VAST EXPANSES

A HISTORY OF THE OCEANS

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For Daniel

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Fathoming All the Ocean

Thou glorious mirror, where the Almighty's form
Glasses itself in tempests; in all time,
Calm, or convulsed – in breeze, or gale, or storm,
Icing the pole, or in the torrid clime
Dark-heaving; boundless, endless, and sublime –
The image of Eternity – the throne
Of the Invisible; even from out thy slime
The monsters of the deep are made; each zone
Obeys thee; thou goest forth, dread, fathomless, alone.
– George Gordon, Lord Byron, from *Childe Harold's Pilgrimage*, Canto IV (1818)

THE NINETEENTH-CENTURY discovery of the depths marked the start of the human relationship with all of the ocean, including its most remote reaches and most inaccessible parts. The ocean is a challenging place to know. Some of its characteristics – such as its opacity, tracklessness and vast scale – profoundly directed and constrained how people have amassed knowledge about it. Historically, sailors, navigators and fishers knew the ocean through their work, using trusted tools and hard-won knowledge passed down through generations. Traditional uses of the sea, especially fishing, trade, emigration and travel, intensified during the nineteenth century as industrialization transformed the blue water into a workplace on an entirely new scale.

New uses for the open sea and the depths that drew seafarers away from regular routes and familiar fishing grounds emerged. When whales became scarce near shore, their hunters embarked on longer voyages farther from land, pursuing deep-diving sperm whales. Whalers' stories sparked questions about the conditions at great depths and whether or not living things could exist there. Their experiences, tarrying in waters

where no previous mariner had paused, inspired writers and engrossed readers. Submarine telegraphy, after successfully spanning short underwater routes, animated the ambition of engineers, entrepreneurs and politicians who dared to imagine transoceanic cables. Such new uses for the sea, far beyond the traditional ones of transportation and fishing, created unprecedented demands for knowledge about the ocean that governments met by supporting research. People before and through the nineteenth century learned about the ocean indirectly, employing technologies, skills and knowledge systems both from traditional forms of work at sea and from modern science, in order to make sense of the ocean's great extent and its profound depths.

More revolutionary than the increased scale of work at sea was the innovation of playing by and on the ocean. Beach holidays, yachting and visits to public aquaria provided salubrious and socially appealing access to the sea. The nineteenth-century discovery of the ocean extended into the private space of the home when families brought back collections of shells or seaweeds, tended aquaria or read maritime books. Alongside its significant and novel political and economic importance, the ocean gained tremendous cultural and even personal resonance.

NAVIGATORS BEFORE THE NINETEENTH century were more concerned to rule out shallowness than to measure depth with any precision. Careful measurement was reserved for waters near land. The 1823 *Encyclopædia Britannica* entry for 'Sea' stated that for 'want of proper instruments, beyond a certain depth, the sea has hitherto been found unfathomable.'[1] Standard navigational sounding equipment included only about 100 fathoms of line at most, while even explorers carried only 200 fathoms, and 'off soundings' referred to sailing in areas deep enough not to concern a navigator. One reason for this practice was rooted in the doubt about whether an object such as a sounding lead thrown overboard in deep water would ever reach bottom. Some

mariners, and some natural philosophers as well, believed that water might be compressible, so that its density would increase with depth. If so, an object would float at the depth at which the water's density matched its own. Reports in the mid- to late nineteenth century record sailors' fear that telegraph cables or a shipmate's body committed to the deep might, as they termed it, 'find their level', and drift around indefinitely in mid-water column.

One distinctive feature of northern European navigation, relative to its Mediterranean origins, was its reliance on sounding. Pilots in the Mediterranean did not need to measure the depths often because its basin slopes steeply from the coasts, its shallow waters are clear, and fogs are rare. The Atlantic, by contrast, with its widely varying seabed slopes, frequent fogs and opaque water, prompted careful attention to the sea's third dimension. Mariners learned that the Atlantic's depth dropped off steeply past the 100-fathom mark, now recognized as the outer edge of the continental shelf, so inbound vessels sounded regularly to identify an approaching coast. When the lead weights of sounding devices were smeared with tallow or other sticky, soft material to pick up grains of bottom sediment, sounding also helped navigators fix their position as experience accumulated of the type of bottom found off various harbours and coasts.

The measurement used to define depth was the fathom. A fathom is about 1.8 m (6 ft), the wingspan of an adult male with arms outstretched. To sound the depth of a body of water, the navigator would heave the sounding lead overboard and watch the attached line run out until its progress slowed or stopped, signalling arrival at bottom. Then, starting from that point, he would haul in the line, one wingspan at a time, and count the number of fathoms of line that had been paid out to reach bottom. Even in relatively shallow waters, recognizing the moment the lead hit bottom required some skill, as did the technique of sounding while under way, which required throwing the lead forward of the vessel's bow so that the line was straight up and down for an accurate measurement by the time the vessel drew alongside.

The intimate connection between the human body and this unit of measure reflects visceral understanding that navigators had of the ocean, knowledge that was not available to ordinary sailors. In Rudyard Kipling's novel *Captains Courageous* (1897), Captain Disko Troop's fleet-wide reputation as the best fisherman and navigator rested in part on his ability to tell where his schooner was on the Grand Banks by feeling, smelling and tasting the bottom sediment retrieved by the sounding lead. One of his crew, Tom Platt, was exceptionally talented at deploying the lead, and the ability of the young protagonist, Harvey, to learn this skill signalled his rise within the ranks beyond ordinary sailor to future navigator.

Just as the working knowledge of navigators and sailors was instrumental to establishing ocean routes, so too did mariners' craft spark the discovery of the ocean's third dimension. Atlantic sailors who grew adept at sounding contributed this invaluable skill and habit to exploration of unknown waters. Whalers were also in the vanguard. Until early in the nineteenth century, most whaling was conducted from bases on shore. The preferred prey were 'right' whales, so-called for their inviting characteristics of swimming near shore, yielding plenty of oil and floating when dead. As whale populations near land declined, their hunters boarded larger vessels to venture farther afield. The introduction of the trywork, a shipboard furnace for rendering blubber aboard seagoing vessels, severed the link to land and sent whalers out to roam parts of the open ocean where traders and navigators, intent on moving between known places, never went.

American whaling captains, for example, were familiar with what became known as the Gulf Stream before men of science thought to ask. Benjamin Franklin, as Deputy Postmaster General for the American colonies, sought the answer to the puzzle of why mail-carrying ships sailing a northern route from England to the American colonies took weeks longer to cross than vessels plying a more southern route. His cousin, a Nantucket ship captain named Timothy Folger, knew the answer. American whalers who criss-crossed the Atlantic Ocean in all directions

had observed that whales avoided certain areas, and noticed that the colour and temperature of these waters differed from surrounding ones. Merchant captains, by contrast, had no reason to notice these features. The detailed records kept by whalers made their working knowledge available when men of science began to enquire. Franklin used a sketch made by Folger as the basis for a published series of charts of the Gulf Stream, including a 1786 version that served as the basis for virtually all Gulf Stream charts until 1832.

In addition to simply traversing strange waters, whalers developed a preference for hunting a new species whose habits introduced them to the profound depths. Prompted partly by declining numbers of other whales, the shift to sperm whales was spurred as well by the superior quality of the oil produced from their blubber, which found demand as a lubricant for the machines of industrial factories. Sperm whales also have in their head cavities a waxy substance, called spermaceti, that produces candles with a brilliant, smokeless flame. Valuable ambergris, a substance found in their intestines, was used to fix perfumes. Like right whales, their carcasses float and they are slow enough for men rowing wooden whaleboats to overtake. Unlike right whales, they feed on giant squid that live at great depths, and can therefore dive very deep – and sometimes they did so when struck with a whaler's harpoon.

Fantastic stories circulated about how sperm whales could remain submerged for hours and about how astonishingly deep they could dive. Scientific experts believed that life could not exist in the sea below about 300 fathoms, yet whalers sometimes had to splice together several 200-fathom or longer lines to prevent the escape of a harpooned sperm whale that dove straight down. Such fish stories made their way to the eyes and ears of men of science through a handful of educated whalers and scientists who gleaned information from mariners. The British whaling captain William Scorseby contributed significantly to knowledge of whales and also of the Arctic seas in which he hunted them, publishing the respected volume *The Northern Whale Fishery* in 1820.

A whale killed in the Pacific had the harpoon of a vessel then working in the Atlantic embedded in its blubber. Such tales supported arguments for expeditions to search for the Northwest Passage and began to attract the attention of the planners of major national exploring expeditions. For instance, the organizers of both the U.S. Exploring Expedition (1838 to 1842) commanded by Charles Wilkes and the lesser-known North Pacific Exploring Expedition (1853 to 1856) both consulted whaling captains who were familiar with the Pacific waters and islands these expeditions would visit.

The captains suggested a study of the seabed to support the whaling industry, following the logic that fishers could use knowledge of bottom type to find rich fishing grounds. The American hydrographer and naval officer Matthew Fontaine Maury also tried to convince Lt John Rodgers to conduct a seabed investigation as part of the North Pacific Exploring Expedition. As Franklin had, Maury bridged the gulf between the working maritime world and the gentlemanly domain of science, taking seriously the knowledge won by whalers and other mariners and incorporating their sea stories into his series of *Explanations and Sailing Directions to Accompany the Wind and Current Charts* (eight editions, 1851 to 1859). Better known to posterity for his work on winds and currents as well as his role in promoting international cooperation in meteorology, Maury also used his position as head of the U.S. Naval Observatory to compile information about whale sightings and kills from logbooks, with the goal of creating useful tools much like his charts of winds and currents that were reputed to shorten sailing times for navigators who used them.

The impulse Maury exercised to compile information about the ocean and display it graphically for the convenience of users was not unique to him. He was inspired by the work of the Prussian explorer and naturalist Alexander von Humboldt in physical geography. Well known for his travels and writings about the continents of South America and Africa, Humboldt began his career fascinated with the ocean, its currents and other physical features, and the distribution of its flora

and fauna in response to their environment. Many natural philosophers, stirred by Humboldt's vision of the interconnectedness of organisms and the physical world, set about collecting data across large areas, and the ocean seemed ideally suited for this approach. Alongside his prodigious work on winds, currents, meteorological observations and whale distribution that directly supported maritime industry, Maury also produced the 1855 book *The Physical Geography of the Sea*, reflecting his ambition to make a lasting scholarly contribution honouring Humboldt's influence as well as adding to practical knowledge.

THE MOST STRIKING AND NOVEL nineteenth-century use for the ocean depended as much on freedom of the seas as global trade did. If sperm whaling stimulated curiosity about the ocean's depths, submarine telegraphy galvanized action to fathom them, literally and figuratively. Early efforts to measure depth in the open ocean were rare and sporadic, such as Sir John Ross's attempt during his 1817–18 voyage to Baffin Bay and the U.S. Exploring Expedition under Charles Wilkes which tried sounding in deep Antarctic waters. In 1840 Ross's nephew, Sir James Clark Ross, conducted the deepest soundings to that time during his Arctic expedition. The prospect of telegraphy transformed deep-sea sounding from an occasional experiment into the responsibility of government hydrographers, and eventually into the routine work of cable company employees.

Oceanic surveying and charting flourished in lockstep with the burgeoning maritime commerce spurred by the Industrial Revolution. Most hydrographers naturally focused on shorelines, harbours and approaches to land from long-established sea routes. When steam began to revolutionize ocean travel, it placed demands for knowledge of the ocean based on new, direct transit routes that made sense for vessels no longer beholden to wind power. Maury's energetic efforts to use science to improve sea travel broadened in the late 1840s to include experimental deep-sea soundings, some of which focused on lanes that

steamships had begun to ply. His motive appears to have combined his own scientific curiosity about the physical geography of the sea, inspired by Humboldt, with the rationale that, if he could find deep water in areas where sailors had reported shoals, he could remove incorrect notations from charts. Mariners, confident of the accuracy of up-to-date charts, could proceed at top speed in proven deep water.

After three years of intensive efforts by naval officers working under his direction, Maury created the first bathymetric chart of the North Atlantic basin in 1853. Based on about ninety soundings, it included shaded zones marking contours of one, two, three and four or more thousand fathoms. Most of the measurements were made using very simple technology and a technique based on traditional sounding. At first hydrographers simply tied package twine to a cannonball, tossed it over the side, and tracked how much twine ran out until they judged that the weight had reached bottom. Then they cut the line and sailed on. A clever innovation by a young lieutenant trained by Maury resulted in a sounding device that recovered a small sample of deep-sea sediment. This practice required the additional labour of recovering the device, but the reward was confirmation that the instrument had, indeed, struck the sea floor. In 1855 Maury made a new chart, recording about 189 soundings, three times the number from the original chart.

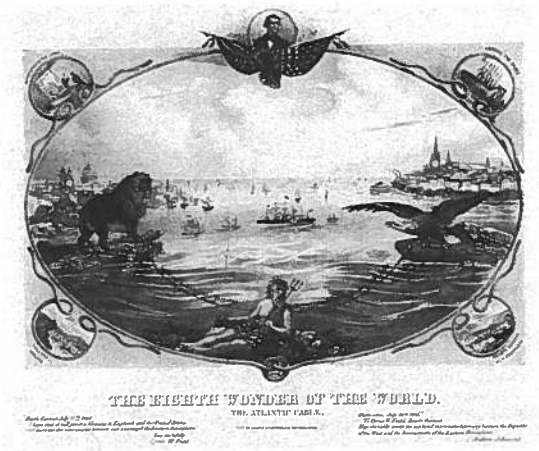
Maury's charts included a line of soundings along the favoured steamship route between Europe and North America, north of the belts of trade winds that sailing vessels had long relied upon. This line also fell near a similar route proposed for the Atlantic submarine telegraph. Promoters hoped to lay a cable from Ireland to Newfoundland, close to the great circle, or the shortest distance across the Atlantic. While it appears that Maury may not have been aware of the Atlantic cable project at the start of his deep-sea sounding work, the prospect of submarine telegraphy immediately accelerated efforts to study the ocean floor.

Maury's bathymetric chart, the first ocean-basin scale chart of its kind, caught the attention of mariners and men of science, but other images he created of the sea bottom reached ordinary people. His famous

'Telegraph Plateau' illustrated the ocean floor feature his hydrographers coincidentally discovered at exactly the place where entrepreneurs planned to lay the cable. This flat plain about 2,000 fathoms deep was located near the great circle, the shortest point between the landmasses of the Old and New Worlds. The drawing shows a jagged and forbidding sea floor south of the plateau, revealing the prevailing belief that the plateau was a providentially placed exception to the mostly rugged sea bottom. This and other images, such as a drawing of the shells of unthreatening diatoms and other microscopic creatures found in the soft mud of bottom samples, appeared on front pages of newspapers and illustrated weeklies, testifying to the appropriateness of the ocean as a home for telegraph cables.

Americans working under Maury and also at the U.S. Coast Survey were most active in deep-sea sounding through the early 1850s. The end of the Crimean War in 1854 freed British resources for deep-sea work. Thereafter the development of the technology for deep-ocean measurement happened on British vessels, reflecting that nation's greater involvement in the transatlantic telegraph cable laying efforts. The primary entrepreneur for the project over the decades it took to complete was the American Cyrus W. Field. A pair of attempts in 1857 and 1858 involved both American and British vessels and resulted in a cable that worked briefly until it failed for electrical reasons. Partly due to the American Civil War, almost a decade passed before a second series of attempts. In 1866, the largest ship ever built to that time, the 211-m (692-ft) SS *Great Eastern*, laid a successful cable, and also managed to locate and complete a cable that had broken the previous year.

On land, the Atlantic cable was hailed as the eighth wonder of the world and welcomed as a communications revolution that would ensure world peace. The work that went into sounding along its route and to reimagining the ocean floor as a safe place to put telegraph wires constituted a cultural discovery of the deep ocean that extended well beyond the desks of naval cartographers, entrepreneurs and engineers. Enthusiastic newspaper coverage about ocean telegraphy's failures and



Lithograph entitled *The Eighth Wonder of the World*, an allegorical scene in honour of the Atlantic cable, 1866.

successes and also popular narratives of cable-laying voyages found readers among Victorian families who may also have had sheet music on their pianos of 'The Atlantic Telegraph Polka' or 'The Ocean Telegraph March', celebrating the cable or its oceanic home in the depths. Or perhaps the lady of the house might have a bottle of 'Ocean Spray' perfume created in honour of Cyrus Field and advertised in *Harper's Weekly*.[2] Enthusiasts might have purchased one of the 50¢ souvenirs made from the 32 km (20 mi.) of leftover cable sold to Tiffany & Company jewellers. Umbrella handles, canes and watch fobs fashioned with sections of cable were also available. Field had a watch fob made for himself with a few precious grains of deep-sea sediment set in it.[3] The spectacular achievement of spanning the Atlantic with telegraph wires brought the bottom of the sea into the minds, lives and homes of ordinary people.

THE ATLANTIC CABLE may have revealed the ocean's depths, but for many people discovery of the sea began at the shore, where the new passion for beach holidays set the stage for dramatic growth of scientific interest in marine life. Beaches did not always hold the attraction they now do. Poor people gathered seaweed and scrounged for usable objects

that washed up. Rumours abounded that wreckers deliberately lured ships aground with lights in order to salvage the flotsam that washed ashore from the wreckage. Before its cultural discovery, the seashore was associated with cannibals, mutineers and shipwreck victims. Daniel Defoe's Robinson Crusoe rarely ventured onto the beach, preferring to stay safely inland. Respectable people avoided the shore.

The rehabilitation of the coast involved both mind and body. Genteel young Europeans visited Holland on the Grand Tour starting in the mid-eighteenth century to witness scenes they knew from Dutch seascape paintings. In the throes of Romanticism, they sought the sublime generated by the extreme calm or the exquisite violence of the water. Romantic artists turned to the shore as an ideal place for reflection, where the correspondence between marine and psychological depths might lead to self-knowledge. Of at least equal attraction was the new-found salubrity of seawater and seaside air. The healthful and social appeal of inland spas evolved into a mania for bathing in the cold waters of northern European shores and breathing the sea air. Aristocrats ventured to the beach first but the social appeal of seaside resorts ensured that upper, then middle, classes followed. American discovery of the beach lagged the European by about a decade. Strictly regulated hydrotherapy promised cures for melancholy, anxiety and spleen. The bather endured the terror of the sea to overcome her maladies but, paradoxically and disguised by the therapeutic alibi, discovered bodily pleasures. By the 1840s, as railroads extended from cities to the shore, virtually everyone could afford at least the occasional day trip to the beach, establishing an association between urban Westerners and the beach that continues today.

Proper Victorians sought to balance the pleasures of new bodily sensations and the fashionable social scene with morality. In their eyes the beach served as a portal to learning about the wonders of nature. Seaside cliffs offered an easy three-dimensional glimpse into deep time for observers who had begun to grasp the new sense of the Earth's history proposed by geologists. Reflection on the endless waves and

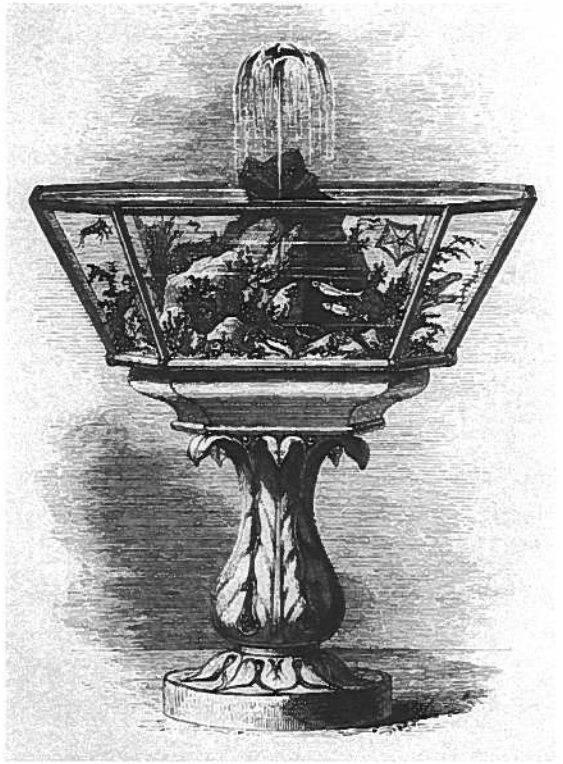
horizon allowed visitors to envision the long stretch of time and the forces that created and reshaped coasts, rocks and cliffs.

The waves tossed treasures from the dark depths at the feet of beachcombers who ventured off the boardwalks and balconies to touch the sand. Beautiful shells had long been prized for eighteenth-century cabinets of curiosities but the vogue for beach holidays expanded natural history to include all marine flora and fauna. Middle-class holiday-goers prowled the shoreline, finding seaweed, shells, marine creatures and their remains. To learn more, they consulted the numerous popular books on marine natural history that appeared, including works by the deeply religious naturalist and science popularizer Philip Henry Gosse, such as *The Ocean* and *A Naturalist's Rambles on the Devonshire Coast* (1844), which celebrated marine life as a sign of God's creation and featured colourful underwater scenes of living sea creatures. The Anglican priest and Cambridge professor Charles Kingsley, who embraced the idea of evolution, wrote a marine natural history book, *Glaucus: or, The Wonders of the Shore* (1855), before penning what became the delightful and popular children's novel *The Water Babies* (1863), about a young chimney sweep who becomes a water creature in order to evolve morally and socially. The American educator Elizabeth Cary Agassiz, wife of the famous zoologist Louis Agassiz and promoter of women's education in science, wrote *Seaside Studies in Natural-History* (1865) with her stepson Alexander, who later became a well-known ocean scientist and invented new ways to sample the depths.

Marine natural history offered an uplifting excuse for men, women and children alike to indulge in the pleasures of the beach, and the seaside holiday context drew women into science. Margaret Gatty, whose contributions to algology were recognized and appreciated by leaders of the field, began studying seaweeds during a stay at the coastal town of Hastings to recover from the birth of her seventh child and a subsequent bronchial ailment. Bored by her uncharacteristic inactivity, Gatty read William Harvey's *Phycologia Britannica* (1846 to 1851) and began wandering the beach to look at seaweeds for herself. She returned

home with a passion for their study and began writing natural history, ultimately publishing the respected *British Seaweeds* in 1863. Gatty recruited her entire family for collecting, transforming holidays into searches for unusual specimens.

While Gatty and her family pursued marine natural history more seriously than most, they were joined on the strand by many middle-class families seeking morally appropriate leisure activities. Families could also enjoy the brand-new hobby of keeping marine animals alive back at home with the invention of what proved to be an enduringly popular instrument of science and entertainment, the aquarium. By the mid-1850s, London had two suppliers of live animals, as well as a public aquarium. Gosse followed his very popular marine natural history books with one titled *The Aquarium: An Unveiling of the Wonders of the Deep Sea*



The Fountain Aquarium, one of many popular means for keeping marine animals in the home during the height of the mid-19th-century aquarium craze.

(1854). Within two decades, Britain had almost a dozen public aquaria, and all major European cities boasted one. As in the case of beach holidays, American embrace of aquaria shortly followed European example. Gosse's son, Edmund, reported his father's chagrin when he recognized that an 'army' of natural history collectors had 'ravaged every corner' of England's rocky tidepools.[4]

Although beach strollers found the occasional zoological or botanical treasure washed up after a storm, serious scientific pursuit of marine natural history required boats. The geologist and zoologist Edward Forbes, who grew up in a maritime community on the Isle of Man, played a key role in promoting natural-history dredging within the British scientific community in the 1830s and 1840s. He arrived at the University of Edinburgh in 1831 to study medicine and joined a group of professors and students who partook eagerly in field excursions to collect material for natural history study. Forbes, familiar with oars and oyster dredges from his father's involvement with local fisheries, contributed his maritime experience to the group's dredging outings in hired fishing vessels and rowboats. One landlubber among his student peers was Charles Darwin, who took his new-found dredging experience with him aboard HMS *Beagle*. Another was George Johnston, who became a physician and an active promoter of marine zoology in Northumberland and founded the Berwickshire Naturalists' Club.

Natural history clubs fostered marine science by providing a meeting place for discussion and exchange, and also because they organized dredging excursions larger in scale than individual collectors could manage. As railroads reached the coasts and enabled wider social access to the seashore, vacationing dredgers discovered yachting as a way to collect marine creatures from deeper water.

The yachting tradition that fostered marine science was not the socially elevated races and lunch parties that characterized the Royal Yacht Squadron's Regatta Week at Cowes. Instead, cruising offered a genteel version of the maritime world that carried marine naturalists away from social centres to zoologically rich, often remote regions, for a

kind of do-it-yourself exploration. Compared with hired fishing vessels, yachts were more physically comfortable for naturalists and provided them with more independence to choose dredging sites and experiment with collecting gear.

Yachting also permitted women to practise science at sea, because they were accepted as members in many of the natural history clubs and welcomed aboard yacht cruises that were as sociable as they were scientific. The 1871 Edinburgh meeting of the British Association for the Advancement of Science featured a dredging excursion for about sixty members including some women. Two years later the inland Birmingham Natural History Club organized a week-long visit to Teignmouth to dredge from the hired yacht *Ruby*. The participation of women added to the sociability of the holiday outing, as evidenced by the resolution of members to make the excursion annual, 'especially as ladies were now for the first time admissible as members'.[5]

Although oceanographers and most historians believe that the field of ocean sciences has been dominated by men from the start, a view from the decks of nineteenth-century vessels reveals that scientific study of the ocean began not only aboard hydrographic surveying ships and fishing vessels, but on rowboats and yachts. Because of the holiday context of beach-going, amateurs, including women and children, practised marine natural history alongside professional scientists. After science became a profession in the mid- to late nineteenth century, specialists in control of universities, museums and other important institutions began to dismiss the efforts of amateurs. Probably the main reason their participation in marine science has been underappreciated, though, relates to the place of the famous 1870s voyage of HMS *Challenger* in historical memory.

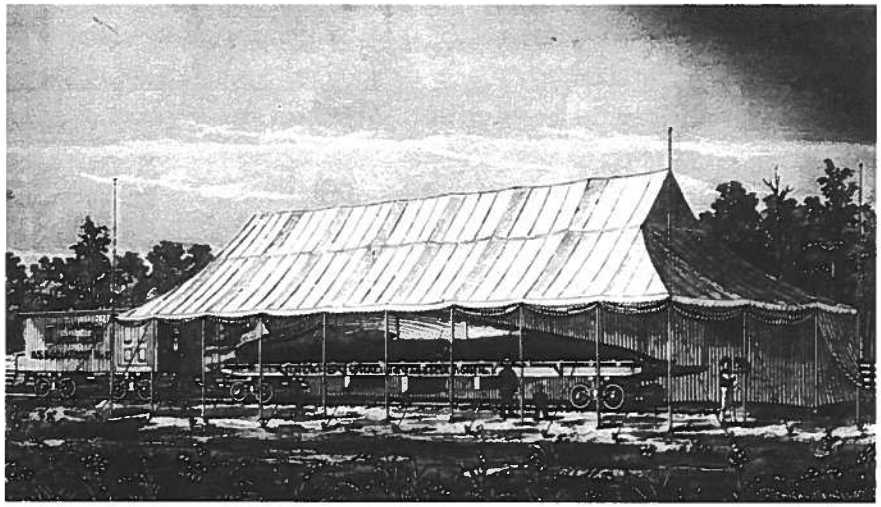
Long considered the foundational event for oceanography, the circumnavigation voyage by the *Challenger* (1872 to 1876) instead represents the culmination of scientific interest in the ocean from many sources. The success of the 1866 transatlantic cable proved the efficacy of submarine telegraphy and strongly motivated ocean-floor investigation

and governmental willingness to fund it. Naturalists, who had begun collecting at the waterline and reached deeper into the sea from the decks of rowboats and then yachts, wanted to understand the distribution of marine creatures and hoped to determine whether life existed at the greatest depths. Based on dredging operations in the Mediterranean, Forbes concluded that life disappeared around 300 fathoms. After his untimely death in 1854 at age 39, the active community of naturalist-dredgers he had helped create began to sample more deeply and continued to find living creatures. The dramatic recovery of a failed submarine telegraph cable from the Mediterranean in 1860, raised from 1,000 fathoms encrusted with unfamiliar marine life, thrust the academic debate into the public spotlight.

A group of British naturalist-dredgers with strong ties to the Royal Society recognized the benefits of the built-in expertise of hydrographers and crews of naval surveying vessels accustomed to deep-sea sounding and lobbied for government help to deploy dredges in the ocean's depths with their help. At the request of the Royal Society, the Admiralty willingly provided vessels for a series of summer research cruises in the 1860s to test the feasibility of sampling beyond several hundred fathoms. The scientists aboard HMS *Lightning* (1868) and HMS *Porcupine* (1869 to 1870) found life everywhere they looked, down to more than 2,000 fathoms. The debate about whether or not life existed at great depths gave way to more multifaceted questions about the nature of life there. Observers noted with fascination that some life forms discovered at depths of several hundred fathoms were previously known only as fossils. In 1866, the Norwegian naturalist Georg Ossian Sars, dredging near Lofoten, discovered a crinoid at 300 fathoms. He and the naturalists he consulted were familiar with crinoids, also called sea lilies, in coastal areas, but Sars's find resembled instead fossil stalked crinoids. The British professor who became *Challenger*'s chief scientist travelled to Norway to see the prized specimens. This and subsequent similar catches raised the prospect that the ocean's depths might hide many so-called 'living fossils'.

That prospect appeared fulfilled in 1868 when Thomas Henry Huxley, known as 'Darwin's bulldog' for his vociferous defence of evolutionary theory but also an explorer who served as surgeon-naturalist aboard HMS *Rattlesnake*, announced the discovery, in stored deep-sea bottom samples, of a protoplasmic primitive organism that he believed to be a precursor to higher life forms. One important challenge to proponents of evolution was the unanswered question about how life began. The new-found creature was christened *Bathybius haeckelii* after the well-known German zoologist Ernst Haeckel, who had recently proposed a third biological kingdom, the Protista, alongside the established animal and vegetable kingdoms.

In this era when specimens from the depths became available for study and popular viewing, discoveries such as *Bathybius* attracted widespread public attention. In 1822 a preserved mermaid had made its way to London, only to be declared by naturalists a fraud created from pieces of an orang-utan, baboon and salmon. In the U.S., P. T. Barnum exhibited a 'Feejee mermaid' in 1842, really a dead baby monkey attached to a fish tail. Although Barnum declined an invitation to be



Print of the Inland Whaling Association's exhibit of an enormous blue whale, displayed in cities throughout the northeastern and midwestern United States in the early 1880s.

involved, entrepreneurs of what became known as the Inland Whaling Association exhibited a dead 18-m (60-ft) blue whale between 1880 and 1882, bringing the 'monster whale' by railroad flatbed car to northern cities on the East Coast and throughout the Midwest. Earlier a blue whale that washed ashore at Ostend, Belgium, in 1825 was de-fleshed and exhibited around Europe for seven years. In 1845, New York City residents could visit the 43-m (140-ft) skeleton of a sea serpent discovered and assembled by Albert Koch, a German immigrant, scientific collector and showman who had previously toured major American cities with a mastodon skeleton. The public greeted the monster enthusiastically, and the German King Frederick William IV purchased the skeleton, but experts pointed out that the bones came from six animals, not one. Despite this sea serpent deception, few sea monster specimens ever appeared for examination. Perhaps because of the plausibility lent by exhibits of fossil plesiosaurs and ichthyosaurs, sea serpents continued to hover in the realm of the feasible in the minds of at least some scientists.

Technological success at dredging and sounding in thousands of fathoms on the *Lightning* and *Porcupine* cruises seemed to promise answers to previously out-of-reach questions. Curiosity about oceanic life and, indeed, the origins of life itself inspired the voyage of the *Challenger*, which sailed from Portsmouth on 21 December 1872, and returned three and a half years, 127,580 km (68,890 nautical mi.), and 362 scientific stations later. The expedition's dredges, trawls and nets found life everywhere they sampled. Half of the 7,000 specimens retrieved proved new to science, and some came from depths over 3,000 fathoms. The results eventually appeared (it took 23 years) in fifty volumes that documented foraminifera, radiolaria, echinoderms, cetacean bones, medusa, copepods, crinoids and dozens of other groups of organisms. The mysterious *Bathybius* eluded *Challenger*'s scientists until the last months of the voyage, when it was discovered in preserved bottom samples. The suspicious chemist aboard investigated and debunked the celebrated proto-life form as a calcium sulphate precipitate formed when seawater reacted with the preserving fluid. Despite this disappointment,

the *Challenger* collections and results formed the foundation for the emerging discipline of oceanography, whose origin owes much to the cultural discovery of the ocean.

IN PARALLEL WITH THE scientific and economic discoveries of the depths, the sea became an inexhaustible source of inspiration and promise for writers, including scientists and explorers alongside literary authors. Dramatically increasing literacy rates boosted readership in general, and the market for books about the ocean and ocean voyages greatly expanded in the nineteenth century, introducing more of the non-seafaring public to the world of ships and voyages. Maritime fiction helped transform the sea into the site of heroism and adventure and rendered ships into microcosms of society. Non-fiction accounts of voyages equally promoted this transformation, and those by scientists contributed to the refashioning of the ocean into knowable, usable and controllable space.

Literature about the sea appealed to a growing market of readers, including the first generations of Europeans and Americans to live in a world with regularly scheduled steam travel across the Atlantic. For the first time ever, people came into contact with the idea and the reality of the deep ocean in a way that had previously been limited to those whose families worked at sea, to residents of port towns or to people whose lives accidentally intersected with the ocean. Between 1815 and 1930 the greatest episode of human migration exposed fifty million Europeans to an ocean voyage. As overseas immigration peaked in the 1850s, the U.S. became home to a population who had experienced sea travel in mass numbers. The crossing experience deeply influenced immigrants, who carried nautical metaphors with them as they moved westwards. Most never sailed again, but the accomplishment of ocean crossing provided Americans with a shared historical past and perhaps fanned their taste for maritime literature. Fashionable steam travel transformed the Atlantic crossing from a life-changing emigration experience or a

work-related necessity into a part of the social season for a wealthy and, increasingly, middle-class families. Both the U.S. and Britain embraced their identities as maritime nations early in the nineteenth century, but awareness of the sea particularly pervaded Britain, the island centre of a global empire.

American and British readers appreciated the new maritime novels. After Defoe's *Robinson Crusoe* (1719), a hiatus interrupted the production of popular maritime fiction until early in the nineteenth century, although the British writer Tobias Smollett employed naval characters and settings in satirical works such as *The Adventures of Roderick Random* (1748). Sir Walter Scott's *The Pirate* (1822) reignited the genre, and James Fenimore Cooper paid homage to Scott and his main character in *The Pilot* (1823), a tale about John Paul Jones's privateering along the Scottish coasts. Cooper, and also Washington Irving, America's first two successful professional writers, both wrote well-received sea stories. A frequent transatlantic traveller, Irving wrote stories of voyages, shipwrecks and pirate treasure, and also authored the widely read *A History of the Life and Voyages of Christopher Columbus* (1828), which blended fiction with fact and originated the myth that Europeans believed the Earth to be flat. Cooper employed his experience sailing as crew on merchant vessels and his subsequent naval service to portray sea work and life authentically. Writing after long voyages had become safer and more predictable, and at a time when most of the world's coasts and oceans had been explored, he presented the sailor's craft of routine maritime work as heroic and adventurous. Cooper's work travelled across the Atlantic, winning critical appreciation and inspiring sea fiction in both Britain and France. Perhaps it inspired Frederick Marryat, the British Royal Navy officer and literary acquaintance of Charles Dickens who published the semi-autobiographical *Mr Midshipman Easy* (1836) and other maritime stories.

As Cooper and Marryat had, many maritime novelists had experience at sea. Americans Richard Henry Dana Jr and Herman Melville numbered among the first professional writers after Cooper to base their

accounts upon personal experience of working at sea as common sailors rather than recreation or leisure travel. Before this time, although retired mariners such as Marryat had turned into writers, educated landlubber writers would not have eagerly faced the dangers associated with working at sea. Some writers gained maritime experience aboard yachts, as had the English Romantic poet George Gordon, Lord Byron. French writers Jules Verne and Victor Hugo were also enthusiastic yachtsmen. Verne, who wrote most of his imaginative tale *20,000 Leagues under the Sea* (1870) while cruising on his yacht *Saint-Michel*, also travelled across the Atlantic as a passenger on the *Great Eastern* the year after it had been used to lay the successful 1866 transatlantic cable.

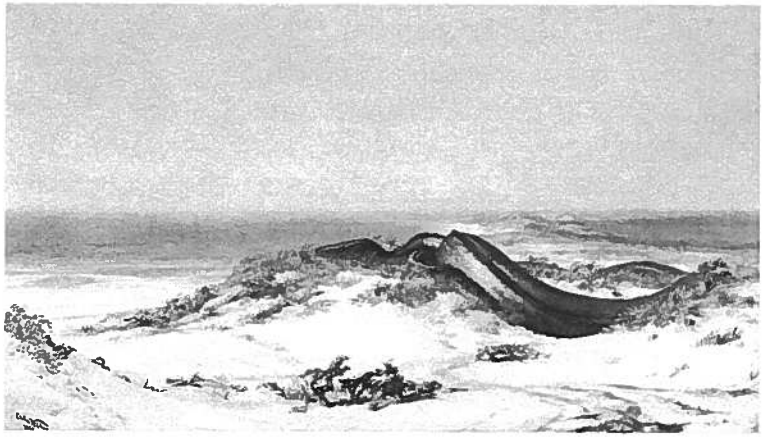
The new breed of maritime writers were often well-educated young men who chose to go to sea yet remained conscious of their social distance from the sailors who became their workmates. Dana, a well-heeled Harvard student in the early 1830s, went to sea for his health, embracing current convictions about the salubrity of sea air. Eschewing a fashionable European grand tour he instead enlisted as a merchant seaman, publishing *Two Years before the Mast* in 1840 as he embarked on a law career in which he advocated on behalf of common sailors and in favour of the abolition of slavery. While he hoped his book would educate the American public about the brutality and ugliness of maritime work, his tale also inspired many landlocked boys to ship out. Melville, who went to sea when his merchant father's death left the family in financial straits, admired Dana's description of rounding the infamous Cape Horn, which, as he put it in his own novel *White Jacket* (1850), 'must have been written with an icicle'.[6] Melville's experiences on merchant and naval vessels and his time in the Marquesas Islands provided grist for many of his books including *Typee* (1846) and *White-Jacket*, among others, while his service on the whaleship *Acushnet* inspired *Moby-Dick* (1851). As Melville's eager reading of Dana's narrative makes clear, the educated young men who set sail did so having read voyaging accounts and often with the expectation of writing about their own experiences.

The first scientists to make the ocean itself a focus of study went to sea in the thrall of sea fiction that presented voyaging as a route to adventure. They also read narratives written by leaders of famous exploring expeditions such as Charles Darwin, Alexander von Humboldt, Captain James Cook and any explorer who had ventured to the particular corner of the globe to which they were headed. Scientists who accompanied the circumnavigation of the *Challenger* carried the memory of Robinson Crusoe's adventures with them. As they approached the island of Juan Fernández, several wrote in their personal journals about Alexander Selkirk, the real castaway whose experiences there inspired Defoe's tale. En route to St Paul's Rocks, 800 km (almost 500 mi.) off Brazil, they consulted Darwin's account of the 1831 to 1836 *Beagle* voyage about his activities there and prepared the bait and hooks he recommended for shark fishing. Most of the *Challenger* scientists published popular accounts of the expedition. Several of the naval lieutenants also did so, and one member of the crew, the steward's assistant, sent letters home that he intended to copy into a single volume for his family after the expedition. The literary context of voyaging made scientific adventurers think of their own seagoing as part of a tradition of writing and publishing. Along with their literary and labouring counterparts, scientists set sail in pursuit of a personal experience, anticipating the opportunity, danger, heroism and self-transformation attendant on the new nineteenth-century encounter with the ocean.

Writers of sea fiction read the books scientists wrote about the ocean, incorporating into their novels state-of-the-art knowledge about the sea. Edgar Allan Poe's *The Narrative of Arthur Gordon Pym of Nantucket* (1838) bears the influence of the so-called 'Hollow Earth' theory that inspired the polar investigations undertaken by the U.S. Exploring Expedition of 1838 to 1842 and also the many Arctic expeditions of the 1850s that tried to find Sir John Franklin, or remnants of his lost expedition, by seeking the reported open polar sea. Through his work as an editor, Poe was well aware of public interest in both sea literature and scientific discoveries about the sea. Melville has Ishmael

refer to William Scorseby and also Thomas Beale, author of *The Natural History of the Sperm Whale* (1839), in the 'Cetology' chapter of *Moby-Dick*. After drafting the chapter 'The Chart', in which Captain Ahab retreats to his cabin after a storm to pore over charts and mark them with information gleaned from old logbooks, Melville learned about Maury's preliminary sketch for a global whale chart, a project which Melville employed to lend credence to the hunt for a single whale in the vastness of the sea. Victor Hugo likewise employed the new ocean science as he wrote *Travaillieurs de la mer* (Workers of the Sea, 1866), including work by Maury, as well as Jules Michelet's *La Mer* (1861).

Visual artists also drew from scientific works to evoke or depict the ocean's depths. In 1864, the American artist Elihu Vedder achieved his first public success exhibiting his oil painting *The Lair of the Sea Serpent*. Vedder, whose work was admired by Herman Melville, sketched studies of an eel as the model for his sea monster but took inspiration also from the fantastical works of Gustave Doré, illustrator by that time of works by Byron but who went on to create illustrations including strange sea creatures for Hugo's *Workers of the Sea* and the 1870 edition of Samuel Taylor Coleridge's *Rime of the Ancient Mariner*. The apparent serenity of



Elihu Vedder, *The Lair of the Sea Serpent*, 1864, a sinister painting which created a stir in the art world when first exhibited. In 1889 Vedder painted another work with the same name.

An undersea version of a Hudson River school landscape painting, Edward Moran's *Valley in the Sea* (1862), may have been inspired by the first Atlantic telegraph cable.

Vedder's scene, a dune overlooking the beach and sea beyond, is unsettled by the open eye and utter stillness of the creature lying in wait and evoking the terrifying mystery of the ocean's depths. Edward Moran's 1862 oil painting *Valley in the Sea* actually depicts the undersea realm in a panorama reminiscent of the Hudson River landscape style of American art. Probably commissioned by its first owner, James M. Sommerville, a Philadelphia physician, amateur artist and naturalist-dredger, the painting was likely inspired by the 1858 Atlantic cable and appears to represent visually the broad, flat oceanic valley described in Maury's 1855 *Physical Geography of the Sea*. Sommerville, who in 1859 published a small scientific book titled *Ocean Life*, also tried to represent the sea floor artistically himself, collaborating with another artist to produce a watercolour similarly titled *Ocean Life*. The colourful underwater scene, crowded with many of the species discussed in the book, was used to make lithographic reproductions to illustrate it.

Maury's work, which was threaded through so many literary and artistic representations of the ocean's depths, influenced Jules Verne, who wrote *20,000 Leagues under the Sea* (1870) with a copy of Maury's *Physical Geography of the Sea* beside him. Verne guided the *Nautilus*

around the world's oceans along a route that shadowed Maury's discussion of geographic regions of the ocean. Whole passages of Verne's *20,000 Leagues under the Sea* mirror Maury's text, a common enough feature in the world of nineteenth-century publishing that demonstrates the importance Verne placed on employing up-to-date geography and science in his work. In addition to incorporating his own sailing experience and Maury's text, Verne questioned the *Great Eastern* crew about the cable-laying work. He was also inspired by a visit to the 1867 World's Fair in Paris, which featured an aquarium and daily demonstrations of new diving equipment. Verne's oceans were equally fact and fancy, just as the mid-century discovery of the depths was as imaginative as it was scientific, as intellectual as it was technological and as personal as it was official.

MID-CENTURY DISCOVERY of the ocean's depths and remote blue waters proceeded through museum visits, aquarium keeping, maritime novel reading and amateur seaweed collecting as much as through government hydrography, professional marine zoology or submarine cable laying. The home was as important as natural history workrooms or ships. Returning seaside vacationers proudly exhibited aquaria or shells in Victorian drawing rooms alongside pianos displaying sheet music celebrating mermaids or the Atlantic cable. People from all walks of life could read in newspapers and popular magazines about the first transatlantic yacht race in 1866 that became the international competition still known as the America's Cup. Parents dressed their children in sailor suits inspired by the fancy nautical costumes favoured by yachtsmen, famously including Queen Victoria's husband and son. By the end of the century, the sailor suit had become a widely popular style for both boys and girls, and even for women. Hobbies, clothing, collections, reading materials, and even restaurant menus featuring choices such as 'deep sea flounder', reflected a spreading acquaintance with the ocean, including its vast third dimension.[7]

Familiarity with the ocean and things maritime reflected a radical new posture towards the ocean that emerged in the nineteenth century. For the first time in history, the sea became a destination. Before, ocean travellers had set sail for other lands, using the ocean as a byway. Naval fleets sailed in search of enemy ships to fight. Navigators followed proven routes. Explorers sought new coasts, direct sea routes and safe harbours. Fishers sought fish or whales and, even when whalers first pointed their bows toward the open ocean in pursuit of sperm whales, their goal was their prey. The point of setting sail was always to get back to land expeditiously. The shift was a social one, wrought by the whalers, novelists, scientists and other seafarers who began to embrace the notion of going *to* sea. Many professional mariners did not share this essentially landlubberly perspective, but the new seafarers who embarked for the purpose of experiencing the sea understood the ocean itself as their destination. Their stories conveyed to armchair sailors the sense of the sea as a place where people tested themselves against nature, creating a stage for heroism, recreation, personal transformation, national triumph or control of natural forces. Sounding, science and submarine telegraphy rendered the sea culturally visible and helped enlarge the human relationship with the ocean to encompass its entirety.

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