BOOKS: PALEOBIOLOGY

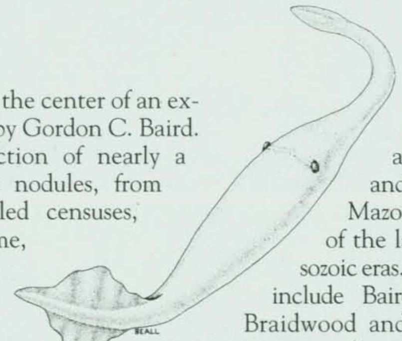
Picture of an Ancient World

Carlton E. Brett

Richardson's Guide to the Fossil Fauna of Mazon Creek. CHARLES W. SHABICA and ANDREW A. HAY, Eds. Northeastern Illinois University, Chicago, 1997. xviii, 308 pp., illus. $101.25. ISBN 0-925065-21-8.

Fossil Lagerstätten, or extraordinary biotas (literally, "mother lodes"), have an importance to paleobiology that is vastly disproportionate to their size and frequency. The exquisitely preserved fossils in siderite (iron carbonate) nodules from the mid-Pennsylvanian (Westphalian) Francis Creek Shale in the vicinity of Mazon Creek, Illinois, are one of the best known examples of these fossil bonanzas. Such rare concatenations of circumstances that lead to the preservation of lightly skeletonized, or even soft, body parts of organisms provide special windows into the geologic past. Thus, the Cambrian Burgess Shale, the Devonian Hunsrück slates, and the Pennsylvanian Mazon Creek deposits provide extraordinary insights into the biology of ancient organisms.

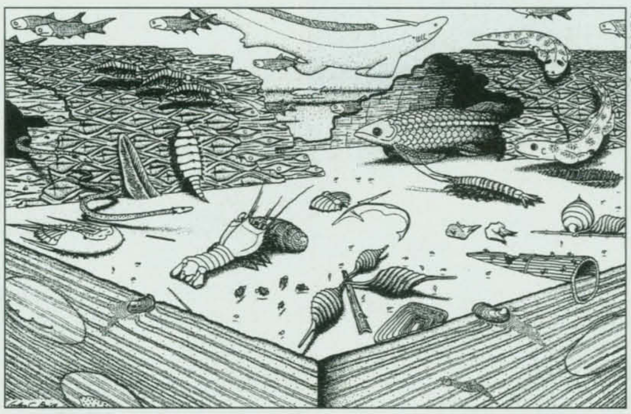
Many of these exceptional fossil deposits, such as the Burgess Shale, are relatively remote, visited by only a handful of specialists, and heavily controlled in terms of specimen collection. However, Mazon Creek is located close to the major urban center of Chicago. Consequently, the bulk of the rare animal fossils has been found by innumerable amateur fossil hunters. A veritable team of amateurs was assembled by the late Gene Richardson beginning in the 1960s and extending through to the time of his death in 1983. These individuals, many of whom spent nearly every weekend in the summer combing the hills of the famed strip mine known as Pit 11 or the banks of Mazon Creek itself, amassed an exceptionally diverse array of fossil organisms. Many of the species bear the latinized names of their discoverers. Moreover, from the late 1970s to the early 1980s, the Mazon Creek area, with its vast strip mines and spoil piles of more than 300 old shaft mines, became the center of an exhaustive survey piloted by Gordon C. Baird. Baird amassed a collection of nearly a quarter-million siderite nodules, from which he made detailed censuses, and, for the first time, mapped the distribution patterns of animal and plant fossils within the area.



Mazon Creek mystery. The enigmatic "Tully monster", *Tullimonstrum gregarium.**

The Mazon Creek Lagerstätten basically tell the tale of two biotas: the Braidwood assemblage of ferns, insects, scorpions, and tetrapods that inhabited nonmarine to brackish water environments, and the somewhat more diverse, brackish to normal marine Essex assemblage dominated by jellyfish ("blobs"), but also containing abundant mollusks, crustaceans of various types, fish, and even remains of previously unseen organisms, such as the famed "Tully monsters."

Richardson's Guide to the Fossil Fauna of Mazon Creek presents an excellent synopsis of decades of work by scientists and amateurs.



Life back then. The animals of the Braidwood assemblage, one of the biotas represented in the Mazon Creek deposits.

The first chapters provide an overview of the history of fossil discoveries as well as of strip and shaft mining for the Colchester coal, which underlies the Francis Creek Shale that contains the fossil-bearing nodules. The chapter by C. T. Ledvina provides a sometimes gripping account of coal mining in northern Illinois, which commenced in the 1840s and continued in varying degrees to the 1970s. This mining activity became an integral part of the fossil discoveries from the Francis Creek Shale. Ironically, it was also the siderite nodules that rendered the roofs of many mines lethally unstable.

A series of chapters mainly authored by Baird gives a fascinating and lucid overview of the Braidwood and Essex faunas, their relative abundance (based on counts of more than 100,000 fossil specimens), the facies and depositional environments, the taphonomy of the fossils, and the broader regional and global significance of Mazon Creek and related biotas of the late Paleozoic and early Mesozoic eras. Highlights of these chapters include Baird's detailed maps of the Braidwood and Essex faunas that show an extraordinarily abrupt jump from the nonmarine to marine biofacies across a 1- to 2-km-wide transition zone, evidence of a unidirectional pathway of transport (seaward) of plant and animal remains, and discussion of the localization or patchiness of invertebrates on the Mazon Creek sea floor. The remains of organisms were evidently buried rapidly in silty sediments that accumulated at rates of up to 1 meter per year and preserved twice-daily tidal rhythms. The exquisite preservation of organism body parts and traces was, paradoxically, the result of their incipient decay. Bicarbonate produced as a by-product of anaerobic decay led to the entombment of the organism remains as nuclei of somewhat lopsided concretions of iron carbonate.

The remaining 25 chapters of the book present a "bestiary" of Mazon Creek organisms. Specialists on each taxonomic group survey collectively the entire spectrum of Mazon Creek fossils (more than 400 species). Each chapter provides a profile of the major features of a taxonomic group, followed by succinct, readable diagnoses, beautifully illustrated with line renderings and photographs of virtually every species (except insects) from *Acantherpestes horridus* to the *Xyloiulus* sp. This portion of the book is a veritable "who's who" of higher animal taxa and reads more like a zoology than a paleontology text. Discussed here are fossil organisms belonging to 14 phyla, more than 33 classes, and about 100 orders; they include forms that are otherwise unknown outside of modern organisms and some bizarre fossils whose affinities remain a mystery. Paleontologists will dimly recall having heard of such groups as the priapulids (phallic worms), echiuroids (serpent worms), chaetognaths (arrow worms), and enteropronuests (hemichordate acorn worms described from the fossil record for the first time in this volume).

Arthropods and all of their major sub-

The author is in the Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY 14627, USA. E-mail: cebh@dbl.cc.rochester.edu

*B. Beall in *The Early Evolution of Metazoa and the Significance of Problematic Taxa*, A. Simonetta and S. Conway Morris, Eds. (Cambridge University Press, Cambridge, 1991), p. 275.

phyla (except trilobites) are particularly well represented in the Mazon Creek nodules by marine, fresh water, and terrestrial forms. One can find expert descriptions and illustrations of arachnids, including the true scorpions, wind scorpions, daddy longlegs, and several extinct groups. Mazon Creek crustaceans include a host of shrimplike forms, stomatopods, isopods, clamlike conchostracans, ostracodes, and goose-neck barnacles. The uniramians, predominantly a terrestrial group since mid-Paleozoic times, are represented in the Mazon Creek nodules by millipedes, centipedes, giant arthropleurids, and, of course, insects (some 150 species). An intriguing chapter by J. Kukalova-Peck outlines a novel hypothesis for the origin of insect wings from the exites, or outer branches, of arthropod limbs. Although certainly controversial, this hypothesis is supported by extraordinary growth series of metamorphosing primitive insects of the so-called *Herdina* group.

Vertebrates are rare, but admirably represented, in the Mazon Creek fauna by a variety of fishes surveyed by David Bardack, who has described from the Mazon Creek specimens the oldest known lampreys and hagfishes, as well as sharks, spiny acanthodians, and palaeoniscids. Amphibians, representing at least four orders, are also present. Included here are exquisite and extremely rare fossils such as *Amphibamus*, a tiny salamander-like fossil so detailed that it even shows partially digested food within the gut. Some of the oldest reptiles are also known from small and extraordinarily rare lizardlike creatures in the Mazon nodules.

The final chapters feature trace fossils and problematica. Herein, one learns of the unusual H and Y organisms, which have spawned much debate in terms of classification. Perhaps no one fossil more epitomizes the mysteries of the Mazon Creek beds than the odd *Tullimonstrum* (Tully monster). Named for farmer and collector Francis Tully, this weird 5- to 10-cm-long organism features a fluked tail, a proboscis with stylets, and a pair of ball-like eyes supported on the ends of transverse bars (looking like the headlamps of an old Model-T Ford). Recently designated as the official state fossil of Illinois, Tully monsters are the stuff of legends. A practical joke perpetrated by Bryan Patterson, and described by Richardson in a famed paper titled "The Dancing Worm of Turkana," involved the hoaxical discovery of a living Tully monster! Despite recent detailed cladistic studies of *Tullimonstrum* and some of the other enigmatic Mazon Creek fossils, the jury is still out on their classification. Studies by Fred Schram in 1991 suggest that Tully monsters may represent either annelid or nemertean worms, whereas those of Bret Beall, performed in the same year, suggest affinities with mollusks or possibly even conodont animals.

Overall, the fossil fauna of Mazon Creek is an exceptional one, and *Richardson's Guide* is itself a "mother lode." This well-produced, finely edited book should be on the shelf of almost every paleontologist and zoologist, as well as on that of anyone else interested in the history of life.

EDUCATION

How to Teach Science

Stephen Arch

Student-Active Science. Models of Innovation in College Science Teaching. ANN P. McNEAL and CHARLENE D'AVANZO, Eds. Saunders College (Harcourt Brace), Fort Worth, TX, 1997. xxvi, 490 pp., illus. Paper, $47, ISBN 0-03-024307-6. From a conference, June 1996.

A persistently recurring concern of the last half of this century has been the reach and adequacy of science education. Sputnik provided a symbolic starting point for a process of curricular revamping already underway in physics and chemistry. Soon to follow was intense examination of biology curricula as well. At least one significant stimulus for these efforts at curricular reform was the perception that pedagogical materials had been left behind in the rapid advance of fundamental knowledge. What we taught had to catch up with what we knew.

Student-Active Science captures the spirit of this process nicely. The contents are the product of a conference sponsored by the National Science Foundation and held at Hampshire College. The gathering was notable for its unexpected composition. The institutions represented were not those historically associated with science education in the liberal arts context nor those known for unusual productiveness in the education of scientists. The programs described at the meeting are fresh and were designed by those who contribute to the volume.

The buzz in this compendium is "student-active learning." As far as I can tell, what this means is almost anything other than the traditional lecture format. And, with a moment's reflection, we can easily recognize it as a dressed-up version of the call for the overturn of the academic patriarchy in the late 1960s. However, this is not to imply that the efforts described here are frivolous.

Many of the approaches are carefully thought out and painstakingly applied. Fortunately, none of the case studies strays into the hot-air zone of one of the introductory essays, in which we are treated to "realities of radical reform," the "3S's of local instantiation," and "reconfiguring temporal constraints." In general, language is used carefully and with a minimum of references to revolution.

Indeed, this is not a document of revolution but a recitation of numerous good-faith efforts to bring students and science together in alternative arenas. I enjoyed browsing through the 20-plus chapters and marveled at the innovation and astonishing hard work that they describe. At the end, however, I was left with three serious concerns.

The first is that each of these cases is a hothouse blossom—lovely, but the product of laborious and concentrated culture, and the generous application of that superb fertilizer, extra funding. One wonders if these hand-raised beauties can flourish on their own in the general curriculum.

The second concern is that, almost uniformly, the student-active curriculum sacrifices content for process. This may be exciting but it is hollow. Science is about things—objects and their relations—that must be known before process can be applied to problems of real interest. Science-fair projects and real science are different things. In the absence of content, process is just another intellectual toy.

And the third concern is that it is difficult to tell if all this effort is really accomplishing much. Program evaluation is addressed in almost every case, but the reliability and sophistication of the efforts vary enormously. In most instances, it is fair to say that no systematic comparative data have been produced. In the one case in which a sufficiently large and unbiased survey was performed, the outcome of the student-active curriculum was not statistically different from that of the traditional mode.

It just may be that counterrevolutionary, old-time lecture hall education is still with us after all these centuries because—although everyone agrees it is a terrible way for students to learn—it's still the best thing anyone has yet invented.

The author is L. N. Ruben Professor of Biology, Reed College, Portland, OR 97202-8199, USA. E-mail: sarch@reed.edu