

Paper in:

Patrick N. Wyse Jackson & Mary E. Spencer Jones (eds) (2002) *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin, pp. viii+381.

The Cincinnati Paleobryozoologists

Roger J. Cuffey,* Richard Arnold Davis† and John E. Utgaard§

**Department of Geosciences (412 Deike Bldg.), Penn State University,
University Park, PA 16802, USA*

*†Biology Department, College of Mount Saint Joseph, 5701 Delhi Road,
Cincinnati, OH 45233-1670, USA*

*§Department of Geology, Southern Illinois University,
Carbondale, IL 62901-4324, USA*

1. Introduction
2. Discovery
3. External-character studies
4. Introduction of thin-sections
5. Taxonomic descriptions
6. Quiescence
7. Modern diversified studies
8. Conclusion
9. Acknowledgements

1. Introduction

Fossil bryozoans are extraordinarily abundant, diversified, well-preserved, and easily collected from the flat-lying Upper Ordovician limestones and shales exposed in the hills and ravines within a 150-km radius around Cincinnati, in southwestern Ohio, southeastern Indiana, and north-central Kentucky. These fossils have therefore been of great scientific interest during most of the history of paleontology; they have also attracted the attention of the general public in the region to an extent unusual in America.

The “Cincinnati paleobryozoologists” are those bryozoan paleontologists who have devoted significant effort toward studying Late Ordovician bryozoans specifically from the Cincinnati region, i.e., from the “type-Cincinnati” strata. Especially in the 19th century, many (but not all) of these people grew up or were employed in that or nearby cities. Later, more lived or worked elsewhere, but all shared a common emphasis on analyzing these fossils.

The Cincinnati paleobryozoologists can be understood best by reference to their

participation in the various phases in the history of type-Cincinnatian bryozoan studies.¹ These phases include the initial discovery of type-Cincinnatian bryozoans, preliminary studies based on external characters, introduction of thin-section methods, taxonomic description of many new genera and species, then relative quiescence, and finally modern proliferation of varied researches ranging from faunal monographs and taxonomic revisions to paleoecologic, paleobiologic, and evolutionary investigations.

Numerous publications deal primarily with type-Cincinnatian bryozoans. A complete listing of these is beyond the limits of the present paper, but most can be seen in three bibliographies.² We cite here only those contributions which had greatest impact, or which are still readily available and essential for current students. In addition, some modern papers include or mention only a few type-Cincinnatian forms among many more from elsewhere, but being collectively analyzed; such are generally omitted here, although would be necessary to include in a comprehensive bibliography.

The Cincinnati-area bryozoans are accompanied by rich assemblages of shelly invertebrates, especially brachiopods, crinoids, trilobites, pelecypods, gastropods, and nautiloids.³ These fossils stimulated many other paleontologists in the same way as they have the Cincinnati paleobryozoologists, thereby leading some writers to label all those people as the “Cincinnati school of paleontology”.⁴ The term “school” implies a more coherent leadership and following than is true for the bryozoan scientists here, and hence seems less appropriate for our purpose. In addition to the bryozoan workers considered here, the Cincinnati “school” included a number of other renowned geologists of the 20th century, such as Charles Schuchert, W.H. Twenhofel, W.B. Scott, and N.S. Shaler. Other bryozoan paleontologists received their professional education at Cincinnati under Kenneth E. Caster (later with the cooperation of Richard S. Boardman at the Smithsonian) and went on to research bryozoans outside the Ordovician period or the Cincinnati area; Helen Duncan, Osborne Nye, and George Farmer may be mentioned among these.

Terminology relating to these fossils can be tricky. The strata around Cincinnati are the standard reference section for the Cincinnatian Series, the North American Upper or Late Ordovician, correlated with the Upper Caradoc plus Ashgill of the British type section recently adopted for international use. Consequently, “Cincinnatian” bryozoans mean animals of Late Ordovician age regardless of where in North America they come from - there are thus Cincinnatian fossils from Pennsylvania, Illinois, and Wyoming, as well as Ohio. In the present paper, we attempt a narrower focus, namely Cincinnatian-age fossils specifically from the Cincinnati region geographically, as the common shared link uniting all the Cincinnati paleobryozoologists.

Present-day readers also need to recall that the earliest works on Cincinnati-area bryozoans refer to them as being in the “Hudson River” and “Utica” rocks, and of “Silurian” or “Lower Silurian” age, because they pre-date introduction of the terms

“Cincinnati Group” and “Ordovician Period”. Likewise, early Cincinnati organizations may be referred to as “western”, from being near the early 19th century frontier of settlement; the Great Plains, Rocky Mountains, and California coast had not yet entered the consciousness of the eastern American public.

2. Discovery

Prior to European settlement, the wooded hills and ravines that were to become the Cincinnati region were sparsely inhabited by two Algonquian Indian tribes, the Miami and the Shawnee. Although natural outcrops scattered throughout the area must have yielded many weathered-out fossil bryozoans, no evidence exists that these Native Americans noticed them. In contrast, other Indians further west were well aware of crinoid columnals, Cambrian trilobites, and dinosaur footprints.

Losantiville had been founded about 1788 on the north bank of the Ohio River, and was designated to be the capital of the Northwest Territory, as well as the site for a frontier protective Fort Washington. By 1790, the settlement had been renamed Cincinnati, and began to serve as a base for launching military pacification expeditions. The town thereafter grew steadily in population right through establishment of the State of Ohio in 1803, that resulted in ever more exposure of bryozoan-rich bedrock, leading in turn to the first geologic inspections of the region.⁵ Inevitably, the abundant fossils weathering out, including bryozoans, soon attracted scientific attention, as well as popular or amateur interest.

J.W. Van Cleve, a naturalist with the Navy-led Wilkes Expedition through the Midwest, collected and wrote up the first bryozoan species (*Constellaria constellata*) from the type-Cincinnati. However, death intervened, and his manuscript description was published later by James Dwight Dana (Figure 1A), the father of the eminent mineralogy professor also at Yale University, in the report of that expedition.⁶ Various problems since have plagued formal recognition of this species,⁷ although Van Cleve's collections were re-studied just before adoption of thin-section methods.⁸

At roughly the same time, Cincinnati-area bryozoans had already been taken over to Europe, and in 1850 the great French paleontologist Alcide M. d'Orbigny published several new type-Cincinnati species, including three of the most abundant forms still recognizable today and now known as *Monticulipora mammulata*, *Parvohallopore ramosa*, and *Heterotrypa frondosa*.⁹ D'Orbigny's type specimens were thin-sectioned early in the 20th century.¹⁰ A year later, Henri Milne-Edwards and Jules Haime, two other French scientists, described more, including *Parvohallopore rugosa* and *Dekayia aspera*.¹¹

Initially, the Cincinnati fossil bryozoans were considered to be small corals, especially the massive and robust-ramose trepostomes, frequently called



Figure 1. The most important *Cincinnati* paleobryozoologists:
 (A) Dana (collection of Southern Illinois University); (B) Nicholson (Hinde, 1899); (C) Ulrich (collection of Smithsonian Institution); (D) Bassler (Caster, 1965); (E) Nickles (Bassler, 1947); (F) Cumings (Shrock, 1970).

“monticuliporoids” after the best-known earliest-described genus. As the 19th century waned, opinion shifted to regarding them as bryozoans, a viewpoint finally firmly established by Cumings in 1912.¹²

3. External-character studies

Once fossil bryozoans were recognized around the *Cincinnati* area, paleontologists began to describe the various species and genera that could be distinguished among these abundant specimens. At that time, American professional higher education had not yet assumed the institutional form characteristic of the 20th century, and so these paleontologists

came from varied, non-academic backgrounds; Caster refers to them as “publishing amateurs”.¹³ Among these, the four Cincinnati paleobryozoologists included here authored significant numbers of short bryozoan papers, far too many to cite, but listed elsewhere.¹⁴ Many other Cincinnati writers mentioned bryozoans occasionally, or dealt with other phyla exclusively, and so are omitted here.

Most of the information derivable from examining bryozoan fossils in these early days concerned external surface characters; a little more came from observing broken or fractured specimens. Most of the genera and species in these papers would not be validly recognizable today except for re-study by numerous later workers who thin-sectioned the type specimens of these earlier papers. Even so, some early taxa have yet to be re-studied in this way, and so remain shrouded in nomenclatural fog.

Carl Ludwig Rominger was born in Germany, received his medical degree (but with a geological thesis) from Tübingen, but almost immediately fled the 1848 revolutions and came to Cincinnati, where the fossil “corals” attracted his attention. One of his earliest papers established one of the few Cincinnati trepostome species distinctive enough to be recognizable externally, now known as *Rhombotrypa quadrata* (Rominger, 1866), and whose original type specimens were much later sectioned and studied in the modern era.¹⁵ At about the same time, he moved to Michigan, where - in addition to his medical practice - he became both Professor of Geology at the University of Michigan and the State Geologist of Michigan.¹⁶

The next Cincinnati paleobryozoologists of note were the prolific father and son pair Uriah Pierson James and Joseph Francis James, who published during 1871-1888 and 1881-1897 (respectively). Uriah James came to Cincinnati from upstate New York as a young printer, and by 1850 had become a publisher and proprietor of a major bookstore (still in business as of this writing). He was an active collector, especially of the local bryozoans (which he always thought were corals), displayed many in his bookstore, and not only authored papers himself,¹⁷ but also published periodicals like *The Paleontologist*.¹⁸ His son, Joseph James, was obviously exposed to Cincinnati-area bryozoans as a child and young clerk in his father’s bookstore. He too wrote on bryozoans,¹⁹ and also jointly with his father.²⁰ Joseph went on to become a Professor of Geology and Botany at Miami University of Ohio, and eventually joined the U.S. Department of Agriculture and also became a practicing physician.²¹ The many type specimens designated by the Jameses were later sectioned and re-illustrated by Bassler in 1906.²²

Samuel Almond Miller was a lawyer and publisher (particularly of the *Journal of the Cincinnati Society of Natural History*) who was massively involved with Cincinnati fossils - he reputedly named a thousand taxa, based on his collection of a million specimens, and published from 1874 until 1897. Most of his efforts involved other phyla, and lengthy, comprehensive, highly useful, but sometimes disparaged compilations.²³



Figure 2. John M. Nickles and Raymond S. Bassler, Upper Eden exposure, Cincinnati, Ohio, 1900 (Photograph from the Bassler Photo Collection, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution).



Figure 3. Bassler and E.O. Ulrich at Bassler's home, Cincinnati, Ohio, July 1900 (Photograph from the Bassler Photo Collection, Department of Paleobiology, National Museum of Natural History, Smithsonian Institution).

However, he did contribute to Cincinnati-area paleobryozoology both by himself and in cooperation with the local soap and candle maker Charles Brian Dyer.²⁴ Finally, two more workers began publishing on Cincinnati-age bryozoans from the Cincinnati area in the 1870s - H.A. Nicholson in 1874²⁵ and E.O. Ulrich in 1878.²⁶ Both were destined to soon become two of the most eminent Cincinnati paleobryozoologists.

4. Introduction of thin-sections

Around 1880, the University of Aberdeen Professor H. Alleyne Nicholson (Figure 1B) introduced the preparatory technique of thin-sectioning to bryozoan studies, a contribution that may well rank as the most significant advance in investigations of the phylum. The sizeable, well-calcified type-Cincinnati trepostomes were ideally suited to application of this method.

Nicholson's thin-section studies began with papers on the Paleozoic "corals" of Ohio published in 1876²⁷ and in general account of the group in 1879;²⁸ both works included some type-Cincinnati bryozoans. Then, in 1881, he published a monumental work focused on trepostomes from Cincinnati (especially "*Monticulipora*"), which elevated understanding of these fossils to a whole new level and thus established Nicholson's role as the leading Cincinnati paleobryozoologist until that date.²⁹

Type specimens of many of Nicholson's species have been re-located and restudied in recent years.³⁰ Although he died at a relatively young age, Nicholson produced a huge body of palaeontological work.³¹

5. Taxonomic descriptions

With the greatly expanded information made available by thin sections, the pace of description and illustration of Cincinnati bryozoans quickened and remained high for the next 35 years. As soon as Nicholson's publications became available, Edgar Oscar Ulrich (Figures 1C, 3, 4A, 4B), a young bryozoan paleontologist just starting out, adopted thin-sectioning to illustrate his species' internal morphology.³² He embarked on a series of papers beginning in 1882,³³ which established many Cincinnati-age taxa from both the Cincinnati area and elsewhere. His studies culminated in two large monographs,³⁴ landmarks in Ordovician bryozoan studies, and confirming Ulrich's achievement as the second truly outstanding Cincinnati paleobryozoologist.

Ulrich grew up in Covington, across the river from Cincinnati proper. He was introduced (at the age of 7) to fossils by his minister. He worked briefly as a surveyor, took a year of medical college, became active in the Cincinnati Society of Natural History by 1877, and worked at various times for different state (and U.S.) geological surveys. Ulrich developed a laboratory business making and selling bryozoan thin-sections; he recruited

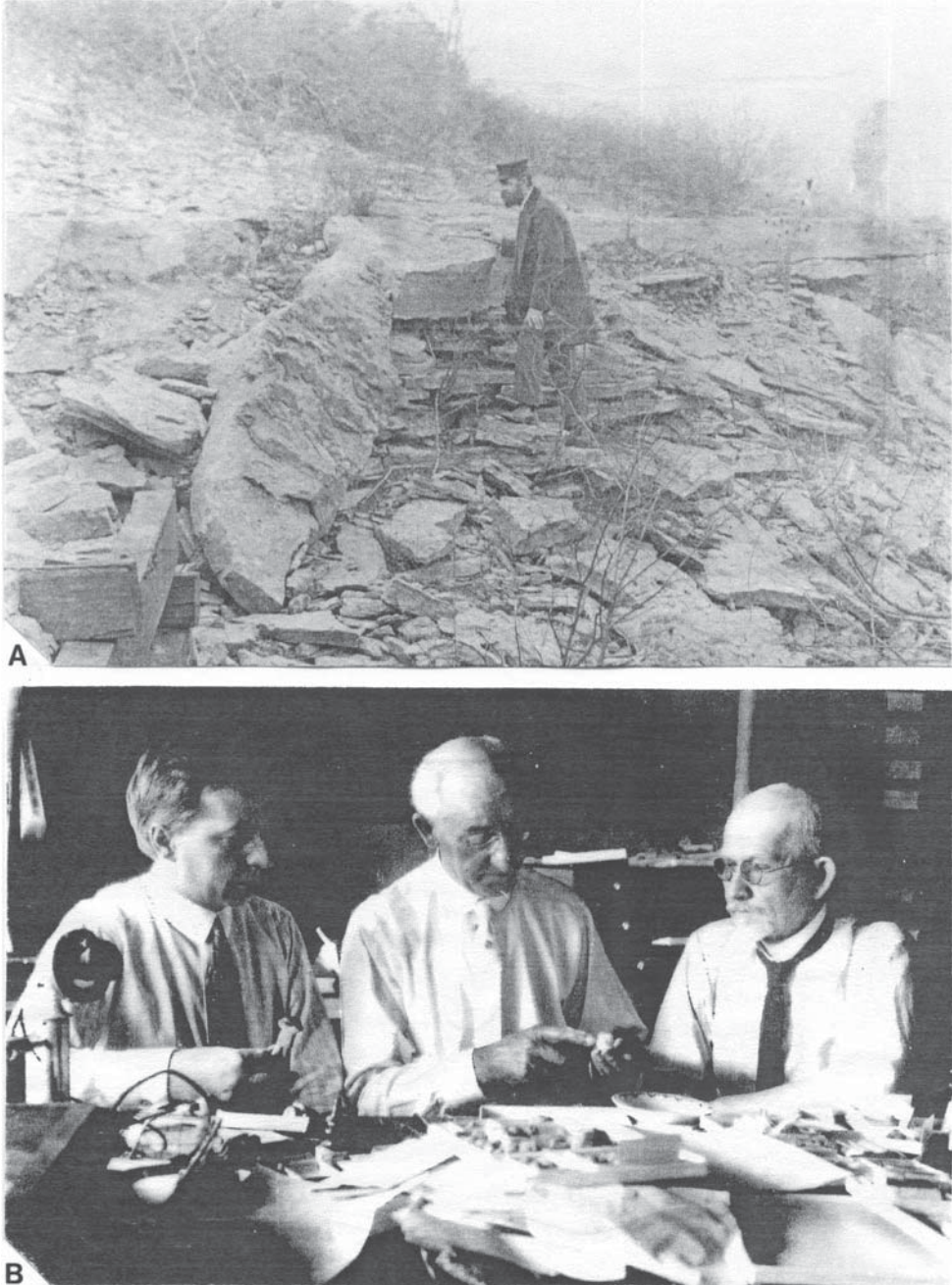


Figure 4. Cincinnati paleobryozoologists at work: (A) E.O. Ulrich in the field near Cincinnati (Davis and Cuffey, 1998); (B) left to right R.S. Bassler, E.O. Ulrich, and their colleague A.F. Foerste in conference at the U.S. National Museum (collection of the Smithsonian Institution).

a number of local youngsters (including R.S. Bassler and J.M. Nickles) to collect fossils or grind sections for him. Eventually, in 1897, due to his increasing reputation, he was hired permanently by the U.S. Geological Survey and moved to Washington, D.C., where he spent the rest of his career, researching not only bryozoans, but also ostracods, conodonts, and Cambro-Ordovician stratigraphy.³⁵

The third really outstanding Cincinnati paleobryozoologist was Ray Smith Bassler (Figures 1D, 2, 3, 4B), initially a high school student hired by Ulrich to help make bryozoan thin-sections. Bassler had already become interested in fossils by childhood collecting near Cincinnati. His high-school principal, George Harper, an amateur geologist himself,³⁶ introduced Bassler to Ulrich, and arranged Bassler's class schedule so that his afternoons were free to work in Ulrich's lab. During Bassler's final year in high school, he and Harper published a catalogue of local fossils.³⁷

Bassler went on to undergraduate study at the University of Cincinnati, continuing to work for Ulrich. Near the end of his bachelor's program, he moved to Washington, D.C. and the Smithsonian when Ulrich was hired there. Bassler combined graduate study at Columbian University (now George Washington University) with paleontologic work at the museum. By the time Bassler received his Ph.D. in 1905, he and Ulrich had co-authored important papers on Cincinnati-area bryozoans.³⁸ By roughly ten years later, in 1915 Bassler had compiled a major bibliography still useful in studying type-Cincinnati bryozoans.³⁹

For the next half century, Bassler continued his major research interests in bryozoans, while adding other important fossil groups (notably corals, echinoderms, ostracods, and conodonts) to his repertoire. Simultaneously, he moved up through the ranks at the Smithsonian to become Head Curator of Geology, and across town eventually also Professor and Head of the Department of Geology at George Washington University. He is reported to have worked effectively with students, collaborators, and colleagues both here and abroad, often extending help beyond what might have been expected.⁴⁰

From Nicholson to Ulrich to Bassler's early work, it had been a continuous 30 years of Cincinnati bryozoan research. While certainly cutting-edge for the time, and while still essential as a base for current investigation, their thin sections tend to be too thick and their microscopic magnifications too low, compared with modern practice. However, such qualifications should not detract from respecting the major contributions which these three important Cincinnati paleobryozoologists made.

Another local Cincinnati amateur acquainted with Ulrich and bryozoans was John Milton Nickles (Figures 1E, 2), about 20 years older than Bassler, but who worked with him to produce another major bryozoan bibliographic work.⁴¹ Nickles soon thereafter also joined the U.S. Geological Survey in Washington, but then built his career compiling

comprehensive bibliographies on geology in general.⁴² Before leaving bryozoans, Nickles utilized them to biostratigraphically zone the type-Cincinnatian formations.⁴³

Edgar Roscoe Cumings (Figure 1F) can be regarded as the fourth major Cincinnatian paleobryozoologist, because of his important papers (some co-authored with his doctoral student J.J. Galloway) advancing fundamental understanding of Cincinnatian bryozoans' colony development,⁴⁴ wall microstructure,⁴⁵ and affinities.⁴⁶ This last is especially significant because it settled the long-standing controversy in favour of the "stony" or "monticuliporoid" trepostomes being bryozoans rather than corals. In addition, he also carried out taxonomic studies,⁴⁷ and monographed faunas on the Indiana side of the Cincinnatian region.⁴⁸ Cumings was Professor of Geology at Indiana University for many years,⁴⁹ and became well-known for pioneering studies of fossil reefs or bioherms.

Jesse James Galloway (1882-1962) was a graduate student co-author with Cumings on two significant Cincinnatian bryozoan papers (cited above). Although he retained a life-long interest in those fossils, his research emphasis shifted to foraminiferans and stromatoporoids. He served on the geology faculty at Columbia University in New York, and then returned to Indiana University to finish out his long career.⁵⁰

Emphasis during 1880-1915 focused mainly on basic descriptive taxonomy of the diverse species and genera among the type-Cincinnatian bryozoans, although the beginnings of other kinds of investigations were also evident. Ulrich's keen observations of anatomy especially, later led to greater paleobiological understanding of those fossils. Adoption of thin-section techniques came gradually, although by 1890 these were universal.

6. Quiescence

The advent of World War I shifted people's attention away from scientific pursuits viewed as being esoteric. The following decades of social change, economic depression, and more global conflict coincided with a low level of interest in type-Cincinnatian bryozoan studies, except for occasional papers including a few such materials as ancillary to faunas elsewhere (especially in Canada).⁵¹

The one Cincinnatian paleobryozoologist remaining active during this quiescent phase was Bassler, who expanded his interests into Cenozoic and Recent bryozoans in cooperation with Ferdinand Canu in France.⁵² Probably his most impactful contribution came toward the end of this time with the publication of his sole-authored bryozoan volume of the *Treatise on Invertebrate Paleontology*.⁵³ Not only did this publication draw together much information on type-Cincinnatian bryozoans, it also provided systematic context for these fossils by incorporating all the rest of their phylum. Moreover, historically, Bassler is remembered as the author of the first volume of the *Treatise* series, one of the most important paleontological publications in general, only now approaching completion

after 50 years.

7. Modern diversified studies

Around 1960, interest in type-Cincinnatian bryozoans revived as part of a wide-spread renaissance in paleontology in general. In retrospect, the cause for this rebirth of the science appears simply to have been the post-World War II expansion of population and the economic growth which it stimulated. Young students grew up, pursued intellectual interests not practical in harder times, found opportunities for academic careers in universities and agencies devoted to serving the rapidly increasing numbers of people, and trained still more young people to carry on. (After a couple of decades, conditions reversed, beginning with collapse of the geologic sector of the oil industry; hence, growth has slowed or ceased, but the character of this renaissance continues to the present day.) A hallmark of this revival in paleontology has been its concern with biological as much as with geological aspects of the fossils which it studies.

These trends have resulted in a new generation of Cincinnati paleobryozoologists, distinguished from the earlier one in two major ways. First, the newer ones are employed professionally over a much wider range of locations and institutions. Second, while basic taxonomic research remains important in the modern phase, a great many additional types of investigations are being pursued by the new Cincinnati paleobryozoologists. Not every such publication is cited here, but enough can be given to indicate the diversity of current activity.

Enthusiastic local amateur collecting remains strong around Cincinnati. Some of this activity is individualistic; some is organized as the "Dry Dredgers", who have contributed significantly by bringing to light scientifically important bryozoan localities and specimens.

Cornerstones of continuing Cincinnati-area bryozoan studies are several faunal monographs detailing the bryozoan species found in particular stratigraphic formations at different horizons within the type-Cincinnatian: high, Whitewater Formation,⁵⁴ and Dillsboro Formation;⁵⁵ middle, Bellevue Limestone;⁵⁶ low, Eden Shale;⁵⁷ transitional, Clays Ferry Formation;⁵⁸ and immediately underlying, Lexington Limestone.⁵⁹ These are essential for the reliable or consistent species identifications on which numerous other investigations are based. Two monographs treat forms from everywhere in the type-Cincinnatian succession.⁶⁰ In addition, four monographs from the earlier phase of taxonomic descriptions are still needed in practice for identifying forms: Two deal with the Cincinnatian bryozoans of the northwestern part of the Cincinnati region;⁶¹ two others include many type-Cincinnatian forms even though focused on other states.⁶²

A number of recent studies coordinate and revise the species belonging to particular genera, especially their type species. Examples which include at least some Cincinnati-

area materials are Boardman,⁶³ Boardman and Utgaard,⁶⁴ Utgaard,⁶⁵ Hickey,⁶⁶ Taylor and Wilson,⁶⁷ and Cutler.⁶⁸ Bibliographic compilations in the tradition of Bassler and Nickles have appeared.⁶⁹ Re-descriptions of critical type species, in addition to those already cited in previous sections of this paper, have been made.⁷⁰ Formal nomenclature adjustments have been proposed and accepted.⁷¹ Many of these taxonomic investigations were undertaken in order to update, revise, and expand the original bryozoan volume of the *Treatise on Invertebrate Paleontology*.⁷² The first part of the revised bryozoan *Treatise* has already appeared.⁷³

Morphologic investigations involving new objectives and tools are reaching beyond basic taxonomy to questions of development and function. Certain studies analyzed soft-part and brown-body morphology.⁷⁴ Others explored new measurement techniques.⁷⁵ Some connected developmental anatomy to growth and function within a colony.⁷⁶ Still others examined the relationships among development, evolutionary processes, and environment.⁷⁷

Other Cincinnati paleobryozoologists traced evolutionary trends in area lineages,⁷⁸ and implications for biostratigraphy.⁷⁹ Taphonomy has been considered on both regional,⁸⁰ and local scales,⁸¹ including bioimmuration.⁸² Some have studied bryozoan encrustation on unusual substrates like cephalopods,⁸³ and cobbles,⁸⁴ leading into biostromal⁸⁵ and biohermal⁸⁶ involvement, as well as participation in overall community succession⁸⁷ and sequence stratigraphy.⁸⁸ Assessment of particular paleoenvironmental factors was carried out for ancient salinity⁸⁹ and bathymetry.⁹⁰ Biogeographic aspects have been considered.⁹¹ Finally, Tuckey and Anstey in 1992 discussed end-Ordovician extinctions affecting the Cincinnati-area bryozoans.⁹²

8. Conclusion

The Cincinnati region of southwestern Ohio and adjacent southeastern Indiana and north-central Kentucky is world-renowned for its abundant and diversified bryozoans from the Upper Ordovician (type-Cincinnatian) Series. These and the many other associated fossils stimulated paleontologic careers for local residents, as well as for visitors from elsewhere. A number of both have made major contributions specifically to local bryozoan studies, and can thus be called "Cincinnati paleobryozoologists".

The abundant, diversified, well-preserved Cincinnati-region bryozoan faunas were discovered and initially described by Van Cleve, Dana, d'Orbigny, Milne-Edwards, and Haime (1846-1851).⁹³ Soon thereafter, many species of these fossils were described from external characters alone, by workers like Rominger, U. James, J. James, Miller, and C. Dyer.

About 1880, Nicholson introduced examination of bryozoans' internal structures via thin sections. Almost immediately, Ulrich applied this method extensively to Cincinnati and other bryozoans, and produced monumental works in the 1890s, which are still

essential references. A younger local protégé, Bassler, began his lengthy career then, which culminated decades later in his authoring the first volume of the *Treatise on Invertebrate Paleontology*. Another protégé, Nickles, cooperated with Bassler to compile important bibliographies, and also used bryozoans to stratigraphically subdivide the type-Cincinnatian. Cumings demonstrated the bryozoan rather than coral affinities of the trepostomes, and he and his student Galloway published sizeable systematic monographs on bryozoans from the Indiana side of the Cincinnati region.

Then, from 1915 until 1960, specifically Cincinnati-area paleobryozoology was largely quiescent, until Perry,⁹⁴ Caster, Boardman, and their students and colleagues (Anstey, Brown, Cuffey, Horowitz, Karklins, Key, Pachut, Pohowsky, Singh, Utgaard, and Wilson) began modern investigations including these fossils, as well as bryozoans from other regions and horizons, investigations which continue to the present day.

9. Acknowledgements

We particularly thank the people who helped provide pictures of various paleobryozoologists: K. Bork, H. Henson, J. Sanner, P.D. Taylor, E. Yochelson. Susan Lauver prepared this manuscript for publication.

Notes

- 1 J.E. Utgaard and T.G. Perry, 'Trepostomatous bryozoan fauna of the upper part of the Whitewater Formation (Cincinnatian) of eastern Indiana and western Ohio', *Indiana Geological Survey Bulletin* 33 (1964), 111 pp., 23 pls.
- 2 Utgaard and Perry, note 1; K.E. Caster, 'Cincinnatian contributions to knowledge of the Lophophora', in *Lophophorates. Notes for a short course*, edited by T.W. Broadhead, *University of Tennessee, Department of Geological Sciences, Studies in Geology*, 5 (1981), 237-251; R.A. Davis and R.A. Spohn, 'Bibliography on the Type-Cincinnatian', in *Sampling the Layer Cake that Isn't: the Stratigraphy and Paleontology of the Type-Cincinnatian*, edited by R.A. Davis and R.J. Cuffey, *Ohio Division of Geological Survey Guidebook*, 13 (1998), 167-194.
- 3 K.E. Caster, E.A. Dalvé and J.K. Pope, *Elementary guide to the fossils and strata of the Ordovician in the Vicinity of Cincinnati, Ohio*. Cincinnati, Ohio, Cincinnati Museum of Natural History, 1955, 47 p., 8 pls; A. La Rocque and M.F. Marple, Ohio Fossils. *Ohio Division of Geological Survey Bulletin*, 54 (1956), v + 152 pp.; R.A. Davis, ed. *Cincinnati fossils. An elementary guide to the Ordovician rocks and fossils of the Cincinnati, Ohio, region*. Cincinnati, Ohio, Cincinnati Museum of Natural History (1992), ii + 61 p., 8 pls; R.L. Anstey and M.A. Wilson, 'Phylum Bryozoa', in *Fossils of Ohio*, edited by R.M. Feldmann and M. Hackathorn. *Ohio Division of Geological Survey, Bulletin* 70 (1996), 196-209; R.M. Feldmann and M. Hackathorn, eds. *Fossils of Ohio. Ohio Division of Geological Survey, Bulletin*, 70 (1996), xx + 577 pp.; R.A. Davis and R.J. Cuffey, eds. *Sampling the layer cake that isn't: the stratigraphy and paleontology of the type-Cincinnatian. Ohio Division of Geological Survey, Guidebook*, 13 (1998), iv + 194 pp.

- 4 K. Becker, 'Cincinnati area, the Mother of Geologists', *Compass*, 19(1) (1938), 188-196; K.E. Caster, 'Cincinnati, Spawning Ground of Geologists', *The Compass of Sigma Gamma Epsilon*, 28(2) (1951), 103-105; Caster 1981, note 2; K.E. Caster, 'The Cincinnati "School" of paleontology', *Earth Sciences History*, 1(1) (1982), 23-28.
- 5 D. Drake, 'Geological account of the Valley of the Ohio', *Transactions of the American Philosophical Society*, New Series, 2 (1825), 124-139; J. Locke, 'Prof. Locke's geological report [on southwestern Ohio]', *Ohio Geological Survey 2nd Annual Report*, (1838), 201-286, 15 pls; C. Lyell, *Travels in North America; with geological observations on the United States, Canada, and Nova Scotia*. London, John Murray, (1845), 316 pp (volume 1) and 272 pp (volume 2). [The geology of the Cincinnati area is discussed on p. 48-51 in volume 2, but see also the cross-section of the eastern United States on p. 92 of volume 1]
- 6 J.W. Van Cleve, (manuscript published in Dana, 1846); J.D. Dana, 1846 (text) and 1849 (plates), *Zoophytes: Reports of the United States Exploring Expedition, 1838-1842, under the Command of C. Wilkes, U. S. Navy*. Initially C. Sherman, later Lea & Blanchard, Philadelphia, volume 7, 740 p., 61 pls, p. 537-538; p. 52, fig. 6a, 6b; D.C. Haskell, *The United States Exploring Expedition, 1838-1842, and its publications, 1844-1874*. New York Public Library, New York (1942).
- 7 J.R.P.P. Ross, 'Constellaria from the Chazyan (Ordovician), Isle La Motte, Vermont', *Journal of Paleontology*, 37(1) (1963), 51-56, pls. 5, 6; J.E. Utgaard, 'Paleobiology and taxonomy of the order Cystoporata', in *Bryozoa: Treatise on Invertebrate Paleontology*, Part G, revised, volume 1, edited by R.A. Robison. Geological Society of America and University of Kansas Press (1983), 327-439.
- 8 C.A. White, 'Van Cleve's fossil corals', *Indiana Department of Geology and Natural Resources, Eleventh Annual Report*, (1882), 376-401, pls. 44, 45; J. Hall, 'Van Cleve's fossil corals', *Indiana Department of Geology and Natural Resources, Twelfth Annual Report*, (1883), 239-318, 2 figs.
- 9 A.M. d'Orbigny, *Prodrôme de paléontologie stratigraphique universelle*. Volume 1; Victor Masson, Paris (1848-1852), lx + 394 pp.; R.J. Singh, 'Trepomatous bryozoan fauna from the Bellevue Limestone, Upper Ordovician, in the tri-state area of Ohio, Indiana, and Kentucky', *Bulletins of American Paleontology*, 76(307), (1979), 157-288, pls. 16-48.
- 10 M. Boule and A. Thevenin, 1906, 'Types du prodrome de paléontologie stratigraphique universelle de d'Orbigny', *Annales de paléontologie*, 1 (1906), 97-100, pls. 8-9; 165-172, pls. 12-13.
- 11 Singh, note 9.
- 12 E.R. Cumings, 'Development and systematic position of the monticuliporoids', *Geological Society of America Bulletin*, 23 (1912), 357-370, pls. 19-22.
- 13 Caster, note 2, p. 237.
- 14 Davis and Spohn, note 2; Utgaard and Perry, note 1.
- 15 See C. Rominger, 'Observations on *Chaetetes* and some related genera, in regard to their systematic position, with an appended description of some new species', *Proceedings of the Academy of Natural Sciences of Philadelphia*, (1866), 113-123. Rominger's material has been redescribed by R.J. Cuffey and T.G. Perry, 'Redescription of the syntypes of the bryozoan species *Rhombotrypa quadrata* (Rominger)', *Contributions from the Museum of Paleontology, University of Michigan*, 19(4) (1964), 37-45, pls. 1-2; and by R.S. Boardman and F.K. McKinney, 'Skeletal architecture and preserved organs of four-sided zooids in convergent genera of Paleozoic Trepomatata (Bryozoa)', *Journal of Paleontology*, 50(1) (1976), 25-78,

- 16 pls.
- 16 H.M. Martin, 'Glimpses into the life of Carl Ludwig Rominger', *University of Michigan, Museum of Paleontology, Papers on Paleontology*, 5 (1973), 1-29; J.D. Wright, 'That remarkable man Carl Ludwig Rominger State Geologist', *University of Michigan, Museum of Paleontology, Papers on Paleontology*, 4 (1973), 1-148.
 - 17 U.P. James, *Paleontology. Catalogue of Lower Silurian Fossils of the Cincinnati Group. Found at Cincinnati and Vicinity-within a circuit of 40 or 50 miles. New ed., much enl. With descriptions of some new species of corals and Polyzoa.* U.P. James, Cincinnati, Ohio (1875), 8 pp.; U.P. James, 'Descriptions of ten new species of *Monticulipora* from the Cincinnati Group, Ohio, index, etc.', *The Paleontologist*, 6 (1882), 45-56, pl. 1.
 - 18 A.J. Howe, W.H. Fisher and A.T. Keckeler, 'In Memoriam.—U. P. James', *Journal of the Cincinnati Society of Natural History*, 12(1) (1889), 5-7; J.F.J. (presumably Joseph F. James) 'Uriah Pierson James', *American Geologist*, (May 1889), 7 pp. + photograph of U.P. James.
 - 19 J.F. James, '*Monticulipora*, a coral and not a polyzoon', *American Geologist*, 1(6) (1888), 386-392.
 - 20 U.P. James and J.F. James, 'On the monticuliporoid corals of the Cincinnati Group, with critical revision of the species', *Journal of the Cincinnati Society of Natural History*, 10(3) (1887), 118-141; U.P. James and J.F. James, 'On the monticuliporoid corals of the Cincinnati Group, with critical revision of the species (continued)', *Journal of the Cincinnati Society of Natural History*, 10(4) (1888), 158-184, pl. 2; 11(1) (1888), 15-47, pl.1.
 - 21 G.K. Gilbert, 'Joseph Francis James 1857-1897', *American Geologist*, 21(1) (1898), 1-11, pl. 1.
 - 22 R.S. Bassler, 'A study of the James types of Ordovician and Silurian Bryozoa', *Proceedings of the U.S. National Museum*, 30 (1442) (1906), 1-66, pls. 1-6.
 - 23 S.A. Miller, *The American Palaeozoic Fossils: a Catalogue of the Genera and Species*, (Privately published by the author); printed by the Cincinnati Times Company, Cincinnati, Ohio (1877), xv + 253 pp.; S.A. Miller, *North American geology and palaeontology for the use of amateurs, students, and scientists*, (Privately published by the author, printed by the Western Methodist Book Concern), Cincinnati, Ohio (1889), 664 pp., 1194 text-figs; S.A. Miller, *Second appendix to North American Geology and Palaeontology*, (Privately published by the author), Cincinnati, Ohio (1897), 719-793; Caster, note 2, p. 238.
 - 24 S.A. Miller, 'Observations upon *Stenopora fibrosa* and the genus *Chaetetes*', *Cincinnati Quarterly Journal of Science*, 1(4) (1874), 368-375; S.A. Miller and C.B. Dyer, 'Contributions to palaeontology', *Journal of the Cincinnati Society of Natural History*, 1(1) (1878a), 24-39, pl. 1-2. (There is a reprint paginated p. 1-16.); S.A. Miller and C.B. Dyer, *Contributions to Paleontology. No. 2*, (Privately published by the authors). Cincinnati, Ohio (1878b), 1-11, pls. 3-4; R.M. Byrnes, L.S. Cotton and F.W. Langdon, 'In Memoriam. Charles B. Dyer', *Journal of the Cincinnati Society of Natural History*, 6(3) (1883), 207-210. C.B. Dyer should not be confused with W.S. Dyer, who published over 40 years later on bryozoans of similar age but from Toronto, not Cincinnati.
 - 25 H.A. Nicholson, 'Description of species of *Chaetetes* from the Lower Silurian rocks of North America', *Quarterly Journal of the Geological Society of London*, 30 (1874), 499-515, pls. 29-30.
 - 26 E.O. Ulrich, 'Descriptions of some new species of fossils, from the Cincinnati Group', *Journal of the Cincinnati Society of Natural History*, 1(2) (1878), 92-100, pl. 4.
 - 27 H.A. Nicholson, 'Notes on the Palaeozoic corals of the state of Ohio', *Annals and Magazine*

- of Natural History*, series. 4, 18 (1876), 85-95, pl. 5.
- 28 H.A. Nicholson, *On the Structure and Affinities of the "Tabulate Corals" of the Paleozoic Period, with critical descriptions of illustrative species*, William Blackwood and Sons, Edinburgh (1879), 342 pp., 15 pls., 44 text-figs.
- 29 H.A. Nicholson, *On the Structure and Affinities of the Genus Monticulipora and its Sub-genera, with critical descriptions of illustrative species*, William Blackwood and Sons, Edinburgh (1881), 240 pp., 6 pls., 50 text-figs.; Hinde, G.J. 'Prof. H.A. Nicholson, M.D., D.Sc., F.R.S., F.L.S., F.G.S.', *Geological Magazine*, 6 (1899), 138-144.
- 30 T.G. Perry, A.S. Horowitz and R.L. Anstey 'Restudy of some Nicholson's types of Palaeozoic bryozoans', in *Living and Fossil Bryozoa*, edited by G.P. Larwood. London, Academic Press (1973), 429-436, 1 pl; J.F. Pachut, R.L. Anstey and A.S. Horowitz, 'The H.A. Nicholson collection of Paleozoic stenolaemate bryozoans: Comparison of cladistic and phenetic classifications,' *Journal of Paleontology*, 68(5) (1994), 978-994.
- 31 See Perry, Horowitz and Anstey, note 30, p. 435-436; Singh, note 9, p. 246; Davis and Spohn, note 2, p. 185; M.J. Benton, 'H.A. Nicholson (1844-1899), invertebrate palaeontologist: bibliography and catalogue of his type and figured material', *Royal Scottish Museum Information Series. Geology 7* (1979) Edinburgh, vii+94 pp.; M.J. Benton and N.H. Trewin, 'H.A. Nicholson Catalogue of type and figured material in the Palaeontological Collections, University of Aberdeen, with notes on the H.A. Nicholson Collection', *Publications of the Department of Geology and Mineralogy Aberdeen 2* (1978), 1-28.
- 32 E.O. Ulrich, 'Descriptions of new genera and species of fossils from the Lower Silurian about Cincinnati', *Journal of the Cincinnati Society of Natural History*, 2(1) (1879a), 8-30, pl. 7; E.O. Ulrich, 'Description of a new genus and some new species of bryozoans from the Cincinnati Group', *Journal of the Cincinnati Society of Natural History*, 2(3) (1879b), 119-131, pl. 12.
- 33 E.O. Ulrich, 'American Paleozoic Bryozoa', *Journal of the Cincinnati Society of Natural History*, 5(3) (1882), 121-175, pls. 6-8; Utgaard and Perry, note 1, p. 111; Davis and Spohn, note 2, p. 192.
- 34 E.O. Ulrich, 'Paleozoic Bryozoa', *Illinois Geological Survey*, 8(2), section 6 (1890), 285-688, pls. 29-78; E.O. Ulrich, 'On Lower Silurian Bryozoa of Minnesota', *Minnesota Geological and Natural History, Final Report*, 3(1) (1893-1895), 96-332, 28 pls. (The title-page of the volume bears the date 1895, but page liii states that 100 copies of the bryozoan part were printed and distributed in early 1893.)
- 35 R.S. Bassler, 'Memorial to Edward Oscar Ulrich', *Geological Society of America, Proceedings for 1944* (1945), 331-352; L.E. Bradshaw, *E.O. Ulrich and the development of American stratigraphy*, University of Cincinnati (Department of History), Cincinnati, Ohio, unpublished Ph.D. dissertation (1989), v + 329 pp.
- 36 V. Kramer, 'Professor George W. Harper', *The Oracle*, 19(1) (1918), 12.
- 37 G.W. Harper and R.S. Bassler, *Catalogue of the fossils of the Trenton and Cincinnati Periods, occurring in the vicinity of Cincinnati*, O. Cincinnati, W. B. Carpenter Co. (1896), 34 pp.
- 38 E.O. Ulrich and R.S. Bassler, 'A revision of the Paleozoic Bryozoa, pt. 1, On genera and species of Ctenostomata', *Smithsonian Miscellaneous Collections*, 45 (1904a), 256-294, 4 pls; E.O. Ulrich and R.S. Bassler, 'A revision of the Paleozoic Bryozoa, pt. 2, On genera and species of Trepostomata', *Smithsonian Miscellaneous Collections*, 47(1470) (1904b), 15-55, pls. 6-14; see also Utgaard and Perry, note 1, p. 109; and Davis and Spohn, note 2, p. 168)
- 39 R.S. Bassler, 'Bibliographic index of American Ordovician and Silurian fossils', *U.S. National Museum Bulletin*, 92 (1915), 2 volumes, 1,521 pp., 4 pls.

- 40 K.E. Caster, 'Memorial to Ray S. Bassler (1878-1961)', *Geological Society of America, Proceedings for 1965*, (1965), 167-173.
- 41 J.M. Nickles and R.S. Bassler, 'A synopsis of American fossil Bryozoa, including bibliography and synonymy', *U.S. Geological Survey Bulletin*, 173 (1900), 663 pp.
- 42 R.S. Bassler, 'In Memoriam', *Geological Society of America. Bibliography and Index of Geology Exclusive of North America*. Volume 11 – 1945-1946 (1947), ii-v. (Obituary of John Milton Nickles, including photograph).
- 43 J.M. Nickles, 'The geology of Cincinnati', *Journal of the Cincinnati Society of Natural History*, 20(2) (1902), 49-100, pl. I [2-page map]; reprint edition, p. 1-53, 1 pl.
- 44 E.R. Cumings, 'Development of some Paleozoic Bryozoa', *American Journal of Science*, series 4, 17(97) (1904), 49-78.
- 45 E.R. Cumings and J.J. Galloway, 'Studies of the morphology and history of the Trepostomata or monticuliporoids', *Geological Society of America Bulletin*, 26 (1915), 349-374, pls. 10-15.
- 46 Cumings, note 12.
- 47 E.R. Cumings, 'A revision of the bryozoan genera *Dekayia*, *Dekayella*, and *Heterotrypa* of the Cincinnati Group', *American Geologist*, 29(4) (1902), 197-217, pls. 9-12.
- 48 E.R. Cumings, 'The stratigraphy and paleontology of the Cincinnati Series of Indiana', *Indiana Department of Geology and Natural Resources, Thirty-second Annual Report for 1907*, (1908), 605-1189, 55 pls; E.R. Cumings and J.J. Galloway, 'The stratigraphy and paleontology of the Tanner's Creek section of the Cincinnati Series in Indiana', *Indiana Department of Geology and Natural Resources, Thirty-seventh Annual Report for 1912*, (1913), 353-479, 20 pls.
- 49 R.R. Shrock, 'Memorial to Edgar Roscoe Cummings', *Geological Society of America, Proceedings*, P. (1970), 177-183.
- 50 T.G. Perry, 'Memorial to Jesse James Galloway (1882-1962)', *Journal of Paleontology*, 36(4) (1962), 845-846.
- 51 W.S. Dyer, 'The stratigraphy and paleontology of Toronto and vicinity. Part 5. The paleontology of the Credit River section', *Ontario Department of Mines, Annual Report 32*, 32(7) (1925), 47-88, 7 pls; M.A. Fritz, 'Bryozoa (mainly Trepostomata) from the Ottawa Formation (Middle Ordovician) of the Ottawa-St. Lawrence Lowland', *Geological Survey of Canada, Bulletin*, 42 (1957), 75 pp., 30 pls.
- 52 F. Canu and R.S. Bassler, 'Fossil and Recent Bryozoa of the Gulf of Mexico region', *U.S. National Museum Proceedings*, 72(14) (1928), 1-199, pls. 1-34. See also J.-A. Sanner, this volume
- 53 R.S. Bassler, 'Part G. Bryozoa', in *Treatise on Invertebrate Paleontology*, edited by R.C. Moore. Geological Society of America and University of Kansas Press, (1953) 253 p.
- 54 Utgaard and Perry, note 1.
- 55 G.D. Brown Jr. and E.J. Daly, 'Trepostome Bryozoa from the Dillsboro Formation (Cincinnati Series) of southeastern Indiana', *Indiana Geological Survey Special Report*, 33 (1985b), 95 pp., 12 pls.
- 56 Singh, note 9.
- 57 R.L. Anstey and T.G. Perry, 'Eden Shale bryozoans: a numerical study (Ordovician, Ohio Valley)', *Michigan State University, Publications of the Museum, Paleontological Series*, 1(1) (1972 [1973]), 80 pp., 22 pls. (title page bears the date 1972, but the verso of the title page states "Published 14 January 1973").
- 58 O.L. Karklins, 'Trepostome and cystoporate bryozoans from the Lexington Limestone and the Clays Ferry Formation (Middle and Upper Ordovician) of Kentucky', *U.S. Geological Survey*

- Professional Paper* 1066-I (1984), 105 pp., 41 pls.
- 59 G.D. Brown Jr., 'Trepotomatous Bryozoa from the Logana and Jessamine Limestones (Middle Ordovician) of the Kentucky Bluegrass Region', *Journal of Paleontology*, 39(5) (1965), 974-1006, pls. 111-118.
- 60 R.A. Pohowsky, 'The boring ctenostomate Bryozoa: taxonomy and paleobiology based on cavities in calcareous substrata', *Bulletins of American Paleontology*, 73(301) (1978), 192 pp., 24 pls; O.L. Karklins, 'Ptilodictyoid Cryptostomata Bryozoa from the Middle and Upper Ordovician rocks of central Kentucky', *Journal of Paleontology*, 57(1) supplement (1983) (*Paleontological Society Memoir* 14), 31 p.
- 61 Cumings, note 48; Cumings and Galloway, note 48.
- 62 Ulrich, note 34.
- 63 R.S. Boardman, 'A revision of the Ordovician bryozoan genera *Batostoma*, *Anaphragma*, and *Amplexopora*', *Smithsonian Miscellaneous Collections*, 140(5) (1960), 28 pp., 7 pls.
- 64 R.S. Boardman and J.E. Utgaard, 'A revision of the Ordovician bryozoan genera *Monticulipora*, *Peronopora*, *Heterotrypa*, and *Dekayia*', *Journal of Paleontology*, 40(5) (1966), 1082-1108, pl. 133-142.
- 65 J.E. Utgaard, 'A revision of North American genera of ceramoporoid bryozoans (Ectoprocta): Part II; *Crepipora*, *Ceramoporella*, *Acanthoceramoporella*, and *Ceramophylla*', *Journal of Paleontology*, 42(6) (1968), 1444-1455, pls. 181-184.
- 66 D.R. Hickey, 'Bryozoan astogeny and evolutionary novelties: their role in the origin and systematics of the Ordovician monticuliporid trepostome genus *Peronopora*', *Journal of Paleontology*, 62(2) (1988), 180-203.
- 67 P.D. Taylor and M.A. Wilson, '*Corynotrypa* from the Ordovician of North America: colony growth in a primitive stenolaemate bryozoan', *Journal of Paleontology*, 68(2) (1994), 241-257; P.D. Taylor and M.A. Wilson, '*Cuffeyella*, a new bryozoan genus from the Late Ordovician of North America, and its bearing on the origin of the post-Paleozoic cyclostomates', in *Bryozoans In Space and Time*, edited by D.P. Gordon, A.M. Smith and J.A. Grant-Mackie. National Institute of Water and Atmospheric Research, Wellington, New Zealand (1996), 351-360.
- 68 J.F. Cutler, *Morphology, taxonomy, and evolution of the bryozoan Constellaria from the Cincinnati Arch*, Columbia University, New York, unpublished Ph.D. dissertation, (1968) 297 pp.
- 69 F.K. McKinney, 'Bibliography and list of the families Constellariidae and Dianulitidae (Ectoprocta, Order Cystoporata)', *Southeastern Geology*, 10(3) (1969), 175-184; F.K. McKinney, 'Bibliography and catalogue (1900-1969) of the Trepotomata (phylum Ectoprocta)', *Southeastern Geology, Special Publication*, 4 (1974), 147 pp.
- 70 J.R.P. Ross, 'Reevaluation of the type species of *Arthropora* Ulrich', *Journal of Paleontology*, 34(5) (1960), 859-861, pl. 108; N. Spjeldnaes, 'A redescription of the type species of the bryozoan genus *Crepipora*', *Journal of Paleontology*, 37(1) (1963), 64-68, pls. 9-10; R.L. Anstey and T.G. Perry, 'Redescription of cotypes of *Peronopora vera* Ulrich, a Cincinnati (Late Ordovician) ectoproct species,' *Journal of Paleontology*, 43(2) (1969), 245-251, pls. 31-32.
- 71 J.E. Utgaard and R.S. Boardman, '*Heterotrypa* Nicholson, 1879, and *Peronopora* Nicholson, 1881, Bryozoa, Trepotomata: proposed designation of a type-species in conformity with generally accepted usage', *Bulletin of Zoological Nomenclature*, 22(2) (1965), 112-118; International Commission on Zoological Nomenclature, 'Opinion 838, Designation under the Plenary Powers of the type species in harmony with accustomed usage for genera *Heterotrypa*

- Nicholson, 1879, and *Peronopora* Nicholson, 1881 (Class Bryozoa) (Ordovician)', *Opinions and Declarations rendered by the International Commission on Zoological Nomenclature*, 24(6) (1968), 835-841.
- 72 Bassler, note 53.
- 73 R.S. Boardman, A.H. Cheetham, D.B. Blake, J.E. Utgaard, O.L. Karlkins, P.L. Cook, P.A. Sandberg, G. Lutaud and T.S. Wood, 'Bryozoa, Part G, revised, volume 1: Introduction, Order Cystoporata, Order Cryptostomata', in *Treatise on Invertebrate Paleontology*, edited by R.A. Robison. Geological Society of America and University of Kansas Press (1983), 625 p.
- 74 R.S. Boardman, 'Mode of growth and functional morphology of autozooids in some Recent and Paleozoic tubular Bryozoa', *Smithsonian Contributions to Paleobiology*, 8 (1971), 51 pp., 11 pls; S.J. Morrison and R.L. Anstey 'Ultrastructure and composition of brown bodies in some Ordovician trepostome bryozoans', *Journal of Paleontology*, 53(4) (1979), 943-949; J.E. Utgaard, 'Mode of colony growth, autozooids, and polymorphism in the bryozoan order Cystoporata', in *Animal Colonies*, edited by R.S. Boardman, A.H. Cheetham and W.A. Oliver. Dowden, Hutchison, & Ross, Stroudsburg (1973), 317-360, 74 text-figs; Utgaard, note 7.
- 75 R.L. Anstey and J.F. Pachut, 'Fourier packing ordinate: A univariate size-independent measurement of the polygonal packing variation in Paleozoic bryozoans', *Mathematical Geology*, 12(2) (1980), 139-156; R.L. Anstey and J.W. Bartley, 'Quantitative stereology: an improved thin section biometry for bryozoans and other colonial organisms', *Journal of Paleontology*, 58(3) (1984), 612-625.
- 76 R.L. Anstey, J.F. Pachut and D.R. Prezbindowski, 'Morphogenic gradients in Paleozoic bryozoan colonies', *Paleobiology*, 2(2) (1976), 131-146; F.K. McKinney, 'Autozoecial budding patterns in dendroid Paleozoic bryozoans', *Journal of Paleontology*, 51(2) (1977), 303-329, 9 pls; M.E. Podell and R.L. Anstey, 'The interrelationship of early colony development, monticules and branches in Palaeozoic bryozoans', *Palaeontology*, 22(4) (1979), 965-982, pls. 126-130; R.L. Anstey, 'Zooid orientation structures and water flow patterns in Paleozoic bryozoan colonies', *Lethaia*, 14(4) (1981), 287-302.
- 77 J.F. Pachut and R.L. Anstey, 'A developmental explanation of stability-diversity-variation hypotheses: morphogenetic regulation in Ordovician bryozoan colonies', *Paleobiology*, 5(2) (1979), 168-187; R.L. Anstey, 'Astogeny and phylogeny: evolutionary heterochrony in Paleozoic bryozoans', *Paleobiology*, 13(1) (1987), 20-43; M.M. Key Jr. 'Partitioning of morphologic variation across stability gradients in Upper Ordovician trepostomes', in *Bryozoa: Present and Past*, edited by J.R.P. Ross. Western Washington University, Bellingham, Washington (1987), 145-152; J.F. Pachut, 'Population genetics of four species of Ordovician bryozoans: stereology and jackknifed analysis of variance', *Journal of Paleontology*, 61(5) (1987), 927-941; J.F. Pachut, 'Heritability and intraspecific heterochrony in Ordovician bryozoans from environments differing in diversity', *Journal of Paleontology*, 63(2) (1989), 182-194; J.F. Pachut, 'Morphological integration and covariance during astogeny of an Ordovician trepostome bryozoan from communities of different diversities', *Journal of Paleontology*, 66(5) (1992), 751-757.
- 78 G.D. Brown Jr. and E.J. Daly, 'Evolutionary trends in *Parvohallopore* Singh in the Dillsboro Formation (Upper Ordovician) of southeastern Indiana', in *Recent and Fossil Bryozoa*, edited by G.P. Larwood and C. Nielsen. Olsen and Olsen, Fredensborg (1981), 29-38; G.D. Brown Jr. and E.J. Daly, 'Analysis of evolution of structural characters of *Parvohallopore* Singh from the Dillsboro Formation, Cincinnati Series, Indiana', in *Bryozoa, Ordovician to Recent*, edited by C. Nielsen and G.P. Larwood. Olsen & Olsen, Fredensborg (1985), 51-58.

- 79 O.L. Karklins, 'Bryozoan biostratigraphy of the upper Middle Ordovician and Upper Ordovician of Kentucky', in *Bryozoa, Ordovician to Recent*, edited by C. Nielsen and G.P. Larwood. Olsen & Olsen, Fredensborg (1985), 346-347.
- 80 R.L. Anstey and S.F. Rabbio, 'Regional bryozoan biostratigraphy and taphonomy of the Edenian stratotype (Kope Formation, Cincinnati area): graphic correlation and gradient analysis', *Palaios*, 4(6) (1989), 574-584.
- 81 S.C. Diekmeyer, *Quantitative analysis of cyclical faunal patterns in the Upper Ordovician Kope through Bellevue sequence, Cincinnati, Ohio*. University of Cincinnati, unpublished M.S. thesis (1990), 168 pp., 15 pls., 33 text-figs; D.H. Errett and R.J. Cuffey, 'Bryozoan mode of occurrence relative to individual beds in the type Cincinnati (Upper Ordovician; Ohio, Indiana, Kentucky)', *Geological Society of America Abstracts with Programs*, 21(4) (1989), 11.
- 82 M.A. Wilson, T.J. Palmer and P.D. Taylor, 'Earliest preservation of soft-bodied fossils by epibiont bioimmuration; Upper Ordovician of Kentucky', *Lethaia* 27(3) (1994), 269-270.
- 83 G.C. Baird, C.E. Brett and R.C. Frey, "'Hitchhiking" epizoans on orthoconic cephalopods: preliminary review of the evidence and its implications', *Senckenbergiana Lethaea*, 69(5/6) (1989), 439-465, 4 pls.
- 84 M.A. Wilson, 'Disturbance and Ecologic Succession in an Upper Ordovician Cobble-Dwelling Hardground Fauna', *Science*, 228(4699) (1985), 575-577.
- 85 C.G. Dively and R.J. Cuffey, '*Monticulipora molesta* - Intraspecific? variability (Bryozoa, Upper Ordovician, southeastern Indiana)', *Geological Society of America Abstracts with Programs*, 26(3) (1994), 15.
- 86 R.J. Cuffey, 'The Maysville bryozoan reef mounds in the Grant Lake Limestone (Upper Ordovician) of north-central Kentucky', *Ohio Division of Geological Survey, Guidebook*, 13 (1998), 38-44.
- 87 F.W. Harris and W.D. Martin, 'Benthic community development in limestone beds of the Waynesville (upper Dillsboro) Formation (Cincinnati Series, Upper Ordovician) of southeastern Indiana', *Journal of Sedimentary Petrology*, 49(4) (1979), 1295-1306.
- 88 J.R.P. Ross and C.A. Ross, 'Bryozoan evolution and dispersal and Paleozoic sea-level fluctuations', in *Bryozoans In Space and Time*, edited by D.P. Gordon, A.M. Smith and J.A. Grant-Mackie. National Institute of Water and Atmospheric Research, Wellington, New Zealand (1996), 243-258.
- 89 K.L. Butler and R.J. Cuffey, 'Reduced bryozoan diversity and paleoenvironmental stress in the Saluda Dolomite (uppermost Ordovician, southeastern Indiana)', in *Bryozoans In Space and Time*, edited by D.P. Gordon, A.M. Smith and J.A. Grant-Mackie. National Institute of Water and Atmospheric Research, Wellington, New Zealand (1996), 55-61.
- 90 R.L. Anstey, S.F. Rabbio and M.E. Tuckey, 'Bryozoan bathymetric gradients within a Late Ordovician epeiric sea', *Paleoceanography*, 2(2) (1987), 165-176; G.D. Brown Jr. and E.J. Daly, 'Trepastome bryozoan distributions in the Dillsboro Formation (Cincinnati Series), Indiana: water depth controls?', in *Bryozoa: Present and Past*, edited by J.R.P. Ross. Bellingham, Washington, Western Washington University (1987), 41-47.
- 91 J.R.P. Ross 'Biogeography of Ordovician ectoproct (bryozoan) faunas', in *Bryozoa, Ordovician to Recent*, edited by C. Nielsen and G.P. Larwood. Olsen & Olsen, Fredensborg (1985), 265-271; R.L. Anstey, 'Bryozoan provinces and patterns of generic evolution and extinction in the Late Ordovician of North America', *Lethaia*, 19(1) (1986), 33-51; R.L. Anstey and T.L. Chase, 'Geographic diversity of Late Ordovician corals and bryozoans in North America', *Journal of*

- Paleontology*, 48(6) (1974), 1141-1148.
- 92 M.E. Tuckey and R.L. Anstey, 'Late Ordovician extinctions of bryozoans', *Lethaia*, 25(1) (1992), 111-117.
- 93 H. Milne-Edwards and J. Haime, 'Monographie des polypiers fossiles des Terrains Palaeozoïques, précédée d'un général de la classification des Polypes', *Archives du Muséum d'Histoire Naturelle, Paris*, 5 (1851), 1-504, 20 pls.
- 94 D.E. Hattin, 'Memorial to Thomas Gregory Perry, 1919-1972', *Geological Society of America Memorials*, 4 (1975), 154-159.