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ANNOTATED BIBLIOGRAPHY OF PENNSYLVANIAN CONULARIIDS
FROM KANSAS, MISSOURI, AND OKLAHOMA

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INTRODUCTION

Conulariids are a clade of extinct marine organisms that secreted an elongate, four-sided but bilaterally symmetrical, phosphatic exoskeleton. Their phylogenetic affinities are unresolved but they have been suggested to be mollusks, worms, cnidarians, conodont animals, invertebrate chordates, vertebrate relatives, and an independent animal phylum. The preponderance of available evidence suggests that they had a triploblastic, and possibly coelomic, grade of organization. That, together with their unique exoskeletal architecture, tends to support the hypothesis that they are not closely related to representatives of any living phylum. Conulariids are comparatively uncommon in most Ordovician to Triassic marine biotas. They are, however, numerically abundant or even the dominant macrofossils in a few stratigraphic deposits. Among the best-known examples are the Ordovician iron-ore beds of Bohemia, Czechoslovakia, the Devonian "Conularia shales" of Bolivia, and the Pennsylvanian cyclothems of the North American Midcontinent.

Conulariids have been used as tools both in biostratigraphy and paleoecology. Because most species and genera have long ranges, their biostratigraphic utility tends to be greatest where more sensitive guide fossils are not present or rare. Their value for interpreting paleoecology, however, is potentially much greater although still largely unexplored or little tested.

At present, conulariids are commonly used for interpreting oxygenation levels of bottom-waters, but their predictive value is diminished by circular reasoning. Many occurrences of conulariids in Pennsylvanian cyclothem of Kansas, Missouri, and Oklahoma have been in dark gray or black shales (so-called core shales) that have been inferred to represent deep-water or poorly oxygenated environments. As a result, these organisms have been commonly interpreted as planktonic or pseudoplanktonic in the adult phase of the life cycle because it is assumed they could not live and reproduce as epifauna at the sediment-water interface. As planktonic or pseudoplanktonic organisms, their remains could be expected in strata having low diversities of marine invertebrates and representing anaerobic or dysaerobic environments because they would not have been subjected to the presumed low-oxygen conditions that existed near the sediment-water interface. Commonly, dark gray and black shales are inferred to have been deposited in relatively deep, offshore water, although recent evidence suggests that such models are oversimplified.

Recent studies that I have completed on the paleobiology of conulariids demonstrate that, as adults, the organisms were epibenthic. They attached to such objects on the sea floor as mollusk shells, plant matter, or perhaps even sediment grains. They attached by means of a flexible stalk. Work on specimens from Pennsylvanian strata of Kansas, Missouri, and Oklahoma shows that conulariids tend to be present in a variety of marine

facies, not just in so-called core shales, as stated by Boardman et al. (1984). These organisms are numerically most abundant in low diversity faunas. The diversity of conulariids in individual Pennsylvanian-age faunas of the North American Midcontinent has never been observed to exceed three species.

The purpose of this annotated bibliography is to provide a source of information about the Pennsylvanian conulariids of Kansas, as well as those of neighboring areas of Missouri and Oklahoma. With one exception (Sinclair, 1948), this bibliography includes only published sources. No attempt has been made to identify the scattered reports in other unpublished theses and dissertations. The reference to Sinclair's Ph.D. thesis has been included because of the great historical importance of the work, and because of the numerous references to conulariids of Kansas, Missouri, and Oklahoma. The bibliography is nearly complete for illustrated or described specimens. Some reports in faunal lists or passing references in texts, however, may have been overlooked.

Taxonomic nomenclature in this text is exactly that published in the cited papers. Conulariids from the Pennsylvanian of Kansas, Missouri, or Oklahoma have been assigned by other authors to three genera (Conularia, Calloconularia, or Paraconularia), but my unpublished studies indicate that all belong to Paraconularia. Table 1 summarizes my taxonomic assignments and all known previous assignments.

Three conulariids have been recognized in Pennsylvanian

rocks of Kansas. As recognized here, they are Paraconularia crustula (White, 1880), P. magna (Ries, 1949), and P. strimplei (Sinclair, 1952). One species, P. holdenvillae (Girty, 1911) has not been yet identified from Kansas but is present in Oklahoma. Only P. crustula has been identified in Missouri.

For the sake of completeness, I should mention that one paper on conulariids of Kansas other than Pennsylvanian ones has been published. The citation of that article follows:

Tasch, P., and A. E. Ehm. 1976. A Conularia species in the subsurface Maquoketa Shale of Rice County, Kansas. Transactions of the Kansas Academy of Science, 79:96.

Tasch and Ehm (1976) report a species of Conularia, said to be new, from a core sample from a well drilled near Lyons, Kansas. The species is from the Maquoketa Shale (Ordovician).

Table 1.--Summary of taxonomic assignments of conulariids from the Pennsylvanian of Kansas, Missouri, or Oklahoma.

<u>Present usage</u>	<u>Previous combinations</u>
<u>Paraconularia crustula</u> (White, 1880).....	<u>Conularia crustula</u> White, 1880
<u>Paraconularia holdenvillae</u> (Girty, 1911).....	<u>Conularia crustula</u> var. <u>holdenvillae</u> Girty, 1911 <u>Conularia crustula</u> <u>holdenvillae</u> Girty, 1911 <u>Calloconularia holdenvillae</u> (Girty, 1911)
<u>Paraconularia magna</u> (Ries, 1949).....	<u>Conularia crustula</u> var. <u>magnus</u> Ries, 1949 <u>Conularia crustula magnus</u> Ries, 1949
<u>Paraconularia strimplei</u> (Sinclair, 1952).....	<u>Calloconularia strimplei</u> Sinclair, 1952

ANNOTATED BIBLIOGRAPHY

Babcock, L. E. In press (scheduled publication date: 1990).

Conulariid pearls, p. 68-71. In A. J. Boucot, Evolutionary Paleobiology of Behavior and Coevolution. Elsevier Science Press (Amsterdam).

Phosphatic pearls are described or figured in specimens of Paraconularia crustula from Johnson County, Kansas, and in P. magna from Okfuskee County, Oklahoma.

Unpublished information about the reported specimens: Specimens of P. crustula are from the Muncie Creek Shale Member of the Iola Formation at the intersection of Route I-435 and Holliday Drive, Kansas City, Kansas. Specimens of P. magna are topotypes from the Lower Tackett Shale Member of the Tackett Formation; see comments under Ries (1949).

Ball, S. M. 1959. Stanton Limestone in northeastern Kansas.

The Compass of Sigma Gamma Epsilon, 36:279-288.

Conularia is reported from the Eudora Shale Member of the Stanton Limestone Formation (p. 283). A specimen collected from a spoil pile in Bert Ross Quarry, southwest corner of sec. 6, T. 17 S., R. 20 E., Kansas, is illustrated (pl.

1B(d)).

Ball, S. M., M. M. Ball, and D. J. Laughlin. 1963. Geology of Franklin County, Kansas. Kansas Geological Survey, Bulletin 163, 57 p.

Conularia is listed from the Eudora Shale Member of the Stanton Limestone at section B6, an abandoned quarry in SW 1/4 sec. 6, T. 17 S., R. 20 E., Franklin County, Kansas.

Bennett, J. 1896. A preliminary catalogue of the invertebrate paleontology of the Carboniferous of Kansas. Kansas Geological Survey, Bulletin (The University Geological Survey of Kansas), 1:270-310.

Conularia crustula is listed from Bourbon and Johnson counties, Kansas. In "General Remarks," the species is described as having been found in a thin calcareous clay near the middle of the Kansas City Series from the bluffs of Kansas City as far west on the Kansas River as Cedar Junction, "where it disappears in the common westerly dip."

Boardman, D. R. II, R. H. Mapes, T. E. Yancey, and J. M. Malinky. 1984. A new model for the depth-related allogenic community succession within North American Pennsylvanian cyclothems and implications on the black shale problem, p. 141-182. In

N. J. Hyne (ed.), Limestones of the Mid-Continent. Tulsa Geological Society, Tulsa.

The distribution of Pennsylvanian conulariid remains in the Midcontinent is related to proposed depth-related communities in which they occur. Conulariids are listed as present only in deep-water communities: the Dunbarella-ammonoid-radiolarian community, the Sinuitina-juvenile ammonoid-Anthraconeilo subcommunity, and the Treospira-mature ammonoid-Anthraconeilo subcommunity (fig. 9, tables 2, 3, p. 163). In studied strata of Kansas and Oklahoma, conulariids "have not been found in any other facies than the black, fissile, phosphatic shale, the black, clay-rich shale, and the dark gray shale," all of which are interpreted "as representing "deeper" water developed at or near maximum transgression" (p. 167).

Branson, C. C. 1965. Oklahoma Pennsylvanian Conularida. Oklahoma Geology Notes, 25:18-19.

Conularia crustula magnus is raised to species rank, placed in Paraconularia, and the gender of the trivial name is corrected from magnus (masculine) to magna (feminine) to agree with the generic name. A "holotype" [sic; should read lectotype] is also selected.

Girty, G. H. 1911. On some new genera and species of Pennsylvanian fossils from the Wewoka Formation of Oklahoma. New York Academy of Science, Annals, 21:119-156.

The new variety Conularia crustula var. holdenvillae is described from the Wewoka Formation of Wewoka and Coalgate quadrangles, Oklahoma. The variety is based upon a "few specimens" that are said to agree "in a general way with C. crustula" but "differ in having the sculpture on a much finer scale." No specimen is illustrated or referred to in the text.

Girty, G. H. 1915. Fauna of the Wewoka Formation of Oklahoma. U.S. Geological Survey, Bulletin 544, 353 p.

Conularia crustula is illustrated and described as being "relatively abundant in the Wewoka formation" of Wewoka Quadrangle, Oklahoma. Conularia crustula var. holdenvillae is illustrated for the first time. Localities from which the species (presumably the syntypes) were collected are: 1) "bluffs on the north side of the Canadian River valley, from the northern part of sec. 5, T. 6 N., R. 9 E., and the adjacent southern part of sec. 32, T. 7 N., R. 9 E. The horizon is in the middle shale of the Wewoka formation, from 25 to 75 feet below the sandstone." 2) "southeast corner of the southwest quarter" and "southwest corner of the

southeast quarter of sec. 32, T. 6 N., R. 9 E. One and probably both are in the middle shale of the Wewoka formation, 50 feet below the sandstone."

Grabau, A. W., and H. W. Shimer. 1910. North American Index Fossils. A. G. Seiler & Co., New York, 909 p.

Conularia crustula is described and listed as occurring in rocks of Missouri, New Mexico, and Arkansas.

Haworth, E. 1896. Resume of the stratigraphy and correlations of the Carboniferous formations. Kansas Geological Survey, Bulletin (The University Geological Survey of Kansas), 1:145-194.

Conularia crestula [sic; should read crustula] is listed from the Erie Limestone of Kansas.

Haworth, E. 1898. Stratigraphy of the Kansas Coal Measures. Kansas Geological Survey, Bulletin (The University Geological Survey of Kansas), 3(1):9-105.

Conularia cristula [sic; should read crustula] is listed from the Erie limestones of Kansas (p. 157).

Hemish, L. A. 1986. Pennsylvanian conulariids from Okfuskee

County, Oklahoma. Oklahoma Geology Notes, 46:202, cover photo of issue no. 6.

Figured specimens from Missourian-age rocks of Okfuskee County, Oklahoma are tentatively identified as Calloconularia strimplei. For a history of stratigraphic nomenclature at this locality, see comments under Ries (1949). For revised taxonomic assignments, see Mapes, Fahrner, and Babcock (1989).

Hinds, H., and F. C. Greene. 1917. Leavenworth-Smithville folio, Missouri-Kansas. U.S. Geological Survey, Geological Atlas of the United States, No. 206. 13 p.

Conularia crustula? (as identified by G. H. Girty) is listed from the Kansas City Formation in the Smithville Quadrangle, Kansas.

Keyes, C. R. 1894. Paleontology of Missouri (Part II). Missouri Geological Survey. Volume 5, 266 p.

Conularia crustula is described and illustrated from the Upper Coal Measures (Upper Carboniferous) of Kansas City, Missouri.

Mapes, R. H., T. R. Fahrner, and L. E. Babcock. 1989. Sublethal

and lethal injuries of Pennsylvanian conulariids from Oklahoma. *Journal of Paleontology*, 63:34-37.

Injuries, some of which may have been inflicted by cladodont sharks, are described in specimens of Paraconularia magna from two localities in the Tackett Formation of Okfuskee County, Oklahoma. Specimens that were provisionally identified as Calloconularia strimplei by Hemish (1986) are reassigned to P. magna. For a history of stratigraphic nomenclature at the type locality of P. magna, see comments under Ries (1949).

Miller, D. E. 1966. Geology and ground-water resources of Miami County, Kansas. Kansas Geological Survey, Bulletin 181, 66 p.

Conulariids are listed as rare in the Eudora Shale Member of the Stanton Limestone in Miami County, Kansas (p. 19).

Miller, S. A. 1889. North American Geology and Palaeontology for the Use of Amateurs, Students, and Scientists. Cincinnati, 664 p.

Conularia crustula and White's (1880) paper describing the species are listed.

Moore, R. C., and H. J. Harrington. 1956. Conulata, p. F54-F66. In R. C. Moore (ed.), Treatise on Invertebrate Paleontology, Part F, Coelenterata. Geological Society of America and University of Kansas Press: New York and Lawrence, Kansas.

A specimen of Calloconularia strimplei from the Upper Pennsylvanian (Missourian) of Oklahoma is illustrated.

O'Connor, H. G. 1971. Geology and ground-water resources of Johnson County, northeastern Kansas. Kansas Geological Survey, Bulletin 203, 68 p.

Conularia is listed as occurring in the Muncie Creek Shale Member of the Iola Limestone (p. 13), and in the Eudora Shale Member of the Stanton Limestone (p. 25).

Pabian, R. K., and R. F. Diffendal, Jr. 1989. Stop 10. Roadcut on county road about 2.5 mi southeast of Table Rock: White Cloud, Cedarvale channel deposits; Cedarvale "core" shale with regressive Rulo Limestone; Silver Lake channel deposits, New "Burlingame" cyclothem, SE 1/4 SE 1/4, sec. 3, T. 2 N., R. 12 E., Pawnee County, p. 42-46. In R. K. Pabian and R. F. Diffendal, Jr. (eds.), Late Pennsylvanian and Early Permian Cyclic Sedimentation, Paleogeography, Paleoecology, and Biostratigraphy in Kansas and Nebraska.

Nebraska Geological Survey, Guidebook for a pre-meeting field trip in conjunction with the 1989 annual meeting of the Geological Society of America (St. Louis).

Conulariids are indicated as occurring in the South Fork Member of the Burlingame Formation at a section in Pawnee County, Nebraska.

Ries, E. R. 1949. A new Pennsylvanian variety of Conularia crustula from the Seminole Formation of the basal Missouri Series. *The Biologist*, 31:117-119.

The new variety of conulariid, Conularia crustula var. magnus, is described from a Missourian-age shale in Okfuskee County, Oklahoma. The variety is said to "agree in general with Conularia crustula White," but differs from it "in being extremely large." The syntypes were collected from "a greenish-brown shale in the Seminole Formation about .2 mile east of the northwest corner of section 3, T. 12 N., R. 10 E., in a field about fifty feet south of the road." Later work by Hemish (1986) indicated that this locality is in the Coffeenville Formation but, most recently, Mapes et al. (1989) correlated this unit with the Lower Tackett Shale Member of the Tackett Formation (Coffeenville Subgroup, Skiatook Group).

Shimer, H. W., and R. R. Shrock. 1944. Index Fossils of North America. Massachusetts Institute of Technology Press, Cambridge, Massachusetts, 837 p.

Conularia crustula is described and figured. Its occurrence is listed as including Missouri, Arkansas, and New Mexico.

Sinclair, G. W. 1948. The biology of the Conularida. Unpublished Ph.D. thesis, McGill University, 442 p.

An important general discussion of conulariid paleobiology, including a listing or description of all known species. The work was unfortunately never published in its entirety, although small portions of the systematics were later published.

Three species described from Kansas?, Missouri or Oklahoma are listed or figured: 1) Paraconularia crustula (informally transferred from Conularia) from Missouri and perhaps Kansas; 2) Calloconularia strimplei (manuscript names for a new genus and species) from Oklahoma; and 3) Calloconularia holdenvillae (informally transferred and raised to species rank from Conularia crustula holdenvillae) from Oklahoma. The term crustula is said to have been "used for any small conularid from the Pennsylvanian" and the listed synonymy for the species "refers to at least seven species, and possibly more."

Sinclair's manuscript names for the new genus and species Calloconularia strimplei later became available in the sense expressed in the "International Code of Zoological Nomenclature" when published by Sinclair (1952).

Sinclair, G. W. 1952. A classification of the Conularida. Fieldiana, Geology, 10:135-145.

A new classification system for conulariids is proposed. The new genus and species Calloconularia strimplei is described. Some information about the locality from which the holotype and paratypes were collected is cited incorrectly but emended by Strimple (1959). Sinclair wrote that he knew of six species in the Pennsylvanian of Oklahoma and Texas that belong in Calloconularia, the only previously named one being Conularia crustula holdenvillae.

Sinclair, G. W., and E. S. Richardson, Jr. 1954. A bibliography of the Conularida. Bulletins of American Paleontology, Vol. 34, No. 145, 143 p.

Bibliography containing most works on conulariids published worldwide before 1954. Listed papers include references to: 1) Conularia crustula White, 1880, which was described from the Kansas City Group near Kansas City, Kansas or Missouri, but has been subsequently listed (although commonly

misidentified) from many other areas of the world; 2) C. crustula holdenvillae Girty, 1911, which was described from the Wewoka Formation near Holdenville, Oklahoma; and 3) and Calloconularia strimplei Sinclair, 1952, which was described from the Ochilate Group near Copan, Oklahoma.

Strimple, H. L. 1959. A notation of Pennsylvanian Conularia. Oklahoma Geology Notes, 19:222.

Locality information concerning the holotype and paratypes of Calloconularia strimplei as published by Sinclair (1952) is emended. The locality from which the specimens were collected is listed as "Pennsylvanian, Missouri series, Ochelata group, an unnamed shale 30 feet above the Torpedo sandstone member. SW 1/4 NW 1/4 section 10, T. 28 N., R. 13 S., Washington County some two miles north-northwest of Copan, Oklahoma."

Tasch, P. 1973. Paleobiology of the Invertebrates. John Wiley & Sons, New York, 946 p.

A specimen of Calloconularia strimplei from the Upper Pennsylvanian of Oklahoma is illustrated by a line drawing.

Tasch, P., A. E. Ehm, and E. West. 1978. New observations on an Upper Pennsylvanian phosphatic zone bearing conulatids

(Wyandotte County). Kansas Academy of Science,
Transactions, 81:179.

Two genera of "conulatids" (one of which is said to be new) are reported from the Muncie Creek Shale Member of the Iola Limestone in road cuts along Highway 32, Wyandotte County, Kansas. The specimens occur at or near the base of a phosphatic zone overlying a black shale. An idea concerning the diagenesis of concretions containing "conulatids" is also mentioned.

Weller, S. 1898. A bibliographic index of North American Carboniferous invertebrates. U.S. Geological Survey, Bulletin 153, 653 p.

Four papers citing Conularia crustula from Missouri, New Mexico, or Arkansas are listed.

White, C. A. 1880. Contributions to invertebrate paleontology no. 8: fossils from the Carboniferous rocks of the interior states. U.S. Geological Survey. Contributions to Paleontology. Nos. 2-8, p. 155-171. (Reprinted in 1883 as U.S. Geological Survey of the Territories, 12th Annual Report 1:151-171.)

The new species Conularia crustula is described, and one

specimen is figured, from "Coal Measure strata near Kansas City." It is the first Pennsylvanian conulariid to be named from North America. In addition to material from the Kansas City area, White stated that a couple of fragments of conulariids collected from near Taos, New Mexico by E. D. Cope are "apparently of this species."