OKLAHOMA GEOLOGICAL SURVEY
Carl C. Branson, *Director*
GUIDE BOOK XVI

Late Paleozoic Conodonts from the Ouachita and Arbuckle Mountains of Oklahoma

MAXIM K. ELIAS

The University of Oklahoma
Norman
1966

CONTENTS

PLATES

Late Paleozoic Conodonts from the Ouachita and Arbuckle Mountains of Oklahoma*

Maxim K. Elias†

ABSTRACT

The conodont subgenus *Harltonodus* and six species from the Late Mississippian of Oklahoma, which were originally described by me in 1959, are here more completely described and discussed in the light of subsequent publications. The 1959 illustrations are in part redrawn with greater detail and are arranged in stratigraphic order, which is correlated with the standard biostratigraphic zones of Western Europe.

The species and subspecies introduced in 1959 and described are: *Gnathodus* (*Harltonodus*) *bransoni*, *G.* (*H.*) *minutus*, *Neoprioniodus rynikeri*, *N. cassilaris keokukensis*, and *N. miseri*. Three forms are introduced here: *Gnathodus* (*Harltonodus*) *delicatus hassi*, new subspecies, *Neoprioniodus erectus rexroadi*, new subspecies, and *N. higginsi*, new species.

The concepts of the following taxa are discussed and/or emended: *Gnathodus* (*Harltonodus*) *bilineatus* (Roundy), *G.* (*H.*) *bilineatus smithi* Clarke, *G.* (*H.*) *delicatus* Branson and Mehl, *G.* (*H.*) *liratus* (Youngquist and Miller), *G.* (*H.*) *multilineatus* Elias, *Neoprioniodus ligo* (Hass), *N. erectus* Rexroad, *N. scitulus* (Branson and Mehl), *N. tulensis* (Pander), *N. cassilaris* (Branson and Mehl), *N. peracutus* (Hinde), *N. solidiformis* (Elias), *N. alatoideus* (Cooper), *N. spathatus* Higgins, genus *Hindeodelloides* Huddle, and *Hindeodelloides bicristatus* Huddle.

INTRODUCTION

Bruce H. Harlton was one of the first geologists to find conodonts in the Late Paleozoic rocks of the Ouachita Mountains. In 1933 he illustrated a few conodonts from the Johns Valley Shale at its type locality and from the Wapanucka Formation, which he believed to be contemporaneous. In subsequent stratigraphic papers (1934, 1938, 1947) he mentioned the presence of conodonts in the siliceous shale units, each having, as he claimed, its own distinctive conodont fauna. However, he neither illustrated them nor supplied lists of identifications. Hugh D. Miser, Thomas A. Hendricks, and other geologists of the U. S. Geological Survey collected samples with conodonts from a number of localities in the Ouachita Mountains, particularly from the Stanley Shale of Arkansas and Oklahoma, and these specimens, together with collections made by Wilbert H. Hass, furnished the material which Hass identified and from which he established the stratigraphic range of more than a dozen species of conodonts. Because nearly all these conodonts are found only as molds in various rocks, Hass published a number of line drawings made from photographs of latex impressions of conodonts, all from the "Middle division of the Arkansas novaculite," except one from the "basal part of the Stanley shale," that of *Gnathodus bilineatus* (Roundy) (Hass, 1951, pl. 1, fig. 1; redrawn here, pl. 2, fig. 15).

The conodonts from the Arkansas Novaculite of Arkansas and its partial equivalent, the Woodford of Oklahoma, were previously described by Cooper (1931a, 1931b, 1935), who also published a comprehensive and beautifully illustrated monograph on the conodonts of the

* This paper is a revision and expansion of an earlier study (Elias, 1959).

† Emeritus professor of geology, University of Nebraska.

Bushberg-Hannibal (pre-Welden) horizon in the northern Arbuckle Mountains (1939). Thus considerable information is at hand on the conodonts from the Lower Mississippian of southern Oklahoma and southwestern Arkansas, but, as this paper shows, additional important information on these fossils may be expected even from the Mississippian of this region.

The method of obtaining conodonts by washing them out of shale has an inherent drawback in that the more fragile conodonts break into unidentifiable fragments. For example, despite the large number of good conodonts recovered by Cooper from the pre-Welden shales, several important conodont groups, such as hindeodells, hindeodelloids, neoprioniodids, and others, are represented in his conodont plates by comparatively few and greatly fragmented specimens. These same fragile groups are also poorly represented in the small conodont fauna from the Caney Shale of the northern Arbuckle Mountains described by Branson and Mehl (1941a). The fact that the fragile conodonts are actually present in fair numbers in the Late Paleozoic rocks of the Arbuckle and Ouachita Mountains is now being proved by repeated collection of shale samples containing conodonts and their molds. Direct collection of conodonts and their molds as individuals in situ in rock fragments (mostly shale) is admittedly tedious and slow, but it seems to be the only method that ensures, in the long run, a reasonably complete conodont representation from all of the local conodont-bearing stratigraphic horizons. Only when reasonably complete conodont faunas are established is it possible to determine which of the conodonts are truly good horizon markers and which have long stratigraphic ranges.

Acknowledgments.—The Ouachita Mountains conodonts described and illustrated in this paper were discovered and collected in the field in 1957 and 1958 by Allan P. Bennison, Lewis M. Cline, Norman L. Johnson, and me, mostly in and near Kiamichi Mountain and the Potato Hills. Our collections are far from complete, but even so they are the first documented conodont evidence from several conodont-bearing horizons in the Stanley Shale and other formations in Oklahoma, and some of them throw new light on the age of the lower part of the Stanley. Many more conodonts from the Ouachita and Arbuckle Mountains have been collected, prepared, and sketched, but lack of time (and space) prevents description and illustration here, and they may be described subsequently. Most of the work in collecting, preparation, sketching, and identification of the described conodonts was sponsored by Dr. C. W. Tomlinson, but important new conodonts from the lower part of the Stanley Shale of the Potato Hills were collected in the course of field work by Allan P. Bennison and Norman L. Johnson of the Sinclair Oil & Gas Company, in which work I participated. I subsequently studied the conodonts for the company and I am grateful for its permission to publish my conodont identifications.

METHOD OF STUDY AND SKETCHING

The procedure employed in the study and sketching of the Ouachita Mountains conodonts and most of those from the Arbuckle Mountains may not be the best possible method, but it is justified by (1) their peculiar state of preservation, (2) the ability of the writer to sketch, and (3) time limitations. If there were at least three or four times as much time available and if complex and delicate illumination for photographing were to be utilized, more exact images of the conodonts could be obtained. Perhaps this same situation confronted Harlton two decades ago, and somewhat later Hass seemingly experienced the same difficulty despite the availability of more elaborate photographic equipment at the U. S. National Museum. Accordingly, only a few conodonts from the Johns Valley and the Wapanucka were illustrated by Harlton, and only one plastotype of a conodont was sketched by Hass (1951, p. 2530, pl. 1, fig. 1) from the basal Stanley Shale (he also published superb photographs of the much better preserved Barnett Shale conodonts from Texas, 1953).

After obtaining a fair number of conodonts and their molds from the shales of different Late Paleozoic ages, I was confronted with the need to demonstrate this record graphically in a reasonably short time and in a way that could be useful for stratigraphic purposes. I therefore decided to sketch the microscope images of the fossils without the aid of the camera lucida.

The main reasons for abandoning the use of the camera lucida were again the complexity of technique and the time element. The conodonts collected presented a motley group of states of preservation. Fully preserved conodonts were extremely rare. Normally only some portions of a conodont were left embedded in the shale; the others were crushed out, and the surface of fractures variously oriented. In only a few cases did a certain light direction produce the clearest possible image of all pertinent details of a conodont in one setting; but even in these cases the best light direction was only in a few instances that from the upper-left corner, the standard direction used in photographing fossils. Some good conodont molds were impressed upon a microscopically uneven surface caused by the gritty nature of the shale. In order to view the complete outline of a conodont (or its mold) and to observe all its pertinent details (denticles, grooves, and other microstructures) with adequate illumination, it was necessary in most cases to rotate a specimen completely.

The devised method of sketching is as follows:

(1) The principal dimensions of a conodont (or its mold) were measured by use of the reticle in the ocular of a binocular microscope. In most cases, several orientations of a conodont were needed to obtain the various measurements because the best illumination for each measured distance is essential for exactness of the whole image. The light should be sufficiently strong for visibility, especially for specimens in which the impression of a conodont is black upon a background of black shale. It is the luster of the impression that distinguishes the conodont impression from the surrounding dull matrix. It was found best to leave the conodonts (or their molds) unmounted when sketching in order to allow complete freedom in orientation. A standard magnification of x40 was used in all cases. The sketches reproduced herein (pls. 1, 2) have been reduced by 25 percent to a uniform magnification of x30.

(2) Details were sketched after the principal dimensions were measured, good understanding of the morphology was reached, and after the presence of cracks, along which some parts were broken off, and other pertinent details were established and understood. After the dimensions were plotted on sketch paper, a freehand filling in of the over-all outline and of details within it was made. Conodont impressions in shale fragments were taken between two fingers of one hand and turned to various positions for better observation of the different parts. The other hand was used for sketching.

(3) Shading was done with the light placed in the upper-left corner of a properly oriented conodont—the standard position. Molds were illuminated in the same way.

TAXONOMY OF CONODONTS

Technical difficulties.—Circumstances conspire to make the taxonomy of conodonts complex and difficult. One difficulty is the existence of a dual nomenclature: one for individual conodonts and another for "assemblages" of conodonts found in apparent or assumed combinations. The genera established for the former are admittedly artificial "form genera," but they are indispensable for classification of by far the greater number of conodonts collected. The first conodont genera (introduced by Pander in 1856) are of this kind. The fact that their types are lost and that their original illustrations are generalized and incomplete adds another difficulty to conodont taxonomy.

Great susceptibility to becoming electrically charged by even slight friction, coupled with fragility, adds to the difficulties in professional handling of these microscopic fossils. Permanent mounting protects them from breakage or loss, but, on the other hand, prevents complete study and illustration because only one side remains exposed. When more than one individual of a species is collected, a combination of differently mounted specimens provides for complete illustration, but for most species of the conodonts collected in the Arbuckle and Ouachita Mountains only one sufficiently preserved specimen is available.

Because of the scarcity of individuals of nearly all species, it is impossible to establish their variability and ontogeny. Some students of conodonts do not mention size, most give no dimensions for their types, and some (especially in the past) maintain no standard magnification for illustrations.

Selection of generic characters.—Selection of generic characters for conodont form genera is obviously arbitrary. Although genera gradually become more or less stabilized, many generic concepts are still in a state of flux, and from time to time are being revised. Of course, this is the case in many other groups of fossils, but, because of artificiality of the conodont genera and lack of ontogenetic and variability controls in establishment of conodont species, the generic concepts of conodonts are particularly unstable and subject to revision. Just as in the case with other groups of fossils, a critical time for revision of genera arises when intermediate forms between two or more supposedly sharply different genera are discovered. Such intermediate forms, or connecting links, are particularly apt to occur when, as in the present case, fossils are newly collected from stratigraphic sections which previously yielded few, if any, specimens.

In his important revision of Pennsylvanian conodonts Ellison (1941, p. 109) remarked: "Little is known concerning the conodonts either of the upper Mississippian or of the beds of questionable age variously referred to the Mississippian or the Pennsylvanian." It is to this Late Mississippian-Early Pennsylvanian interval of time that many of the recently collected conodonts of southern Oklahoma belong, and in the course of work on them I became aware that even the earlier Mississippian conodonts, down to the inception of Carboniferous time, are in need of taxonomic reappraisal for the reception of conodonts recently collected and studied from the Ouachita and Arbuckle Mountains.

Taxonomy and stratigraphy.—Paleontologists are becoming more aware of the necessity of working out the taxonomy of their fossils in intimate contact with advances in detailed stratigraphy. The whole future of paleontology depends upon its adjustment to detailed stratigraphy, not only because such adjustment assures its effective use in economic geology, but because it also assures progress in our understanding of fossils as ancient organisms, whose shape and size were dependent upon a combination of fluctuating environments and the march of time in the same manner as they are in extant organisms; and it is the detailed stratigraphy that provides a paleontologist with a down-to-earth control that protects him from premature generalizations based upon erroneous stratigraphic premises.

Procedure in revision of genera and species.—The primary aim of taxonomy is orderly cataloging. It is an indispensable tool that allows us to handle the millions of living and fossil species. Revision of taxonomy of even a small group of these organisms should be expedited with the least disturbance to the previously established orderly cataloging, no matter how imperfect. One of the ways of introducing a new genus or a new species is first to "smuggle" it in as a subgenus or subspecies. This method, frequently practiced in the past, perhaps should not be now recommended for natural genera and species. On the other hand, this practice seems still proper and desirable in handling of artificial genera and species. One of its advantages is that it provides a solid link with previously used and well-known generic and specific names, an important help in adjusting our memory of the newly gained knowledge to that previously accumulated. Another advantage is that it provides for a period of time in the course of which the validity and practicability of a new taxonomic unit may be tested by various workers upon fossils in question.

Basic assumptions in conodont taxonomy.—E. O. Ulrich, the founder of the modern taxonomy of Paleozoic bryozoans, was labeled by his contemporaries as a "species maker," implying that he created an unnecessarily large number of fossil species. In some cases, we are now finding it necessary to recognize two or more species where Ulrich saw only one. When dealing with the great number of conodonts recently collected, we naturally try to identify as many of them as possible with those previously described. Knowing so little about their variability and ontogeny, we are apt to consider some deviations from a type with which we attempt to identify our newly collected form as being mere individual variations. It is when we collect from a number of successive horizons, and our collection becomes large enough for the recognition of slight but perceptible evolutionary changes in what previously was considered a long-ranging and more or less variable genus or species, that a reevaluation of the taxonomic significance of various characters becomes timely, as it may lead to greater usefulness of a fossil group. Such is the present situation with the Carboniferous conodonts of southern Oklahoma.

In connection with this research some of the pertinent previous taxonomic errors and confusion are analyzed and remedied. The illustrations of the conodonts involved in them are republished in the form of sketches at a uniform scale of x30, and arranged in stratigraphic order.

SYSTEMATIC DESCRIPTIONS

Family IDIOGNATHODONTIDAE Harris and Hollingsworth, 1933

Genus *GNATHODUS* Pander, 1856

Subgenus *Harltonodus* Elias, 1959

Type species: *Polygnathus bilineatus* Roundy, 1926.*

?1900. *Gnathodus mosquensis* Hinde (not Pander): p. 342; figs. 2-4.
?1928. *Polygnathus* (*Gnathodus*) *mosquensis* Holmes (not Pander): p. 11, 18, 37; pl. 7, figs. 2-4 (not pl. 6, fig. 31).
1959. *Gnathodus* (*Harltonodus*) Elias: p. 144.
not 1856. *Gnathodus mosquensis* Pander: p. 33-34, 90; pl. 2A, figs. 10a-c.
not 1926. *Gnathodus mosquensis* Roundy: p. 12; pl. 2, figs. 6a-d (Pander's figures republished).
not 1926. *Gnathodus mosquensis* Ulrich and Bassler: p. 54; fig. 5, subfig. 14 on p. 44 (one of Pander's figures republished).
not 1928. *Gnathodus mosquensis* Holmes: p. 10; pl. 6, fig. 31 (Pander's figure republished).
not 1939. *Gnathodus mosquensis* Cooper: p. 388; pl. 41, figs. 23-25, 30-32.

The subgenus *Harltonodus* was proposed (Elias, 1959) for conspicuously lopsided bar conodonts previously placed by some in *Gnathodus* and by others in *Polygnathus*. It differs from both of these genera in having the outer part of the platform two to three times as wide as the inner part, the two parts also bearing more or less different oral (upper) sculpture. The outer part is covered with numerous variously arranged round or elongate (ridgelike) tubercles, whereas the inner part is mostly covered with subequal transverse ridges, which may dwindle to tubercles, customarily at the posterior. The latter type of sculpture characterizes both outer and inner parts of the symmetrical platform in the Devonian *Icriodus* Branson and Mehl; Devonian-Mississippian *Polygnathus* Hinde; Mississippian *Pseudopolygnathus* Branson and Mehl, *Siphonodella* Branson and Mehl, and *Taphrognathus* Branson and Mehl; Mississippian-Permian *Cavusgnathus* Harris and Hollingsworth; Pennsylvanian *Polygnathodella* Harlton and *Streptognathodus* Stauffer and Plummer; and Pennsylvanian-Permian *Gondolella* Stauffer and Plummer.

No other known genus or subgenus seems to have a similarly asymmetrical sculpture, and thus it may also be considered characteristic of the subgenus *Harltonodus*.

Because the oral (upper) surface of the type species of *Gnathodus* Pander, *G. mosquensis* (Pander, 1856, pl. 2A, figs. 10a-c), is unknown, we know not what its sculpture is. However, judged by Pander's illustrated aboral (lower) view of the same (republished by Roundy, 1926, pl. 2, fig. 6c), the widths of the outer and inner sides of its platform are subequal. Because of this fact it would seem proper to continue to place in *Gnathodus* sensu stricto all species which have equal to subequal sides of the platform, orally sculptured or unsculptured. Here belong, therefore, *Gnathodus texanus* Roundy (not his *Polygnathus texanus*), *G. inornatus* Hass, and similar Mississippian species placed by various authors either in *Gnathodus* or *Spathognathodus* (*Spathodus*) Branson and Mehl. As Huddle judiciously remarked (1934, p. 89), "*Spathodus* [now *Spathognathodus*, because *Spathodus* is preoccupied] is probably a synonym of *Gnathodus* Pander, but until the true characters of Pander's genus are determined it will be advisable to use the name *Spathognathodus*." Hence it would seem proper to accept *Spathognathodus* as another subgenus of *Gnathodus* if we wish to retain this genus at all, as most paleontologists do.

Stratigraphic significance.—The stratigraphic range of *Gnathodus* (*Spathognathodus*) is from Silurian to Lower Permian, whereas that of *Gnathodus* (*Harltonodus*) is strictly Mississippian.

* No type species was designated in 1959, but the first described species of the subgenus was *G.* (*H.*) *bilineatus* (Roundy, 1926).

Hass (1950, p. 1581) summarized the stratigraphic significance of lopsided gnathodids in the Stanley-Jackfork rocks of the Ouachita Mountains by stating that "*Gnathodus bilineatus* or a very closely related species" ranges from the "lower part of the Stanley to the Wesley siliceous shale of Harlton" that is, it ranges throughout Stanley-Jackfork rocks.

Gnathodus (Harltonodus) bilineatus (Roundy, 1926)

Pl. 1, figs. 3-12

1926. *Polygnathus bilineatus* Roundy: p. 13; pl. 3, figs 10a-c.
1941a (part). *Gnathodus pustulosus* Branson and Mehl: p. 172; pl. 5, figs. 36, 37 (not figs. 32, 38) (redrawn here as pl. 1, figs. 5, 6).
1953 (part). *Gnathodus bilineatus* Hass: p. 78-79; pl. 14, figs. 25, 26 (not figs. 28, 29).
1956 (part). *Gnathodus bilineatus* Elias: p. 118; pl. 3, figs. 26, 29 (not figs. 23-25) (redrawn from Hass, 1953, pl. 14, figs. 25, 26).
1956 (part). *Gnathodus pustulosus* Elias: p. 115; pl. 3, figs. 1, 6* (not figs. 2, 3) (redrawn from Branson and Mehl, 1941a, pl. 5, figs. 36, 37).
1957. *Gnathodus modocensis* Rexroad: p. 30-31; pl. 1, figs. 17, 17a.
1957 (part). *Gnathodus bilineatus bilineatus* Bischoff: p. 21; pl. 3, figs. 11, 16-18 (not figs. 15, 19, 20).
1958. *Gnathodus modocensis* Rexroad: p. 17-18; pl. 1, fig. 2.
1959. *Gnathodus (Harltonodus) bilineatus* Elias: p. 145; pl. 1, figs. 3-12.
1962. *Gnathodus bilineatus* Higgins: p. 14; pl. 2, fig. 25; pl. 3, fig. 32.
1962 (part). *Gnathodus bilineatus bilineatus* Bartenstein and Bischoff: p. 64; pl. 6, fig. 40.
1964. *Gnathodus bilineatus modocensis* Rexroad and Furnish: p. 670; pl. 111, figs. 4, 5.
not 1959. *Gnathodus bilineatus* Voges: p. 282; pl. 33, figs. 31-33.

Holotype.—USNM 115101; *Polygnathus bilineatus* Roundy, 1926 (pl. 3, figs. 10a-c), Barnett Shale, Texas; Hass, 1953 (pl. 14, fig. 26).

Description.—Gnathodids with "shallow V-shaped valley" between principal (median) ridge and ridgelike inner side of platform (cup), a character indicated by the specific name *bilineatus*. The lesser development of the "valley" and the differentially sculptured oral side of the platform influenced Roundy's decision to separate from his *Polygnathus bilineatus* another species, *P. texanus*, which Hass (1953) considered a mature form of *bilineatus*. I suggested (1959, p. 146) restricting *bilineatus* to the sense originally intended by Roundy, which makes it possible to add the following characters for this species: oral side of the wider (outer) side of platform ornamented with tubercles, which are somewhat irregularly distributed but with a mixed tendency toward lineation in both longitudinal and transverse rows; and oral side of narrower (inner) side of platform ornamented with subequal transverse bars, which customarily dwindle into separate tubercles in the posterior of the platform.

Discussion.—Hass' treatment of the species *Polygnathus texanus* Roundy as a mere mature form of *P. bilineatus* Roundy may be questioned. In *Gnathodus pustulosus*, identified by Hass (1953, p. 78) with *P. bilineatus*, the outer side of the platform (cup) in the mature form (Branson and Mehl, 1941a, pl. 5, fig. 38) is not "expanded laterally in its anterior two-thirds" as in *P. bilineatus* (Hass, 1953, p. 79; pl. 14, figs. 28, 29; republished by Elias, 1956, pl. 3, figs. 23, 25). Such expansion is observable, on the other hand, in a smaller than medium-sized example of *G. pustulosus* (see Branson and Mehl, 1941a; pl. 5, fig. 32; redrawn by Elias, 1956, pl. 3, fig. 14). By keeping Roundy's original understanding of *P. bilineatus* we can identify with it only the holotype and another illustrated specimen of *G. pustulosus* Branson and Mehl (1941a; pl. 5, figs. 35 (holotype), 37; redrawn by Elias, 1956, pl. 3, figs. 1, 6), which have an irregularly tuberculate sculpture of the outer side of the platform.

Under this restricted understanding of *Gnathodus (Harltonodus) bilineatus* the remaining two specimens illustrated by Branson and Mehl (1941a, pl. 5, figs. 32, 38) may be classified as *Gnathodus (Harltonodus) bransoni* Elias.

I agree with Hass (1953, p. 79) that Cooper's "*Gnathodus bilineatus*" (1939, p. 388, pl. 42, figs. 59, 60; pl. 1, fig. 2, herein) from the pre-Welden shale of Oklahoma cannot be put in synonymy with *G. bilineatus* (even in the broad sense used by Hass) because "Roundy's species possesses many characteristics not recorded by Cooper." I consider it a potential new species ancestral to both *G. bilineatus* and *G. bransoni*,

* Cited erroneously as figures 3 and 5 by Elias (1959, p. 146) in the synonymy of *G. (H.) bilineatus*, but identified correctly in the text.

the arrangement of the nodes in the outer part of the platform showing a combination of the arrangements displayed in both.

Occurrence.—Lower and middle parts of the Stanley Shale, Delaware Creek Member of the Caney Shale, and the Barnett Shale of Texas.

Gnathodus (Harltonodus) bilineatus smithi Clarke, 1961

Pl. 1, figs. 13, 14

1961. *Gnathodus smithi* Clarke: p. 26-27; pl. 4, figs. 13, 14; pl. 5, figs. 9, 10.

Holotype.—PS 870 (H. M. Geological Survey, Edinburgh); *Gnathodus smithi* Clarke, 1961 (pl. 4, figs. 13, 14), Upper Limestone, Monkcastle, Scotland.

Discussion.—Clarke noted "close similarity between *G. smithi* and *G. pustulosus* Branson and Mehl, but the latter has a more rectangular outer lobe bearing a definite line of nodes close to the carina, features not present in *G. smithi*" (1961, p. 27).

The reference to a more rectangular outer lobe (outer part of cup) in *G. pustulosus* is hardly applicable in a comparison with the specimen of plate 5, figure 38, among the specimens illustrated by Branson and Mehl (1941a), whereas the reference to a definite line of nodes close to the carina is not clearly demonstrable in the specimens of plate 5, figures 32 and 37, of the same paper, where the alleged line of nodes does not extend to the posterior end of the carina. On the other hand, the two species appear to differ in another way, the existence of a liplike anterolateral protrusion in the inner lobe (part) of the cup in *G. smithi*, which extends anteriorly farther than the elevated nodose portion of the same lobe. This character is particularly noticeable in plate 5, figures 9 and 10 (Clarke, 1961). In this respect *G. smithi* is closer to the original *G. bilineatus* (Roundy, 1926; pl. 3, fig. 10a-c), from the Barnett Shale of Texas, than to the original *G. pustulosus* from the Delaware Creek Member of the Caney Shale in Oklahoma (Elias, 1956). On the other hand, the holotype of *G. smithi* (redrawn here as pl. 1, fig. 14, from Clarke, 1961, pl. 4, fig. 13) is closer to *G.* (*H.*) *bransoni* from the Barnett of Texas (redrawn here as pl. 1, fig. 19, from Hass, 1953, pl. 14, fig. 29).

In view of these facts it would seem best to regard *G. smithi* as a subspecies of *G. bilineatus*, at a taxonomic level with *G. bilineatus semiglaber* Bischoff (1957, p. 22; pl. 3, figs. 11, 15-20; pl. 4, fig. 1).

Occurrence.—Clarke recorded the occurrence of *G. smithi* in Monkcastle, Glencart, and Linn Spout of the Upper Limestone Group of Scotland, and also in the "Castlecary limestone and shales" under the Millstone Grit (1961, table 1). The specimens (1961, pl. 5, figs. 9, 10) with the particularly prominent anterolateral protrusion are from the Monkcastle and Glencart. The recorded stratigraphic range places *G. smithi* in about the middle part of zone E in Scotland, as established by Currie (1954, table 1) upon the evidence of the goniatites. My opinion, based upon somewhat different morphologic analysis of the same goniatites, is that it correlates rather with zone P_2.

Gnathodus (Harltonodus) bransoni Elias, 1959

Pl. 1, figs. 15-20

1926. *Polygnathus texanus* Roundy: p. 14; pl. 3, figs. 13a-b.

1941a (part). *Gnathodus pustulosus* Branson and Mehl: p. 172; pl. 5, figs. 32, 38 (not figs. 36, 37).

1951. *Gnathodus bilineatus* Hass: p. 2540; pl. 1, fig. 1 (p. 2530-2531).

1956 (part). *Gnathodus bilineatus* Elias: p. 118; pl. 3, figs. 23-25 only (= Hass, 1953, pl. 14, figs. 28, 29; and Roundy, 1926, pl. 3, fig. 13a).

?1956. *Gnathodus* cf. *G. bilineatus* Elias: p. 118; pl. 3, fig. 40.

1956 (part). *Gnathodus pustulosus* Elias: p. 115; pl. 3, figs. 2, 3 (not figs. 1, 6) (redrawn from Branson and Mehl, 1941a, pl. 5, figs. 32, 38).

1957 (part). *Gnathodus bilineatus bilineatus* Bischoff: p. 21; pl. 3, figs. 15, 19, 20 (not figs. 11, 16-18).

1958. *Gnathodus bilineatus* Stanley: p. 464-465; pl. 68, fig. 7.

1959. *Gnathodus* (*Harltonodus*) *bransoni* Elias: p. 147; pl. 1, figs. 13-18.

1961. *Gnathodus bilineatus* Higgins: pl. 10, fig. 5.

1962 (part). *Gnathodus bilineatus bilineatus* Bartenstein and Bischoff: p. 64-65; pl. 6, fig. 41.

Holotype.—USNM 115103; *Polygnathus texanus* Roundy, 1926 (pl. 3, figs. 13a,b). A photograph of the oral view of this specimen is one of Hass' illustrations of *Gnathodus bilineatus* (1953, pl. 14, fig. 28).

The specific name *texanus* could not be used for the species when it was transferred by Cooper (1939, p. 388) and later by Hass (1951, p. 2534) and Elias (1956, p. 118) to the genus *Gnathodus* because *Gnathodus texanus* was preempted by Roundy (1926, p. 12).

The specific name *pustulosus* is also unavailable because the holotype of *Gnathodus pustulosus* Branson and Mehl (1941a, pl. 5, fig. 36, Univ. Mo. C543-1) is here referred to *Gnathodus (Harltonodus) bilineatus* (Roundy) sensu stricto. Hence *G. pustulosus* becomes a junior synonym for *G. bilineatus*.

In view of these facts the species was given the new name *G. bransoni* (Elias, 1959, p. 147). Its presence is here recognized in the material from the lower part of the Stanley Shale of Oklahoma.

Description.—Strongly asymmetrical gnathodids with posterior end of main ridge (carina) bearing chevron-shaped nodes, and reinforced by two small short ridges on either side. Outer side of platform (cup) sculptured by subparallel rows of nodes, many of which are fused into short ridges along these rows, which are straight to curved, and in more or less diagonal orientation to the main ridge. The inner side of the platform is about half as wide as the outer side, with a single wide ridge divided transversely into small parallel ridges; its edge is angularly convex in the middle and concave at the flaring anterior.

Discussion.—*G. (H.) bransoni* differs from *G. (H.) bilineatus* (Roundy) by the regular linear arrangement of nodes and ridges in the outer side of the platform, by farther posterior extension of transverse bars in its inner side, and perhaps also by more pronounced concavo-convex outline of the outer edge of the inner side of the platform.

In view of the younger age of the Barnett Shale of Texas in relation to the Delaware Creek Member of the Caney Shale of Oklahoma (Elias, 1956, p. 69-70), the larger size of the Texas examples of *G. (H.) bransoni* over those of Oklahoma may be of stratigraphic significance. Furthermore, transverse ornamental ridges on the inner side of the platform in Oklahoma examples are more nearly subequal than are the corresponding ridges in the Texas examples. An apparent increase in size of *G. (H.) bransoni* with the advance of geologic time is indirectly supported also by the fact that all of the four examples of a closely related species, *G. (H.) minutus* Elias, in the lower part of the Stanley Shale in association with the typical Lower Mississippian conodonts, are much smaller than both Delaware Creek Shale specimens of *G. (H.) bransoni* (Branson and Mehl, 1941a, pl. 5, figs. 32, 38; redrawn by Elias, 1956, pl. 3, figs. 2, 3, and herein pl. 1, figs. 16, 17). Of similarly small size is Cooper's "*Gnathodus bilineatus*" from the pre-Welden shale (1939, pl. 42, figs. 59, 60; reillustrated here as pl. 1, fig. 2).

Occurrence.—Delaware Creek Member of Caney Shale of Oklahoma; questionably in basal Stanley Shale, 120 feet above the base, at Caddo Gap, Arkansas; and in Barnett Shale of Texas. A poorly preserved specimen (pl. 1, fig. 20) from the basal part of the Goddard Shale at its type locality in Oklahoma roughly matches the species.

Gnathodus (Harltonodus) delicatus
Branson and Mehl, 1938

1938. *Gnathodus delicatus* Branson and Mehl: p. 145; pl. 34, figs. 25-27.
?1939. *Gnathodus bilineatus* Cooper: p. 388; pl. 42, figs. 59, 60.
?1939 (part). *Gnathodus mosquensis* Cooper: p. 388; pl. 41, figs. 23-25; pl. 42, figs. 75, 76; questionably pl. 41, figs. 30-32.
1947. *Gnathodus perplexus* Mehl and Thomas (not Branson and Mehl, 1938): p. 10; pl. 1, fig. 4.
1959 (part). *Gnathodus delicatus* Hass: p. 394; pl. 46, figs. 3-5 (not fig. 7); pl. 48, figs. 1-3, 5 (not fig. 4).
1959. *Gnathodus bilineatus* Voges: p. 282; pl. 33, figs. 28-30.
1964. *Gnathodus delicatus* Rexroad and Scott: p. 29-30; pl. 2, figs. 4-6.
not 1951. *Gnathodus delicatus* Hass: pl. 1, fig. 4.
not 1963. *Gnathodus delicatus* Higgins, Wagner-Gentis, and Wagner: pl. 5, fig. 24; pl. 3, fig. 33.

Holotype.—Univ. Mo. C68-5; *Gnathodus delicatus* Branson and Mehl, 1938 (p. 145, pl. 34, fig. 26).

Discussion.—The original concept of *G. delicatus* Branson and Mehl has been expanded by Hass (1959) and by Rexroad and Scott (1964) to include *G. perplexus* Branson and Mehl. However, Cooper recognized the independence of the latter species by the peculiarities of the oral sculpture of the platform: "faintly pustulose, with a row of larger nodes along anterior edge almost normal to carina" in the wide outer part; and the narrow inner part "topped by a row of nodes parallel to carina" (Cooper, 1939, p. 388). On the other hand, Cooper has incautiously identified a number of his pre-Welden specimens from Oklahoma with *Gnathodus mosquensis* Pander, of which the oral surface of the platform is unknown (see the discussion of the subgenus *Harltonodus* above).

Most of the specimens placed by Cooper in *G. mosquensis* are fairly close to *G. delicatus* Branson and Mehl, as he tacitly recognized this fact by placing the latter species in his synonymy of *G. mosquensis* (1939, p. 388).

Description.—Hass' description of *G. delicatus*, based upon his own material from the Chappel Limestone of central Texas, is generally comprehensively and beautifully illustrated by a greater number of views (mostly oral) of the species than had been published previously. These illustrations add substantially to Hass' somewhat brief description (1959, p. 394) of the oral side of the platform (cup): "in its oral surface noded except for smooth marginal band" —actually not a constant character even within his own set of the illustrated specimens; and "Nodes on posterior one-half to three-quarters in inner side of cup generally fused into ridge paralleling carina"—also the case in only some specimens, whereas in the others, such as illustrated in his plate 48, figures 2 and 4, the nodes of the posterior half of the inner side are fused into subequal transverse bars.

Rexroad and Scott (1964, p. 30) characterized this same species, principally by the sculpture of its oral surface, thus:

> a low, broad platform ornamented by low nodes that tend to be arranged in rows subparallel to the carina. A single row of nodes is developed in the narrow inner side, and two or more rows generally are developed on the wide outer side of the platform . . . Minor variations in the arrangement of the nodes and the outline of the platform should not be considered taxonomically significant . . . The low, broad, asymmetrical outline of the platform and the linear arrangement of nodes seem to be consistent characters, and we believe *G. delicatus* should be restricted to forms having these characters.

Comparison.—The quoted principal characters for differentiation of *G. delicatus* are consonant with those used by me in 1959 for the same purpose: the lopsidedness of the platform in differentiation of the subgenus *Harltonodus* (1959, p. 144-145) and the arrangement of nodes on the outer part of the platform, irregular in *G. bilineatus* (Roundy) sensu stricto versus aligned in "parallel rows . . . straight to curved, and in more or less diagonal orientation to main ridge [carina]" in *G. (H.) bransoni* Elias (1959). The taxon was "not considered a valid species" by Rexroad and Collinson (1961, p. 7), but they gave no reason for their decision.

In my first paper on conodonts, I differentiated a new species, *Gnathodus multilineatus*, upon the basis of the occurrence in its "wider of the two expansions . . . [of] three to four parallel rows of small nodes, whereas similar nodes over the same expansion in *G. bilineatus* are arranged in six to eight or nine rows, which gently curve and converge toward the posterior" (1956, p. 119). The indicated difference in the sculpture of the wide outer side of the platform should be now understood as referred to *G. (H.) bransoni* Elias and not *G. bilineatus* sensu stricto. Because *G. (H.) delicatus* also has the nodes on the outer part of its nodose platform arranged in rows parallel to the carina, it is pointed out that *G. (H.) multilineatus*, as characterized in 1956, and particularly as restricted in 1959 (to the specimens illustrated in 1956 in pl. 3, figs. 49, 51-53 only), differs from *G. (H.) delicatus* by a greater regularity of the rows of nodes, accentuated by the development of straight grooves between the rows, which is not the case in *G. (H.) delicatus*. It further differs from the latter by having a substantially narrower carina and carinal nodes; these nodes in *G. (H.) multilineatus* are twice as long as wide, whereas in *G. (H.) delicatus* the corresponding cardinal nodes are consistently slightly wider than long; the nodes which are arranged in a single row in the narrow inner part of the platform in *G. (H.) multilineatus* are also longer than wide.

Occurrence.—Pre-Welden shale, Oklahoma (Cooper, 1939); topmost beds (*Bactrognathus communis* zone) of the Chappel Limestone, Texas (Hass, 1959, p. 395).

Gnathodus (Harltonodus) delicatus hassi
Elias, new subspecies

Pl. 1, fig. 21

1959 (part). *Gnathodus delicatus* Hass: p. 394; pl. 48, figs. 1-3, 5, 8 (?) (not pl. 46, figs. 3-7; pl. 48, fig. 4).
1959. *Gnathodus delicatus* Voges: p. 283; pl. 33, figs. 31-33.

Holotype.—USNM 115029; *Gnathodus delicatus* Branson and Mehl, 1938 (Hass, 1959, pl. 48, fig. 5; reillustrated herein, pl. 1, fig. 21).

Discussion.—Voges accepted Hass' broad understanding of *G. delicatus* but identified with it only the somewhat more massive forms (1959, pl. 33, figs. 31-33) of the gnathodids of the group, and referred the more delicate forms (1959, pl. 33, figs. 28-30) to *G. bilineatus.* Whereas the latter identification is questionable, the differentiation of the group into two taxa appears to be valid and may be accepted on a subspecies level. In fact, the first step toward such differentiation can be detected in the separated treatment by Hass (in his plates of illustrations) of the two stratigraphically different groups of specimens within his broadly understood *G. delicatus* in the Chappel Limestone of Texas. In one group he placed the more delicate specimens "from collections assigned to the *Bactrognathus communis* faunal zone" (1959, pl. 46, figs. 3-7), and in the other group the generally more massive specimens from the collections assigned to the *Siphonodella cooperi* faunal zone (1959, pl. 48, figs. 1-5, 8). The former zone is the highest of the three recognized by him in the Chappel Limestone (1959, p. 367) and was considered as "probably lower Osage," whereas the latter zone, where "the greatest thickness of the Chappel Limestone belongs," was assigned to the "Upper Kinderhook (Chouteau)."

In my opinion, however, the following two among Hass' illustrated specimens should be removed from *G. delicatus.* The one illustrated in his plate 46, figure 7, appears to be an immature *G. punctatus,* the outer side of its cup comparable to that of *G. punctatus* of Hass' plate 47, figures 15 and 17, whereas the inner side of this same cup is comparable to that of *G. punctatus* of Hass' plate 47, figure 13. The second specimen to be removed is that of his plate 48, figure 4, the inner side of its cup showing the small round nodes distinctly arranged in three adjacent subparallel rows at a sharp angle to the carina. In this and nearly all other respects the second specimen closely resembles the holotype of *Gnathodus perplexus* Branson and Mehl (1938, p. 145, pl. 34, fig. 24) from the Chouteau Limestone of Missouri, Hass placed *G. perplexus* in the synonymy of *G. delicatus,* an assignment with which I disagree.

Description and comparison.—The subspecies *G.* (*H.*) *delicatus hassi* includes the specimens of *G. delicatus* from the *Siphonodella cooperi* biozone which were illustrated by Hass (1959, pl. 48, figs. 1-3, 5). They are about the same size and shape as *G. delicatus* Branson and Mehl, but in most specimens the cup is somewhat larger and more nearly square in outline. Particularly characteristic of the subspecies is the conspicuously transverse elongation of its barlike "nodes" in the anterior one-half to two-thirds of the inner side of the cup.

The Sauerland specimens identified by Voges as *G. delicatus* are similar to the American specimens of *G.* (*H.*) *delicatus hassi,* especially in regard to the sculpture of the inner side of the cup, described above. In both American and German specimens of the new subspecies are "nodes on posterior one-half to three-quarters of inner side of cup generally fused into ridge paralleling carina" (Hass, 1959, p. 394), but this character does not encroach upon the abovementioned transverse barlike modification of the anterior "nodes" in this side of the cup.

Occurrence.—*Siphonodella cooperi* zone in the Chappel Limestone of Texas; middle part of the "*Pericyclus* Stufe" (cuII β/λ zones) of Sauerland.

Gnathodus (Harltonodus?) liratus
(Youngquist and Miller, 1949)

Pl. 1, figs. 22-24

1949. *Gnathodus liratus* Youngquist and Miller: p. 619-620; pl. 101, figs. 15-17.
1959. *Gnathodus* (*Harltonodus*?) *liratus* Elias: p. 148; pl. 1, figs. 19-21.

Holotype.—SUI 4178; *Gnathodus liratus* Youngquist and Miller, 1949 (p. 620; pl. 101, figs. 15-17); figure 15 reillustrated by Elias

(1959, pl. 1, fig. 19; reproduced herein, pl. 1, fig. 22).

Description.—Asymmetrical gnathodid with "considerably expanded" outer side of platform (cup), "relatively flat and . . . ornamented by irregularly spaced nodes" (Youngquist and Miller, 1949, p. 620). In top view of holotype (pl. 101, fig. 17), these same nodes are shown arranged in three rows, the nodes diminishing in size toward the interior of the platform. The inner side of the platform is shown ornamented by a single marginal nodose ridge instead of being transversely divided into small ridges, as is characteristic for the subgenus *Harltonodus*; hence the species is questionably referred to the subgenus.

Discussion.—Youngquist and Miller stated that their species "somewhat resembles" *G. pustulosus* Branson and Mehl, but differs "in having the inner oral margin of the platform sharply curved orad forming a narrow furrow between the edge of the platform and the carina; also the latter structure is stouter than in *G. pustulosus*."

The species is like *G.* (*H.*) *bilineatus* (Roundy) in having a furrow ("valley" of Roundy) between the main ridge (carina) and marginal (inner) ridge, the nodes of which, prior to retouching in the photograph (mentioned by the authors), could have been more like the short transverse ridges in the type of *G. bilineatus* (Hass, 1953, pl. 14, fig. 26); the whole outline of this marginal ridge is also much like that in Roundy's species. On the other hand, the arrangement of nodes in rows on the outer side of the platform seems to be transitional between the sculpture of *G.* (*H.*) *bilineatus* and that of *G.* (*H.*) *bransoni*.

In view of these facts, *G.* (*H.* ?) *liratus* may be considered, at least for the present, a distinct species. This view is strengthened by the recovery of two molds of a gnathodid quite similar to it from the shale exposed in Jerusalem Hollow, 6 miles southwest of Clayton, Oklahoma. In one of these molds (pl. 1, fig. 23) the outer side of the platform bears three parallel, slightly curved rows of nodes fully comparable in size and arrangement to those in the species from the Pella beds; and the second mold, of an aboral (lower) side of a platform (pl. 1, fig. 24) is an almost exact replica of the corresponding view of the Pella bed species (Youngquist and Miller, 1949, pl. 101, fig. 16).

Occurrence.—Pella beds (just above St. Louis Limestone), 4 miles south of Pella, Iowa; Johns Valley Shale (above Game Refuge Sandstone), near NW¼ NW¼ sec. 33, T. 1 N., R. 18 E., south side of Jerusalem Creek, 6 miles southwest of Clayton, Pushmataha County, Oklahoma. The strata in Jerusalem Hollow are correlated, upon the basis of the presence of *Goniatites choctawensis* reported by Cline and Shelburne (1959, p. 210), with the Delaware Creek Shale of the Arbuckle Mountains.

Gnathodus (Harltonodus) minutus Elias, 1959

Pl. 1, figs. 25-28

1959. *Gnathodus* (*Harltonodus*) *minutus* Elias: p. 148-149; pl. 1, figs. 22-25.

Holotype.—OU 5709; *Gnathodus* (*Harltonodus*) *minutus* Elias (1959, pl. 1, fig. 24); original illustration reproduced herein (pl. 1, fig. 27).

Description.—Small, strongly arched gnathodids, with the outer side of the platform two to two and a half times as wide as the inner side; outer side of the platform with three to four posterolaterally curved ornamental ridges, paralleling its curving outer edge; main (median) ridge prominent, nodose, posteriorly acuminate, and fused with subequally acuminate ends of the outer and inner sides of the platform. Inner side of the platform about as narrow as the main ridge, approximating it in height and nodosity, separated from it by a deep furrow, shallowing posteriorly. The remains of a flattened and tangentially sheared specimen (pl. 1, fig. 26) reveal the inner structure of the outer side of the platform, showing the roots of all four curving ornamental ridges. The posterior part of the main ridge is narrow, two and a half times as long as the platform.

Discussion.—This species resembles *G.* (*H.*) *bilineatus* in the outline of the platform and the deep furrow (valley) separating the main ridge from the nodose crest of the inner side of the platform; but the ornamentation of the outer side of the platform is quite different, approaching in its curving lineation that of *G.* (*H.*) *bransoni*. However, this ornamentation differs from that of the latter in the solid (and deep-seated) nature of the curving ornamental ridges, whereas corresponding ornamental ridges in *G.* (*H.*) *bransoni* are broken into short ridges and nodes. Another difference from the latter is the evenly curved posterodorsal edge of the outer side, and the absence of the anterior concavity in the edge of the inner side of the platform. In addition, *Gnathodus* (*Harltonodus*) *minutus* differs from both *G.* (*H.*) *bilineatus* and *G.* (*H.*) *bransoni* in being smaller and having a strongly arched platform. The increase in size from *G.* (*H.*) *minutus* to *G.* (*H.*) *bransoni* to *G.* (*H.*) *bilineatus* may have stratigraphic significance.

Occurrence.—Known only from the lower part of the Stanley Shale, 475 feet above its base, southwestern part of the Potato Hills, Oklahoma.

Gnathodus (Harltonodus) multilineatus Elias, 1956

Pl. 1, figs. 29-31

1956. *Gnathodus multilineatus* Elias: p. 119; pl. 3, figs. 49, 50, 51-53.

1959. *Gnathodus* (*Harltonodus*) *multilineatus* Elias: p. 149; pl. 1, figs. 26-28.

Lectotype.—Specimen illustrated by Elias (1956, pl. 3, fig. 49); reillustrated by Elias (1959, pl. 1, fig. 26; reproduced herein, pl. 1, fig. 29).

Description.—Asymmetrical gnathodids with the outer side of the platform sharply truncated and sculptured orally by subequal small nodes densely spaced in each of four (in holotype) rows, which are strictly parallel to the main ridge, and sharply separated from each other by narrow linear depressions. The inner side of the platform is about half the width of the outer side and extends only slightly farther anteriorly, ornamented by one (?) long nodose ridge (outer edge incomplete). The main ridge is serrated into elongate subequal denticles, with a slight tendency toward chevron shape at the posterior end. The two younger individuals (pl. 1, figs. 30, 31) have fewer rows of subequal nodes ornamenting the outer side of the platform, and one nodose ridge ornamenting the inner side.

Discussion.—*G.* (*H.*) *multilineatus* is nearest to *G.* (*H.*) *bransoni* but differs in that its platform has a straight outer edge, parallel to the main ridge, and by the greater regularity of its ornamentation; it consists of sharply differentiated rows of subequal nodes strictly parallel to the main ridge, instead of a combination of short ridges and nodes as in *G.* (*H.*) *bransoni.* For comparison with *G.* (*H.*) *delicatus*, see discussion of the latter.

Occurrence.—Upper part of Sand Branch Member, ⅛ mile east of Girty's station 2082, about 3 miles southeast of Wapanucka, Johnston County, Oklahoma.

Genus *NEOPRIONIODUS* Rhodes and Müller, 1956

Type species: *Prioniodus conjunctus* Gunnell, 1931.

The revision of Pander's genus *Prioniodus* by Öpik (1936), and particularly by Lindström (1954), cleared the way for the introduction of a new genus, *Neoprioniodus,* which embraces the species ranging from the Ordovician to the Lower Triassic and formerly assigned to *Prioniodus* in a broad sense. Lindström's definition of *Prioniodus* (1954, p. 589), "Compound conodonts with a subcentral cusp, from the base of which diverge three denticulate edges or processes, one posteriorly, one anteriorly, and one laterally," clearly excludes from the old genus the familiar "prioniodids" with an anteriorly placed (instead of subcentral) cusp, or fang, from which extends only one bar, or "process" (posterior to cusp), instead of three in three different directions.

In an attempt to preserve the well-established use of *Prioniodus,* Branson and Mehl suggested continuance of its broad application, although admitting that their study of the new material from Pander's type locality indicated that the type species, *Prioniodus elegans,* is an "atypical species" (1944, p. 241). Rhodes and Müller (1956) disagreed with this view and introduced the new generic name *Neoprioniodus* for the forms excluded from *Prioniodus* Pander by Lindström's emended generic definition, and selected the type species *Prioniodus conjunctus* Gunnell.

Rhodes and Müller (1956, p. 698) defined *Neoprioniodus* as follows:

> Compound conodonts consisting of a denticulate posterior bar, at the anterior end of which a large fang (main cusp) is developed. The base of this fang may or may not extend downward below the level of the bar to form an 'anticusp,' the anterior edge of which may or may not be denticulated. There is normally a basal cavity below the fang, which may be extended as a shallow groove on the aboral surface of the posterior bar.

The definition gives sufficient latitude for an inclusion in *Neoprioniodus* of nearly all species previously described as *Prioniodus*, except for a few strictly Ordovician forms with "three denticulate edges or processes, one posteriorly, one anteriorly, and one laterally" (Lindström, 1954, p. 589).

However, the selection of *N. conjunctus* as the type species makes the greatly expanded base of the main cusp in this species most typical for *Neoprioniodus*. Ellison described it thus: "anticusp plow-shaped, strongly extended below general aboral outline, widely expanded on inner side into a flaring apron, anterior edge of many specimens show germ denticles in transmitted light" (1941, p. 114). Close to *N. conjunctus* in this and other respects is Hass' species, *Prioniodus inclinatus* (1953, p. 87; pl. 16, figs. 10-14), from the Barnett Shale of Texas, in which anterior denticles are well developed (pl. 16, fig. 14), or an anterior shelflike projection for their development is evident (pl. 16, fig. 11).

Species which have a flaring apron and incipient to fully developed anterior denticles constitute only a small group of species customarily placed in *Prioniodus* (now *Neoprioniodus*), whereas most of them have a laterally compressed main cusp with no flaring basal expansion and no anterior denticles, nor shelflike anterior projection. Pending further division of the numerous prioniodids, other than *Prioniodus* and *Neoprioniodus* in the restricted sense, into smaller genera, tentative grouping of some species here described and revised appears desirable. Besides the group *Neoprioniodus* sensu stricto, three other groups are suggested: the *Neoprioniodus ligo* (Hass) group, the *N. cassilaris* (Branson and Mehl) group, and the *N. alatoideus* (Cooper) group.

Group of *Neoprioniodus ligo* (Hass) ("Lazy T" Prioniodids)

The group is characterized by perpendicular orientation of the bar to a straight tusk (cusp-anticusp combination), the whole resembling the "lazy T" of a cattle brand.

The stratigraphic range of the group is from the Delaware Creek Member of the Caney Shale to the basal part of the Springer group in the Ardmore basin. It occurs in the Barnett Shale of Texas, and in Illinois it ranges from the Keokuk to the Renault of the Chester Series.

Additional characters of the group are as follows:

1. Bar sharply differentiated from cusps-anticusps.
2. Anticusp shorter than cusp, normally half as long as cusp, and not less than one-third of cusp.
3. Denticles subequal, discreet to widely spaced.

It seems that the group originated from *Neoprioniodus cassilaris* (Branson and Mehl, 1941b, p. 186; pl. 6, figs. 11, 12, 16, 17) or related species through sharper differentiation of the bar from the "tusk," or cusp-anticusp as can be seen in what I believe to be a subspecies of *N. cassilaris*, which may be differentiated as *N. cassilaris* subspecies *keokukensis* Elias (originally differentiated as a variety, Elias, 1959, p. 150).

Type of group.—*Neoprioniodus ligo* (Hass), Barnett Shale, Texas.

Other species of group.—*Neoprioniodus erectus* Rexroad, *N. scitulus* Branson and Mehl sensu stricto, and *N. rynikeri* Elias.

Neoprioniodus ligo (Hass, 1953)

Pl. 2, figs. 12-14

1926 (part). *Prioniodus peracutus* Roundy: p. 10; pl. 4, figs. 7, 8 only.
1953. *Prioniodus ligo* Hass: p. 87-88; pl. 16, figs. 1-3.
1956. *Prioniodus ligo* Elias: p. 109; pl. 2, figs. 16-18 (redrawn from Hass, 1953, pl. 16, figs. 1-3).

1956. *Prioniodus* cf. *P. ligo* Elias: pl. 3, fig. 51.
1959. *Neoprioniodus ligo* Elias: p. 150; pl. 2, figs. 12-14.

Holotype.—USNM 115172; *Prioniodus ligo* Hass, 1953 (pl. 16, fig. 1); reillustrated by Elias (1959, pl. 2, fig. 12) and herein (pl. 2, fig. 12).

Description.—The species was well characterized by Hass, and, judged by three examples illustrated, is only slightly variable. For its difference from closely related *N. erectus* and *N. scitulus* sensu stricto, see discussion under the description of *Neoprioniodus erectus* Rexroad.

Occurrence.—Barnett Shale (late Chesterian), Texas.

Neoprioniodus erectus Rexroad, 1957

Pl. 2, figs. 10, 11

1957. *Neoprioniodus erectus* Rexroad: p. 34; pl. 2, figs. 23, 25.
1959 (part). *Neoprioniodus erectus* Elias: p. 150; pl. 2, figs. 10, 11 (not figs. 8, 9).

Lectotype.—2P58 (Ill. State Geol. Survey); *Neoprioniodus erectus* Rexroad, 1957 (pl. 2, fig. 25). Of the two cotypes illustrated by Rexroad I designated as the lectotype the specimen illustrated by him as plate 2, figure 25 (Elias, 1959, p. 151, pl. 2, fig. 11; reproduced herein, pl. 2, fig. 11).

Description.—Because all sides of specimens liberated from the rock from Illinois are open for examination, Rexroad's description of the species is complete in all details:

> *Posterior bar short, thin, arched, bowed inward; denticles probably seven or eight in number, slightly compressed laterally, free. Terminal fang* [*cusp*] *long, narrow, strongly compressed laterally* with sharp edges fore and aft; outer side more convex in cross section; from lateral view *anterior margin* [*of cusp*] *slightly convex, posterior margin straight;* viewed anteriorly fang is concave inward; tip slightly twisted. Aboral projection [*anticusp*] *long, pointed, postero-aboral margin convex, meeting aboral margin of bar at low obtuse angle.* Lateral tips of pit not flared, extending from tip of aboral projection onto aboral margin of posterior bar, making pit exceptionally long and narrow . . .

The italics are mine, to indicate principal characters of the species which can be recognized in the ordinarily encountered conodont molds in the siliceous Stanley Shale.

The specimen illustrated in Rexroad's plate 2, figure 25, was selected as the lectotype because the posterior edge of its anticusp ("postero-aboral margin" of "aboral projection" in Rexroad's description) is not merely convex, as described, but shows a slightly rounded angularity at a point nearer to the posterior bar than to the tip of the anticusp. Similar, but less conspicuous, angularity is observable in the corresponding convex margin of Rexroad's figure 23, excepting that here it is closer to the tip of the anticusp than to the bar. The specimen of figure 25 is also preferable for the lectotype because its denticles are better preserved.

Although two other neoprioniodids in my collections were previously identified with *N. erectus* (Elias, 1959, p. 151, pl. 2, figs. 8, 9) I segregate them now into a subspecies, *N. erectus rexroadi*, described below.

Most characteristic features common to *N. erectus* are as follows: straight, knifelike main cusp, with gently convex anterior edge, with maximum convexity opposite posterior bar; posterior bar narrow, perpendicular to main cusp, and slightly arched; denticles few, subequal, discrete, perpendicular to bar and parallel to main cusp; anticusp wider than cusp, its posterior edge angularly convex.

Discussion.—Rexroad pointed out that "*N. erectus* has an outline almost identical with that of *Prioniodus ligo* Hass," but he found differences in their anticusps. Perhaps the most important differences between the two species are the practically straight anterior edge of the cusp-anticusp in *Neoprioniodus ligo* (instead of a slight, but quite distinct, convexity of the edge in *N. erectus*) and the larger size of *N. ligo*, which is nearly twice that of *N. erectus*.

Also similar to both these species is *Neoprioniodus scitulus* (Branson and Mehl) from the Delaware Creek Shale. As Hass (1953, p. 88) expressed it: "in gross features *Prioniodus ligo* closely resembles *P. scitulus* Branson and Mehl, but differs in that it is larger and has the aboral side of its main cusp grooved instead of excavated." Besides, the anterior edge of the cusp-anticusp in *Neoprioniodus scitulus* is distinctly convex, being in this respect similar to that in *N. erectus*. Other differences in *N. scitulus* are the palmate arrangement of the denticles (instead of a parallel arrangement as in *N. ligo* and *N. erectus*) and the fact that the anticusp in *N. scitulus* is as wide as the cusp, whereas in *N. ligo* and *N. erectus* it is wider than the cusp.

The two neoprioniodids from the Vienna-Menard and Golconda of Illinois, identified as *N. scitulus* by Rexroad (1957, pl. 2, figs. 22, 26), match neither *N. ligo* nor *N. scitulus*, and are placed here in *N. cassilaris* (Branson and Mehl).

Occurrence.—Renault Limestone of Illinois.

Neoprioniodus erectus rexroadi Elias, new subspecies

Pl. 2, figs. 8, 9

1959 (part). *Neoprioniodus erectus* Elias: p. 150; pl. 2, figs. 8, 9 (not figs. 10, 11).

Holotype.—OU 5707; *Neoprioniodus erectus* Rexroad (Elias, 1959, pl. 2, fig. 9); original illustration reproduced herein (pl. 2, fig. 9).

Description.—Cusp-anticusp straight, with anterior slightly convex in the middle and slightly concave in the upper part. Tapering of narrow cusp gradual, becoming almost parallel-sided blade in upper half. Anticusp about one third to one quarter as long as the cusp, its width at base being equal to its height; anticusp with distinct posterior flare. Bar subperpendicular to cusp-anticusp and about half as wide as the latter, straight or slightly arching (in holotype); denticles subequal, subparallel, fingerlike, disposed sparsely, with intervals between them as wide as their width.

Discussion.—*Neoprioniodus erectus rexroadi*, new subspecies, differs from *N. erectus* Rexroad (1957, p. 34, pl. 2, figs. 23, 25) by the sparse disposition of its denticles and by the absence of an anterior turning of the tip of the anticusp, which is displayed in the lectotype of *N. erectus* (pl. 2, fig. 11).

Occurrence.—The holotype is from the Johns Valley Shale, which directly overlies the Game Refuge Sandstone, about NW¼ NW¼ sec. 33, T. 1 N., R. 18 E., south side of Jerusalem Creek, about 6 miles southwest of Clayton, Pushmataha County, Oklahoma. The paratype is from the Delaware Creek Member of the Caney Shale, Henryhouse Creek, Ardmore basin, Oklahoma.

Neoprioniodus scitulus (Branson and Mehl, 1941)

Pl. 2, figs. 6, 7

1941a. *Prioniodus scitulus* Branson and Mehl: p. 173; pl. 5, figs. 5, 6.
1956. *Prioniodus scitulus* Elias: p. 109; pl. 2, figs. 9, 10.
1959. *Neoprioniodus scitulus* Elias: p. 150; pl. 2, figs. 6, 7.
not 1957. *Neoprioniodus scitulus* Rexroad: pl. 2, figs. 22, 26.
not 1958. *Neoprioniodus scitulus* Rexroad: pl. 5, figs. 10-14.
not 1961. *Neoprioniodus scitulus* Higgins: pl. 11, fig. 1.

Lectotype.—Univ. Mo. C545-4, designated by Elias (1959) from two cotypes bearing the same number; *Prioniodus scitulus* (Branson and Mehl, 1941, pl. 5, fig. 6; reillustrated by Elias, 1956, pl. 2, fig. 9; Elias, 1959, pl. 2, fig. 7; and herein, pl. 2, fig. 7).

Description.—Branson and Mehl (1941a, p. 173) described *N. scitulus* as follows:

> *Posterior bar straight or very slightly arched,* laterally straight or slightly concave inward, *short, thin;* aboral edge truncated and medially grooved. *Bar* denticles slightly inclined backward, laterally compressed, *small, slender, subequal, with gradually tapering sharp free apices.* Terminal *fang* [cusp-anticusp] *erect,* straight or somewhat curved, concave inward, laterally compressed with sharp edges, *exceptionally long and slender, gradually tapering to a sharp point; produced aborally* [*below*] *in a sharply pointed process* [*anticusp*] *that extends considerably below the aboral edge of the bar; anterior edge,* viewed laterally, presenting a regular, *gently convex* outline. Excavation beneath the fang shallow, narrow, with sharp lateral edges neither of which is greatly flared.

The italics are mine, to indicate the characters observable in the lateral view of the species.

Discussion.—The best way to understand *N. scitulus* in its original narrow sense is to remember its close similarity to *N. ligo*, the type of the "lazy T" group of prioniodids. The designation of the lectotype of *N. scitulus* helps to emphasize the two principal differences between these two species: *N. scitulus* has a distinctly convex edge of the anterior instead of the straight to basally slightly concave edge of *N. ligo;* the anticusp in *N. scitulus* is proportionately shorter, and its denticles are slightly palmate, particularly so in the lectotype.

For other comparisons see the discussions under *N. erectus* and *N. cassilaris.*

Occurrence.—Delaware Creek Shale Member of the Caney Shale, northern Arbuckle Mountains, Oklahoma.

Neoprioniodus rynikeri Elias, 1959

Pl. 2, fig. 15

1959. *Neoprioniodus rynikeri* Elias: p. 152, pl. 2, fig. 15.

Holotype.—OU 5713; *Neoprioniodus rynikeri* Elias, 1959 (pl. 2, fig. 15; reproduced herein, pl. 2, fig. 15).

Description.—Typical "lazy T" prioniodid of *Neoprioniodus ligo* group, with cusp-anticusp straight, laterally compressed, anterior edge straight to curved backward in upper part of cusp. Anticusp nearly as long as cusp. Bar straight, perpendicular to cusp-anticusp; denticles slender, in palmate arrangement, with spaces between approximately equal to width of denticles.

Discussion.—*Neoprionidus rynikeri* differs from other species of the *N. ligo* group by the nearly equal length of its cusp and anticusp, and by the palmate arrangement of its denticles. It is nearest to *N. ligo*, but the latter is twice the size of *N. rynikeri*, and its denticles are subparallel and densely spaced.

Occurrence.—Subsurface Delaware Creek Shale, Gulf Oil Corp. 1 Riner well, SW¼ SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., depth 6,215 feet, near Overbrook, Carter County, Ardmore basin, Oklahoma.

Group of *Neoprioniodus cassilaris* (Branson and Mehl)

Prioniodids with imperceptible transition from anticusp to posterior bar, that is, with no clear-cut differentiation between the two structures. Other characters are as follows:

1. Cusp dominant (except in late species).
2. Base of cusp with anteroposterior flare.
3. Bar arching to posteriorly deflected.
4. Denticles more or less descreasing in size posteriorly, confluent or not confluent at base.

The stratigraphic range of the group is from Middle (?) Devonian to early Springeran.

The oldest representative of the group is *Neoprioniodus alatus* (Hinde). The group seemingly differentiated from *Neoprioniodus* sensu stricto through loss of flaring apron at anterior.

Type of group.—*Neoprioniodus cassilaris* (Branson and Mehl).

Other species of group.—*Neoprioniodus tulensis* (Pander), *N. solidiformis* Elias, *N. miseri* Elias, *N. higginsi*, new species, and two undescribed species in the middle part of the Goddard and the basal part of the Springer of the Ardmore basin.

Neoprioniodus tulensis (Pander, 1856)

Pl. 2, fig. 40

1856 (part). *Prioniodus tulensis* Pander: p. 30; pl. 2A, fig. 1 only (not figs. 18-20).

1928 (part). *Prioniodus tulensis* Holmes: p. 22; pl. 3, fig. 18 only (not figs. 16, 17, 20-22).

not 1963. *Neoprioniodus tulensis* Rexroad and Collinson: p. 18; pl. 2, figs. 17, 22, 23.

not 1965. *Neoprioniodus tulensis* Rexroad and Collinson: p. 12; pl. 1, figs. 28, 29.

Lectotype.—Specimen of *Prioniodus tulensis* illustrated by Pander (1856) as plate 2A, figure 1; redrawn herein (pl. 2, fig. 40); designation by Rexroad and Collinson (1963, p. 18).

Discussion.—Rexroad and Collinson made a useful decision to "designate Pander's specimen shown by his figure 1, plate 2A, as the holotype [lectotype], and . . . [to] refer the species to *Neoprioniodus*"; and to refer his "figures 18, 19, and 20 to *Ligonodina* Ulrich and Bassler" (Rexroad and Collinson, 1963, p. 18).

However, they did not attempt to redescribe the "holotype" (lectotype) designated by them but instead stated generally that "The middle Mississippian species *Prioniodus cassilaris* Branson and Mehl as shown by our studies of Burlington, Keokuk, Warsaw, Salem, and St. Louis specimens is quite variable. The species [as thus understood] includes specimens closely similar to Pander's specimen . . ." Rexroad and Cullinson pointed particularly to their figure 31 on plate 2 as an example of such close similarity—an obvious inadvertent error, for the illustration referred to is of *Spathognathodus scitulus*

(Hinde); possibly they had intended to refer to figure 23 of plate 2.

It is possible, however, that the material studied by the authors actually does include specimens which may be considered specifically identical with the lectotype of Pander's *N. tulensis*, but in my opinion none of the specimens illustrated by them in 1963 (pl. 2, figs. 17, 22, 23) and 1965 (pl. 1, figs. 28, 29) can be seriously considered conspecific with *N. tulensis*, emended Rexroad and Collinson.

The reasons for this opinion are as follows: Pander's illustration of the lectotype of *N. tulensis* clearly shows the prolongation over the whole height of the posterior bar of every one of its thirteen denticles, a character observable in few Mississippian prioniodids of America, such as *Neoprioniodus ligo* (Hass, 1952, pl. 16, figs. 2, 3; redrawn from Hass, in Elias, 1959, pl. 2, figs. 13, 14, and herein, pl. 2, figs. 13, 14) and *Neoprioniodus solidiformis* (Elias, 1956, pl. 2, fig. 28; republished in Elias, 1959, pl. 2, fig. 26, and herein, pl. 2, fig. 26).

Apparently this character has not been previously described and its morphologic and taxonomic value evaluated, at least not in American literature. In most published side views of specimens of the genus, prolongation of the denticles over the supporting bar is not observable, and in most views the upper boundary of the bar appears as a straight to gently curving line, below which the bar appears to be somewhat swollen, thus emphasizing the boundary with the denticles. The lectotype of *N. tulensis* shows not the slightest evidence of such swelling (pl. 2, fig. 40), but it is clearly observed in all four lateral views of *Neoprioniodus cassilaris* (Branson and Mehl, 1941b, pl. 6, figs. 12, 15-17; republished in Elias, 1959, pl. 2, figs. 17-19, 22, and herein, pl. 2, figs. 17-19, 22).

Another feature characteristic of *N. tulensis* is the slenderness of the subparallel denticles and of their prolongation over the bar. No magnification of the sketch of *N. tulensis* is indicated, but the following ratios of width to length of the denticles can be established: 1:8 for the first five denticles (starting from the cusp), 1:7 for the sixth, 1:6-6.5 for the seventh, 1:5 for the eighth, and 1:4 for the tenth. On the other hand, the corresponding ratio of the few complete denticles in the side views of *Neoprioniodus cassilaris* illustrated by Branson and Mehl (1941b) is that determinable from their plate 6, figure 17, 1:4 for the third and fifth denticles from the cusp. The outer and inner lateral views of the adult specimens illustrated by Rexroad and Collinson and identified by them as *N. tulensis* (1963, pl. 2, figs. 17, 23) show not a trace of prolongation of the denticles over the supporting posterior bar. As to the ratio of width to length of the denticles, it can be measured only in the complete denticles of their specimen (pl. 2, fig. 23), which perhaps they meant as an example of a specimen "closely similar to Pander's specimen." Indeed, in this American specimen the denticles are about as slender as those in Pander's specimen, and the first two are even more slender than the corresponding ones in Pander's specimen. But the whole set of denticles in the American specimen is strikingly different from that in Pander's specimen, and also from all other known American specimens of this and other species of *Neoprioniodus*, by their heterogenous, instead of subequal width, length, and width-to-length ratio. In Rexroad and Collinson's specimen (1963, pl. 2, fig. 23), the first two denticles are not the longest of the set, but are substantially shorter than the following third to fifth and also about half as wide as the latter, whereas the sixth and following denticles have an abruptly, instead of gradually, lesser width than the preceding third to fifth denticles. Besides the heterogeneous instead of subequal development of the denticles, this prioniodid has a conspicuous posterior flare of the anticusp, not a trace of which is present in Pander's specimen. It appears that the development of this flare in the American specimen caused the diminution in the length of the first two denticles by arresting their lateral prolongation onto the bar. Unless this specimen is biologically odd, perhaps a pathological development, it should be considered a new species, and at any rate not specifically identical with neither *N. tulensis* (Pander) nor *N. cassilaris* (Branson and Mehl).

In the light of this morphologic and taxonomic analysis, *Neoprioniodus cassilaris* (Branson and Mehl) should be returned to its full status as an independent species, not conspecific with *N. tulensis* (Pander).

Neoprioniodus cassilaris
(Branson and Mehl, 1941) emended

Pl. 2, figs. 17-21

1941b (part). *Prioniodus cassilaris* Branson and Mehl: p. 186; pl. 6, figs. 11, 12, 16, 17 (not fig. 15).
1950 (part). *Prioniodus cassilaris* Youngquist, Miller, and Downs: p. 528; pl. 67, fig. 24 (not fig. 23).
1957. *Neoprioniodus scitulus* Rexroad: pl. 2, figs. 22, 26.
1959. *Neoprioniodus cassilaris* Elias: p. 153; pl. 2, figs. 17-21.
1965 (part). *Neoprioniodus tulensis* Rexroad and Collinson: p. 12; pl. 1, fig. 29 (not fig. 28).

Holotype.—Univ. Mo. C575-3; *Prioniodus cassilaris* Branson and Mehl, 1941 (p. 186, pl. 6, fig. 12); reillustrated by Elias (1959, pl. 2, fig. 19; reproduced herein, pl. 2, fig. 19).

Description.—Branson and Mehl described their holotype and cotypes, liberated from rock, as follows:

> Fang [cusp] laterally compressed with sharp anterior and posterior edges, *gently tapering from an antero-posteriorly wide base;* in lateral view *straight and slightly recurved* with *slightly concave anterior outline,* in some cases convex in its proximal half; moderately extended aborally. *Posterior bar arched,* slightly curved laterally, of moderate length, comparatively thick and narrow; *denticles not confluent* at their bases, but offset with sides of the bar, moderately compressed, *closely crowded but distinct,* with short free pointed apices. Aboral excavation beneath the fang [cusp] without laterally flaring lips, very shallow, bilaterally almost symmetrical, greatly extended antero-posteriorly and extending as a groove on the flat aboral surface of the posterior bar.

The italics are mine, to indicate principal characters of the species which can be recognized in side view.

Branson and Mehl demonstrated variation in the anterior outline of *P. cassilaris* in lateral views of four specimens, and considered that the specimen of their figure 16 "may represent another species" (1941b, explanation of pl. 6). The present attempt to segregate the "lazy T" group of prioniodids influenced my judgement that still another of the four original specimens of *P. cassilaris* may be considered its "variety *keokukensis*, n. var." (Elias, 1959, p. 153), and ancestral to this group. The remaining three specimens, including the holotype, may be characterized by:

1. Expansion of cusp (fang) into its base with slight anterior flare that results in concavity of the anterior edge near its base.
2. Straight anterior edge, except for the slight concavity near base.
3. Expansion of base posteriorly with greater flare than that of the anterior, which tends to minimize differentation from it of the posterior bar.
4. Palmate arrangement of denticles.

When thus characterized, the species is recognizable in the described collections from the middle of the Goddard Shale in the Ardmore basin, apparently its highest stratigraphic occurrence.

The more complete of the two Burlington conodonts identified with *N. cassilaris* by Youngquist, Miller, and Downs (1950, pl. 67, fig. 23) seems nearer to *N. cassilaris keokukensis* than to the typical form of the species; the second (1950, pl. 67, fig. 24) is like the typical form.

Two specimens of *Neoprioniodus scitulus* from the Vienna-Menard and Golconda illustrated by Rexroad (1957, pl. 2, figs. 22, 23) seems to be referable to *N. cassilaris* sensu stricto as here emended, as they appear similar in all respects to the types illustrated by Branson and Mehl (1941b, pl. 6, figs. 12, 16, 17).

Discussion.—Comparison of Rexroad's two illustrations with the three illustrations of specimens from the Kincaid identified by Cooper as *Prioniodus scitulus* (1947, pl. 20, figs. 1-3) shows that the concept of *Neoprioniodus scitulus* (Branson and Mehl) became overly broad. When it is restricted to the narrow original sense, neither Rexroad's nor Cooper's identifications are acceptable. Five specimens from the Glen Dean of the Chester Series identified by Rexroad (1958, pl. 5, figs. 10-14) as *Neoprioniodus scitulus* represent a species seemingly new, but are more nearly like *N. cassilaris.* Nearest to the latter are the two younger examples (figs. 10, 11), which may recapitulate ancestral characters. *N. cassilaris* sensu stricto differs from *N. scitulus* sensu stricto by basal anteroposterior flaring of the cusp (fang), so that the base of the cusp-anticusp can hardly be considered an anticusp. *N. scitulus* could have developed from *N. cassilaris* through greater differentiation of the posterior bar, such as is seen in *N. cassilaris keokukensis* Elias (Branson and Mehl, 1941c, pl. 6, fig. 15).

Occurrence.—*N. cassilaris*, in the narrow sense suggested here, ranges from the upper part of the Keokuk (Branson and Mehl, 1941b, p. 181; or "probably Warsaw," according to Rexroad and Collinson, 1965, p. 4) to the Menard, Chester Series (Rexroad, 1957).

Neoprioniodus cassilaris keokukensis Elias, 1959

Pl. 2, fig. 22

1941b (part). *Prioniodus cassilaris* Branson and Mehl: p. 186; pl. 6, fig. 15 (not figs. 11, 12, 16, 17).
1959. *Neoprioniodus cassilaris* var. *keokukensis* Elias: p. 154; pl. 2, fig. 22.

Holotype.—Univ. Mo. C578-3; *Prioniodus cassilaris* Branson and Mehl, 1941 (pl. 6, fig. 15); reillustrated by Elias (1959, pl. 2, fig. 22; reproduced herein, pl. 2, fig. 22).

The name *keokukensis* was given by me (1959, p. 154) to a prioniodid which differs from typical *N. cassilaris* in prolongation of the basal part of the cusp into a more individualized anticusp, the width of which almost equals that of the cusp. Another difference of the subspecies is the greater length of the posterior bar.

The mentioned difference may be considered transitional from the *N. cassilaris* group of prioniodids to the *N. ligo* group.

Occurrence.—Known only in the upper part of the Keokuk Formation of Illinois, which, according to Rexroad and Collinson (1965, p. 4), "probably is the Warsaw."

Neoprioniodus peracutus (Hinde, 1900)

Pl. 2, figs. 36, 37

1900 (part). *Prioniodus peracutus* Hinde: p. 343; pl. 10, fig. 22 (not figs. 21, 23).
1926. *Prioniodus peracutus* Roundy: p. 10; pl. 4, fig. 6 (reillustrated from Hinde, 1900).
1928. *Prioniodus peracutus* Holmes: p. 21; pl. 3, fig. 38 (reillustrated from Hinde, 1900).
1958 (part). *Neoprioniodus scitulus* Rexroad: p. 23; pl. 5, fig. 11 (not figs, 10, 12-14).
1961. *Neoprioniodus peracutus* Clarke: p. 14; pl. 2, fig. 6.
not 1957. *Prioniodus erectus* Rexroad: p. 34; pl. 2, figs. 23, 25.
not 1964. *Neoprioniodus peracutus* Rexroad and Furnish: p. 674; pl. 111, fig. 25.

Lectotype.—PS 888 (H. M. Geological Survey, Edinburgh); *Prioniodus peracutus* Hinde, 1900; designation by Roundy (1926, p. 10, pl. 4, fig. 6). A photograph of the lectotype appears in Clarke (1961, pl. 2, fig. 6; redrawn herein, pl. 2, fig. 36). Upper Limestone, Monkcastle (not Law; see section on occurrence, below), Dalry, Scotland.

Description.—The importance of the revised description and an excellent photograph of the lectotype of *N. peracutus* published by Clarke (1961, p. 14) justifies the following complete citation of his description:

> The bar is thin, slightly bowed and arched near the cusp. Posteriorly it slopes downwards and terminates in a sharp edge. The nine bar denticles are unequal, small and compressed. All have a slight posterior inclination and in the anterior part of the bar they are fused at their bases. The cusp is tall, compressed and laterally erect, but slightly curved inwards. The anterior edge of the cusp is carinate and the carina continues down below the cusp as the slightly concave edge of the anticusp, the depth of which is about a quarter of the height of the cusp. The aboral surface of the bar is narrow but broadens at the base of the cusp, whence it narrows toward the bottom of the anticusp. A median groove is present and is expanded into a fairly deep lachrymiform escutcheon at the junction of the bar and the anticusp.

Discussion.—Clarke (1961, p. 14) placed *Neoprioniodus erectus* Rexroad (1957, p. 34, pl. 2, figs. 23, 25) in the synonymy of *N. peracutus*, but gave no reason for doing so. Rexroad and Furnish (1964, p. 674) followed Clarke's revision, but did not discuss or revise the concepts of either *N. peracutus* or *N. erectus*. Despite obvious similarity of the general features of these two species, I believe that the following differences demand recognition of both as independent species.

In *N. erectus* the cusp is not as acutely wedge-shaped as in *N. peracutus* and, what is more important, the denticles of the bar are subparallel and adjacent to each other and to the cusp, whereas in *N. peracutus* they are somewhat loosely palmately disposed. Furthrmore, the shape and size of the denticles in *N. peracutus* are irregular, the fingerlike denticles intermingling with acutely triangular ones. Unfortunately, the upper parts of all denticles in both originally illustrated specimens of *N. erectus* (Rexroad, 1957, pl. 2, figs. 23, 25) are broken at various levels, but it is possible to conclude from the preserved basal parts that in none of them was the base sufficiently wider than in the others to match the rapidly narrowing triangular denticles of *N. peracutus*.

Because of this recognition of the taxonomic importance of the shape and disposition of the denticles in the two species, I feel obliged to retract my 1959 identification of the two Oklahoma prioniodids with *N. erectus* (1959, pl. 2, figs. 8, 9; pl. 2, figs. 8, 9, herein). In these specimens all denticles are fingerlike, subequal, subparallel, and separated from each other by intervals subequal to their widths. Because of these and other differences, I have segregated these specimens into a new subspecies.

It is tempting, indeed, to consider all the discussed differences in shape and disposition of denticles as individual variations within a single, broadly conceived species, so as to make it seemingly more useful as an index species for distant correlation. In the literature, however, the following discrepancy appears as to the exact stratigraphic position of the lectotype and the only illustrated specimen of *N. peracutus* from Scotland.

Occurrence.—Roundy (1926, p. 10) designated "Hinde's figure 22 (reproduced here, pl. IV, fig. 6) . . . as representing the type specimen" for the reason that "the description [by Hinde] and my specimens agree best with Hinde's figure 22."

Clarke (1961, p. 14) agreed "with Roundy's designation of this specimen [Hinde's pl. 10, fig. 22] as the type specimen of *P. peracutus*," and pointed out (p. 14-15) that "Hinde's syntypes (1900, pl. 9, figs. 21, 23) differ generically; figure 23 is *Ligonodina loisae* and figure 21 appears to be another *Ligonodina*, but the specimen has been lost." *Ligonodina loisae*, which is based upon the specimen illustrated by Hinde (pl. 10, fig. 21) is described by Clarke (p. 11) as a new species and is illustrated in his plate 2, figure 3. He gave the type locality as Lower Limestone, Law, Dalry, which is exactly the same as that given by Hinde in the plate explanation on page 345 for the specimen shown as figure 21 on plate 10, as well as for that of figure 23, one specimen of which is lost. The same occurrence for *L. loisae*, in "Lower Limestone Group" at Law, is shown also in table 1 (faunal list) of Clarke's paper (1961).

On the other hand, a discrepancy exists between Clarke's references to the "type locality and occurrences" and Hinde's original statement on the occurrence of *Prioniodus peracutus*. In his descriptive text of *Neoprioniodus peracutus* (Hinde), Clarke (1961, p. 14) mentioned "Upper Limestone, Law, Dalry" and gave the same in the explanation to his plate 2, figure 6, for the "Lectotype, inner lateral view, PS 888"; but in table 1 (faunal list) the occurrence at Law is placed in the "Lower Limestone Group," and not a single occurrence of *N. peracutus* is indicated within the "Upper Limestone Group" of the table.

No discrepancy of any kind exists in Hinde's (1900) reference to the occurrence of the specimen of *Prioniodus peracutus* illustrated in his plate 10, figure 22, in the explanation of which the occurrence is mentioned as "from the Upper Limestone, Monkcastle, Dalry"; in the description (1900, p. 341) Monkcastle is mentioned among the occurrences of the species; and, in the list of "the stratigraphical position of the various localities in which I [Hinde] have found conodonts in the carboniferous limestone strata of the West of Scotland," "Monkcastle, Dalry" is placed in the "Upper Limestone."

Evidently, the latter is the true locality and stratigraphic position of the lectotype of *Neoprioniodus peracutus* (Hinde), and thus an appropriate correction should be entered in Clarke's descriptive text and in the explanation to his plate 2, figure 6. Also, in his table 1, the occurrence of *N. peracutus* should be entered in the graph of Monkcastle and stricken from the graph of Law. Indeed, in Hinde's list of the occurrences of *Prioniodus peracutus* (1900, p. 343-344), Law is mentioned, but the locality is indicated in the explanation to plate 10 (p. 345) only for the specimens of figures 21 and 23, which are now correctly placed by Clarke in the genus *Ligonodina*.

Currie (1954, p. 532, table 1) indicated that the Lower Limestone Group, with the "Top Hosie Limestone (Calderwood Cement)" at its top, is in zone P_2 of the Upper Visean, whereas the Upper Limestone Group is in zone E_2 of the Lower Namurian.

Neoprioniodus miseri Elias, 1959

Pl. 2, figs. 23, 24

1959. *Neoprioniodus miseri* Elias: p. 154; pl. 2, figs. 23, 24.

Holotype.—OU 5717; *Neoprioniodus miseri* Elias, 1959 (pl. 2, fig. 23; reproduced herein, pl. 2, fig. 23); Delaware Creek Member, Caney Shale, Ardmore basin, Oklahoma.

Description.—Laterally compressed prioniodid with conspicuously wide and thin cusp-anticusp, with two or three longitudinal to diagonal gentle corrugations. Cusp passing imperceptibly into laterally compressed, anteriorly flaring bar. Denticles nearest to cusp appear to cleave from its posterior edge, first four or five subequal, descending along posterior edge of cusp in positions offset to each other. Subsequent denticles gradually diminishing in size on gradually tapering bar.

Discussion.—Two nearly identical specimens (pl. 2, figs. 23, 24) were recovered: one in the Delaware Creek Shale of the Ardmore basin, and the other in the lower conodont-bearing bed of an equivalent to the Delaware Creek Shale on the Hershel Craig farm about 6 miles southwest of Clayton, Pushmataha County, Oklahoma. The type of the species from the Ardmore basin has a more acuminate cusp than has the example from the Ouachita Mountains, but the bar of the latter is more acuminate than that of the former.

N. miseri differs from all other species of the *N. cassilaris* group in having a flaring anticusp and a steeply posteriorly deflected bar, and in cleavage-type development of the denticles nearest the cusp.

Occurrence.—*Neoprioniodus miseri* has been found only in the Delaware Creek Shale and its equivalents in the Arbuckle and Ouachita Mountains. A somewhat similar, but distinct, undescribed species occurs in the middle part of the Goddard Shale, and another similar and undescribed species occurs in the basal part of the Springer Group, both in the Ardmore basin.

Neoprioniodus higginsi Elias, new species

Pl. 2, fig. 38

1961. *Neoprioniodus scitulus* Higgins: pl. 11, fig. 1.

Holotype.—Univ. of Sheffield E1.E15; *Neoprioniodus scitulus* (Branson and Mehl, 1941) (Higgins, 1961, pl. 11, fig. 1).

Discussion.—Higgins did not describe or discuss the large prioniodid which he referred to *Neoprioniodus scitulus* (Branson and Mehl). It is indeed comparable to the latter species in size and shape of the cusp-anticusp, but differs from it by a slight notchlike concavity in the anticusp and by a slight, but distinct, posterior flare which brings the posterior of the anticusp under the first three denticles of the bar. Furthermore, the nearly straight bar descends down from the cusp-anticusp at an angle of about 45° instead of the approximately 90° angle of the straight bar in *N. scitulus*. The straightness and orientation of the bar and the size of the cusp-anticusp are similar to those in *N. miseri*. Hence it would seem more natural to regard the North Staffordshire prioniodid as more closely related to the latter form than to *N. scitulus*. It differs from *N. miseri*, however, in having no anterior concavity in the upper edge of the cusp, and the denticles are coarser and more nearly uniform in width throughout the length of the bar, and are sharply differentiated from the cusp. The new species also generally resembles *N. peracutus* (Hinde) as illustrated by Clarke (1961, pl. 2, fig. 6; redrawn herein, pl. 2, fig. 36), but differs by having much greater size and proportionately more massive (wider) and more sharply inclined bar.

Occurrence.—Lower Namurian marine band with *Eumorphoceras* aff. *E. pseudobilingue* at Cauldon, North Staffordshire, England.

Neoprioniodus solidiformis (Elias, 1956)

Pl. 2, figs. 25-27

1956. *Prioniodus solidiformis** Elias: p. 109-110; pl. 2, figs. 28, 29.

1959. *Neoprioniodus solidiformis* Elias: p. 154; pl. 2, figs. 25-27.

Holotype.—Specimen illustrated by Elias (1956, pl. 2, fig. 28); reillustrated by Elias (1959, pl. 2, fig. 25; reproduced herein, pl. 2, fig. 25).

Description.—The original description (Elias, 1956, p. 109-110) is as follows:

* Erroneously spelled *solidifundus* in the explanation of plate 2.

> The new species differs from other known species of the genus by having the basal edge of the bar running into the large anterior tooth without appreciable change in direction, so that this straight, or nearly straight, common edge makes about a 45 degree angle with the anterior edge of the large anterior tooth.

It may be added that the anterior edge of the cusp is convex over greater length, but becomes concave below. The five denticles are large, the first four being subequal in size and subparallel to the cusp. The bar is short, laterally compressed, and practically undifferentiated from the cusp-anticusp.

Occurrence.—About 150 feet above the base of the Goddard Shale at its type locality (Oil Creek) in the Ardmore basin, Oklahoma. Incompletely preserved specimen (pl. 2, fig. 27) from Johns Valley Shale, Hershel Craig farm, about 6 miles southwest of Clayton, Pushmataha County, Oklahoma.

Group of *Neoprioniodus alatoideus* (Cooper)

No attempt is made here to set limitations upon this large, quite tentative group, but it may be broadly defined as laterally compressed prioniodids, with long and slender, straight or curved cusp-anticusps; and well-differentiated, straight or arched bars, inclined to the cusp-anticusp at various angles of less than 90 degrees.

The group seemingly originated in Late Devonian time.

Typical species of the group is *Neoprioniodus alatoideus* (Cooper) sensu lato of Early Mississippian age.

Neoprioniodus aff. **N. alatoideus** (Cooper, 1931)

Pl. 2, figs. 1-3

1931b. *Prioniodus alatoideus* Cooper: p. 232; pl. 28, fig. 1.
1934. *Prioniodus alatoideus** Huddle: p. 37-38; pl. 1, figs. 4, 5.
1935. *Prioniodus alatoideus* Cooper: p. 310; pl. 27, fig. 3 (same as 1931b, fig. 1; in smaller [x30] magnification).
1947 (part). *Prioniodus alatoideus* Bond: p. 34-35; pl. 1, fig. 6 only.
1959. *Neoprioniodus alatoideus* Elias: p. 155; pl. 2, figs. 1-3.

Holotype.—Univ. Chicago, Walker Museum 38053; *Prioniodus alatoideus* Cooper, 1931 (pl. 28, fig. 1; reproduced by Cooper, 1935, pl. 27, fig. 3); reillustrated by Elias (1959, pl. 2, fig. 1; reproduced herein, pl. 2, fig. 1). Woodford Formation, Oklahoma.

Description.—Cooper stated (1931b, p. 232) that the "single available specimen" of his species is incomplete, lacking the posterior part of the bar. His description is as follows:

> The bar is straight and somewhat thin . . . The denticles are broad, fused, sharp pointed, and relatively long. The main cusp is more slender than in *P. alatoides* Holmes and more inclined forward. The posterior side of the downward projection [anticusp] of the cusp is at right angles to the bar; the whole projection [anticusp] is short and thick as compared with the width of the base of the cusp.

Huddle illustrated two specimens of two similar species from the upper part of the New Albany Shale of Indiana, admittedly of considerably larger size than Cooper's type (Huddle, 1934, pl. 1, figs. 4, 5; Huddle's fig. 4 redrawn herein, pl. 2, fig. 2) and it seems that Huddle's specimens may be accepted as somewhat variable adults of Cooper's juvenile type. If so, Huddle's description (p. 37-38) constitutes a more complete one for the species:

> Tooth small with short, thin, laterally compressed bar; cusp long, narrow, gradually tapering, sharp edged, rounded on one side, and flattened on the other side; denticles numerous, 20 to 24, long, slender, apparently deeply inserted, and closely appressed. Anticusp subtriangular with anterior edge forming a straight line with the cusp and the posterior edge perpendicular to the bar. Length 0.8-1.6 mm.
>
> The species differs from *P. alatus* and *P. alatoides* in having a narrower cusp and numerous slender denticles.

* Erroneously misspelled *altoideus* in plate explanation on page 114.

Only one of the two specimens illustrated by Bond (1947, pl. 1, fig. 6) may be accepted as another example of *P. alatoideus.*

A single mold obtained from the lower part of the Stanley Shale (pl. 2, fig. 3) is certainly closer to *P. alatoideus* than to *P. alatus* and *P. alatoides*, but if identified with *P. alatoideus* would constitute another potential subspecies of the species. Its size is intermediate between that of Cooper's and Huddle's specimens, the angle between the lower (aboral) edges of the anticusp and bar is much larger than 90 degrees, and the denticles are less numerous (15) and, beginning with the fourth denticle behind the cusp, suddenly diminish in size.

Discussion.—If the illustrated examples placed here in the synonymy of *Neoprioniodus alatoideus* represent more than one species, they may be at least considered as a group of closely related conodonts of Early Mississippian age; their delicate cusps and denticles contrast conspicuously with those of all other contemporaneous prioniodids. Somewhat similar prioniodids collected from younger beds in the Ouachita and Arbuckle Mountains have differences beyond those within the variability of *N. alatoideus* sensu lato.

Occurrence.—Woodford Formation of Oklahoma; middle and upper parts of the Arkansas Novaculite (identified but not illustrated by Cooper, 1935, p. 310); upper and middle parts of the New Albany Shale (identified but not illustrated by Huddle from the middle part of the New Albany Shale, Indiana, 1934, p. 38); Ohio Shale of Ohio; and lower part of the Stanley Shale of Oklahoma.

Group of *Neoprioniodus* sensu stricto

Neoprioniodus spathatus Higgins, 1961

Pl. 2, fig. 39

1961. *Neoprioniodus spathatus* Higgins: p. 217-218; text-fig. 5; pl. 11, figs. 2, 4.

Holotype.—Univ. Sheffield E1.E22; *Neoprioniodus spathatus* Higgins, 1961 (pl. 11, fig. 4).

Discussion.—*Neoprioniodus scitulus* is the only species with which Higgins compared his prioniodid, *N. spathatus*, and he pointed out (1961, p. 218) that it "differs from *Neoprioniodus scitulus* Branson and Mehl, 1941, in possessing a spatulate anticusp and [bearing] anterior denticles."

The spatulate and denticulate termination of the anticusp in *N. spathatus* may be considered an advanced development of the anteriorly curved tip of the anticusp in *N. erectus* and *N. peracutus*, both of which are probably of a somewhat earlier geologic age.

Occurrence.—Lower Namurian marine band with *Eumorphoceras* aff. *E. pseudobilingue* at Cauldon, North Staffordshire, England.

Genus *HINDEODELLOIDES* Huddle, 1934, emended Elias, 1959

Type species: *Hindeodelloides bicristatus* Huddle, 1934.

1934. *Hindeodelloides* Huddle: p. 48.
1947. *Hindeodelloides* Hass: p. 132-134.
1959. *Hindeodelloides* Elias: p. 156.

Huddle (1934, p. 48) defined the genus *Hindeodelloides* as follows:

> Bar laterally compressed, thin, straight or gently curved, with an anticusp which gives the tooth a T-shaped appearance similar to the pick shape of *Ligonodina*. The plane including the denticles on the anticusp is inclined to the plane of the bar and cusp. Denticles laterally compressed, closely appressed, and usually alternating in size.
>
> The genus differs from *Hindeodella* in having an anticusp; from *Ligonodina* in the close appression of the denticles; from *Hamulosodina* in that the anticusp is entirely denticulate, and from *Falcodus* in that the denticles on the anticusp are at an angle to the plane of the bar and cusp.

Whereas Ellison (1946, p. 108) considered this genus a probable junior synonym of *Hindeo-*

della, other authors, and particularly Hass (1947), recognized its validity, as do I. The recognition of *Hindeodelloides* is particularly important in view of its restricted stratigraphic range; it has been found only in Upper Devonian and lowermost Mississippian strata.

Huddle did not clearly indicate in what respect *Hindeodelloides* differs from *Hindeodella,* thus facilitating Ellison's decision to regard them as congeneric. The so-called anticusp in *Hindeodelloides* is not a direct prolongation of the cusp but is in a more or less offset position to it. One of the original seven species included by Ulrich and Bassler in their genus *Hindeodella, H. decurrence* (1926, pl. 8, fig. 13), has nearly the same kind of an offset anticusplike frontal prolongation of the cusp, and thus could easily be referred to the genus *Hindeodelloides.* On the other hand, all three species originally included by Huddle in *Hindeodelloides* have the following character which is absent in *Hindeodella decurrence* and all other species of *Hindeodella*: the posterior of their bar sags downward slightly but abruptly, whereas its height, or only the height of the denticles arising from it, increases. In this respect *Hindeodelloides* is much like the two other genera of Huddle, *Angulodus* and *Metaprioniodus,* which have a stratigraphic range as narrowly restricted as that of *Hindeodelloides.* All three form genera could have come from a jaw of the same biological genus, their Upper Devonian-lowermost Mississippian stratigraphic range being the same. The highest recorded stratigraphic occurrence of *Angulodus* is that of a single fragmentary specimen in an extraordinarily large conodont fauna from the pre-Welden "Bushberg-Hannibal horizon" in the northern Arbuckle Mountains. It was identified by Cooper (1939, p. 385, pl. 47, fig. 78) as *Angulodus* cf. *A. spissus* Huddle, a species originally established in the middle part of the New Albany Shale (Upper Devonian), where it is rare. The absence in the prolific pre-Welden fauna of the biological companion genera *Metaprioniodus* and *Hindeodelloides* suggests that this occurrence of a solitary imperfect *Angulodus* cf. *A. spissus* may be the result of redeposition.

The present finding of a fragile, yet fully preserved, *Hindeodelloides* is an important indication of a much older Mississippian age for the lower part of the Stanley than previously believed (Hass, 1951, p. 2526-2527).

Recently Rhodes and Müller (1966, p. 3) commented upon Huddle's genus *Hindeodelloides* as "probably junior synonym of *Ligonodina* Bassler, 1925." They did not, however, state the reason for their conclusion.

Hindeodelloides bicristatus Huddle, 1934

Pl. 2, figs. 28-30

1934. *Hindeodelloides bicristatus* Huddle: p. 48; pl. 7, figs. 2, 3; pl. 12, fig. 6.
1959. *Hindeodelloides bicristatus* Elias: p. 157; pl. 2, figs. 28-30.

Holotype.—Indiana Univ. 1862; *Hindeodelloides bicristatus* Huddle, 1934 (pl. 12, fig. 6).

Discussion.—Huddle described three species of *Hindeodelloides* and left unnamed three additional potential species, known only from fragments. *H. bicristatus* was found to be "rare throughout the New Albany Shale"; and Huddle illustrated three specimens of *H. bicristatus,* one from the lower part and two from the upper part of the New Albany Shale. Greater angularity of the anticusp to the bar can be observed in the specimens from the upper part of the New Albany Shale than in those from the middle part, especially in the specimen illustrated in his plate 7, figure 3; and it is this same specimen that, in this and other respects, is much like the specimen from the Stanley Shale, illustrated herein (pl. 2, fig. 30). The magnification given by Huddle for his plate 7, figure 3, indicates that the specimen is 1.25 mm long; he gave the range of the length of *H. bicristatus* as from 0.6 to 1.2 mm (p. 48), which includes the length of the Stanley specimen.

The Stanley specimen may seem to have denticles on the anticusp that are more sharply differentiated than is suggested by Huddle's photographs on his plate 7, but this impression may be due to imperfection of the photography, as he shows the denticles clearly differentiated in the sketch of his plate 12.

Taking all the similarities and differences into account, the specimen from the Stanley is well within the variability of *Hindeodelloides bicristatus.*

Occurrence.—475 feet above base of Stanley Shale, southwestern part of the Potato Hills, Latimer County, Oklahoma.

Age consideration.—The upper part of the

New Albany Shale, from which *H. bicristatus* has been collected, is now stratigraphically differentiated from the underlying part of the New Albany. The latter is named the Blackiston Formation and is referred to the Upper Devonian, and the former is divided, in ascending order, into the Sanderson, Underwood, and Henryville Formations, all Lower Mississippian. Campbell referred Huddle's upper New Albany conodonts to these three formations (1946, p. 840, 854-855).

Huddle concluded (1934, p. 23) that "the upper 5 to 10 feet of the formation, including the upper conodont fauna, afford the only likelihood of a zone of Mississippian age," the underlying, greater part of the New Albany Shale remaining in the Upper Devonian.

Branson and Mehl (1941c, p. 201-204), who examined Huddle's types and collected from the New Albany, discounted part of the conodonts included by Huddle in his upper New Albany conodont fauna as coming from the weathered underlying Devonian shale. They identified the restricted upper New Albany conodont fanua with the Bushberg ("basal Mississippian") conodont fauna of Missouri. They considered the conodont fauna described by Cooper (1939) from the one-foot-thick shale under the Welden Limestone in Oklahoma as Middle Mississippian, or possibly "a mixed fauna, Bushberg and Welden; or that the Bushberg in south-central Oklahoma is equivalent to not only the Bushberg of Missouri but also to the Chouteau in its broadest sense and probably the Burlington and the Keokuk as well" (1941c, p. 204-205). It may be mentioned, in connection with this, that my identification of the numerous undescribed bryozoans from the lower part of the Sycamore in the Ardmore basin indicates a Burlington-Keokuk age for this part of the limestone, which is an approximate equivalent of the Welden in the northern Arbuckle Mountains.

In view of these facts it is suggested that the lower part of the Stanley Shale which bears *Hindeodelloides bicristatus*, may not be as young as the Sycamore or Welden, that is, its age is substantially older than that of the Delaware Creek Shale and even more so than that of the Barnett of Texas.

Genus *LIGONODINA* Ulrich and Bassler, 1926

Thanks to the research of Cooper and Huddle, the understanding of the genus *Ligonodina* has been clarified. As a supplement to the brief record of the genus in the lower part of the Stanley Shale, given below, Huddle's (1934, p. 58-59) characteristics of the genus are quoted:

> Conodonts with rounded cusp, denticulated bar and anticusp. The denticles on the anticusp are at right angles to the plane of the bar and cusp, and are inclined upward. The anticusp extends downward from one side of the cusp, and a deep groove extends from the tip of the anticusp on the undenticulate side to the end of the bar along the aboral [lower] side.
>
> The essential characters of the genus are the lateral attachment of the anticusp and the fact that the denticles on the anticusp are at right angles to the plane of the bar and cusp.

The characteristic relating to the orientation of the denticles of the anticusp perpendicular to the plane of the bar and cusp makes generic identification difficult. In many cases only the bar or its anticusp is observable because the two parts have been separated or one is hidden by matrix. In few such cases is specific assignment possible. Huddle illustrated many such well-preserved parts without specific identification.

Because such isolated parts, preserved as molds, are the only forms observable in the lower part of the Stanley Shale, they are here classified as *Ligonodina* sp. Generally, the molds are adequately preserved for this generic assignment and for comparison with previously illustrated species of the genus. Such comparison indicates that the lower Stanley molds are closely related to some Upper Devonian species, but particularly to the Lower Mississippian species.

Ligonodina sp. A
(cf. **Ligonodina** sp. of Huddle, 1934)

Pl. 2, figs. 32-35

1934. *Ligonodina* sp. Huddle: p. 62; pl. 12, fig. 8.
1959. *Ligonodina* sp. cf. *Ligonodina* sp. Huddle; Elias: p. 158; pl. 2, figs. 32-35.

Discussion.—An amazingly high proportion of the conodont molds recovered from the lower part of the Stanley Shale can be placed in the genus *Ligonodina,* the frequency of the occurrence in itself suggesting an Early Mississippian age. The detached denticulate anticsups, such as illustrated here (pl. 2, figs. 33, 34), are quite like some of those illustrated by Huddle (1934, pl. 12, figs. 17, 19, 21) from the upper part of the New Albany Shale; and they are quite unlike the rarely described, much smaller anticusps of the genus from younger Mississippian rocks, such as those from the Barnett of Texas (see *Ligonodina fragilis,* Hass, 1953, pl. 15, fig. 1).

Molds of typical *Ligonodina* bars, the best of which is illustrated herein (pl. 2, fig. 35), are also fairly comparable to the examples of the genus from the New Albany Shale, one of which is shown here (pl. 2, fig. 31).

Occurrence.—Common in the lower part of the Stanley Shale, 475 feet above its base, southwestern part of Potato Hills, Latimer County, Oklahoma.

EXPLANATION OF PLATES AND VARIOUS COMMENTS

Until the middle of 1958 I felt strongly that the conodonts collected by me and by others in the Ouachita Mountains tended to support a Late Mississippian to Early Pennsylvanian age for the Stanley-Jackfork sequence, an opinion reached by some paleontologists in the past upon the evidence of a few other marine invertebrates and terrestrial plants. This opinion conflicts with the field geologic evidence accumulated within the past few years by Cline and accepted by Tomlinson and Bennison (with all of whom I have been associated in the study of the geology and paleontology of the region).

A small but stratigraphically important collection of conodonts from the lower part of the Stanley Shale provided strong evidence in favor of an Early instead of Medial or Late Mississippian age for the lower part of the Stanley of Oklahoma, and this necessitated revision and reevaluation of other paleontologic evidence, particularly that of the earlier collected conodonts. The results of such a reevaluation were published (Elias, 1959) as a proposed taxonomic revision of some conodont groups, the knowledge of which appeared to be more complete than of others. This earlier work is presented above in a refined and amended version. Plates 1 and 2, herein, are based essentially upon the corresponding plates which appear in the 1959 publication and express, in modified form, the stratigraphic import of the several conodont groups. In the lower part of each plate are shown all conodonts of the described groups known from the middle and upper parts of the Arkansas Novaculite and the lower and middle parts of the Stanley Shale of the Ouachita Mountains, and from their equivalents elsewhere. In the upper part of each plate are shown similar conodonts from the Delaware Creek Shale and higher Mississippian units of the Arbuckle Mountains, and some conodonts from the Mississippian of Illinois. To these are added the following conodonts from elsewhere: a few collected by Cline and by me from a stretch of Johns Valley Shale exposures in a narrow valley of the Kiamichi Mountains southwest of Clayton, and from the Barnett Shale of Texas. In each of the latter cases the stratigraphic position of the additional conodonts was determined upon the evidence of the associated goniatites. Cline and I readily agree that the few goniatites from the shale southwest of Clayton are of undoubted Caney age (I think they are Delaware Creek—middle Caney). The goniatites of the Barnett Shale associated with the conodonts described are a natural mixture of some characteristic latest Visean (P_2) forms and some equally characteristic earliest Namurian (E_1) forms of the British Isles and eastern Europe. The Barnett fits into a postulated hiatus (Elias, 1956, p. 70) between the Delaware Creek Shale and the Goddard Shale in the Ardmore basin.

The information on the Middle and Upper Mississippian conodonts of Illinois, Iowa, and Missouri, particularly that on the Chester conodonts described by Rexroad, and my recent unpublished identification of the bryozoans and other invertebrates from the lower part of the Sycamore Limestone of the Ardmore basin collected by Jeff Prestwich, are used here in an attempt to correlate the Middle and Upper Mississippian of the Arbuckle Mountains with the classical Mississippian.

Although many conodonts from the upper part of the Stanley and the lower part of the Jackfork were also collected and partly prepared and identified, additional work on these is needed. Conodonts were also collected by me (but not studied) from two shale intervals in the Sycamore Formation at the spillway of the Goddard ranch dam. These and additional conodonts from the ever-growing number of horizons and localities in the Ouachita Mountains will undoubtedly provide us with much more complete information on these microfossils, and will advance their use for stratigraphic purposes in the surface and subsurface Mississippian and Early Pennsylvanian of southern Oklahoma.

REFERENCES

Bartenstein, Helmut, and **Bischoff, Günther,** 1962, Paläozoikum Ausgewählte Beispiele aus dem deutschen und mitteleuropäischen Paläozoikum, **in** Simon, Wilhelm, and Bartenstein, Helmut, eds., Leitfossilien der Mikropaläontologie: Berlin-Nikolassee, Gebrüder Borntraeger, p. 35-65, pls. 1-6, tables 1-3.

Bischoff, Günther, 1957, Die Conodonten-Stratigraphie des rheno-herzynichen Unterkarbons, mit Berücksichtigung der Wocklumeria-Stufe und der Devon/karbon-Grenze: Hessische Landesamtes Bodenforschung, Abhandlungen, vol. 19, p. 64.

Bond, R. H., 1947, Ohio shale conodonts: Ohio Jour. Science, vol. 47, p. 21-37, 2 pls.

Branson, E. B., and **Mehl, M. G.,** 1933, A study of Hinde's types of conodonts preserved in the British Museum: Mo., Univ., Studies, vol. 8, no. 2, p. 133-156, pls. 11-12.

__________1938, Conodonts from the Lower Mississippian of Missouri, **in** Stratigraphy and paleontology of the Lower Mississippian of Missouri, Part II: Mo., Univ., Studies, vol. 13, no. 4, p. 128-148, pls. 33, 34.

__________1941a, Caney conodonts of Upper Mississippian age: Denison Univ., Sci. Laboratories, Jour., vol. 35, p. 167-178, pl. 5.

__________1941b, Conodonts from the Keokuk Formation: Denison Univ., Sci. Laboratories, Jour., vol. 35, p. 179-188, pl. 6.

__________1941c, The recognition and interpretation of mixed conodont faunas: Denison Univ., Sci. Laboratories, Jour., vol. 35, p. 195-209.

__________1944, Conodonts, **in** Shimer, H. W., and Shrock, R. R., Index fossils of North America: New York, John Wiley & Sons, Inc., p. 235-246, pls. 93-94.

Campbell, Guy, 1946, New Albany shale: Geol. Soc. America, Bull., vol. 57, p. 829-908, 7 figs., 3 pls.

Clarke, W. J., 1961, Scottish Carboniferous conodonts: Edinburgh Geol. Soc., Trans., vol. 18, p. 1-31, 5 pls., 1 table.

Cline, L. M., 1960, Stratigraphy of the Late Paleozoic rocks of the Ouachita Mountains, Oklahoma: Okla. Geol. Survey, Bull. 85, 113 p., 45 figs.

Cline, L. M., and **Moretti, F. J.,** 1956, Description and correlation of two complete stratigraphic sections of the Jackfork sandstone in Kiamichi Mountains, central Ouachita Mountains, Oklahoma: Okla. Geol. Survey, Circ. 41, 20 p., 1 fig.

Cline, L. M., and **Shelburne, O. B.,** 1959, Late Mississippian-Early Pennsylvanian stratigraphy of the Ouachita Mountains, Oklahoma, **in** The geology of the Ouachita Mountains, a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 175-208, 18 figs.

Collinson, Charles, Scott, A. J., and **Rexroad, C. B.,** 1962, Six charts showing biostratigraphic zones and correlations based on conodonts from the Devonian and Mississippian rocks of the Upper Mississippi Valley: Ill. State Geol. Survey, Circ. 328, 32 p., 6 charts.

Cooper, C. L., 1931a, Conodonts from the Arkansas novaculite, Woodford formation, Ohio shale and Sunbury shale: Jour. Paleontology, vol. 5, p. 143-151, pl. 20.

__________1931b, New conodonts from the Woodford formation of Oklahoma: Jour. Paleontology, vol. 5, p. 230-243, pl. 28.

__________1935, Conodonts from the upper and middle Arkansas novaculite, Mississippian, at Caddo Gap, Arkansas: Jour. Paleontology, vol. 9, p. 307-315, pl. 27.

__________1939, Conodonts from a Bushberg-Hannibal horizon in Oklahoma: Jour. Paleontology, vol. 13, p. 379-422, pls. 39-47, 3 figs.

__________1947, Upper Kinkaid (Mississippian) microfauna from Johnson County, Illinois: Jour. Paleontology, vol. 21, p. 81-94, pls. 19-23 (reprinted as Ill. State Geol. Survey, Rept. Inv. 122, 1947).

Cooper, C. L., and **Sloss, L. L.,** 1943, Conodont fauna and distribution of a Lower Mississippian black shale in Montana and Alberta: Jour. Paleontology, vol. 17, p. 168-176, pls. 28-29, 1 fig.

Currie, E. D., 1954, Scottish Carboniferous goniatites: Royal Soc. Edinburgh, Trans., vol. 62, pt. 2, p. 527-602, 4 pls., 9 text-figs., 1 table.

Elias, M. K., 1956, Upper Mississippian and Lower Pennsylvanian formations of south-central Oklahoma, **in** Petroleum geology of southern Oklahoma, vol. I: Tulsa, Amer. Assoc. Petroleum Geologists, p. 56-134, 6 pls., 2 figs.

__________1959, Some Mississippian conodonts from the Ouachita Mountains, **in** The geology of the Ouachita Mountains, a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 141-165, 2 pls.

Ellison, S. P., Jr., 1941, Revision of the Pennsylvanian conodonts: Jour. Paleontology, vol. 15, p. 107-143, 4 figs., pls. 20-23.

__________1946, Conodonts as Paleozoic guide fossils: Amer. Assoc. Petroleum Geologists, Bull., vol. 30, p. 93-110, 3 figs.

Gordon, Mackenzie, Jr., 1964 [1965], Carboniferous cephalopods of Arkansas: U. S. Geol. Survey, Prof. Paper 460, 322 p., 96 text-figs., 30 pls., 11 tables.

Gunnell, F. H., 1931, Conodonts from the Fort Scott limestone of Missouri: Jour. Paleontology, vol. 5, p. 244-252.

Harlton, B. H., 1933, Micropaleontology of the Pennsylvanian Johns Valley shale of the Ouachita Mountains, Oklahoma, and its relationship to the Mississippian Caney shale: Jour. Paleontology, vol. 7, p. 3-29, 7 pls.

__________1934, Carboniferous stratigraphy of the Ouachitas, with special study of the Bendian: Amer. Assoc. Petroleum Geologists, Bull., vol. 18, p. 1018-1049, 8 figs.

__________1938, Stratigraphy of the Bendian of the Oklahoma salient of the Ouachita Mountains: Amer. Assoc. Petroleum Geologists, Bull., vol. 22, p. 852-914, 23 figs., 2 pls.

__________1947, The siliceous shale members of the Stanley-Jackfork deposits in the Ouachita Mountains, Oklahoma, with notes on the "Johns Valley" shale, **in** Field conference in western part of the Ouachita Mountains in Oklahoma: Tulsa Geol. Soc., Guidebook, p. 41-46.

__________1959, Age classification of the upper Pushmataha series in the Ouachita Mountains, **in** The geology of the Ouachita Mountains, a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 130-139, 4 figs.

Harris, R. W., and **Hollingsworth, R. V.,** 1933, New Pennsylvanian conodonts from Oklahoma: Amer. Jour. Science, vol. 225, p. 193-204, 1 pl.

Hass, W. H., 1947, Conodont zones in Upper Devonian and Lower Mississippian formations of Ohio: Jour. Paleontology, vol. 21, p. 131-141, 6 pls.

__________1950, Age of lower part of Stanley shale: Amer. Assoc. Petroleum Geologists, Bull., vol. 34, p. 1578-1584.

__________1951, Age of Arkansas novaculite: Amer. Assoc. Petroleum Geologists, Bull., vol. 35, p. 2526-2541, 1 pl.

__________1953, Conodonts of the Barnett formation of Texas, **in** Shorter contributions to general geology, 1952: U. S. Geol. Survey, Prof. Paper 243-F, p. 69-94, pls. 14-16.

__________1959, Conodonts from the Chappel limestone of Texas, **in** Shorter contributions to general geology, 1956: U. S. Geol. Survey, Prof. Paper 294-J, p. 365-399, pls. 46-50.

Higgins, A. C., 1961, Some Namurian conodonts from North Staffordshire: Geol. Magazine, vol. 98, p. 210-224, 6 text-figs., pls. 10-12.

__________1962, Conodonts from the "Griotte" Limestone of north-west Spain: Instituto Geologico y Minero de España, Notas y Communicaciones, no. 65, p. 5-21, 2 figs., 3 pls.

Higgins, A. C., Wagner-Gentis, C. H. T., and **Wagner, R. H.**, 1963, Basal Carboniferous strata in part of northern León, NW. Spain: Stratigraphy, conodont and goniatite faunas: Soc. Belge Géologie Paléontologie Hydrologie, Bull., vol. 72, p. 205-248, text-figs. 1-3, pls. 1-5.

Hinde, G. J., 1900, Notes and descriptions of new species of Scotch Carboniferous conodonts: Nat. Hist. Soc. Glasgow. Trans., vol. 5, new ser., pt. 3, p. 338-346, pls. 9-10.

Holmes, G. B., 1928, A bibliography of conodonts with descriptions of Early Mississippian species: U. S. Natl. Museum, Proc., vol. 72, art. 5, 38 p., 11 pls.

Horn, M., 1960, Die Zone des **Eumorphoceras pseudobilingue** im Sauerland, **in** Das Karbon der subvariscischen Saumsenke, ein Symposium: Geologischen Landesamt Nordrhein-Westfalen, Fortschritte Geologie Rheinland Westfalen, vol. 3, pt. 1, p. 303-342, 6 text-figs., 5 pls., 1 table.

Huddle, J. W., 1934, Conodonts from the New Albany shale of Indiana: Bull. Amer. Paleontology, vol. 21, no. 72, 136 p., 2 figs., 13 pls.

Lindström, Maurits, 1954, Conodonts from the lowermost Ordovician strata of south-central Sweden: Geologiska Föreningen Stockholm, Förhandlingar, vol. 76, no. 4, p. 517-604.

Lys, Maurice, and **Serre, Bernadette**, 1958, Contribution à la connaissance des microfaunes du paléozoique; études micropaléontologiques dans le carbonifère marin des Asturies (Espagne): Révue de l' Institut Français du Pétrole et Annales des Combustibles Liquides, vol. 13, no. 6, p. 879-916, 11 pls., 2 tables, 1 map.

Mehl, M. G., and **Thomas, L. A.**, 1947, Conodonts from the Fern Glen of Missouri: Denison Univ., Sci. Laboratories, Jour., vol. 40, p. 3-19, pl. 1.

Öpik, Armin, 1936, Konodontidest: On the conodonts: Tartu, Äratrükk Eesti Loodusest, no. 3, p. 105-107, figs. 57-59.

Pander, C. H., 1856, Monographie der fossilen Fische des silurischen Systems der russisch-baltischen Gouvernements: St. Petersburg, K. Akademie Wissenschaft, 91 p., 9 pls.

Rexroad, C. B., 1957, Conodonts from the Chester series in the type area of southwestern Illinois: Ill. State Geol. Survey, Rept. Inv. 199, 43 p., 22 figs., 4 pls.

__________1958, Conodonts from the Glen Dean formation (Chester) of the Illinois basin: Ill. State Geol. Survey, Rept. Inv. 209, 27 p., 14 figs., 6 pls.

Rexroad, C. B., and **Collinson, Charles**, 1961, Preliminary range chart of conodonts from the Chester Series (Mississippian) in the Illinois basin: Ill. State Geol. Survey, Circ. 319, 11 p., 1 pl.

__________1963, Conodonts from the St. Louis Formation (Valmeyeran Series) of Illinois, Indiana, and Missouri: Ill. State Geol. Survey, Circ. 355, 28 p., 5 text-figs., 2 pls.

__________1965, Conodonts from the Keokuk, Warsaw, and Salem Formations (Mississippian) of Illinois: Ill. State Geol. Survey, Circ. 388, 26 p., 2 figs., 1 pl., 1 table.

Rexroad, C. B., and **Furnish, W. M.**, 1964, Conodonts from the Pella Formation (Mississippian), south-central Iowa: Jour. Paleontology, vol. 38, p. 667-676, 1 text-fig., pl. 111.

Rexroad, C. B., and **Nicoll, R. S.**, 1965, Conodonts from the Menard Formation (Chester Series) of the Illinois basin: Ind., Geol. Survey, Bull. 35, 27 p., 5 figs., 2 pls., 2 tables.

Rexroad, C. B., and **Scott, A. J.**, 1964, Conodont zones in the Rockford Limestone and the lower part of the New Providence Shale (Mississippian) in Indiana: Ind., Geol. Survey, Bull. 30, 54 p., 1 fig., 3 pls., 2 tables.

Rhodes, F. H. T., and **Müller, K. J.**, 1956, The conodont genus **Prioniodus** and related forms: Jour. Paleontology, vol. 30, p. 695-699.

__________1966, Comments on conodonts, **pt. 1 of** Treatise on invertebrate paleontology, part W, conodonts, conoidal shells, worms, trace fossils: Comments and additions: Kans., Univ., Paleont. Contr., Paper 9, p. 2-5, 2 figs.

Roundy, P. V., 1926, Introduction; The micro-fauna, **in** Mississippian formations of San Saba County, Texas: U. S. Geol. Survey, Prof. Paper 146, p. 1-2, 5-23, 4 pls.

Schmidt, Hermann, 1925, Die carbonischen Goniatiten Deutschlands: Preussischen Geologischen Landesanstalt, Jahrbuch, vol. 45, p. 489-609, 2 text-figs., pls. 19-26.

Scott, A. J., and **Collinson, C. W.**, 1961, Conodont faunas from the Louisiana and McCraney Formations of Illinois, Iowa, and Missouri, **in** Northeastern Missouri and west central Illinois: Kans. Geol. Soc., Guidebook, 26th Ann. Field Conf., p. 110-141, 5 figs., 3 pls.; **also issued as** Mo., Div. Geol. Survey and Water Resources, Rept. Inv. 27 (1961).

Stanley, E. A., 1958, Some Mississippian conodonts from the High Resistivity shale of the Nancy Watson No. 1 well in northeastern Mississippi: Jour. Paleontology, vol. 32, p. 459-476, 2 text-figs., pls. 63-68.

Stauffer, C. R., and **Plummer, H. J.**, 1932, Texas Pennsylvanian conodonts and their stratigraphic relations, **in** Contributions to geology, 1932: Texas, Univ., Bull. 3201, p. 13-50, pls. 1-4.

Ulrich, E. O., and **Bassler, R. S.**, 1926, A classification of the toothlike fossils, conodonts, with descriptions of American Devonian and Mississippian species: U. S. Natl. Museum, Proc., vol. 68, art. 12, no. 2613, 63 p., 5 figs., 11 pls.

Voges, Adolf, 1959. Conodonten aus dem Untercarbon I und II (**Gattendorfia** und **Pericyclus**-Stufe) des Sauerlandes: Paläontologische Zeitschrift, vol. 33, p. 266-314, 5 text-figs., pls. 33-35, 1 table.

Youngquist, W. L., and **Miller, A. K.**, 1949, Conodonts from the Late Mississippian Pella beds of south-central Iowa: Jour. Paleontology, vol. 23, p. 617-622, pl. 101.

Youngquist, W. L., **Miller, A. K.**, and **Downs, H. R.**, 1950, Burlington conodonts from Iowa: Jour. Paleontology, vol. 24, p. 525-530, pl. 67.

Ziegler, Willi, 1963, Conodonten aus dem Unterkarbon der Bohrung Münsterland 1, **in** Aufschlussbohrung Münsterland 1, ein Symposium: Geologisches Landesamt Nordrhein-Westfalen, Fortschritte Geologie Rheinland Westfalen, vol. 11, p. 319-328, 2 pls., 2 tables.

PLATE 1

(All figures are x30)

		Page
1.	"Gnathodus delicatus **Branson and Mehl"; from middle part of the Arkansas Novaculite, Arkansas** (redrawn from Hass, 1951, pl. 1, fig. 4).	13
2.	Gnathodus (Harltonodus) **new species?; from pre-Welden shale, northern Arbuckle Mountains, Oklahoma** (drawn from Cooper, 1939 [Gnathodus bilineatus], pl. 42, fig. 59).	11
3-12.	Gnathodus (Harltonodus) bilineatus **(Roundy), sensu stricto.**	11
	3. **From lower part of Stanley Shale, 475 feet above base, southwestern Potato Hills, Oklahoma (specimen lost).**	
	4. **Specimen OU 5701; from middle part of Stanley Shale, 8 miles east of Clayton, Oklahoma.**	
	5, 6. **From Delaware Creek Shale, 5 miles south of Ada, Oklahoma** (after Branson and Mehl, 1941a [Gnathodus pustulosus], pl. 5, figs. 36, 37).	
	7. **Specimen OU 5710; from Delaware Creek Shale at 6,513 feet in subsurface, Gulf Oil Corp. 1 Riner well, SW¼ SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., near Overbrook, Ardmore basin, Oklahoma.**	
	8. **From Paint Creek Formation, Illinois** (after Rexroad, 1957 [Gnathodus modocensis], pl. 1, fig. 17a).	
	9. **From Glen Dean Formation, Illinois** (after Rexroad, 1958 [Gnathodus modocensis], pl. 1, fig. 2).	
	10, 11. **From Barnett Shale, Texas; figure 11 is holotype USNM 115101** (after Hass, 1953, pl. 14, figs. 25, 26).	
	12. **From middle part of Goddard Shale, Grindstone Creek, Ardmore basin, Oklahoma (specimen lost).**	
13, 14.	Gnathodus (Harltonodus) bilineatus smithi **Clarke; from Upper Limestone, Dalry, Scotland.**	12
	13. **Paratype GSE 10945 (H. M. Geol. Survey, Edinburgh); from Glencart** (after Clarke, 1961, pl. 5, fig. 10).	
	14. **Holotype PS 870 (H. M. Geol. Survey, Edinburgh); from Monkcastle** (after Clarke, 1961, pl. 4, fig. 13).	
15-20.	Gnathodus (Harltonodus) bransoni **Elias.**	12
	15. **From basal Stanley Shale, 120 feet above base, Caddo Gap, Arkansas** (redrawn from Hass, 1951 [Gnathodus bilineatus], pl. 1, fig. 1).	
	16, 17. **From Delaware Creek Shale, 5 miles south of Ada, Oklahoma** (after Branson and Mehl, 1941a [Gnathodus pustulosus], pl. 5, figs. 32, 38).	
	18, 19. **From Barnett Shale, Texas; figure 18 is holotype USNM 115103** (after Hass, 1953, pl. 14, figs. 28, 29).	
	20. **From basal Goddard Shale, 150 feet above base, Goddard Ranch, Oil Creek, Ardmore basin, Oklahoma (specimen lost)** (after Elias, 1956 [Gnathodus bilineatus], pl. 3, fig. 25).	
21.	Gnathodus (Harltonodus) delicatus hassi **Elias, new subspecies, holotype USNM 115029; from Chappell Limestone, Texas** (after Hass, 1959, pl. 48, fig. 5).	15
22-24.	Gnathodus (Harltonodus?) liratus **(Youngquist and Miller).**	15
	22. **Holotype SUI 4178; from Pella beds, Iowa** (after Youngquist and Miller, 1949, pl. 101, fig. 15).	
	23, 24. **From shale southwest of Clayton, Oklahoma; correlated with the Delaware Creek Shale of the Arbuckle Mountains (specimen of figure 23 lost; figure 24 is OU 5703).**	
25-28.	Gnathodus (Harltonodus) minutus **Elias; from lower part of Stanley Shale, 475 feet above base, southwestern part of Potato Hills, Oklahoma; figure 27 is holotype OU 5709 (specimen of figure 25 lost; figure 26 is OU 5702; figure 28 is OU 5704).**	16
29-31.	Gnathodus (Harltonodus) multilineatus **Elias; from upper part of Sand Branch Shale, northern Arbuckle Mountains, Oklahoma; figure 29 is the lectotype** (after Elias, 1956, pl. 3, figs. 49, 51, 53).	17
32.	Gnathodus (Harltonodus) cf. G. (H.) multilineatus **Elias; from lower part of Sand Branch Shale, northern Arbuckle Mountains, Oklahoma.**	17

Note: Except as noted below, all figures are reproduced directly from plate 1 of Elias (1959) at a smaller scale (x30 vs. x40). Figures 2, 7, and 12 are new, more accurate drawings of the corresponding figures of the earlier publication. Figures 13, 14, and 21 are new additions.

PLATE 1

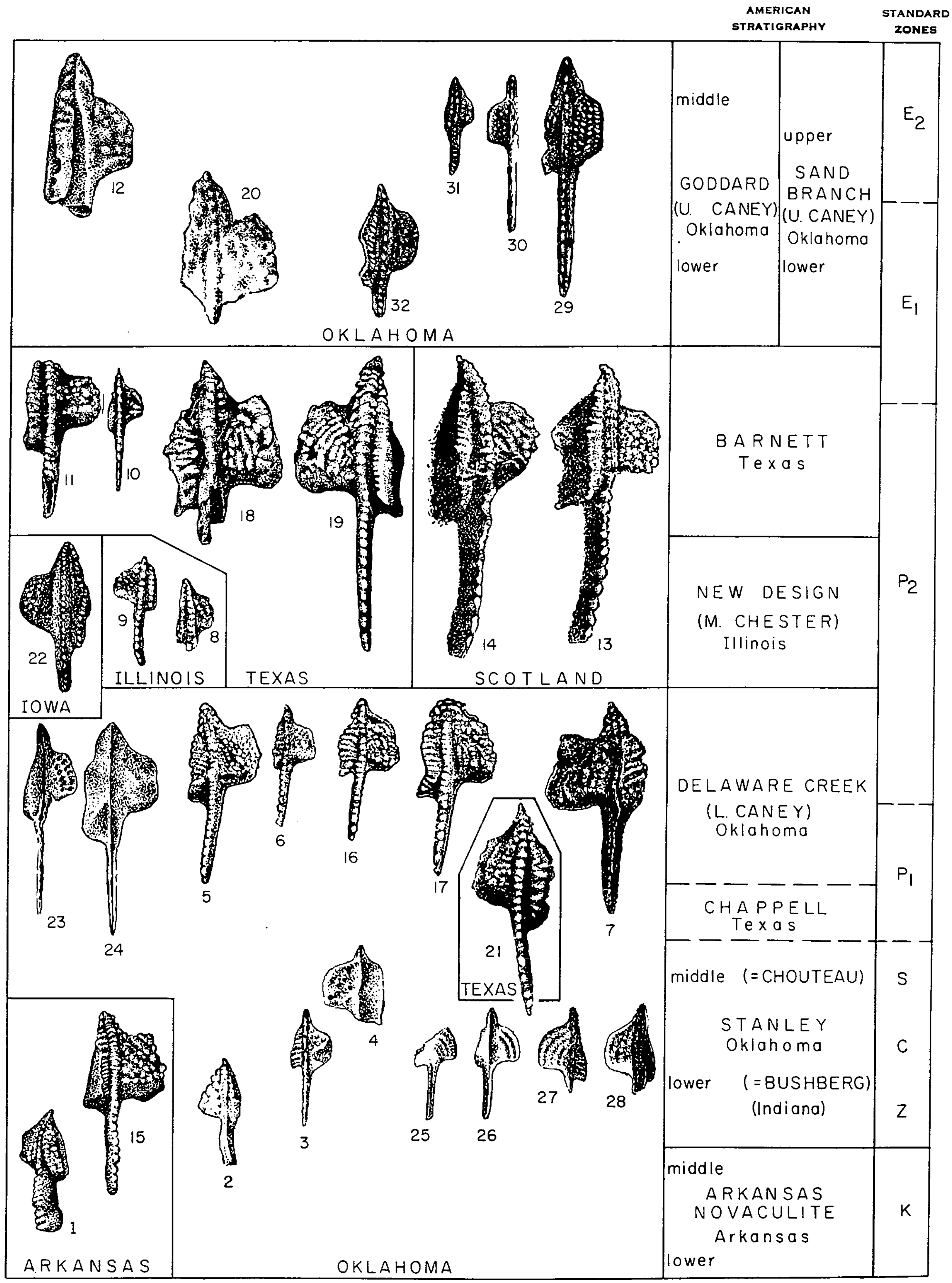

AMERICAN STRATIGRAPHY
STANDARD ZONES
12
20
31
30
29
32
OKLAHOMA
middle
GODDARD (U. CANEY) Oklahoma
lower
upper
SAND BRANCH (U. CANEY) Oklahoma
lower
E2
E1
11
10
18
19
14
13
BARNETT Texas
22
9
8
IOWA
ILLINOIS
TEXAS
SCOTLAND
NEW DESIGN (M. CHESTER) Illinois
P2
23
24
5
6
16
17
21
TEXAS
7
DELAWARE CREEK (L. CANEY) Oklahoma
CHAPPELL Texas
P1
1
15
2
3
4
25
26
27
28
ARKANSAS
OKLAHOMA
middle (=CHOUTEAU)
STANLEY Oklahoma
lower (=BUSHBERG) (Indiana)
S
C
Z
middle
ARKANSAS NOVACULITE Arkansas
lower
K

PLATE 2

(All figures, except figure 40, are x30)

Page

1-3. Neoprioniodus alatoideus **(Cooper), sensu lato.** 27

- 1. **Holotype Univ. Chicago, Walker Museum, 38053; from Woodford Formation, northern Arbuckle Mountains, Oklahoma** (redrawn from Cooper, 1931, pl. 28, fig. 1).
- 2. **From upper part of New Albany Shale, Indiana** (redrawn from Huddle, 1934, pl. 1, fig. 4).
- 3. Neoprioniodus **aff.** N. alatoideus; **specimen OU 5705; from lower part of Stanley Shale, 200 feet above base, southwestern part of Potato Hills, Oklahoma.**

4. Neoprioniodus **sp. of** N. alatoideus **group; specimen OU 5714; from middle part of Stanley Shale, 8 miles east of Clayton, Oklahoma.** 27

5. Neoprioniodus **sp. of** N. ligo **group; specimen OU 5715; from middle part of Stanley Shale, 8 miles east of Clayton, Oklahoma.** 18

6, 7. Neoprioniodus scitulus **(Branson and Mehl); from Delaware Creek Member, Caney Shale, 5 miles south of Ada, Oklahoma; figure 7 is lectotype Univ. Mo. C545-4** (drawn from Branson and Mehl, 1941a, pl. 5, figs. 5, 6). 20

8, 9. Neoprioniodus erectus rexroadi **Elias, new subspecies.** 20

- 8. **Paratype OU 5706; from Delaware Creek Member, Caney Shale, Henryhouse Creek, Ardmore basin, Oklahoma.**
- 9. **Holotype OU 5707; from Johns Valley Shale above Game Refuge Sandstone, about 6 miles southwest of Clayton, Oklahoma.**

10, 11. Neoprioniodus erectus **Rexroad; from Renault Formation, Chester Series, Illinois; figure 11 is lectotype 2P58 (Ill. State Geol. Survey)** (redrawn from Rexroad, 1957, pl. 2, figs. 23, 25). 19

12-14. Neoprioniodus ligo **(Hass); from Barnett Shale, Texas; figure 12 is holotype USNM 115172** (redrawn from Hass, 1953, pl. 16, figs. 1-3). 18

15. Neoprioniodus rynikeri **Elias; holotype OU 5713; from Delaware Creek Member, Caney Shale, 6,215 feet in subsurface, Gulf Oil Corp. 1 Riner well, SW¼ SW¼ SW¼ sec. 32, T. 5 S., R. 2 E., near Overbrook, Ardmore basin, Oklahoma.** 21

16. Neoprioniodus **sp. of** N. ligo **group; specimen OU 5716; from basal part of Springer Group, Oil Creek, Ardmore basin, Oklahoma.** 18

17-21. Neoprioniodus cassilaris **(Branson and Mehl).** 23

- 17-19. **From Keokuk Formation, Illinois; figure 19 is holotype Univ. Mo. C575-3** (redrawn from Branson and Mehl, 1941b, pl. 6, figs. 16, 17, 12).
- 20, 21. **From Vienna-Menard and Golconda Formations, Illinois** (redrawn from Rexroad, 1957 [Neoprioniodus scitulus], pl. 2, figs. 22, 26).

22. Neoprioniodus cassilaris keokukensis **Elias; holotype Univ. Mo. C578-3; from Keokuk Formation, Illinois** (redrawn from Branson and Mehl, 1941b, pl. 6, fig. 15). 24

23, 24. Neoprioniodus miseri **Elias.** 26

- 23. **Holotype OU 5717; from Delaware Creek Member, Caney Shale, 160 feet above base, Henryhouse Creek, Ardmore basin, Oklahoma.**
- 24. **Specimen OU 5718; from Johns Valley Shale above Game Refuge Sandstone, about 6 miles southwest of Clayton, Oklahoma; correlated with the Delaware Creek Member, Caney Shale, of the Arbuckle Mountains.**

25, 26. Neoprioniodus solidiformis **Elias; from Goddard Shale, 150 feet above base, Oil Creek, Ardmore basin, Oklahoma; figure 25 is the holotype** (after Elias, 1956, pl. 2, figs. 28, 29). 26

27. Neoprioniodus **cf.** N. solidiformis **Elias; specimen OU 5750; from Johns Valley Shale above Game Refuge Sandstone, about 6 miles southwest of Clayton, Oklahoma; correlated with the Delaware Creek Member, Caney Shale, of the Arbuckle Mountains.** 26

28-30. Hindeodelloides bicristatus **Huddle.** 29

- 28. **Paratype Indiana Univ. 1864; from lower part of New Albany Shale (Upper Devonian), Indiana** (redrawn from Huddle, 1934, pl. 7, fig. 2).
- 29. **Paratype Indiana Univ. 1863; from upper part of New Albany Shale (Lower Mississippian), Indiana** (redrawn from Huddle, 1934, pl. 7, fig. 3).
- 30. **Specimen OU 5708; from lower part of Stanley Shale, 475 feet above base, southwestern part of Potato Hills, Oklahoma.**

31. Ligonodina cryptodens **Huddle; holotype Indiana Univ. 2277; from lower part of New Albany Shale, Indiana; end view of anticusp** (redrawn from Huddle, 1934, pl. 12, fig. 17). 31

32. Ligonodina **sp. A; specimen Indiana Univ. 2273; from upper part of New Albany Shale, Indiana; lateral view of bar** (redrawn from Huddle, 1934, pl. 12, fig. 8). 30

Hills, Oklahoma (specimen of figure 34 lost; figure 33 is OU 5711; figure 35 is OU 5712).

33-35. Ligonodina **sp. A; from lower part of Stanley Shale, 475 feet above base, southwestern part of Potato Hills, Oklahoma (specimen of figure 34 lost; figure 33 is OU 5711; figure 35 is OU 5712).** 30

36, 37. Neoprioniodus peracutus **(Hinde).** 24

- 36. **Lectotype PS 888 (H. M. Geol. Survey, Edinburgh); from Upper Limestone, Law, Dalry, Scotland** (redrawn from Clarke, 1961, pl. 2, fig. 6).
- 37. **Plesiotype; from Glen Dean Formation, Chester Series, Illinois basin** (redrawn from Rexroad, 1958, pl. 5, fig. 11).

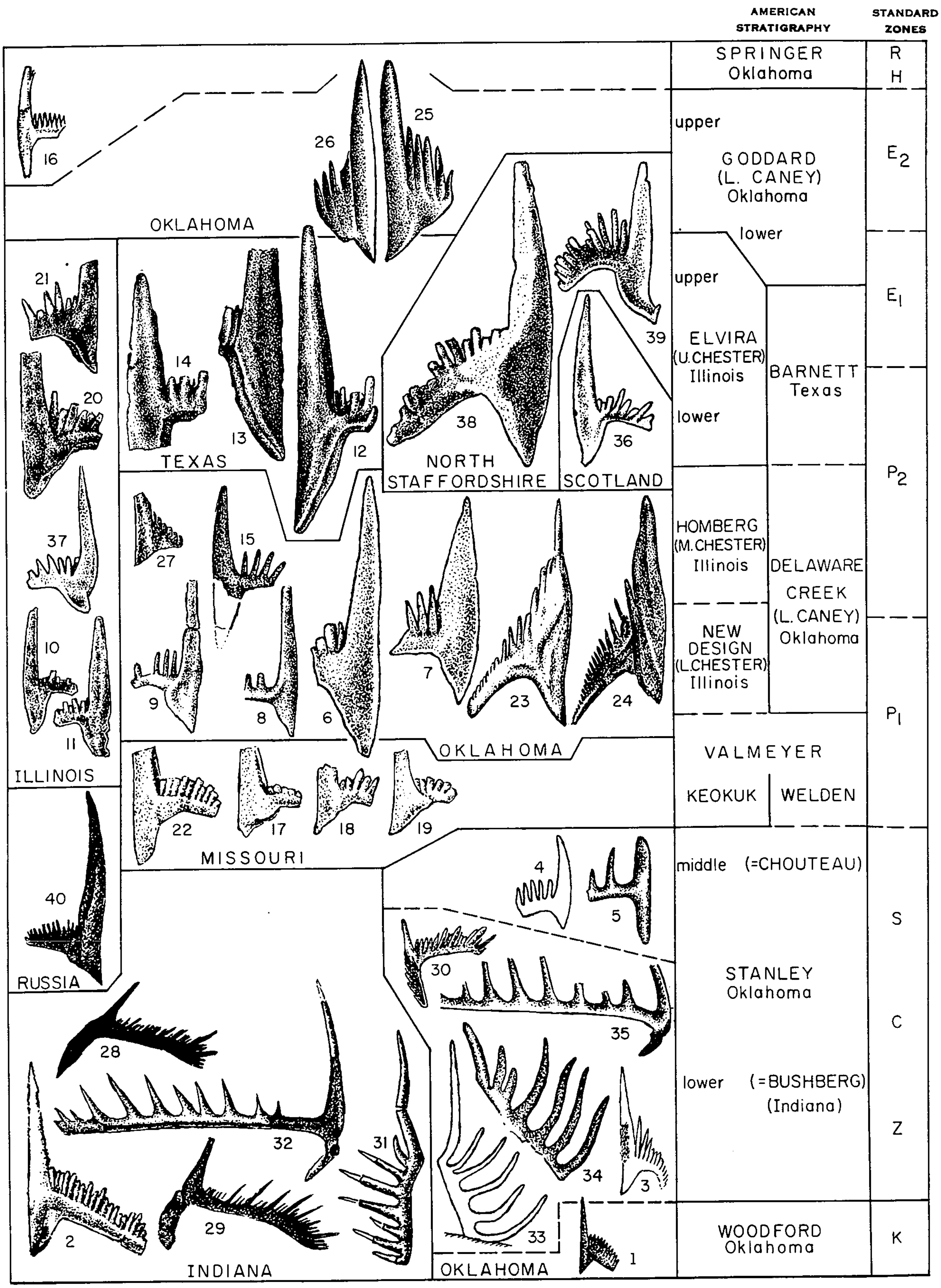
38. Neoprioniodus higginsi **Elias, new species; holotype Univ. of Sheffield E1.E15; from lower Namurian of North Staffordshire, England** (redrawn from Higgins, 1961 [Neoprioniodus scitulus], pl. 11, fig. 1). 26

39. Neoprioniodus spathatus **Higgins; from lower Namurian of North Staffordshire, England** (redrawn from Higgins, 1961, pl. 11, fig. 2). 28

40. Neoprioniodus tulensis **(Pander); lectotype; from Lower Carboniferous limestone, Tula Province, Russia** (redrawn from Pander, 1856, pl. 2A, fig. 1, no scale indicated). 21

Note: Except as noted below, all figures are reproduced directly from plate 2 of Elias (1959) at a smaller scale (x30 vs. x40). Figures 6, 7, and 16 are new, more accurate drawings of the corresponding figures of the earlier publication. Figures 36 through 40 are new additions.

Plate 2



AMERICAN STRATIGRAPHY
STANDARD ZONES
SPRINGER Oklahoma
R
H
upper
GODDARD (L. CANEY) Oklahoma
lower
E2
upper
ELVIRA (U.CHESTER) Illinois
lower
E1
BARNETT Texas
P2
HOMBERG (M.CHESTER) Illinois
NEW DESIGN (L.CHESTER) Illinois
DELAWARE CREEK (L. CANEY) Oklahoma
P1
VALMEYER
KEOKUK
WELDEN
middle (=CHOUTEAU)
STANLEY Oklahoma
lower (=BUSHBERG) (Indiana)
S
C
Z
WOODFORD Oklahoma
K
OKLAHOMA
ILLINOIS
TEXAS
NORTH STAFFORDSHIRE
SCOTLAND
MISSOURI
RUSSIA
INDIANA