PERCEPTIONS OF SCIENCE

Deep-Sea Biology: Living with the Endless Frontier

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In the summer of 1833, Edward Forbes set sail from his home on the Isle of Man for Norway, where he and a friend intended to do some "botanizing" and rock-collecting. Years later he would become known as the father of deep-sea biology; but then, he was just a budding naturalist, 18 years of age, loose of limb, long of hair, and very eager. In Bergen, Forbes checked into a rooming house and found that he did not even need to go outside to start exploring [(*1*), p. viii]:

> Amongst my Bergen treasures I especially value a quantity of sand, which I found in a spitting box in my lodgings. As yet I have only examined a small portion; but I expect many minute curiosities in the shell way from it. Several species hitherto only found in Britain have rewarded my search already.

To some 19th century explorers, the deep was a little too endless for comfort.

Natural history was all the rage at the time. The beaches of Britain were being combed for shells and seaweeds by legions of passionate amateurs. Forbes made himself into something more: by 1843, 10 years after his trip to Norway, he had published learned treatises on starfish and mollusks. In May of that year he became Professor of Botany at Kings College in London. "Much, very much remains to be done," he said in his inaugural lecture, "and there is no fresher field for original research and the development of a grand philosophy than that of Natural History" [(*1*), p. xi].

Yet, 3 months later, this open-minded, ambitious young man told a meeting of the British Association for the Advancement of Science that there was probably nothing alive to study on the whole of the deep-sea floor: below 300 fathoms lay a vast "azoic zone." Having marveled at the contents of a spittoonful of sand, Forbes was ready to dismiss more than half the planet as uninteresting.

Forbes and his followers (who were more set on his hypothesis than he was) had a plausible argument. How could anything live in the freezing, crushing dark of the deep sea? Forbes even had some pioneering data. During more than a year in the eastern Mediterranean on H.M.S. *Beacon*, a Royal Navy survey ship, he had dragged a small dredge along the bottom at a hundred different places. Going as deep as 230 fathoms, he noticed that the number of organisms he caught got smaller the deeper he dredged. Extrapolating that trend, he arrived at a "zero of animal life" at 300 fathoms, and extrapolating from the tiny Aegean to the whole world ocean, whose average depth is around ten times the depth reached by Forbes, he arrived at a general principle. Forbes was interested in general principles. The "grand philosophy" he was after was no less than an explanation for the distribution of all life on Earth. So he extrapolated.

We now know that the extrapolation was horribly wrong—Forbes's dredge let most organisms escape, and the Aegean is much poorer in sea-floor life than most areas of the deep ocean—but there is no denying that it was fruitful. By claiming that deep-sea biology did not exist, Forbes helped bring it into existence. The azoic zone hypothesis was an irresistible challenge. It was disproved by a series of three British expeditions, on ships called *Lightning*, *Porcupine*, and *Challenger*. They were all led by the same man, Charles Wyville Thomson, who believed, even before he had collected proof, that the deep-sea floor was "the land of promise for the naturalist, the only remaining region where there were endless novelties of extraordinary interest ready to hand" (*2*).

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H.M.S. Challenger.

Circumnavigating the globe from 1872 to 1876, *Challenger* found animal life on the sea floor everywhere she looked. When Thomson published an account of the voyage a year after getting back, his first conclusion was succinct and historic: "Animal life is present on the bottom of the ocean at all depths" (*3*). Yet in his third conclusion, he fell into the same trap as Forbes:

> there is every reason to believe that the fauna of deep water is confined principally to two belts, one at and near the surface and the other on and near the bottom; leaving an intermediate zone in which larger animals, vertebrate and invertebrate, are nearly or entirely absent.

In other words, Thomson had merely moved the azoic zone to a new location. There it stayed for another few years, until nets were invented that could reliably bring back samples from intermediate depths and show that it was very much alive. More than a century after *Challenger*, the intermediate depths remain an unexplored frontier, hundreds of millions of cubic miles of living space that we have barely looked at and do not understand.

Living with our own smallness, which the ocean constantly reminds us of, can be uncomfortable. As Thomas Huxley, another great 19th century biologist, once put it: "Life seems terribly foreshortened as [old men] look back and the mountain they set themselves to climb in youth turns out to be a mere spur of immeasurably higher ranges" (*4*). Faced with the vastness of the world, even scientists of the caliber of Forbes and Thomson sometimes yield to the temptation to cut it down to size—the better to leave an enduring mark on it.

Huxley, incidentally, also lost a great hypothesis to *Challenger* observations. After noticing a mysterious slime in a few jars of Atlantic bottom mud preserved in alcohol, he had proposed that the sea floor might be covered with a quivering mass of living primordial protoplasm, which he named *Bathybius*. It turned out to be a precipitate of calcium sulfate.

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References

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2. C. W. Thomson, *The Depths of the Sea* (Macmillan, London, 1873), p. 49.
3. C. W. Thomson, quoted in E. Linklater, *The Voyage of the Challenger* (John Murray Ltd., London, 1972), p. 276.
4. T. H. Huxley, *Autobiography and Selected Essays*, A. L. F. Snell, Ed. (Houghton Mifflin, Boston, 1909); http://human-nature.com/darwin/huxley/autobiography.html.