4

Crossing the path of HMS *Challenger*

> We were daily accompanied by many of the great albatrosses and the large dark petrels, and still more numerously by several varieties of speckled Cape pigeons. These birds added a degree of cheerfulness to our solitary wanderings, contrasting strongly with the dreary and unvarying stillness we experienced while passing through the equatorial regions, where not a seabird is to be seen …
>
> William Spry, *The Cruise of Her Majesty's Ship 'Challenger'; Voyages over Many Seas, Scenes in Many Lands*, 1877, p.123.

The diary

Saturday 31 December 1972

Site 265 Site 2 (53°32.45′S; 109°56.74′E) Water depth 3,582 m.

Occupied 30–31 December 1972

I stayed up to watch us come on site around midnight. How strange it is to be making such a concerted effort to arrive, watching depth recorders, seismic records and the satellite navigation—all directed to the place we are steaming for, then to have it all come together and actually arrive, with a distinct feeling of relief, at this unmarked spot in an endless grey ocean. We're here! We're here! No crowds, no road signs, no station platforms. But we're here! The sea is flat and grey, and there are snowflakes in the air.

The voyage of HMS *Challenger*

It was by sheer coincidence that we left our starting port of Fremantle just 100 years—minus one day—since our namesake vessel, the HMS *Challenger,* began its four-year voyage traversing all the world's major oceans. Theirs was the first cruise dedicated wholly to the scientific investigation of the sea. When the *Glomar Challenger* crossed its track, HMS *Challenger* had been on track from the 'neighbourhood of the Great Southern Ice Barrier', as instructed by the Royal Society, to its next port—Melbourne. They had taken dredge samples in the icy seas close to the continent.

Figure 4.1. The *H.M.S. Challenger in the Southern Ocean*. Watercolour by Sub-Lieutenant Herbert Swire.

Source: Courtesy of State Library of Victoria.

The genesis of the *Challenger* expedition, and its slow but meticulous progress through the world's oceans, has been well described in a popular account by geologist Richard Corfield in *The Silent Landscape: In the Wake of HMS Challenger* published in 2003 that deals with both history and science. Eric Linklater's earlier (1974) volume *The Voyage of the Challenger* is another account, particularly rich in illustrations.

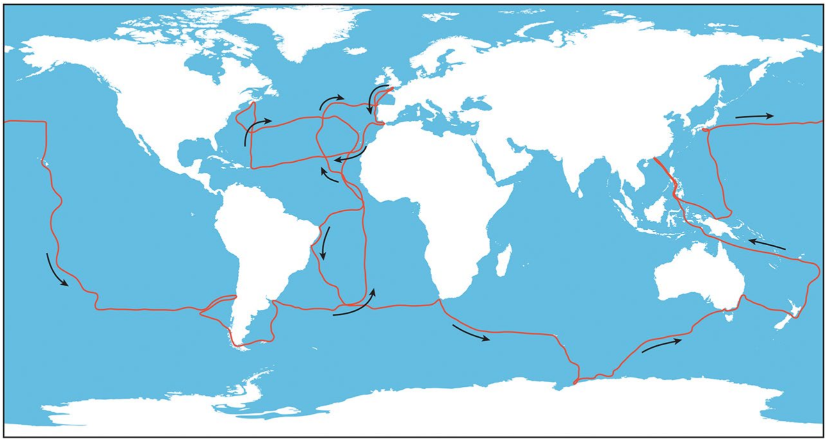

Figure 4.2. Route of HMS *Challenger*.
Source: Drafted by Clive Hilliker from a variety of sources.

The expedition was a scientific circumnavigation of the world—lasting almost four years and traversing 68,900 miles (110,800 km or 127,600 nautical miles). It left Portsmouth on 21 December 1872 and returned in May 1876. The complex route of the *Challenger* (Figure 4.2) shows the vessel starting from Portsmouth, sailing south to Lisbon and Gibraltar, then crossing the Atlantic to Bermuda, back again across the Atlantic to the African coast, then to the Cape of Good Hope and south to the Antarctic margin. From there the vessel voyaged in a northeasterly direction to Australia and New Zealand, followed by complex routes in the south and north Pacific, eventually passing through the straits of Magellan between Tierra del Fuego and the tip of South America to arrive in the Falkland Islands. Headed for home, northwards in the Atlantic they followed the line of the Mid-Atlantic Ridge, sailing past the Azores and back to Portsmouth.

Challenger was a three-masted, steam-powered corvette, aptly described by Richard Corfield (2003) as 'a hybrid straddling the years of steam and sail'. She had been built for the Royal Navy in Woolwich in 1858 essentially as a ship for war and diplomatic purposes. Readying the vessel to explore the sea required major changes. Most of the 17 original guns were removed to make way for laboratories and the storage of samples and equipment; a platform was constructed where dredging equipment was to be operated. Both hemp—ordered from Italy—and steel piano wire were used for dredging and a steam engine assisted in pulling up dredged samples. To accommodate the samples collected, a purposebuilt laboratory was filled with instruments, microscopes and alcohol-filled specimen jars. William Spry, a sub-lieutenant in the engine room, described the chemical laboratory thus:

> Here were ranged retorts, stills, tubes of all sizes, hydrometers, thermometers, blow-pipes—in fact all the usual paraphernalia found in laboratories; chemicals in drawers, and jars in racks; all secured from accident from the rolling of the ship by many ingenious devices. (Spry 1877, pp.8–9)

The *Challenger* expedition marked a fresh interest in the sea, stimulated by the enthusiasm of two scientists, Charles Wyville Thomson and William Carpenter. Wyville Thomson was Professor of Natural History at the University of Edinburgh, an institution with a long history of involvement with the natural sciences, which claims Charles Darwin as a distinguished alumnus. A former professor was Edward Forbes, whose ideas were influential in developing a cruise such as the *Challenger*'s. Forbes believed that the deep sea below 300 fathoms (550 metres) was barren of any kind of life. This he called the 'azoic' region. The theory caught the public imagination, but Wyville Thomson was not convinced. He had seen life forms in dredge samples from deep Norwegian fjords, and barnacles that adhered to deep cables in the Mediterranean. These samples from the deep oceans spurred him to investigate Forbes's theory in a more systematic way.

Carpenter was a vice-president of the Royal Society, a position of considerable influence in the scientific world of the time. He was able to persuade the Admiralty to let Wyville Thomson have use of a small steam frigate to dredge in the North Sea during the summer of 1868. In that cruise, living organisms were brought up from depths of more than 600 fathoms. Further short cruises followed, with less spectacular results. They nonetheless showed how valuable dredgings and soundings were in exploring the deep oceans. As a result the Royal Society approved a larger and better-equipped expedition—the voyage of HMS *Challenger.* The expedition was funded and by modern standards organised with admirable speed. Wyville Thomson and Carpenter requested funding in 1871 and approval was granted in April 1872. The vessel underwent a complete refit in the naval dockyard at Sheerness. It then sailed—not without incident—to Portsmouth for departure on 21 December.

The Royal Society agreed on objectives for the cruise. These included: investigating the physical conditions of the deep sea in the great ocean basins as far as the neighbourhood of the Southern Great Ice Barrier (now the Ross Ice Shelf); determining the nature and chemical composition of seawater at various depths; examining the physical and chemical character of deep sea sediments and their sources; and, importantly, investigating the distribution of organic life at different depths in the oceans.

Personnel; scientists and ship's crew

The total ship's complement was 269 souls. In such a small ship this meant crowding and discomfort for her crew, a factor that was to cause many desertions. The ship was captained, at least for about half the venture, by George Nares, in later years a distinguished explorer of the Arctic. He commanded some 20 naval officers. Wyville Thomson himself managed the science, with a staff of six. There was the naturalist Henry Nottidge Moseley, scientist and explorer, who keenly documented the events of the voyage. The popularity of his account *Notes by a Naturalist on the 'Challenger'*, first published in 1879, had a public appeal that approached Darwin's *Journal of Researches into the Geology and Natural History of the Various Countries Visited by H.M.S. Beagle*, and ran to many editions. The Swiss-born artist John James Wild acted as secretary to Wyville Thomson, but was also official artist for the voyage, providing illustrations for some of the scientific reports, and drawing the terrain of islands they encountered. After the voyage, Wild emigrated to Australia, where, after struggling to support himself teaching languages, he contributed illustrations of great accuracy and beauty to the *Prodromus of the Zoology of Victoria.*

There was John Murray, the energetic Scot who was ultimately responsible for the publication of the *Challenger* reports. With more than 70 reports eventually produced, overseeing this massive documentation was a major achievement. Murray, as well as managing and editing many of the reports, also supported their publication with some of his own funding, part of this financial input coming from his investment in guano mining from Christmas Island in the Indian Ocean. A small specimen sent to him after the voyage by a shipmate on the *Challenger* sparked his interest in this. The specimen was a piece of reef coral in which was embedded a pebble of pure phosphate of lime. Murray subsequently persuaded the

British Government to annex the island; this meant he was able to benefit from leases to mine the phosphate. In later years he took some pleasure in pointing out that the returns to the British Government, in the form of royalties and taxes from phosphate mining, had, by 1910, far exceeded the cost to the country of the entire *Challenger* expedition.

On board the *Challenger*, Murray was the naturalist and technician, involved both in making observations and in improving the instruments. Importantly, he took it upon himself to describe the sediments of the sea floor, establishing that the organisms that made up the oozes—whether they are limy or siliceous—had ultimately been dwellers at the sea surface. His report on these, entitled *Deep-Sea Deposits*, published together with the Belgian scientist Abbé Alphonse Renard, gave us the first comprehensive view of the origins and extent of this superficial cover of the sea bottom. After the voyage Murray was appointed to the *Challenger* office in Edinburgh. From there he could guide and oversee the publication of the reports from a diversity of scientific specialists. It was Murray's lifelong passion for the sea that led to his being referred to as 'the father of oceanography'—indeed, it was he who first coined the name of that discipline.

Figure 4.3 Dried foraminiferal (*Globigerina*) oozes collected by HMS *Challenger*.

Source: Photograph courtesy of the Bristol Museum, UK.

The expedition's chemist was John Young Buchanan, a shy but practical man, capable of making his own glassware—a useful skill for replacing breakages on a rolling ship. The young German zoologist Von Willemoes Suhm, recruited by Wyville Thomson in Edinburgh, was the last to join the *Challenger*'s scientific team.

In keeping records of the voyage, and in keeping the events of the voyage in the public eye, the ship's officers were as important as the scientists—perhaps more so. In this group were Sub-Lieutenant Lord George Campbell, Sub-Lieutenant Herbert Swire and Sub-Lieutenant William Spry, Engineer. It was these naval gentlemen who dubbed the somewhat earnest scientific staff 'the philosophers'. All of these officers published their personal narratives of the voyage—sometimes, as for Lord George Campbell, this was simply a confessed 'tidying' of the daily log. All, however, are filled with descriptions of daily life—some with the boredom of routine tasks; in other cases with vivid descriptions of islands visited, and with jokes about the scientific staff. The officers' naval training had also equipped them with the drawing skills with which they enlivened their accounts—Herbert Swire's volume in particular is embellished with his vivid and accomplished drawings and watercolours (Figure 4.1).

Scientists and officers were not the only ones to tell the story of the *Challenger*'s voyage. Below decks the assistant steward Joe Matkin, a youth with sharp perception, an extraordinary literary bent and a good education, sent lively letters home to his family in which he revealed much of the day-to-day operations of the vessel including the relationships between 'scientifics' and crew, and details of the ports of call. He showed as well an interest in, and a keenness to understand the science of the expedition.

In a pioneering development for marine exploration, the *Challenger* was equipped to take photographs. Just who performed the role of an official photographer is uncertain, and neither is there any record of the cameras used. One of the reasons that this aspect of record-keeping on board remains obscure is that at least two of the designated photographers jumped ship during the voyage—one, Caleb Newbold, listed as a corporal in the Royal Engineers, deserted at Cape Town, hence missed out on photographing the icebergs of the Southern Ocean. While we have little knowledge of the cameras used, there are records of a darkroom being set up at the start of the cruise and records of orders for some of the developing and printing materials used, such as albuminised paper, a variety of chemicals, and glass plates.

A catalogue of the photographs created during the *Challenger* expedition, published by English historian Rosamunde Codling in 1997, suggests that there are just eight images of icebergs. These—mounted in four pairs—are the first photographic images of Southern Ocean or near-Antarctic icebergs. They illustrate the formal narrative of the voyage published by Wyville Thomson and John Murray in 1885. Given the popularity amongst the general public of images of the Arctic, perhaps sparked by the search for Sir John Franklin and the Northwest Passage, this seems a rather meagre record. But photography might have been difficult by the very nature of the voyage, with deck space cluttered by trawling and dredging equipment, and little room to set up cameras. And the pitching of the vessel would not have made focusing easy.

Most of the photographs of icebergs were taken during the period 11–26 February 1874, the period when the vessel entered Antarctic waters and dredged diatom oozes. This was the interval when encounters with icebergs became life threatening. The artist J.J. Wild made a number of drawings of icebergs during this time, and it has been suggested that he may have used photographs as the basis of some of the iceberg drawings in his own account of the voyage—*At Anchor: A Narrative of Experiences Afloat and Ashore during the Voyage of H.M.S. Challenger, from 1872 to 1876*, published in 1878 after the end of the voyage. Interestingly, some of the photographs were traded among members of the crew, serving as a convenient 'on the spot' record of the voyage and perhaps enlivening their letters home.

Other visual records of the *Challenger* voyage come from unusual sources. In 1968 a small volume of exquisite watercolour paintings of ports of call on the voyage was discovered in an antique shop in Boston. Research showed these vivid little paintings to be the work of one Benjamin Shephard, a cooper on the *Challenger*, who had stayed with the expedition throughout its four-year voyage. The paintings, just 15 by 22 centimetres in size, show many of the ports and islands where the *Challenger*'s crew landed. Some 25 images are preserved, each surrounded by a drawn girdle with titles and localities. As far as is known, Shephard died in Australia after the voyage.

Images of events in the voyage, this time in pen and ink, but similarly surrounded by a belted girdle, were made by another workman-artist on HMS *Challenger.* These were produced by Able Seaman J.J. Arthur, a ship's painter, about whom we know little. These are held in the State Library of Victoria (Figure 4.4).

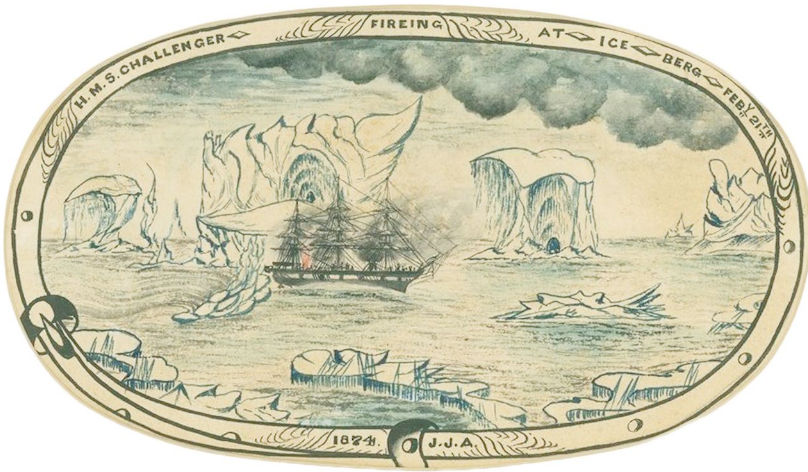

Figure 4.4. *HMS Challenger firing at the ice berg, Feby. 21*. Drawing on cardboard by J.J. Arthur.

Source: Courtesy of State Library of Victoria.

The scientific reports of the *Challenger* expedition would fill a library on their own. Not only did members of the expedition contribute them but more specialist reports were commissioned after the voyage. They were based on samples distributed to a wide range of international experts after the end of the voyage. In all, the reports filled more than 70 volumes, and were some 20 years in the making. They covered numerous specialist volumes; there were 62 on the zoology, ranging from fishes to corals, starfish, green turtles, birds (including penguins), and the tiny microrganisms present in the water. There were further separate reports on the temperature and chemistry of seawater, and on meteorological and magnetic observations. Just two reports on the botany were produced; they cover accounts of the microscopic diatoms, and accounts of land and marine plants from Subantarctic islands such as Kerguelen, the Crozets and Prince Edward islands. Many of the plants they record were species described by the young Joseph Hooker on the earlier voyages of the *Erebus* and *Terror*. The dramatic illustrations of life forms from the expedition and the carefully curated collections from the *Challenger* are mostly held by the British Museum, are accessible online and remain available to the scientific community.

Glomar Challenger crosses its namesake's path

A little to the north of Site 265, *Glomar Challenger* crossed the track of HMS *Challenger*. Our report from Site 265 states that the drill bit first recovered 'soft to soupy diatom ooze lying directly beneath the seafloor'. This turned out to be diatom ooze some 370 metres thick, overlying 75 metres of nannofossil ooze and chalk of Late to Middle Miocene age—some 10 to 15 million years old. The change in sediment type from the bottom of the hole upwards suggests a change in climate, with the diatom-rich sediments reflecting cool seas; the limy nannofossil oozes and chalks showing deposition under earlier, warmer conditions.

Not far to the south of our drill site, HMS *Challenger* had also recovered diatom oozes from dredges dropped to the sea floor. In describing these floor dredgings as diatom oozes they made the first use of that vividly descriptive term in the scientific and popular literature. *Challenger* at this point had reached the most southerly stretch of its world-encircling voyage in February 1874. They had encountered the first icebergs just south of 60°S. They reported one flat-topped berg some 2,000 feet long and 219 feet high.

These oozes, and others collected in this perilous southern region, were described by John Murray and the Abbé Alphonse Renard in their *Report on the Deep-Sea Deposits*:

> The deposit when collected and when wet has a yellowish straw or cream colour; when dried it is nearly pure white, and resembles flour. Near land it may assume a bluish tinge from the admixture of land detritus. The surface layers are thin and watery, but the deeper ones are more dense and coherent, breaking up into laminated fragments in the same way as the deeper layers of Radiolarian Ooze. It is soft and light to the touch when dried, taking the impress of the fingers and sticking to them like fine flour, and in most respects has the same physical appearance as the purest samples of Diatomite of freshwater origin. Small samples appear quite homogeneous and uniform, but in all the soundings there were fragments of minerals and rocks, and gritty particles can be felt when the substance is passed between the fingers. (Murray and Renard 1891, p.209)

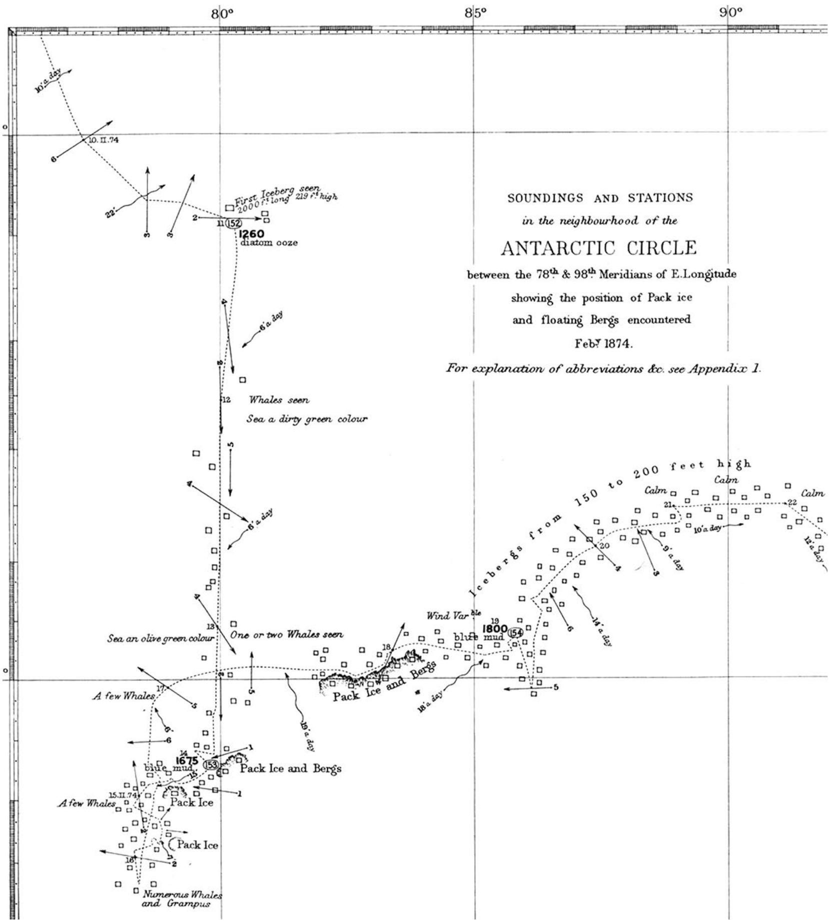

Figure 4.5. Chart of HMS *Challenger*'s path, showing the site of dredging the first diatom ooze that their scientists had encountered at their Site 1260.

Source: *Challenger* reports online (www.19thcenturyscience.org/HMSC/HMSC-INDEX/index-linked.htm).

The chart of this part of the expedition (Figure 4.5) shows the vessel continuing to voyage south, reaching their furthest south—latitude 66°40′S on 16 February 1874. Here, their chart records 'numerous Whales and Grampus', as well as pack ice. An almost fatal encounter with a giant iceberg occurred on 24 February when attempts to shelter in its lee almost brought the vessel undone, as a lull in the weather caused the *Challenger* to lunge forward and run into the wall of ice, smashing its jib boom and leaving much of the head gear 'in a state of wreck'. For the rest of the day and subsequent night, they ducked and weaved, using the steam engine to dodge backwards and forwards to avoid colliding with the abundant bergs. The jib boom was successfully replaced. After these bleak and terrifying encounters, the *Challenger* turned and headed towards the northeast, this time under steam power. *Challenger* skirted the edge of the pack in their search for 'Termination Land' so-called by Charles Wilkes of the US Exploring Expedition of 1842. This feature, shown on modern maps as Termination Tongue, is now known to be an icy finger projecting from the Shackleton Ice Shelf, rather than land as described by Wilkes. *Challenger* then—in February 1874—headed on a northeasterly course towards Melbourne.

The arrival of the *Challenger* in Melbourne, where she docked on 19 March, caused considerable interest locally. The Victorian appreciation of natural history is evident in the report in next day's *Argus* newspaper. The reporter had clearly enjoyed a tour of the vessel, and was impressed by:

> a formidable array of instruments devoted entirely to the furtherance of science, while all around the ship there are apartments fitted up for naturalists, chemists, photographists and others … The instruments and appliances on board used in prosecuting the various researches and recording them would form quite an inventory, and the specimens of animate and inanimate nature fished up from the dark but not unfathomed caves of ocean would stock a museum. (*Argus* (Melbourne), 20 March 1874)

He was impressed too by the 'large and very fine collection of photographs of all places and objects of interest'.

The scientific legacy of the *Challenger* voyage

The voyage of HMS *Challenger* was the first large scale expedition specifically set up to study the science of the world's oceans. As such, it holds a firm place in the foundation of modern oceanography—and enjoys what has been called 'an almost mythical status' in this field.

Its lasting impact is evident in the use of the name in the North American Space Program. The name was lent to the Lunar Module *Challenger* that ferried two astronauts to the moon's surface in 1972 and alas also to the ill-fated shuttle vehicle that broke up after launch in 1986.

The most obvious successes of the voyage include a dramatic increase in understanding the topography of the sea floor. There was the recognition of the elongated mountain chain in the middle of the Atlantic—now well known as the Mid-Atlantic Ridge. But other observations included the presence of deep linear depressions in the sea floor. The Mariana Trench in the western Pacific—the deepest known—was sounded by the *Challenger* in 1875.

Among the directives given to the *Challenger* before her departure in 1872 was that the expedition should 'collect information on the distribution of temperature in the ocean … not only at the surface, but at the bottom, and at intermediate depths'. This was to be carried out using thermometers lowered into the sea, heavily armoured to protect them from the influence of pressure at depth. The thermometers were of a kind that measures maximum and minimum temperatures, consisting of a curved tube filled with mercury and attached to a bulb containing creosote; this liquid expands and contracts with temperature changes, pushing ahead of it a metal index that preserved the extremes of temperature.

HMS *Challenger*'s results play an important part in understanding current issues of global warming. The ocean temperatures taken by the *Challenger*, both at the surface and in deeper waters, have provided an important baseline against which recent changes in ocean temperatures are being measured. The oceans play a key role in climate, and especially in warming climates, through their capacity to store heat. The mixing of ocean waters removes heat from the sea surface and distributes it through current actions, both locally and across a wide spread of the globe. Currents, driven by surface winds and by changes in the temperature and salinity of water masses, transport warmth towards the poles and cold water from the polar regions back towards the tropics. Increases in the temperature of the oceans will skew this relationship, forcing more of the accumulated heat polewards. In effect, ocean warming can reasonably be equated with global warming.

It has been possible to compare modern sea surface and deeper measurements taken by a global array of floating sensors—the Argo Programme—based on data from nearly 4,000 instruments with a worldwide distribution, with the temperatures taken by 300 thermometers lowered into the sea from HMS *Challenger* during the years 1872–76. Comparison between the two datasets shows a mean surface warming of just over half a degree (0.59°C ±0.12) in the years to around

2004–10; below the surface the warming at 366 metres, or 200 fathoms, has been less, at 0.39°C. These measurements, comparing the *Challenger* data with the Argo Programme, show that, globally, the oceans have been warming since at least the late nineteenth century. The *Challenger* records allowed calculations of warmings for the Atlantic and Pacific oceans only, rather than truly global measurements; they took few measurements in the Indian Ocean or at high southern latitudes.

Another significant contribution was the study of sea floor sediments, largely through the work of John Murray, and the recognition that a major component of these—the oozes, of biological origin—originated at the sea surface. The presence of a rich and abundant, sometimes bizarre, life at depths in the ocean, and its documentation, was another major achievement, laying to rest Edward Forbes's idea of an 'azoic' zone in the abyssal regions. A discussion of Forbes' 'desert-like' sea floors was given by Anderson and Rice (2006).

But while the successes, and the scale, of the *Challenger* expedition have lent it iconic status in the annals of the science of the sea, there have been more critical evaluations. One such was published in 2001 by science historian Margaret Deacon and contributors, in *Understanding the Oceans: A Century of Ocean Exploration.* There, a range of authors explored both the successes and failures of the expedition and examined just how much it has influenced the modern science of oceanography. In essence, the reasons for the success of the *Challenger* voyage are seen as twofold. First, the government was amenable to providing the considerable funding necessary first to modify the vessel, and then to support the time at sea. Second, the production of comprehensive reports is another oft-quoted success, and these were published within what might be considered a reasonable time frame—a mere 20 years after the return of the voyage. But government funding to procure the completion of the reports was parsimonious to the point of being stingy, and completion was only made possible by John Murray's contributions, both financial and editorial.

In terms of technology, it may be that the *Challenger*'s use of technology was less innovative than is usually claimed. Theirs may have been more of an adaptation of what was available, rather than new designs. Steam power, for one example, had been available since the early 1800s. *Challenger* made use of it both for lifting dredges and dodging icebergs. Another example is that the cables developed for marine telegraphy had been available since the mid-1800s, and there had been considerable experimentation on the most effective composition of these, including the use of copper and hemp. But on board *Challenger* the use of rope for dredging and sounding persisted, although there were instances where rope had been entwined with piano wire. But rope was allegedly Wyville Thomson's choice, and he adhered to it simply because of custom. The nature of the trawling equipment was similarly criticised, with trawl nets sometimes coming up empty because of their design. The thermometers used for measuring water temperature were subject to temperature changes; although corrections were initially applied to their readings, the uncertainty of these meant that the published temperatures were 'as read'. These technological choices have given rise to the *Challenger*'s working philosophy being described as 'conservative rather than innovative'.

But such criticisms and debunking of the *Challenger*'s status do little to detract from the voyage's reputation as a precursor of modern large-scale research projects. The production of the voyage reports after the expedition's end is part of its lasting legacy. Whether or not a time frame of 20 years for some of the reports can be considered reasonable is debatable—it would not be acceptable in the faster-moving times of the twenty-first century, but in the slower pace of the late nineteenth century it was perhaps forgivable. It should be remembered that the reports were the work of a largely international cohort of scientists—sometimes against a degree of ill-feeling from British scientists. And all this was the product of a pre-electronic age. And, vitally, both funding and editing were made available for their completion, although provision for these came in part from private sources. Such guarantees are not always available to support today's projects.

This text is taken from *A Memory of Ice: The Antarctic Voyage of the Glomar Challenger*, by Elizabeth Truswell, published 2019 by ANU Press, The Australian National University, Canberra, Australia.