

OCEANOGRAPHY

First Views of the Depths

William A. Berggren

Portsmouth, England, provides many obvious reminders of Britain's rich maritime heritage, including the Royal Naval Museum; the Victorian navy's crown jewel, HMS *Warrior*; Admiral Nelson's flagship, HMS *Victory*; and Henry VIII's favorite warship, the *Mary Rose*. But visitors may overlook another link between the city and naval history, the December 1872 departure of HMS *Challenger* on her 3.5-year circumnavigation of the globe for "the primary purpose of gathering scientific information." In *The Silent Landscape*, Richard Corfield presents an engaging account of this epochal voyage, which was to forever change our view of the nature and history of the oceans.

To weave his intriguing tale, Corfield (an Earth scientist and writer based at Oxford University) draws on the voyage's 50-volume scientific report and the diaries and memoirs of the ship's crew and researchers. He sketches the science-politics that led, in under two years, to the approval, funding, and staffing of the expedition. Of the voyage's several objectives, Corfield suggests that the most important may have been to find support for Darwin's theory of descent with modification by proving his idea that living fossils inhabit the ocean depths. This goal may help explain why the *Challenger* expedition had the same significance for the English Victorians as the Apollo moon landings had for Americans a century later.

Perhaps the most enjoyable and rewarding aspect of this slim volume is the deft manner in which Corfield alternates between the expedition's many original discoveries and our present understanding of the same phenomena. (The latter relies heavily on findings from the Deep Sea Drilling Project, 1968–1983, which used the vessel *Glomar Challenger*, and the subsequent Ocean Drilling Program.) For example, dredging—a tedious drudgery that eventually led to the desertion of a quarter of the original 269 crew members—quickly revealed the presence of a plethora of

life forms well below the 300-fathom (approximately 550-m) limit to life postulated by Edward Forbes, a finding that permanently laid to rest the "azoic" theory of a barren, lifeless seafloor. After discussing this discovery, Corfield presents a condensed history of oceanographic instrumentation: thermometers, water flasks, dredges and beam trawls for collecting seafloor sediments and biota, and a succession of devices for determining ocean depths (from weighted piano wire to modern multibeam sonar).

Corfield follows the course of the voyage to Gibraltar; back and forth across the North Atlantic; south and east to Capetown, Antarctic waters, Australia, and New Zealand; north to Japan; across the Pacific to Hawaii and Chile; and home via the Straits of Magellan. He takes up various topics as they are raised (or approached) by the *Challenger*'s findings. Three seminal discoveries came from the traverse of the North Atlantic: The first was manganese nodules, which are now known to form extensive deposits at depths below 3 km. The second was the Mid-Atlantic Plateau (now Ridge), which elicits a felicitous digression by Corfield on plate tectonics and continental drift. The third was the shallow-to-deep ordering of "pteropod ooze," "*Globigerina* ooze," and red clay. Although the researchers could not explain this pattern, they had documented the calcium carbonate compensation depth and the depth-controlled role of carbonate dissolution in the geographic distribution of sedimentary facies on the seafloor. Charles Wyville Thomson, the expedition's chief scientist, believed that the *Globigerina* ooze formed in situ. But by the end of the cruise, the young naturalist John Murray had convinced him that globigerinids live in the surface waters, their shells sinking to the bottom after they

die. Having introduced the reader to planktonic foraminifera, Corfield then briefly reviews their use in paleoceanographic and paleoclimatic studies (from the observations of Wolfgang Schott in the late 1920s to the CLIMAP project of the 1970s and 1980s).

At several points along the journey, Corfield digresses from the ship's course. Although *Challenger* did not enter the Mediterranean, the author recounts the desiccation of that sea 5.5 million years ago (a 1970 discovery of *Glomar Challenger*). Wyville Thomson and his colleagues were turned back by icebergs after reaching 61°S, but Corfield continues south to discuss the vast (10,000 km²) Lake Vostok, buried under 4 km of ice in Antarctica. From there, he proceeds to the search for possible life in the ice-covered ocean of Europa, one of Jupiter's moons. Later, the onychophoran *Peripatus* that the expedition collected in New Zealand provides the author with a link to the Cambrian Burgess Shale fauna.

After describing the *Challenger*'s discovery of the deepest part of the world's ocean (now known as the Challenger Deep in the Mariana Trench), Corfield recounts the exploits of William Beebe's bathysphere and Auguste and Jacques Piccard's deep-submergence vehicle *Trieste*. As he approaches the end of the voyage, the author discusses the French-American FAMOUS

project of the 1970s and its discovery of hot vents along midocean ridges. He also summarizes the story of the Mohole Project and its eventual evolution into the Deep Sea Drilling Project (which early in its history proved beyond doubt the reality of continental drift and seafloor spreading, the framework of plate tectonics).

Corfield concludes with a short summary of the postreturn lives of the expedition's main figures. After Wyville Thomson's early death, John Murray edited the entire official

report of the scientific results. Murray paid considerable sums from his own fortune to see the report's completion. This may have been appropriate, as much of his money came from the guano deposits he had noticed on Christmas Island in the Moluccas. Before his death in 1914, his company had paid royalties to the British government that sur-

The Silent Landscape
The Scientific Voyage of HMS Challenger
 by Richard Corfield
 Joseph Henry Press (National Academies Press), Washington, DC, 2003. 299 pp. \$24.95, C\$34.95. ISBN 0-309-08904-2.



The planktonic foraminiferan *Globigerina bulloides*.

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passed the entire cost of the *Challenger* expedition. The sad fate of the ship itself is one of the many interesting topics that the author covers on his Web site, www.richardcorfield.com/pages/books/silent_landscape.htm.

The meticulously edited text shows careful attention to detail. Scientific gaffes are rare, although this stratigrapher was pained by two: the Pleistocene Epoch is described as “broadly the last 2.6 million years” (for over 20 years, its base has been placed at 1.8 million years ago), and poor phrasing elsewhere obscures the distinction between the Cenozoic era and the Tertiary period. I heartily recommend *The Silent Landscape* to all persons, professional and lay alike, who have an interest in maritime history or the Earth or ocean sciences—or who simply possess an abiding intellectual curiosity.

BEHAVIORAL ECOLOGY

Culture Among Sperm Whales?

Ian L. Boyd

The strategies marine mammals use to exploit oceanic resources have evolved through natural selection for different phenotypes. Through cultural evolution, people have developed a parallel set of specialized fishing strategies, each of which demands different infrastructure and knowledge. In *Sperm Whales: Social Evolution in the Oceans*, Hal Whitehead argues that culture also forms part of the repertoire of evolutionary mechanisms in cetaceans. Sperm whales (*Physeter macrocephalus*) exploit the massive resources of squid that inhabit depths between 200 and 1000 m. Have the unusual challenges of exploiting this resource, which has as yet defeated human ingenuity, led to circumstances in which a culture can evolve?

The book provides us with an intriguing insight into the biology of the sperm whale, an animal that has been steeped in mystery because of its strange appearance, its complex social structure, and the remoteness of its deep ocean habitats. Mystery

can lead to romantic and biologically illogical interpretations of life histories, of which sperm whales have attracted more than their fair share. Whitehead, an ecologist

at Dalhousie University, brings a refreshingly reasoned approach to the subject, and the book begins to undermine the mythology of sperm whale life history and social structure. Grounded on a theoretical framework, its thorough examination of the facts illustrates the value of hypothesis generation and testing.

There is little doubt that sperm whales are important ecological components of the world's oceans. Whitehead calculates that their global population, even in its currently depleted state (following high levels of whaling through the 1960s and 1970s), probably consumes a greater mass of marine resources than the world's fisheries. One of the book's central purposes is to explore what makes the sperm whale so successful.

Whitehead begins by providing essential information about the animal and its environment. Early chapters include an examination of the function of the spermaceti organ (most probably, he concludes, a large, powerful sonar for tracking squid), a discussion of the extremely heterogeneous distribution of sperm whale food, and an analysis of these whales' slow population dynamics. In the chapters on behavior and vocalizations and on sperm whale societies, the book moves into more controversial areas. Evidence of social cohesion in sperm whale populations abounds, and Whitehead develops these ideas by presenting data gathered during a demanding series of studies. Boxes embedded in the main

text and an appendix expand his descriptions of methods and his analyses of some controversies involved in interpreting data. The author makes some powerful arguments about the cohesiveness and composition of social groups, their role in anti-predator defense, and their apparent role in coordinated foraging. However, as Whitehead points out, the data—in spite of the massive effort to collect them—represent a short glimpse into the lives of these animals. As a result, they are weak in some critical areas.

The book's central thesis is that sperm whales have evolved a social system that could be described as cultural. Whitehead is careful to define what he means by culture in terms of social learning and the consequences it has for evolution. Though he uses the available information about vocalization and movement patterns very effectively, he is confronted by the problem that the data really are not sufficiently robust to lead to firm conclusions. On the basis of what appear to be consistent intergroup differences in behavior that he considers likely to result

from intergenerational transfer of knowledge, he argues strongly for the existence of culture in sperm whales. But he draws his conclusions from very small sample sizes and uses uncalibrated surrogates for some of the main variables (e.g., defecation rates to measure foraging success). Consequently, the arguments for the fitness advantages associated with such a highly evolved social system are not well supported.

Some cetacean biologists favor a more conventional explanation for the social structure, one based on genetically inherited traits. But in presenting his case, Whitehead has made an important contribution to the fields of social learning, comparative animal behavior, behavioral ecology, and marine ecology. He illuminates the life history of an animal that, by most standards, is almost impossible to study. He makes skillful use of parallel examples from other, more easily studied species (particularly elephants), but he understates the difficulty of observing

Image not available for online use.

Defending with tails. The Marguerite formation is a response to a killer whale attack.

sperm whales and the huge uncertainties that result. His analyses show ingenuity and perseverance, and it is all too easy to resort to armchair criticism and neglect the enormous advances in knowledge these studies represent. Nonetheless, where data are inconclusive, he often resolves conflicting interpretations by placing conclusions in the context of his own personal views.

Superficially a dispassionate and objective view of sperm whale biology, the book in places strays from this path. This tendency culminates in concluding remarks about sperm whales possibly having the capacity to handle abstract concepts and even religion—ideas that reflect a fertile imagination rather than rigor. There is a danger that biologists who become closely and emotionally associated with their study animals begin to imbue them with a sense of self. There is much in *Sperm Whales* to applaud, and the work will justifiably take its place in a long series of excellent monographs from its publisher. All the same, I remain unconvinced that there is evidence for cultural evolution in sperm whales.

Sperm Whales Social Evolution in the Ocean by Hal Whitehead

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