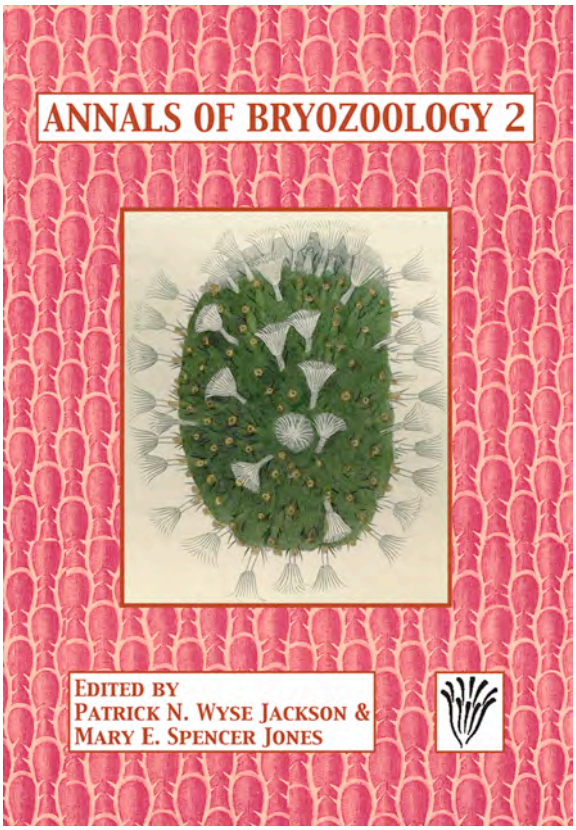

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Some early American history of the sectioning of Paleozoic Bryozoa: a personal view

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The great majority of Bryozoa of Paleozoic age are not identifiable below the order level using external taxonomic characters alone. As a result, unsectioned Bryozoa are generally listed by phylum name and make no contribution to stratigraphic or regional studies. Oriented thin sections and peels of these drab and unrevealing colonies, however, disclose a wealth of detailed internal morphology that provides ample numbers of characters and character states for use in modern systematics. We have no information on the first discovery of the complex interiors of these colonies. It must have been a scene of immediate excitement and wonder.[1] Published drawings of sections of the internal morphology of fossil stenolaemate bryozoans apparently began as early as 1845 in a contribution by William Lonsdale[2] and secondly in 1876 in a short paper by H. Allyn Nicholson.[3] His monographs of 1879 and 1881 firmly established the thin section technique as essential to the taxonomy of Paleozoic bryozoans.[4] Nicholson (1844–1899) was a Scottish paleontologist who taught at the University of Aberdeen for many years. He wrote extensively on zoology, geology and paleontology and received many honors from societies and other universities.[5] He also spent three years at the University of Toronto beginning in 1871. While there Nicholson collected extensively and so contributed to the early bryozoan paleontology of North America as well as Great Britain. He prepared the thin sections and camera lucida drawings himself to produce the published lithographs,[6] and argued for the necessity of sectioning oriented interiors for identification.[7] He interpreted Paleozoic bryozoans to have been corals, even after making a detailed comparison with the living genus *Heteropora*, a known bryozoan.[8] He apparently held this belief throughout his career. Today Nicholson is known chiefly as the earliest systematic user of thin sections in taxonomy. In addition to bryozoans he sectioned corals and stromatoporoids.

Edward Oscar Ulrich (1857–1944), an American, followed closely behind Nicholson in the use of thin sections to describe and illustrate Paleozoic Bryozoa (two published papers in 1879).[9] He was the first to study the complex interiors in depth. He established the Trepostomata as a suborder,[10] and with some hesitation considered them Bryozoa.[11] His series of papers published in the *Journal of the Cincinnati Society of Natural History* from 1882 through 1884 illustrated and described many Ordovician genera of the

Cincinnati region and provided the nucleus for Ordovician bryozoan taxonomy everywhere.[12] The achievement and intellectual quality of his two giant monographs on Paleozoic Bryozoa (1890, for the state of Illinois and 1893, for Minnesota)[13] established him as the founder of the present day studies of Paleozoic Bryozoa. How he arrived at this predominance is most unlikely and remarkable as seen from present day perspectives.

Ulrich grew up and lived in early life in the Cincinnati, Ohio area. The southern Ohio and Indiana regions are among the most prolific collecting grounds in the world for Ordovician Bryozoa, especially colonies of trepostomes, many of them unbroken. The fossils are so intriguing that in the late 1800s a "Cincinnati School" of self-taught amateurs developed, some of whom rose to prominent professional status.[14]

Ulrich started collecting fossils in grade school when he learned of the significance of the odd shaped stones from a local geologist. Later, at his father's urging, he attended Ohio colleges in preparation first for the ministry and then for medicine. His preference for fossils triumphed over his scholastic education, however, and at the age of 20 he accepted the curatorship of the Cincinnati Society of Natural History. In the next 20 years (1877 to 1897), Ulrich sectioned and studied Paleozoic bryozoans in remarkable detail and taxonomic scope from several mid western states. He also published on sponges, ostracods, and lamellibranches. During this period he earned just enough to survive with the help, in part, of odd jobs as a carpenter, draftsman, and lithographer.[15]

Ulrich's publications in the Cincinnati Journal from 1882 through 1884 (referred to above) established him as a major student of Paleozoic bryozoans of the time. As a result of those publications he received contract work from a number of organizations including the bryozoan chapter in Zittel's *Text-book of Palaeontology* (the Eastman translation of 1896)[16] and prepared bryozoan collections for the British Museum (Natural History) and the Museum at the University of Munich. Ulrich also did contract work in both geology and paleontology for several states that included his two major works on bryozoans, the Illinois monograph (1890) and the Minnesota monograph (1893), (referred to above). His preface to his Illinois monograph on Paleozoic Bryozoa is a classic introduction to both the new approach to the internal study of bryozoans and the science of paleontology current at that time.[17] His ideas expressed in the preface can be followed virtually seamlessly to a "second generation" of greatly advanced knowledge as expressed in the 1983 revised volume Part G, Bryozoa, of the *Treatise on Invertebrate Paleontology*.[18] Sometime during this 20-year period Ulrich became convinced that the "monticuliporids" (present day bryozoans) were actually bryozoans and not corals as held by Nicholson. For example, in 1890 he pointed out that they had no structures comparable to coral septa.[19]

In 1897, at the age of 40 and apparently without formal training in geology and paleontology, Ulrich's bryozoan production and reputation brought him an appointment to the U. S. Geological Survey. All survey paleontologists at that time were housed in the National Museum of Natural History in Washington. He brought most of his type specimens and sections and unstudied collections from Cincinnati and one of the major collections of bryozoans of the world was started. Unfortunately for the future of bryozoan research, the Survey position soon caused Ulrich to shift his major research from

paleontology to stratigraphy.

Raymond Smith Bassler (1878–1961) was the second major figure in the study of bryozoans at the National Museum. He came to Washington from Cincinnati as a technician in 1900, where he had been a voluntary assistant making thin sections for Ulrich as a high school teenager. He was also a cataloger by nature and together with John Nickles, another cataloger from Cincinnati, published a masterful compilation or synopsis of American Fossil Bryozoa, whose coverage and scope was mostly Paleozoic.[20] This and Bassler's subsequent catalogs and bibliographic work have been consistently reliable and accurate.[21]

By production and reputation, Ulrich and Bassler were the leading bryozoan taxonomists of their day and apparently neither had formal college training in geology or paleontology. Bassler had some college experience, but he told me several times with considerable pride that he never had a formal college course in geology or paleontology. Shortly after arriving in Washington, Bassler said he registered for the beginning geology course at George Washington University. After one meeting the lecturer realized that Bassler knew more geology than he did so he promised him an A in the course if he would not come to class for the rest of the semester, which he did. Bassler's story seems to conflict with his Master's degree, 1904, and Ph.D., 1905, from George Washington University, but apparently no formal geology courses were included.

Bassler soon rose to a research curatorship at the Museum and published important papers on Paleozoic Bryozoa between 1903 and 1911.[22] Bassler's greatest contributions to the study of Bryozoa were the naming of as many new taxa of all ages as possible and building the huge collection of Bryozoa at the Museum. He took shortcuts at times during his efforts to describe many taxa. For example, in his 1911 taxonomic study of the Early Paleozoic Bryozoa of the Baltic region, Bassler identified many Baltic specimens with established American species and refigured only the American types to illustrate some of the Baltic fauna.

With the help of Ferdinand Canu of Paris beginning in 1905,[23] Bassler greatly expanded his interest in post-Paleozoic bryozoans and reduced his time spent on Paleozoic studies. Together they published two major monographs on the North American Tertiary Bryozoa.[24] Preparation of the manuscripts took place on both sides of the Atlantic during the height of World War I and not a single mailing was lost according to Bassler.

Bassler was the junior member in his work with both Ulrich and Canu and always said that he accepted and followed their leadership. Consistent with that role, he followed Ulrich's early approach to the study of Paleozoic Bryozoa and did the majority of the manuscript preparation with Canu. As a result, he produced few ideas of his own. His summary treatment of Paleozoic Bryozoa in 1953 in part G Bryozoa of the *Treatise on Invertebrate Paleontology*[25] contains little or no advancement in biologic interpretation and taxonomic philosophy beyond Ulrich's ideas of more than 50 years earlier.

I first came to the Museum as a Survey trainee graduate student in 1952 and immediately was made aware of some of my bryozoan predecessors' turn of the century foibles. For example, by today's standards, Ulrich and Bassler's collecting units were too

thick and they are reported to have collected "float", colonies washed out of weathered outcrops. Ulrich reportedly had a remarkable memory and routinely did not take time to label collections until he was back at the Museum. He was famous around the Museum for long and loud arguments about localities with his longtime field assistant and technician, Rector Mesler. After retirement in 1932, Ulrich remembered some localities differently and changed them. Fortunately, by then he had developed shaky handwriting. These localities probably should be ignored if the original locality information is still visible. Further, Ulrich believed that the upper Ordovician Richmondian stage was really Lower Silurian, so Lower Silurian labels (including many of Bassler's) in the Museum bryozoan collections are incorrect. Fortunately, some of the occurrence data has been improved upon by comparing the morphology of original type specimens with that of secondary specimens more closely collected.

Ulrich and Bassler's thin-sectioning technique evolved little through the years from Ulrich's original routine in the late 1800s.[26] Bassler used much of Ulrich's original language to redescribe the procedure,[27] another one of Bassler's timesaving procedures. I happened on to one of the sandstone slabs in the Museum that they had used for grinding the sections. It was dished (concave) so badly that hand grinding would produce sections with edges necessarily thinner than the middles. Wire nippers were used to break off smaller pieces of a specimen and these irregular pieces were then sectioned, producing sections of relatively small area and minimal information. They used Canada balsam to glue the sections to glass slides. Cooking the balsam just the right amount to produce the exact hardness required to complete a section was extremely sensitive and resulted in having to discard up to a third of the attempts. (Canada balsam was still used in the 1950s when I started to sections for my dissertation at the Museum). Ulrich claimed that 40 or 50 sections could be made in a day hand grinding on sandstone slabs and using Canada balsam.[28] Bassler told me that he and Ulrich reportedly continued to live near the poverty line for several years after moving to Washington. Both in Cincinnati and Washington they sold identified sets of Paleozoic sections to a number of universities in North America and abroad. In Cincinnati they could not always afford to buy standard laboratory slides so cut window glass into the 1 by 3 inch slide size and used them. Unfortunately, the slides were too thick to fit into the slots of slide boxes so they ground down the ends (that was real dedication). Some of these overly thick slides can still be found in museum and university collections.

Grinding tools for thin sectioning underwent a slowly improving evolution. A visit to J. J. Galloway's laboratory at Indiana University in the mid 1960s (see below) revealed a cutoff saw with a diamond blade and a fixed stage, requiring the operator to slide a specimen on the immovable stage in the exact plane of the blade. The slightest variation produced a minor explosion, another nick in the blade, and shattered nerves.

Ulrich and Bassler's method for microscopic study of finished slides was interesting. Shortly after arriving at the Museum in 1952, Bassler asked me to bring in some of my Devonian thin sections to see what I was finding. He took out a X10 hand lens, examined them, and pronounced them most interesting. A monocular microscope was sitting on his

desk.[29] I rescued the microscope from being thrown out a number of years ago and it now is in the safe hands of Patrick Wyse Jackson in the country that saved Civilization. Bassler's use of a hand lens got my attention and with some trepidation I asked him if he ever used his microscope to look at sections. He answered that every time he used it he saw too many structures that he did not understand (still true today). Actually, he understated himself because somewhere he has written that describing new species required a microscope; a hand lens was generally adequate for identifying previously described species. On the same subject, Ulrich was famous around the Museum for the tongue in cheek expression, "If I can't see it with a X10 hand lens it doesn't exist."

Ulrich and Bassler together sectioned and described an enormous number of bryozoan species, using what we would today consider an unfortunate shortcut. They sorted specimens into species from a single locality on external appearances, sectioned one of the best specimens, described the species internally from those two or three sections, and made cotypes (syntypes) of both the sectioned and unsectioned specimens. This was in the days when it was thought that there was little or no morphologic variation within species. Subsequent sectioning of individual cotype suites has revealed as many as two or three genera, further establishing the futility of using external characters alone.

The lack of formal training must have contributed to Ulrich and Bassler's seemingly undisciplined and rather colorful study procedures. They transferred overly shortened study methods from highly developed amateur careers to two of the most desirable positions in their profession and piled up newly described species. I do not remember Bassler ever suggesting to me that one or more of their practices had been unfortunate and should have been corrected.

Under Ulrich's leadership and consistent with the philosophy of the day, they did give considerable thought to the higher taxonomic categories of the Trepostomata. Their use of zooecial wall structure to determine families is compiled[30] from two of their papers.[31] Bassler's 1911 paper is his most thoughtful treatment of trepostomes, in spite of his illustration of some of the Baltic species with American types that he considered to be conspecific (see above).

Running concurrently with the Ulrich and Bassler careers was the thoroughly professional and outstanding research of Edgar R. Cumings and James J. Galloway at Indiana University. Cumings published first on trepostomes while a graduate student at Yale University.[32] The description of their collecting standards was in marked contrast to Ulrich and Bassler's and was thoroughly professional.[33] Cumings demonstrated that the fenestellids and trepostomes started colony growth in the same manner as living Bryozoa[34] and his final conclusions that they differed from typical tabulate corals[35] ended the controversy started in the late 1800s by Nicholson. The paper by Cumings and Galloway on the morphology and histology of the Trepostomata, published in 1915, was the first of its kind, a classic paper that dealt exclusively with mode of growth and function.[36] I met Cumings just once and at an advanced age he remembered details of collecting localities without hesitation. I spent three months (1956) at Indiana University with Galloway after he retired and was working on stromatoporoids. Galloway received his degree from

Indiana and was one of Cumings' earliest graduate students. He was a most unforgettable character. His enthusiasm for paleontology was matched by his sense of humor and his interest in the world around him. At various times in his life he had been a prizewinner as a typist, chess player, bridge player, and was still an excellent pool player in his later years. He also claimed that he held the world's record for making a thin section in the shortest time. One afternoon he got everything out ready to go and started frantically. Unfortunately it had been years since he had made a section, his cutoff saw with the fixed stage exploded, and he grinned and gave up.

As impossible as it seems, genera and their type species are routinely resurrected for present day use that start out poorly described and "homeless", that is, with little or no reliable occurrence data. Most trepostome genera were begun with "first generation" descriptions that were generally too brief with minimal illustration. Described characters were those easily seen that required little biologic understanding. Through the years, subsequent workers developed improved and generally accepted concepts for many of the more common genera. Type suites are searched for lectotypes that best illustrate the current or newly realized generic concepts where holotypes were not designated. "Second generation" descriptions have resulted from newly detailed study of type and related species and application of the biologic understanding realized during the last half century.[37]

Notes

1 For a detailed history of bryozoan study before sectioning see Ulrich, E. O. 1890, Paleozoic Bryozoa. *Illinois Geological Survey* 8, 283–688, pl. 29–78, p. 323–329.

2 See P.N. Wyse Jackson, this volume, for details of this thin-section, which is now in the Natural History Museum, London.

3 Nicholson, H. A. 1876. Notes on the Palaeozoic corals of the State of Ohio. *Annals and Magazine of Natural History*, series 4, 18, 85–94.

4 Nicholson, H. A. 1879. *Structure and affinities of the "Tabulate Corals" of the Paleozoic Period*. William Blackwood & Sons, Edinburgh and London, 337 p., 44 text-fig., 15 pl.; Nicholson, H. A. 1881. *On the structure and affinities of the genus* Monticulipora *and its subgenera, with critical descriptions of illustrative species*. William Blackwood and Sons, Edinburgh, 240 pages, 50 fig., 6 pl.

5 Royal Society Year-book. 1899, 4 p.

6 Nicholson, H. A. 1879. *Structure and affinities of the "Tabulate Corals" of the Paleozoic Period,* p. x of Preface.

7 Nicholson, H. A. 1881. *On the structure and affinities of the genus* Monticulipora *and its subgenera,* p. vii of Preface.

8 Nicholson, H. A. 1880. On the minute structure of the Recent *Heteropora neozelanica*,Busk, and on the relations of the Genus *Heteropora* to *Monticulipora*. *Annals and Magazine of Natural History*, Series 5, 6 (35), 329–339, 414–423.

9 Ulrich, E. O. 1879a. Descriptions of new genera and species of fossils from the lower Silurian about Cincinnati. *Journal of the Cincinnati Society of Natural History,* 2, 8–30; Ulrich, E. O.

1879b. Description of a new genus and species of bryozoans from the Cincinnati group. *Journal of the Cincinnati Society of Natural History,* 2, 19–131.

10 See Ulrich, E. O. 1882. American Paleozoic Bryozoa. *Journal of the Cincinnati Society of Natural History*, part I, October, 121–175, pl. 6–8; part II December, 232–257. pl. 10, 11, on page 151.

11 Ulrich, E. O. 1882. American Paleozoic Bryozoa, page 12.

12 Ulrich, E. O. 1882. American Paleozoic Bryozoa; Ulrich, E. O. 1883. American Paleozoic Bryozoa. *Journal of the Cincinnati Society of Natural History*, part III, April, 82–92, 1 pl.; part IV, July, 148–168, pl. 6, 7; part V, December, 245–279, pl. 1–3; Ulrich, E. O. 1884. American Paleozoic Bryozoa. *Journal of the Cincinnati Society of Natural History*, part VI, April, 24–51, pl. 1–3.

13 Ulrich, E. O. 1890. Paleozoic Bryozoa. *Illinois Geological Survey* 8, 283–688, pl. 29-78; Ulrich, E. O. 1895. On lower Silurian Bryozoa of Minnesota. *Minnesota Geological Natural History Survey*. Final Report 3(1), 96–332, fig. 8-20, 28 pl. (Author's separate issued 1893).

14 For a detailed account of the "Cincinnati School", and pictures of Nicholson, Ulrich, and Bassler (among others) see Cuffey, R. J. 2002. The Cincinnati Paleobryozoologists, p. 59–80. In P. N. Wyse Jackson & M. E. Spencer Jones (eds), *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin. For more pictures of Bassler see Sanner, JoAnn. 2002. Canu & Bassler, p. 243–250, in the same volume.

15 Much of the information given in this paragraph is taken from Bassler, R. S. 1944. Edward Oscar Ulrich. *Bulletin of the American Association of Petroleum Geologists*, 28, 687–689.

16 Ulrich. E. O. 1896. Bryozoa. In K. A. von Zittel & C. R. Eastman (trans. & ed). *Textbook of Paleontology*, volume 1, 257–291, text-figs 411–488. Macmillan and Co., New York.

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18 Boardman, R. S., Cheetham, A. H., Blake, D. B., Utgaard, J., Karklins, O. L., Cook, P. L., Sandberg, P. A., Lutaud, G. and Wood, T. S., Bryozoa. In R. A. Robison, ed., *Treatise on Invertebrate Paleontology, Part G, Revised*, 625 p., 295 figs. University of Kansas Press, Lawrence, and the Geological Society of America, Boulder.

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23 See details of their relationship in Sanner, 2002, p. 243–250, note 14.

24 Canu, Ferdinand and R. S. Bassler. 1920. North American Early Tertiary Bryozoa. *U. S. National Museum, Bulletin* 106, 842 p. 162 pls; Canu, Ferdinand and R. S. Bassler. 1923. North American Later Tertiary and Quaternary Bryozoa. *U. S. National Museum, Bulletin* 125, 292 p., 47 pls.

25 Bassler, R. S. 1953. Bryozoa. In R. C. Moore, ed., *Treatise on Invertebrate Paleontology* Part G: 253 p., 175 fig. The Geological Society of America & The University of Kansas Press. New

York and Lawrence

26 Ulrich 1890, note 13, p. 292.

27 Bassler, R. S. 1922. The Bryozoa, or moss animals. *The Smithsonian Report for 1920*, 339–380, 4 pls. Washington Government Printing Office, p. 348; Bassler, 1953, note 25, p. G17.

28 Ulrich 1890, note 13, p. 292.

29 The same microscope is pictured in much earlier years, in Sanner, 2002, note 14, fig. 3.

30 Boardman, R. S. 1960. Trepostomatous Bryozoa of the Hamilton Group of New York State. *U.S. Geological Survey Professional Paper* 340, iv+87 p., 27 fig., 22 pl. on p.25)

31 Ulrich, E. O. and Bassler, R. S. 1904. A revision of the Paleozoic Bryozoa. Pt. II - On genera and species of Trepostomata. *Smithsonian Miscellaneous Collections* 47, 15-55; Bassler, 1911, note 23.

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34 Cumings, E. R. 1904. Development of some Paleozoic Bryozoa. *American Journal of Science*, 17, 49–78, figs. 15-82.

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36 Cumings, E. R. and Galloway, J. J. 1915. Studies of the morphology and histology of the Trepostomata or Monticuliporoids. *Bulletin of the Geological Society of America*, 26, 349–374, pls. 10–15.

37 See the revised volume part G, Bryozoa, of the *Treatise on Invertebrate Paleontology* Boardman *et al*., 1983, note 18.