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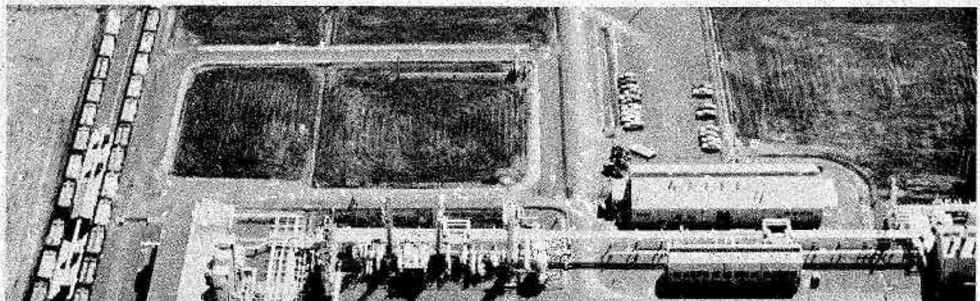
OKLAHOMA GEOLOGY NOTES



HELIUM PLANT, CIMARRON COUNTY

OKLAHOMA GEOLOGICAL SURVEY • THE UNIVERSITY OF OKLAHOMA • NORMAN, OKLAHOMA

Cover Picture

MINERAL INDUSTRIES OF OKLAHOMA

Helium

Helium, because of a set of properties that can be truly called remarkable, finds uses ranging from the prosaic to the exotic. It is used for the levitation of the penextinct airship and as an essential element in the operation of Telstar. It is an irreplaceable adjunct to shielded-arc welding and to plasma physics. About 75 percent of the helium used in the United States is consumed by Federal agencies, principally in space programs.

Helium is extracted only from natural gas, and the yearly production is essentially controlled by the availability of gas produced for commercial purposes. Helium-bearing gases from several large gas fields are sent through U. S. Bureau of Mines helium-extraction plants and then returned to commercial channels. A few privately owned helium-extraction plants produce a small amount for private consumption.

Oklahoma's entry into helium production began in 1959 with the construction of the U. S. Bureau of Mines helium plant at Keyes, Cimarron County. In that year, although operations began in August, the Keyes plant contributed 25 percent of the national production. Since then annual Oklahoma production of helium has been more than 40 percent of the national yield. Cumulative Oklahoma production through 1963 is 1.117 billion cubic feet of helium with a value of more than $30 million.

—A. N.

(Photograph courtesy of Oklahoma Department of Commerce and Industry)

Edestus giganteus Newberry is *Edestus vorax* Leidy

Carl C. Branson

In a previous paper (Branson, 1963, p. 276, 277) *Edestus giganteus* Newberry, 1888, was referred to synonymy with *Edestus vorax* Leidy, 1885. Dr. Bobb Schaeffer of the American Museum of Natural History kindly provided a latex mold of the holotype of *Edestus giganteus*, from which Stephen Hall made a cast.

From examination of the original illustration (Newberry, 1888, pl. 6; 1889, pl. 40) and of the cast, the specimen is seen to be 32 cm long and 12 cm high. Five toothlike elements are well preserved and a fragment of a sixth is present. A seventh element is believed to have been present at the posterior end. The cast seems to indicate that an attempt has been made to restore the toothlike elements of the holotype by adding simulated crowns. These are incorrectly done if Newberry's illustration (fig. 2) can be trusted. The toothlike elements are

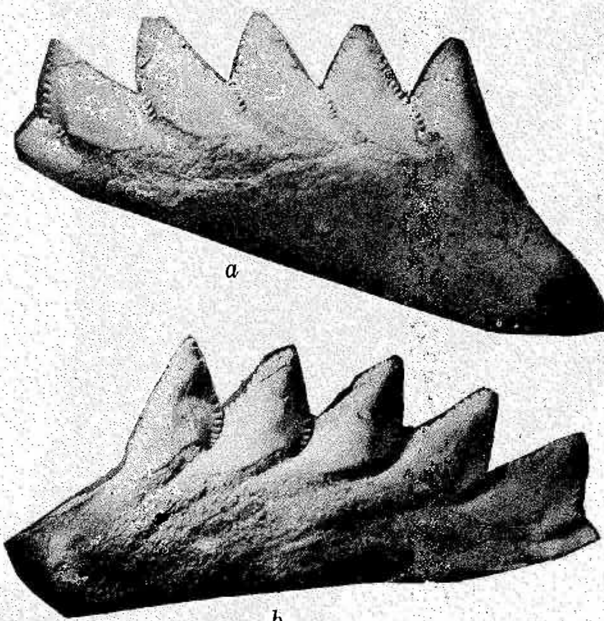


Figure 1. Plastoholotype of Edestus giganteus **Newberry, x0.3**
a. Left side
b. Right side

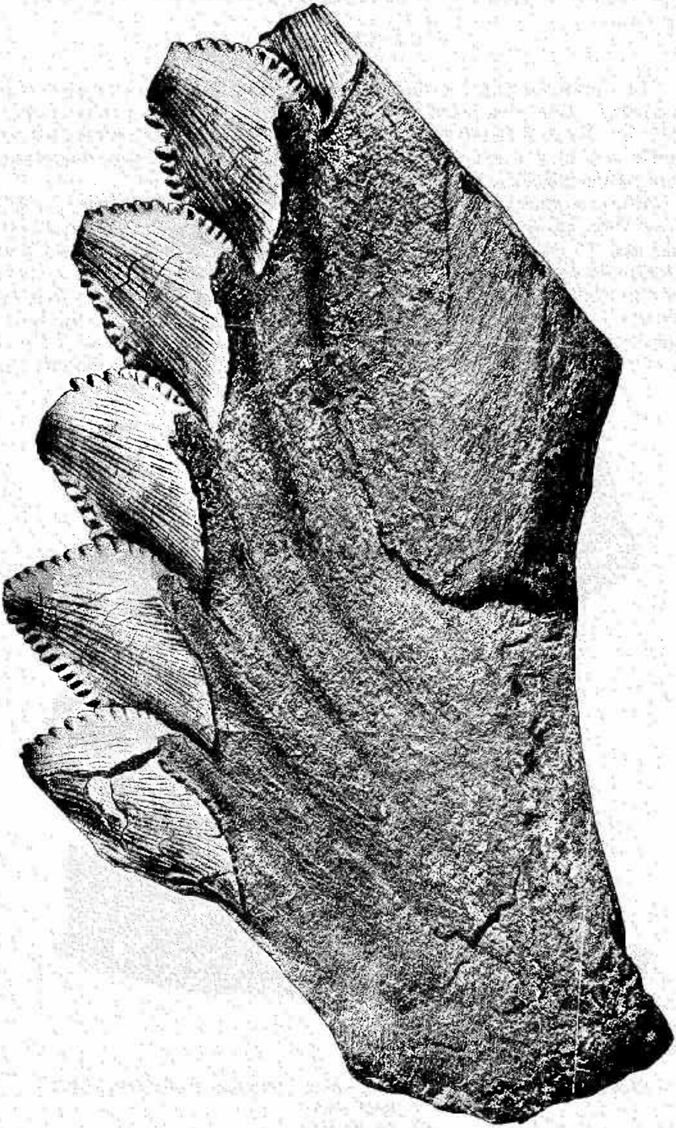


Figure 2. Original illustration of holotype of Edestus giganteus, x0.5, Reproduced from Newberry, 1888.

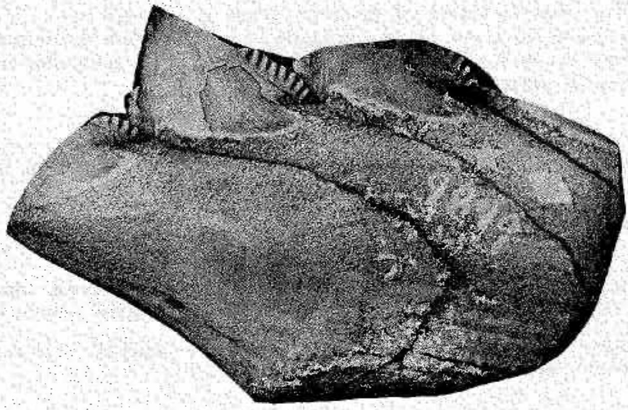


Figure 3. Right side of holotype of Edestus vorax, **x0.7.**

shorter, stouter, and more rounded on their posterior edges than they appear in the illustrations of the cast (fig. 1).

Newberry's specimen was said to be from the Coal Measures, Decatur, Macon County, Illinois. The specimen was collected by H. A. Wheeler of Washington University (St. Louis). The American Museum sent a label reading "225 Edestus Giganteus Newberry Carboniferous (Coal Measures, Decatur, Ill.)." The probability is that the specimen was obtained from the caprock of the Illinois No. 5 coal and from a coal mine. The specimen is almost black and appears to have some carbon in some areas (letter from Dr. Schaeffer, December, 18, 1963).

Edestus vorax (fig. 3) was described by Leidy from a single specimen in the collection of the Academy of Natural Sciences of Philadelphia. Although the labels show it to have been collected at Frozen Rock, Arkansas River, Indian Territory (3 miles east of Muskogee, Muskogee County, Oklahoma), it clearly did not come from that locality or horizon. The specimen was donated by "an itinerant showman." Because of its identical preservation and because it is the same species, *Edestus giganteus*, it is considered probable that the specimen came from Illinois and quite probably from the same horizon and general region, but not from Decatur or elsewhere in Macon County. Coal production from that county began after 1880 and the specimen was collected before 1855. The coal is shallow in Peoria, Fulton, and Knox Counties (Andros, 1915a; 1915b), and probably the specimen came from one of these counties.

It is unfortunate that the type species of *Edestus* must be interpreted from a specimen about which no stratigraphic or geographic information is available. With the knowledge of the second specimen of *E. vorax* (*E. giganteus* Newberry) the morphology of the type species is well known.

The element known of the form genus is regarded as a dorsal spine. Bone does not occur internally in sharks, and the massive sectional bar with serrated "toothlike" elements is not adaptable to a masticatory function.

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Sclerites? from Bromide Formation

Carl C. Branson

Specimens considered to be sieve plates of an echinoderm (probably a holothurian) from the Bromide Formation of Oklahoma were figured and described in January (Reso and Wegner, 1964). The authors properly noted that the absence of holothurian elements other than the plates cast doubt upon the affinity.

Three species (two new) and one undetermined fragment were figured. All specimens are from the well-known Rock Crossing outcrop of the Pooleville Member of the Bromide Formation.

Allen Graffham of Ardmore sent three specimens to the Oklahoma Geological Survey and stated that he had "noted these before in the *Sowerbyella* zone" and had considered them to be parts of broken cranidia of *Dolichoharpes* (letter dated February 9, 1964). He had obtained his specimens from the same zone in the quarry in sec. 22, T. 5 S., R. 1 E., in the Criner Hills, Carter County, Oklahoma.

Examination of specimens of harpid trilobites (fig. 1) shows that Graffham is probably correct in his observations. The cephalic marginal fringe is broad and has closely spaced pits. The plates seem to be fragments from the fringes of trilobite moults. Material is being sought in the Bromide to prove or disprove this conjecture. The "sclerites" have no definite shape, no pattern of arrangement of the perforations is apparent, and some of the perforations appear to be pits. Evitt (1951) has discussed pits on the fringes of harpids and has noted perforations and the thin floor of pits. Middle Ordovician sclerites described by Gutschick (1954) from Illinois have an oval, circular, or nearly polygonal shape and an appearance of perforation patterns, yet even this occurrence should be checked for fringes of trilobite moults.

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Reso, Anthony, and **Wegner, Karen**, 1964, Echinoderm (holothurian?) sclerites from the Bromide Formation (Black Riverian) of southern Oklahoma: Jour. Paleontology, vol. 38, p. 89-94, pl. 23, 1 text-fig.

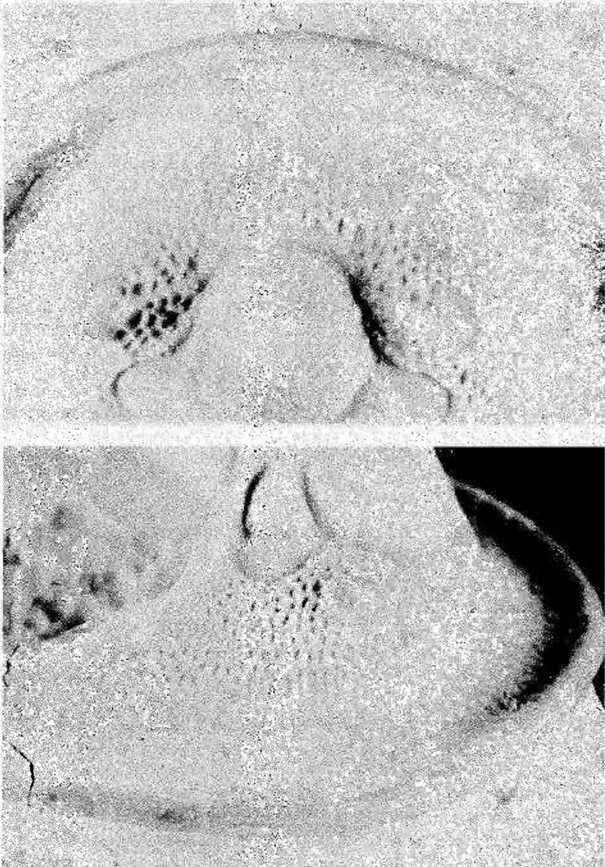


Figure 1. Two views of the fringe of a specimen of a mature Dolichoharpes **showing the pattern of pits, x8. Bromide Formation, Rock Crossing, Carter County, Oklahoma.**

(Photographs by Jan Cannon)

Subgenera of the Conodont Genus *Multioistodus* in Simpson-Burgen (Ordovician) of Oklahoma

R. W. Harris

In the summer of 1957, during a detailed investigation of the Burgen, Tyner, Fite, and Fernvale exposures on the Illinois River, in northeastern Oklahoma, the writer found a zone of rather large cephalopods in the upper third of the 100-foot Burgen Sandstone sequence. Approximately two dozen cephalopods were forwarded for identification to R. H. Flower, New Mexico Bureau of Mines and Mineral Resources. In his reply of November 5, 1957, he stated that he suspected the forms to be Chazyan in age, possibly correlating with Oil Creek, and he added:

> On superficial examination, the fauna is one of dominantly orthocones, which have a wide range in the Ordovician. There are baltoceroids which range from Whiterock into lower Trenton, including an apparent **Murrayoceras**, a crushed member of the Valcouroceratidae, an annulated form which may or may not be **Masnaquaceras** (lower Chazy). The fauna is one of a type which we find in the lower Chazyan, again in the Lowville, and I have a similar association from above the Plattin at Zell, Missouri, and a somewhat similar association from the Carters (I think) of Tennessee. Until we see what sections will do, we cannot go much farther, but my guess is that this may be early rather than late. There are no big actinoceroids here at all, which occur in Lowville or shortly younger faunas. There are some possible Steroplasmoceroids and Allumettoceratidae here. My guess is that this should be Oil Creek stuff but if I am wrong, I will not be greatly surprised. What is surprising is the absence of good actinoceroids, any coiled forms, and the presence of only one cyrtocone.

After examining additional cephalopods forwarded to him, Dr. Flower stated in his letter of December 20, 1957:

> The annulated beast is certainly not **Mesnaquaceras,** a lower Chazy genus, nor a **Stereospyroceras;** rather it appears to be the type of **"Cycloceras"** that occurs in the Lowville up to the lower Trenton (Rockland) which has been called **"Cycloceras."** The **Murrayoceras** is again a long-ranging type, best known from Lowville and Rockland faunas.

Following Flower's tentative assignment of Oil Creek age to Burgen strata upon cephalopod evidence, the writer discovered corroborative evidence in Burgen, Tyner, and Oil Creek deposits in three established species of Missouri Dutchtown conodonts of the genus *Multioistodus* Cullison, 1938. At the time Cullison reported the conodonts, he surmised that the Dutchtown might be older than the Oil Creek of Oklahoma, although included in evidence for such tentative correlation was the bryozoan *Crepipora globulifera* (unknown in sediments "older than Oil Creek" in Oklahoma).

The Chazyan trilobite *Pseudomaria (Pliomerops) nevadensis* was discovered in the lower part of the Tyner Formation of Oil Creek age near the Illinois River in northeastern Oklahoma (Huffman and Starke, 1960; Starke, 1961, p. 18). This trilobite has been recovered from many Oil Creek exposures throughout the Arbuckle Mountains and the Criner Hills of southern Oklahoma. Thus, Oil Creek, Burgen, and the lower part of the Tyner have been proved correlative.

The multioistodids that Cullison (1938) described were obtained 11 feet above the base of a 15-foot middle member of the Dutchtown (Ordovician), cropping out 1.5 miles west of Dutchtown, Missouri. The Dutchtown Formation in Missouri ranges in thickness from zero to 170 feet, unconformably separating the underlying St. Peter Sandstone from the overlying Joachim Limestone. Cullison (1938) established the conodont genus *Multioistodus* to accommodate three denticulate species, each consisting of a simple, recurved, "fibrous" cusp, bearing one, two, or three posteriorly directed basal denticles. Cullison named the form with a single denticle *Multioistodus subdentatus* and designated it as type species. He named the form with two denticles *M. lateralis* and the form with three, *M. tridens*. Types were deposited in the paleontological collections of the Missouri School of Mines and Metallurgy.

No other species of the genus has been described, although three new Dutchtown multioistodids recorded by McLaughlin (1941) were illustrated by Branson (1944). Camp and others (1942) listed Cullison's multioistodid species as Pisces, incertae sedis.

Branson and Mehl (1944) described *Multioistodus* and illustrated the type species.

Youngquist and Cullison (1946) included additional details and illustrations of *M. subdentatus* and *M. tridens* in describing a Missouri Dutchtown conodont fauna of thirty species.

Fay's conodont catalogue of 1952 and his supplement of 1958 each includes a terse description of *Multioistodus* and a lateral sketch of the type species.

Genus *Multioistodus* Cullison, 1938

Multioistodus Cullison, 1938, Jour. Paleontology, vol. 12, p. 219, 226; Fay, 1952, Kans., Univ., Paleont. Contr., Vertebrata, art. 3, p. 131; 1958, Okla. Geol. Survey, Okla. Geology Notes, vol. 18, p. 103.
Additional synonymy in Fay, 1952, p. 131.

Cullison described the genus as follows:

> Base lachryforme to subtriangular, narrows anteriorly, broadens posteriorly, deepest about center. The cusp is most prominent, usually bladelike to subtriangular in cross section, bearing one or more prominent carinae. The denticles, usually bicarinate, one or more in number, are outgrowths from the base of the cusp, rather than from the area of the basal plane. This genus is established to include those species of a fibrous character that seem to be transitional between the simple bases and cusps of the genus **Oistodus** and the more complex dental units that have the denticles and cusp arising directly from the base.
>
> Genotype: **Multioistodus subdentatus** Cullison new species, [collected] 11 feet above base of Middle Dutchtown, 1.55 miles east of Dutchtown, Missouri.

Cullison attached generic significance to the recurved cusp, although he recognized variations in cross sections of cusps of his three different species. Specific characters involved varying numbers and differing positions of denticles upon the base of the cusp.

Upon the basis of examination of more than two dozen multioistodid species and/or subspecies recovered from Oklahoma Simpson and equivalent strata, three new subgenera are herein established, with Cullison's three species as type species, under Multioistodidae, new family.

The multioistodid type species with single basal denticle, originally described and illustrated as *Multioistodus subdentatus* Cullison, now becomes *Multioistodus (Multioistodus) subdentatus* (Cullison) (pl. I, figs. 1, 2) and is designated type species for monotypic subgenus *Multioistodus*, new subgenus.

The multioistodid with two basal denticles, originally described and illustrated as *Multioistodus lateralis* Cullison, now becomes *Multioistodus (Dirhadicodus) lateralis* (Cullison) (pl. I, figs. 3, 4) and is designated type species for monotypic subgenus *Dirhadicodus*, new subgenus.

The multioistodid with three basal denticles, originally described and illustrated as *Multioistodus tridens* Cullison, now becomes *Multioistodus (Trirhadicodus) tridens* (Cullison) (pl. I, fig. 5) and is designated type species for monotypic subgenus *Trirhadicodus*, new subgenus.

Family MULTIOISTODIDAE, new family

Simple cusp and distinctly excavated basal expansion bearing a single denticle at one or more of its anterior, posterior, or lateral carinate basal slopes or angles.

Genus *Multioistodus* Cullison, 1938

Subgenus *Multioistodus*, new subgenus

Type species: *Multioistodus subdentatus* Cullison, 1938

A simple concept of the genus is that of an asymmetrical scandodid to subdrepanodid cusp with anterior (oral) and posterior (aboral) keels; the posterior keel extends proximally across edges of a denticle on posterior face or outer edge of basal expansion; projection of denticle is essentially posterior in plane of elongate axis of base. A growth axis is visible in some representatives.

Remarks.—The cusp of the subgenus is basically like that of *Scandodus* Lindström; that is, the broadly convex (though possibly carinate) outer surface is wider and more uniform in arc from anterior through posterior keels. The inner surface reveals peripheral channeling separating and accenting anterior edge and median to submedian convexity of cusp (a scandodid characteristic). The cusps of some species, however, are flattened (even foliaceous), and, accordingly, is subdrepanodid in aspect. In such species with subdrepanodid cusps, the peripheral channeling is obscure along the anterior edge of inner surface. In most species the anterior keel is more pronounced than is the posterior. Recurvature and deflection of cusp varies within rather wide limitations, according to species.

The denticle may vary considerably, according to species. It may be a short stubby node, a distinct acicular denticle, or a compressed or foliaceous blade. Some specimens from the basal part of the Joins reveal the denticle expanded to cusp proportions, with growth axis visible along the upper edge. The position of the denticle ranges from outer lateral edge of base, to middle of posterior face of base, to complete width and height of posterior face of base. In some species a thin, rudderlike keel serves to connect denticle and basal angle. In direction, the denticle may project posteriorly in plane of cusp, to slightly flexed laterally, upward, or downward ("hooked"); it may be slightly twisted.

Aboral (basal) profile is subelliptical to subtriangular, depending upon degree of inflation of inner face of base (species with compressed base display narrow, elliptical aboral profiles). Anterior end is more acutely angled.

Basal cavity is relatively shallow to deep (apex on level with upper edge of denticle); in lateral view it is subtriangular to Phrygian caplike, with apex near-median to anterior. Steeper anterior slope of cavity is straight to slightly concave. The cavity is limited essentially to cusp, but in species with exceptionally large denticle developed from basal slope and angle, the cavity involves also part of the denticle.

According to Article 9, Rules Zoological Nomenclature: "if a genus be subdivided into subgenera, the name of the typical subgenus must be the same as the original genus"; hence, the derivation of the subgeneric name.

Multioistodus (Multioistodus) subdentatus (Cullison), 1938
Plate I, figures 1, 2

Multioistodus subdentatus Cullison, 1938, Jour. Paleontology, vol. 12, p. 222, 226-227, pl. 29, fig. 13a, b; Fay, 1952, Kans., Univ., Paleont. Contr., Vertebrata, art. 3, p. 131; 1958, Okla. Geol. Survey, Okla. Geology Notes, vol. 18, p. 105, fig. 4.
Additional synonymy in Fay, 1952, p. 131.

Lachrymiform base of Dutchtown type specimen is subtriangular in basal profile; outer edge of profile gently convex, inner border expanding posteriorly, anterior end subacute, posterior end blunt. The bicarinate cusp rises at an angle of approximately 45° and curves posteriorly to a position subparallel to basal plane. Outer surface of cusp is broadly and evenly convex; inner surface flatter, and bounded anteriorly by a pronounced, full-length keel extending through fairly sharp, ridgelike anterior nose. From outer basal edge of cusp a fairly stout, slightly compressed denticle projects posteriorly essentially in plane of cusp, although in some specimens this denticle is flexed outward and downward.

This species in lower Simpson and Burgen-Tyner outcrops of

Oklahoma appears identical with the Dutchtown type species. Relatively large and robust specimens were recovered from upper Joins, Oil Creek, uppermost Burgen, and lower Tyner strata, although some of the Tyner specimens were "reworked." The species is recognizable essentially by two characteristics: (1) inner face of base is inflated, resulting in subtriangular aboral profile (inner margin flaring posteriorly), and (2) the posterior denticle is on the outer edge (not middle) of the base. Growth axis is plainly visible in Simpson specimens, although not evident in many Burgen and lower Tyner forms. The anterobasal cusp angle is 80° to 85°, but the cusp gracefully recurves to a position essentially parallel with the basal plane.

The species is the most abundant of the several species of the subgenus found in Simpson and Burgen-Tyner outcrops.

Homoeotype OMC 121 (pl. I, fig. 2) from horizon 10 feet below top of the Burgen Sandstone, beneath east end of Illinois River bridge at Eagle Bluff, 12 miles northeast of Tahlequah; homoeotype OMC 122, from Oil Creek roadside exposures, on Bromide-Connerville road, 4.1 miles west of Bromide; and homoeotype OMC 123, from horizon 20 feet above base of the Oil Creek Formation, west side of U. S. Highway 77, south side of Arbuckle Mountains.

Explanation of Plate I

(Magnification x25, except figure 5)

Figure 1. Multioistodus (Multioistodus) subdentatus **(Cullison)**
Dutchtown hypotype 2988, Iowa State University, redrawn from Youngquist and Cullison (1946, pl. 89, fig. 18).

Figure 2. Multioistodus (Multioistodus) subdentatus **(Cullison)**
Burgen homoeotype OMC 121
a. Inner surface.
b. Aboral profile.

Figure 3. Multioistodus (Dirhadicodus) lateralis **(Cullison)**
Dutchtown holotype 7199, Missouri School of Mines and Metallurgy, redrawn from Cullison (1938, pl. 29, fig. 14).

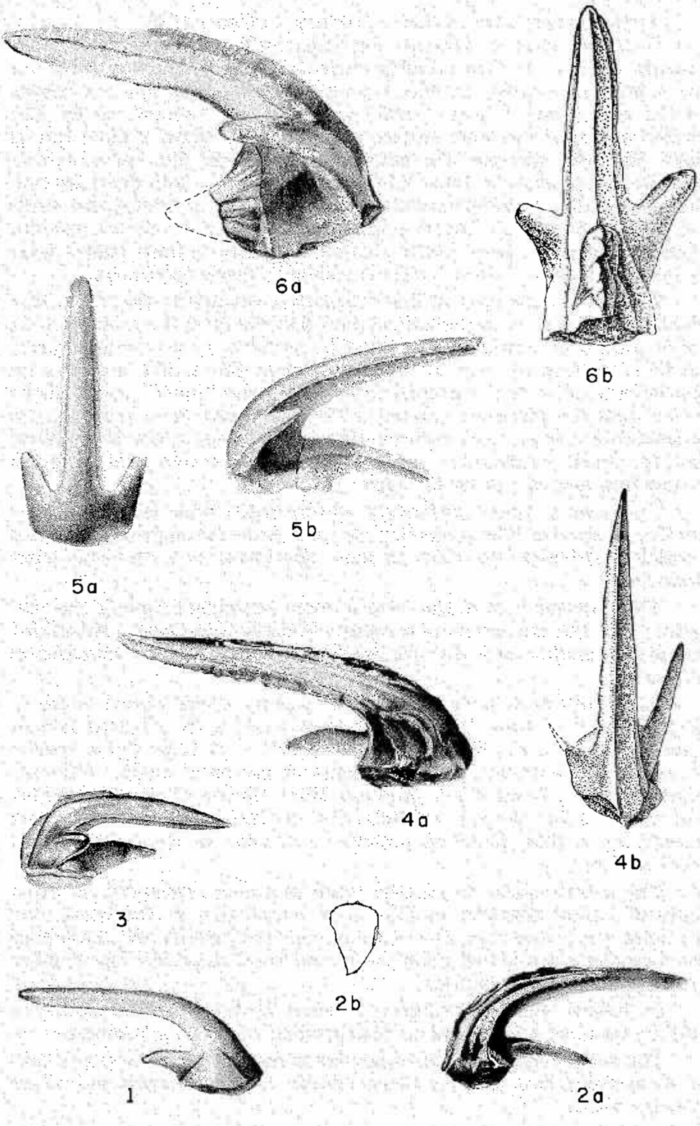
Figure 4. Multioistodus (Dirhadicodus) lateralis **(Cullison)**
Oil Creek homoeotype OMC 124
a. Inner surface.
b. Oral view.

Figure 5. Multioistodus (Trirhadicodus) tridens **(Cullison), x40**
Dutchtown hypotype 2990, Iowa State University, redrawn from Youngquist and Cullison (1946, pl. 90, figs. 10, 11).
a. Oral view.
b. Lateral view.

Figure 6. Multioistodus (Trirhadicodus) tridens **(Cullison)**
Oil Creek homoeotype OMC 127
a. Lateral view.
b. Posterior view.

(Drawings by Nancy Halliday)

Plate I



Subgenus *Dirhadicodus*, new subgenus

Type species: *Multioistodus lateralis* Cullison, 1938

Recurved cusp is basically asymmetrically acodid; outer surface broadly convex (though possibly carinate) from anterior to posterior keels, and inner surface divided by a submedian carina into low convex to flat or concave "inner" (oral) and posterior (aboral) faces. The posterior keel of the outer surface extends across edges of outer lateral basal denticle, whereas the submedian carina of the inner surface extends across edges of inner lateral basal denticle. Both denticles project essentially posteriorly, with variable degrees of lateral and vertical deflection. Aboral (basal) profile subtriangular to suboval, anterior corner most acute; basal cavity shallow to relatively deep (upper edge of lateral denticle). Growth axis is visible in many specimens.

Remarks.—The cusp of this subgenus is essentially that of *Acodus* Pander. Thus, it is asymmetrical and subtriangular in cross section, exact profile of triangle determined by position of submedian carina on inner surface of cusp. In most specimens the carina is so low on the inner surface that subequal faces result, the "inner" (oral) being wider than the posterior (aboral). The outer surface of most species is smoothly convex from anterior through posterior keels, but a West Spring Creek (Arbuckle) species exhibits a carina and adjacent channeling near the posterior edge.

The cusp projects posteriorly within rather wide limitations, according to species. The projection may bifurcate the angle of the lateral denticles, although the cusp in most specimens is nearer the outer denticle.

The anterior keel of the cusp is more prominent than is the posterior. The anterior carina of a minute West Spring Creek (Arbuckle) species terminates in a distinct, thickened buttress at the anterobasal angle.

As a rule both laterals originate slightly above aboral edges in posterior half of base. The inner lateral tends to be situated farther forward (even at or slightly ahead of middle). A basal Joins species reveals both denticles as developments of postbasal angles, although involving some basal slope. Another West Spring Creek (Arbuckle) and basal Joins species exhibits the denticles (particularly inner lateral) as a thin, platelike posterior extension of the entire lateral basal surface.

The subtriangular to suboval basal profile is influenced by proximity of lateral denticles to the aboral edges; that is, the nearer the denticles are to the edge, the more angular the profile; and the higher the denticles are situated upon the lateral basal slope, the less angular (more rounded) the profile.

In lateral view the subconical basal cavity is subtriangular in outline, its apex terminating at near-median to anterior position.

The subgeneric name *Dirhadicodus* is derived from the Greek prefix *di* meaning two, and the Greek *rhadix* meaning branch and *odous* meaning tooth.

Multioistodus (Dirhadicodus) lateralis Cullison, 1938

Plate 1, figures 3, 4

Multioistodus lateralis Cullison, 1938, Jour. Paleontology, vol. 12, p. 222, 226-227, pl. 29, fig. 14; Fay, 1952, Kans., Univ., Paleont. Contr., Vertebrata, art. 3, p. 131.

Additional synonymy in Fay, 1952, p. 131.

The Dutchtown type species possesses a slightly excavated, flared base that in aboral profile is subtriangular to subrhomboidal. The acodid cusp, triangular in cross section, recurves posteriorly to a position essentially parallel to basal plane. Outer surface of cusp is smooth and broadly convex; inner surface is divided by a submedian carina into subequal faces, a flattened "inner" (oral) and a flattened to concave posterior (aboral). Anterior keel of outer surface forms carinate "backbone" of cusp; posterior keel of outer surface extends basally across edges of the slightly compressed outer lateral denticle. Submedian carina of inner surface extends basally across edges of inner lateral denticle. In posterior curvature the cusp bisects angle between denticles, but in some specimens it is nearer the outer denticle.

Curvature of the subtriangular acodid cusp of relatively large and robust Simpson and Burgen-Tyner representatives ranges from 45° to a position slightly above the horizontal plane. The anterior keel of the outer surface forms a carinate "backbone" of the cusp and terminates in a relatively sharp, prominent anterobasal buttress. Posterior keel of the outer surface is extended basally across edges of the slightly compressed outer lateral denticle. The smooth convex outer surface of largest specimens displays a low, narrow median carina only along its basal half (carina fades distally into general convexity of cusp at approximately midlength).

Submedian carina of inner surface of most specimens is well below median line, thus dividing inner surface subequally into a wider, flattened to concave "inner" (oral) face, and a narrow, flattened to gently convex posterior (aboral) face. In some specimens, however, "inner" and posterior faces are essentially equal in width. The median carina is extended basally across edges of the inner lateral denticle.

Both lateral denticles originate slightly above aboral edge of cusp. Some specimens have a slightly constricted peripheral band below the denticles. Outer lateral denticle appears slightly longer and more compressed than does inner lateral denticle. Furthermore, the contact of upper edge of outer lateral denticle with cusp is slightly higher than is that of opposing denticle.

Posterior face separating the denticles is gently convex, although sloping obliquely inward from base of outer lateral to base of inner lateral denticle.

Aboral basal profile is suboval to broadly subtriangular, with rounded posterior margin flaring and slightly produced at inner corner. The anterior aboral margin of some specimens displays an incised arch beside outer edge of anterobasal buttress. Apex of cavity is near-median to slightly anterior.

Typical robust representatives were recovered in horizon 50 feet below top of Joins Formation and from several Oil Creek horizons in the Arbuckle Mountains. The form is less abundant in topmost Burgen and lower Tyner outcrops on Illinois River.

Homoeotype OMC 124 (pl. I, fig. 4), from Oil Creek roadside exposures on Bromide-Connerville road, 4.1 miles west of Bromide; homoeotype OMC 125, from horizon 20 feet above base of the Oil Creek Formation, west side of U. S. Highway 77, south side of Arbuckle Mountains; and homoeotype OMC 126, from topmost Burgen outcrops, coring at roadside culvert, south end of Eagle Bluff on Illinois River, 12 miles northeast of Tahlequah.

Subgenus *Trirhadicodus,* new subgenus

Type species: *Multioistodus tridens* Cullison, 1938

Simple, basally expanded and excavated, posteriorly curving, essentially symmetrical, distacodid to subacontiodid cusp with outer lateral, inner lateral, and posterior carinae extended proximally across edges of three corresponding basal denticles.

Remarks.—The cusp of this subgenus occurs in two distinct shapes: (1) a symmetrical cusp with broadly and smoothly rounded anterior face, and acutely angled to broadly convex posterior slopes (subtriangular to subcircular in cross section), with the two lateral carina, accordingly, near anterior margin or middle of cusp, as in genus *Distacodus* Hinde; and (2) an asymmetrical cusp, with anterior edge keeled, and lateral slopes extending almost to posterior margin (subelliptical in cross section), with the two lateral carina, accordingly, near posterior margin, as in genus *Acontiodus* Pander.

Trirhadicodus tridens (Cullison), the type species, is typical of the symmetrical cusp, subtriangular in section, in which the anterior face is broadly rounded, and the two posterior slopes are flat and acutely angled. The more common type (represented by the majority of Simpson and Burgen species) is the asymmetrical type (subelliptical in cross section), that is, smooth curvature of outer and inner surfaces extends from anterior keel to positions near posterior carina of cusp. In essentially all species of the asymmetrical type, subequal lateral slopes result in outer surface extending farther posteriorly. Accordingly, the outer lateral carina and its related basal denticle are also nearer posterior margin, and the inner lateral denticle is farther forward. In other words, outer lateral and posterior carinae appear more closely related. Indeed, in a small basal Joins species of the asymmetrical type, the posterior carina bifurcates from the outer lateral at approximate midlength of cusp. Incidentally, this primitive basal Joins representative of the subgenus supplies further evidence of evolution, in this instance, of the cusp; that is, the inner lateral carina of the species is also so near the base of the cusp that the entire cusp is not subacontiodid, but is subdrepanodid in aspect, the typical cusp of *Dirhadicodus*, new subgenus.

Locations of the three carinae across base of cusp are directly related to positions of the three denticles. Because outer lateral and posterior carinae are closely related in trirhadicodid species, outer lateral and posterior denticles are closely related also, possibly in other features more basic than that of close proximity observed in some lower Simpson species.

Denticles may be nodose, acicular, platelike, or foliaceous. In symmetrical distacodid cusps the uniform lateral denticles are nearer the anterior face and higher on the cusp. All denticles display some degree of posterior curvature in conformity with general direction of curvature of cusp. Variations in vertical and horizontal deflection (even possible torque) are evident in both denticles and cusp, according to species. The posterior denticle may display a carinate basal "rudder."

Aboral (basal) profile of the symmetrical distacodid type is essentially an isosceles triangle, with anterior margin gently convex to flat or concave, and posterior slopes more acutely angled. Aboral profile of asymmetrical subacontiodid type may be subtriangular, subelliptical, subovate, or subquadrate. Basal cavity is relatively deep; apex is in near-median to anterior position.

A growth axis is visible in the majority of specimens (in cusp and denticles).

The subgeneric name *Trirhadicodus* is derived from the Greek prefix *tri* meaning three, and the Greek *rhadix* meaning branch and *odous* meaning tooth.

Multioistodus (Trirhadicodus) tridens (Cullison), 1938

Plate I, figures 5, 6

Multioistodus tridens Cullison, 1938, Jour. Paleontology, vol. 12, p. 222, 227, pl. 29, fig. 15a, b; Fay, 1952, Kans., Univ., Paleont. Contr., Vertebrata, art. 3, p. 131-132.

Additional synonymy in Fay, 1952, p. 131.

Dutchtown specimens (pl. I, fig. 5) display a subtriangular base with symmetrical, distacodid cusp, recurved essentially to horizontal plane. Anterior face of cusp is broadly rounded to mid-lateral position; posterior slopes are flattened and acutely angled, thus effecting a subtriangular profile of cusp. Lateral carinae extend proximally across edges of short, slightly compressed, lateral denticles located slightly above aboral edge. A sharp postmedian carina extends the length of cusp and across edges of slightly compressed median denticle.

Lower Simpson and Burgen-Tyner strata contain several species of the subgenus, including the typical symmetrical form, *Trirhadicodus tridens,* although asymmetrical subacontiodid types are more abundant. *T. tridens* in Oklahoma is essentially identical with the Dutchtown type, except that cusps are recurved to approximate 45° position (not horizontal). Recurvature of cusps bisects angle of lateral denticles in most specimens; tip of cusp is tilted upward in some forms. Posterior slopes of cusp are gently convex in Oil Creek specimens, although flatter in Burgen specimens. Anterobasal stretch of cusp is flattened, resulting in lateral denticles near front edges (and slightly above aboral margin). Lateral denticles are essentially uniform in size, shape, curvature, and points of origin.

Aboral (basal) profile is triangular, with concave anterior margin (owing to frontal flattening of base) and acutely angled, straight posterior margins. Basal cavity is deep and its apex is distinctly forward.

The species was recovered sparingly from the uppermost 50 feet of the Joins Formation and from several horizons in the Oil Creek Formation of the Arbuckle Mountains. It is uncommon in topmost Burgen and lower Tyner outcrops of northeastern Oklahoma.

Homoeotype OMC 127 (pl. I, fig. 6), from Oil Creek roadside exposures, on Bromide-Connerville road, 4.1 miles west of Bromide; homoeotype OMC 128, from horizon 20 feet above base of the Oil Creek Formation, west side of U. S. Highway 77, south side of Arbuckle Mountains; and homoeotype OMC 129, from topmost Burgen outcrop, coring at south end of Eagle Bluff on Illinois River, 12 miles northeast of Tahlequah.

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Cores from Hunton Group Rocks Needed

The Oklahoma Geological Survey is interested in acquiring cores from rocks of the Hunton Group in Oklahoma. This includes cores previously taken and those that will be taken in the future. Those which include all or most of the section are preferable, but even short cores would be useful. Anyone interested in lending or giving such cores please contact Carl C. Branson, Director, Oklahoma Geological Survey, Norman, Oklahoma.

Unusual Oklahoma Structure

Carl C. Branson

The seemingly impossible structure shown by the vertical airplane photograph is in Pittsburg County. The picture is one of the photographs taken for the Soil Conservation Service of the U. S. Department of Agriculture in 1948.

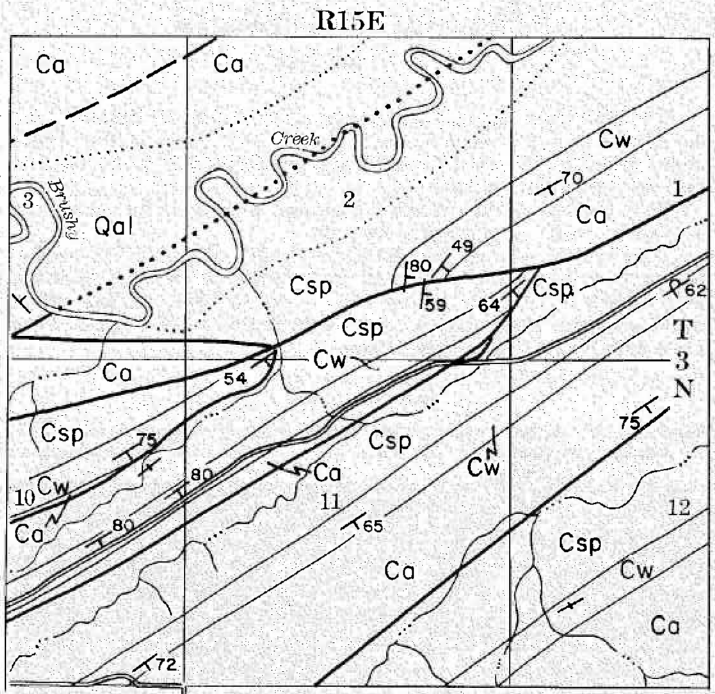
The answer to the structural pattern arrived at by Hendricks and others (1947) is given on page 120.

The map is redrawn from Hendricks (1947, sheet 1). The area is four miles east of Blanco, in Pittsburg County, Oklahoma, embracing parts of secs. 1, 2, 3, 10, 11, and 12, T. 3 N., R. 15 E. All four ridges are Wapanucka Limestone dipping southward 60 to 75 degrees. Four faults account for the various offsets.

Reference Cited

Hendricks, T. A., and others, 1947, Geology of the western part of the Ouachita Mountains in Oklahoma: U. S. Geol. Survey, Oil and Gas Inv., Prelim. Map OM-66.

Scale—1:31,680



Interpretation of geology of area shown in photograph on page 119 (redrawn from Hendricks and others, 1947)

Scale—1:31,680

Qal	Alluvium	Cw	Wapanucka Limestone
Ca	Atoka Formation	Csp	Springer Formation

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