PALEONTOLOGY

Reading Behavior from the Rocks

Sören Jensen

Adolph Seilacher has made substantial contributions to sedimentology, taphonomy, functional morphology, and more recently to the interpretation of Ediacara-type fossils, but it is with ichnology (the study of trace fossils) that his name is most closely associated. Trace fossils—burrows, tracks, trails, and other evidence of organism-sediment interactions preserved in the rock record—are unique in that they can provide direct evidence of how animals lived millions of years ago, sometimes recording events lasting a few minutes or less. No one has been quite so successful in bringing trace fossils to life as Seilacher, and the long-anticipated *Trace Fossil Analysis*, which grew out of courses he gave at Tübingen University, offers an excellent introduction to his approach.

Trace Fossil Analysis
by Adolf Seilacher
Springer, Berlin, 2007.
240 pp. $69.95, £38.50.
ISBN 9783540472254.

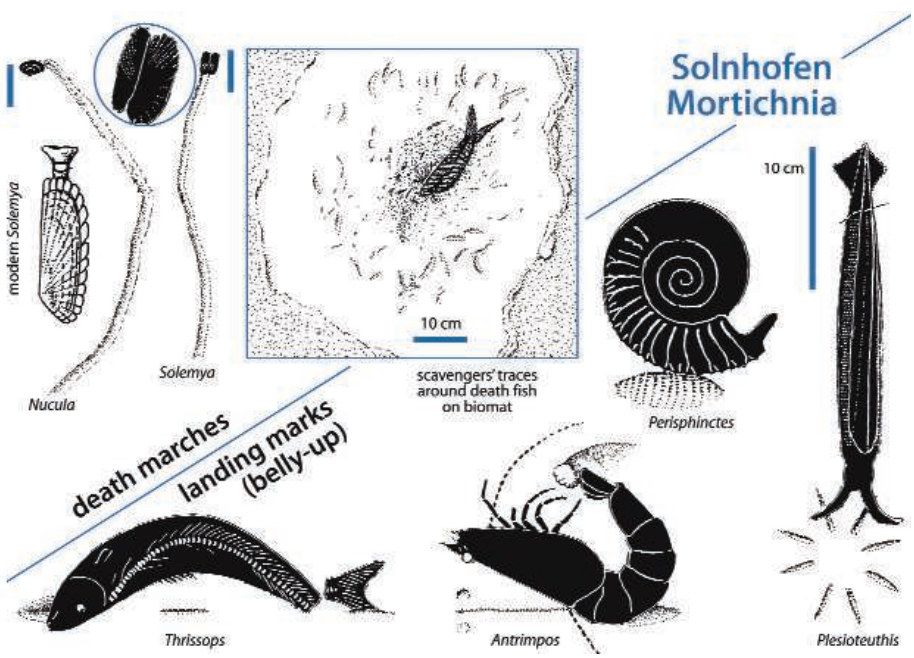
One of the book's plates includes a Sherlock Holmes–like silhouette. This is a reasonable allusion to Seilacher's ability to recreate a scenario of trace producer and behavior on the basis of evidence that may at first seem unpromising—for example, in deducing the "adventures of an Early Cambrian trilobite" from faint scratches on a bedding plane. Seilacher's ichnological publications span half a century and have played a large role in shaping the field. They are characterized by an economic and precise prose, also found in the book, but more than anything else what sets them apart are his drawings. It is therefore fitting that Seilacher structured *Trace Fossil Analysis* around his sketches and diagrams of distinctive and representative ichnogenera. These are arranged in 75 plates, each accompanied by about one page of text ("in the form of extended captions"). The plates and text are grouped into chapters with titles such as "Burrows of Short Bulldozers," "Deep-sea Farmers," and "*Cruziana* Stratigraphy." Through his discussions of informative examples, Seilacher addresses such topics as the application of trace fossils in environmental studies, the study of trilobite trace fossils, and the analysis of deep-sea trace fossils.

Readers already acquainted with Seilacher's publications will find much that is familiar, but the book also contains a number of new illustrations and the text is sprinkled with fresh insights and thoughts. For example, the section examining the evidence for pre-Ediacaran trace fossils includes images and discussion of the 1.7-billion-year-old (1.7-Ga) Sterling biota of western Australia (*1*). Here Seilacher also mentions a new take on the Chorhat "worm burrows" (circa 1.5 Ga) from India. He now suggests foam menisci as an alternative to his earlier interpretation (*2*) that these structures were made by wormlike animals even though they are much older than the presumed origin of metazoans.

In a text as wide-ranging as this, there are of course details with which not everyone will agree. One such instance appears in the chapter "Pseudo-Traces," where Seilacher interprets *Protospiralichnus* from the Early Cambrian of Siberia as a system of concentric microfaults. Having had the opportunity to examine this material in Moscow, I agree with the original interpretation of this structure as a trace fossil resulting from concentrated circling motion (a type of trace fossil commonly known from Cambrian strata as "*Taphrhelminthopsis*" *circularis*).

In the preface, Seilacher explains that the book is not intended to be a comprehensive text on ichnology. Instead, he aims for it to encourage the training of observational skills and of a "method of morphological thinking in terms of processes that could easily be transferred to any other subject matter." Nevertheless, the book will prove an indispensable aid to anyone teaching trace fossils at the university level. To that end, the annotated reference lists occurring at regular intervals throughout the book will be quite helpful. The emphasis is heavily on the trace-making activity of marine invertebrates in soft sediments, but there are also sections on vertebrate traces and on various sedimentary structures that might mistakenly be attributed to the activity of organisms. Seilacher includes the majority of the more common and meaningful ichnogenera, although the naming of trace fossils is not an important theme of the book. (It should also be noted that the criteria for defining ichnotaxa vary widely among different trace fossil workers.) The author does not treat trace fossils on hard substrates, and he refers readers to other sources for discussion on ichnofabrics—the broader look at the sediment structure resulting from bioturbation and an increasingly important branch of trace fossil analysis over the past several decades.

Trace Fossil Analysis will be cherished by ichnologists, even though they already know what to expect. But it will be particularly



Solnhofen stories. Many of the biogenic structures in the Upper Jurassic lithographic limestones from southern Germany record "the last movements (or even postmortem convulsions) of the trace makers preserved together with them."

CREDIT: ADOLF SEILACHER/FROM *TRACE FOSSIL ANALYSIS*

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handy to nonspecialists, who may not have the time, wish, or opportunity to track down Seilacher's original publications (some of which are in hard-to-find volumes). Nonspecialists should, however, keep in mind that such are the communicative powers of Seilacher's drawings and text that one can easily forget that these are interpretations—albeit ingenious ones and probably more often than not correct. This stimulating book documents the wonders that can be achieved by the eye and pen of a fertile mind.

References

1. B. Rasmussen, S. Bengtson, I. R. Fletcher, N. J. McNaughton, *Science* **296**, 1112 (2002).
2. A. Seilacher, P. K. Bose, F. Pflüger, *Science* **282**, 80 (1998).

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SCIENCE POLICY

What Can Science Do for the President?

Gregory A. Good

Consider a tale of two United States presidents and their approaches to science policy advice. The first preferred advisers who honestly disagreed with him and with each other, but who advised him with the best interests of the country at heart. The second preferred advisers who told him what he wanted to hear. The first preferred advisers who were skeptical of technological fixes; the second, advisers who thought technology could answer most challenges. The first preferred advisers with backgrounds in academia; the second, advisers from industry. The first president doubted the advice of ideologues and religionists; the second used their advice to form science policy on issue after issue. The first respected free and open debate; the second formed policy behind closed doors and presented carefully censored reports to the public.

The second U.S. president above is clearly George W. Bush. Readers may be surprised, however, to find that the first is General Dwight David Eisenhower, who in 1957 established the President's Science Advisory Committee (PSAC).

Zuoyue Wang's *In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America* reminds us in rich detail of various ways in which U.S. presidents, especially in the mid- and late 20th century, have obtained advice on science. Wang (a historian at California State Polytechnic University, Pomona) focuses on the period from the Eisenhower administration to that of Richard Nixon but glances backward and forward. Despite these glances, his book is neither a prescription nor a diatribe but rather a careful and nuanced historical analysis. Readers looking for simple answers to where American science policy should go next need to look elsewhere. In Wang's book they will instead find a fully developed and complex historical analysis.

In Sputnik's Shadow
The President's Science Advisory Committee and Cold War America

by Zuoyue Wang

Rutgers University Press, New Brunswick, NJ, 2008. 477 pp. $49.95. ISBN 9780813543314.

Eisenhower created PSAC in the midst of the Cold War, soon after the Soviet Union's October 1957 launch of Sputnik. Eisenhower charged the committee with advising him mainly on science and technology relevant to defense and nuclear weapons—or more to the point, relevant to arms control. Presidents before Eisenhower had sought advice from scientists, through either the National Academy of Sciences or ad hoc arrangements, but PSAC was intended to regularize the process. In addition, during World War II the Office of Scientific Research and Development, the Radiation Lab, and the Manhattan Project had fundamentally altered the culture of physics in the United States.

A recurrent theme throughout the book concerns the dual nature of science in American politics: science in policy versus policy for science. This seemingly cryptic phrase has a simple, direct meaning. Presidents realize that to forge policies regarding defense, energy, etc., government needs competent advice about science and technology, and PSAC provided such expert advice. Scientists have another interest, namely the funding and promotion of their research and their institutions. As Wang encapsulates the distinction: what can science do for the government versus what can government do for science? PSAC scientists recognized that these two perspectives are inextricably linked, and committee members often linked the country's policy interests with the self-interest of their science. Aware of the distinction, Wang narrates many efforts of PSAC to "blur the boundary."

Wang also emphasizes the balance that PSAC scientists tried to maintain between technological enthusiasm and technological skepticism. They insistently included technological limitations, environmental and social risks, and policy implications in their analyses—as in those regarding nuclear-powered airplanes, the supersonic transport, antiballistic missiles (ABM), and pesticide use. Wang notes "theirs was not an argument against technology, but one for appropriate technology, for a broadened concept of technological rationality that encouraged technological development not for its own sake but for its benefits in achieving social, political, cultural, and economic goals in a democratic society."

The demise of PSAC came during the Nixon years, in large part through tensions magnified by the ABM debate. Nixon first distanced himself from his science adviser, Lee DuBridge, and ultimately, just weeks after the 1972 election, decided to dissolve the Office of Science and Technology and with it the committee. The decision then took six months to be finalized. As Wang suggests, PSAC's closing occurred at least in part because Nixon did not want the broader technological rationality that previous presidents had favored. He resented disagreement from his advisers.

Wang provides the scientific community and policy-makers with a most timely reminder of the positive roles that scientists can play in an open society. We can only hope that Barack Obama will turn a page and not let ideology, personal beliefs, or party politics interfere with his seeking of sound science advisement. *In Sputnik's Shadow* offers a history that both policy-makers and scientists should heed well.

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After Sputnik. Lee DuBridge (second from the left) and Vice President Richard Nixon hold a model of Explorer 1 at Caltech's Jet Propulsion Laboratory (1958). DuBridge would later serve as Nixon's science adviser to the president.

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