165, 115166, 115167, 115168, 115169, 115170, 115171.

Locality.—C–15, about 2,500 feet N. 88° W. of the southwest bank of the Llano River at Whites Crossing, Mason County, Tex. Collection 9301.

Oral view.—Axis straight or but slightly curved inward. On young specimens carina narrow and above level of rest of cup; on mature specimens anterior two-thirds of carina fused with adjoining nodes on inner and outer sides of cup, resulting in series of transverse ridges. Cup pointed anteriorly, widest posteriorly; asymmetric, with outer side larger than inner. Oral surface of cup commonly node-bearing; in addition, cup of large specimen supports four rows of nodes radiating from junction point of blade and carina. The two rows on posterior portion of inner side of cup, and row flanking posterior margin of outer side of cup commonly present on very small specimens. The fourth row, bisecting angle between carina and above-mentioned row of outer side, may be poorly developed. Blade may be twice as long as carina, thickest just above aboral side. Each denticle of blade fused nearly to its sharp-edged tip.

Lateral view.—Summit line of axis gradually increases in height posteriorly with reference to straight aboral side of blade. Summit line of unit may be smooth or toothed.

Aboral view.—Blade sharp edged to near pulp cavity where it is split with its sides merging into those of expanded pulp cavity, or cup. Aboral surface of expanded pulp cavity grooved along midline; smooth, with shallow indentation beneath each of above-mentioned rows of nodes.

The characteristics of the oral side of the cup distinguish *Gnathodus punctatus* from all other species of *Gnathodus*. Cooper's (1939) species *Gnathodus litus*, *G. macrolobus*, and *G. oxys* are herein considered to be conspecific with *G. punctatus* because the characteristics that distinguish each of them can be recognized in any large suite of intergrading specimens of *G. punctatus*.

Gnathodus punctatus is an extremely abundant and characteristic fossil of the middle faunal zone of the Chappel limestone—to which it therefore lends its name. A few specimens of the species have also been found in collections from the overlying *Bactrognathus communis* zone and from the underlying *Siphonodella cooperi* zone.

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PLATES 46–50

PLATE 46

[All figures 30×. Figures 1–14, 17–27, and 29–32 are of specimens from collections assigned to the *Bactrognathus communis* faunal zone; figures 15 and 16 are of specimens from collections assigned to the *Gnathodus punctatus* faunal zone; figure 28 is of a specimen regarded as having been reworked into the basal bed of the Barnett formation]

FIGURES 1, 2, 8. *Neoprioniodus lanceolatus* Hass, n. sp. (p. 384).

1. Lateral view of inner side, holotype, USNM 115040, collection 9393.
2. Lateral view of outer side, paratype, USNM 115039; 8, lateral view of inner side, paratype, USNM 115041. Both from collection 9305.

3–7. *Gnathodus delicatus* Branson and Mehl (p. 394).

Oral views of hypotypes showing individual variations. (See also pl. 48, figs. 1–5, 8.)

3. USNM 115032; 4, USNM 115033; 5, USNM 115034; 6, USNM 115035; 7, USNM 115036. All from collection 9303.

9, 10. *Roundya* sp. A (p. 385).

9. Lateral view, hypotype, USNM 115038, collection 9305.
10. Anterior view, hypotype, USNM 115037, collection 9304.

11. *Roundya* sp. B (p. 385).

Lateral view, hypotype, USNM 115046, collection 9304.

12, 13, 21. *Staurognathus anchoraria* Hass, n. sp. (p. 393).

12. Aboral view, paratype, USNM 115044; 13, oral view, paratype, USNM 115042; 21, oral view, holotype, USNM 115043. All from collection 9304.

14–17. *Ligonodina singularis* Hass, n. sp. (p. 384).

14. Lateral view of inner side, paratype, USNM 115152, collection 9357; 15, lateral view of inner side, paratype, USNM 115153, collection 9307; 16, lateral view of inner side, holotype, USNM 115154, collection 9314; 17, lateral view of outer side, paratype, USNM 115155, collection 9357.

18, 19. *Scaliognathus anchoralis* Branson and Mehl (p. 392).

18. Oral view, hypotype, USNM 127999; 19, aboral view, hypotype, USNM 128000. Both from collection 15579.

20, 25–27, 30, 31. *Bactrognathus communis* Hass, n. sp. (p. 380).

20. Lateral view of outer side, paratype, USNM 115053.

25–27. Oral views of paratypes. 25, USNM 115048; 26, USNM 115049; 27, USNM 115050.

30. Oral view of holotype, USNM 115051.
31. Aboral view of paratype, USNM 115052. All from collection 9304.

22, 23, 29. *Bactrognathus penehamata* Hass, n. sp. (p. 381).

22. Oral view, holotype, USNM 115055; 23, aboral view, paratype, USNM 115054; 29, lateral view of outer side, paratype, USNM 115056. All from collection 9303.

24. *Staurognathus cruciformis* Branson and Mehl (p. 393).

Oral view, hypotype, USNM 115045, collection 9357.

28, 32. *Doliognathus excavata* Branson and Mehl (p. 388).

28. Oral view, hypotype, USNM 115047, collection 9028.
32. Oral view, hypotype, USNM 128001, collection 11124.

CONODONTS OF THE CHAPPEL LIMESTONE

CONODONTS OF THE CHAPPEL LIMESTONE

PLATE 47

[All figures 30×. Figures 1–18 are of specimens from collections assigned to the *Gnathodus punctatus* faunal zone; figures 19–26 are of specimens from collections assigned to the *Bactrognathus communis* faunal zone]

FIGURES 1, 2. *Siphonodella obsoleta* Hass, n. sp. (p. 392).
Oral views. 1, paratype, USNM 115163; 2, holotype, USNM 115162. Both from collection 9301.

3. *Neoprioniodus oligus* (Cooper) (p. 384).
Lateral view of inner side, hypotype, USNM 115159, collection 9307.

4, 5. *Ozarkodina* sp. A (p. 386).
Lateral views. 4, inner side, hypotype, USNM 115160; 5, outer side, hypotype, USNM 115161. Both from collection 9301.

6. *Hindeodina uncata* Hass, n. sp. (p. 383).
Oral view, holotype, USNM 115006, collection 9301.

7, 10. *Dollymae sagittula* Hass, n. sp. (p. 394).
7. Aboral view, paratype, USNM 128002; 10, oral view, holotype, USNM 128003. Both from collection 9307.

8, 9. *Polygnathus communis* Branson and Mehl var. *carina* Hass, n. var. (p. 391).
8. Aboral view, paratype, USNM 115158; 9, oral view, holotype, USNM 115157. Both from collection 9307.

11–18. *Gnathodus punctatus* (Cooper) (p. 395).
11. Lateral view of inner side, hypotype, USNM 115171. Oral views of hypotypes showing individual variation, and development of characters during ontogeny. 12. USNM 115164; 13, USNM 115165; 14, USNM 115166; 15, USNM 115167; 16, USNM 115168; 17, USNM 115169.
18. Aboral view, hypotype, USNM 115170. All from collection 9301.

19–26. *Pseudopolygnathus lanceolata* Hass, n. sp. (p. 391).
19. Lateral view of inner side, paratype, USNM 115003. Oral views showing development of characters during ontogeny.
20. Paratype, USNM 114997; 21, paratype, USNM 114996; 22, paratype, USNM 114998; 23, paratype, USNM 114999; 24, holotype, USNM 115000; 25, paratype, USNM 115001.
26. Aboral view, paratype, USNM 115002. Figures 19, 24–26 are of specimens from collection 9304; figures 20–23 are of specimens from collection 9303.

PLATE 48

[All figures 30×. Figures 1–17, 19–25, and 27–36 are of specimens from collections assigned to the *Siphonodella cooperi* faunal zone; figures 18 and 26 are of specimens from a collection assigned to the *Gnathodus punctatus* faunal zone]

FIGURES 1–5, 8. *Gnathodus delicatus* Branson and Mehl (p. 394).
Oral views show individual variations. (See also pl. 46, figs. 3–7.)
1. Oral view, USNM 115027; 2, oral view, USNM 115028; 3, aboral view, USNM 115031; 4, oral view, USNM 115030; 5, oral view, USNM 115029; 8, lateral view of outer side, USNM 115026. All figures are of hypotypes from collection 9300.

6, 7, 10. *Polygnathus radina* Cooper (p. 391).
6. Aboral view, hypotype, USNM 114980, collection 9300.
7. Oral view, hypotype, USNM 114979, collection 9302.
10. Lateral view of outer side, hypotype, USNM 114981, collection 9300.

9, 13, 14. *Spathognathodus longus* Hass, n. sp. (p. 388).
9. Lateral view of inner side, holotype, USNM 115017.
13. Lateral view of outer side, paratype, USNM 115016.
14. Lateral view of inner side, paratype, USNM 115018. All from collection 9300.

11, 12. *Polygnathus communis* Branson and Mehl *bifurcata* Hass, n. var. (p. 390).
11. Aboral view, paratype, USNM 114932.
12. Oral view, holotype, USNM 114930. Both from collection 9300.

15. *Falcodus* sp.
Lateral view, hypotype, USNM 115005, collection 9302.

16, 20. *Spathognathodus cooperi* Hass, n. sp. (p. 387).
Lateral views of outer side, both from collection 9300.
16. Holotype, USNM 115014; 20, paratype, USNM 115015.

17. *Hindeodina simplaria* Hass, n. sp. (p. 382).
Lateral view of inner side, holotype, USNM 115010, collection 9300.

18, 21, 26. *Hindeodella fragilis* Hass, n. sp. (p. 383).
Lateral views of inner side.
18. Paratype, USNM 115025, collection 9301; 21, paratype, USNM 115024, collection 9300; 26, holotype, USNM 115023, collection 9301.

19, 22. *Neoprioniodus insolitus* Hass, n. sp. (p. 383).
Lateral views of inner side; both from collection 9300.
19. Paratype, USNM 115019; 22, holotype, USNM 115020.

23, 24. *Nodognathus spicata* Cooper (p. 387).
Oral views of hypotypes from collection 9300.
23. USNM 114982; 24, USNM 114983.

25, 29. *Subbryantodus radians* Branson and Mehl (p. 385).
Lateral views of hypotypes from collection 9300.
25. Inner side, USNM 115008; 29, outer side, USNM 115009.

27, 28, 30–34. *Polygnathus allocota* (Cooper) (p. 389).
27. Lateral view, USNM 114994.
Oral views showing individual variations.
28. USNM 114993; 30, USNM 114989; 31, USNM 114990; 32, USNM 114991; 33, USNM 114992.
34. Aboral view, USNM 114995. All figures are of hypotypes from collection 9300.

35, 36. *Siphonodella cooperi* Hass, n. sp. (p. 392).
35. Oral view, paratype, USNM 114988; 36, oral view, holotype, USNM 114987. Both from collection 9300.

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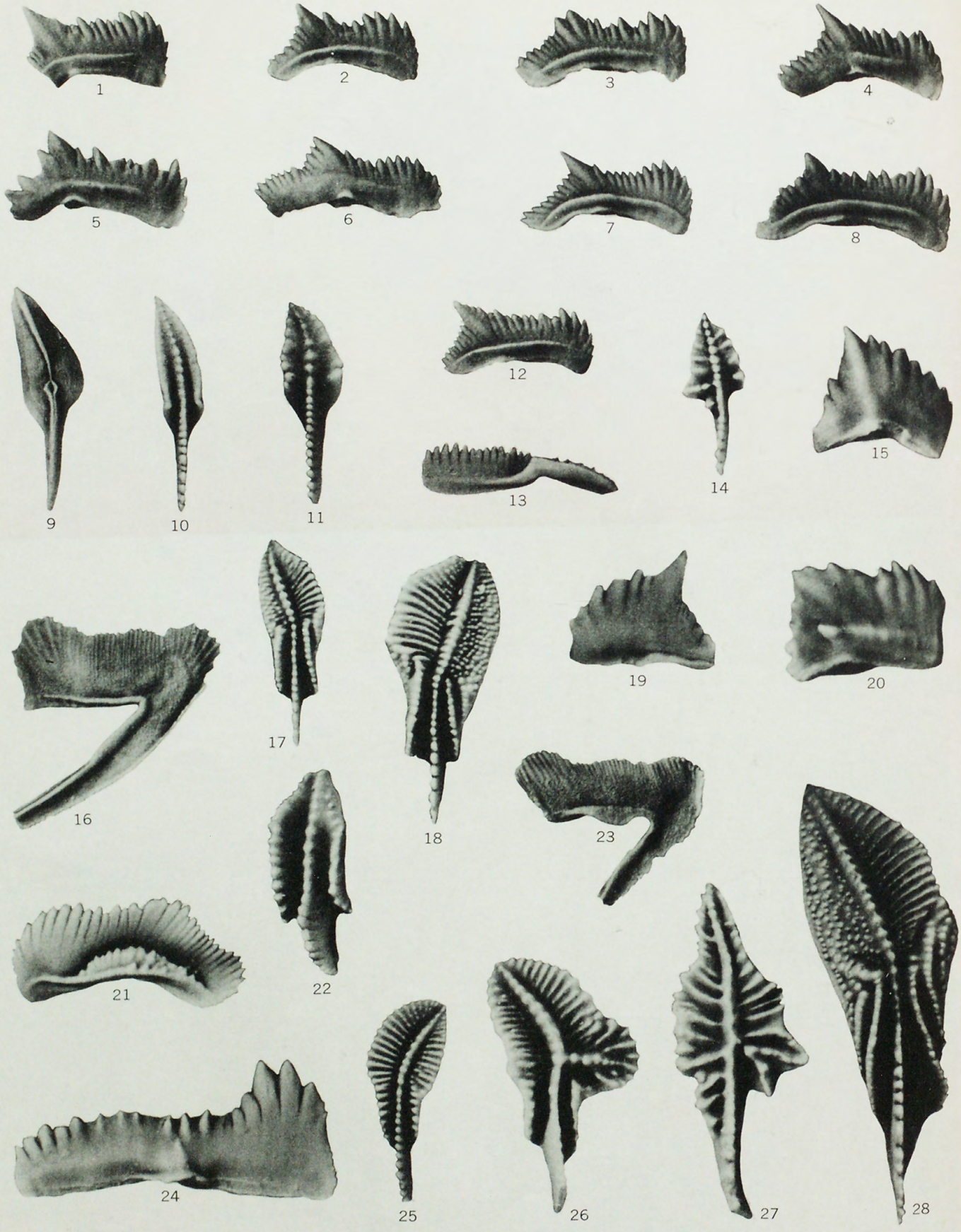

CONODONTS OF THE CHAPPEL LIMESTONE

PLATE 49

[All figures 30×. Figures 1–9, 11–13 and 19 are of specimens from a collection assigned to the *Siphonodella cooperi* faunal zone; figure 10 is of a specimen from a collection assigned to the *Gnathodus punctatus* faunal zone; and figures 14–18 and 20–28 are of specimens from collections from the Houy formation]

FIGURES 1–8, 12. *Elictognathus lacerata* (Branson and Mehl) (p. 386).
Lateral views of hypotypes from collection 9300 showing individual variation.
1. Inner side, USNM 114961; 2, inner side, USNM 114957; 3, inner side, USNM 114959; 4, outer side, USNM 114958; 5, outer side, USNM 114956; 6, outer side, USNM 114955; 7, inner side, USNM 114954; 8, inner side, USNM 114960; 12, inner side, USNM 114953.

9–11, 13. *Polygnathus communis* Branson and Mehl (p. 390).
9. Aboral view, hypotypes, USNM 114931, collection 9300; 10, oral view, hypotype, USNM 114928, collection 9301; 11, oral view, hypotype, USNM 114929, collection 9300; 13, lateral view, hypotype, USNM 114933, collection 9300.

14. *Pseudopolygnathus asymmetrica* Cooper.
Oral view, hypotype, USNM 114944, collection 9264.

15, 19, 20. *Pinacognathus profunda* (Branson and Mehl).
Lateral views of hypotypes.
15. Outer side, USNM 114978, collection 8653; 19, inner side, USNM 115004, collection 9300; 20, inner side, USNM 114977, collection 8653.

16, 23. *Dinodus fragosus* (E. R. Branson).
Lateral views of inner side of hypotypes from collection 9264.
16. USNM 114969; 23, USNM 114967.

17, 18, 25. *Siphonodella duplicata* (Branson and Mehl).
Oral views of hypotypes from collection 9264. Figures 17 and 18 are of specimens recorded in some of author's papers as *S. duplicata* var. A.
17. USNM 115139; 18, USNM 115140; 25, USNM 115132.

21. *Elictognathus bialata* (Branson and Mehl).
Lateral view of inner side, hypotype, USNM 114966, collection 9264.

22. *Polygnathus inornata* E. R. Branson.
Oral view, hypotype, USNM 115135, collection 9008.

24. *Spathognathodus aciedentatus* (E. R. Branson).
Lateral view, hypotype, USNM 115148, collection 9264.

26. *Siphonodella lobata* (Branson and Mehl).
Oral view, hypotype, USNM 115150. Collection 9264.

27. *Pseudopolygnathus prima* Branson and Mehl.
Oral view, hypotype, USNM 114940, collection 9264.

28. *Siphonodella quadruplicata* (Branson and Mehl).
Oral view, hypotype, USNM 115146, collection 9264.

PLATE 50

[All figures 30×. Figure 1 is of a specimen considered reworked into a collection assigned to the *Gnathodus punctatus* faunal zone; figures 2–22 are of specimens from collections from the Houy formation]

FIGURE 1. *Panderodella gracilis* (Branson and Mehl).
Oral view, hypotype, USNM 114827, collection 9053.

2. *Icriodus* sp.
Oral view, hypotype, USNM 114843, collection 9264.

3. *Branmehla inornata* (Branson and Mehl) (p. 381).
Lateral view of inner side, hypotype, USNM 115120, collection 9264.

4. *Drepanodus* sp.
Lateral view, hypotype, USNM 127996, collection 9264.

5. *Scolopodus* sp.
Lateral view, hypotype, USNM 127997, collection 9264.

6. *Branmehla disparilis* (Branson and Mehl).
Oral view, hypotype, USNM 114854, collection 9264.

7. *Ancyrognathus quadrata* Branson and Mehl.
Oral view, hypotype, USNM 114846, collection 9264.

8. *Palmatolepis subperlobata* Branson and Mehl.
Oral view, hypotype, USNM 114826, collection 9264.

9. *Panderodella glabra* (Ulrich and Bassler).
Oral view, hypotype, USNM 114822, collection 9264.

10. *Panderodella distorta* (Branson and Mehl).
Oral view, hypotype, USNM 114828, collection 9264.

11. *Polygnathus linguiformis* Hinde.
Oral view, hypotype, USNM 114904, collection 9264.

12. *Ancyrognathus bifurcata* (Ulrich and Bassler).
Oral view, hypotype, USNM 114834, collection 9264.

13. *Neoprioniodus mutabilis* (Branson and Mehl).
Lateral view of inner side, hypotype, USNM 114927, collection 9264.

14. *Palmatolepis perlobata* Ulrich and Bassler.
Oral view, hypotype, USNM 114830, collection 9264.

15. *Spathognathodus jugosus* (Branson and Mehl).
Oral view, hypotype, USNM 114867, collection 9264.

16. *Panderodella quadrantinodosa* (Branson and Mehl).
Oral view, hypotype, USNM 114820, collection 9264.

17. *Palmatolepis rugosa* Branson and Mehl.
Oral view, hypotype, USNM 114831, collection 9264.

18. *Polylophodonta confluens* (Ulrich and Bassler).
Oral view, hypotype, USNM 114849, collection 9264.

19. *Polygnathus pennata* Hinde.
Oral view, hypotype, USNM 127851, collection 9266.

20. *Palmatolepis unicornis* Miller and Youngquist.
Oral view, hypotype, USNM 127853, collection 9266.

21. *Ancyrognathus euglyphea* Stauffer.
Oral view, hypotype, USNM 127998, collection 9266.

22. *Palmatolepis subrecta* Miller and Youngquist.
Oral view, hypotype, USNM 127854, collection 9266.

CONODONTS OF THE CHAPPEL LIMESTONE