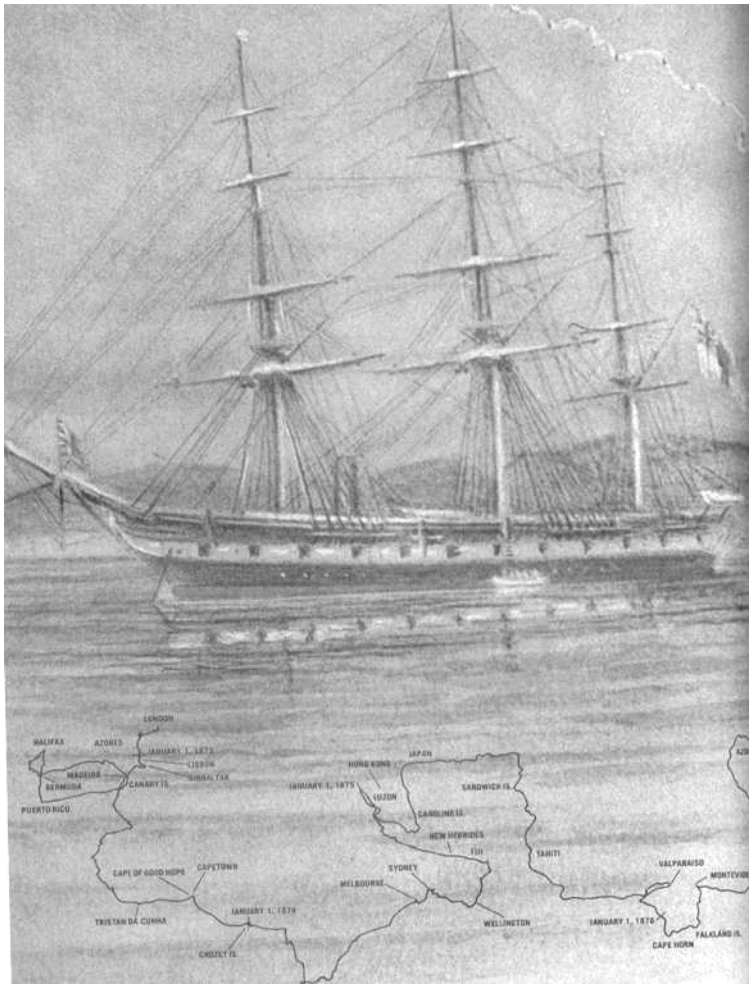
EXPLORERS OF THE OCEAN DEPTHS

The Challenger Expedition of 1872-1876

By Phillip Drennon Thomas



A century ago last December, there began one of the momentous endeavors in the history of scientific exploration. On the 21st of December, 1872, H.M.S. CHALLENGER cast off her moorings at Portsmouth, England, and embarked upon a voyage of oceanographic discovery which would last almost three and a half years. During this 41-month cruise, the CHALLENGER made observations in all of the world's oceans, except for the Arctic, crossed the Equator six times, sailed a distance of 68,890 miles, and made soundings at 362 stations.[1] More importantly, the data and new specimens collected on this expedition broadened the horizons of marine science and popularized the study of oceanography among nineteenth-century scientists.

Although popular tradition bestows upon the Challenger Expedition the honor of beginning modern oceanography, more realistically it was the fulfillment on a grand scale of the aspirations of a number of marine scientists. It was clearly the first major, sustained effort to systematically investigate the depths, temperatures, and fauna of the oceans of the world. The publication of the results of the expedition in the multi-volume Report on the Scientific Results of the Voyage of H.M.S. Challenger provided widespread dissemination of the most current knowledge of oceanographic subjects. The inaugural volume commented upon the basic premise which precipitated this voyage: "The vast ocean lay scientifically unexplored. All the efforts of the previous decade had been directed to the strips of water round the coast and to enclosed or partially enclosed seas; great things had certainly been done there, but as certainly far greater things remained to be done beyond. This consideration led to the conception of the idea of a great exploring expedition which should circumnavigate the globe, find out the most profound abysses of the ocean, and extract from them some sign of what went on at the greatest depths."[2]

The conception for this project was originally developed by the talented British naturalist, William B. Carpenter. An early supporter of Darwin and a respected physiologist, in his later years Carpenter became interested in marine science. In 1868 and 1869, in cooperation with Charles Wyville Thomson, Carpenter sought support from the British Admiralty for an investigation of marine life at depths beyond 300 fathoms. Thomson — who became Regius Professor of Natural History at the University of Edinburgh in 1870, a position held by Edward Forbes fifteen years earlier — had become interested in deep-sea fauna after a meeting with the distinguished Norwegian scientist, Michael Sars, in 1866. While visiting Sars at Christiania (now Oslo), Thomson had the opportunity to examine animals collected by his host's son at depths beyond 300 fathoms. Thomson's interest in these specimens led him to question the azoic hypothesis of Edward Forbes, one of his earliest mentors in marine science. Forbes believed that in depths beyond 300 fathoms marine life would cease to exist.

Carpenter, who was at that time Vice President of the Royal Society, persuaded the Admiralty to provide them with a ship. In August 1868, on board the obstreperous paddle steamer H.M.S. LIGHTNING, Thomson and Carpenter began their work. Thomson recorded his, thoughts on this voyage. "Through about two months of wretched weather, we knocked about in LIGHTNING, a somewhat precarious little gun-boat, between Scotland and Faeroe. Nine tolerable days fortunately checkered the uniformity of heavy weather, and on these we registered some remarkable results. We found that there was an abundance of animal life at the bottom of the sea to a depth of 600 fathoms at least, and that the life there was not confined to the more simply organized animals, but extended very irrespective through all the invertebrate classes, and even, included some true bony fishes."[3]

Forbes' azoic theory was not the only widely held belief seriously questioned by the results of the LIGHTNING'S cruise. Perhaps the most surprising discovery of the voyage was the anomalies encountered in temperatures taken at similar depths but in different regions. This led the two scientists to reexamine the traditional belief in a relatively constant submarine temperature below certain depths. As Thomson noted, "we had adopted the current strange misconception with regard to ocean temperature; and it is perhaps scarcely a valid excuse that the fallacy of a universal and constant temperature of 4°C below a certain depth and varying according to latitude, was at the time accepted and taught by nearly all the leading authorities in Physical Geography."[4]

Both the success of and questions raised by the LIGHTNING'S brief cruise, stimulated interest in further deep-sea investigations. Consequently, in the summer of 1869, H.M.S. PORCUPINE was placed at the disposal of Carpenter, Thomson, and Gwyn Jeffreys, an eminent British conchologist. From May to September of 1869, the PORCUPINE made three different voyages, and she was again used in 1870. "The PORCUPINE . . . was much better suited in every way to our purposes than the LIGHTNING. The weather was more favourable, and we succeeded in dredging to the depth of 2,435 fathoms, and establishing the fact that even at that depth the invertebrate sub-kingdoms are still fairly represented."[5] A new dimension was now added to the research, for Carpenter and Thomson began to analyze the chemical composition of seawater obtained from various depths.

They were convinced that the cruises of the LIGHTNING and PORCUPINE had opened up a new realm for scientific investigations. As Thomson observed, "I had long previously had a profound conviction that the land of promise for the naturalist, the

only remaining region where there were endless novelties of extraordinary interest ready to the hand which had the means of gathering them, was the bottom of the deep sea."[6] They believed there was an immediate need to expand their investigations to the world's oceans. Carpenter had conceived of a voyage of oceanographic circumnavigation in 1869, but it wasn't until the summer of 1871 that he began to actively pursue the idea. In a remarkably short time for a project of this magnitude, a proposal was submitted by the Royal Society to the British Admiralty (December 8,1871), support was granted by the government (March 2, 1872), and the House of Commons voted funds for the expedition (April, 1872). One of the telling arguments in the government's consent to support this project was the fact — one that even Punch alluded to — that the voyage would not cost much more than keeping the vessel in commission for regular naval duty. Preparation of the vessel, pilotage, fuel, and salaries for the voyage were approximately 75,000 pounds, while the scientific salaries and supplies were around 15,000 pounds. Queen Victoria's government did not realize in 1872 that in later years they would expend almost as many pounds to publish the Reports of the expedition as they had to fund the cruise itself. Ultimately, almost 200,000 pounds were expended for both the cruise and publication program.[7] A monumental sum in Victorian England, but one which befitted a truly remarkable project.

Other arguments, as well as the financial one, led to support for this venture. There was the traditional British pride in the nation's prowess upon the sea, for example. In words which reflected England's national noblesse oblige towards marine affairs, Thomson commented: "Our cousins across the Atlantic had been working along with us pari passu, and ere long several of the European states sent out deep-sea expeditions more or less effective. None of these were attended with any great amount of success, and it seemed evident that England must give, at all events the first broad outline of the physical conditions of the bed of the ocean."[8]

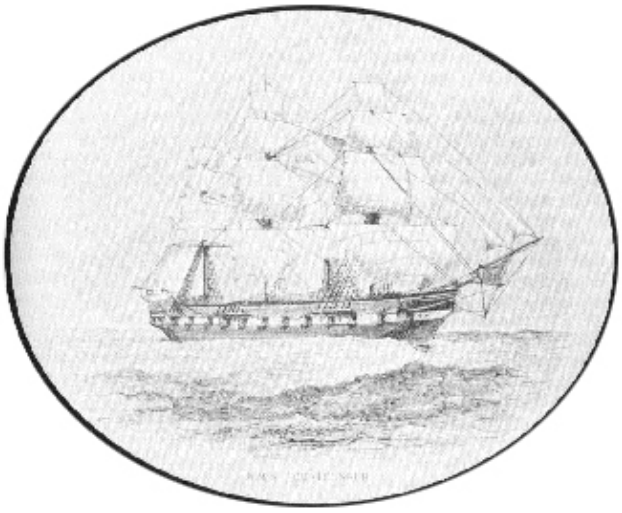
In addition to the purely scientific justifications for such an expedition, there were also practical considerations. The growth of marine telegraphy required more precise knowledge of undersea conditions. These factors led to public acceptance, if not avid support. Thomson was aware of this, and he noted that "public interest was now fairly aroused in the new field of research. The rapid development of ocean telegraphic communication made all these results which affected telegraphy in any way—the precise depth, the nature and composition of the bottom, the presence or absence of animals capable of making inroads into hemp or gutta-percha, the temperature of the water through which telegraph cables might have to pass—of the highest practical value; while the novelty and peculiarity of many of the observations awakened a wide-spread curiosity and interest in even the purely scientific bearings of the inquiry."[9] With Carpenter's decision not to accompany the expedition, the Royal Society suggested that the leadership of "Scientific Civilian Staff" be entrusted to Thomson. One of the most popular teachers of natural history at Edinburgh, Thomson resigned his professorship, and for 1,000 pounds a year accepted the responsibility of directing the scientific work of the expedition. John Young Buchanan was selected as staff chemist, and it was he who later discovered that the strange nodules the CHALLENGER's dredges recovered from the depths were composed of manganese peroxide.

Henry Nottidge Moseley, John Murray, and Rudolph von Willemoes Suhm served as naturalists for the expedition. Suhm unfortunately died of erysipelas in the third year of the voyage. Moseley later married Gwyn Jeffreys' daughter, and in 1881 became a

professor of anatomy at Oxford. Their son was the distinguished physicist, Henry Gwyn-Jeffreys Moseley, killed in World War I.

Of the naturalists who accompanied the expedition, John Murray had the most distinguished post-CHALLENGER career. Indefatigably energetic, Murray had studied medicine at Edinburgh but had never taken his degree. During the voyage, he was assigned responsibility for plankton studies, deep-sea deposits, and the investigation of the origin and formation of coral islands. After Thomson's death in 1882, Murray painstakingly supervised the completion of the CHALLENGER's scientific reports, a task which took a further thirteen years. In the course of this work, Murray became the only CHALLENGER scientist to become wealthy from his scientific efforts. While examining a rock sample from Christmas Island in order to compare it with a CHALLENGER sample, he discovered that the island specimen contained phosphates. At Murray's suggestion, Christmas Island was annexed by the British government in 1888. Murray then formed a company which developed the phosphate deposits. The British eventually collected more funds in taxes and royalties on these deposits than they had expended on the entire Challenger Expedition. Murray later used some of his wealth to subsidize oceanographic studies.

For the use of the expedition, the Admiralty designated the 2,306-ton steam corvette, H.M.S. CHALLENGER. With a spar upper deck and 1,234 horsepower engine, the CHALLENGER was ideally suited for the work before her. From June to November of 1872, the ship was modified for her special assignment. All but two of her eighteen guns were removed. In order to have working space for the scientists, a carefully designed 18-by-12-foot zoological laboratory was erected on the port side of the gun deck. On the starboard side, a chart room of the same dimensions was built for the surveying officers. A chemical lab and a photographic room were also constructed. Unfortunately, the photographer jumped ship in the middle of the cruise to hunt for diamonds. Beneath the mainmast on the port side a pair of nine-horsepower donkey engines were installed to raise the dredge and sounding apparatus. With a coal reserve of only 240 tons, steam power was allocated almost exclusively to the critical operations of sounding and dredging. The voyage itself was made almost entirely under sail. When the CHALLENGER sailed, she was equipped with the most modern scientific equipment; and she carried almost 144 miles of sounding rope and twelve miles of sounding wire.



H. M. S. Challenger

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

To command the 240-man crew of the CHALLENGER, an experienced survey officer, Captain George S. Nares, was appointed. He proved to be an excellent choice. He fulfilled not only his naval responsibilities, but also skillfully integrated the civilian staff into the occasionally "vexatious" shipboard life. In December 1874, Nares left the CHALLENGER at Hong Kong to assume command of the British Arctic Expedition of 1875-1876. Captain Frank Tourle Thomson took his place. Life on board the CHALLENGER involved much monotonous work for the crew, and some deserted during the voyage. Seven lives were lost during the 41 months of the expedition. Surprisingly, in such a large crew and for an expedition of this nature, there were no skilled fishermen aboard. Official notice was taken of this: "It is most important that on any future scientific expedition it should be arranged, if possible, that some of the seamen composing the crew should have been trained as fishermen. It might be expected that plenty of fishermen would be met with in any ship's company but such is not the case; the men in the navy are mostly such as have been trained for special duties."[10]

The Admiralty's instructions to Captain Nares were quite clear. "The main object of the voyage is to investigate the physical condition of the deep sea throughout the three great ocean basins, that is, to ascertain their depth, temperature, circulation, & c., to examine the physical and chemical characters of their deposits, and to determine the distribution of organic life throughout the areas traversed, at the surface, at intermediate depths, and especially at the deep ocean bottom.

"As secondary but by no means unimportant objects, are the hydrographical examination of all unknown or partially explored regions which you may visit, a diligent search for all doubtful dangers which may be in or near your track, with a view to expunging them from the charts or definitely determining their positions, a careful series of magnetical and meteorological data, and the observation and record generally of all those oceanic and atmospherical phenomena which, when faithfully recorded, afford the means of compiling practical information of the greatest importance to seamen....

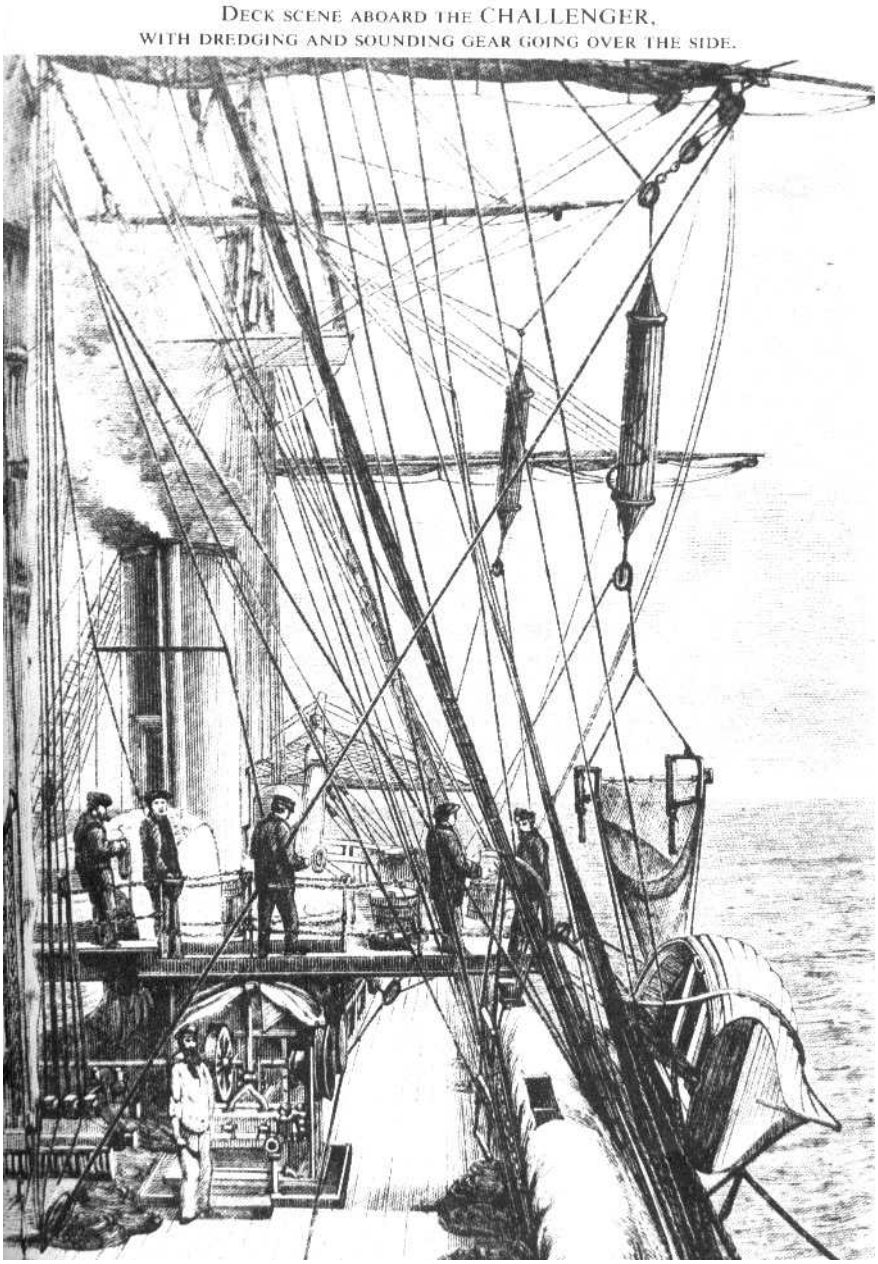
"If any one of the various objects of the expedition is more important than another, it may be said to be the accurate determination of the depth of the ocean, for on this must depend many other problems of deep scientific interest.

"If the bottom is reached by the sounding line, late experience has shown that it can be examined by the dredge even at very great depths; thus the existence and distribution of organic life is ascertained, as well as the temperature, specific gravity, and chemical condition of the sea from the surface to the bottom. With this view you have been abundantly supplied with all the instruments and apparatus which modern science and practical experience have been able to suggest and devise, and, with the exception of a few beaten tracks in the Atlantic and other isolated lines through the Indian Ocean, you have a wide field and virgin ground before you.

"Independently of the great scientific interest which attaches to these experiments, it is to be remembered that the rapidly progressing establishment of electric communication between all parts of the earth renders it most important that the accurate depths of the ocean and the character and temperature of its bed should be known."[11]

The Royal Society recommended to the Admiralty, and the Admiralty agreed, that the functions of the Challenger Expedition could best be accomplished by having the ship "pass down the coast of Portugal and Spain, to cross the Atlantic from Madeira to

the West-lndian Islands, to go to Bermuda, thence to the Azores, the Cape Verde Islands, the Coast of South America, and across the South Atlantic to the Cape of Good Hope. Thence by the Marion Islands, the Crozets, and Kerguelen Land, to Australia and New Zealand, going southwards en route, opposite the centre of the Indian Ocean, as near as may be with convenience and safety to the southern Ice-barrier. From New Zealand through the Coral Sea and Torres Straits, westward between Lombok and Bali, and thence through the Celebes and Sulu Seas to Manila, then eastward into the Pacific, visiting New Guinea, New Britain, the Solomon Islands; and afterwards to Japan, where some considerable time might be profitably spent. From Japan the course would be directed across the Pacific to Vancouver Island, then southerly through the eastern trough of the Pacific, and homewards round Cape Horn. This route will give an opportunity of examining many of the principal ocean phenomena, including the Gulfstream and Equatorial currents; some of the biological conditions of the sea of the Antilles; the fauna of the deep water of the South Atlantic, which is as yet unknown, and the specially interesting fauna of the borders of the Antarctic."[12] The expedition held rather faithfully to this itinerary. In the southern waters, the CHALLENGER may have been the first steamship to cross the Antarctic Circle. While examining icebergs, she collided with one and suffered minor damage.


DECK SCENE ABOARD THE CHALLENGER,
WITH DREDGING AND SOUNDING GEAR GOING OVER THE SIDE.

In order to fulfill her scientific mission, the CHALLENGER had to stop at approximately every two hundred miles along her track to sound, dredge, and make other necessary observations. In the words of one of the naval sublieutenants, this made for "dull sailing" and our "cruises at sea very long and wearisome."[13] Initially, the whole crew was interested in the

dredging operations, for, as Moseley recorded: "At first, when the dredge came up, every man and boy in the ship who could possibly slip away, crowded round it, to see what had been fished up. Gradually, as the novelty of the thing wore off, the crowd became smaller and smaller until at last only the scientific staff and usually Staff Surgeon Crosbie, and perhaps one or two others besides the one on duty, awaited the arrival of the net on the dredging bridge; and as the same tedious animals kept appearing from the depths in all parts of the world, the ardour of the scientific staff even abated somewhat, and on some occasions the members were not all present at the critical moment, especially when this occurred in the middle of dinner-time, as it had an unfortunate propensity of doing. It is possible even for a naturalist to get weary of deep sea dredging. Sir Wyville Thomson's enthusiasm never flagged, and I do not think he ever missed the arrival of the net at the surface."[14]

Dredging, or as the bluejackets called it, "drudging," was the most difficult operation performed at sea, and one which led to occasional disagreements. Moseley, who was keenly interested in these operations, observed that "often when the dredge or trawl appeared there was nothing in it at all, and then frequently a somewhat warm debate ensued between the members of the scientific staff and the naval officers as to whether the instrument had ever been on the bottom or no, the scientific view being that it had not."[15]

Lord George Campbell, who was serving as a naval sublieutenant on the CHALLENGER, saw these operations in a less sanguine light. "Dredging, I may say without fear of contradiction, was our — the naval officers' bete noir. The romance of deep-water trawling or dredging in the CHALLENGER, when repeated several hundred times, was regarded from two points of view; the one was the naval officer's, who had to stand for ten or twelve hours at a stretch carrying on the work, and who, always excepting that he did not like his day's work to have been done in vain, did not know much about, or scientifically appreciate, the minute differences between one starfish, one shrimp, one sea cucumber, one sea-urchin, and another. The other point of view was the naturalist's, to whom the whole cruise was a yachting expedition, who had not to carry on the practical working of the dredge, to whom some new worm, coral, or echinoderm, is a joy forever, who retires to a comfortable cabin to describe with enthusiasm this new animal, which we, without much enthusiasm, and with more weariness of spirit, to the rumbling tune of the donkey-engine only, had dragged up for him from the bottom of the sea."[16]

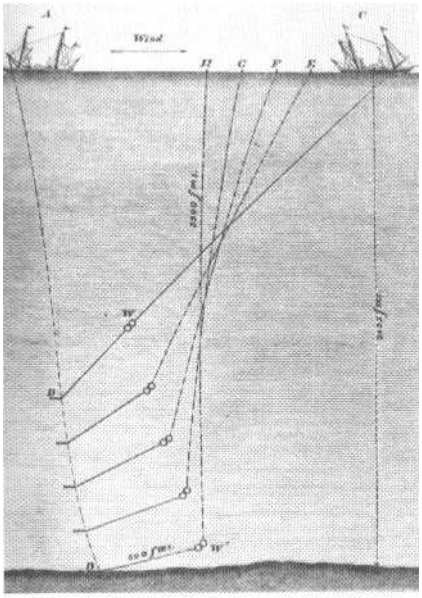


DIAGRAM OF THE RELATIVE POSITION OF THE SHIP, THE WEIGHTS, AND THE DREDGE, IN DEEPWATER DREDGING.

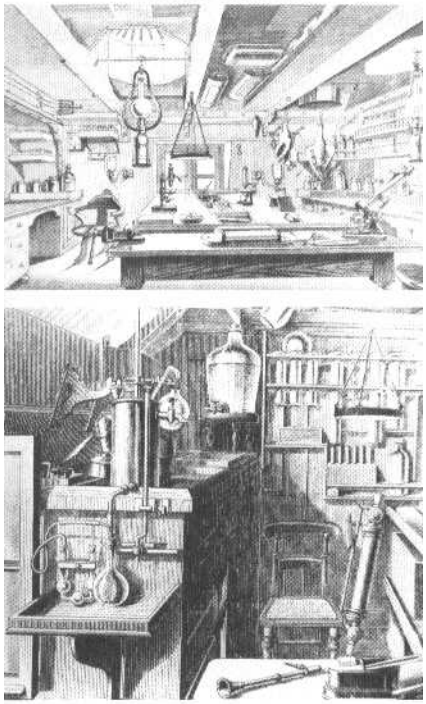
Campbell even had a more personal criticism of some of the scientific labors. "I may here say that, excepting on one occasion, the trawl never assisted our cuisine. Trawling at 3,000 fms. is not the same, as far as results go, as trawling on the English coast in 60 fms. If fish did come up, which they did in numbers between none and nineteen, they were all invaluably rare, or of totally new species — fit only for the delectation of science, not for the hungry sailor."[17]

Sounding was a less onerous but nevertheless time-consuming operation, and a procedure which had to be performed under steam. Navigating sublieutenant Herbert Swire commented upon the task in which he

was frequently involved: "It has been found that in all deep soundings it is absolutely necessary to use steam power. No trustworthy results can be obtained from a ship under sail, as even in the calmest weather the heave of the sea, or the surface current, is sufficient to drift the ship in a very short time a considerable distance from the place where the lead was originally let go."[18] Moseley recorded that "the vastness of the depth of the Ocean was constantly brought home to us on board the CHALLENGER by the tedious length of time required for the operation of sounding, and dredging in it.

When the heavy sounding weight is dropped, with the line attached, it takes about an hour and a quarter to fall to the depth of 4,500 fathoms, and thirty-five minutes to reach the bottom in the average depth of 2,500 fathoms."[19]

Even a parrot on board the CHALLENGER referred to these operations. Suhm had a trained parrot which frequently squawked out "What! two thousand fathoms, and no bottom! Ah, Doctor Carpenter, F.R.S." The CHALLENGER made her deepest sounding when she found a trench 26,580 feet deep off the Mariana Islands (latitude 11°24' N, longitude 143° 16' E).



(ABOVE) THE ZOOLOGICAL LABORATORY.
(BELOW) THE CHEMICAL LABORATORY.

At last the sounding and dredging came to an end, and on May 24, 1876, H.M.S. CHALLENGER returned to the berth from which she had departed in the winter of 1872. Much work still lay before the members of the staff, for the enormous amount of data and specimens had to be organized and distributed among other scientists for detailed study. The CHALLENGER probably returned with more data and specimens than any other expedition up to that period in history. Confronted by this enormous amount of material, the CHALLENGER scientists were confronted by a strikingly modern problem: what was the best way to analyze and present the scientific results of the voyage? Thomson was responsible for the publication of the scientific data, and he was immediately confronted by a host of petty and bureaucratic problems.

The British Museum wanted the natural history specimens placed under their supervision, but Thomson refused to bow to their will. The specimens were taken to Edinburgh and then distributed to qualified scientists for study. Even then, local scientific societies constantly sought portions of the Challenger collections for their own displays. Debate quickly arose over the selection of scientists to analyze the data. Thomson insisted that the developing science of oceanography could best be served by selecting the leading specialist in each field to work up the materials. This meant the inclusion of foreign scholars, and it sparked a heated debate among British scientists. The successful return of the CHALLENGER kindled a new interest in marine science among English scientists, and scholars who had earlier demonstrated at best a casual attitude toward this field now wanted to participate in the preparation of the reports. When they learned that Thomson was adamant about using international scholars, they sought to have him alter his position. They argued that the expedition had been

undertaken in a British vessel and funded with British sterling. Fortunately, this scientific chauvinism did not prevail, and a group of skilled international scientists was assembled to prepare the monographs on the data. T. H. Huxley, Alexander Agassiz, and Ernst Haeckel were among the scholars who participated. The demanding work of editing and publishing the results of the expedition overtaxed Thomson's health, and he died in March 1882. John Murray now assumed the editorship of the reports; and he carefully supervised publication until their conclusion.

While many clearly acknowledged the importance of both the expedition and the Reports, there was occasional criticism from those who neither understood nor appreciated the importance of the developing science of oceanography. One newspaper critiqued the expedition in that vein: "The first volume recording the adventures of the Challenger yachting trip is now out, and the other fifty-nine will be ready in less than a century. Everybody knows that Mr. Lowe sent a man-of-war away laden with Professors, and that these learned individuals amused themselves for four years. They played with thermometers, they fished at all depths from two feet to three miles; they brought up bucketfuls of stuff from the deep sea bottom, and they all pottered about and imagined they were furthering the grand Cause of Science. Then the tons of rubbish were brought home, and the genius who bossed the excursion proceeded to employ a swarm of foreigners to write monographs on the specimens. There were plenty of good scientific men in England, but the true philosopher is nothing if not cosmopolitan; so the taxpayers' money was employed in feeding a mob of Germans and other aliens. The whole business has cost two hundred thousand pounds; and in return for this sum we have got one lumbering volume of statistics, and a complete set of squabbles which are going on briskly wherever two or three philosophers are gathered together. I believe the expedition discovered one new species of shrimp, but I am not quite sure." [20]

While the Challenger Expedition began to articulate answers to many of the important questions of oceanography, it also uncovered just as many new questions that would have to be answered by further deep-sea investigations. There were many accomplishments, particularly in the realm of zoology. Over 700 new genera and 4,000 new species were discovered by the CHALLENGER's scientists. In the realm of physical oceanography, the expedition did not accomplish as much as in the fields of zoology. It collected the first systematic record of currents, temperatures, and depths from the great oceans. With these data, the question of oceanic circulation was debated but not successfully resolved; and the characteristics of the sea floor at great depths began to be carefully studied. Thomas Huxley's mysterious Bathybius was at last shown to be not a form of protoplasm from the ocean's depths but instead a precipitate of calcium sulfate which appeared when marine specimens were preserved in alcohol.

The Challenger Expedition on the whole dramatically fulfilled the mission with which it had been charged. It had circumnavigated the globe and had found the "most profound abysses of the ocean," extracting "from them some sign of what went on at the greatest depths."

Explorers of the Ocean Depths

FOOTNOTES

[1] Sir Charles Wyville Thomson, *The Voyage of the Challenger*, Vol. 1, p. xvi.

[2] Sir Charles Wyville Thomson and John Murray (ed.), *Report on the Scientific Results of the Voyage of H.M.S. Challenger* , Vol. I, part 1, p. 1.

[3] Thomson, *The Voyage of the Challenger*, Vol .I, p. 5.

[4] Sir Charles Wyville Thomson, *The Depths of the Sea*, pp. 56-57.

[5] Thomson, *The Voyage of the Challenger*, Vol. I, p. 6.

[6] Thomson, *The Depths of the Sea*, p. 49.

[7] Harold Burstyn, "Science and Government in the Nineteenth Century: The Challenger Expedition and Its Report," *Bulletin De L'lnstitut Oceanographique*, Numero special 2, Vol. 2, p. 606.

[8] Thomson, *The Voyage of the Challenger*, Vol. I, p. 8.

[9] Ibid., pp. 7-8.

[10] Thomson and Murray, *Report on the Scientific Results*, Vol. I, part 1, p. 10.

[11] Ibid., p. 34

[12] Ibid., p. 23.

[13] Lord George Campbell, *Log-Letters from "The Challenger*," pp. 482-83.

[14] H. N. Moseley, *Notes by a Naturalist Made During the Voyage of H.M.S. Challenger*, p. 501.

[15] Ibid., p. 502.

[16] Campbell, *Log-Letters*, p. 494.

[17] Ibid. p. 478

[18] W.J.J. Spry, *The Cruise of Her Majesty's Ship "Challenger,"* ,p. 43.

[19] Moseley, *Notes by a Naturalist*, p. 501.

[20] Margaret Deacon, *Scientists and the Sea*, 1650-1900, p. 378.

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