

The Legacy of Invertebrate Paleontology at Yale University

This document is an outgrowth of presentations given by Russell D. White at the 1996 annual meetings of the Society for the Preservation of Natural History Collections and the Geological Society of America.

Abstract

During the past 200 years, seven generations of faculty and students have shaped invertebrate paleontology at Yale University. Benjamin Silliman began acquisitions of invertebrate fossils in the 1820s and for much of the century the holdings continued to grow through his efforts and those of James D. Dana. In 1866, the early collections were incorporated into the newly endowed Peabody Museum of Natural History, and through the efforts of Othniel C. Marsh, the collections' size and scope gained an international stature. The first invertebrate paleontologist at Yale was Charles E. Beecher who was appointed Curator and Professor of Geology in 1891. Using both Yale's and his personal collections, Beecher developed one of the earliest classifications for trilobites and brachiopods. The invertebrate fossil holdings grew enormously when Charles Schuchert replaced Beecher after an untimely death in 1904. With Schuchert's generosity, Yale's collections grew enormously through purchase of private collections, support of graduate student field work, and the acquisition of choice brachiopod collections. In 1920, Carl O. Dunbar, Schuchert's former student, was appointed to the Yale faculty and Peabody curatorial board. Initially, Dunbar spent his summers collecting in the Appalachians and Midwest, expanding his familiarity with North American paleontology and stratigraphy, and building a regional stratigraphic collection for teaching and exhibition. During the Schuchert–Dunbar era, the holdings of invertebrate fossils increased seven-fold, approaching three million specimens. Following the Schuchert–Dunbar era, the direction of invertebrate paleontology research changed to molluscan systematics and evolution with the appointments of Karl M. Waage and A. Lee McAlester.

Introduction

Nineteen faculty members have been associated with the invertebrate paleontology since the mid-19th century. The invertebrate fossil holdings rapidly expanded after the faculty appointment of Charles E. Beecher, Yale's first invertebrate paleontologist. Beecher was followed on the faculty by Charles Schuchert and Carl O. Dunbar, both of whom added enormously to the holdings through field excursions, purchases of private collections, and especially through cooperative research efforts with their many graduate students. Karl M. Waage and A. Lee McAlester led several teams of students and post-doctoral fellows studying molluscan evolution and systematics. In total, 110 graduate students have received advanced degrees from Yale University, based in whole or in part on invertebrate fossils.

The Victorian Era

In 1802, President Timothy Dwight of Yale College appointed Benjamin Silliman Professor of “Chymistry” and Natural Philosophy. After a three year educational sojourn around eastern North America and Europe, Silliman returned to New Haven prepared to teach natural history at Yale (Skinner and Narendra, 1985). During his professorship, the “College Cabinet,” or teaching collection, began to take shape, initially containing only minerals but later expanding to include fossils. Acquisitions of invertebrates took direction in the 1830s when Silliman introduced himself, through a letter, to a British physician, Gideon Mantell. Quite coincidentally, a letter from Mantell to Silliman, introducing himself, passed in the mail at the same time. A friendship was soon forged across the Atlantic, highlighted by numerous gifts and exchanges.

For much of the century the holdings continued to grow through the efforts of Silliman and James D. Dana. Dana, Silliman's son-in-law, assumed the position of Silliman Professor of Natural History in 1850. After Dana graduated from Yale College in 1833, he began an odyssey on the U.S. Exploring Expedition of 1838–1842 as the resident geologist. During the trip Dana acquired many corals, which he later described in a monograph (Dana 1846), that form the backbone of Peabody's Division of Invertebrate Zoology's coral collection. Most of the fossil material that Dana collected resides in the Smithsonian Institute, but the Peabody does have a small collection of Permian fossils from Australia and New Zealand. Dana's works on crustacean and coral systematics, and his influential papers on atoll evolution gained him an international reputation for biological and paleontological studies. Coincidentally, Charles Darwin simultaneously published a series of articles that mirrored Dana's theory of atoll evolution. In 1863, Dana published his *Manual of Geology* and used invertebrate fossils from the “Cabinet” to describe the stratigraphy of North America.

Fresh from his tutelage under Louis Agassiz at Harvard College, Addison E. Verrill subsequently assumed the position of Professor of Zoology at Yale in 1864 and the post of Curator of the Zoology Collections in 1867. Although Verrill's paleontological contributions were minor, he did donate collections from Bermuda, Maine, New Brunswick and Quebec. His most important find may have been a small collection of Anticosti Island fossils that he made with Nathaniel S. Shaler of Harvard College. These Anticosti collections would later provide Schuchert with the inspiration to explore Anticosti Island and the adjacent Mingan Islands with his student William H. Twenhofel.

In 1866, Yale's collections were incorporated into the newly endowed Peabody Museum of Natural History, and through the efforts of Othniel C. Marsh, the collections' size and scope gained international stature. Marsh, who finished his B.A. degree at Yale in 1860, spent two years of post graduate studies in Yale's Sheffield Scientific School and three years at Heidelberg University. While in Germany, Marsh acquired many specimens for the Cabinet of Yale College, including numerous specimens from the famed Solnhofen Limestone (provenance of the fossil bird *Archaeopteryx*).

In the late 19th century, the western interior of the United States was opened for exploration, and expeditions were being organized to map these uncharted terrains. Many of the leaders of expeditions sent collections back to the east coast to the Smithsonian Institution, Academy of Natural Sciences of Philadelphia and Yale College. A few of the party leaders and scientists were students of Dana, and were honored to send fossil material to the Yale College Museum. Later, Dana and Marsh secured collections made by the other Territory Expeditions from the Smithsonian Institution and the burgeoning U.S. Geological Survey.

Yale's First Invertebrate Paleontologist

As the Yale holdings of invertebrate fossils grew, it became obvious to Marsh that he needed a trained professional to maintain the growing collection. Charles E. Beecher, an assistant to James Hall at the New York State Museum, was called to Yale to assist Marsh as a preparator in 1887. Two years later, he completed his dissertation on the enigmatic group Brachiospongidae, and was hired in 1891 as Yale's first invertebrate paleontologist. Beecher's promotion was rapid. He ascended to Professor of Historical Geology in 1897, and on the death of Marsh in 1899, Beecher succeeded him as Curator of the Geological Collections, the informal Director of the Museum.

As a youth in Warren, Pennsylvania, Beecher collected unionid shells and fossils from the Devonian Chemung sandstones and Mississippian Waverly shales. When Beecher was resident in Albany, he continued to build his collection of Recent Mollusca until 1886 and 1887, when he donated 20,000 unionids to the New York State Museum. In his free time, he made day trips to the rich fossil beds of Clarksville and Indian Ladder, in the nearby Helderberg Mountains, and also made extensive collections from the Middle Devonian Hamilton shales near Canandaigua Lake, New York and from the Silurian beds of Waldron, Indiana. Ultimately, Beecher's skill at preparation led him to investigate the biological aspects of brachiopods, corals, and trilobites. Acid etching of the Indian Ladder collections proved to be an excellent method of fossil extraction, often preserving the ornamentation and delicate internal structures. Washing and sieving clays from Waldron and the shales from Canandaigua Lake also provided Beecher with large series of well-preserved, microscopic juvenile and adult invertebrates. After Beecher arrived at Yale, his collection of fossils and recent shells, which continued to grow, was a source of great personal pride.

When Beecher arrived at Yale, his research interests began to mature. Initially interested in brachiopods and trilobites, Beecher sought to apply the "Hyatt methods" to unravel genealogical relations of living and fossil organisms (Beecher and Clarke 1889).

Because of his experience preparing descriptions and illustrations for Hall's series, *Paleontology of New York*, Beecher was able to attack these problems with a well-rounded understanding of invertebrate systematics. Using embryonic, juvenile, and adult stages of the Brachiopoda, Beecher proposed a

classification consisting of four orders based on the brachidium or loop-bearing organ (Beecher 1893), and presented a classification for the trilobites that consisted of three orders, based on juvenile and adult structures (principally the free-cheeks; Beecher 1897). In addition, using acid etchings from the Hamilton shales, he worked out the ontogenetic and phylogenetic relationships of several other minor groups of brachiopods, including Bilobites, Terebratalia and Zygospira, and received great recognition for his study of the loop-bearing Silurian Brachiopoda from Waldron, Indiana. Beecher's interest in developing a classification for trilobites was divested when W. D. Mathews announced the presence of antennae on *Triarthrus*. However, Beecher's great skill at mechanical preparation and his untiring patience, allowed him to work out the minute details of the antennae and ventral anatomy. After Beecher's early death at 48, Percy Raymond continued the research on *Triarthrus*, which led to a monograph that included many of Beecher's original illustrations.

During Beecher's brief tenure at Yale, he supervised nine students, all of whom generated important thesis collections and went on to be leaders in the fields of paleontology and stratigraphy. In 1899, Beecher unconditionally presented his private collection of 100,000 invertebrate fossils to Yale.

"He Mapped the Ancient Seas and Fathomed the Geologic Past"

Charles Schuchert, whose formal education went no further than the sixth grade, was called to Yale shortly after Beecher's death in 1904. Through Schuchert's efforts the size and scope of the collections grew dramatically. From 1904 to his death in 1942, Schuchert attracted many graduate students who worked on stratigraphic and paleontologic projects in unexplored terrains. A pioneer in paleogeography, Schuchert sought worldwide reference collections from all geologic systems and often supported students' research by paying their field expenses, thus insuring that Yale acquired well-documented and studied collections, and thus expanding the University's stratigraphic collections to include fossils from many intervals of geologic time.

Schuchert was passionate about building his personal collection of brachiopods and the Museum's reference collections. Using personal resources, he acquired several noteworthy collections from, among others, George Asherman, Fred Braun, S. S. Buckman, Noah Getz, Darling K. Greger, Anton Handlirsch and Frank Springer. He also enlisted the service of many European authorities (such as Buckman) to send him toponotypic material. This was fortuitous because many of the museums housing the types of these species were destroyed during World War II.

One collection that Schuchert persisted in trying to acquire (for over 20 years) was the Fred Braun Collection of invertebrate fossils and natural curiosities. Braun (1852–1930) was a leading purveyor and private dealer of fossils and antiquities in the United States. His name is often associated with crinoids from the Crawfordsville area of Indiana, as he developed many quarrying techniques for their extraction. However, his collection included more than 100,000 lots and 15,000 species from North America and

Europe. In fact, Braun traveled throughout Europe for three years and collected from many now classic localities in England, France, Germany, Italy and Switzerland. As Braun's health began to fail, he offered his entire collection for sale for \$30,000 to John Clarke of the New York State Museum, but Clarke was unable to raise the funds from the New York State Congress. Several years later, Schuchert was approached by George Ashby, a merchant from Brooklyn who assumed ownership of the Braun Collection after Braun's death in 1918. After failing to acquire funds from Yale University to purchase the Braun Collection, Schuchert negotiated a deal with Ashby. With a business-like mind, which probably stemmed from his days working in his father's furniture factory, Schuchert had a legal contract drafted for this purchase (a practice that Schuchert commonly employed when acquiring a collection).

Schuchert had an extensive network of colleagues who would submit fossils to him for identification, usually exchanging the specimens for the identification and age determination. Occasionally he would contract people to make collections from newly discovered sites (such as Alexander Petrunkevitch). Schuchert's 38 years at Yale yielded more than 1,000 accessions covering 150,000 lots of invertebrate fossils—about half of Peabody's current collection.

From the Wheat Fields of Kansas

Encouraged by William H. Twenhofel to attend graduate school at Yale University, Carl O. Dunbar began a long association with the Peabody Museum. He received his doctorate in 1917, and after a brief stay at the University of Minnesota, returned to Yale in 1920. Initially, Schuchert assigned Dunbar the task of designing the Hall of Invertebrates for the Museum, which was scheduled to move into a new building.

On one particular excursion to the Midwest, Dunbar stopped in Chicago to see the Field Museum of Natural History. At the Field, Dunbar reviewed the display of invertebrate fossils and the layout of exhibits; he continued to do so at many of the leading natural history museums in northeastern North America, formulating his ideas of object presentation and exhibition design. Later, in 1942, when Dunbar became Director of the Peabody Museum, his experience and knowledge of exhibition became a vital element in the evolution of the Museum's dioramas and exhibits.

During Dunbar's early career, he spent nearly every summer in the field collecting for Schuchert, attempting to build a stratigraphic teaching collection and exhibition series of invertebrate fossils while expanding his familiarity with the regional geology of Newfoundland, New York, Kansas, Iowa and Tennessee. The geology of the Appalachians and Maritime Canada would prove to be the subject of many of Dunbar's students' dissertations. His work with Schuchert in Newfoundland culminated with a GSA memoir, *The Stratigraphy of Western Newfoundland*. Although Dunbar's dissertation was a monograph on the Lower Devonian stratigraphy and paleontology of western Tennessee, his first publications showed no particular inclination toward any group of fossils.

As his research interests matured, he became a specialist on two groups, brachiopods and fusulinids. At the urging of Schuchert, Dunbar participated in a venture with G. E. Condra, Director of the Nebraska Geological Survey, describing the Pennsylvanian brachiopods of Nebraska. While working on this project Dunbar became intrigued with fusulinids. In the late 1920s, as he became more involved in problems of world-wide correlation of Late Paleozoic strata and continent evolution, he turned his attention to fusulinids almost exclusively. He and his students (such as P. B. King, R. E. King, G. A. Cooper, N. D. Newell, C. A. Ross, F. F. Sabins, W. W. Tyrell and T. E. Williams) demonstrated how an evolutionary lineage could be applied to stratigraphic problems by developing a worldwide zonation for the Permian using fusuline foraminifera. As the chair of the National Research Council's Committee on Stratigraphy and as a member of International Geological Congresses, Dunbar made collections from many significant stratigraphic sections, expanding Yale's holdings of the cosmopolitan and provincial guide fossils that are used for global and local stratigraphic correlation.

The Cretaceous Seaway Comes Alive

Shortly after World War II ended, Karl M. Waage arrived at Yale and joined Dunbar as Curator. As Dunbar became more involved in administration, Waage filled the teaching void and subsequently became involved in the modernization of the Museum's Hall of Invertebrates along with Willard D. Hartman, Professor in the Biology Department and Curator in Invertebrate Zoology. Together, Waage and Hartman adopted a synoptic approach in the Invertebrate Hall focusing on diversity, ecology and evolution.

Initially, Waage's research took him to the Colorado Front Range to map aluminum deposits for the U.S. Geological Survey. Eventually though, he found his way to the Fox Hills of South Dakota where he pursued his long-standing interest in biostratigraphy and the evolution of scaphitid ammonoids of the Late Cretaceous. In 1959, A. Lee McAlester, whose primary interest was the evolution and paleoecology of Paleozoic bivalves, was appointed Curator, replacing the retiring Dunbar. Waage and McAlester set the course for the 1960s and 1970s; that is, their efforts led to the modernization of Schuchert's "Paleontological Laboratory" and the reorganization of the collections in the new Kline Geology Laboratory. With National Science Foundation funding, they segregated the type specimens from the general research collections into separate secure cabinets.

When Donald C. Rhoads was appointed to the faculty of the Geology and Geophysics Department, Yale became a leading center for molluscan research. David E. Schindel continued the tradition of molluscan research after the departure of McAlester in 1975. Schindel's research focused on microstratigraphy and gastropod evolution. During the Waage–Schindel era, 25 students contributed collections to the Museum.

Waage's career in the Geology Department paralleled those of two professors in the Biology Department who shared his interest in invertebrate paleontology. One was Charles L. Remington, an entomologist

influenced by the paleoentomologist Frank Carpenter while he was a graduate student at Harvard University. Remington developed a course in entomology that included lectures and lab exercises utilizing the fossil insect orders as well as the Recent insect orders. The other was Willard D. Hartman, who received all his education at Yale, culminating with a Ph.D. in 1953. While a student, Hartman enrolled in the year-long course in invertebrate paleontology taught by Dunbar. Later, when Hartman joined the faculty, he continued Dunbar's tradition of using fossils along with Recent specimens to demonstrate many aspects of invertebrate biology and evolution. Hartman also directed many students whose research was paleontological as well as neontological. Aspects of his research focused on the congruency of sclerosponges and stromatoporoids, confirming their identity as sponges (Hartman and Goreau 1970).

The Present is the Key to the Past

When Waage and Rhoads retired and Schindel left for a position at the National Science Foundation in 1986, John Ostrom filled the curatorial void in invertebrate paleontology until 1993. Concurrently, Adolf Seilacher and James Valentine each offered specialty courses in invertebrate paleontology. While Seilacher was at Yale, he was enamored with the Museum's collections and sought a part-time teaching position in the Geology and Geophysics Department; he assumed an adjunct faculty position in 1988. Kuo-Yen Wei, a micropaleontologist studying foraminifera and nannoplankton, was appointed in 1989 as Assistant Professor of Geology; he left in 1994 for a faculty position in Taiwan. Leo Buss, Professor in the Department of Ecology and Evolutionary Biology, served as Acting Curator from 1992 to 2003.

The Division of Invertebrate Paleontology has come full circle in the past century. Charles Beecher (1887–1904) approached invertebrate fossils as a paleobiologist. He was interested in understanding systems and developmental aspects of invertebrate organisms. The current Curator in Invertebrate Paleontology is Derek Briggs, Professor in the Department of Geology and Geophysics, with Professor Sean Rice in the Department of Ecology and Evolutionary Biology as Assistant Curator, and Adolf Seilacher as Adjunct Curator. All three research the genealogical and phylogenetic relations of living and fossils organisms. Although the methods and techniques have changed since the time of Beecher, one could indeed, say that “the present is the key to [understanding] the past.”

Literature Cited

Beecher, C. E. 1893. Revision of the families of loop-bearing Brachiopoda. *Trans. Conn. Acad. Arts. Sci.* v. 9, pp. 376–391, 395–398, 2 pl.

Beecher, C. E. 1887. Outline of a natural classification of Trilobites. *Am. J. Sci.* ser. 4, v. 3, pp. 89–106, 181–207, 3 pl.

Beecher, C. E. and J. M. Clarke. 1889. The development of some Silurian Brachiopoda. *Mem. New York St. Mus.* v. 1, n. 1, 95 pp., 4 tf., 8 pl.

Dana, J. D. 1846. *Zoophytes*. U.S. Exploring Expedition, v. 7. Philadelphia: C. Sherman.

Dana, J. D. 1863. *Manual of Geology: Treating of the principles of the science with special reference to American geological history, for the use of colleges, academies, and schools of science*. Philadelphia: Theodore Bliss and Co.

Schuchert, Charles and C. O. Dunbar. 1933. Stratigraphy of Western Newfoundland. *Mem. Geol. Soc. Amer.* 123 pp., 8 tf., 11 pl.

Skinner, B. J. and B. L. Narendra. 1985. Rummaging through the attic; or, a brief history of the geological sciences at Yale. *Cen. Spec. Vol. Geol Soc. Amer.* n. 1, pp. 355–376, 15 tf., 1 tbl.