The Archive of American Journalism
Ray Stannard Baker Collection

McClure's Magazine
December, 1900

The Bottom of the Sea

An Authorized Account of the Researches of Sir John Murray in the Science of Oceanography

OF all the cargoes that the ships of the sea ever brought into port in all the years that ships have sailed, without doubt the strangest and most wonderful was the cargo of the famous ship "Challenger. " In the year 1872 the "Challenger" sailed from Sheerness in England without a cargo and without a destination. She was a man-o'- war, a square-rigged three-master, commanded by officers of the Royal Navy, and .having on board some of the most eminent scientists of Great Britain. For nearly four years she sailed the seas of both hemispheres, from the Arctic to the Antarctic, infrequently touching land and yet constantly accumulating her strange cargo. She dragged the ocean with nets, not only for the ordinary fish of the sea, but for the myriad forms of lesser life which feed in its vast blue meadows; she let down dredges and sounding plummets into the deep, mysterious valleys of the sea bottom; she explored all but limitless plains, desert with black darkness, and cold, and never-broken silence. In single dredgings she brought upon the eyes of man quantities of primeval ooze that had required the slow accumulations of a million centuries, perhaps, to deposit; she discovered submarine rivers, some of them flowing outward from the land and rising like a fountain from the ocean bottom; she learned of new and mighty ocean currents, not the surface currents known to navigators, but those which creep along the sea bottom, a foot in a century, perhaps, carrying life-giving oxygen to the creatures of the deep sea; she located stupendous mountain ranges and volcanoes, with precipices and declivities so awful that it is well, perhaps, that they are hidden forever from the eye of man. And as evidence of the almost inconceivable strangeness of the bottom of the sea, she brought back some of its denizens, both vegetable and animal— the appropriate creatures of cold and darkness and the crowding presence of the seas—odd, pulpy, warty fishes, some blind, some with eyes greatly developed, some that peer their way about these depths with lanterns, and a thousand other forms of life equally strange. And of the thousands of specimens collected few had ever before been seen by the eye of man.

It is not often that a ship sails away for a brief four years and brings back a new science; but that was the accomplishment of the "Challenger," and the science thus founded is now known as Oceanography. Not quite four years was expended in exploration and observation; but it required nearly five times as long to place the results in orderly and comprehensive form before the world. It was not until 1895 that the final volume of the great report of the expedition, which might well have been called the "Book of Oceanography," was published. This report is not only one of the very greatest of existing works of science, but in mere material mass it is quite the biggest book ever produced. It is published in fifty royal octavo volumes containing 29,500 pages, 3,000 plates, and a large number of maps and pictures. This stupendous work, which will always remain one of the greatest monuments to English science, was under the direction, during the first few years after the return of the Challenger" of Sir Wyville Thompson, and, after his death, of Sir John Murray. Eminent

scientists in all parts of the world had a part in making the reports—Haeckel of Germany, Agassiz of the United States, Renard of Belgium, and others equally celebrated. Since the time of the "Challenger" there have been other deep-sea exploring expeditions, notably those of Agassiz, and of Chun of Germany, the report of whose voyage in the "Valdivia" is just now being published. All these explorations may be said to have laid bare the floor of the sea, so that it is better known and more carefully charted in many places than certain regions of the land. And yet the deep sea will ever be the home of mystery—an inexhaustible field of discovery, a place where the human imagination may run riot, and yet never reach the limit of wonder.

For many years Sir John Murray, the director of the "Challenger" work, has been the foremost authority in all questions pertaining to the new science. All the dredgings made by scientists the world over, including those taken by the cable companies while making surveys of proposed cable routes, find their way, sooner or later, into his hands and are examined at his laboratory. It was my pleasure to spend some time recently with Sir John Murray at his home in Scotland, and to hear from him some account of the recent developments in the knowledge of the deep sea. During my stay in Edinburgh Sir John Murray was working on a series of dredgings made by a recent German expedition. A little incident in the course of the investigation will show how thoroughly the sea bottom is known to a scientist who, like Murray, has devoted his whole life to its study. The dredgings came in small bottles; they were mostly grayish or reddish in color, fine of texture, and, to the ordinary eye, as much alike as so many peas. An assistant had placed a sample from one of the bottles under the microscope. Murray looked at it, and, although having no knowledge as to what part of the world of water it was from, he said, after a brief examination:

"This was dredged off the northern coast of Africa in about 900 fathoms of water."

The assistant looked at the label; the soil was from the ocean bottom near the Cape Verde Islands, depth 1,000 fathoms. Extraordinary as it may seem, Murray had been able to give the location correctly at sight, the depth almost correctly, certainly a convincing evidence of the development of the science of the sea, almost unknown thirty years ago. It reminded one of the famous skipper of Nantucket—the one of the old ballad— who could tell the exact location of his ship in fair weather or foul by the taste of the soil which his sounding lead had brought up.

Although Sir John Murray has already done what, for many men, would constitute a life's work in science, having won most of the rewards which learned societies and universities can bestow, from the famous Prix Cuvier down, he is still in the prime of life, a man not yet gray, of robust physique and unbounded energy. Besides the deep-sea work, in every minute development of which he is interested, he is now working on a bathymetric survey of the Scotch lochs, and promoting a Scottish Antarctic expedition, it being his firm belief that a thorough survey of the sea bottom in the regions of the South Pole will yield profoundly important scientific results, especially as regards scientific knowledge of deep-sea life.

Murray tells you that he is an American by birth—he was born in Canada—but he has lived nearly all his life in Scotland. His home is just in the outskirts of Edinburgh on the shore of the Firth of Forth, where he can always hear the sound of the sea. It is a fine old stone building, pillared in front and surrounded by wide green lawns and ample grounds. He calls it "Challenger Lodge." He is a world-wide traveler —when I saw him he was planning a voyage to Java—a broad thinker, and a most entertaining talker—a man whom it is good to meet.

When Murray began his work in oceanography some thirty-eight years ago, scientific knowledge of the sea was meager and unsatisfactory. Something over three-fifths of the globe is covered with water, and there is a greater amount of life—far greater—both vegetable and

animal in the water than on the land, and yet this storehouse of wonder—the great swarming seas of the world—had been almost unexplored. Huxley had awakened interest in the deep sea by the enthusiastic announcement of his famous Bathybius theory. In the course of examining a number of deep-water dredgings he had discovered traces of a gray gelatinous mass, somewhat resembling protoplasm. This he designated the primeval living slime, the unorganized beginning of life. It was a suggestion that caught the imagination; here deep in the sea bottom, in darkness and cold, floated, as it had floated from the beginning, the essence of life from which the whole earth had been clothed with the green of plants and populated with thousands of varying forms of animal life. And if all life on land were to be laid low in a night, here waited the slow, dull life-stock upon which could be built anew the fabric of creation.

But when Sir John Murray and the other scientists on the "Challenger" began to study the problem, they found that Huxley had been misled by the fact that strong alcohol, such as had been used for preserving the specimens collected, will throw down a chemical gelatinous precipitate from sea water; this flocculent mass Huxley had erroneously called the Bathybius. A beautiful theory was thus demolished, but the structure of facts reared in its place was quite as wonderful.

Instead of being the first place on the earth to be inhabited, the deep sea, according to the conclusions of the scientists of the "Challenger," was the last. As life became multitudinous in shallow water, and competition for food grew stronger, the weak species were slowly driven into the deeper, colder, and darker depths of the sea, where they could live their lives with less interference, and their bodies became slowly modified to suit the new conditions. As a consequence, life is now found everywhere in the sea, even in those awful deeps five miles and more below the surface of the water. The entire surface of the world's oceans, though the water may seem ever so clear, is filled with life. To a depth of 300 feet there are both animals and plants; below that plant life ceases, and there are only animals. Indeed, the whole sea surface is a vast, rich meadow which supports the life of countless millions of animals, both in the surface waters and on the ocean floor miles beneath. These animals, feeding in their own waving green pastures, are in turn the prey of larger animals, and in dying they drop down where the slow, crawling creatures of the great depths are lying in wait for them. If it were not for this swarming life, the ocean would appear a dense black, for these little creatures serve to reflect the light of the sun and give the appearance of color to the water. In the greater depths of the sea, as is now well established, there is no light whatever, the rays of the sun penetrating only a few hundred feet. Some of the fish that live here have, therefore, developed a curious whip-like projection above their heads, on the end of which grows a real lantern, a small bulb producing phosphorescent light. Most of them have huge mouths, and as they swim slowly about through the water other fish, perhaps some of those which have developed enormously large eyes, are lured straight into the cavernous mouth of the lantern-bearer, there to be digested at leisure. Other fish there are that creep their lives out on the sea floor, sluggishly taking in the ooze and digesting the bits of vegetable or animal substances that remain to it after it has fallen through miles of sea water. Sir John Murray thinks it probable that fully three-quarters of the deposits now covering the ocean bottom have passed thus through the alimentary canals of marine animals.

Many animals of the deep sea are able to produce phosphorescent light, so that although no sunshine ever penetrates so deep, and many fishes, through centuries of almost total darkness, have lost their power of sight, there is yet some light even here. If one were able to take his place on a sea cliff two miles below the ocean level he would probably see thousands of queer, glowing, moving lights, like holes in black darkness, such as men cannot well imagine. Some of them would appear like bright points, fairly clear, while others would be mere hazy nebulae.

Here in these vast depths, as on the land, the struggle for life is forever in progress, the strong preying on the weak; and whether strong or weak, every creature of the sea must keep his place in his own depth of water. No man-made social rule of caste ever kept the lowborn creature in his lowborn place as does this unlettered law of the deep sea. Water is water, one thinks, and all of it is therefore free to the swimming creature; but no fish of the deep sea, accustomed as it is to the enormous weights of water above it—at two miles deep there is a pressure of over two tons to the square inch—may venture to swim upward out of its depths. It sometimes happens that a deep-sea fish, in the excitement of chasing its prey, gets out of its depth and goes tumbling upward. As the pressure is relieved it swells rapidly and finally bursts, and scientists may find its terribly mutilated body floating on the surface of the water. All deep-sea fish when brought up in dredges are dead and usually badly broken, so little are they adapted to the surroundings with which man is familiar.

It is difficult to realize what this pressure at the ocean bottom really means; how enormous it is at three miles in depth. It is greater by several times than the pressure exerted by the pistons of the very greatest steam-engines. Scientific men ascertain the temperature of the deep sea by sending down thermometers enclosed in small, strong, thick glass tubes. Sometimes these tubes suddenly collapse to a fine powder under the enormous pressure of several miles of depth. Indeed, one may say every hollow, manmade thing that sinks in the deep sea is crushed beyond recognition before it reaches the bottom. The strongest steel ships are hardly more resisting here than pasteboard boxes. It is astonishing how little people who cross the ocean—I mean passengers—think of these wonders beneath them; but John Tar of the fo'c'stle, who has lived at sea long enough to feel its mighty mysteries—he thinks! It is a very real terror that dwells beneath him. Sir John Murray tells how the fo'c'stle once sent a deputation to him to ask what had become of Jim. Jim had died the day before, and, sewed in sail-cloth, his body had slipped over the side in mid-ocean. Part of the fo'c'stle asserted that Jim would never reach bottom and part asserted that he would. Murray explained the crushing pressure of the water; how one by one the bones would be broken in—implosion, science calls it; how the flesh would be crushed into the interstices of the bones, and the clothing flattened over them, until, on reaching the bottom, the body would probably not be larger than a man's wrist. It is a gruesome thought, and yet nothing could give a more impressive idea of the awful power of the deep sea.

It is a belief common among sailors that a wreck never goes to the bottom; that it sinks until the pressure of the water holds it fast, and there, rocking about in the shadowy depths, it slowly dissolves. What food for the imagination lies in this fleet of the lost navies of the world, still floating up and down in the deep, meeting and passing in silence, no voice ever calling through the dark, no sail ever rising to a breeze. Kipling has voiced this idea in one of his poems:

"The wrecks dissolve above us; their dust drops down from afar—
Down to the dark, the utter dark, where the blind white sea snakes are."

It is unfortunate, however, that the poetic view is not the scientific view.

"Anything that will sink in a glass of water," says Sir John Murray, "will practically sink to the bottom of the deepest sea."

Murray points out that water is one of the most incompressible of substances; that although the pressure may be enormous at the ocean bottom, the water is only a very little more dense than at the surface. And yet the compression is sufficient, so that if it were suddenly released, say by the suspension of the attraction of gravitation, and all the water over all the globe should expand until it was of the same density as the surface water, the

oceans would instantly rise some 500 feet, covering practically all the inhabited land in the world.

The question as to whether man will ever be able to descend into the depths of the ocean and make direct explorations of its varied life and discover treasures of derelict gold, has always furnished rich fruit for speculation. It is not wise in these days of mechanical wonder to place too positive a limit to man's accomplishment, but it is probable that man's eyes will never look upon the bottom of the sea in the greater depths. Several years ago it was my fortune to make a voyage in Mr. Lake's submarine boat, the "Argonaut." We started from Atlantic Highlands in New Jersey and ran some distance off Sandy Hook on the bottom of the Atlantic Ocean. The "Argonaut" was built in the shape of a huge cigar of enormously strong plates of steel, many times riveted, and yet Mr. Lake dared sink her hardly deeper than thirty or forty feet for fear of the pressure of the sea. When one realizes that the ocean has deeps of nearly 30,000 feet, a thousand times as much, one feels the utter feebleness of man and the inadequacy of his poor inventions. And yet even at a depth of thirty feet one may gain some impression of the awful somberness of the sea deeps. We had left sunshine and a blue sea dotted with the sails of oyster smacks, and we had descended to almost total darkness, the water here being somewhat muddy. There was a dim yellowness beyond the glass ports, and here and there the shadowy form of a curious fish. But what sank heaviest on the spirits was the eternal silence, the motionlessness, the coolness; and if this impression came so strongly at thirty feet, what must be the awful loneliness of 30,000 feet? We were submerged for some three or four hours, and never did sunshine and green hills look more welcome than they did when the "Argonaut" thrust her back above the waves.

A wreck, therefore, though battered and crushed almost beyond recognition, will always reach bottom, there to be slowly eaten away until the last of it disperses. For the sea is a vast laboratory in which all things are dissolved. It is a significantly curious fact that of all the thousands of dredgings made in the deep-sea bottom, nothing man-made has ever has been brought up, except some worm-riddled portions of a ship's plank dredged by Sir John Murray from a depth of three-quarters of a mile, to the north of Scotland during the "Triton" expedition, although many dredgings have been taken in main routes of vessels across the Atlantic. The ocean receives what fortune brings, and not only swallows it silently, but utterly wipes it out of existence, in its original form, until its substance is a part of its own transparent blue. It may be that bits of glass and gold from sunken ships remain long after the steel of the hulk has dissolved, but sooner or later even these disappear. We are accustomed to think of wrecks in the sea bottom as slowly being covered by deposits from the water: the suggestion of a sunken ship instantly brings a vision of a half-buried hulk with skeleton ribs and the stump of a mast reaching out above, and sea-weed and peering fishes. In shallow water near shore or in harbor mouths wrecks are thus buried, but in the deep ocean there is very little deposit falling to the floor of the sea. Geology has pointed out vast cliffs of stratified rocks formed by deposits from sea water where the land was submerged, but as Sir John Murray shows, such rocks could never has been deposited in very deep water far from continental land. From the shore of the land outward to a depth of about 600 feet, an average of 200 miles from shore, there are deposits of sand and gravel worn from the land by the action of waves and rivers. In the vast sloping plains beyond that depth the bottom is covered with dull blue, green, and red muds, clays, and organic oozes. In medium depths these muds, or oozes, are made up of uncounted billions of the shells and skeletons of minute animals which once lived in the water above—mollusks, foraminiferae, algae, diatoms, and radiolarians. Hence we hear of diatom oozes, radiolarian oozes, and so on, and it is from a knowledge of the nature of the ooze brought up and the kind of shells that it contains that the scientist is able to tell so accurately the spot in the ocean from which it is dredged.

Descending the plains of the sea into still deeper depths, where the bottom is from two miles to five miles below the surface, even these shells disappear, the delicate and fragile ones first, and there is a vast stretch of soft red clay, covering, as Murray estimates, fully half of the entire ocean floor. Here the shells have fallen so far through the water that they have been wholly dissolved, and the deposit is made up, as the dredgings show, of pumice thrown up by volcanoes, along with the products of its decomposition, and of meteoric or cosmic dust which, through ages, has fallen into the sea. Here, also, are found considerable deposits of the ear bones of whales and the tips of the teeth of huge sharks, the hardest of bones, many of them covered with deposits of manganese. A single dredging from the "Challenger" in the Central Pacific brought up many bushels of manganese nodules, 1,500 sharks' teeth, and 500 fragments of whales' bones. What a graveyard is this! How many thousands of centuries it must have taken to deposit so many remains of animals in one small spot! The fact that many of the bones were from extinct species that lived long ago, and that they are found mingled with bones of living species, shows how slowly the bottom of the sea is being filled in. The "Challenger" dredge brought up in one haphazard sweep materials that the slow ocean had been hoarding there, perhaps, for a million years or more. Sir John Murray hopes that some time a dredge will be devised for boring into the bottom of the deepest sea, so that scientists may learn just how deep the deposits really are, and what was their nature when the oceans were new.

In this connection one of the most interesting facts established by the "Challenger" expedition was the large proportion of the ocean in which the depths are profound. We are accustomed to thinking of 100 fathoms (600 feet) as deep water, but only a small proportion of the sea is of this depth or less—a thin fringe around the land, about 7 percent of the total sea area. Of the remainder of the ocean area, 62 percent is deeper than 2,000 fathoms (nearly two and one-half miles). In making his charts of the sea floor Murray has marked no fewer than forty-three places in various parts of the world in which the ocean is over 3,000 fathoms, or nearly three geographical miles in depth. These he calls "deeps," and to each he has given the name of some famous oceanographer or navigator. Every passenger on an Atlantic steamship passes over or nearly over some of these awful deeps. Libbey and Sigsbee Deeps, the latter being named for Captain Sigsbee of "Maine" fame, are south of Nova Scotia and east of New York; Suhm Deep is a little further to the east. These are all small in area. Nares Deep, northeast of the West Indies, is much larger in extent. Other ocean valleys are the Tuscarora Deep off the coast of Japan, the Aldrich Deep east of New Zealand, the Eoss Deep of the Antarctic. These great deeps cover more than 7,000,000 square miles of the ocean floor, and of all of them the deepest, so far as science was informed a year ago, is the Aldrich Deep, and the deepest spot there found is to the east of the Kermadecs and Friendly Islands. Here the thin steel piano wire used in soundings reached bottom at a depth of more than five geographical miles. One has to pause and think before he can realize what such a depth really means. Compare with it the greatest heights of the dry earth. Sink Mount Everest of the Himalayas here in the sea, and its extreme summit would do no more than reach to the surface of the water. Even though the sea were bare of water, it would be a bold man indeed who would dare to venture into this awful valley, and though he dared, ho might not live to tell the story of his intrepidity. It is a curious fact that the distance from the top of the highest mountain to the bottom of the deepest sea is over ten miles, so that in reality, measuring from the earth's deepest valley, our highest mountains have an altitude of ten miles. The surface of the earth is thus broken and scarred, and yet, compared with the size of the planet, its deepest depths are mere plow-furrows scratching its surface. There are many volcanoes on the sea bottom—volcanoes that burst open the ocean floor, belch forth quantities of molten earth, and are then choked out by the water. Sometimes mariners see the results of these eruptions on the surface, and sometimes so deep are the disturbances that nothing ever reaches the top or

ruins the peace of the sea's surface. Then there are probably other great commotions—vast avalanches slipping from the steep mountains and plunging thousands of feet, perhaps, into deeper depths—avalanches that rush and fall without a sound.

Deep dredgings show that most of the sea bottom is a region of cold, the temperature of the water, even at the equator, being sometimes below the freezing point of fresh water. For a time science could not offer any satisfactory explanation for this strange condition, but it is now proved that the water of all the oceans circulates steadily, not only in the familiar superficial currents of which the Gulf Stream is the most representative type, but in a slow and mighty movement from the Arctic and Antarctic poles, creeping southward and northward along the sea bottom to the hot regions of the equator, there rising to the surface very slowly, and setting northward and southward toward the poles, thus keeping up a constant circulation. The cold water of the frigid zones absorbs air and carries it downward to supply the creatures of the deep sea with oxygen. If it were not for this provision of nature, it is probable that life could not exist beyond a few hundred feet below the surface of the water. The Black Sea, which has no deep connection with the ocean, and has, therefore, no such circulation, is without deep-sea life, except bacterial, its depths being filled with foul, sulphur-charged water. It is estimated that over 92 percent of the ocean floor has a temperature lower than 40° Fahrenheit, the freezing point of fresh water being 32°. Frequently, while in hot equatorial regions, the "Challenger" dredges brought up great masses of this icy ooze for cooling the ship's drinking water. The warmest of all bodies of salt water is the shallow Red Sea, which has a temperature, even in its greatest depths, of 70°. It sometimes happens that great storms or violent off-shore winds displace the surface water to such an extent that large amounts of cold water are brought up from the depths. In such cases the creatures of the deep sea meet their doom, millions of them being killed. In 1882, off the eastern coast of North America, there was a sudden change of this character, and uncounted billions of creatures, mostly tile-fish, were killed, and it was estimated that a layer of their bodies six feet in thickness covered the ocean bottom for many square miles, a condition bringing forcibly to mind Coleridge's lines:

> "The very deep did rot: O Christ!
> That ever this should be!
> Yea, slimy things did crawl with legs
> Upon the slimy sea."

The whole science of oceanography is replete with fascination and wonder, and each year it appeals more strongly to investigators as well as to the popular mind. Professor Agassiz has just returned from a long voyage in the Pacific on the United States ship "Albatross." A German expedition is now fitting out for Antarctic exploration, an English, expedition will soon sail, and, as I have already mentioned. Sir John Murray is promoting a Scotch expedition. And thus oceanography, though new, is becoming one of the great departments of natural science.