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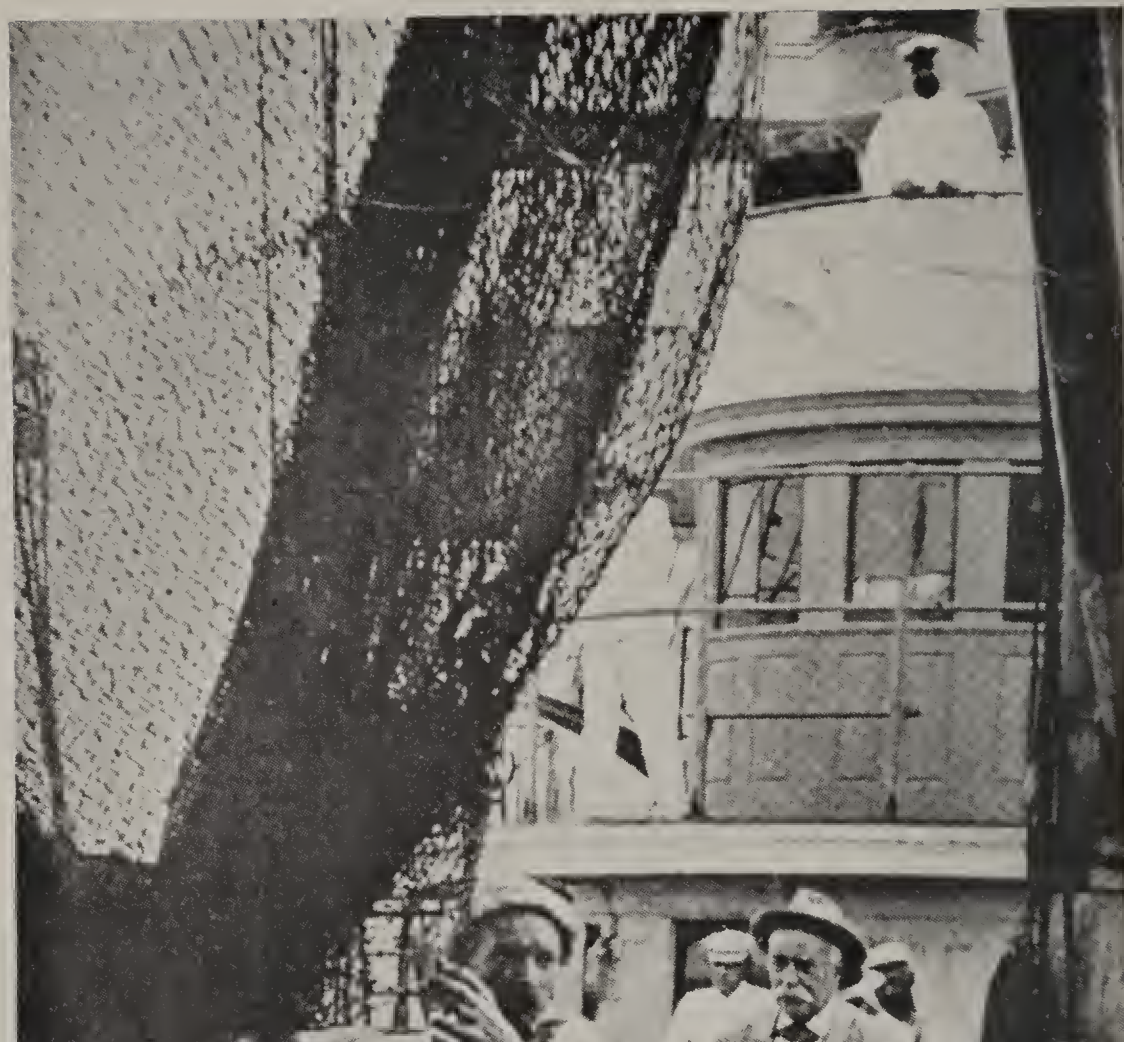

Alexander Agassiz on *U. S. S. Albatross* in Tropical Pacific,
Watching the Arrival on Deck of a Deep-Sea Trawl.

HUNTERS OF OCEAN DEPTHS

By

FRANCIS ROLT-WHEELER

Author of "U. S. Service Series"

WITH SIXTY-SIX ILLUSTRATIONS
FROM PHOTOGRAPHS AND PRINTS

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Hunters of Ocean Depths

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PREFACE

Down, far down, in the eternal dark, at a depth of thousands of fathoms beneath the surface of the ocean, is a world almost unknown. Only within very recent years has any knowledge of the life in that profound abyss come to the ken of Man. Only by great oceanographical expeditions, equipped with highly complicated scientific instruments, can further problems be solved.

The conditions of life in the ocean depths are not only extraordinary in themselves, giving rise to strange creatures, but they are so far removed from terrestrial life as to give a sense of something weird and remote. Even the microscopic life of the sea is as astonishing as it is beautiful.

What is the bottom of the ocean like? How can fish live at a pressure which would crush a steel safe flat like a pancake? What are the strange and ghostly lights which gleam in that perpetual night? How and where do the teeming millions of the sea's population find their food? How did the oceans come to be, and what strange forces still whirl them hither and thither in vast currents? To these and a score of other questions, oceanographers have given the answers. To reveal this scarce-known world, and to show the part that American scientists are playing in its exploration, is the aim and purpose of

THE AUTHOR.

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CHAPTER I

A DUEL OF MONSTERS

"GLORY! Look at that! He's got the big fellow by the jaw!"

"That snaky arm must be all of eighteen feet long! And what suckers!"

"Down they go, once more!"

The sea closed over the combat, but, under the oily swell, the swirl of water showed that the Titans of the ocean were still locked in deadly grapple.

Bernard's startled eyes were set in a fixed stare; his heart was thumping in excitement. From the tense ejaculations of the scientific men around him, he realized that it was extremely rare to witness such a sight.

"There they come again!" exclaimed Nifstrod. "Why doesn't that cachalot blow?"

"He's been under water a quarter of an hour already, hasn't he, Professor McDree?" queried Lee, the young marine botanist.

"All of that!"

The chief of the expedition called up to the bridge:

"Bring her a wee bit nearer, Cap'n, if you can!"

The little naval scout cruiser, *U. S. S. Kittiwake,* edged closer.

"He can't blow!" declared the famous Norwegian ichthyologist.

"Why not, Nifstrod?"

"If you'll notice, Professor McDree, one of the big tentacles is right over the blow-hole."

The chief whistled softly.

"Eh, man, that's so!" said he. "It takes your eyes to see a thing like that in this poor light. There they plunge for a fourth time! If the cachalot doesn't nip that arm off, he's not likely to see daylight again."

There was a silence of a few minutes, and terrible minutes they must have been for that life-and-death clinch under the water.

"What's a cachalot's breathing limit, Professor?" asked one of the younger men.

"Twenty minutes is the longest time I've ever known a whale to be down, and that was a harpooned bottle-nose. I suppose thirty minutes would be the limit in an extremity. If yon squid should happen to shift his tentacle an inch one way or t'other, the whale would have a chance; if not ——!"

"But, Professor," queried Bernard, "a squid couldn't eat a whale, could it?"

"It could get a hearty meal, at the least, my boy. The calcareous beak of a decapod as big as yon squid could rip up the hide of a whale without any trouble at all. I've found beaks of squid between five and six inches in length in the stomach of a whale, and fearsome-looking implements they are, too."

He turned to the Norwegian.

"Yes, Nifstrod; what is it?"

"There seems to be a big flurry under the water. See the bubbles?"

"The death-flurry, probably. Well, I'm sorry! My sympathies were with the whale; it's a more human sort of beast. In any case, we couldn't have seen much more; it's getting dark."

He put his hand on the boy's shoulder.

"You're certainly in luck, Bernard! This is my ninth oceanographical cruise, and Nifstrod, here, has been on more than twenty, and neither of us ever had a glimpse of such a fight before. Yet you tumble upon the sight on your very first trip! Why, even the Prince of Monaco, who has spent a fortune in deep-sea study, never had such a chance. He came no nearer than witnessing a harpooned whale eject the fragments of a squid it had just swallowed, but, even from those pieces, science learned a good deal."

"I wish I could have seen the end of the scrap, though!" declared Bernard, regretfully.

"Why don't you dive down and take a look?"

Bernard eyed the sea.

"I am a pretty good diver," he suggested, almost as though he were considering the suggestion seriously.

"Perhaps! But I wouldn't advise you to make too close acquaintance with *Architeuthis Dux*," the Professor rejoined with a smile. "You'd just make a nice sandwich for him between two bites of whale. Besides, you can be sure that he's pulling yon cachalot downwards, and you'd have to dive a good deal farther than you'd want to go. The Giant Squid doesn't like finding himself near the surface of the water. He's all for the deepness and the dark."

"But we really saw so little of the fight!"

"Get Chu Ting to make you a picture of it, then. Or," Professor McDree added, "if you can get him to talk, he'll give you a description a hundred times more striking than any impression you'd have got for yourself, even had you been able to watch every minute of the combat."

The Chinese artist of the expedition, who had been standing with his arms on the rail, absorbed in the fleeting glimpses of that duel of the sea-monsters, bowed at the compliment, but, as usual, said nothing. Bernard made no comment, for, on board the *Kittiwake,* it was a proverb that Chu Ting spoke only once a month, indeed there were some of the scientific workers who had never heard him utter a word, though he had the reputation of being a powerful speaker when he chose.

Six bells rang and the men separated to get ready for dinner, half an hour later. This was generally a very necessary preparation, for deep-sea dredging and trawling, in rough weather, is dirty work. Many of the scientists had been busy with the dissection of rare fish brought up in the nets, others with measurements and examination of the bottom ooze, and yet others with highly delicate chemical experiments. Certainly there was no idle person on board. Even Bernard had his work.

As usual, after dinner, the scientists gathered aft, each in his deck-chair. This regular meeting formed what was known on board by the somewhat irreverent name of the "Chin Club," but it served a very important purpose. Every evening, each man briefly summarized the result of the day's investigations in his own department; and, since all oceanographical work must be interrelated in the various departments, the evening talks of the "Chin Club" often led to valuable scientific results.

The day of the ocean duel had not produced any sensational "find," and reports were brief. Indeed, some of the scientists were beginning to stir, either to go back to their microscopes or perhaps to turn in—for many hours of exacting work in a small steamer on a tossing sea is extremely fatiguing—when, from out the dark, there came a soft singsong voice, using English of the most curious precision:

"Does not any one speak of the great battle of the deep?"

The group of oceanic explorers hushed on the instant, struck dumb with astonishment and anticipation.

Was Chu Ting really going to talk? It seemed so, for he went on:

"Beautiful, indeed, are the tiny forms of life we find in the sea, and magical do they seem under a microscope; but size has its grandeur, also. The battles of the mighty are surely more imposing than the battles of the insignificant. Ah! It paints itself, that duel of the giants!"

Chu Ting's hand shot to his breast pocket, where he always carried a little book of Chinese paper-colors, for, as a rule, he spoke more readily in paint than in words. But dark had fallen, and the "Chin Club" held its regular sessions with no other light than that of the red pin-point of a cigarette, the glow of a cigar, or the ruddy reflection of a pipe. Hence the little color-book remained in the artist's pocket.

"Every evening, here," he went on, equably, "I have the honor of hearing what this device has brought to light, or what that instrument has revealed. But, if Professor McDree will permit me to say so, the eye of the painter is an instrument, also. The art of the painter is his proper microscope, with which he may see subtleties invisible to the untrained eye.

"For, look you, gentlemen, you have witnessed but a few tumultuous incidents of that battle between the cachalot and the squid, and that only for a few moments' time; but I have seen it all, from first to last, and done so without diving to the bottom of the sea, as our impetuous young friend Bernard had wished to do."

"No one who knows your amazing drawings is likely to doubt your powers of seeing what has escaped the notice of others," the chief replied, during the pause that followed, and, indeed, the Chinese artist's sketches and paintings of microscopic objects were renowned throughout the scientific world. "What you have seen, tell us, Chu Ting; we are all ears."

"And I am all eyes, perhaps you would say! Eyes, and a few fingers to draw and to paint with—that is an artist? Is it not so that you think? No more than that? Many of the men I met at Harvard used to believe so, and some were so impolite as to say so.

"You will permit me to mention that Science is not omniscient—there is also, Art! Vision is a mystery, gentlemen, that you cannot unriddle by any dissection of the human eye, however cleverly it may be done."

The slightly mocking tones hit home. A creaking of chairs suggested that some of the scientists had moved suddenly, but whether in agreement or resentment was hidden by the dark.

"Professor McDree was kind enough to suggest that I should give you a description of that combat in the deep. He was right. I am the only one on board the *Kittiwake* who can do so. I am the only one who has truly seen. Shall I prove it to you?

" I say that I have seen that battle, down, down in the ocean depths. I have an inner telescope which pierces to a depth where no arrangement of lenses will help. Is it imagination? Is it inspiration? Let us not dispute over names. I say that I see that combat, still. How, it matters not. Let me, then, make you see it, too! "

He paused a moment, but no one stirred. Every one was afraid to break the spell.

So Chu Ting began, his foreign accent and the clipped fervor of his tones making the scene live before the eyes of his hearers:

" The open sea! An expanse of greasy, blue-green movement, with a slow and sluggish swell; smooth waves ramping like the undulations of a snake, as though below, far, far below, the Primeval Kraken, never seen by human eyes, were writhing over the ooze of the ocean floor. The crests of the rounded waves slipping over down into the greener trough, without a curl, without the slightest pallor of foam. Waves on a swell, and a whitey-blue sky with mares'-tail wisps of cloud, heralds of coming wind. One or two gulls," the painter's slender fingers imitated swiftly the down-stroke of a gull's wings, " flying low, and, just beyond, the blue transparence of a whirring flying-fish. And that is all!

" No, it is not all! Ever the changing sea holds some surprise. See! In the near foreground, there! Just where the flying-fish has leapt fearfully in air on outstretched silver fins!

" A shivering column, gray-white, translucent, rises from the water, high, quite high, ten, twelve, yes sixteen feet in height, a pillar of air and water, with prismatic colors trembling on the edge where the westering sun strikes sideways through the bubbles.

" The smooth, oily surface of the sea then slips apart, as upheaves a gray-black bulk, huge, ungainly, primeval-looking; and floats there, almost submerged, the smooth low billows plashing lazily over its back. There he looms, the greatest creature of all the seas; greatest of all creatures since the world began, for, as you know, gentlemen, even the prehistoric monsters of the Age of Reptiles could not compare in weight and massiveness with the sperm whale of to-day.

" A colossus of the seas, he is, indeed, but not their monarch. A blundering, overgrown fellow, rather, a mammal out of his element, not too well adapted to a water-life, even yet, despite the centuries that have passed since first his remote ancestors swam in the Miocene seas, some millions of years ago.

"See him, there! That overbrowed, ungainly head, nearly one-third the length of the bulky body, bumping slowly along at the surface of the sea; a lopsided and crooked head, since the single blow-hole is on the left side, making the left nostril larger than the right. A strange and distorted head, with its projecting and up-built snout, seemingly so top-heavy and yet but a device for floating, a huge nose of fat and oil-cells, for the long, narrow, forward-pointing skull is far below. And yet it is not altogether impotent, that head, for though the teeth of the upper jaw are rudimentary, the lower jaw is armed with fifty sharply pointed teeth, of good ivory. And, behind the joining of the jaw, are the two small beady eyes.

"What can he see with his little eyes, deep-sunk in fact, that gray-black creature floating on the surface of the sea? Rarely has he seen the sun, save when some great danger lashes him to fury and his whole head emerges from the water; usually only the blow-hole at the very top of his square head comes above the surface, and that for breathing, only. Of moon and stars, the Great Whale knows nothing.

" Above him, in the daytime, is the light of the sky, seen through a film of water, a wavering grayish-green white; in front of him, as he floats at or near the surface, is the troubled yellow-green of the wave-stirred levels of the upper sea. In this green dimness, he breathes and sleeps.

" But, down below, lies the deep green-black mysteriousness of the waters of the abyss. There must he go a-hunting, for the toothed whale, like nearly every creature which ravens in the sea, must win his food by speed, or skill, or by the dreadful issue of life-and-death combat. There is no mercy in the deep, and no finny fighter cries for quarter. To eat one's neighbors and to be eaten by them at the last is a sea-dweller's whole existence.

" To me, as I look at his enormous bulk, his overbalanced and protruding head, his swollen girth and the fingered-flippers so small in proportion to his size, I cannot, at the first, picture him as a hunter. That massive form suggests a perennial basking on the surfaces of lazy seas, not the plunging fury of a gigantic beast of prey, speeding to a death duel in the watery underworld.

" Yet he must eat, that cachalot, whom we never see save when he is floating idly at the surface, alone, or with a school of his ponderous mates. He cannot cruise slowly along the surface, like his cousin the Right Whale, sucking in shoals of small food by filtering great mouthfuls of water through frayed whalebone fibres. Look at his teeth! They tell a different story.

"For him, the world holds little of lazy sauntering. His life is a life of strife. He must win his food by battle, and a warm-blooded creature, such as he is, must eat enormously. He must find that food, too, in a hunting territory where it is always dark, and where all his purposed victims move exceeding swiftly. How, with his small black eyes, can he find enough to eat, the Mighty One, when all the little fish, faster swimmers than he, can scatter and dart in all directions, too speedily for his great bulk to follow?

"Where can he go, the Great Sperm Whale, to find a meal worthy of his huge body, almost eighty feet in length? So mighty a creature must have a mighty prey! Somewhere, then, in the dark recesses of the watery abyss, there must lurk giant forms worthy of his questing.

"What manner of monsters can these be? What strange hunting goes on continuously in those far-hidden regions of the eternal ocean? Can your telescopes, gentlemen, pierce to those depths? Do your drag-nets, even of the latest pattern, bring them to the surface?

"Let the eye of vision be added to the eye of outer sight. So shall we learn to see."

The slightly sing-song Chinese accent deepened.

"Out through the S-shaped blow-hole of the Mighty Whale, the column of air rises again. It lifts to a little higher than before, for all the air must be blown out of those tremendous lungs, that a new supply may reach to the uttermost cavity. It may be needed, for there are times—though these be rare—that the Cachalot must go down three thousand feet to find his prey, and there may be fighting to be done.

"The column of expired air diminishes and disappears. I hear the sucking indraught of the air which must be held, so long held, during all the hunt below. The great body rises a little higher in the water as the cavernous lungs fill.

"Slowly the head turns downwards as the nostrils close beneath the blow-hole. Here is seen no clumsy shouldering half out of the water as does the Hump-Back Whale, no swift cleaving of the billows like the Fin-Back Whale. Silently and smoothly, scarce leaving even a slick on the surface of the sea, the huge back of the Sperm Whale disappears. Leaving behind him the greenish-white glimmer of daylight just beneath the surface, his vast form plunges, down, down towards the dark.

"Follow him down!

"Ah! What is that?

"A deep brown staining of the water, bronze-like in the deepening green, colored like a chrysoprase. Only a cloud of jelly-fish, of trailing medusæ; rich food, these, for a whalebone whale, but useless to our toothed Cachalot who requires a more substantial diet. He spurns the jellyfish, and mocks at their stinging tentacles. The sweeping screw-like strokes of his great tail-flukes churn hundreds of the frail medusa-forms to shapeless pulp, as the Mighty One sounds down, and ever down.

"Two hundred fathoms (1,200 feet) deep! It is not yet quite dark, but only a few of the red or yellow rays of sunlight have penetrated so far, and the light is a ghostly and unearthly blue. Startled fishes dart to every side as the great Cachalot plunges downward. Even the hungriest and most daring of the larger predatory creatures of the deeper waters keep well away from the descending rush of a hunting whale, whose eight-foot mouth is rimmed by fifty gleaming teeth.

"Three hundred fathoms deep! Here, or hereabouts, is the Sperm Whale's true hunting-ground. This is not far from the edge of the eternal dark. Perhaps some finny slayer with well-developed eyes may be able to detect a darker shadow swifting by, in that shadow-world of sombre peacock-blue, but, to the Cachalot, it is as darkest night. He has reached his hunting-ground, but how will he find his prey?

"Already it is colder than the surface water he left a couple of minutes back, very nearly twice as cold. Well for him that he has his overcoat of blubber, for the lower strata of the sea come far too close to freezing for a warm-blooded mammal such as he. But Nature has protected him, and cold can scarcely penetrate that layer of oily fat.

"How, in that boundless world of dark, cold water, can he pursue his way? Peer as he will, he cannot see; the faint gleam of those blue rays which filter through the green water overhead will show him naught. He cannot move by scenting, for the Sperm Whale does not smell; his olfactory organs are but rudimentary. Nor can he feel, as do certain sea-forms with long and sensitive antennæ, and he has no sense of touch. Not even does he possess those strange sense-organs which are found in the lateral-line nerve system of fishes.

" But can he hear? Truly, there are two tiny earholes, far back, close behind the eyes. Can these mean anything? Observe them well! The orifice is small, but the inner ear is designed for hearing, built like a shell, to catch the slightest sound and to perceive the faintest vibrations in the water.

" The Mighty One halts in his descent, flukes and flippers motionless.

" Keep still, O all ye creatures of the middle deep! Move neither tail nor fin! The Great Whale is among you, hungry and listening.

" One flipper stroke partly turns the huge body, in the deep water no longer unwieldy, but responsive to the slightest effort. That inner shell-shaped ear, keen to catch the slightest outspreading wave of movement, has received some faint message of another presence.

" Something dared to stir!

" There! It was down there!

" A swirl of the great lateral-shaped flukes, and, with a sweeping downward glide of tremendous force and speed, the Great Whale rushes open-mouthed through the darkness at the prey he cannot see.

" A jet of water in the water itself brings him another signal. It came from near! Something is quite close by!

"Unseen to the Cachalot, the Something stirs again!

"A monstrous nightmare creature, spawned of the dark and of his own hideous ancestry, darts back a dozen yards, and waits vindictively. A vile thing, this!

"A body half as long as that of the Great Whale, with writhing tentacles larger than any python that earthly jungle ever saw, a sickly pallid squashiness of unhealthy pinkish flesh, splotched with black; malevolent, repulsive and actively most evil. A misshapen form, with vicious and malignant head amid its writhing tentacles, armed with a parrot-beak able to shear through steel, and two huge, unblinking, ink-black eyes, so highly developed as to be able to catch those faint rays of peacock-blue light, eyes that stare and frighten. A hideous monster of which lesser denizens of the deep may well stand in awe.

"Beware, O Mighty Diver of the Seas, for your foe can see, and you cannot!

"Beware, O Cachalot, for though the Devil of the Deep fears you and you alone, it is an evil fighter, and a dangerous!

"Well knows the Great Sperm Whale the tactics of this battle. The Giant Squid, great *Architeuthis*

Dux, chiefest of all the cuttle-fish, can dart backwards with astounding speed, but can change its direction far less easily.

" Could the Cachalot but catch his evil foe a-napping, then for a mouthful of that yielding body, and away! But the Giant Squid is no sleeper, and that soft gristly body is well protected by the eight huge tentacles which grow about its head, and by the two still longer arms, all powerfully weaponed with ridged suckers.

" Watch them as they wait—one, the biggest of all living creatures, and the other, the foulest of all horrid forms begotten since the world began. Such is a duel to stir the blood! Never in Roman arena did such colossal gladiators meet, never has sunlight looked upon a comparable fight!

" For a few seconds, the Great Whale hesitates. Largest of all sea creatures he may be, but the Giant Squid is a dreadful antagonist to meet, face to face. Yet breath will soon be growing short, and it is a long way to the surface. There is no time to waste. Moreover, hunger drives, for this is the Great Whale's tenth dive without finding a bite of food. The fight must be! His dinner is the death of his prey, or it is his own.

" See! He speeds to the conflict!

" The powerful flukes and flippers strike the water with all the muscular force of the great cetacean, the mouth gapes wide, showing his lower jaw bristling with teeth, and, with a battering rush, the Great Whale launches himself upon his prey.

" Again the Giant Squid darts back, but this time to a posture of defence and not in mere alarm. For, as his mighty foe hurls forward, the eight ridged tentacles of the Devil of the Deep lash out in all their clutching and encircling sweep.

" The jaws of the Great Whale snap together! His fifty teeth bite through a tentacle fifteen feet long and eight inches through at the base. This mouthful will stay his hunger, and, on the instant, knowing his awful danger, the flukes swirl screw-like and the great head turns upwards, seeking the air, to breathe.

" Too late for such escape, O Cachalot; too late!

" The Devil of the Deep is ready!

" Those black unwinking eyes, inky pools of hatred, are watching his slightest move. Scarce have the whale's jaws closed on the dismembered tentacle, than five of the other seven snake-like lengths of muscled power and the two whip-like arms wind about him like a coil of doom. The suckers clamp upon his leathery skin, and one thick tentacle snaps under his jaw and binds it in a hellish grip. The other tentacles lash out on either side, in hope to find something whereon to hold.

"Should there be rock or reef near by, it would mean the whale's swift death, for nothing that lives on earth or in the water, no creature ever born since the world began, can tear away the hold of the Giant Squid.

"Fortune favors the Cachalot. There is nothing that the Devil of the Deep may grasp.

"Jerking his square head upwards, despite the half-ton weight of the Giant Squid constricting his head and jaws, the Great Whale calls on the muscles of his mighty body, and the flukes beat in a pounding rhythm. But not so fast!

"The Monstrous Cuttle-Fish, sucking in great volumes of water beneath its mantle-skirt, ejects them in great jets from its thrice-muscled siphon, giving a jerking backward propulsion which drags the Whale's head down. No sooner does the Great Cetacean point his head upward and surge forward a fathom or two, than the siphon jet, expelled with incredible force, drags it back to the horizontal, or even lower.

"Yet is the Cachalot the stronger, still.

"Ordinarily, he can reach the surface from a three-hundred fathom depth in a couple of minutes. Now, with the Giant Squid hanging to his head, he drives upwards but very slowly. He has been under water a quarter of an hour, now, and his great tail-strokes, given with all his might, are telling heavily on his breath.

"For this is the real fight, as the Devil of the Deep knows well. It cannot hope to crush its gigantic foe with its tentacles, nor yet to tear his vitals with the parrot-like beak. No! But if it can hold the whale beneath the water long enough, that Titan of the seas must drown.

"Fright and consternation reign in the middle deep. For hundreds of yards in every direction, the vibrations set whirling by the appalling struggle throb through the water, and the panic-stricken fish scurry madly away. Only the slow swimmers come within the radius of the fearful wrestle of the sea-monsters, and none of these have eyes sufficiently developed to be able to see that duel to the death.

"The powerful strokes of the flukes drive on, and steadily the Great Whale drags his unwilling captive and captor to the surface. True, the Devil of the Deep might let go, with the loss of but one arm. Yet, despite the Giant Decapod's rudimentary intelligence, instinct teaches that the tooth-ranged jaw of its foe is closed, and will stay closed as long as the tentacles do not relax their grip.

" Up, up and ever up!

" The lungs of the whale are near to bursting, and he is only at the level of the brown medusæ. The light is growing clearer, though, and the whale knows well that at the upper edge of that pale green world above him is where he can find the breath which is his life.

" The Many-Armed knows it, too, and the jets of water from the siphon pulse quicker and stronger. This is a crucial minute of the fight. The wearied whale can no longer give the great strokes of the beginning, and the upward pace grows slower and ever slower. Twenty minutes down, and still fifty fathoms to reach the surface!

" The steadily increasing light gives courage and hope, while the loss of breath breeds that desperation whence comes the strength to call out the last reserve of force. The tiny eyes of the Great Whale can begin to see his foe, and, in their beady depths, one can perceive agony and distress within, for the mammal has a brain and can know what it is to fear.

" Up, Great Whale, summon the last of your strength! You have but a minute or two more!

"The Giant Squid is tiring, too. The siphon jets are weakening.

"Up! Once more!

"Up!

"There is the light, and air!

"The blow-hole of the Great Whale pierces above the surface, and the expiration jet of the condensed air shoots eighteen feet in air. What relief! What marvellous relief!

"But, before he can fill his lungs again, the Squid drags him below the surface. A few feet below, only, and there the struggle becomes yet more desperate. His vast lungs empty of air, the Great Whale is less buoyant. The slightest change of balance will decide the issue.

"The Cachalot rises once, holds his place for a few brief seconds by frantic tail-strokes which churn the water into foam; he gets a half-breath.

"Watch for yourself, now, Devil of the Deep!

"The air goes through and oxygenates the blood of the half-exhausted mammal. Strength comes back partly to the Mighty Whale.

"Now is his time! If he can but shake off these encumbering and crushing tentacles which hold him in a constricting grip!

"Strongly, he drags his enemy to the surface, and fills his lungs to the uttermost with the life-giving air.

"The Giant Squid feels the strength coursing through the huge body of its foe. It dare not let go, now, for well it knows that long, long before it could reach the darkness of the deeper water, the Great Whale would be upon it from above, and, this time, able to see and to tear it to pieces in enormous mouthfuls.

"There is one only hope—to hold its grip. And yet, what hope is there? Sooner or later, it must relax. Death, a horrid piecemeal death, is sure, but it will fight to the end.

"Can fear be known to such a primitive creature as a Squid, merely a monstrous shellfish, after all, one that has lost its shell? But let no one doubt that it can fight, none the less, and those ink-black, glaring eyes look horribly, inhumanly intelligent.

"The Cachalot, refreshed and vigorous again, sure of his victory, and equally certain of a meal worthy of his enormous bulk, has but to shake off those encircling tentacles, which bind his jaws close shut. He sinks a few feet, gathers energy for a tremendous effort, and drives his flukes into the water with such terrific force that the whole of his great head shoots clear. Then down, with his whole weight, jarring the tentacles upon the surface of the water with a shock of half a ton.

"The suckers do not budge, yet must the shock have weakened them, for the two free tentacles are also thrown about his head, and all seven arms hold him fast.

"At the same instant, the beak of the Giant Squid, which lies amid its tentacles, comes close to the Great Whale's snout. There is a snap and a crunch. A wound gapes open and the red blood flows.

"The flesh and blubber instantly reach the simple pouch-like stomach of the Devil of the Deep. A small eater, this food gives it a swift renewal of strength. The sudden increase of force in the siphon jet warns the Great Whale of his adversary's added power, and the pain of the wound drives him to greater fury.

"Again he surges upward, head out of the water, and again strikes down. Ah! That was a blow!

"One of the clinging tentacles is battered from its hold. For a second, only, for it lashes out instantly, only to get a firmer grip on another place.

"Once more the parrot-beak snaps forward, shearing skin and flesh, and a second wound reddens the sea. They are not dangerous, these wounds, for all the upper part of the head of the sperm whale is but a reservoir of blubber cells and oils, but the injuries are galling to the nerves, and weakening, from loss of blood.

"There is more danger, still. The blood may attract the Killer Whales from far, and, as the Great Cachalot knows well, the coming of the little Killer Whales would mean the instant death of both grim combatants.

"Thinking that speed may perhaps help, the Great Whale rushes forward at his utmost pace, hoping that the drag of the water will weaken the pressure of those unyielding tentacles. It is in vain! The sucking clutch resists. Yet there is a moment of relief, for, at that speed, the Giant Squid can do no more than hold on tightly, and dare not try to snap out with that vicious beak again.

"But speed takes breath, and the Giant Whale is getting breathed. He prepares to blow.

"Then—terror!

"A sudden and awful fear!

"In that last shifting of the tentacles, one of the suckers of the Devil of the Deep has lashed out across and closed upon the blow-hole.

"He cannot breathe!

"Now, indeed, the Great Whale turns to panic.

His breath is his life. He is no fish, to breathe the water by means of gills. He is an animal, a water-dwelling mammal with lungs, and so, and only so, can he live by breathing.

" He must get free!

" His great heart beats faster in the sudden terror, the blind terror of the hunted animal. Unless that tentacle can be released ——!

" Far different are his plungings and his short dives, now! To right, to left, up into the air, down with a sudden rush, flippers and tail-flukes working in the maddest flurry, the Great Whale fights for life, fights to move that binding tentacle even one inch away from the blow-hole.

" Is the Devil of the Deep conscious of the change which the chance lashing of a tentacle has given it?

" That is too much to ascribe to the intelligence of a mollusc, for mollusc that monster is, despite its giant size and its eyes of an unblinking fiend. Maybe it knows, in that dim realm which we call instinct, that its foe is weakening. But it does not know why. Blind chance has favored it. How many hundreds of its ten-armed brethren had already passed into the Great Whale's stomach! Are they, now, to be revenged?

" Panic is a poor ally. The mad rushes of the

Great Whale tire him, he is choked for lack of breath.

"For a single second he pauses, and, immediately, a third great wound is swiftly ripped by the ever-ready beak.

"There is a wild surge of resistance, but the siphon-jet, which the Giant Squid has not troubled to use during all this mad racing to and fro, begins to work anew, and drags the head of the Giant Whale below the water.

"Yet still he tries to rise, the heart-bursting Cachalot, and so irresistible are the efforts of that giant of the seas, that he reaches to the surface once again.

"It is in vain!

"The air is there! The life-giving air!

"But the sucker on the tentacle of the Devil of the Deep closes the blow-hole tightly, and the air can neither go out nor in.

"Little by little, the coursing blood in the whale's heart and arteries, unpurified by contact with the air, grows more and more empoisoned by itself. The movements of the Cachalot grow sluggish.

"He is suffocating.

"Is the Giant Squid conscious? Never a sign will show in those uncanny and cruel eyes.

"The pulsing strokes of the siphon begin anew, and this time, they play the stronger part.

"Slowly, slowly, down to the darker and the colder depths of the sea, the Ten-Armed Devil draws his mighty foe, the movements of whose flippers and whose flukes grow ever more and more feeble.

"Down through the shoal of brown jellyfish, down into the region of the blue-black dark, is dragged the massive bulk of the Great Whale, half inert, and all but lifeless.

"The Giant Squid, now certain of his prey, relaxes three of his tentacles, for they are strained and wearied by the terrible muscular contraction by which it has fought its enemy for more than one long hour.

"The blow-hole of the Great Whale is uncovered.

"Instantly, there surges up through the water a torrent of rising bubbles.

"The lungs of the whale are free!

"If only he were at the surface now!

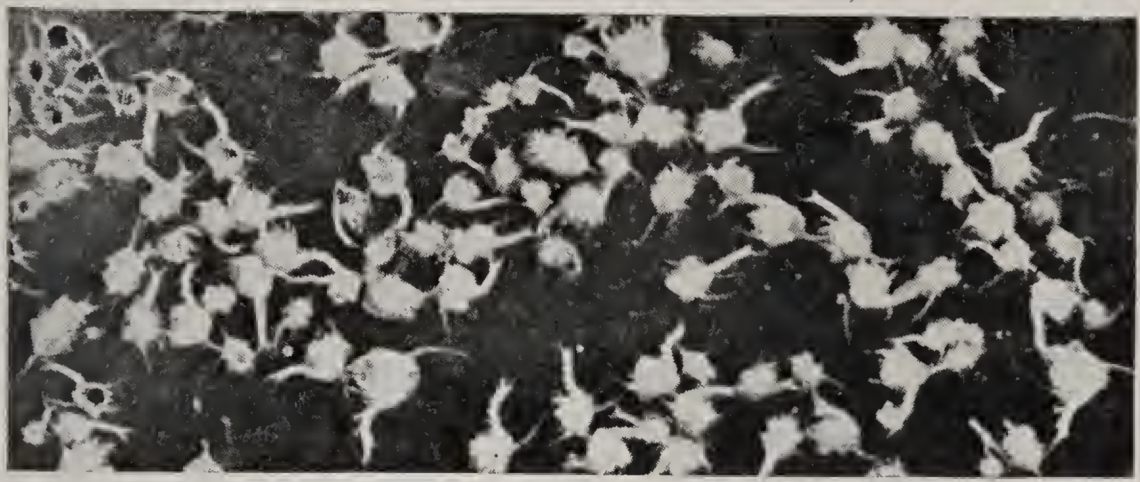
"But the remaining tentacles hold him fast.

"The lungs can endure no more.

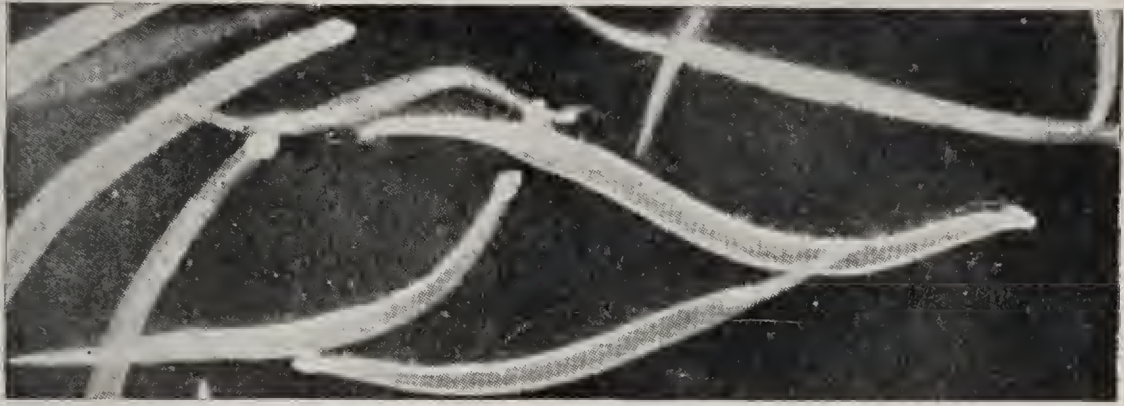
"Unconscious, suffocating, the Cachalot draws in a mighty inspiration.

"Ah, Poor Whale, that is not air, but water!

"The lungs fill. The Great Whale drowns.



Zoëa, or baby form of the common crab, magnified 20 times.



The transparent arrow-worm, twice natural size.

Baby stage of barnacle, magnified 30 times.

Older stage of barnacle, magnified 30 times.

The Copepod *Oithona*, magnified 10 times.

Courtesy of Edward Arnold & Co.

"And the Seas Swarmed with Life."

Small Portion of the Skin of a Cachalot, Showing Marks of Combat with a Giant Squid.

Courtesy of Macmillan Co.

Dead Cachalot, Showing the Long and Deep White Stripes Cut into the Skin by the Tentacles of the Giant Squid. Their Enormous Length May Be Judged by These Unbroken Lines of Wounding: Evidences of a Terrific Fight.

"And, far below, in the darkness and the coldness of the abyss, the Devil of the Deep malignantly enjoys his feast."

CHAPTER II

OYSTER AND OCTOPUS

"BUT I don't get hold of the idea, at all, Mr. Bower!" declared Bernard, after breakfast, the next morning, his tired eyes betraying that he had been puzzling over the matter most of the night. "Chu Ting said yesterday that the Giant Squid is a mollusc!"

"So it is, Bernard; what then?"

"But a mollusc's a thing like an oyster or a clam, or something of that sort!"

"An oyster is certainly a mollusc, if that's what you mean."

"Well, a squid, big or little, isn't the least bit like an oyster!"

"Oh, yes, he is, my boy. He's fully as much like an oyster as a monkey is like a whale."

The expert on invertebrates smiled at the boy's evident bewilderment at this comparison. The two were very good friends, for Bower's brother was one of the great lights in the baseball world, and, in Bernard's eyes, some of the reflected glory shone on any member of "Batter Bower's" family.

"If you've time to wait a few minutes," the scientist went on, "I'll show you."

"I can wait," assented Bernard. "The Professor's busy writing reports this morning; he doesn't need me."

Bower nodded. He was superintending the lowering of one of the abyssal drag-trawls, for finding out just what kind of creatures really do live at the bottom of the ocean, and, save for instructions to the sailors, he made no further remark until the requisite depth of 3,000 metres had been reached and the huge cable-laid piano-wire line had been made fast. This was a delicate operation, for such a length of line meant a terrific strain.

The operation concluded, the zoologist beckoned the boy to come to his "bench," as each of the tiny laboratories on board the *Kittiwake* was called. From under a pile of pencil drawings and anatomical sketches, he reached out a big flat book, full of biological figures.

"They look hard to you, I suppose, Bernard?" he queried, ruffling the pages. "About as hard as the letters of the Chinese alphabet might look, eh? But they're not so hard as that! This is the zoological alphabet."

"But with how many letters, Mr. Bower?"

queried the boy, a little staggered by the number of designs.

"Eighty-one; a letter for each Class. Once you know these eighty-one letters, you can read zoology like an open book, and every kind of animal—from a microscopic protozoon to an elephant—will seem like an old friend.

"In point of fact, if you're going to stick to oceanographical work, as your father wanted you to do, you'll have to learn these letters some time, and the botanical alphabet as well. Now that Chu Ting has awakened your interest in the Giant Squid, perhaps this is as good a time as any for you to find out something about them."

"I do want to find out," declared Bernard, earnestly. "Before Father died, he told me that he considered oceanography the most interesting of all modern sciences, that it was the newest and least known, and that a fellow had a chance to make his name in it. It was mighty good of Professor McDree to take me on board here as a microscopical assistant, and I thought I was learning something; but I certainly got lost last night, when Chu Ting sprang on me the idea that a sixty-foot Squid was first cousin to an oyster!"

"I'm not surprised that it staggered you. I'll admit," the expert agreed, with a smile, "certainly the habits and the shape of that voracious Devil of the Deep you heard about, yesterday evening, don't suggest those of the harmless oyster; but neither do the habits and shape of the Great Whale suggest those of a monkey. Yet, as I just suggested to you, the types are closely related, as you'd see in a minute if you compared the bones in a whale's flipper and a chimpanzee's hand."

"You won't mind my saying that I don't see it a bit, not with the squid, anyhow!" declared Bernard stoutly.

This positiveness was quite in keeping with the boy's character. Ever since he was quite small, the lad had been trained to help his father in preparing microscope slides, and his fingers were very deft, so that his choice as a microscopical assistant had not been entirely due to Professor McDree's personal friendship with the family. Moreover, Dr. Webster, who had been an eminent pathologist, had taught his son to be conscientiously exact in his observations, to be sure never to imagine that he had seen a thing under the lens unless he had observed it at the precise focus and in all its details, and, above all, never to say that he understood a statement unless he really did understand it thoroughly.

"Why does the resemblance, or, rather, the lack of resemblance, puzzle you so?" the zoologist queried, curious to follow the boy's reasonings.

"Well! An oyster has a shell, and can't swim, what's more, it hasn't any head or arms; a squid hasn't a shell, it can travel through the water mighty fast, it's got a sure-enough head with jaws and eyes and all the rest of it, and no less than ten arms into the bargain!"

The expert leaned back in his chair and lighted his pipe in leisurely fashion, meantime putting a fossil on the pages of the open book for a paper-weight.

"If it's a good thing to start from the bottom," he rejoined whimsically, "you're in the right position to begin learning, Bernard, because you're wrong on pretty nearly everything you say.

"Oysters, and some other shellfish of the same Class have heads and eyes, nearly all of them are able to swim while they are young, and a good many have foot-tentacles around their heads—something like those of a squid—as you will see for yourself once I've shown you how to look.

"As for the Giant Squid, you're all wrong about him, too! He has a shell, though you can't see it on the outside because it's of the internal kind; and as for the 'arms,' as you call them, they are tentacles which are but extensions of a single foot, such as the clams and most shellfish possess."

"His ten arms are all part of one foot! You're not fooling, Mr. Bower?"

"Not in the least, my boy! I'm willing to 'fool' on a good many subjects, but never on Science. There's never any need to exaggerate or to do anything to make Science any more exciting than it is; all you have to do is to understand it, and then you'll find it exciting enough.

"Look here, Bernard! Suppose you didn't know the rules of baseball, and had never seen it played before. Even a red-hot major league game would only bore you. If you understood it, just a little bit, then the game might interest you, mildly. But if you were wise enough to understand the subtleties of double plays and all the rest of inside baseball, then you couldn't keep your seat on the bleachers for excitement. Isn't that so?"

"It sure is!"

"It's exactly the same with Science. Don't imagine, for a moment, that zoology is dry! I've seen a grey-haired scientist go hopping 'round the deck from sheer excitement over a discovery which only an expert could appreciate, and I've seen a whole crowd of us, on board the *Michael Sars,* too wild with the thrill of a 'find' to be able to go below to eat. An outsider would have seen nothing remarkable, but we knew all the inside workings of the game."

"I can see that, all right!"

"You remember what Chu Ting said: that with an artist's eye, you can learn to perceive things which you'd never notice without. He's perfectly right, there, and his description of that battle between the Giant Squid and the Cachalot excited me every bit as much as it did you; maybe more, because I was able to marvel at its exactitude as well as to revel in the astonishing vitality and color it revealed.

"But the scientist's eye is just as powerful, my boy, and, to my thinking, even more wonderful. When I look at a worm which builds its tube-house while burrowing through the oceanic ooze, or at a jellyfish apparently idling along a current but really awaiting its chance to sting an unwary passer-by, or at a copepod with its bewildering array of feather-like processes for floating, I see a great deal more than the outside of that worm, or that jellyfish, or that copepod.

"I see his inside at the same time as his outside, I know what his ancestors were like, I can picture how later forms have developed, I'm aware of the part he plays in the great scheme of Nature, and I can show how even the tiniest and most inconspicuous bit of him fits into every other organism on sea or land, as well as into the special conditions of his environment. I'm speaking perfectly seriously when I say that, if you show me a worm, with the scientific eye I can also see an elephant!"

"And, from an oyster, you can see a squid?"

"Very easily. It mightn't seem such a simple chain of development to you, because the various Classes of the Mollusca are a bit confusing at first sight. But, once you get the clue, you can go right along. Let us roll up our sleeves and dig in, my boy; nothing is worth doing that isn't a bit hard to begin with, and I'll cut the complications short.

"As a matter of fact, there are five great Classes of Mollusca; we'll run over them quickly.

"There are the Chitons, little creatures which look a good deal like limpets, but have plates on their backs instead of shells.

"Next come the Gastropods, a Class containing many very different-looking forms, such as the limpets, the sea-butterflies, the tritons—a good many of the spiral shells you pick up on the beach are tritons—as well as all the different kinds of slugs and snails.

"The third Class is a small one: the Scaphopoda, or burrowers, queer little creatures looking like a long tooth or a thin cornucopia; they burrow into the ooze or mud at the bottom of the ocean, head-first, and just leave the tail end of their shells sticking out.

"Then comes the Lamellibranchia, a very big Class, to which mussels, clams, oysters, and some other tens of thousands of shellfish belong.

"The fifth and last Class is that of the Cephalopoda, containing such very different forms as the pearly nautilus, the squid, the octopus, and the argonaut. These Classes make five out of the eighty-one letters of the zoological alphabet."

"And they are really related? One wouldn't ever guess it by their looks!"

"Why not? A chiton looks a good deal like a limpet, a sea-butterfly isn't unlike a slug with flaps on his back, and a sea-snail suggests a nautilus."

"The oyster and the squid don't resemble each other, just the same," insisted Bernard, determined not to lose sight of the point which had worried him.

"Learn to look on the inside, my boy, not on the outside! Suppose you didn't know that clothes could come off and on, and that you saw for the first time a silk-petticoated Chinese mandarin and a fur-clad Eskimo walrus-hunter, you'd never think that those two were the same kind of beast at all; but if both were stripped, ready for a swim, you'd see at once that there wasn't so much difference between them. Skins are a kind of natural clothing.

"Shells, if you want to put it that way, are a good deal like clothes, or like skin. Put a shell on a slug, and you've got something that looks a good deal like a crawling snail; take the shell off a snail, and you've a reasonably good idea of a slug. And, if you started to dissect the two, you'd see the resemblance even closer."

"That's clear enough," the boy admitted. "But an octopus and an oyster!"

"Don't go off at score again! Let us take the thing quietly, Bernard. Biology isn't really so difficult. It's a lot easier than it appears to the outsider.

"Let us take a look at the external characters of the Molluscs. Outside appearances are not the surest, nor always the clearest signs for classification, but they're the quickest to see, just as it's easy enough to realize that the main external character of a quadruped is that it has four feet and of a bird that it has a feathered wing. Are you ready to be introduced to the Molluscs?"

"Quite!"

"Here goes, then! You will know a Mollusc by his possession of four characteristic organs: the single foot, the ctenidia or breathing apparatus, which take the place of the gills in fishes; and the radula, which you can think of as a forerunner of jaws.

"Most Mollusca are bilaterally symmetrical, that is to say, they resemble human beings in being different on the back and the front (dorsally and ventrally), and in being alike on each side. Man is built that way, as you can see if you think for a moment, having a backbone in the back, stomach and intestines in front, but with two arms, two legs, and so forth; he is not entirely symmetrical, however, since the heart is on one side. This mars his symmetry.

"That much ought to be clear. Any time that you find a creature with a mantle and a shell, a single foot, ctenidia and radula, those four things, and generally with bilateral symmetry, you can be perfectly sure that you're looking at a mollusc; just as sure as that any time you find a creature with a backbone you know it's a vertebrate, or any time you get hold of a creature with a feathered wing, you know it's a bird."

"If that's all, Mr. Bower, I could spot a Mollusc all right, then!"

"You could, if all the Mollusca had these four characters in a perfect form, but they haven't. Many Gastropods, for example, are twisted all out of shape, while the Cephalopods have nearly lost their shells. The rudiments are generally there, however. When you find some creature with two or three of these Molluscan characters, examine him a bit closely, and you'll generally find some sign of the others, though it may puzzle you sometimes, as, for instance, to trace a Gastropod's head."

"But haven't Molluscs a real head?" queried Bernard. "Some of them have eyes, that's sure—look at the Giant Squid! And eyes don't come anywhere except in a proper head, do they?"

"That depends a good deal on what you mean by a 'proper head,' and by an 'eye'!" the zoologist replied. "Plenty of creatures have organs of vision which have no definite head—in the sense you mean—and any number of creatures with a well-developed head—abyssal fish, for example—are blind. Strictly speaking, any creature which has the front part of its body different from the hinder part has a head, and the sense organs are generally there. All Molluscs follow this pattern, though it's harder to find the head of an oyster than a snail."

"Worms have heads, and they're not Molluscs," objected Bernard, more with a desire for further information than as an objection.

"So do you have a head," retorted the scientist, "but you're not a Mollusc. I didn't say that everything which has a head is a Mollusc, but that every Mollusc has a head ——"

"But hasn't every animal got a head?" the boy interrupted.

"By no means! Where's the head of a sponge?"

"A sponge! That's not an animal! Oh, yes, it is, too," Bernard corrected himself. "I hadn't thought of that."

"Another characteristic of the Mollusca," the zoologist continued, "is that the stomach and intestines are always on the back, while the belly-part or lower half of the body is the foot."

"The squid hasn't them on the back, surely!"

"The squid has," his informant corrected, quietly. "Turn him so that his mouth is downwards, which brings his foot—extended into arms—into its proper place, and you'll see that what you would probably call his tail is his back, and his intestines are in there. The octopus shows it you more easily, and he always swims that way."

"So he does," admitted Bernard thoughtfully.

"The next thing you need to remember," Bower went on, "is that the skin of the back secretes the shell, and that this shell grows from the middle of the back down towards the single foot. A shell has to grow, just as your skin has to grow, or perhaps your hair is a better example. You've got skin on your scalp, and that skin grows hair; the Mollusc has skin on his back, and that skin grows shell.

"Between the shell and the foot lies a groove of skin, and the hinder edge of this groove grows down into a long fold or flap, which is called the 'mantle' or the 'mantle-skirt.' In some Molluscs, this skin is only a little longer than the shell, in a great many, it grows upwards again and half-covers the shell; but, in a few cases, just as in your friend the Giant Squid, the mantle so entirely covers the shell that the latter is hidden and becomes internal. Indeed, the shell is sometimes eliminated entirely, as in the octopus. Those flat, white, oval lance-points which one may pick up in quantities on many beaches, are nothing but the internal shells of cuttlefish."

"Are they? I never knew where they came from, before. They're used for making tooth-powder, aren't they?"

"And for polishing-paste for jewels. Fine castings of gold are made in cuttle-bone powder. Don't be led astray by the trade word 'cuttle-bone,' for, obviously, no Mollusc has a bone.

"The mantle, which grows up over this internal shell, may not really look like skin, but it is. If you examine it under the microscope, you would be able to see that even the inside of a mantle is made of outside skin—ectoderm."

"I know the difference in looks between ectoderm and endoderm," said Bernard, nodding. "I've made lots of skin slides for Father's lectures."

"So much to the good," approved the zoologist; "there's nothing like microscope training for teaching exactness, and for giving the ability to know what you see.

"The next things to be noted are the ctenidia, or breathing organs, using the word breathing, of course, to mean water-breathing. These ctenidia grow out of the body in the mantle cavity, and, naturally, are connected with the blood-stream ——"

"Do Molluscs have blood, Mr. Bower?"

"Certainly they have blood! Some even have red blood, though in most the blood is colorless; a few have it blue from corpuscles containing a solution of copper. This blood-stream, whether colorless, blue, or red, has to be oxygenated, and the Molluscs get their oxygen from the water.

"In order to have a constant supply of moving water, these ctenidia are provided with little cilia, or lashing hairs, like tiny oars, which sweep water over the breathing organs; that's the way an oyster does. But among the Cephalopods, the octopus or the squid, for example, there is no need for these muscular hairs, because they can travel fast enough to keep the water moving."

"The squid swims forwards as well as backwards, doesn't he?"

"Certainly. He doesn't swim backwards at all, he merely propels himself backwards with muscular ejections of water from his siphon, at the same time usually discharging a cloud of sepia from his ink-bag, as a protective measure. But he can and does swim forwards, some forms with fair speed, the hideous Vampire Squid being an active swimmer."

"And they catch their prey by swimming after it?"

"Some do. The smaller squids live around rocks and stalk prawns which are resting, some of the more active forms follow schools of fish, and two or three species have modified their tentacles to form a sort of fishing net. But they all keep the radula of the typical Mollusc, and some have developed a hard, chalky beak.

"The radula, itself, in its simplest form, is a hardened band roughened with teeth, which moves up and down (not from side to side) like a rasp. The tooth-like excrescences are in transverse rows, with a larger central tooth. The radula grows all the time, just as your finger-nails do, so that it has to be worn off by use.

"There, then, are your four characters of Molluscs, shell, foot, ctenidia, and radula; let us see how they work out in the different species.

"The Mollusca form an immense 'phylum'—which is the name given to the principal divisions of the animal world; there are twenty-two 'phyla' in all. In the Mollusca there are five 'Classes,' thirteen 'Orders,' some scores of 'Families,' some hundreds of 'Genera,' and over 28,000 different 'Species,' each of which, of course, differs from every other. So, although this outline I've given you is common to all, there are over 28,000 different variations."

"How in the world can you ever tell them all apart, Mr. Bower?"

"Very easily! By the letters of the zoological alphabet I was telling you about. All these 28,000 species fall into the five Molluscan Classes—five of the letters of this alphabet. I'll show you how they fit in.

"Take the first Class: the Chitons or Amphineura. They are little creatures, something like a limpet—as I told you—and to be found in all oceans. They have a series of shell-like plates, instead of a shell, but otherwise possess the four typical Molluscan characters. See:" he drew a rough design, "there's a Chiton, your first Molluscan letter! See if you can copy it!"

Accustomed to microscopical drawing, Bernard copied the simple outline in a few quick pencil strokes, and the zoologist nodded, greatly pleased at the boy's aptitude.

"The second letter in the Molluscan alphabet is the Gastropoda. For an example, let's take the limpet, with his high pointed shell protecting his intestines on the back, his hooded mantle-skirt all round him, his single foot for creeping, his ctenidia—like gill-blades—and his well-developed radula. But he lacks bilateral symmetry, for the hinder intestine twists and doubles back on itself so that the hinder opening comes forward again, near the mouth.

With a twist of that kind, you see, there couldn't be an evenly balanced arrangement inside.

"He's a queer little beast, is the limpet, living mainly on rocks that are clear of water at low tide. When his rock is under water, he takes a walk of a few inches or so, but always returns to the identical spot where he's taken up his homestead, and stays quiet when the tide is out. Plenty of his near relatives have spiral shells, and the twistings that their insides take are weird to behold; however, with the anatomy of Mr. Limpet as a guide, you can easily see that they're all built on the same pattern, without having to be a scientific Sherlock Holmes.

"The periwinkle and the whelk, which belong to another group of Gastropods, show a better developed head than the limpet, but the body remains twisted. Some members of this group have a proboscis, like an elephant's trunk, carrying the radula; this enables them to bore holes in the shells of their neighbors, and then to put in the mouth-bearing proboscis so as to feast on the victim inside. Most of them, too, have a pair of head tentacles.

"The sea-hare is a good example of the third group of Gastropods and he ought to interest you, Bernard, for his mantle-skirt grows backwards over the shell, leaving only a tiny bit exposed at the top;

this gives a good idea how, in other forms, such as the squid, the mantle entirely covers the shell and makes it internal. Although a fully-shelled creature, he has eyes and four cephalic tentacles.

"The Pteropods also belong to this group, and they may give you another clue to the answer of your question, for they are really free-swimming shellfish—such as the squid and the octopus are by origin. These 'wing-feet' have the single foot extended into two flaps, which serve as fins."

Bernard sketched rapidly, following the designs shown him by the zoologist as he was speaking. His disbelief was waning fast, for, on the paper under his pencil, he saw the steady development of the strange forms which he had always lumped under the contemptuous word: "shellfish."

"The fourth and last group of the Gastropods—we're still in the second Class, remember—includes the slugs and land-snails, though there are marine forms as well. Here the ctenidia have been turned into a kind of lung, for air-breathing, but, otherwise, the land-snails resemble the predaceous sea-snail.

"It is among this group that *Oncidium,* the Many-Eyed, is found. This little creature answers the question you asked me about eyes, Bernard, for, in addition to the two proper eyes in front, this lunged gastropod has a large number of eyes scattered all over his back."

"Real eyes?"

"Oh, very much so! Unusually elaborate, in fact, each one having a lens, retina, optic nerve, and all the rest of it."

"What does he want them on his back for?"

The zoologist shrugged his shoulders.

"That's always a hard question to ask in science, and, seven times out of ten, there isn't any answer. Why do you have five fingers instead of six? Why does a mouse have a tail?

"The third Molluscan Class is the Scaphopoda, all the forms being modified for burrowing. You don't need to waste much time over the Tooth-Shells, for there isn't any other creature resembling them. The Molluscan type holds, except that the muscular action of the mantle at the hinder end does the work of the ctenidia.

"The fourth Class or letter of the Molluscan alphabet is the biggest. That is the Lamellibranchia, and includes nearly all the bivalves or two-shelled shellfish. You've got to look a bit sharp, here, to follow the Molluscan anatomy.

"Where they differ from such a form as the limpet, for example, is that they are double-shelled, that the head parts are rudimentary, and that the rear part of the mantle-skirt is developed into a pair of tubes or siphons, one of which acts to admit water, the other to expel it. This is very useful to sluggish or fixed forms. Although none of them have real eyes in a real head, a few species have developed simple eyes on the edge of the mantle-skirt."

"Has the oyster got eyes of that kind, Mr. Bower?"

"No. He's a degenerate type, is the oyster, and starts his inactive life even when very young. When you compare him, either in the young or the adult stage, with other Lamellibranches, you'll see that the differences of structure are due to a change in feeding habits. The oyster has given up the Molluscan habit of hunting for his food, and has adopted the indolent habit of allowing himself to be nourished by filtering the water which comes to him, and retaining the tiny organisms therein.

"So much for this Class. But, before leaving it, don't forget the siphons of these Lamellibranches, and remember the tentacles on the heads of the Gastropods!"

"Ah! Now I see how we're coming to the make-up of the squid!" affirmed Bernard.

"So you should, for we've reached the fifth Class, the fifth letter of the Molluscan alphabet. This is the Cephalopoda, and, by now, you ought to have a fair idea what kind of anatomy to expect from the Giant Squid.

"Chu Ting gave you a marvellous idea of what the outside of that monster looked like, in his description of the battle with the cachalot, deep in the green-blue water, but he couldn't picture for you what its inside was like. It takes a scientist's eye to do that, my boy!"

Bernard took note of the ring of satisfaction in the zoologist's voice.

"The Cephalopods run fairly true to Molluscan form," the expert continued, "but all the characters have been altered. In the Nautilus, the shell is not only external, but greatly extended, containing abandoned chambers which are full of gas; the shell has become internal in the squid, forming the 'cuttle-bone' I told you about, a moment ago; and it is rudimentary or entirely absent in the various species of octopus. The mantle-skirt has become a tough skin, and forms the characteristic 'octopus-hide.' The ctenidia are well developed as paired gill-plumes.

"The single foot has developed some very strange forms. It has grown up around the head, so as to surround the mouth, and in the type-form—the Nautilus—it isn't easy to say which is head and which is foot. The head-foot is drawn out into tentacles, or 'arms,' short in some species and extraordinarily long in others, generally eight or ten in number, and always paired. There is a siphon, very muscular in the squid. The hinder part of the foot is either quite small or absent. The toothed radula is very fully developed, and often has a chalky accretion like a parrot's beak.

"Now, Bernard, if you take a pearly nautilus out of his shell, and compare him with the ordinary small squid, you'll see the likeness at once. If you compare either of them with a typical Lamellibranch—such as the oyster's half-brother *Mactra*—there are shell, mantle-skirt, and siphon; if you compare either of them with a gastropod, such as a snail, there are the head tentacles, the single foot, and the radula; if you compare either of them with the humble little chiton, at the bottom of the scale, all the five anatomical characters are there.

"That way, my boy, with the clues I've given you, if you go to work and examine the Giant Squid, you'll have no great difficulty in seeing for yourself how that voracious Devil of the Deep resembles a limpet, a periwinkle, a slug, a snail, a clam, an oyster, or a nautilus, and how all these various types of Mollusca hang together.

"To remember them easily, think of these five letters as a Chiton, a Snail, a Tooth-Shell, a Mussel, and a Squid, and, to the end of your days, you'll always be able to tell a Mollusc; the 28,000 species in this division of the animal Kingdom will become to you as easy to recognize as that a swallow is a bird or that a mackerel is a fish."

Bernard drew a great breath and looked up from the sheet of paper which he had covered with rough sketches and designs.

"Before I get to sleep to-night," he declared, "I'll know the look of all those Molluscs as well as if I'd gone to school with them!"

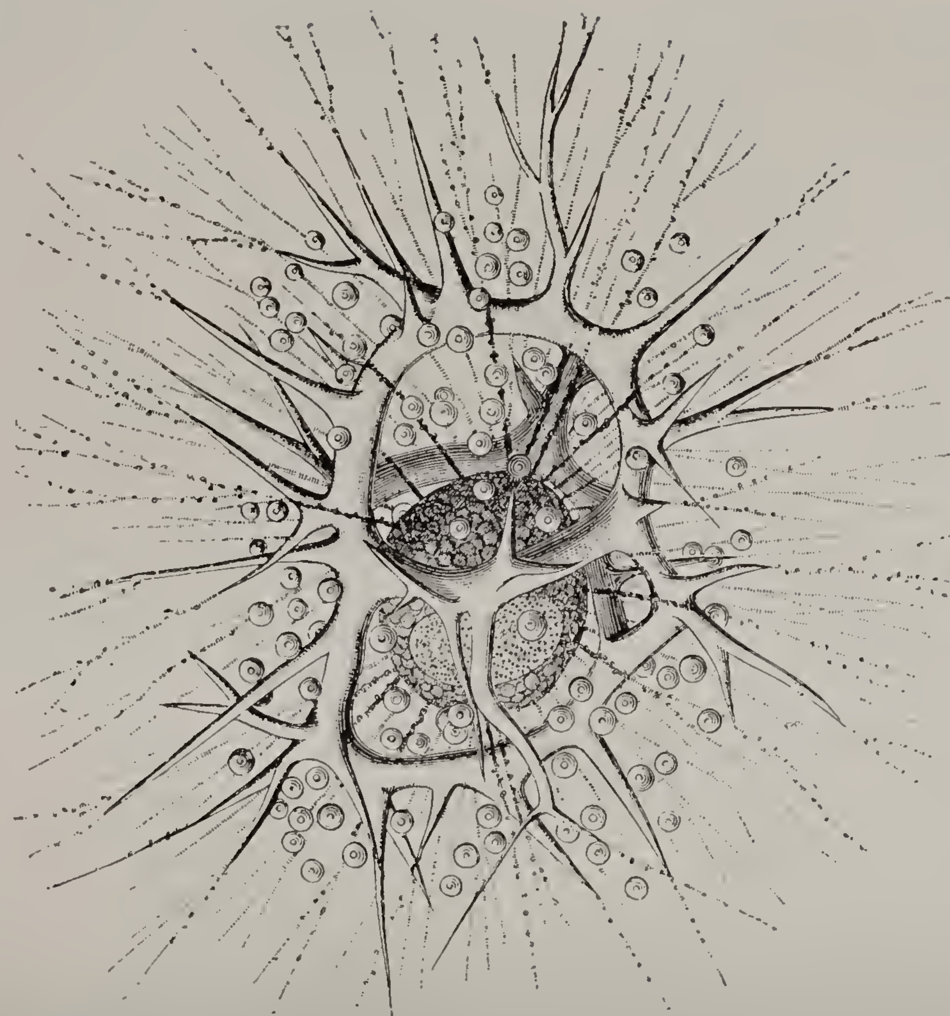
"What! All the twenty-eight thousand?"

"Well, maybe, not all. But it'll take more than an oyster or an octopus to fool me next time!"

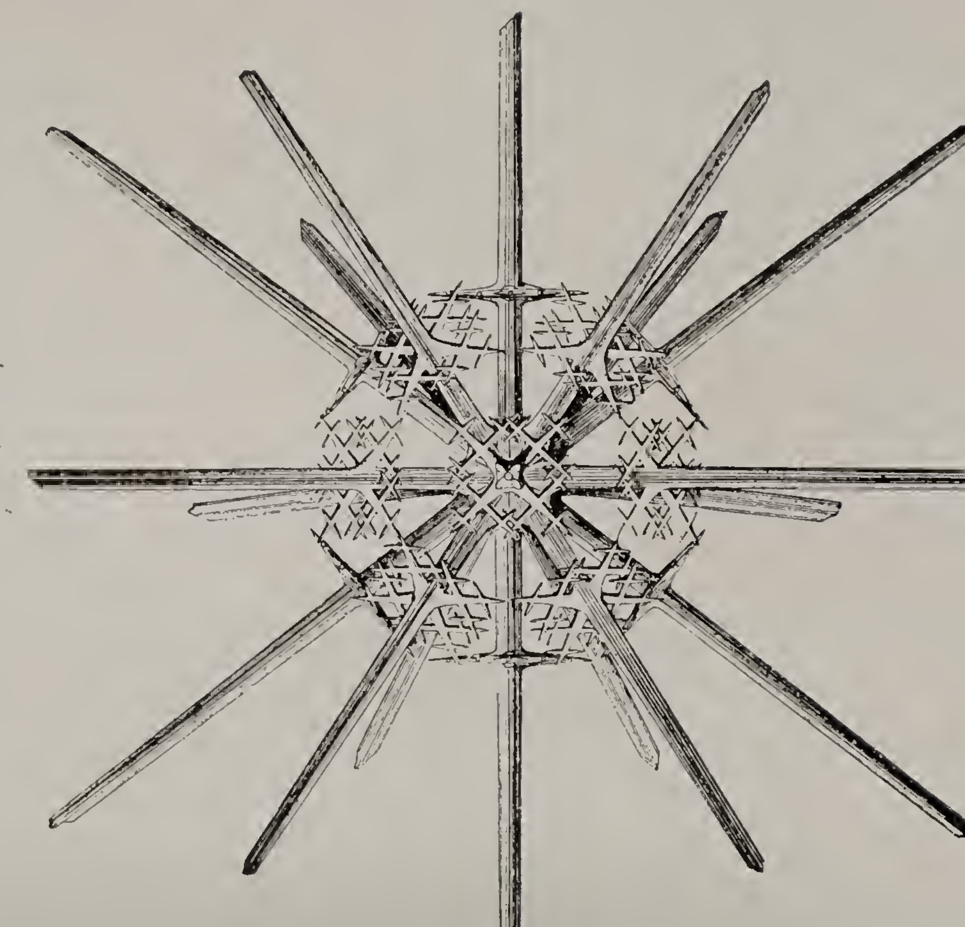
Courtesy of Am. Mus. of Nat. Hist., N. Y. C.

A MICROSCOPIC ONE-CELLED ANIMAL IN ALL ITS BEAUTY.

Model of the Radiolaria, *Anloceros Elegans*, one of those which form the deep-sea ooze.



The Eucoronis Challengeri.



The Stauracantha Murrayana.

The Living Microscopic Animals known as Radiolaria, whose Shells cover Thousands of Square Miles of the Ocean Floor, drawn to a magnification of 2000 times.

CHAPTER III

CAPTURED BY A TURTLE

Bernard made good his boast, if not indeed that very evening, not long after. The strange and unexpected likenesses which he had commenced to find in the most unlike shellfish fascinated him; the drawings which came from his own hand seemed almost as wonderful to him as if he had made the creatures themselves. He began to feel that fever of accomplishment which comes not only from learning new things but from making them, such a fever as many boys know well in the construction of electrical or mechanical models.

Chu Ting had not spoken since the famous evening when he had described the battle between the cachalot and the Giant Squid, although, several times, Bernard had tried to tempt him into talk.

Late one afternoon, when the light was fading and Bernard had taken his sketch-block of the Molluscan alphabet on deck to take advantage of the last rays, the Chinese artist came up from below. Seeing the boy engaged in drawing, he came up quietly and took the sketch-block from his hand, fingering the pages swiftly and appraising the designs with a master's eye.

Then, from his pocket, he took the tiny oblong loose-leaf book of Chinese paper-colors which he always carried, and, with a few swift strokes of a brush of frayed wood—little larger than a match—he splashed in the hues. The pencilled creature—it was a sea-butterfly—leaped from the paper as if it were alive.

Even though knowing Chu Ting's marvellous powers, Bernard gasped at the swiftness and precision shown.

"That's magic!" he exclaimed.

Only the faintest smile gleamed on the Chinaman's face. Closing the book of colors, he took up the lad's pencil, and, on the outside of the little booklet, wrote the boy's name, turning away without a word. Bernard pursued him along the deck, profusely thanking him, but before disappearing down the companionway, Chu Ting turned his head and said, quietly:

"Sunday!"

This enigmatic response puzzled Bernard, and, knowing that his chief understood Chu Ting better than any one else on board, he decided to ask the professor in the morning. Accordingly, when he laid out the microscopic slides which he had prepared the day before, the boy related the incident.

"Eh! Did he do that?" exclaimed the oceanographer, in evident surprise. "H'm, it's a good deal for Chu Ting to do, though I showed him some of your drawings from the microscope the other day. There's no doubt as to what he means, to my notion. He expects you to make as many colored drawings as you can, by Sunday, following the general handling of the one he's done for you. You're clever with your pencil, as it is, and if you could learn to use color, the gift might come in most usefully. That is," he added, with stern emphasis, "if you do it with exactitude."

For a few moments there was silence, while the professor manipulated the extremely delicate screws of his high-power microscope, for he was examining the internal organs of some very minute forms. Bernard waited, pencil poised, to take down the dictation of the description.

"As a matter of fact," the scientist went on, some time later, when he had finished his dictation and was removing the slide, "our ignorance of the causes of coloration in marine forms of life is one of the great puzzles which comes up for study on an expedition such as this. It's excessively difficult to work out a proper theory from a few minutes' examination of a half-dead specimen brought up in the nets, or else preserved in alcohol, which fades the colors. Faithful sketches in color, made from life, are of the first importance."

"But I thought that question was all settled long ago, Professor McDree! I'm sure Father told me once that it was all a matter of protective coloration. I thought the colors of fishes were specially arranged to keep them from being easily seen by the bigger fishes who want to eat them. Isn't that why the top of a fish is dark, and the underneath is light?"

"That theory explains some types of coloring, but not all," was the reply. "It wouldn't be a puzzle, if that were all there is to it; but biology is rarely as simple as that, my boy. How does such a theory explain the rich coloring of a jelly-fish, for example, or the glowing hues of a sea-anemone, or the vivid yellow-and-black splotches of a Killer Whale?

"The real difficulty is that the protective coloration theory doesn't explain everything, but leaves just enough knotty points to prevent its full acceptation. One of the reasons why the *Kittiwake* is heading for the Sargasso Sea, is that we can make a special study of coloration, especially in the deeper regions of the sea, where all the hues are sombre.

"That's why we sent to China to get Chu Ting, and our Government had to get special permission from the Chinese Government to let him go. The Chinese, you know, attach enormous importance to visual or graphic description, and, while they don't do a great deal of scientific work, anything they do undertake is carried out with a detail and an exactitude far greater than ours. We've got some good American artists, no doubt, but they can't be depended on; they're too anxious to make pretty pictures. I chaffed Chu Ting, the other day, by saying that I believed he counted the number of scales on a fish before drawing it, and he admitted that he did!

"Now, you can see for yourself, Bernard, that a man who's as exact in that, and who's as well trained in his art as Chu Ting, isn't likely to make any misjudgment in coloring; that's of incalculable value when it comes to scientific investigation."

"I wish I could do even half as well!" put in Bernard.

"Eh! You're not asking much! Why, my boy, Chu Ting is the only one of his kind! Don't run away with illusions. It's probably out of the question for you to become an artist of his calibre, though there's no denying that you've got a natural talent for scientific drawing."

"I began young enough," declared Bernard. "So far back as I can remember, I used to amuse myself copying Father's drawings. Mother used to teach me, too. I've got just piles of books, at home, all filled with pencil sketches from the microscope. But I never learned anything about painting."

"Well, if you don't learn now, you never will," his chief rejoined. "Chu Ting seems to have taken a fancy to you—though he'd never admit it—and a few hints from him on this voyage would be worth a couple of years in an art school, where they'd teach you a whole lot of things you don't need to know.

"And I don't mind telling you, Bernard," he went on, gravely, "that if you should work up along some such line as that, it might turn out to be your future. Your father's idea that you should devote your life to oceanography is all very well, but, as I told him myself, it's a career that takes money. Aside from the great Institute at Liverpool, the special schools in Norway, and some classes at Monaco and Naples, there isn't much opportunity for a training which would lead to any definite paying position except in the fisheries, and that field is already overcrowded.

"An oceanographical cruise for the sake of pure science is such a confoundedly expensive thing—

Courtesy of Institut Oceanographique, Monaco.

The Prince on the Bridge of His Yacht.

The Prince of Monaco, sovereign and oceanographer, through whose devotion to science all the winnings from the gambling tables of Monte Carlo were used to benefit humanity.

The Monaco Museum of Oceanography.


Courtesy of Musée Oceanographique, Monaco.

LIFTING THE PELAGIC TRAWL.

RAISING THE BIG PLANKTON NET.

Important oceanographic hauls made by the Prince of Monaco in his yacht, *Princesse Alice*.

often undertaken by two or three governments combined—that only the most eminent men, selected from various countries, are likely to get appointments. For some time, at least, oceanography is bound to remain in the hands of the people with independent incomes—like the late Prince of Monaco, for example, who devoted all the earnings from the gambling tables of Monte Carlo to the earnest study of oceanography—or to those who, by reason of their high standing as chemists, or biologists, or as authorities in some other related science, have been chosen by their respective governments.

"But a trained scientific artist—such as Chu Ting, for example—can command his own price. He will be in demand for any oceanographical expedition, no matter what Government is undertaking it; and, after the results of such an expedition have been published—the *Challenger* Expedition volumes took twenty years to produce—he will be equally sought by the great museums.

"You must remember, Bernard, that expensive as is the voyage itself, the study and the publication of the results costs just about as much. In the great expedition which was proposed in 1920—but which the British Government did not feel itself rich enough to undertake—the cost was placed at three million dollars for the voyage and three million dollars for five years of subsequent detailed study and the extensive and richly illustrated publications necessary. And, you know, Bernard, it's difficult to get six million dollars from any government for pure science!"

The next microscopic slide being duly adjusted under the lens, Professor McDree broke off talking, and commenced his investigation. It was not until shortly before lunch that he returned to the question to which he had referred earlier in the morning.

"Yes," he resumed thoughtfully, "it's queer about the colors of fish. It looks like a subject which ought to explain itself, and still it doesn't. Of course, there are some general observations.

"First of all, as you probably know, in all nets towed at or near the surface one will always find any number of colorless young fish, while the transparent leptocephali occur in considerable quantities."

"But I thought leptocephali were young fish, Professor!"

"Young eels, my boy, though there are early stages of eel-like fish among them. The discovery of young eels—which, for more than a century, were never recognized as such—thousands of miles away from the habitual abode of grown-up eels reveals one of the most curious life-histories of the deep-sea waters, and you ought to ask Nifstrod to tell you the details. But, for the moment, all you need to remember is that leptocephali or eel-young are transparent, even their blood being colorless. When sorting them out of living material, one can only see their small black eyes; the outlines of the bodies being indistinguishable.

"Other fishes of the extreme surface are often quite a striking blue, especially those of tropical waters. Perhaps one of the most characteristic is the flying-fish, which, naturally, never goes into deep water. In all, I could name you at least a dozen blue fish, ranking from sky-blue to sea-blue, and not a single one of these is ever found as much as seventy-five fathom (450 feet) down, which is regarded as the lower limit of the purely surface dwellers.

"The region between seventy-five fathom and two hundred and fifty fathom is a general layer for thousands of species, and, in this region of blue-silver twilight, gray, mirror-like, and silvery colors are common hues for fish. Many of the characteristic forms of this depth are blue on the back, silvery on the sides, and whitish below; protective coloration is evidently acting in these cases, for the water viewed from above is slaty-blue, viewed sideways it is silvery, while the sky, seen through the water from below, is white.

" Adaptation to surroundings, too, can hardly be denied. As you'll see, when we come to the Sargasso Sea, the disguisement of the creatures living in the Gulf-weed is simply astounding. Coast fish of rocky regions, too, often of brownish or reddish hues, resemble brown and red algæ, while the gaudy painting of coral-reef fishes, surrounded as they are by bright-hued anemones and gay sea-fans, certainly suggests adaptation."

" But that idea of adaptation wouldn't explain the parrot-fish or the butterfly-fish, would it? " suggested Bernard. " Certainly there's no weed or rock that they could resemble! "

" And it wouldn't explain the groupers of Bermuda, either, my boy; they can change their color at will, from a light gray to a deep black, according as they are hungry or no. Certainly, if the gray is protective, the black can't be, and vice versa. As I said to you, protective coloration doesn't explain everything, though, in a general way, it has a good deal of value.

" Now, let us take the next layer down, from the

250-fathom to the 500-fathom line. This is the lowest layer of sunlight; only very special photographic plates will register any light rays after an hour's exposure at this thousand-metre depth. Here, in general, the fish are of duller colors, a darkish blue-gray being the favored hue. Towards the lower line, black fishes and red prawns begin to be found."

"Red! Why red? I should think they'd be easy to see!"

"No. On the contrary. Below 250 fathoms, no red rays of sunlight penetrate. You remember Chu Ting's description of the peacock-blue light? In that illumination, any red form would appear black. What seems to prove this is that in northern waters, or coastal waters, that is, either where the light is fainter or the water more turbid—so that the red rays of sunlight cannot penetrate so far—these red prawns swim higher up.

"This gradual deepening of hue is seen in plenty of other sea forms. Take the brown medusa, of which there are four varieties, each darker than the other. The lightest-colored is found at 150 fathoms, the next species at 250 fathoms, the third at the 500-fathom line, while the deepest-colored of all are found below, in the region of eternal dark.

"The smaller squids reveal the same condition.

The most transparent of all, having only a slightly pinkish tint, have been caught mainly on the surface; the transparent reddish kind, lower down; the reddish with luminous patches, lower still; the coral and blue, below 250 fathoms; the dark red, in the region of the red prawns; the vivid orange, just below the line of sunlight penetration; while the brilliant scarlet and orange have been brought up from deeper still, where, certainly, no light can penetrate."

"But if no light gets down there, why should any creature take the trouble to make itself scarlet and orange?"

"That, my boy," said the Professor, smiling, "is only one of the scores of puzzling questions that can be asked. That most fantastic of fish, the Chimæra, colored brown, blue, and light violet, with bright yellow eyes, lives below the line of sunlight. Why does he deck himself out so gaudily, when the vast proportion of deep-sea fishes, the dwellers of the lowest pelagic or swimming layer, are content with black, deep brown, or a sombre purple?

"There seems to be a general vertical migration at night, and, in the dark, our nets at shallow levels catch fish for which we should have to trawl very deep, in the daytime. Even your friend the Giant Squid, who is happy only in the faintest light, will venture near the surface on a moonless night, in spite of the danger he runs of coming within hearing of a hungry whale. It's because of this vertical migration that fishermen like to put out their nets in the night-time, for, since nets must necessarily be superficial, during the dark hours there are more fish near the surface which may be caught.

"But we are still a long way from understanding all the mechanism of the response of fish to light, and the question of color which is therein involved, and so every additional observation is of value. Since we shall arrive on the borders of the Sargasso Sea in a few days, I'll relieve you temporarily from the preparation of slides; young Lee can take my dictation. Go ahead with your color-drawings. Compare your results with the work of Chu Ting, and that'll teach you to see where your observation has been defective.

"When we get to the Sargasso Sea, take every chance to be out in the small boat whenever you can, if the sea be calm, and make as many drawings as time will permit. Learn to observe at a glance, and to work fast. I've seen Chu Ting do five first-class color-drawings in an hour!

"Then, too, there's always the possibility that good fortune may put right before your eyes some form that no one else has ever seen before. I haven't a doubt that there are thousands, yes, hundreds of thousands of new species yet to be found in the sea. What a triumph for you, if you could find one on your first cruise!"

The Professor smiled encouragingly.

"If you do, Bernard, I'll promise to call it by your name: '*Something Bernardi'!*"

"It sounds great!" declared Bernard, his eyes flashing. "I'll find a new one, Professor McDree, sure!"

"Even if you have to dive down below the 500-fathom line after it, eh, as you wanted to do for the Giant Squid?" chuckled his chief, rising from his chair as "eight bells" sounded, and carefully putting his microscope away.

It can be imagined with what intense ardor Bernard set himself to his drawing and to his first use of the Chinese paper-colors, the smallest scrap of which, put into a saucer containing prepared albumen and water, made a most intense but always transparent color. The boy congratulated himself that no one had ever shown him any method of painting, for the Chinese technique which he picked up from Chu Ting was absolutely different from anything he would have learned otherwhere.

Especially, the gradations of tints and hues which Chu Ting could distinguish were far beyond Bernard's perception. Where, between a blue and a violet, the lad could discern but four or five shades, the Chinaman could see twenty, and Chu Ting considered a thousand tones of color as the very smallest number which a beginner ought to know.

There were times when Bernard's impatience and the American feeling of doing a thing "somewhere about right" almost overcame him, and twice this sloppiness of habit nearly cost him Chu Ting's help and advice. But the Chinese artist was so consummate a master, and Professor McDree so thoroughly drummed into the boy's head the value of exactitude, that Bernard forced himself to bend beneath the iron yoke of precision, exasperating as he found it.

Little by little he learned the use of the match-like pieces of frayed wood which the Chinaman used for a brush, which were never used for two different colors and were always thrown away at the end of a day's work. Every day, too, he found his eye growing more and more sensitive and responsive to fine distinctions of color, though far behind the standard demanded by Chu Ting.

And, every day, the *Kittiwake* steamed nearer to the Sargasso Sea, which was to prove, for Bernard, the test of his new powers.

"I've read some queer things about that sea, Mr. Bower," he said one evening to his friend the zoologist. "Do you suppose it's really as bad as the old legends used to tell? Is it a fact that ships get stuck in there and can't ever get out because of the masses of seaweed?"

The scientist shrugged his shoulders.

"There certainly must be some truth as well as a good deal of exaggeration in those old-time stories," he replied. "Certainly, there are any number of cases recorded in the logs of sailing ships where they have been delayed there; for all we know to the contrary, some of the thousands of ships listed at Lloyd's as 'missing' may have found their ocean graves in those parts. Columbus was held in the Sargasso Sea for two weeks. The British frigate *Agamemnon* found herself caught there with weeds, at the beginning of the nineteenth century, and her captain has left quite a thrilling record of the difficulty the man-o'-war's-men found in cutting a path through the weed from small boats and towing the frigate to clear water where she could make sail.

"It's true that, in 1910, an oceanographical expedition on the *Michael Sars* approached the region, and found the surface to be only partly covered by patches of weed, but the *Michael Sars* was running short of coal and merely touched the fringe of the northeast corner. So that's not much to go by.

"Now, fourteen years later, we've no idea what we're going to find. Personally I think we may run into a good deal of weed, for, last year, a Norwegian sailing-ship skipper, calling at the Azores, reported an enormous amount of Gulf-weed floating on the southern edge of the Gulf Stream."

"Just how big is the Sargasso Sea, then, Mr. Bower?"

"That's a bit hard to say, exactly. It shifts to and fro a little, following the seasonal changes in oceanic currents. In general, I suppose one might say that it is about 400 miles north and south, and 700 miles east and west, about 280,000 square miles in all. A good deal of it is really unexplored, though soundings have been run, here and there."

"But what is it that makes it a 'sea,' right in the middle of the ocean?"

"It isn't a true 'sea,' in the sense of having a bed of its own. It's an integral part of the North Atlantic Ocean, but it's called a sea because it has some very definite peculiarities. Its existence is due to surrounding ocean currents, which leave it a somewhat calm and isolated stretch of water. The vast patches of weed keep the heavy waves down a good deal, and storm tracks, as a rule, curve round it.

"The Gulf-weed which covers its surface comes mainly up the Gulf Stream, running from the Gulf of Mexico past the Keys of Florida, and some of it is carried by the Gulf Drift, which takes the same general direction but comes from the Equatorial Current, curving northward and eastward outside of the West Indies. There's never any difficulty in knowing when you're in the Sargasso Sea, my boy; the amount of Gulf-weed is a certain sign. I shouldn't be surprised if we were on the very edge now. I noticed several stray tufts of Gulf-weed in the water to-day."

So eager was Bernard to get his first sight of the Sargasso Sea that dawn saw him on deck next morning. Early as he was, Chu Ting was there before him. No one on watch had ever witnessed a sunrise or a sunset without having perceived the impassive Chinaman intently absorbed in the spectacle.

Once, one of the navigating officers of the *Kittiwake* had chaffingly accused the artist of worshipping the sunset; to this flippancy, Chu Ting had replied, without turning his head:

"To do so, at least, would show more wisdom than that possessed by the ignorant man who sneers at beauty and is blind to wonder!"

The naval officer, duly and most unexpectedly snubbed, quickly went away.

The sun rose lemon-yellow in a sky generally clear save for a few puff-balls of cloud, and with some stray wisps of mares'-tails trailed by haze, suggestive of fine weather to be followed by wind. The morning itself was calm, and the water was without a ripple.

The sea itself had a curious patched look, like the splotches of some illimitable jaguar-skin, in blocks of golden-brown and intense blue. A moment or two passed before Bernard realized that these splotches of golden-brown were great patches or expanses of the famous Gulf-weed, so unlike any other seaweed that grows, its branches and little berries looking almost like golden holly.

"This is really the Sargasso Sea, then?" exclaimed the boy, in high excitement.

Chu Ting nodded, but did not turn away from the sunrise sky.

Then, almost under the ship herself, a large shadow passed slowly. Bernard peered over the side.

"Oh! Look! A sea-turtle!"

Chu Ting pointed, first to one spot, and then another. Two more of the great turtles were floating motionless on the surface.

"Are those the big leatherbacks?" queried Bernard, eagerly. "I've never seen one before!"

The Chinaman shook his head.

"Green turtles, then? The eating ones! Yum, yum! We ought to have turtle soup enough for a week or two!"

But Chu Ting shook his head again.

"Not green turtle? The hawk's-bill, that tortoise-shell comes from? No? Not that one, either? The loggerhead, then?"

This time the Chinese artist nodded.

"Well, I don't know if that's worth eating. Maybe. Hullo! Isn't that the boat going out? Wonder if they'll take me?"

He raced along the deck, and, seeing Nifstrod making ready to join, begged to be of the party.

The sport proved to be less exciting than he expected. The turtles lay sleeping, and the boat was given way enough so that she would glide up noiselessly on the glassy surface, the steersman turning her so that she slipped just behind the animal. As the boat passed, two sailors grabbed hold of a hind leg apiece, and heaved the turtle on board. Four were taken thus, before breakfast.

Little bright-colored wreckfish, blue with black bars, swam close to the turtles' shells, and right under the shadow of one of the great chelonians—with a carapace nearly four feet long—were seen quantities of little bright blue isopods, tiny semi-parasitic crustaceans. In addition to this, the waters on every side were iridescent with swarms of shining chains of Salpa, some of these as much as ten feet long.

"You ought to study those Salpæ carefully," Nifstrod told him, pointing out both the solitary and chain-like forms. "Although they look like a ribbon of jelly, they really belong to the Vertebrates—though you'd never guess it.

"In their larval form, though, some of the Tunicata—as this Class is called—resemble tadpoles and have a notochord, which is the precursor of the backbone. But they degenerate and lose almost every sign of advanced form when they grow older and fix themselves to the sea-bottom. Those Salpæ you see there are permanently free-swimming forms. I hear Bower has been giving you some ideas about the Mollusca. Come to me, some of these days, and I'll tell you some things even more surprising about the lower vertebrates."

Bernard thanked the Norwegian, but in an absentminded manner, for his interest was concentrated on observing the coloration of the little creatures that spend their entire lives in the clusters of Gulf-weed.

Following Nifstrod's suggestion, the boy had taken a small-meshed net into the boat, as well as a flat, glass-covered dish. With his very first scoop amid the Gulf-weed, he had secured a dozen exquisitely colored tiny fish and crabs, each one more gaily-hued than the other. So much did they look like the weed itself, that the boy could hardly believe his eyes.

To test this protective coloration, he dropped a piece of the weed in the flat glass-covered dish. Instantly the tiny fish rushed to it, and simply vanished. Though Bernard's nose was almost touching the glass cover of the dish—which was not more than two inches deep—he could not discern the slightest sign of the fish. Even when he opened the jar and pulled out the weed, the fish did not want to leave it, but clamped themselves to the branches by their front ventral fins, which had developed into a clinging organ that looked almost like a wrist and a hand.

Although he had not yet breakfasted, Bernard was almost peevish when the word was given to return on board. The scientists were extremely anxious to examine the contents of the stomachs of the turtles, and, despite the Professor's promise of freedom, Bernard was required to stay on board and to make some special frozen-section slides of a new species of solitary Salpa, two specimens of which had been found in the stomach of one of the loggerhead turtles.

As the sea remained glassy smooth, however, late in the afternoon the Professor allowed the boy to go out in the boat to continue his sketching, promising him more free time the next day. Bernard went out in the smallest boat, with only one sailor at the oars, for the other boat was out on marine botanical work, under Lee.

They rowed slowly from clump to clump of the weed, the boy constantly using his scoop-net and finding scores of specimens of entirely different life-forms, each one characteristic of the Gulf-weed and colored in a different way. Some of the more resistant forms, such as small crabs, he put in bottles, but others, of a frail character, he sketched and colored as fast as he found them.

Once, indeed, he noticed that the *Kittiwake* seemed quite a distance away, for she had moved astern a little, to make a deep sounding. For a moment, prudence counselled him to go back, but there was still a long evening before him, and Bernard realized that, if windy weather should come, he might never again have a chance to make a discovery really on his own. To him, of course, nearly all the queer fish, crustaceans, larval forms, and medusæ were startlingly new, but he was not so foolish as to suppose that they were species unknown to science because he was ignorant of them.

Presently, the sailor began to eye the distance to the ship with a hint of uneasiness in his manner.

" I'm afraid there's a capful o' wind comin', young sir," he said, after a while.

" Oh! I can't stop now! " declared Bernard, who thought his companion had other reasons for desiring to return. " Look here, Brown, you're not in such a hurry for supper, are you? Isn't five dollars better than supper? "

The sailor grinned and pocketed the bill.

" You'll be sure to tell 'em on board, sir, 'twas you as told me to stay? "

" Of course! Professor McDree won't mind; he told me to get as much drawing done as I could."

Even the most intense eagerness, however, cannot postpone the dusk. Gradually it began to get too dark to see colors, and, regretfully, Bernard put his sketch-block away.

"We'll have to go back, now, I suppose," he said with a sigh. "Give me an oar, Brown, and I'll take a hand. The *Kittiwake* must be nearly a mile away."

"More'n two!" declared the sailor, and started to pull.

They rowed steadily, and rapidly lessened the distance to the ship. Then, quite unexpectedly, the boat's bow plunged into a bank of thick weed. Bernard and the sailor put their backs into the pulling, absolutely without result.

"We'd better back out, sir," came the warning; "it won't do for us to get stuck so's we can't move."

"But where the deuce did all this weed come from?" demanded Bernard. "It wasn't between us and the ship, before."

"We've been rowin' a bit to the south'ard. It'll be all right, sir. Just a bit 'round to starboard'll bring us clear."

Brown was right, and open water soon gleamed between them and the *Kittiwake,* still sharply outlined in the clear evening light. Then the sailor, pointing with his finger, remarked casually:

"There's a big one, sir!"

"What? Where? Oh, a turtle! We've had lots of those to-day."

Then, a second later, in quite a different tone, the boy added:

"Hold on, though, Brown! That isn't a loggerhead turtle, that's a hawk's-bill, and I believe they're rare in these seas. I'm sure they eat different things than the loggerheads do; who knows what we mightn't find in his tummy? The Professor would be wild if we missed such a chance. Brown, we must have him!"

They changed their course, but, incautiously, Bernard made a little splash with his oar.

The hawk's-bill turtle, taking fright, began to swim, but kept only a few inches below the surface, where his pursuers could keep him in view in spite of the growing dark.

"He's a-goin' t'other way from the ship, sir," the sailor warned.

"Can't bother about that now; we've got to get him, Brown. He might have some entirely new species in his stomach!"

The sailor shrugged his shoulders. Ever since the *U. S. S. Kittiwake* had been loaned by the United States Navy for this oceanographical cruise, the sailor, like all the rest of the crew, had heard of nothing but "new species." He was convinced that all the scientists were mad, Bernard among them.

Still, remembering the five dollars, and hopeful of a further tip, he rowed on.

Three times the turtle led them this dance, but, the third time, it came quite up to the surface of the water and stopped, as though tired.

"Now's our chance," whispered Bernard; "come on!"

Softly, very softly, the boat crept closer, and the boy turned her into position, at the same time shipping his oar. The skiff rounded up into position, slipping exactly behind the turtle.

"Ready, sir?"

Bernard nodded.

"Grab!"

Both reached out at the same moment, and the little boat almost overturned. A trifle put off his balance by the rocking of the boat, Bernard's grip slipped.

But Brown held hard to the hind-leg he had seized, and the turtle, not being asleep, started off with a mighty flipper stroke which pulled the sailor overboard, the gunwale of the boat being almost level with the water. One of the oars went by the side at the same time.

Bernard, frantic at the upset, but still more frantic at the thought of losing the turtle, which was floundering at the surface with the sailor hanging on to its hind-leg, threw a loop of the painter, or boat-rope, over the chelonian's head.

Something caught!

Whether it was that the turtle nipped the rope in its mouth, or whether the rope had caught in a projection of the carapace, the boy never knew. All that he realized was that the boat began to shoot through the water at a terrific pace.

At the same instant, the turtle dived slightly, and the sailor had to let go. He came up to the surface, blowing and out of breath, as the boat shot past.

"Help!" he gurgled.

There was not a second to lose.

If Bernard did not save him, the navy man stood a strong chance of being drowned, for dusk was falling. It would be difficult to swim to the ship, and impossible if the swimmer should find himself entangled in weed.

Snatching up the remaining oar, Bernard thrust it out, and yelled:

"Grab hold, Brown!"

The sailor threw out a hand, and, more by good luck than skill, caught the handle.

The jerk nearly pulled Bernard out of the boat, too, but he had been expecting it, and had braced himself for the shock. He set his teeth and hung on. It was all he could do, for the turtle was working its flippers furiously, and the boat was simply tearing through the water.

After a moment's respite, Brown came up the oar-handle, hand over hand, reached the stern of the boat and climbed in.

For a moment he sat panting, for his strength was nearly spent. Then he looked at the boy with a broad grin.

"You wanted to get that turtle, young sir," he said. "It looks to me, right now, as how that turtle has got us!"

CHAPTER IV

LOST IN THE SARGASSO SEA

"WHEE! This is some free ride!" declared Bernard exultantly, a few moments later, as the little boat tore through the water under the vigorous strokes of the turtle.

"You said it, sir! An' with a runaway hoss at that!"

The unexpected seriousness of the tone caught the boy's attention.

"Why, you're not scared, Brown?"

The sailor wriggled a little uneasily at the word, but he replied, sturdily:

"Well, I'd feel safer in my bunk, sir, an' that's a fact."

"Go and cut the rope, then, if you haven't the nerve to stay with it!" exclaimed Bernard, with fine scorn. "But I didn't think a navy man would have wanted to quit so soon!"

This slur slid off Brown like water from a sea-gull's back.

"As for cuttin' the rope," he answered, "I wouldn't ha' waited to ask leave. If it could ha' been done, I'd ha' cut it right away, an' you can lay to that! But it can't be cut."

"Why not?"

"Like on all Navy boats, the first fathom an' a half o' the painter is chain, to keep from chafin' when made fast to a pier. There's no way o' gettin' that loose, without a file."

"Then sit back and enjoy yourself. You don't get a ride like this every day."

"An' I don't want to!"

The answer was abrupt, almost offensive.

Bernard forbore to reply.

After a moment or two of muttering to himself, Brown burst out:

"You're young, you are; it's easy to see you ain't had much to do wi' the sea."

"What's that got to do with it?"

The sailor reached into his hip-pocket and took out a plug of tobacco, cutting himself off a substantial quid.

"It's got a lot to do with it. The sea ain't no plaything to fool with, when you ain't got a good ship under your feet. I've been shipwrecked, young sir, an' I know."

"Shipwrecked?"

"Ay."

He paused.

" In an open boat."

Again a pause.

" Like this one! "

An icy finger seemed to pass down Bernard's spine, chilling his jubilation with a shock. Certainly the words " shipwreck " and " open boat " had an ugly sound.

" You mean ——"

" Yes, that's jest what I do mean."

" But look here," pursued Bernard, trying to shake off the feeling of depression which Brown's sudden gravity had caused him, " that turtle ahead there is sure to let up in a few minutes."

" Let's hope so. But we're gettin' farther from the ship every minute."

" Well, he's got to quit, sometime! "

" When he does," the sailor responded, " we'll haul up hand over hand on the painter until we reach the rope, an' my sheath-knife'll do the rest. Leave it to me! "

" But that way, we'll lose the turtle. I want to take him to the ship! "

" Jump in the water an' 'rastle him, then! I'm with you, if you say so. No one ever yet saw Jock Brown back down from a fight. But a turtle in water ain't no easy thing to tackle, an' while I'm a good-enough swimmer, I ain't no mermaid."

Bernard laughed nervously.

"You don't look like one," he said.

But Brown did not echo the laughter, and this gravity, even more than the sailor's former words of warning, convinced the boy that the situation was more serious than he had thought. Brown clearly had something on his mind.

"Suppose our tugboat takes a notion to dive, sir, what then?"

"Oh, turtles don't dive much!" retorted Bernard. Then he corrected himself. "Yes, they do, though. I hadn't thought of that."

"We may have to think of it. Sure, if he pulled the boat in, so's she filled, it'd make a bigger drag an' make it harder for him to tow. But there ain't no sayin' about sea critters. He's a big-enough brute to pull the boat clear under, an' we'd have to quit her."

"And swim all night?"

"Or drown! But there's the oar, at least, that'll keep us afloat a while. Durn ornery that you let t'other go!"

For a moment or two he sat musing, then he bestirred himself.

"One thing sure, when the sun gets up we'll need fresh water an' we'll need it bad!"

"The sun!"

Bernard was staggered. This phrase brought him sharply up against reality. Not until that very second had he realized that a return to the ship had already become impossible.

"I hadn't thought about drinking-water, Brown!"

"I've been shipwrecked before, an' you can bet it's the first thing I did think of. No one could help it if he's been through what I have."

"Well, there's no way of finding fresh water, here!"

"Yes, there is, sir. It's a Navy regulation to have three days' rations of water an' ship's biscuit kept in every boat."

The skiff gave a sudden dip by the head, and Brown scrambled over the thwarts in a hurry.

He wrenched open the bow locker and heaved a sigh of relief.

"The water-keg's here, all right."

With a stroke of his sheath-knife he cut the lashings.

"Here are the biscuits, too! Better take 'em, sir, quick!"

"What for?" queried Bernard, a little dazed. "Aren't they safer in there?"

"An' if we have to jump free from the boat, suddenly?"

"That's so," agreed the boy, taking the box.

Brown made his way back to the stern, better to balance the boat and to make it more difficult for the turtle to pull the bow under, and, for a few moments, neither spoke.

"Suppose we got out now and swam, before we get pulled too far from the ship?" proposed Bernard.

"To far already, an' too dark. Look at the *Kittiwake's* lights! She's four miles away if she's an inch!"

"Well, I've swum four miles, before this!"

"Yep, in daylight an' in clear water, maybe. But s'pose your feet got tangled in the weed? We ain't been followin' a straight course, if you've noticed, an' there may be a mile o' weed between us an' the ship. No, better stick to the boat as long as she'll stick to us."

"All right; you're captain of this cruise, now!" the boy responded, more lightly than he felt.

His first sensation of the great joke in being towed by a turtle had been abruptly checked, but Bernard could not yet bring himself to realize that there was actual danger. Every second he expected the turtle to give up the mad race.

"The confounded beast doesn't seem to want to stop!" he burst out, a few minutes later.

"He don't. He's scared stiff at findin' something hitched on to him, an' he's beatin' it for all he's worth. I'm only afraid of his divin' sudden, that's what! Give me a hand to wrench off that stern thwart."

The thwart was solidly set in, with small iron braces, but the two managed to pry most of it away, though badly splintered.

"That's got a bit more buoyancy than the oar. Here, sir, lash the box o' biscuit 'round your neck. It's water-tight. Don't let go o' those loose boards. An' don't go to sleep, whatever you do. If anything happens, be ready to jump. If we do have to swim for it, keep close to me, for I've got the water-keg. A man can stand 'most anything, an' he can last for days, so long as he gets a drink o' water."

For a few moments there was silence.

"Another thing! Don't lose your hat. You're apt to think you don't need it now, an' then, by to-morrow noon, if we're not found, your brain'll be grillin'! Tie it on!"

Obediently, for he realized that the sailor knew what he was talking about, Bernard put a piece of string around his hat and fastened it under his chin.

Twice, during the next hour, the turtle stopped, and, each time, Brown tried softly to haul in the painter chain, hoping to get near enough to the rope to cut it; each time the turtle took fright, and started off again.

The pace had become a good deal slower, now, and it was evident that the turtle was tiring, but he showed no signs of giving up.

In spite of Brown's warning, Bernard must have dozed off, for he woke with a sudden start to see a green light shoot across the sky.

"Rockets!" the sailor explained. "They're gettin' worried about us, on board the *Kittiwake,* an' no wonder! If we had the big lifeboat, now, we could answer 'em, for there's rockets an' flares in her stern locker. It ain't reckoned necessary to stow 'em on a little skiff like this, which ain't never slung out o' the davits, 'ceptin' in port."

After another little cat-nap, Bernard started again at the sound of his companion's voice.

"The moon's goin' to get up pretty soon," the sailor said cheerfully, pointing to the east; "we'll be able to see where we're goin', anyway."

"You mean we've been travelling for three hours, already?"

"About that. You fell asleep, though I shook you, good an' hard. An' our flipper-power tug-boat's been goin' right along. If you'll notice, you can't see the lights o' the ship any more, not till she sends up a rocket."

Again the green flare shot into the heavens, marking the exact position of the *Kittiwake,* but, as the sailor had said, not one of her side-lights was visible.

"Will she be in sight by the morning, do you think?"

"If she isn't, we'll be in bad, for she won't know which way to look for us. It'd never get into their heads how we could go chasin' off this way. Oh! We're in Dutch! We can stand it for a while, though, if that cussed beast at least leaves us the boat."

Slowly the moon rose, the waning edge showing her to be a couple of days past the full. At first the ovoid honey-colored orb gave but little light, but, as she cleared the horizon and lifted herself above the haze on the sea-edge, the shafts of silver light began to sparkle on the slightly rippled sea. Almost immediately there came a tilt, and the bow of the boat began to point more downwards.

"I thought as much! As soon as it gets light, that bloomin' turtle'll want to keep beneath the surface. He's afeared o' bein' seen. Durn the brute! If he'd only keep still long enough to let me haul up on him!"

"I should think he'd be played out!"

"Not he! Much more like to amuse himself doin' a divin' act. I'd kick my shoes off, if I were you."

Brown seemed to have judged the animal's purposes accurately. Steadily the turtle swam lower and lower, dragging the bow of the boat ever closer to the water-line.

"Stand by with those boards o' yours," the sailor warned. "If you've got any o' that sleepiness left still, shake it off! I'll be good an' surprised if we're not in the water afore ten minutes."

"But why ——"

The boy had no time to finish his question, when, with a sudden lunge, the bow of the boat tipped down, under.

"Jump!"

As the boat plunged and filled, both Brown and the boy leaped to one side, the first gripping tightly the boarding of the stern thwart, the other holding the oar. The water was warm and almost calm, and

Bernard's blood tingled not unpleasantly with the shock.

"All right, sir?" queried the sailor.

"Perfectly all right! These boards keep me up fine. I don't have to swim hardly at all."

"Get your legs kicking a little, just the same, to keep the blood goin'," the sailor advised.

"Are you going to try and swim for the ship, now? They're still sending up rockets!"

"Nope. We'd never get there. Better try an' follow the boat. I've a hunch that blasted turtle dived to get under an island o' weed. If he did, he won't ever tow the boat through. She'll stick fast.

"Anyway, she's gone, an' we've got to keep afloat the best way we can. It'll begin to get daylight about two bells o' the mornin' watch. That's a little over four hours, yet. Can you stand it?"

"I've often been in swimming all afternoon; that's more than four hours."

"These here hours'll seem longer to you'n those. I was afloat for two days an' two nights, once."

As the boy made no comment to this, Brown snapped out:

"Keep talkin'!"

"What for?" retorted the boy, annoyed by the curt order.

"Helps to pass the time."

Brown did not add that he was anxious to aid Bernard to overcome the lethargy which rapidly overcomes a swimmer thrown into a warm sea, almost as dangerous in its way as the "cramps" which so easily attack a swimmer in a cold sea. The sailor knew by experience that the body becomes more easily water-logged when the peripheral nerves are allowed to relax.

"What do you expect me to talk about?" he asked in a disgruntled way.

"You're one of these scientific chaps, ain't you, even if you are a youngster? Tell me how this here weed got here; or maybe you don't know!"

This latter aspersion piqued Bernard's vanity, as it was intended to do.

"Oh, yes, I do know," snapped back the boy, none too amiably. "It grows mainly in the Gulf of Mexico and in the Caribbean Sea."

"That's a long way from here," persisted Brown, seeing that the boy stopped.

"I know it is!" retorted Bernard. "That's what I'm explaining to you, if you wouldn't be so confoundedly impatient!

"When the stems of this Gulf-weed become too long and reach near the top of the water, they grow brittle and are easily broken off. The weed floats up to the surface, and, as there's a current of several miles an hour in the Gulf, the weed shoots out of the Florida Straits and is carried up here by the Gulf Stream. A sort of back eddy switches it back to this Dead Sea in the middle of the ocean, and here it stays. That's why this place is called the Sargasso Sea, after the scientific name (*Sargassum bacciferum*) of the seaweed."

"You mean it's all dead weed? It doesn't look like it!"

"No, it isn't dead, though I suppose, in a way, you could call it dying—that is, dying slowly. According to what Lee told me last night, this Gulf-weed grows very freely in the Gulf of Mexico, just piles up in huge masses everywhere it can find the exact depth and the kind of bottom it likes. It's got to have a lot of sunshine, too. It takes the sun to make it grow.

"But when it gets broken off from its rock-hold, and is carried up by the Gulf Stream or any other current, it's just like a cut flower in a vase full of water. It goes on growing, after a fashion, in the same way that a rosebud put into water will open, or some wildflowers will live for a long time, opening and shutting morning and evening. They're dying, of course, since they're without roots, but it's a sort of death delayed."

He paused for a moment to watch the curve of a rocket from the ship, vainly pointing them out the way to safety.

"This Gulf-weed lives in much the same kind of way," he went on. "It grows vegetatively, as botanists call it, but it can't reproduce itself. If it could, I suppose, this whole sea would soon become solid, so that you could walk on it, as some of the old stories used to tell that castaway folk did."

"I don't see why it doesn't get solid, if there's more 'n' more weed floatin' up all the time," the sailor commented, not that he was at all interested in marine botany, but merely to keep Bernard's mind occupied and active.

"Ah, but there is a reason, though," the boy went on, his interest increasing as he extended his explanation. "When this seaweed is growing in the Gulf of Mexico, properly fixed to the sea-bottom, not only has it got the necessary organs of reproduction and all the rest of the functions of the simple alga or marine plant to which it belongs, but, in addition to that, it grows a very large number of gas bladders—those are the little round vesicles which look like berries, Brown—maybe almost as many bladders on their little stalks as there are leaves on the stem. Anyway, there are at least eight bladders to every ten or twelve leaves.

"Now, when that weed gets detached, and starts floating in the Gulf Stream, it doesn't seem to have the strength, or the nourishment, or something, to put out the same proportion of gas-bladders, although it seems to have no trouble putting out leaves. The result is that it gets less buoyant, and becomes more and more submerged. Even what looks like a fresh bit of weed, here in the Sargasso Sea, will only have five or six gas-bladders to the dozen leaves, and the older pieces may have only three or four.

"Now, Gulf-weed needs a good deal of sunlight, and, to get that, it must either grow in very clear water or else be very near to the top. If it sinks a little low, naturally, it gets less sunlight. The lessening of sunlight lowers its vitality and makes it all the harder for the seaweed to form gas bladders. The slowly growing leaves make it heavier and heavier.

"About a couple of fathom down, the Gulf-weed gets to be dark brown, instead of golden-colored, the leaves are long and harsh, and the gas-bladders become small or even shrivelled. It's just coming to the point where it's heavier than the water, and so, its life over, it sinks slowly to the bottom. So you see, Brown, while there's always a new lot of weed coming in from the Gulf Stream, about the same proportion sinks in the sea."

"Them berries ain't fruits, then; there's no way of eatin' 'em?"

"Why, no! Seaweeds don't have fruits and flowers! They're algæ ——" and Bernard passed into a long description of the very simple forms of plant life which are to be found in sea water, Brown struggling to show an interest in what he heard, but inwardly congratulating himself that he was keeping away the dreaded lethargy from his young companion.

When the subject flagged, the sailor began to spin yarns about his former shipwreck, adding the most improbable and impossible features in order to arouse the spirit of contradiction in the boy, thereby successfully keeping a high pitch of nervous energy in both of them.

Gradually the east lightened with the grayness of false dawn, and Brown breathed a sigh of relief, for, by day, at least, there was a great likelihood of their being seen, and he was getting anxious about Bernard's endurance.

"It's too bad this here weed ain't solid, like you say people used to think," he remarked. "I wouldn't be sorry to feel something under my feet."

"There ought to be lots of wreckage floating about, I should think," suggested Bernard, hopefully. "Daylight may give us a chance to see."

"You're gettin' pretty tired, eh?"

"A little."

"Not numb at all? You can wiggle your toes all right?"

Bernard tried.

"I can move them a little bit, but they feel mighty stiff."

"That'll be all right. You'll warm up as soon as the sun gets to shinin'!"

It was getting lighter rapidly, and the coming daylight revealed them hemmed in on three sides by weed, apparently not very dense, but still thick enough to prevent swimming.

"We ought to be able to see the *Kittiwake,* now," suggested the boy, though with little hope in his tone, for he felt instinctively that, had the ship been within sight, Brown would have seen her long before, and would have said so.

"Maybe, when it gets a bit lighter, we will," came the reply, and Bernard's heart sank, for he knew that this answer implied but a small hope of seeing the ship.

They swam on, slowly, respectively depending on the boards and the oar to keep afloat, and, presently, the sun rose gloriously, its very first rays causing Bernard to realize how wise had been Brown's advice regarding the retention of his hat.

Eagerly the two of them scanned the surface of the sea, first, hopefully, where they had seen the rockets, and then vainly, around the entire circle of the horizon.

There was a lump in the boy's throat as he turned to his companion.

"You don't see her, Brown?"

"Nope," said the sailor, "I don't. An' we're a thousand miles, good, from the nearest land!"

CHAPTER V

A SEARCHLIGHT RESCUE

The reality of being far from all human help, once definitely grasped, began to gnaw at Bernard's powers of resistance. His legs suddenly seemed to have grown pounds heavier. The stiffness in his feet increased proportionately.

Brown, on the contrary, was stimulated to greater effort. Not only was the question of saving his own life at stake, but he had also the responsibility of the boy.

Rising as high out of the water as the buoyancy of the air would permit, he scanned the sea with the piercing glance of a fish-hawk. Accustomed to long hours on the lookout, the slightest difference on the surface of the water attracted his attention.

No longer could he arouse Bernard's interest, no matter what he said, and this worried him sorely.

Suddenly, with a sharp exclamation, he turned at a sharp right angle and began to swim vigorously, pushing his oar before him.

"What is it?" queried Bernard, struck by the sailor's evident eagerness.

"I thought I saw—yes, that's right! Here's an old log! Bully boy, we're in luck!"

Bernard's hopes rose with a jump, but when he swam beside the sailor and saw nothing but a barnacle-grown piece of ship's timber, they sank again, for this did not answer to his expectations.

"Why! It's nearly water-logged!" he said, disgustedly.

"So 'tis, but it's floatin' just the same. It'll be more use'n you think. Just watch!"

He straddled one end of the log, his weight just sinking the end until only just his nose and mouth were out of the water, but, like a seesaw, this weight brought the other end high and dry.

"Now you climb on that log an' lie flat down in the sun. In ten minutes, you'll be dry an' warm."

"But you?"

"Ten minutes more o' this won't hurt me. After that time, you come an' sit here in the water, an' I'll go an' take a warm. Then you'll take a half-hour o' toastin', an' I'll take a half-hour o' toastin', turn an' turn about. While you're restin', take a bite o' biscuit an' a drink o' fresh water. After your second rest, you'll feel as lively as a kitten."

Bernard wanted to protest and let the sailor warm up, first, but he knew that Brown was right. While careful not to let go of the splintered stern thwart of the boat, which certainly had saved his life during the night, he stretched himself on the log which the sailor's weight brought endwise partly up out of the water.

Several minutes passed before the circulation began to return, and his legs and feet tingled as though he had been stung by nettles.

"Wow!" he exclaimed. "I feel as if I'd been swimming in a bunch of those stinging jellyfish!"

"Prickling, eh? That's fine! That's what I wanted to hear! Now, you slide out to this end of the log, an' give me a chance."

Bernard did so, but his weight was not sufficient to bring the log out of the water high enough for Brown to lie on, and remain dry.

"You couldn't stand on it, eh?" the sailor queried.

"I can try!"

The boy did so, but he slid off the slimy surface immediately.

"I feel an old ring-bolt here, though," he remarked. "Do you suppose, if I put the boards of the thwart crosswise on the log, and jammed the ring-bolt in where the wood is splintered, it would make a foothold? I might be able to stand upright on that."

" Have a whack at it! I sure would like a chance to get warmed up, myself."

After several attempts, the boards were thrust into position. The perch was insecure, especially as there was a trifle of swell on the sea, but Bernard managed to keep his poise for half an hour and more, though feeling like a tight-rope walker, or a Canadian lumber-jack rolling logs down " white water " on the spring log drive.

It took Brown a little longer than Bernard to get his circulation back to normal, for he had not the resiliency of youth, although he had more endurance. But, presently, he got warmed through and dry. Thereupon he munched a couple of ship's biscuit, and took a good drink of water.

" Now," said he, " I'm fit for anything until night-time! Slide along the middle of the log, an' come an' have some grub! "

Although the old timber was a good deal water-logged, so that it sank a few inches below the surface, still it served as a kind of watery seat and gave both of them a rest. Brown had expected greater supporting power from it, but the thoughtful fellow did not want the boy to see his disappointment.

" Think I'll swim around a bit," he said, " an' see if I can get hold of any more wreckage. We might find enough to make a raft!"

But Bernard paid no heed; he was staring hard at a distant patch of weed.

"Look here, Brown!" he exclaimed excitedly. "Isn't there something white over there?"

"Where?"

The boy pointed.

"By the Great Clove Hitch, it's the boat! What do you know about that!"

The sailor made as though to slap his thigh, but only succeeded in splashing himself.

"Split the ratchet! I forgot I was sittin' in water!"

Bernard laughed almost gaily, the bite of food and the sight of the boat having brightened his spirits amazingly.

"Do you suppose we can bail her out?"

"Four of us could lift her enough to do it," said the sailor doubtfully. "As for two—I don't know. We can have a shot at it, anyway. I'll go an' see how she is. You stay there. No need to exert yourself more'n you have to."

Rested and refreshed, he set off with a powerful stroke. As he had said, he was a good swimmer, but, evidently enough, he found it difficult to battle through the weed. He tugged at the boat for a while, and then swam back.

"You've got your turtle still," he said, "but I think he's dead."

"Cut the rope, then!"

This time, it was the sailor who objected.

"I've got another idea. S'pose we tow this log to where the boat is."

"And then?"

"Hitch the turtle to the log. That way we'll have the boat free, and the turtle to boot."

"Great stuff, Brown!"

The boy's enthusiasm for science, which had been at a low ebb during the past few hours, began to mount again.

"We might be able to find out what's in his stomach, yet!"

"Or put him in ours!"

Bernard looked sharply at the sailor.

"That's what you were thinking about, when you were so anxious to save the turtle, eh?"

"Why, sure! The longer we can make the biscuit last, the better chance we've got. You haven't seen any sign o' the ship, have you? An' any turtle's good enough eatin', when a chap's hungry."

"Well, come along and make him fast, then!"

Slipping into the water, the two swam with long side-strokes, pushing the log in front of them. It was heavy to move, being so water-logged, but the distance to the boat was not great.

"That was a slick idea of yours, following the boat all night, Brown."

"Wait till we get her right side up an' afloat, afore we begin to brag."

In less than an hour, they had managed to push the log close beside the boat.

"I'm a-goin' to dive down an' pay a visit to Mr. Turtle," then said the navy man.

But Bernard dissuaded him.

"That's dangerous. You might strike weed coming up again, and if you couldn't get your head above water, you'd be done for."

The sailor pondered for a moment.

"Maybe you're right, sir. Better not chance it. Well, I'll try to give the painter a turn around the ring-bolt and take two half-hitches in it."

"And if the turtle starts off again?"

"Then we'll know he's alive, anyway, an' it'll worry him some more to have to tow that log along! Are you ready, sir? We've got to dive down just a yard or so to grab the chain."

"Come on, then!"

Both dived.

Four bare feet splashed simultaneously above the surface of the sea.

Thirty seconds after, both came up, almost at the same second, each one with a firm hand-hold on the painter chain.

"Ship-shape an' Bristol fashion!" approved the sailor.

"And never a kick out of Mr. Turtle, either!" commented Bernard.

"Oh, he's gone where the good niggers go, I'm thinkin'. What turtle soup we could have, if we'd only got a pot!"

"And a fire!"

"We can make that, all right. I've a 'briquette' an' you've got your drawin'-paper."

For the first time since the evening before, Bernard thought of his sketches, in which he had taken such a pride.

"Nice shape my paintings will be in!" he remarked ruefully. "I guess the paper's about all they'll be good for. And that's all wet to a pulp."

"I wouldn't worry over that," said Brown, a little scornfully, for he regarded all oceanographic work as a kind of child's-play for grown-ups; "if you don't get back to the ship, it won't matter; an' if you do, you can make a plenty more."

Far from consoling the boy, this only nettled him.

"How long are we supposed to be holding up this confounded turtle?" he complained. "He's heavy!"

"Just a second, sir!"

The sailor disappeared beneath the surface. When he came up again, the farther end of the log was sticking up out of the water.

"You can let go, now. I've made the beggar fast. He'll stay there till the Tropics freeze, unless some one casts him off."

"Or until we're picked up!" added Bernard with attempted cheerfulness.

"Sure, or until we're picked up," the sailor echoed, but less confidently. "Anyway, we've grub an' water for a week; three days' rations for a crew o' four is enough for seven days for two, if we go easy."

"And how about the boat?"

"I cut her adrift, she's free. But the bow's badly stuck in the weed, an' it'll be a mean job to get her out. Like you said, it ain't pleasant divin' under that weed. Makes you feel like the water was all full o' snakes."

Freeing the boat was difficult, much more difficult than either of them had expected. The turtle must have struggled all night long, and had pulled the boat this way and that, entangling the skiff until she was like a fly in a spider's web. Apparently, then, utterly confused, the turtle had turned and run his head into a kink of the rope and then continued to flounder furiously until he had strangled himself.

It was not until well on in the afternoon that the two castaways, thoroughly exhausted, pulled the boat into clear water, and sat on their log to take a rest.

" But how are we going to bail her out? " queried Bernard. " The water will come in at one side as fast as we can put it out at the other."

" That's jest the trouble," the other agreed. " Afore we found that log, I didn't know myself how to do it."

" How's the log going to help? "

" I don't know if it's a-goin' to work," Brown replied, " but here's my idee! First of all, there's the weight o' the turtle on one end o' the log. That's a kind o' leverage. S'pose we go to the other end, an' put our weight on that. Seein' as we're heavier'n the turtle, that'll bring our end o' the log down.

We slip that end under the boat, as near amidships as we can. See that, so far?"

"Sure! But I don't see how that's going to help much."

"Let me go on! After we've got the log under, we let go, softly, just so's the weight o' the turtle'll keep the log in place, keep it from slidin' along the keel, like. Then we go to the turtle end o' the log an' heave down on that. The weight of all three ought to tilt up the boat a bit, even if it's only a few inches, enough, anyway, to slop some o' the water out of her. We can't expect to lift her clear, or it'd be easy.

"Then, while I hold down the log, bein' the heavier, you go an' try an' slide the boat over the side o' the log, easy like, opposite way to where she was pointin' when we lifted her. If we're lucky, an' can strike it just right, she ought to slide over into the water with maybe an inch o' free-board. Then, if we could bail her out, just a few drops at a time, without touching her side the least bit, she'd begin to float an' we'd get there in the end."

Bernard considered this plan in all its details.

"It doesn't sound right, somehow," he said, "but the boat's a light one and the scheme might work. Anyway, I can't think of any other. It's worth trying, that's sure, and there's no sign of the *Kittiwake!*"

They tried, once, twice, a dozen times.

Twice in these twelve attempts they almost succeeded. It was not until the fourteenth trial that Brown's plan worked exactly as he had originally planned it, and the little skiff, having been sufficiently tilted to let some of the water slop out, slid over the end of the log and into the water on the other side without swamping herself anew.

Brown had spoken of an inch or two of free-board. There was scarcely half an inch!

With infinite precaution, they moved her, just by light touches of the finger-tips, until she was in the lee of the log and free from danger of shipping water by even the tiniest ripple. Then Brown, treading water beside the boat, but so delicately as not to make any stir, began to work the bailer, careful not to make the slightest wave, which would compel the weary work to be begun all over again. In ten minutes, the free-board was an inch high. In half an hour, two inches, and the danger from ripples was greatly reduced. Before an hour had passed, the little skiff began to show some buoyancy.

The vagueness of a scarce-dared hope now took on the firmer outlines of expectancy, the more so as, twice in the afternoon, a faint blur of smoke on the horizon seemed to hold out a promise that the *Kittiwake* was still searching for them, or, at least, that she had not steamed away.

Evening was drawing down when the boat was sufficiently clear for Bernard to climb on Brown's shoulders and delicately to step into the boat. Then the bailer was plied fast and furiously, and, in half an hour more, she was free of water. Brown climbed in.

"Feels good to be a sailor again, an' not a bloomin' mermaid!" was his only comment.

They jammed the stern thwart back into place as best they could, and gladly unfastened the water-keg and the biscuit-box which had been like lead around their necks during all that long day of work in the water.

"You turn in, right now," was the sailor's next order. "It's sure time for a watch below. You're still wet through, an' we ought to dry an' get our clothes dry afore sundown. That log saved us, though; we'd never ha' got through a day's work like that, without a chance to rest, now an' again. Take a sleep, sir! We'll have to keep watch an' watch to-night, in case the *Kittiwake* comes our way."

"You think she's still looking for us? That smoke was a long way off!"

"Sure, she's on the hunt! What do you think? Anyway, it's a sea rule to spend two days lookin' for any one that's gone overboard, if there's a ghost of a chance.

"I reckon she's probably steamin' in a slow spiral, beginnin' small an' gettin' bigger. All to-day, most like, she's been circlin' pretty close to where we were last seen. Our disappearance must ha' struck 'em as a reg'lar sea mystery."

"But you think she'll circle out wider, and find us?"

"Swing out wider, she sure will, but findin' us in all this weed's another thing. We've got a better chance, now we're in the boat, for she stands out o' the water a bit, is painted white, an' easy to see."

"But that won't help us at night!"

"Oh, yes, it will. It's a safe bet they've rigged up the searchlight, to-day."

"Why not last night?"

"It's stowed away, for use in war-time an' maneuvers, an' it takes the electricians a few hours to get everything wired up right."

"That's all very well, but still ——"

"No more talkin', now! Lie down an' go to sleep, while the sun is still shinin' enough to keep you warm. I'll give you some grub when you wake up."

The night was far advanced when at last Bernard stirred. As on the night before, the first thing he saw was a green rocket, but, right beside it, was the nervous beam of a searchlight, sweeping the surface of the sea in a great white finger of brilliance.

"There they come!" cried the lad, triumphantly.

"Yep, they're comin'," agreed the sailor, though less contentedly. "They're makin' a whale of a wide circle, though, an' steamin' slow. At the rate she's goin', I reckon it'll be two or three hours, good, before she comes near enough for any one on board to spot us. I can't help any, right now. Are you fit enough to keep watch?"

"Me? I'm as wide-awake as if I'd had a night's sleep in my bed at home!"

"Fine!"

He dropped his voice to a note of gravity.

"It means a serious watch, you understand? If you don't keep awake it may cost the lives o' the two of us!"

"Don't worry, Brown; I won't drop off!"

"Then I will. I'm about all in."

He was. Not one minute passed before the sailor was in a sound and absolutely motionless sleep, utterly worn out. It was amazing that he had kept up so long, especially after his exertions in diving, for he had been under water thirty or forty times, and, save for short rests on the slippery log, had been working in water for nearly twenty-four hours.

The rockets from the *Kittiwake* continued to go off at rare intervals, one every half-hour; the searchlight swept the sea in long scythe-strokes of illumination. Watching carefully, Bernard could see that the light was gradually coming nearer, but at an angle which would take the searching ship wide of their path. Quite obviously, great intercepting banks of weed prevented the ship from maintaining a series of concentric circles. The longer he watched, the more sure it seemed that the course of the ship would lead her some distance away. Although Brown was sleeping profoundly, Bernard decided to wake him.

"I'm afraid they're going to miss us, clean," he said, "and I thought you ought to know before the ship gets any farther. We've got one oar. Ought we to scull so as to try to cross her path? If only we had some sort of a signal!"

Brown yawned portentously and rubbed his eyes, listening to the boy the while.

"Scullin's useless," he answered, "at night-time, anyway; we'd only run the risk o' gettin' tangled up in weed. As for a signal, we'll do what we can, though it ain't much!

"I reckon I can make jest one blaze. In the inside o' your sketch-papers there were a few pieces not wet, because the rest o' them had stuck, all round the edges. Then, while you were snorin' your head off, I sculled a bit here an' there an' picked some dry bits o' frayed seaweed stickin' above the surface o' the water on a bank o' weed. I've a small ball o' rope yarn in my pocket, an' tar'll burn, even if it's wet. I dried some cigarette papers in the wind an' I think they'd take light. We can only try it, anyway."

"And if they don't see it?"

"Well, then, I reckon to-morrow we'll have to make a sail out of our shirts an' a mast out o' the oar, an' try to get into the track o' ships, either north to the Gulf Stream or south to the trades, whichever way the wind's blowin'. But we'll try the blaze, first."

"And when do you think we ought to make it?"

Brown kept quiet for a few minutes while he watched the movements of the searchlight.

"You're right," he said, "the ship's sweepin' out in a big circle an' drawin' away from us, steadily. If we're goin' to do it at all, it'll have to be done now."

He took the briquette out of his pocket and began the meagre preparations.

"Wait till after the next rocket goes up," he added. "We don't want to run the risk o' havin' our little blaze blinded out by the glare."

Making a little nest of the tarred rope yarn, the sailor put the dried cigarette papers in the middle and surrounded the whole with a cone of paper made from the leaves taken from Bernard's sketch-block and intended to act as a wind-shield.

"There she goes!"

The green flare of the rocket shot into the sky.

As the sparks settled, died down and went out, Brown bent, whirred the little steel wheel against the flint, and the benzine-soaked wick of the briquette flamed, spluttering indeed, from the water that was in it, but alight none the less. The cigarette paper lighted immediately and the tarred rope yarn caught fire, burning with a yellow and smoky flame.

But how small!

"They'll never see that!" cried Bernard, who had somehow expected a small bonfire.

"It's every scrap we've got!"

Both fixed their eyes on the spot whence the green rocket had flared up, their hearts thumping with anxiety.

Then, suddenly, like a darting falcon, leaving its steady circling sweep, the searchlight flashed in their direction, close to them, away again, closer and then still farther.

"They don't see us!"

There was a wail in the boy's voice.

"They've seen something!"

The sailor crumpled the pieces of paper and put them in the dying fire. They blazed up for a second.

"Look! *Look!* LOOK!"

Three rockets leaped simultaneously into the air.

"What does that mean, Brown? What's that?"

"It means: 'We're Standing By!'"

"Have they seen us? Have they seen us?"

The boy's voice was shrill with a panicky eagerness.

"They've seen something, that's sure!"

How slowly the seconds passed!

"Yep, they're turnin', boy!"

But the searchlight, while wandering near them, sometimes within only a few yards, and sometimes a quarter of a mile away, never actually shone on the little boat, so solitary a speck on that vast expanse of dark and weed-filled water.

"Another fire, Brown; quick!"

"We've got no more!"

Once, indeed, the searchlight came so near that the two castaways could almost have touched the lighted spot of water with the oar, but it shot away immediately and commenced to range far, far beyond where they were. It was clear that the *Kittiwake* was running at half speed, but it was also clear that she was not on a straight course for them.

The strain was fearful, for, if the searchlight did not actually fall on that wee spot which was the boat, the ship would go steaming on, still looking, still hunting, and would not pass on that circle again. She might come even within a few hundred yards of them, just out of hearing, but with their last chance of signalling gone, what could they do to attract attention?

"She's headed nearer to us than she was before," said Brown encouragingly, but he knew that this meant but little.

The steamer was surely drawing nearer, but, the closer she approached the more sure did it appear that she would pass nearly a mile away.

Bernard, who had held up bravely, suddenly felt as if he could scream for sheer rage and disappointment.

"Isn't there something that'll burn? The boat! Break off some splinters!"

"The wood's all soaked."

"A handkerchief—something!"

"Everything's soppin' wet."

Then an idea came to Bernard.

"Those matches of mine?"

"They ain't no drier'n the rest."

"The phosphorus won't be! Your briquette might light them!"

"Try it!" agreed the sailor, shrugging his shoulders.

In frantic haste the boy pulled out the matchbox, which was, indeed, thoroughly soaked.

The flame of the briquette, at first, had no effect, except that, probably, of drying the chemicals, for, with a sudden "whoof!" the heads of the matches exploded, giving a bright flash which lasted for not more than a fraction of a second. It was all they could do. Would it succeed?

The searchlight sprang at them!

Evidently the operator was keenly on the watch, but the flash had been so brief that he could not mark down the place.

"Brown! She's changed her course! They saw it!"

"Ay, she's headed our way, now."

The two watchers could now see both the port and the starboard lights of the vessel together, sure sign that she was coming bow on, but she was coming very slowly.

Then, quite suddenly, the slow sweep of the searchlight fell full on the boat!

Brown, who had been sitting with his shirt off, expectantly, leaped to his feet and waved the shirt madly in the full glare of the brilliant white beam.

The light steadied, stayed fixed!

The whistle of the *Kittiwake* sent out a siren scream, as if the very machinery of the vessel were rejoicing.

Presently the black bulk of the steamer forged up close, the searchlight never leaving them. She was now so close that they could hear the telegraph on the bridge ring for "Quarter-Speed," and then for "Stop."

Then came the captain's voice:

"Boat ahoy! Is that you, Brown?"

"Ay, ay, sir; it's me."

"Both of you all right?"

"Both, sir!"

A ringing cheer burst out impulsively from those on board.

The telegraph rang for "Turn ahead," and the steamer forged slowly nearer.

Came another voice, that of the boatswain's mate:

"Below there!"

"Ay, ay!"

"Stand by for a line!"

The line came whizzing. Brown caught it deftly and made it fast.

A moment later, a rope ladder was dropped over the side.

"Do you want help?"

Brown answered:

"We can make it, sir, all right."

"Get aboard, then!"

But Bernard suddenly piped up:

"I won't leave my turtle!"

"What's that?"

It was the voice of the chief of the expedition.

"Oh, Professor," excitedly cried Bernard, from the darkness, "I've got a hawk's-bill turtle tied to a log, here, and I'm just sure he's got a new specimen inside him!"

Covrtesy of U. S. Coast Guard.

BELOW A THOUSAND FATHOMS.

The crew of the *U. S. S. Modoc* making a deep-sea cast; the sailor at the rail is unclasping a water-bottle which has been submerged for observations.

Courtesy of U. S. Coast and Geodetic Survey.

ELECTRIC DRIVE DEEP-SEA SOUNDING.

Modern machine used by the United States Coast and Geodetic Survey for rapid and exact work.

CHAPTER VI

TALES OF A LOST WORLD

A HOT meal, a stirring hot drink, and Bernard was hurried off to his bunk, for Professor McDree felt that the boy had gone through enough excitement, without having to repeat his adventures to the other members of the expedition, intensely curious as they were to hear them. The bare outlines of the story, especially the capture of the boat by the turtle and the mad race through the night, were learned from Brown, who was, naturally, the hero of his mess.

With this as a basis, the scientists waited patiently until after dinner the following evening. At the regular meeting of the "Chin Club," by common consent all reports were set aside in order that every one might listen to the boy's story, for here was a veritable tale of the Sargasso Sea!

Knowing his audience, Bernard kept a close watch on himself not to make the account seem boastful or exaggerated. Indeed, the tale did not need any extra coloring. Amazing as it seemed, there could not be the slightest doubt as to its entire accuracy. The boy had been picked up nearly thirty-five miles away from the place where he had been sketching, the strangled turtle with a loop of the boat's painter still tight around its neck was a strong proof in itself, and the boat revealed all the evidences of the struggle. There was also the log which had played so large a part in saving the castaways, and which Lee, the botanist, had spent the day in examining with delight, having found some rare microscopic algæ thereon. Furthermore, Brown, who was not especially imaginative in character, had already given his version of the story, which, aside from natural differences between the narrators, fitted in with the boy's descriptions in every particular.

"So that's how it was!" exclaimed the Professor, when the long recital had come to an end. "You see, gentlemen, we were all wrong! Not one of us, in our most extravagant suggestions, had thought of a turtle tugboat!

"You know, Bernard," he continued, turning to the boy, "scientists can't possibly get along without theories. Well, there were a good many theories about your disappearance, for certainly the way you vanished on a summer night in a calm sea was a mystery without a parallel!"

"We thought of that, Brown and I, and wondered what in the world you would have imagined."

" Personally, I thought that a whale coming up to breathe had poked his big head under the boat, staving it in, and that you were swimming for your lives in the sea. And since the second officer said that, a little while before dusk, he had seen you a mile away on the starboard bow, rowing towards the ship, we weren't alarmed at first. A mile swim isn't anything in a smooth sea, but, to make sure, we sent out the lifeboat. You weren't to be found anywhere, and you didn't answer our hails.

" Bower had another idea. In these seas there's a specially large medusa with very venomous stinging cells, and he thought you might have run across one of these creatures and have tried to take it into the boat, either as a specimen or as a model for drawing. Certain of these jellyfish can sting badly enough to give a temporary paralysis, lasting, at the longest, a couple of hours. But, when midnight came, and you hadn't returned, this idea of the stinging medusa had to be abandoned.

" Lee then suggested that you were playing a prank on us, and had stayed in the boat trying to sketch some of the luminous or luminescent forms of the Sargasso Sea, but, when the hours passed by, and you didn't even respond to our rockets, it became clear that the situation was serious.

"At the beginning, some of us were inclined to chaff. Nifstrod declared that you must have dived down to the 300-fathom line to visit the Giant Squid and see if Chu Ting had given a correct description; Montgomery insisted that you and Brown had met a mermaid who had arranged to take you down to the submerged palaces of the Lost Atlantis. But, according to your story, you didn't have much time to do either!"

"We certainly didn't, Professor McDree, but I'm sure if a mermaid had come up and offered to take us somewhere pleasant, during that long night swim, we'd have accepted right away, no matter where it was to!"

"Even to the Lost Atlantis?" put in Montgomery, the geological expert of the expedition, part of whose special work it was to look after deep-sea soundings, to make detailed charts of the ocean floors, and to help clear up the still unsolved mystery of the origin of the oceans.

"I think we'd have gone even there," Bernard answered, "though I've never been sure if such a place ever existed. Did it?"

At this question the Professor rose hastily from his deck-chair, the usual signal for the breaking-up of the "Chin Club" meetings, for this was a famous subject of dispute among the members of the expedition.

"It's a bit late to start Montgomery talking on that!" he declared emphatically. "But console yourself, Bernard; we're going to try to find out definitely about Atlantis, before we start north for a study of marine life along the icebergs. Maybe, if you ask him nicely, Montgomery will let you tie yourself to the deep-sea lead, and you can go down a thousand fathom or so, to see what you can find down there!"

Next morning, after another good night's rest, Bernard felt himself as fit as ever, and reported for duty at the laboratory. The Professor had carefully scanned the boy's smudged and wetted color-drawings, so far as they remained recognizable, and, though their value was nil in their existing state, he considered that they showed a good deal of promise. Upon Chu Ting's advice, he decided to send the boy out on another trial.

Great, accordingly, was Bernard's delight, when, that morning, he was told that he could go out in the skiff again, with Brown, the faithful companion of his great adventure.

"On one condition!" the chief warned him, half-seriously. "That is, that if the Deep-Sea Serpent does come up to have a look at you, you won't try to put salt on its tail!"

Which Bernard promised faithfully.

For three days, the sea remained calm: ideal weather for the various purposes of the expedition, such as making careful studies of the character of animal and plant life at various levels and depths in the sea, dredging the bottom itself and studying the floor-dwelling creatures, determining the salinity and chemical constitution of the water, and mapping the contours and the composition of the deposits of the ocean bed.

During these three days, Bernard remained almost constantly in the small boat, without a recurrence of any wild adventure. He did not achieve the remarkable success in his color-drawings which he had fondly hoped, for he was under the constant disadvantage of having to compare his sketches with those of Chu Ting, a comparison which very efficiently knocked all the vanity out of his head.

None the less, Professor McDree and the Chinese artist privately agreed that the boy's work held great possibilities, provided he could be rigorously kept away from the habit of slap-dash work, the curse of every would-be scientific draughtsman and colorist. The chief of the expedition, anxious to help on the career of the son of his old friend, urged Chu Ting to undertake the boy's training, offering a handsome personal remuneration, which the Chinese artist promptly refused.

" 'To teach those who are wise in their youth is a duty; to teach those who are not wise is a peril to the state,' " said he. "Such is a saying of Confucius. One should not be paid for doing one's duty, still less for spreading what is a peril to the state."

And, following this cryptic acceptation of the responsibility of tuition, he drove Bernard nearly frantic with compulsory drawing of complicated Radiolaria done from a microscope.

After the three days of calm, the weather turned stormy. While this hindered the taking up of fixed oceanographical stations, a further week was spent in the Sargasso Sea, since wireless soundings and surface work could be carried on vigorously in spite of rough water, and the Sea itself was explored with much care.

The distribution of weed was found to be extremely irregular, and though, by slow steaming and careful navigation, the *Kittiwake* did not get into any more serious trouble than that of having her propeller choked with weed four times, still it was made clear that a sailing vessel might find herself in trouble in certain parts of this sea. The captain of the *Kittiwake,* when asked his opinion whether the Gulf-weed could actually wreck a ship, shook his head doubtfully.

"A sailor will always tell you that almost anything can happen at sea," he answered. "I suppose if a barque were running before a gale, with a good spread of sail set, and suddenly got jammed in a bank of weed, her masts might go by the board. It would be the captain's fault for carrying too much canvas in a sea which it is a navigator's business to avoid. But the thing might occur.

"In such a case, if the ship were deeply loaded, her boats might not be able to tow her out to clear water and she'd be derelict. Yes, it is possible for a sailing-ship to be marooned by Gulf-weed in the Sargasso Sea, or for the choking of a steamer's propeller by weed to twist her propeller shaft. While I have never heard of such a case, I wouldn't see any reason to disbelieve such an occurrence if it were told to me by a responsible ship's officer.

"I'll go so far as to say that I consider the Sargasso Sea is rightly marked as 'dangerous' on the charts. Since weeds drift here in great quantities, derelicts may do so, also, and no lookout can tell whether or no there's a derelict just awash under a thin layer of seaweed. On such, a vessel might easily crash and go down. I've kept the *Kittiwake* to 'half speed' ever since we have been in these seas, and, as you have probably noticed, gentlemen, I sleep in the chart room. Since we're bearing away from the Sargasso, to-morrow, I don't mind telling you that I shall be a good bit easier in my mind when we get into open seas."

"We're going to look for the Lost Atlantis, now, Captain," put in one of the younger men.

"Deep soundings!" affirmed the naval officer, with a smile. "At least I sha'n't be afraid of running aground on that land!"

And, with a word of excuse, he went up on the bridge.

"Just exactly what is the tradition of the Lost Atlantis, Mr. Montgomery?" Bernard asked, late that afternoon, during the before-dinner pause in laboratory work, when daylight had grown too dim for microscopic study. "One hears such a lot about it, and so little that seems to be true."

"You've hit the mark, exactly," the geologist replied. "One does hear a great deal about it, and very little of what is told is true. The reason why the Lost Atlantis is so much talked about, is because a few sensational half-scientists have taken an old legend, furbished it up with some supposed discoveries of modern times, and then used this patched-up tale to support some absurd theory of their own.

"If you really want to know, Bernard, I'll tell you the old legend, show you how it has been mishandled, and then give you the real oceanographical facts so far as they're known. Maybe that'll give you better ideas about the ocean bottom than if I described it as I would to a group of students in my classroom."

"I'll have to do the classroom work later, probably," the boy replied, "but I would like to get the hang of it now, if I could."

"So you shall!" Montgomery replied heartily, for this subject was his special hobby. Nothing interested the ardent geologist so much as the question of the long rolling plains, the hills and valleys, the mountains and ravines, the peaks and chasms, and all the strange and never-beheld scenery of the bottom of the great oceans.

"First of all," he began, "let me tell you the old tradition. Homer, long, long ago, spoke of a land at the setting sun, and several ancient authors, after him, seem to have had some vague perception that the lands on either side of the Straits of Gibraltar were not necessarily the end of the habitable world.

"But the Lost Atlantis, as such, does not go back as a tradition any farther than a supposed date of 605 B. C., when certain Egyptian priests were supposed to have told this history of the land beyond the sea to Solon, the Athenian legislator. In Plato's 'Timæus,' written in 398 B. C., he makes the famous statement concerning Atlantis, which I have repeated so often in my lectures and classes that I know it by heart. It runs as follows:

"'A strange tale, but certainly true, as Solon declared. . . . When Solon was in Egypt, he fell into talk with an aged priest of Sais, who said to him:

"'"Solon, Solon, you Greeks are all children, there is not one old (wise) man in Greece. You have no traditions and know of but one deluge, whereas there have been many destructions of mankind, both by flood and fire. . . .

"'"More, you are ignorant of your own past. For, long before Deucalion (the Greek Noah) nine thousand years ago, there was an Athens, founded, like Sais, by Athena, a city rich in power and wisdom, famed for mighty deeds. Of these the greatest was this:

"'" At that time there lay an island fronting the mouth which you, in your tongue, call The Pillars of Hercules (Straits of Gibraltar). This island was larger than Libya and Asia (as then known) put together, and there was passage thence for the traveller of that day to the rest of the islands as well as from those islands to the continent beyond. The sea in front of the Pillars was indeed but a small harbor; that which lay beyond the islands, however, was worthy of the name of ocean, and the land which had surrounded that greater sea might truly be called a continent.

"'" In this Island of Atlantis had grown up a mighty power, whose kings were descended from Poseidon (god of the sea) and had extended their sway over many islands and over a portion of the great continent. Even Libya (North Africa) up to the gates of Egypt, and Europe as far as Tyrrhenia (Etruria–Italy) submitted to their sway.

"'" Then, O Solon, did the strength of your republic become clear to all men, by reason of her courage and force. Foremost in the arts of war, she met the invader at the head of Greece. Abandoned by her allies, she triumphed alone over the western foe, delivering from the yoke all the nations within the Pillars.

" ' " But afterwards, came a day and a night of great floods and earthquakes. The sea engulfed all the Atlanteans capable of bearing arms, and Atlantis disappeared, swallowed up by the waves. Hence it is that this sea (the Atlantic Ocean) is no longer navigable by reason of the vast mud-shoals left by this vanished island." ' "

" My word, what a tale! " exclaimed Bernard.

" And it is not the only one of its kind. The Carthaginian historians told of a wonderful Island of the Meropians, where there was a great civilization, extremely rich. This mysterious land, covered with handsome palaces and luxuriant gardens, was said to be only a few weeks' sail from the northwest coast of Africa.

" As for smaller islands which were either supposed to be of a wandering habit, or which have disappeared beneath the sea, there are any number. Some of the best-known are the Islands of the Seven Cities, Lyonesse, Hy Brasil, Avalon, the Breton city of Is, and the Blessed Isles of St. Brendan, which latter land was marked on all nautical charts as late as the eighteenth century. The Saga of the Voyage of St. Brendan is one of the most curious and most elusive legends in all sea lore, fantastic, miraculous, and yet, here and there, strangely in accord with geographic fact. A very curious tale, especially for Americans! "

" And none of these islands ever existed? "

" None! Unless, perhaps, some vague hint of the West Indies and of the continent of America had reached the ancients from some unknown source. Plato's description of a ring of islands guarding a continent, on the same latitude as the Straits of Gibraltar, is curiously suggestive of the West Indies. What is still more strange is that Pliny declared these 'Islands of the Hesperides' to be forty-two days' sail from the coast of Africa, and Columbus took exactly forty-two days to reach the West Indies from a port in Spain."

" H'm, that sure is queer! "

" But what really brought the Atlantis notion into prominence were the fantastic and absurd inventions of an American writer, one Ignatius Donnelly. In the maddest way, this lover—and maker—of mysteries, took the old Platonic legend, fabricated so-called 'scientific facts' right and left with all the glibness of an accomplished liar, and set forth a harebrained theory of 'Atlantis, the Antediluvian World' as a means of solving every difficulty which could possibly be imagined, past, present and future, in every branch of history and geography."

Bernard grinned.

" That must be a wild book! " he exclaimed.

" It is; it's more than wild! This man Donnelly took Plato's tale of the island described to Solon by an Egyptian priest as an established fact. He used the legend to prove that a great continent existed. He made this supposed land larger than Africa and Asia combined, and, when there was some difficulty in fitting this overgrown continent into the North Atlantic Ocean, he moved degrees of latitude and longitude around to suit himself. He went on to claim that this antediluvian world of his invention was the original Garden of Eden—as well as the Asgard of the Northmen and the Happy Hunting Ground of the American Indians—and calmly asserted that Man must first have been created there, since no one could prove that the Creation had taken place anywhere else! "

" No? You're chaffing, Mr. Montgomery! "

" I'm not! I have the book down in my cabin, right now, and you can see for yourself! But that was only the beginning. From that point Donnelly started out to show that Atlantis was not only the original home of the human race, but also the source of all civilization, all language, all religion—everything, in fact! Whites, negroes, Chinese—everybody came from there. Every possible similarity he seized on to bolster up his ideas, and every dissimilarity he explained away by the simple statement that the missing evidence in favor of his theory had gone down to the bottom of the sea with Atlantis. Handy, eh?

"Egypt, according to his idea, was just a little colony of Atlanteans. So was Mexico. The fact that there were pyramids in both countries—though their characters and purposes are quite unlike—he proclaimed as an absolute proof. He cared as little for dates as he did for degrees of longitude. Although he declared that Atlantis had sunk beneath the sea long before the time of Homer, he sent the Lost Ten Tribes of Israel there, in spite of the fact that the Jewish dispersion didn't happen until several centuries later. Oh, Donnelly didn't hesitate to put in anything which would make his book sensational and exciting. He got the book sold and himself talked about, which was all he wanted."

"And every bit of it was lies?"

"Well, suppose we say that in the light of modern knowledge it is incorrect in every particular. That's about the same thing, but it sounds better."

"But isn't it possible that, sometime, there might have been land, there?"

"Where?"

"Between Europe and America."

"Not only possible, but certain. There was!"

Bernard gaped at him open-mouthed.

"But I don't understand, Mr. Montgomery; you just said there wasn't!"

"No, my boy, I said that Donnelly's statement was all wrong. So it was! At the period when there may have been land where the Atlantic Ocean rolls to-day, there were no human beings. It's doubtful if there were even many mammals, for it must have been early in the Tertiary Period. So far as that is concerned, at that time there wasn't any America or any Africa, in the definite shape that you think of them as continents.

"But that's a long time ago! Generally speaking, for the last few million years the main ocean depressions—those below the 2,000-fathom line—have been where we see them now, and the main continental plateaus—including the shallow coastal waters above the 1,000-fathom line—have remained but little changed, if at all. Therefore the supposed Lost Continent of Atlantis, inhabited by human beings, and possessing a civilization from which everything else was derived is a pure absurdity, since it would have been compelled to occupy a large part of the two great oceanic depressions into which the North Atlantic is divided.

"Of course, Bernard, shallow seas have intruded or receded on the Continental Shelf, here or there, according as the land fell or rose, from time to time. Thus the relations between land and water have constantly changed, and are still changing, though the main forms of the ocean beds and the continental plateaus have not."

"I don't quite see that, Mr. Montgomery," put in the boy.

"Yet it's easy enough. Maybe if I explain it to you on a small scale, you'll be able to understand it better. You know that the Mississippi is a very muddy river?"

"It sure is!" agreed Bernard emphatically, recalling some summer-time swims in that turbid flood.

"And you can see for yourself that all the mud it carries down must go somewhere?"

"Yes, into the Gulf of Mexico."

"Where it forms a large delta. This delta, obviously, must be growing every year, eh?"

"Of course."

"Therefore the shore-line of the Gulf of Mexico, at that point, is increasing every year or encroaching on the water; in other words, the relation of land and sea is changing. Now, all the rivers of the world are doing the same thing. Every wind that blows reduces some infinitesimal portion of a mountain range into dust, and every drop of rain that falls carries that dust down into a stream, thus helping to wear down the land and to fill up the sea."

"But, if that keeps on, the sea will get all filled up!"

"No danger of that! It'll take a long time before all the land is worn away. The amount of soil, or eroded rock, carried down to the sea every year has been reckoned as containing nearly four cubic miles, and, by another authority, has been estimated as weighing over twenty-one billion tons (21,102,704,000 tons).

"Sir John Murray, one of the greatest of all oceanographers, calculated that, if the present rate of erosion continued—and there were no land upheavals intervening—the whole of the land surface would be transferred to the sea in 6,340,000 years. This figure can be multiplied by ten, at least, for the rate of deposition would necessarily be reduced as the land surface diminished.

"So we don't need to worry about there not being any solid ground to stand on, for sixty million years, at least. After that, mankind, if it still exists, will have to live in boats or develop fins, the latter probably, for there'd be no timber and no way of mining metals."

"You mean we'd become aquatic mammals like whales and seals?"

"Perhaps!"

"But," protested Bernard, "I don't see it, even yet. If all the land were worn away, why wouldn't it fill up the sea? Look at the mountains!"

"And think of the ocean 'deeps,' my boy! Two-thirds of the surface of the Globe is water, and the average depths of oceans and seas is far greater than is the average height of land. You ought really, Bernard, to try to get an idea of the general shape of the ocean floor.

"First of all, there is the division between land and sea, either the high tide or the low tide mark, the laws differing in various countries. The land between extreme high tide and extreme low tide is known as the 'Foreshore.' Where the gradient is slow and tides have a large rise and fall, this foreshore may be more than a mile wide; on a cliff coast, with small tides, the foreshore may stretch only an inch or two.

"Next, my boy, you must picture to yourself a bottom sloping gradually from the low tide line out to a depth of 100 fathoms; this is called the 'Continental Shelf.' Its average gradient is about one in fifty-seven, so that you'd have to walk about a hundred yards to be out of your depth. In some places it is wide—over a hundred miles off New York,—in places there is no Continental Shelf, for the bottom slopes into deep water right from shore. The average width, the world over, is a little over five miles.

"If such a contour line were drawn on a map of Europe, and if the water were withdrawn, it would wipe out the Irish Sea, the English Channel, the North Sea and the Baltic Sea; Russia, Sweden, Germany, Denmark, Holland, Belgium, France, England and Ireland would form an unbroken land. Bering Sea is equally shallow, so that northeastern Asia and Alaska would join. The Gulf States would more than double their land area. Southern Asia would nearly reach to Australia, and Indo-China would gain a piece of territory as large as the United States. The Continental Shelf occupies seven per cent. of the water area of the Globe.

"The next important belt of water is that which overlies a bottom sloping from the 100-fathom depth to the 1,000-fathom depth; I call this the 'Continental Step.' This has an area of eight per cent. of the surface of the sea."

"At that rate," put in Bernard, "about eighty-five per cent. of the water surface of the Earth is Ocean, and fifteen per cent. is Marginal Sea."

"Exactly! But, in the North Atlantic, for example, the proportion of shallow water is much greater. There's one exceedingly deep place, though, where, for more than half a million square miles, the bottom is more than 3,000 fathoms below sea level, and where the *U. S. S. Dolphin* reached soundings of 4,662 fathoms (27,972 feet). This region, which lies northeasterly from the West Indies, is known as the Nares Deep.

"About the edge of the Continental Step, then, in the neighborhood of the 1,000-fathom line, comes a much steeper pitch, with a gradient of one in ten; this is called the 'Continental Slope.' It is the true underwater shore of the Ocean, and you should always think of the ocean as bordered by this deeply hidden shore.

"Once you get to the foot of the slope, usually somewhere about the 2,000-fathom line, the bottom is almost level, for more than half the water area of the Earth has a depth of between 2,000 fathoms and 3,000 fathoms. A slope of a fathom to a mile, or one in 880 would be too small to be noticed; even a glass marble wouldn't roll on so slight a pitch."

"My word! It must be mighty flat!"

"It is, and, in so vast a plain, the 'hills' and 'mountains' which form shoals, keys, reefs, or islands, are scarcely noticeable. These far-stretching levels below the 2,000-fathom line form the Ocean Beds.

"These ocean beds, together with certain permanent land elevations known as 'Shield Lands'—and which are the backbones of continents—have not changed for millions of years. They form unalterable features of the Earth's surface, in strong contrast with the ever-changing but superficial shifting of the Marginal Seas. These latter are in constant movement, either receding so that the land regains a part of the Continental Shelf, or advancing to swallow up some of the low-lying stretch above the Foreshore.

"Now, by considering these various levels, we can begin to see how wildly impossible was Donnelly's theory of the Lost Atlantis.

"I have shown you the changes—especially in Europe—that would come if the Continental Shelf were clear of water. Even more sensational things would happen if the Continental Step were clear. Europe would be solid land with Greenland and Greenland with Labrador. As Bering Sea is so shallow that it would be dried up before, you could drive a caterpillar motor-car all round the world and never get the wheels wet. The straits of Gibraltar would be closed, and the Mediterranean reduced to three small lakes, so that the caterpillar car I spoke could jump backwards and forwards to Africa. It could almost tour to Australia, but not quite, a narrow belt of water intervening.

"All these changes, however, would be local, or rather superficial, for we are dealing only with the Marginal Seas. The Ocean Beds, you remember, do not change.

"The North Atlantic bed, however, shows a very remarkable feature. This is the Central Atlantic Ridge. South the Continental Step, stretching from Ireland to Labrador, is a wide submarine plateau with an average depth of 1,400 fathoms. This is known as the Telegraph Plateau, because it was right over this that the first submarine cables were laid.

"Exactly midway between Europe and America, this ridge turns southwards, and, almost exactly equidistant between the land areas of the two hemispheres, it runs clear down to the latitude of Cape Horn, closely following the curves of the shores of South America and Africa. The average depth of this long, narrow ridge is below 1,600 fathoms, or about 10,000 feet.

"It is, then, unquestionably, an integral part of the Atlantic Ocean bed, with an original geological relation to the continental masses which it parallels. It is not a subsidence; if anything, it is rising. It does not and cannot represent any portion of a Lost Continent of Atlantis.

"I wish I had Donnelly here! I'd tie a good big chunk of lead around his feet and let him go down those ten thousand feet to have a look for himself!"

Bernard grinned at this fierceness, for Montgomery was known to be the softest-hearted man on board.

"A map showing the 2,000-fathom line," the geologist continued, "gives a very queer look to the North Atlantic Ocean. It divides it into two different seas, joined only by narrow channels at the Equator and in the Antarctic Ocean."

"Are those seas the 'deeps,' then?"

"No. Deeps are isolated depressions, lower than 3,000 fathoms, some very large and some quite small, scattered—without any apparent geological reason in some cases—over various parts of the two hemispheres. There are fifty-seven of them, sixteen of good size. Seven have each an area of more than half a million square miles, and two, the Challenger (including Nero) and the Aldrich Deeps, have given soundings of more than 5,000 fathoms."

"And how far down is the deepest spot of all, Mr. Montgomery?"

"A nice little basin of 5,346 fathoms, or 32,076 feet, my boy!"

"Deeper than Mount Everest is high?"

"By more than three thousand feet! And when you remember, Bernard, that six per cent. of the Ocean is in these Deeps, giving nearly one-seventeenth of the water area of the globe a depth of more than 18,000 feet, you can easily see for yourself that there would be no great difficulty in tucking all the dry land away. There are more than seven million square miles of ocean, deeper than Mont Blanc is high."

The boy whistled.

"And, even then, the highest mountain and the profoundest deep are nothing when compared with the Earth as a whole, less than the scratch of a needle on a polished globe of crystal, six feet in diameter."

"Erosion of all dry land wouldn't really make much difference, then?"

"Hardly any. If the mountains were put in the deeps, and the rest of the land spread evenly over the sea bottom, the ocean would still average two miles deep. So, you see, we'd need fins, as I said."

"But what's the bottom really like?" queried Bernard.

"We're going to take a look at it," responded the geologist, gravely.

"At the real bottom? 'Way, 'way down? Oh, when?" asked the boy, excitedly.

"To-morrow!"

CHAPTER VII

PIRATE GOLD

"You wanted to see the bottom of the ocean, eh? Well, there it is! Just as we saw it at daylight this morning!"

"That's just a sample of mud!" cried Bernard, disappointed.

"It shows the ocean bottom just as surely as a piece of rich gold ore will show you a gold mine."

"But mud, plain mud!"

"Not so fast! What is mud?" the geologist demanded, as he stood by the elaborate sounding and testing apparatus which was being prepared for another deep-sea test.

Bernard thought over this apparently simple question for a moment.

"Why, it's—it's dust that's got wet."

"I don't think very much of that definition, my boy; try again."

"Well, mud—oh, I know: mud is soil carried down by rivers."

"That's a little better. But what is soil, then?"

"Soil is—let me think! I suppose it's what we were talking about yesterday; it's the dry land which has been eroded and has been carried into the sea."

"So is sand. But surely you can see some difference between sand and soil?"

"Oh, yes; lots. Soil has in it the remains of leaves and plants, and all sorts of things; it's finer-grained, too."

"And what is it that makes it so fine-grained?"

"I know that, Mr. Montgomery. The half-rotted remains of plants in earth are good eating for earthworms, and they munch their way through the soil, chewing it up fine."

"I'm not sure that Mr. Bower would quite approve of your phrase 'chewing it up,' Bernard, but I see you have grasped a part of the idea, though you must remember that eroded material from some rocks—shales, for example—can be very fine. Of course, shales, themselves, are only dried and compressed mud. Now, you say that soil has 'all sorts of things' in it; what do you mean by that?"

"Things which won't dissolve or rot."

"Such as?"

Bernard thought for a moment.

"Well, bones stay a long while in the soil, so do snail-shells and things of that kind."

"Now you're beginning to come to it! Mud, you say, comes down rivers, but when a river reaches the sea, does the current go on?"

"Why, no; it stops."

"And what happens to the mud?"

"It forms a delta, as you were saying about the Mississippi, yesterday."

"And the very fine mud, held in suspension by the water, where does that go to?"

"A little way out to sea, I suppose, and settles there."

"Very good. Now, this sample that I just showed you is not mud at all, but ooze."

"What's 'ooze'?"

"I'll explain that to you presently; it's quite different from mud. But you ought to see, Bernard, that we're more than two thousand miles from the mouth of any river, here, and a great quantity of mud couldn't be so finely divided as to float—without the aid of a river current—a distance of two thousand miles before settling down.

"But, since we've started on the question of mud, let us finish with it. You remember I told you, yesterday, that the first division of the sea was the water of the Foreshore, that is, water overlying a bottom between high and low tide marks?"

"Yes, sure."

"Now, that Foreshore bottom, being covered by the sea twice a day, must necessarily have a different character from the beach lying above the high tide mark, as you've probably noticed for yourself, time after time."

"Of course. In some places the Foreshore—we used to call it the 'strand,' at home—is of smooth sand, in other places it's of rocks separated by patches of sand, the rocks being covered with seaweed, while, near the mouths of rivers or on shore flats, it's mighty apt to be mud."

"Exactly. And, if you add shingle and boulders to the list, you'll have the Foreshore deposits fairly completely. The differences on various beaches are due to the nature of the adjacent land, the strength of the tides and the shape of the coast-line. All such bottoms comprise more than two-thirds of mineral particles derived from the land; they are known as Terrigenous Deposits.

"The sand is generally quartz; pebbles are often of flint, chalk-covered; both sands and shingles contain a small proportion of broken or complete molluscan shells, of the chalky remains of nullipores, and of the sandy tubes of marine worms.

"Yet, as you know, Bernard, while you can find plenty of shells on the beach, generally they are empty. The molluscs which lived in them could not live on the Foreshore, exposed to the air twice daily; the empty shells have been washed up with the tides. You do find, though, in certain places, large quantities of the sandy tubes of annelid marine worms, such as *Sabellaria,* which actually do live on the Foreshore."

"What's *Sabellaria?*" the boy interrupted.

"It's a marine worm which makes a tube-house for itself. It belongs to the Phylum of the Appendiculata. You told me the other day that you knew the animal world was divided into twenty-two 'phyla' or main divisions. The Mollusca is one; the Appendiculata is another, and one of the largest. There were only five classes in the Mollusca, five letters of the zoological alphabet; there are nineteen classes or letters in the Appendiculata, including such different-looking creatures as rotifers, marine worms, earthworms, leeches, centipedes, bugs, flies, crabs, spiders, and scorpions."

"But those can't have the faintest resemblance to each other, even inside!"

"Oh, yes, they have, every bit as much likeness as there is between an oyster and an octopus! This is the clue: the bodies of all of them are composed of a greater or lesser number of hollow rings, each ring possessing (typically) a pair of hollow lateral appendages, moved by its own muscles and with blood-spaces.

"Surely you can see how a worm and a leech resemble each other, an ant and a wasp, a spider and a scorpion? Now, if you take a creature like the spider-crab, which is a true crustacean, you'll certainly think of a spider, right away; while the caterpillar of a butterfly isn't so unlike a centipede. It's the same way with a good many of the rest of the forms.

"But if you want to find out how each Class of the Appendiculata fits into the other, you'd better go and ask Bower. I'm not a zoologist, remember, I'm a geologist, and I only mentioned the marine worm *Sabellaria* because it makes great blocks of sand-tubes cemented with slime, which form a typical organic deposit of the Foreshore."

"You spoke of nullipores. Are they a kind of worm, too?"

"Sakes alive, no! They're seaweeds, but with the soft plant tissues so impregnated with calcium carbonate, or chalk—the same material of which oyster-shells are made—that they have become stony in texture. On coral-reefs, especially, there are numbers of these, but they are to be found, too, all along the shores of America.

"Now, as soon as you get below the line of low tide, Bernard, you find an entirely different kind of sea-bottom which is characteristic of the Continental Shelf, that is, which runs out to about the 100-fathom line. First of all, there may be a good deal of sand, coarse, near the shore, smaller, farther out. More important are the finer silts, muds, and clays; mud and clay differ from sand in that they consist mainly of alumina particles, while sand is mainly quartz.

"The heavier particles of silt, mud, or clay, drop upon the Foreshore, the lighter drop on the Continental Shelf and form the Mud Line, about 100 fathoms out. The finer particles, which are almost but not quite held in suspension by the water may drift far out over the Continental Step before they gradually fall and form an ever-decreasing proportion of the sea bottom.

"In addition to these fine mud particles, which may actually reach out as far as the 1,000-fathom line, there are still finer particles, carried still farther out to sea in what is known as a 'colloidal' state. They are so excessively small that their spherical area is proportionately very much larger than their bulk, and, consequently, they float until long exposure to salt water produces certain chemical changes and they begin to sink. There are a good many other characters typical of colloids, but we don't need to go into that, just now.

" That way, there is formed, about or just beyond the Continental Slope, a still finer terrigenous deposit, only to be found in deeper waters. It may be colored blue or red by hydrated oxides of iron, and is known as Blue Mud or Red Mud. Another variety contains a mineral called glauconite, somewhat mysteriously formed in the shells of certain one-celled animals called Foraminifera, about which I shall have something to tell you, later on, and this kind is called Green Mud. Volcanic muds, formed largely of pumice and ash, and Coral Muds, near coral formations, explain themselves.

" So, Bernard, seeing that we're 'way out in the middle of the Atlantic, that sample I showed you couldn't possibly have been mud."

" No," admitted the boy, thoughtfully, " I see. It couldn't."

" But, before we go on to take a look at the real Ocean Bottom," the geologist continued, " we ought to cast another glance at the bottoms of these Marginal Seas, for we're not dealing with a dead inorganic world, but with a living one. *Sabellaria* or tube-worm, is one of the very few actually living on the Foreshore.

"But, on the floors of the shallow seas, below the tide-water mark, there live and grow an enormous number of animals and plants which are bottom-dwellers. Some are able to run about with a good deal of speed, such as crabs; some slither stealthily forward, like the octopi; some advance very sedately, such as star-fishes and sea-urchins; some painfully push themselves along with a single foot, like clams; some burrow with extreme rapidity, like tooth-shells or Scaphopods; some move only a few inches all their life long, like limpets; some are practically motionless, like oysters; and some are absolutely fixed, like sea-lilies. There is also a large variety of sea-plants. All these, together, are called bottom-dwelling or 'benthonic' organisms.

"While most of these are eaten by their fellows, a few of the short-lived ones die a natural death. But, so hard are the protective coverings of many of these creatures, that the predatory creatures who live on them do not try to swallow them whole. When an octopus catches a crab, he only breaks the under shell and rasps out the interior with his radula; when a star-fish, after several hours of pulling on each shell, forces an oyster to open, he only sucks out the oyster inside, he does not swallow the shell. So, in hard-shelled or otherwise protected organisms, both those which die a natural death and those which are eaten leave their hard parts behind.

"The bottoms of the Marginal Seas, therefore, contain whole and fragmentary molluscan shells; the limy plates and spines of star-fishes, sea-urchins and sea-lilies; the chalky skeletons of plant-like animals, such as the polyzoa; the limy sand-tubes of marine worms; the skeletons of foraminifera, the spicules, or tiny spikes, of certain calcareous sponges; the carapaces or shells of crustaceans—from the big crab to the tiniest amphipod, as well as even the teeth and ear-bones of the larger swimmers, such as whales and sharks. Ear-bones, or otoliths, designed for vibrating to sound-waves, are of a different substance than bone and very much harder.

"There are animal remains of a flinty or siliceous character, too, such as the skeletons of radiolaria—an important one-celled form which I'll explain to you later, and which forms the fifth letter of the zoological alphabet, to which may be added the spicules of the glass sponges. There are also some chalky remains of plant life, such as the stems of nullipores and the calcareous parts of certain microscopic algæ, and, to wind up with, siliceous plant remains in the form of frustules or frames of diatoms.

"In the shallowest parts of these shallow seas, such organic remains may be more or less smothered by the quantities of sand or mud laid down at the same time; in the deeper parts, the proportion of Terrigenous Deposit diminishes, and that of organic remains increases. Where the bottom is more than two-thirds organic remains, it is known as a Neritic Deposit."

"That's clear enough!" declared Bernard.

"Yes, there's nothing difficult, so far. Now, beyond the Continental Slope, after the passing of the 1,000-fathom line, the Terrigenous Deposits disappear. No muds are to be found on the floor of the real Ocean. Their place is taken by a very different matter called 'ooze,' of which there are four varieties, each of them of extraordinary interest. I'll tell you about them a little later, while the deep-sea sounding is being taken. Right now, you'd better watch what's going on."

This measuring of the depth of the ocean, and the bringing up of samples from the very floor, thousands of fathoms deep, never failed to interest Bernard. This particular occasion was to be of special importance, for, immediately after the taking of the deep-sea sounding, an effort was going to be made to tow a bottom trawl along the very floor of the ocean, to bring up from there the bottom-dwelling creatures who live in the eternal dark under a pressure of several tons to the square inch. So important was to be this test—for the ship was over the Nares Deep—that Professor McDree, the chief of the scientific staff, came up on deck personally to supervise the manipulation of the instruments.

"Well, Bernard, has Montgomery promised to let you tie yourself to the deep-sea lead, and to go down and look for the Lost Atlantis?" he queried chaffingly.

"I haven't asked, Professor! After finding out how deep the sea is, right here, I decided to stay on deck."

"You'd better, unless you want to end your oceanographical studies by suicide, as Aristotle did."

"Aristotle, the Greek philosopher?"

"Why, yes; didn't you ever hear how he died? He jumped into a whirlpool in despair of being able to understand the causes of the shifting currents in the Strait of Euripus; at least, so the legend runs."

"Was he trying to find out how deep it was, too?"

"Not so far as I know. That doesn't seem to have been of much importance to the early navigators, though a writer named Posidonius declared he had measured the depth of the sea in the neighborhood of Sardinia to 1,000 fathoms."

"Do you suppose he did?"

"No, I don't. He left no statement as to how he did it, and there wasn't any kind of rope known in those times which would support its own weight for 6,000 feet of length, in addition to a stone or a chunk of lead at the end of it. What's more, how would a handful of boatmen on a cockle-shell of a Greek boat pull up the line again? Posidonius was probably just guessing.

"The first real effort at deep-sea sounding was made by Magellan, when he was becalmed in the Pacific, during the first circumnavigation cruise that ever was made. He dropped a hand sounding-line, several hundred fathoms long, and, finding no bottom, wrote in his log that he had discovered the deepest part of the ocean. He hadn't, of course, but he'd shown that the Pacific was not a shallow sea, as he had expected, but a true ocean. Captain Cook is said to have reached 500 fathoms.

"The first scientific deep-sea sounding was done on Lord Mulgrave's expedition to the Arctic in 1773, when 683 fathoms was reached with a special grabbing apparatus which brought up a large sample of Blue Mud. Sir John Ross, on his Baffin's Bay voyage in 1829, reached 1,050 fathoms, bringing up Green Mud. Sir James Clark Ross more than doubled this, in 1840, attaining the depth of 2,425 fathoms.

" The first effort to draw the contours of the ocean bottom was made by M. F. Maury of the U. S. Navy. By a very curious coincidence, on his return voyage Maury crossed the Central Atlantic Ridge near the Equator, just at the very point where it is broken by a deep channel, and thus missed the realization that the southward extension of the Telegraph Plateau—which he duly marked—runs all the length of the Atlantic. His soundings to 3,000 fathoms were fairly accurate, but, beyond that, he guessed a good deal.

" Modern oceanography, in all its details, dates from the expedition of *H. M. S. Challenger,* which lasted from 1872 to 1876; this was the greatest expedition of the kind that ever was or ever can be. All the oceans were surveyed, the depths to 4,000 fathoms were accurately charted, the life of the sea at various levels was discovered and examined—proving, incidentally, that there was life at all depths—and the character of the ocean bottom settled for all time. The fifty huge volumes dealing with the results of this expedition—they took twenty years to produce—form the basis of all deep-sea study."

He paused for a moment, in response to a hail from the men at the sounding-machine.

"Everything in good order, Mr. Montgomery? Very well, you can let go!"

The small reel began to whir, and the thin but enormously strong steel wire ran out with a hum.

The Professor turned back to the boy.

"Prior to Maury," he resumed, "all deep-sea sounding was done with a hand lead, let down by hand on a long line and pulled up the same way. Brooke, a midshipman of the U. S. Navy, suggested a system of having a ball of lead, like a large bullet, with a hole through it, through and below which projected a hollow sounding-tube. The weight of the lead would drive the end of this tube into the ocean floor, to take up a sample of the bottom. This bullet was attached to the main sounding-line by a short separate line on a spring catch, which catch was only held in place by the weight of the bullet. When the bullet touched bottom, therefore, the sudden lightening of the weight released the spring catch and thereby detached the short piece of line and the heavy lead, so that it was necessary only to haul up the sounding-tube."

"What a good scheme!" exclaimed Bernard.

"As a pioneer device, it worked very well," the chief of the expedition agreed, "and it enabled Maury to make the valuable soundings which gave to the world its first map of the bottom of the ocean, known as a 'bathymetrical chart.' American naval vessels, especially the *U. S. S. Dolphin* and the *U. S. S. Arctic,* then undertook systematic soundings in the North Atlantic; the Central Atlantic Ridge having been first clearly defined by the men aboard the *Dolphin,* it was long known as the Dolphin Ridge.

"During these early soundings occurred a very curious example of the grave mistakes into which really great men can fall. This was the supposed discovery of a marvellous form of life known as 'Bathybius.' That's a real scientific mystery tale of the sea. 'Bathybius' was fully as interesting to men of science as a genuine green-haired mermaid with a shining silver tail would have been, perhaps more. This creature—which never existed, except in the imagination—was the basis of several learned books, and even Huxley and Sir Wyville Thomson (in his youth) wrote about it in most scholarly wise."

"And this 'Bathybius'—whatever it was—really was nothing but a humbug?"

"Well, it was about as true as the story of the Lost Atlantis, as dressed up by Donnelly, and you know how true that is! Oh, 'Bathybius' is quite a queer tale; I'll tell you about it.

"In 1857, the English vessel *H. M. S. Cyclops* was sent to run a line of soundings a little north of the *Dolphin* line. Naturally, the tube of bottom deposit secured at each deep-sea sounding was carefully set aside, most of the water poured off, and the rest of the tube filled with alcohol to preserve any microscopic life or organic remains which might be found in the deposit. At the end of the cruise, these tubes were turned over to Huxley for examination and analysis.

"To his amazement, Huxley found, under the microscope, in every tube, a grayish-blue material, which resembled organic matter. Struck by the significance of this discovery, Huxley suggested that this might be a primitive, protoplasmic slime covering the whole of the ocean bottom, on which more highly organized creatures might live; he went farther, and tentatively brought forth the theory that this might be the earliest—or even the original—form of life. You're too young to know about it, but, when I was a boy, there was furious controversy as to how this primordial protoplasm originated. Church folk declared it must have been created, biologists tried to prove that it had been evolved. But neither one side nor the other doubted the existence of this protoplasm covering the bottom of the ocean.

"How could they? The German scientists, delighted to find in this protoplasmic slime a substance which solved a hundred puzzles of science, repeated the *Cyclops* soundings and checked Huxley's microscopical examinations. They agreed! The Germans were not satisfied with this confirmation, they went farther—a great deal farther—they 'discovered' the typical organism of this so-called protoplasmic slime, and gave it the name of 'Bathybius,' or Deep-Life; what was more, they drew most attractive pictures and diagrams of it as an amœboid organism, and, in great detail, described its habits of moving and feeding."

"And there actually was no such thing?"

"None! Not the remotest trace of such an organism! On the *Challenger* Expedition, our friend 'Bathybius' was set apart for very special study. Alas for his fame! He vanished like a ghost under a strong light. The chemist of the expedition found that when alcohol is added to salt water, sulphate of lime is precipitated in an amorphous (shapeless) form, which clings to shells or grains of matter, and which, under the microscope, closely resembles protoplasm. And that was the inglorious end of 'Bathybius.'"

He turned to the men at the instruments.

"Running out smoothly?"

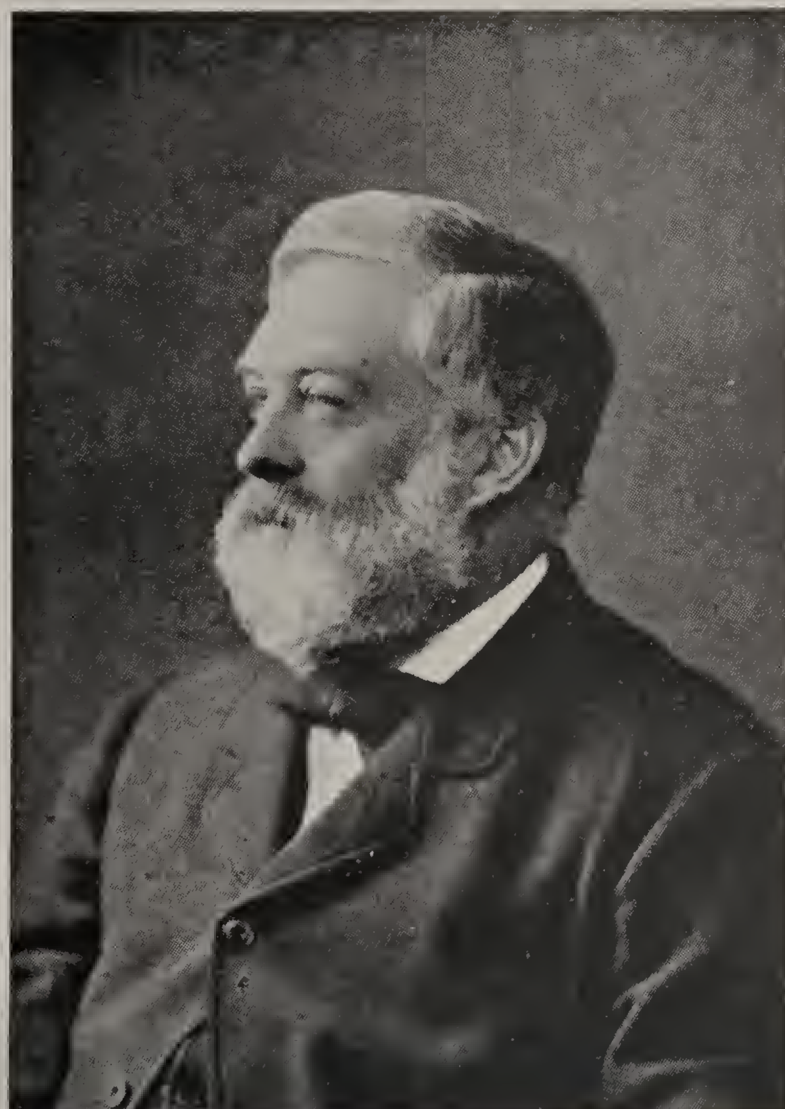
"No hitch, sir."

"Good. Now," he went on, turning again to Bernard, "we can take a look at the *Challenger* Expedition's methods of sounding. The *Challenger* was a three-masted full-rigged sailing ship with an auxiliary engine, specially prepared for deep-sea work and with a scientific staff on board, of very unusual ability. Deep-sea sounding and deep-sea dredging was her work, but, so far as the scientists were concerned, the whole ocean was their province, for they were the first explorers in a new world.

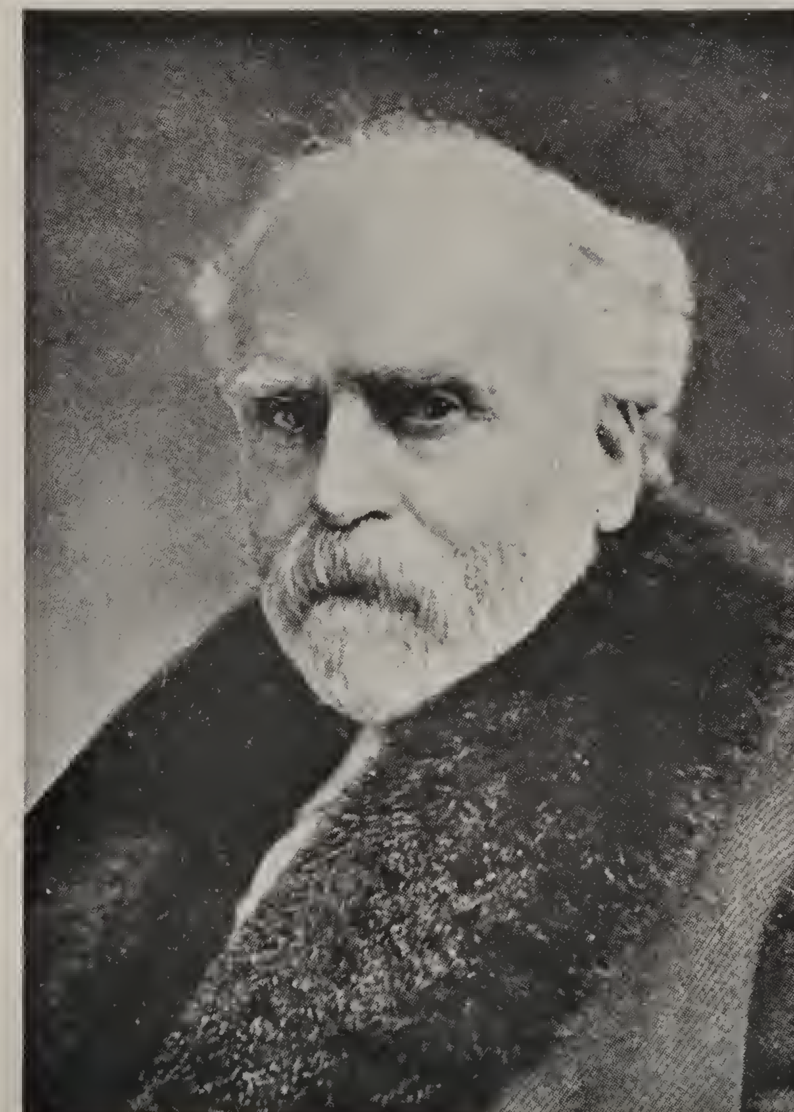
"The sounding-line used on board the *Challenger* was of one-inch hemp, 6,000 fathoms long. For the deepest soundings a weight of 400 pounds was used, and, as the weight of the line itself, in sea water, at the deepest sounding was about 350 pounds, the total weight was a third of a ton. You can see, at once, how hard this would be to pull up by hand.

Courtesy of Macmillan Co.

SOUNDING AND TRAWLING ON BOARD THE *CHALLENGER*.
Note the India-rubber accumulator. (Photography was in its infancy when this all-important oceanographic cruise was made.)



Sir Wyville Thomson.



Sir John Murray.

THE MEN WHO MADE OCEANOGRAPHY A SCIENCE.

"Now the breaking strain of this extremely carefully made hemp line was about 1,300 pounds, which left very little margin for friction in the water or possible jerks. In order to give play, an accumulator was used. This was a cylinder, three feet long, composed of forty three-foot bars of India rubber, each three-quarters of an inch thick. The accumulator was fastened to one of the ship's yards, and to it was hung the block through which the sounding line passed. This india rubber accumulator could be stretched from its original three feet of length to seventeen feet length with safety, and thus it took off all shock from the line. Some improvements were made on Brooke's device, but the Baillie sounding-machine, which was used on board the *Challenger,* operated on the same principle.

"The next advance was made by Sir William Thomson (Lord Kelvin) and the Thomson sounding-machine was used by the *U. S. S. Tuscarora* and the *U. S. S. Blake.* Steel piano-wire was used instead of hemp line. In this machine, the wheel lowering the line was braked by a second wheel on which counterbalance weights took the place of the elastic india rubber. The depth was measured by the number of revolutions of the wheel. The weight resembled closely the system of Midshipman

Brooke, but there was an additional device known as the Kelvin Sounder, which indicates the distance up an air-filled tube that water is forced by the pressure at the depth reached.

" The most modern deep-sea work has been done by a special steamer, the *Michael Sars,* built in 1900 by the Norwegian Government to do research work in connection with fisheries. Nearly all her earlier cruises were taken in the North and the Norwegian Seas. But, in 1910, Sir John Murray, the great oceanographer, took the vessel for a summer trip in the Atlantic, and this cruise was reminiscent of the great *Challenger* Expedition, though on a very much smaller scale. The work of the *Michael Sars* Expedition was rather a study of deep-sea fauna than the making of soundings, and the Lucas sounding-machine, which had been developed by cable-laying ships, was used for depth measurements. This machine, still further improved, has become a most efficient device, and we are using the Lucas, on board, here.

" The use of steam, of course, affords a great saving of time. Maury had difficulty in hauling by hand from deep water at a rate of six fathoms a minute, so that a sounding was an all-day job. The *Challenger* men, using steam, raised their hemp line at thirty fathoms a minute. By improved steam winches and with a wire line, the *Blake,* the *Michael Sars* and the *Kittiwake* have reached sixty. Thus we can drop a lead actually within one of the 'deeps' and haul it up in less than two hours from start to finish.

"There is every reason to suppose that the next great oceanographic expedition, one which, if possible, will be comparable to the great *Challenger* Expedition of 1872–1876, will be sent out by the United States. As you know, Bernard, a most important Conference on Oceanography was held under the Secretary of the Navy in Washington on July 1, 1924, and it was amazing what a vast number of unsolved oceanographical problems were presented.

"The general idea, at that conference, was that the time is not yet ripe to spend millions of dollars on a world cruise, for men must be specially trained and many devices need to be perfected. I happen to know that this important oceanographic training will take the form of a four-months' cruise—probably in the Gulf of Mexico—during the summer of 1925, in preparation for a vast world expedition in 1926 or 1927. This cruise of the *Kittiwake,* on which you're lucky enough to find yourself, is a sort of preliminary canter to next year's serious beginning."

"Is that why you're using wireless for getting echoes from the bottom of the ocean?"

"You mean the Sonic Depth-Finder? That isn't wireless, my boy! That works by sound waves, not by wireless waves, a very different thing."

"But it's the newest way of finding the depth of the ocean, isn't it?"

"And the quickest. The principle is very simple. An apparatus attached to the bottom of the ship makes a small, sharp explosion. The sound wave it sets up spreads out in a sphere. On reaching the sea bottom the sound is reflected and the echo is transmitted back to the surface, where it can be heard by an observer with a specially designed and very delicate receiving apparatus. Obviously, half the time between the explosion and the hearing of the echo is the length of time that it took for the sound to get to the bottom."

"But do we know how quickly sound travels?"

"Of course! Sound waves in sea water of average density travel at the rate of approximately 800 fathoms a second, with slight differences according to the saltness and temperature. If, therefore, four seconds elapse between the explosion and the reception of the echo, that means that the sound wave has travelled 3,200 fathoms, and, since it has gone to the bottom and back again, the bottom at that point must be 1,600 fathoms."

"And that simple scheme really works?"

"Admirably! The U. S. Coast and Geodetic Survey Ship *Guide* has been experimenting for a year or more with the Sonic Depth-Finder, and has corrected its observations with the latest types of sounding-machines. The accuracy has been found to be extremely close.

"The best of the Sonic Depth-Finder is that soundings can be continuous, even when a ship is travelling at full speed, so that the entire bottom of the ocean can be mapped without any trouble. A vessel approaching a lee shore, in a fog, at the slow speed of fifteen knots, is running at a quarter of a mile a minute; if she can get soundings in two or even three seconds when she is still a mile away, or even half a mile away, there is plenty of time to turn, but if soundings must be made by a lead-line—taking four minutes, even under the best conditions, she'll hit the rocks and be a total wreck. The device is being put on a good many merchant ships, so that the depth of every travelled corner of the sea will soon become known."

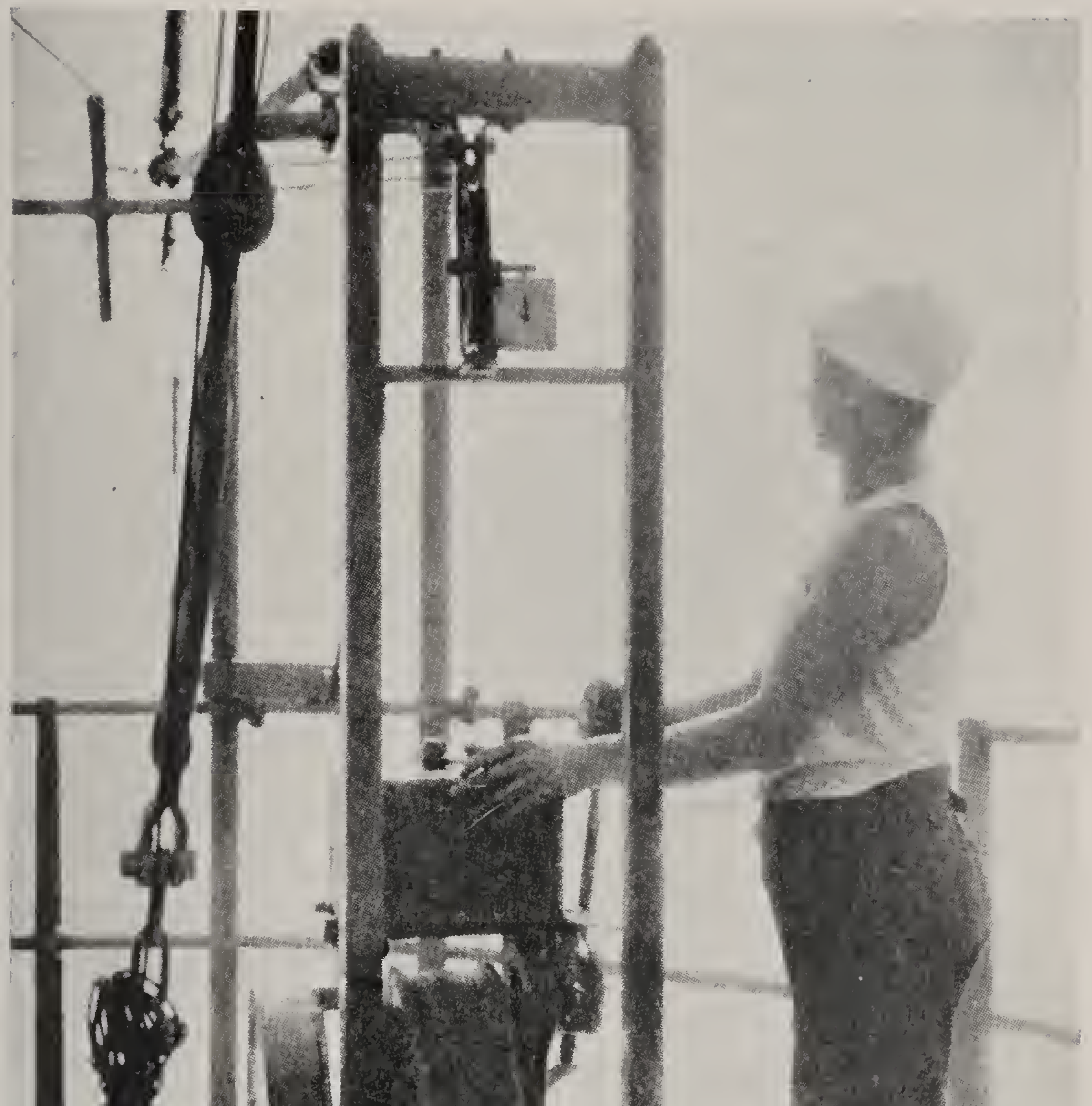
"But the Depth-Finder doesn't tell what the bottom is like."

"No. And it won't tell the temperature, or the salinity, or the chemical composition of the water, or a great many other necessary things. That's why —as you saw just now—our deep-sea lead carries down with it four reversing thermometers, two pairs of different types to correct each other, as well as both Greene–Bigelow and Nansen–Pettersson collecting water-bottles. Improved thermometers are needed for the registration of temperature at different levels, especially far down.

"If you had hitched yourself to that deep-sea lead, Bernard, my boy, you'd have been pretty cold by now. Deep water is cold water. In the tropics, the temperature at the surface may be as high as eighty degrees and it may be at twenty-nine degrees —or three degrees below freezing-point—a little distance from the bottom."

"Why doesn't the sea freeze, down there, then, if it has a freezing temperature?"

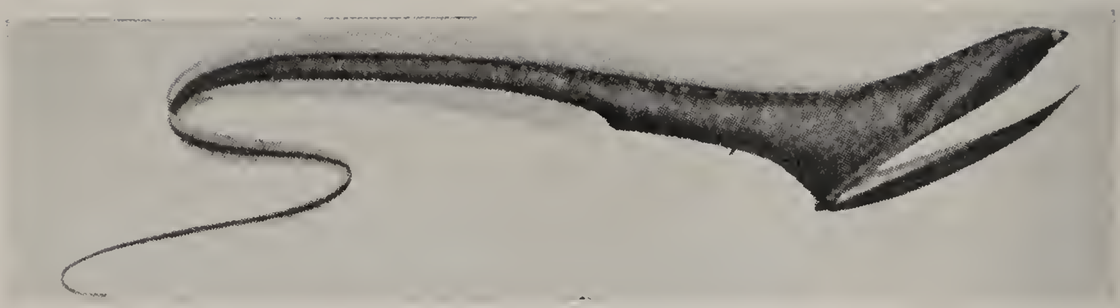
"Pressure prevents it, for one thing. For another, you must remember that, while fresh water freezes at thirty-two degrees Fahrenheit (0.00 C.), salt water doesn't freeze until twenty-eight degrees (–2.22 C.). The freezing point differs with the salt-



Courtesy of U. S. Coast & Geodetic Survey.

"HEAVING THE LEAD"—IN A MODERN WAY.

One man, with the aid of electricity, can sound a depth of 2,000 fathoms in a tenth of the time it took a crew of twenty men to do. of old.

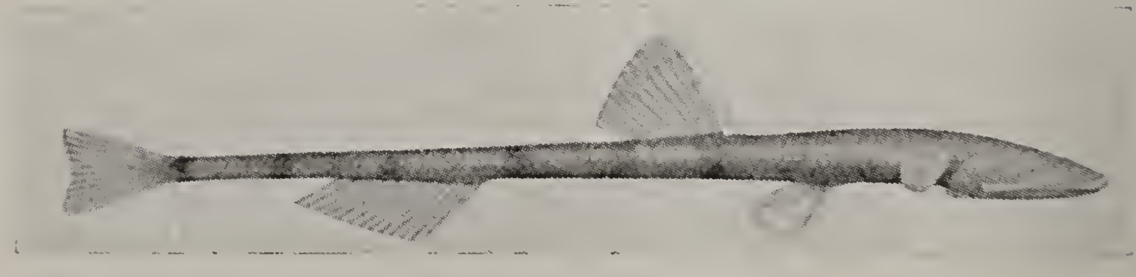


The bottom-dweller, *Gastrostomus Bairdii.*

A new genus of *Gastrostomus.*

The wide-spread *Hariotta Raleighana.*

A new form of blind fish, *Cetomimus.*



The eyeless *Bathymicrops Regis.*

Courtesy of Macmillan Co.

FISHES FROM THE VERY PROFOUNDEST DEEPS.

ness or salinity, and this, too, needs to be measured with the most extreme exactness."

" But does it really make much difference whether the sea is a little more or a little less salt, or is it just for the fun of finding out? "

" It makes an enormous difference, my boy. Both the temperature and the salinity play a very large part—perhaps the main part—in determining the courses of the ocean currents. In their turn, the ocean currents determine the climate of continents, so, you see, whether there's much or little salt in the sea is of prime importance to everybody, even to people living a thousand miles inland.

" The date of spring flowers in Norway has been found to correspond exactly with the greater or lesser saltness of the water off the shores of Cuba the year before; in other words, thanks to the Gulf Stream, the amount of pasture and the yield of butter, the time for seeding and therefore for harvest, and many such apparently remote conditions in Europe may depend on what may seem like trifling variations in the sea, a hemisphere away.

" And there's a good deal more salt in the water of the sea than you'd imagine, Bernard. If all the salts were evaporated out, they would make a glittering white block of salt as big as the United States and twice as thick through, thick enough, indeed, to be moulded to form all the mountain ranges twice over. You could, in fact, make two complete models of the whole United States, every peak and valley its natural size, and there would still be some salt left over."

"Oh, that's impossible, Professor!"

"It does sound that way, doesn't it? But there are at least 4,800,000 cubic miles of salts in solution in the ocean, more than three-quarters being sodium chloride, or common salt, largely in the form of ions. But you don't need to bother yourself with that, Bernard, for not even Chu Ting is likely to ask you to draw or to paint an ion!

"Now, while there are nearly five million cubic miles of salt, the area of the Continental United States is less than three million square miles, and I should be very much surprised if the average of the whole country were more than 4,000 feet above sea level! I think, after making the whole United States twice over, you'd have plenty of salt left."

"That does seem to make it right," agreed the boy thoughtfully, "but ——"

He was interrupted by a hoarse shout.

"By the mark!" cried the sailor who was watching the tally-wheel of the sounding machine, using the old leadsman's cry.

One of the naval officers stepped forward and read off the dial.

"Three thousand, one hundred and ninety fathom, Professor McDree!"

"We're just over the edge of the Nares Deep, then! Very good, Lieutenant. Will you please send word to the operator of the Sonic Depth-Finder to make a sounding to check this one?"

"Certainly, Professor."

Then, to the man at the winch:

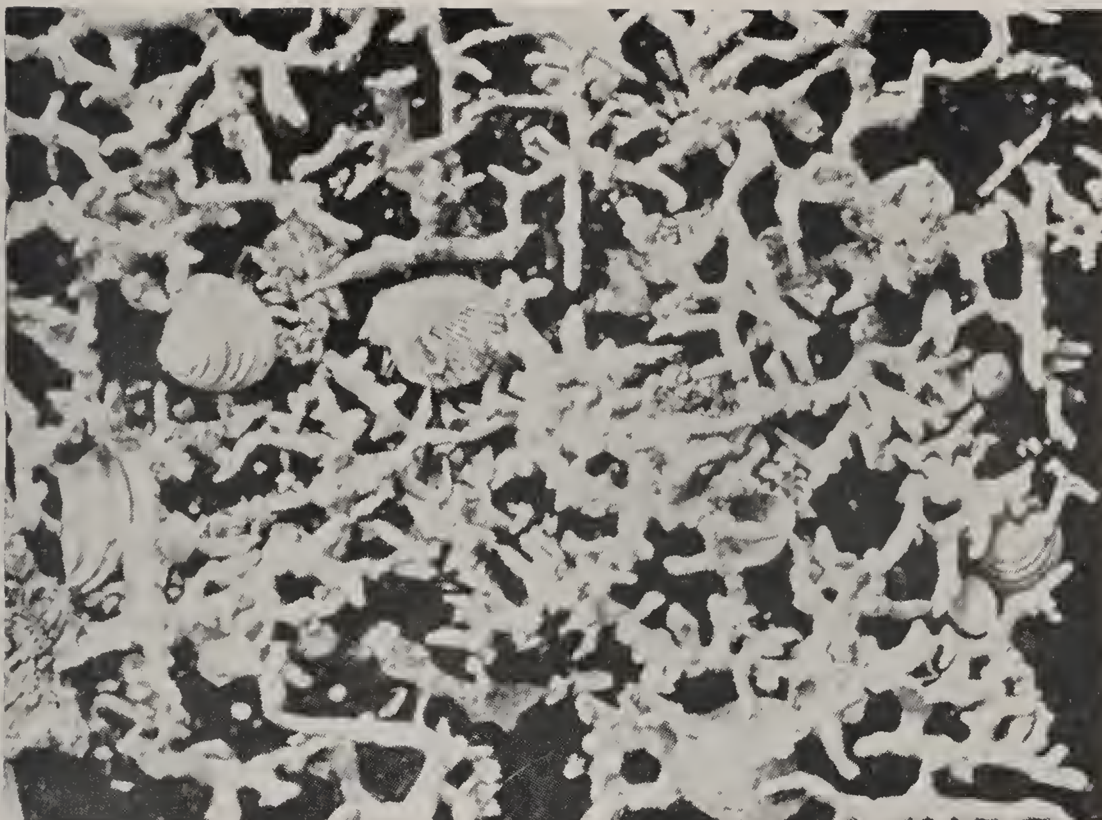
"Wind in!"

Immediately began the steady clank of the steam winch hauling up the quadruple sounding-tube—for the weight had been automatically detached—the four deep-sea reversing thermometers, and the two specially constructed water-bottles for taking a sample of water from the very bottom of the ocean, while remaining closed both before and after.

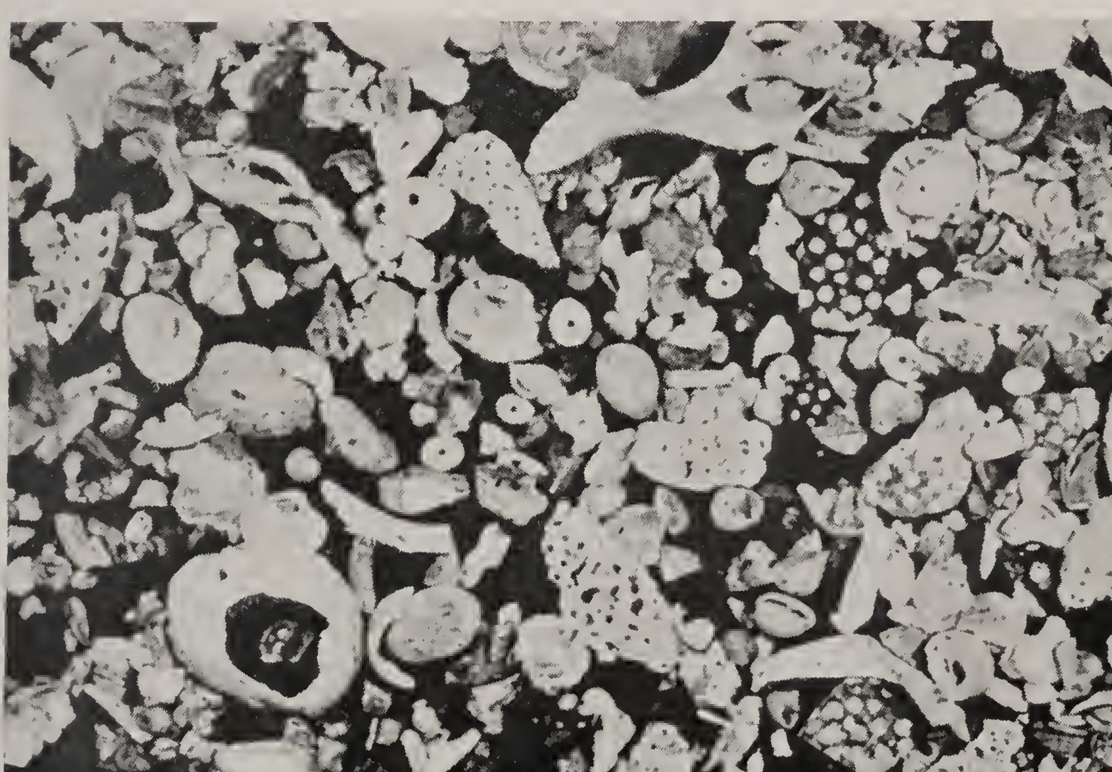
"As I was saying, Bernard," the chief of the expedition continued, as the line was being hauled in, "in Oceanography, all the various questions interlock. Depth is a prime factor in the distribution of marine plants and animals. Some organisms are benthonic, that is to say they live exclusively on the bottom; yet there are enormous differences between those which live on the floors of sunlit shallow seas, those which crawl under deeper waters where there is eternal night, and those of the dismally cold abyss.

"The same is true, too, of nektonic or pelagic organisms, meaning those which swim freely in water, as also of the planktonic organisms, which means those that float or drift in the water with little or no powers of independent locomotion. Those whose lives are spent at the surface differ in many ways from those which live lower down and never come to the top, and these again are quite unlike the forms of the abyssal seas, in whom modifications of structure have occurred in order to enable them to survive the terrific pressure, this being largely due to osmosis, as it is called, a phenomenon well known to physics by which liquids of differing densities traverse the walls of cells. Thus, the pressure inside each cell of a deep-dwelling fish becomes the same as the pressure outside upon it," and he proceeded to give Bernard a score of examples, mainly of the strange forms of the lower levels.

"Temperature also plays a very large part," he went on. "Certain fishes and other organisms can live only where the water is warm; others, where it



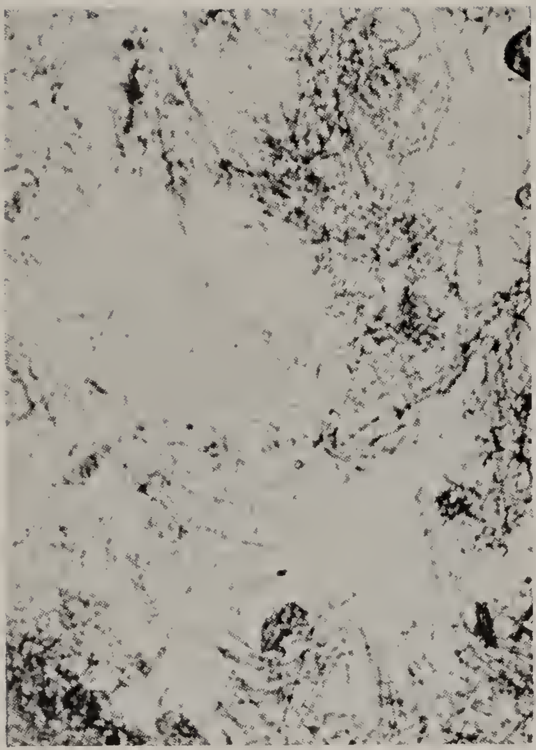
Plant deposit, showing the chalky stems of multipore, natural size.



Courtesy of Port Erin Biological Station.

Animal deposit, mainly the remains of Molluscs, Echinvoderms, and Polyzoa, natural size.

WHAT THE BOTTOM OF THE SHALLOW SEAS LOOKS LIKE.



The Diatom *Rhinzosolenia Semspina*, magnified 20 times.

The Diatom *Chactoceras Decipiens*, magnified 120 times.

Courtesy of Edward Arnold & Co.

Mixed phyto-plankton, mainly diatoms, copepods, and larvae: the basic food for small fishes. Magnified 30 times.

There may be a Million of These in a Quart of Sea-Water.

is very cold. A coral-reef fish wouldn't last long near the edge of an ice-floe, and you'd never find cod in the Sargasso Sea. A very curious thing is that the young of cold-dwelling deep-sea fishes live all the days of their youth in the warmth and sunlight of the upper sea.

"The difference of even a fraction of a degree of saltness in the water has an important effect on sea life, especially on the organisms which form the food supply of the fish we eat. The movement of the great shoals of herring, for example, is largely a matter of currents bearing water of a greater or lesser salinity.

"Sunlight is an essential point to Diatoms and other plants in the sea, which are the food of young fish. Under favorable conditions, there may be as many as a million of them to a quart of sea water ——"

"A million to a quart, Professor!"

"Fully that; 448,000 have actually been counted, in one case, and, in another, 200 were found in a single drop. Not estimated, you understand, but counted under the microscope, one by one!"

"What work!"

"But, under unfavorable conditions, there may be only a few thousand. Stretches of ocean—we don't know why—suddenly seem to be lacking in micro-organisms, while, at other times, the surface of the sea gets thick like soup with them. But when there's a scarcity of these microscopic forms, then it means real Famine, and the teeming sea becomes depopulated. Small fish die for lack of food, big fish die for lack of the small fish on which they must feed constantly, and the whole balance of life is disturbed.

"But there is an even more curious example of the effect of sunlight on the sea and the instant response of marine life. During the years of 'sun-spots,' when the heat and light of the sun are slightly diminished, the surface of the sea becomes less heated, the ocean currents change their courses, marine plant life diminishes, fishes alter their migration habits and fail to appear at their accustomed feeding grounds; this may impoverish or even ruin a fishing population and even affect the destinies of a whole nation, such as Norway, which depends largely upon the fishing industry."

He broke off, as the winch slowed down and stopped.

"Ah! Here comes the tube! We'll see just what the bottom of the ocean, more than three miles below us, really looks like."

Unscrewing one of the four short tubes, he tapped the contents into a little white glass bowl, for a first rough examination.

" Red clay, of course, as I supposed," he said, at the first glance.

Then, smoothing the ooze out with his finger, he encountered something hard.

" What's this? A meteoric spherule? Why, no, it's flat! "

He rubbed the tiny object with his finger, so as to clear it of mud, took a small but exceedingly powerful magnifying lens from his pocket and examined it carefully.

" Here, Mr. Montgomery," he said, and there was a ring of excitement in his voice, " you're a mineralogist; take a look at this! "

The geologist cast a swift glance at the object, looked up at his chief with unmeasured surprise, and then bent to a closer examination.

" It's gold! " he announced.

" So I thought. Gold, and ——"

" And copper, with perhaps tin. I'd need to put a translucent slice under a petrological microscope to determine the proportions. But it's an alloy, certainly."

" Then? "

" The remains of a coin, I should say."

" What! " cried Bernard, in high excitement. " Gold from the bottom of the sea? Three miles down? A gold coin? Spanish treasure? From a sunken pirate ship? Oh, let me see! Could it be that? "

He fairly stuttered in his eagerness.

" Could it be sunken treasure? Why not? Anything is possible in the deep sea," the Professor replied. " But this is gold, certainly, and, very likely —pirate gold! "

CHAPTER VIII

THE DERELICT'S SECRET

"OH, Professor! Send down the trawl! Quick! Before we lose the spot! There may be a whole shipload of Spanish doubloons down there!"

"Eh! What do you want me to do? Bring up the whole pirate craft in the trawl, black flag and crossbones, and all? It would be a better idea to send you down there to look for the treasure chest."

"If I only could!"

Bernard eyed the sea longingly.

"But three thousand fathoms! There's no diving suit which could stand that, is there?"

"No, indeed; nor yet three hundred fathoms."

"And I suppose a fellow couldn't recognize the ship, anyway, even if he did get down there," admitted the boy thoughtfully.

"Eh! Why not?"

"Wouldn't it be all squashed flat as a pancake by the pressure?"

"What would squash it? What kind of pressure? You've got your ideas mixed up, my boy! Consider a moment. Here, on board ship, we are under the pressure of one atmosphere, which amounts to nearly fifteen pounds to the square inch, and we don't notice it. At any given depth in the sea, there is the added weight of the water above; thus, as a cubic foot of sea-water weighs sixty-four pounds, the pressure increases by one atmosphere for each ten metres (thirty-three feet). At the deepest soundings which have yet been reached, this pressure is over six and a half tons to the square inch, or, roughly, nearly a thousand times as great as at the surface."

"That's just about what I was thinking, Professor, though I didn't know the figures."

"Of course, I saw that. But what you forgot to think of was that the water itself, at that depth, would be at the same pressure. Water is almost incompressible. It does not become greatly more dense, even at the extremest depth of the ocean. At the lowest soundings, a mass of iron will only weigh one per cent. lighter than at the surface.

"If you have fallen into the folly of believing the old fable that water gets a great deal denser as it gets deeper, so that there comes a point where everything floats and nothing ever reaches bottom, put the notion right out of your head. Even the lightest and most fairy-like sea-shell, once it commences to sink, will not be stopped because of the density of the water, but may go all the way down."

"But I'm sure I've read somewhere that, while a cork floats, if you take it down deep enough, it will start to sink."

"And that is perfectly true, my boy, for, at a certain depth, the pressure of the water will force in all the air cavities of the cork, imploding it instead of exploding it, and the woody fibre, freed of all air and crushed flat like a coin, will sink, as anything else would do.

"As for your pirate ship, or any other ship which is lying at the bottom of the ocean—the *Titanic* for example—she is not squashed, but is lying at the bottom of the sea, but little changed. Anything hermetically sealed—such as the pirate captain's half-emptied case-bottle of rum, or the steam-gauges and boilers of that unhappy steamer which foundered on an iceberg—have been imploded, but every place where the water could enter has remained intact, for the pressure has been equalized on both sides.

"Pressure does play some strange tricks, though. It doesn't surprise us that one can be hurt or even killed by a fall from a height, but it would seem queer to think of being hurt by a violent fall upwards. Yet this can easily happen to deep-sea fishes. In their own depths, the exchange of liquids through cell-walls equalizes the pressure, but if they accidentally get out of their accustomed depth and pressure, the expansion of the air in their swim-bladders renders them so buoyant that they continue to tumble upwards to the surface, helpless, and are killed by the distention of their bodies and the disorganization of their tissues, due to diminished pressure, the change of pressure occurring too rapidly for the slow process of osmosis to become effective. Really, they are killed by falling upwards.

"So, you see, Bernard, between you and the creatures of the abyssal deep there is an impassable gulf; you cannot go to them without drowning, nor they to you without bursting. We can do no more than bring up little tubefuls of deep-sea ooze ——"

"And pieces of gold!" interrupted Bernard.

"And pieces of gold—one piece, in the whole history of Oceanography!—and from that we must try to get an idea of what the floor of the ocean looks like."

"But I thought there wasn't any Mud far out to sea? Where did that Red Clay come from, then, Professor McDree?"

"Red Clay isn't Mud, my boy. As to what it really is, you'd better ask Montgomery, whom I overheard telling you about deep-sea deposits just before this last sounding. There are four different kinds of 'oozes' in addition to the Red Clay. Once you get hold of the causes of the formation of these oozes—and they're not difficult to understand, you'll have a key to the whole ocean bottom."

He turned to the geologist.

"Make it simple for the boy, Mr. Montgomery; and let him come to me in half an hour or so; I've got some slides for him to mount."

"Certainly, Professor McDree! Indeed, Bernard, there isn't any need to go into detail," the scientist began, as soon as the chief of the expedition had gone to his laboratory, "but there's not much use telling you what the floor of the ocean looks like unless I make it clear how it comes to be that way. The explanation happens to be amazingly interesting, and for you, with your pencil and color-brushes, most picturesque.

"You remember I told you how the organic remains on the floors of the shallow seas become less smothered in eroded material from the land according as you get farther out from shore?"

"Yes, I remember."

"And that the Blue and Green Muds, which are deposited from colloidal clay, are found still farther away from the land, out beyond the Continental Slope?"

"Of course."

"And that, in addition to the remains of bottom-living animals, the sea floor also contains the remains of the free-swimming and the drifting creatures who have lived in the waters above?"

"Why, yes, Mr. Montgomery, I get that all right. Naturally, if everything sinks down to the bottom, in the way Professor McDree said, those remains must settle down, too."

"Good. If you thoroughly realize that, my boy, it's half the battle. Now, let's get a good look at the bottom-dwellers who make their homes in the deeper seas. A good many of the smaller forms eat nothing but plants, so we must begin with the plant world.

"Marine algæ, whether microscopic or enormous in size, require a good deal of light, and even the deeper-dwelling types need some of the sun's rays, however much dimmed by passing through water. Seaweeds thrive best on the stretch between the Foreshore and the 100-fathom line, on the Continental Step, therefore. From that on, down, in the dim twilight zone where your friend the Giant Squid lives, the proportion of plant life grows less and less. At the verge of the photic or light zone, seaweeds grow few and stunted, and, just beyond it, they vanish utterly.

" In the lower part of this zone, then, there can be but few bottom-living plant-eating organisms, for there is not food enough to support a large number. It follows, in consequence, that the bottom-living flesh-eating organisms—such as crabs and octopi, for instance—must become more scarce, since there is but little prey for them on which to feed."

" Sure. That's a case of the supply controlling the demand, instead of the other way."

" In the greatest depths," the geologist continued, " there is no plant life at all, because of the utter darkness. It is true that all the principal groups of animal life are represented in the abyssal fauna, such as crustacea, echinoderms, molluscs, worms and sponges. Still, the species which the deep-sea dredge brings up from those depths—when we are lucky enough to have a successful haul—are very different from those which dwell in the shallow water."

" But if there's nothing for them to eat, how do they live down there, at all? "

" A good many of the smaller species—rhizopods and the like—eat the ooze, which contains a good deal of organic remains, and others live on them or on dead whales or other large fish, of which some shreds have escaped the voracious jaws, first of the surface fish, then of the middle-dwelling, and lastly of the bottom-fish, all the long way of the downward journey. For all of these, their food floats quietly down to them from their water-sky. You must remember, Bernard, putrefaction is very slow at the sea-bottom, especially in a temperature which may be below freezing point. Yet this is but a scanty food-supply, so, in deep-sea deposits, the remains of the bottom-dwellers appear in lessening proportions the farther you go down.

"In the deep sea, therefore, there is no terrigenous material, very little Mud and but scant remains of the bottom-dwellers. It follows that the floor of the deeper regions of the ocean must be principally made up of the remains of free-swimming or of drifting organisms, either plant or animal. Is that clear?"

"Quite, Mr. Montgomery. But are there enough of them to form a real deposit?"

"Enough? There are hundreds of billion times more than you'd ever guess! A net, no bigger than your hat, at a single scoop will catch from forty to sixty millions! If I started telling you about all the pelagic and the planktonic organisms in the sea, you'd be standing there, listening all day. But I'm a geologist, not a biologist, and, just now, I'm only occupied with the types which go to make up the 'oozes' of the ocean.

"Of these oozes there are five types, three of which are based on depth, only, and two of which are due to temperature. The three main divisions are: Pteropod Ooze, in lesser depths, Globigerina Ooze in the middle depths, and Red Clay in the deeps. The other two regional groups, largely based on temperature, are Diatom Ooze in the Antarctic Sea, and Radiolaria Ooze in the tropical Pacific and Indian Oceans. These names may seem a bit stiff, but you ought to try to remember them."

"That's not so hard: 'Pteropod,' 'Diatom,' 'Globigerina,' 'Radiolaria' and 'Red Clay,'" the boy repeated. "But I don't see why they should be found at different levels!"

"Ah! That's just the secret and the mystery of the whole affair! I'll give you an example. Suppose a hill, rising from the bottom of the sea to within a hundred fathoms of the surface, not high enough, therefore, to form an island. Suppose that in the waters, above all the long slopes of this hill, all the various pelagic or planktonic organisms swim or float as usual. Then, in spite of the fact that the overhead life was uniform, you would find Pteropod Ooze on the crest of the hill and on the slopes as far down as 1,000 fathoms, you would find Diatom Ooze to 1,500 fathoms, Globigerina Ooze to 2,500 fathoms, Radiolaria below that depth, and, below 3,500 fathoms you would find nothing but Red Clay right down to the uttermost depth of 5,000 fathoms."

"Now I'm clean lost!" declared Bernard. "You say that these different kinds of beasties were all swimming at the surface, above the submarine hill?"

"Yes."

"And that the remains of some of them are found in shallow waters and others only in deep water? Why? That doesn't sound reasonable! Professor McDree told me that anything which sinks a little way in water will go all the way down. Why won't Pteropods sink as far as the Red Clay? Why aren't the lowest ones—Radiolaria, I think you called them—found near the top?"

"That, my boy," the geologist declared, "is exactly the point to which I wanted to bring you. Let us take a closer look at each of these 'beasties,' as you call them. Do you know what Pteropods are?"

"Rather!" affirmed Bernard, with confidence. "They're the winged snails. They're molluscs, like limpets and oysters and nautilus and all the rest of that big bunch, molluscs which are able to swim because their single foot has been modified into a sort of double skinny fin. Oh, I know a mollusc, now, when I see him!"

"Do the Pteropods have shells?"

"Of course! All molluscs have shells—except the octopus and a few forms like 'whale-food' (*Clione*) —at least, so Mr. Bower told me."

"If Bower said so, you can depend on it. But are the shells of these Pteropods thin or thick?"

"Mighty thin, I should think. After all, they're not very big, and they've got to carry the shell around, while swimming."

"Perfectly right. The shells are very thin and some of them are quite small, almost invisible to the naked eye. Many Pteropods live on the surface, or near it, and make their thin shells with great rapidity. It is quite important to notice that, although their shells are made of calcium carbonate (a form of chalk or lime) like those of the oyster, the actual compound is a calcareous mineral called 'aragonite,' whereas the oyster's shell is 'calcite.'

"There is a very large amount of calcium carbonate in the sea. Indeed, it is almost at a saturated solution, that is to say, sea-water cannot easily take up any more, at least in the form of calcite. But it is not saturated for aragonite. To give you an example of what I mean: you can make a saturated solution of sugar—a syrup—in which a lump of sugar could rest forever, and never dissolve, because the water has all the sugar it can hold. Yet a spoonful of salt, in that same syrup, could dissolve."

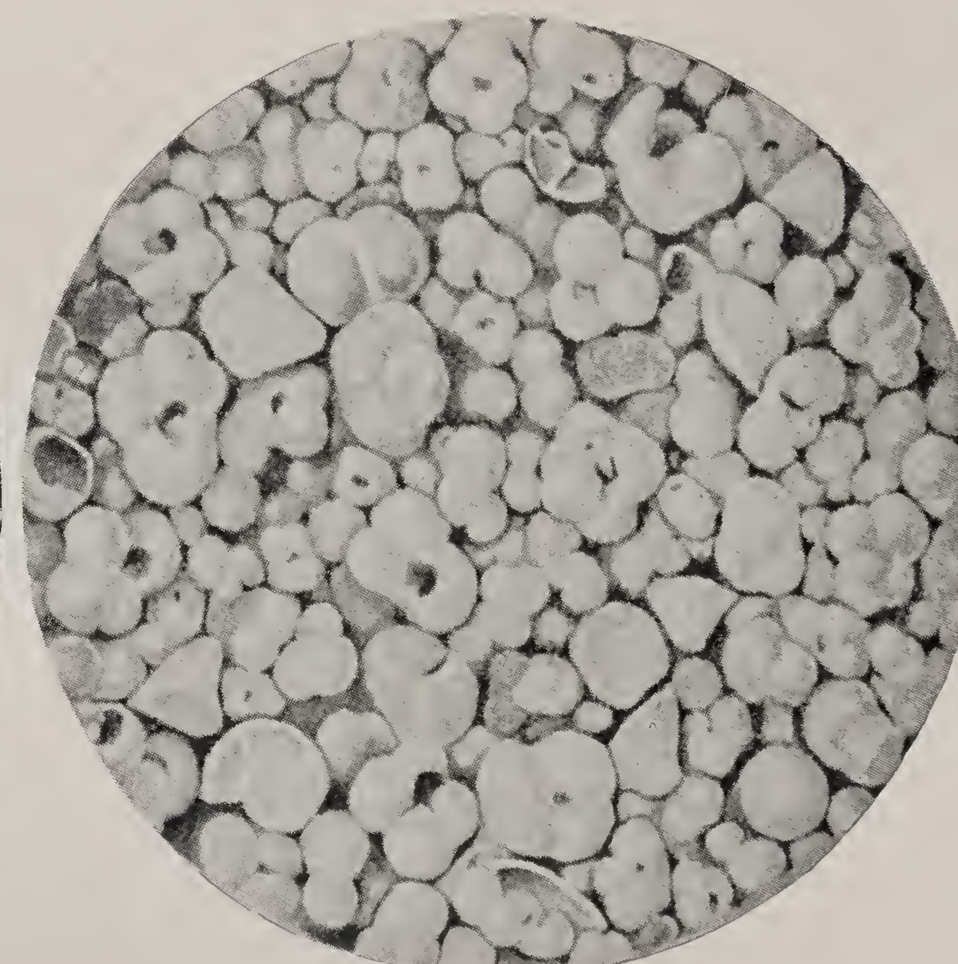
"Oh!" Bernard jumped at the idea. "You mean that Pteropod shells can dissolve in the sea?"

"Not only can, but do. The dissolving process, however, is slow. During life, certain of the organic constitutents of the Pteropod prevent the dissolving, but just as soon as a Pteropod dies, or is eaten, the shell is exposed to the solvent action of the water. Let us suppose that a thin aragonite Pteropod shell—as thin as a piece of tissue paper—takes five hours to dissolve, a thicker one, as thick as a visiting card, takes ten hours, while a still thicker one, like a post-card, takes fifteen hours. Let us farther suppose that these thin curved shells sink at the rate of a fathom a minute. Then, at the 300-fathom depth, the thinnest would have disappeared, at the 600-fathom depth the middling ones would have been dissolved, and at 900 fathoms, or thereabout, every kind of Pteropod shell—even the thickest—would have vanished."

"Woof! I'd never have thought of that!"

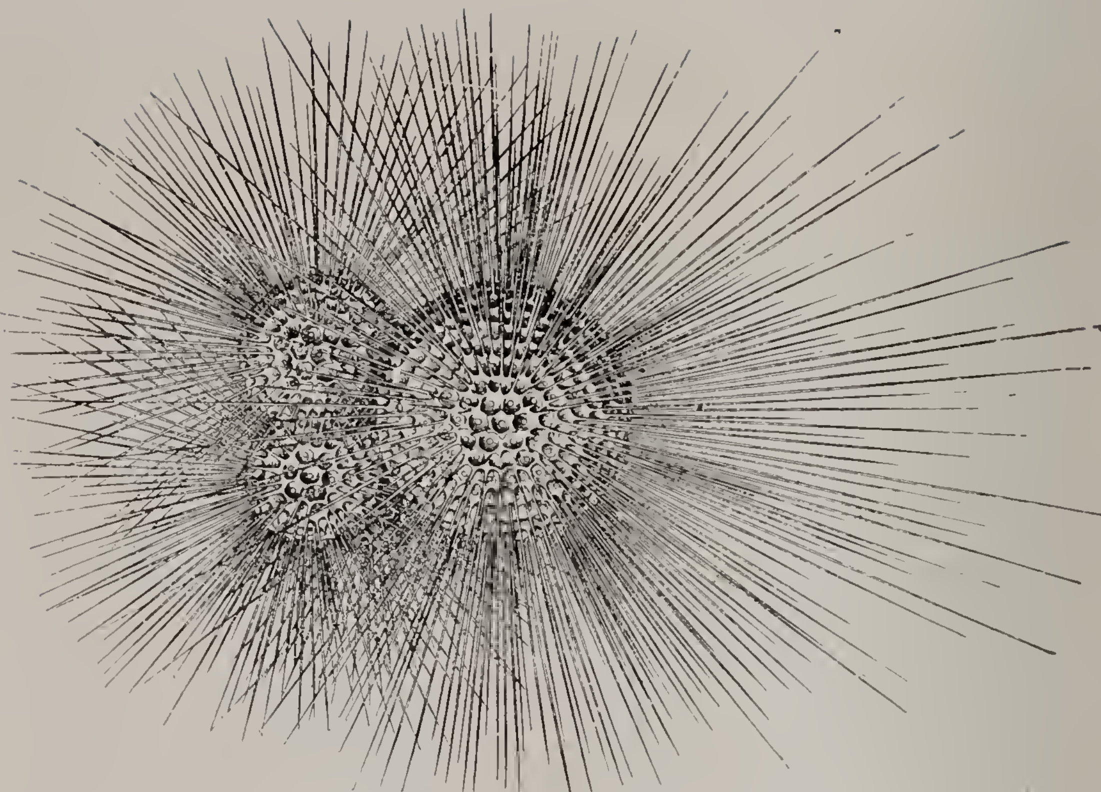
Pteropod Ooze.

The characteristic floor of the ocean in shallow waters far from any continent; taken at 162 fathoms, magnified 1600 times.

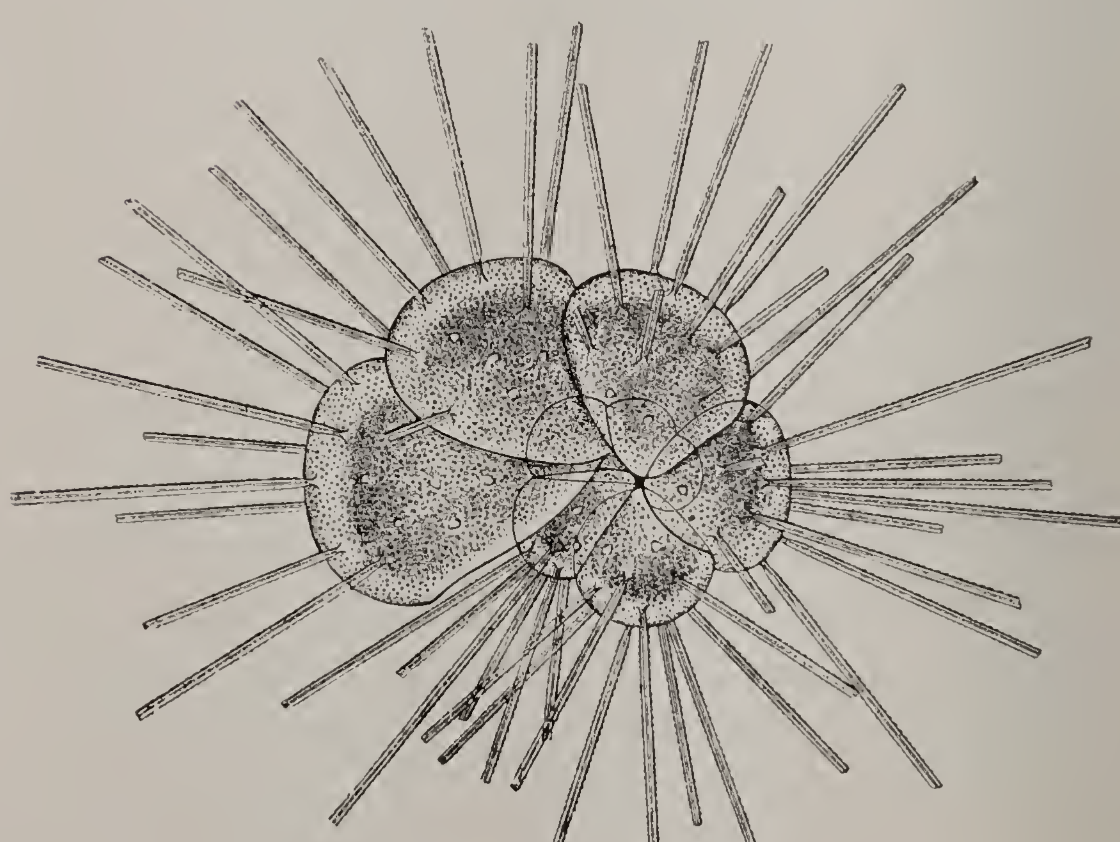


Globigerina Ooze.

The principal floor of all oceans, in deep water, taken at a depth of 1878 fathoms, magnified 1600 times.



The *Globigerina Bulloïdes.*



The *Hastigerina Pelagica.*

Two of the Principal Foraminifera Whose Skeletons Make Up the Greater Part of the Ooze Which Covers the Ocean Floor; Magnified About 2,000 Times.

"Yet it's very important. That way, you see, Bernard, a dredge at 100 fathoms would bring up plenty of the thinnest shells, as well as the thicker ones; a dredge at 500 fathoms would have no thin ones and only a selection of the middle ones; a dredge at 750 fathoms would only have the thickest types; a dredging at 1,000 fathoms wouldn't bring up any Pteropod shells at all. Now you can see why, on that submarine hill I was speaking of, the crest and the upper slopes would be covered with Pteropod Ooze."

"But the other shells would be there, too?"

"Of course they would. But Pteropods, being visible to the naked eye, are enormous in size when compared with microscopic organisms. One single Pteropod shell may be bigger than many millions of Globigerina or Radiolaria. Even if they were thousands of times fewer in the sea, still they would greatly outbulk the others. Of course, there are Heteropods and various other molluscan forms in this mixture, but the Pteropods are so predominant that they have given their name to this ooze."

"That seems only fair!"

"So I think. The same system of naming, too, has been used in the case of the Globigerina Ooze, for *Globigerina bulloides* is but one of the twenty pelagic foraminifera whose remains go to make up the sea bottom from 1,000 fathoms to the 2,500-fathom line. Various species of *Orbulina* and *Hasterigena* also are found in extraordinary numbers.

"If you want to find out all about these microscopic creatures, some of which possess the most beautiful forms in the whole world of Nature, you'll have to go to Bower. I'll just tell you enough about them to give you an idea of their place in the biological scale and of the part they play in making the bottom of the sea.

"The Zoological Alphabet is divided into two great divisions: the Protozoa, or one-celled animals; and the Metazoa, or many-celled animals. The first Division contains fourteen Classes, or letters; the latter sixty-seven, making eighty-one in all. The difference between these two divisions, put briefly, is that among the Protozoa, the cell is complete in itself in every way; among the Metazoa, the cells are differentiated to perform distinct functions and cannot maintain a separate existence apart from their fellows.

"There are four great groups, or 'phyla,' of Protozoa. These are: the Sarcodina, with a body of mere protoplasm, not entirely surrounded with shell, but often possessing shells into which a part or the whole of the body can be withdrawn. Their only means of movement, either for locomotion or for the capture of food, is the outflow of the protoplasmic body and a folding of it around the object to be seized, in the manner known as amœboid. This is something like turning one's stomach inside out around one's dinner and digesting it in that way.

"The second phylum is known as the Mastigophora, and is characterized by the presence of two or more whips or flagellæ, which are delicate thread-like extensions of the protoplasm, with a property of contraction, enabling them to form whip-like lashing movements and to advance the cell in that way; the body protoplasm is sometimes naked, but is generally limited by a cuticle or shell.

"The third phylum is the Sporozoa, all species being parasitic in the bodies of animals; a great many of the disease germs belong to this group, making it a very important one.

"The fourth phylum is that of the Infusoria, in which forward movement or the capture of food is performed by means of the cilia, threadlike extensions of protoplasm, more like hairs than whips, and having a different kind of contraction power than that of the flagellæ, hence the movements are somewhat like the rowing of oars. The body is always limited by a cuticle.

"The latter three groups leave insignificant or easily dissolved remains. So you see, Bernard, only one of these phyla, that of the Sarcodina, is of any importance so far as the ocean floor is concerned.

"Let us carry on this same method of elimination in the seven Classes of this phylum. The first Class, that of the Proteomyxa—the first letter of the zoological alphabet—contains organisms mainly parasitic on plants; the second Class, the Rhizopoda, comprises fresh-water forms mainly, and the few bottom-living marine species form neither a calcareous nor a siliceous shell; the Heliozoa, or sun-animalcules, though sometimes found in a living state on the sea-bottom, have no true shells but only a few fine and easily-dissolved spicules; the Labyrinthulidea have no shell of any kind; and the Mycetozoa, or spore-animals, have neither shell nor cuticle. Out of all the Protozoa, this leaves only two Classes with which you need to concern yourself. These are the Foraminifera—of which *Globigerina* is an Order; and the Radiolaria."

"Whew! I'm glad there are only those two, Mr. Montgomery. I was beginning to get dizzy!"

"Small wonder," the geologist admitted. "I ran you through the list pretty quickly. But to know all the various species in all these classes and to understand their habits is quite another story. The Protozoa form a life-study by themselves, and a very complicated one.

" Let us leave all the other classes alone, and take a look at the Foraminifera. There are about seventy Orders, the names of which I won't trouble to tell you, for you'd probably forget them promptly, if I did. But nearly all of them have shells. These take an infinite variety of shapes, like cartwheels, like roses, like round perforated balls, like carved lanterns, like lace-work baskets, like pine-cones, like cornucopias, like chains, like boats—shapes of a beauty and a delicacy in structure such as you'd never dream of!

" Most of the Foraminifera are bottom-dwellers but some thirty species are pelagic, mainly drifters, though a few may be able to make slight movements in the water. Their shells are of calcite, and therefore less easily dissolved than the shells of Pteropods, but some of them are thin and excessively fragile, while others, despite their microscopic size, are exceedingly hard."

" And I suppose, like the shells of Pteropods, the thinner ones dissolve as they go down? "

"Exactly. The deeper waters of the sea are less saturated with lime, and, in addition, there are other chemical solvents which act upon the slowly falling rain of shells, so that, at 1,000 fathoms, the Pteropod Ooze merges into an ooze containing a large number of Foraminifera; this again, still lower down, contains fewer and fewer of the thinner species and therefore a larger proportion of *Globigerina bulloides,* one of the harder forms.

"Deeper down you come to Red Clay. This is usually red-brown in the Atlantic and chocolate-brown in the Pacific. Its origin is, mainly, the decomposition of volcanic and meteoric dust. It is the ultimate residue of the undissolvable material of the world, for there are few substances that water and time will not dissolve. Red Clay occurs in all oceans at a depth of 2,800 fathoms and below.

"Judging from the still uncovered deposits which are found there—such as the teeth of fossil sharks which have not existed since Tertiary times—it has been calculated that the Red Clay does not increase in thickness more rapidly than a tenth of an inch every million years. While an enormous quantity of excessively fine dust sifts down into the ocean, nearly all of it is dissolved as it slowly sinks through four or five miles of water.

"Geologically, my boy, it is quite important to notice that there is no terrestrial rock which in any way resembles Red Clay, and hence there is no evidence that the bottom of the ocean—I am not speaking of the Marginal Seas, mind!—has been above the surface of the water ever since the world came to be.

"Paleontologists are somewhat given to the habit of inventing convenient continents of aforetime, whenever and wherever they want to explain how certain fossil species come to be found in certain regions, but it's a little dangerous to swallow these hypotheses whole; even Wegener's modern notion that the two Americas split off from Europe–Africa and drifted west over the plastic layer underlying the rock-crust of the world needs to be received with caution. Shallow seas did recede in times past, there's no doubt of that, land-bridges did once exist which are now beneath the sea; but when a paleontologist goes so far as to make the Nares Deep a part of the American continent, even in Jurassic times, he's simply playing ducks and drakes with geology.

"But we're getting away from the oozes, and your half-hour is nearly up.

"Radiolarian Ooze," the geologist resumed,

" must be regarded as a geographical rather than as a purely depth deposit. It is a Red Clay containing a large proportion of the shells of Radiolaria. These are also one-celled animals or Protozoa, with fine perforate skeletons, through which the hair-like extensions of the protoplasm pass. The skeletons, instead of being chalky like those of the Globigerina, are siliceous or flint-like and dissolve less easily than the chalky ones."

" These flint-like skeletons are found lower down, then? "

" Exactly. Yet even these dissolve, and, when the surface waters contain only a small number of Radiolaria, but few of the flinty shells reach the greater depths. In tropical seas, where the Radiolaria are present in large numbers, the rain of shells is so great that the shells finally accumulate to make a Radiolaria Ooze at the sea bottom.

" Diatom Ooze is also a siliceous deposit, but it is of plant, not of animal life. It is formed of the frustules or skeletons of microscopic one-celled plants. Their sculptured forms are of rare beauty, being like globes, or drums, spindles, ribbons, or hairs, generally marked with geometrical patterns of great complexity—and yet so small that millions can be put in a teaspoon. Diatoms thrive in the cold seas, and Diatom Ooze forms a broad band encircling the Earth all around the Antarctic Continent.

"These five types of ooze, Bernard, are all the variety that the ocean bed affords, and each of them requires the microscope for the detection of its origin. No jungles or meadows of seaweed break the interminable wastes of the deep-sea floor; all is dark, cold and flat. Even the crawling bottom-life is scant.

"Surely, if Neptune has a palace in the sea, it will not be in the greater depths that he holds his court; not there do the tritons and the mermaids live, and escape our cleverest nets! No, surely it must be in some coral archipelago, close to the surface, some warm sea where the sunlight filters through, a vivid and tender green. The coral reefs are the gorgeously-colored gardens of the sea."

"I've often wondered just how coral reefs were made," the boy put in. "I asked Mr. Bower the other day, but he threw up his hands and told me to ask you."

"I'll do the same," answered the geologist, smiling, "There are three contradictory theories on the subject, each one just as good as the other. The origin of coral reefs is an unsolved problem, and it is one of the things to be taken up by the U.

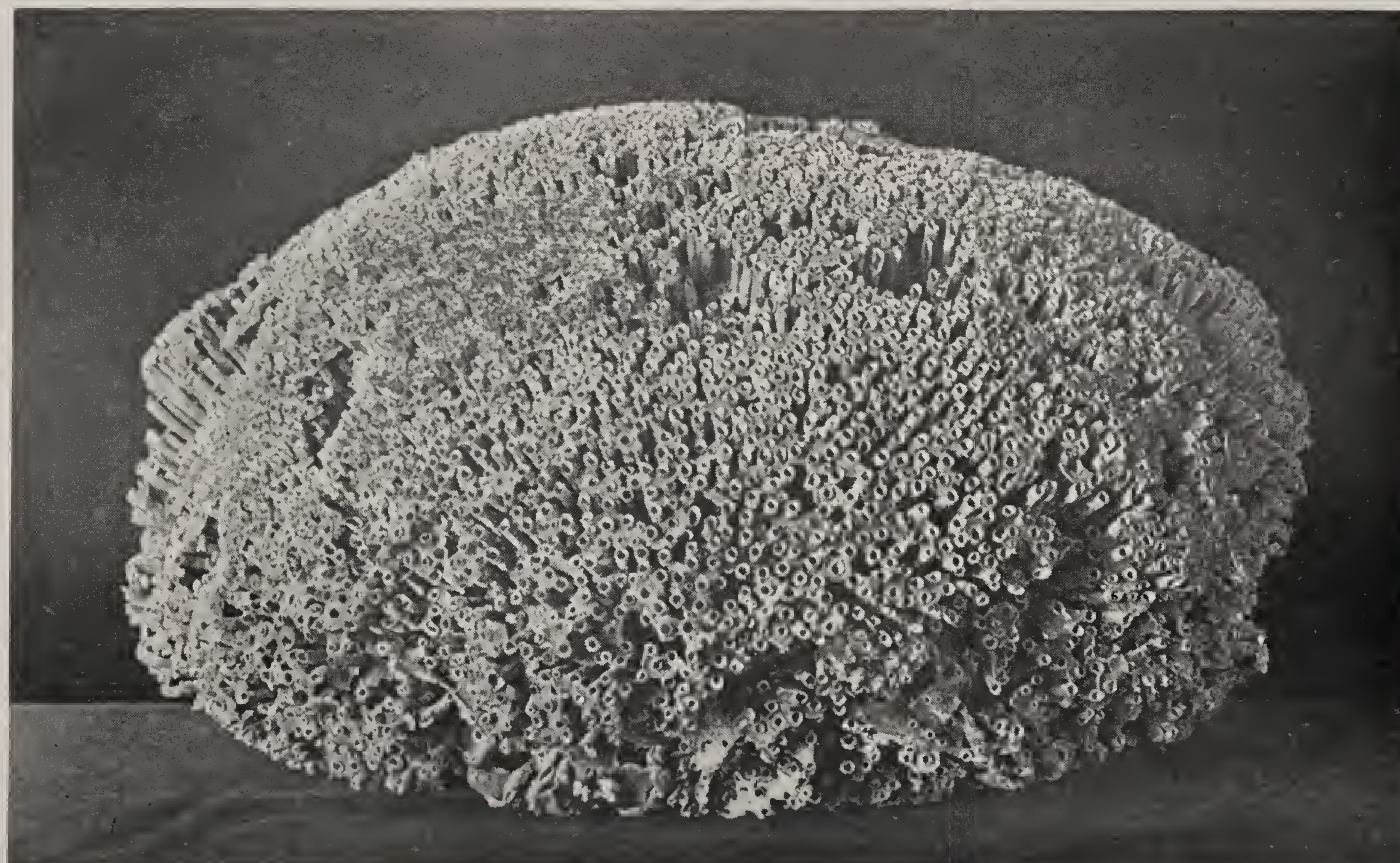
S. Oceanographical Expedition of 1925. You ought to try to get an appointment on that."

"I'm wild for it! Chu Ting can't possibly go next year, so he says, and Professor McDree has been hinting that I might have a chance if I stick to my color-drawing on this cruise, and learn comparative anatomical drawing next winter."

"Then I'll give you a piece of advice. Don't ever keep Professor McDree waiting, for he can rage like a volcano, when he gets impatient. As for the coral reefs, if you're really interested I'll tell you the various theories some day, but you needn't worry yourself, now."

"I'll come and find out, just the same; I mightn't have so good a chance again," declared the boy, as he hurried off to the laboratory.

For the next few days Bernard was busier than ever. Partly as a record of the expedition, partly for the boy's scientific instruction, and partly to teach him how to handle some of these most exquisitely delicate forms of life, the Professor set him to make a microscopic color-drawing of every complete shell of every species of Foraminifera, Radiolaria, or Pteropod found in the various samples of the sea-bottom secured by the soundings of the *Kittiwake.*



Courtesy of Am. Mus. of Nat. Hist., N. Y. C.

A Flower-animal from the Sea-Bottom.

The gaily-colored polyps of this *Cladactis Costae* shoot in and out of their glassy tubes like gorgeous sea-anemones.

Nets for Catching Sea Creatures Too Small to Be Seen with the Naked Eye.

Courtesy of Port Erin Biological Station.

Half a Million Tiny Crustaceans Are Brought Up by This Net at Each Haul.

Great was Bernard's pride, one day, when, in a comparison with some of the color-drawings in the volumes of the *Challenger* Expedition, he was told that one of his sketches of an *Eucoronis* was almost as well done as the classical example, and very much more exact in tint. Chu Ting ruled the boy with a rod of iron, but the results amply justified the Chinaman's rigid method.

A few days later, coming on deck at sunrise, Bernard was astonished to find the ship's bow pointing east.

"Why, I thought we were going north, Lieutenant!" he exclaimed, addressing the young naval officer who had read off the depth dial of the sounding machine, a few days before.

"So we are. At least, that's where we're bound, I'm told. But every ship can be called away from her course in a case of rescue."

"Rescue! S O S, you mean?"

"Yes. We've been receiving some queer wireless messages during the night."

"How? What?"

"Well, the Coast Guard Cutter *Seneca* has been broadcasting the usual notifications about derelicts, and has reported one as drifting in the latitude where we are now, but a few degrees to the east.

There's nothing strange in that, of course, and, since it isn't our business to blow up and destroy menaces to navigation—there's a special vessel detailed to do that work—we didn't pay any attention to it.

" But, during the night, our wireless operator got a rather jumbled report from the *Trig,* a sailing ship, saying that she'd passed a derelict a couple of days before, which was showing a light. She tacked back and tried to pick up the light again, but there was nothing to be seen. The captain added something about the Phantom Ship, but his sending apparatus evidently wasn't good for much, and our man could only get a word here and there."

" A light! On a derelict! "

" Yes. Queer story, isn't it? "

" You mean there might be somebody on board? "

" Unless the skipper of the windjammer was dreaming, and his mention of the Phantom Ship looks a little that way. A man who'll take the trouble to rig up an amateur sending station on a sailing ship might be apt to think anything. But it's punishable with a whacking big fine to send out incorrect information of danger at sea, and this chap was quite willing to give his own name, that of his ship, and the names of owners, so it sounded straight enough."

"What can it be? Do you think we'll really find a derelict?"

The officer shrugged his shoulders.

"They're hard to pick up—except by running into them," he added grimly. "But we ought to be around the reported latitude and longitude by noon."

"I'd like to be the first on board her!"

"You might find a 'new species' derelict, eh?" commented the lieutenant, laughingly, as he turned away.

Bernard was not the only one on board who was excited by the news. The *Kittiwake* had left the Sargasso Sea, but she had not yet reached that traffic-zone of the ocean known as the "lane of Atlantic travel," so that ships were still few and far between. A derelict, in those latitudes, might drift for a long time before being sighted by any passing craft.

The naval vessel cruised slowly, all day long. Twice a false alarm was given that the wrecked vessel was in sight, but, on steaming nearer, the supposed derelict awash was found to be only a whale asleep on the surface of the sea.

By evening, the search was no further advanced, and, at the "Chin Club" that evening, the captain of the *Kittiwake* was very much inclined to pooh-

pooh the whole affair. He had enlivened the evening's proceedings with several tales of derelicts, some gruesome and others humorous, and was just launching out upon an old-time typhoon yarn when the Chief Officer came aft and asked permission to speak to him.

"This is a very curious thing, gentlemen," said the captain, a moment later, turning to the assembled scientists. "The operator at the Sonic Depth-Finder, who was instructed to take a sounding at two bells, reports that he hears under-water signals."

"What kind of signals?"

"Regular and irregular at the same time, like some one trying to beat out a tune, so he says. I've sent the Chief Officer to look into the matter."

"Could that possibly be some one on the derelict, do you suppose?" the chief of the scientific staff queried.

"Anything is possible at sea, Professor McDree, and especially those things which seem the most improbable. The skipper of the sailing-ship was most emphatic about having seen a light."

"But if there's any one aboard the derelict, how's he going to attract our attention?"

"There's the reported light, and there are those knocking signals!" put in Montgomery.

" I've had the searchlight rigged up, too, and I've given orders to flash regularly in groups of three, with two minutes' pause between," the captain added. " If there is some poor fellow on that drifting wreck, and if he has a light, he ought to respond."

But it was not until an hour later, that, almost simultaneously from the fo'c'sle head and from the foretop there came in two voices the same cry:

" Light on the starboard bow, sir! "

Bernard, who was on the bridge by special permission, turned his marine glasses in the direction indicated, and, sure enough, saw a light. But it did not resemble any light he had ever seen at sea before.

" It's blue! " he declared. " And it's right close on! "

" It does look blue, for a fact," the officer of the watch agreed, and rang the engine-room telegraph. The vessel slowed down and came almost to a stop.

The searchlight, after a few moments' quest, presently fell direct on the black splotch of a floating hull, almost awash, on which could be seen the crouching figure of a man, apparently stooping over a lamp or a fire which gave out a bluish light.

" Man the Number Three boat! " came the order.

"Oh, please, may I go?" pleaded Bernard.

The officer smiled indulgently.

"I don't see that you can run into any harm under Lieutenant Hamilton," he agreed. "Yes, go ahead, if you want to."

The boat was dropped over the side, Bernard aboard, much to the sailors' delight, for, ever since the turtle escape in the Sargasso Sea, he was regarded by the crew as something of a mascot.

"Why! The chap's singing!" cried the boy.

And, almost at the same moment, recurred a tapping, as on iron, such as the operator of the Sonic Depth-Finder had heard from far.

"That light is certainly blue!" declared the officer. "Give way, men!"

The boat drew closer, though, from the lack of vigor in the strokes, it was not hard to guess that the members of the crew of the Number Three boat were superstitiously afraid of approaching the strange and phantom-like gleam and would have been well pleased to be back on board the *Kittiwake.*

Yes, there was no doubt that the man was singing, but the strains sounded weird and out of place, just as the bluish light, scarcely visible under the fierce glare of the searchlight, had in it something unearthly and unnatural.

Perhaps the queerest thing of all was that the man did not move.

" He must be blind! " declared Bernard, reading the officer's puzzled thought.

" Then why make a light? " was the prompt retort.

Coming closer, the lieutenant called out in a ringing hail:

" Derelict ahoy! "

There was no answer.

" In oars! "

The boat slid up to the derelict, and the bow man held her in place with a boat-hook.

" Brown and Johnson, follow me," ordered the lieutenant, " and keep a sharp eye on that fellow."

He turned to Bernard.

" You'd better stay where you are," he cautioned. " I can't take you aboard. It isn't safe."

" Not safe? "

" No," said the lieutenant, listening to the strains of that wild song, " the man's raving mad! "

CHAPTER IX

THE GHOSTLY LIGHTS

THE naval lieutenant stepped cautiously on board the derelict, closely followed by the two huskily built sailors. With a swift look around, he appraised the vessel's situation.

The hulk, evidently the wreck of a cargo steamer, was almost flush with the sea, but seemed to have been floating in that state for some time. Derricks, masts, and funnels were gone. The bridge had been swept away. The deck cabins were shattered, but, with the butt of the mainmast as one foundation and the after cargo-winch as the other, a kind of rough shelter had been constructed, braced with iron bars and wound about with wire cable until it was as solid as if it had been riveted to the iron deck. Nowhere could be better proof of a ship which was derelict, yet not abandoned.

The lieutenant's second glance was for the strange inhabitant of this fantastic dwelling. He was a man of middle age, thin and weather-worn, looking like a spectre in the white glare of the searchlight, but not emaciated, as might have been expected. His beard was long and bristling, his clothes beaten to rags.

Most mysterious of all, a long and heavy chain was clamped about his right ankle.

What could this mean? The punishment of some mutineer? Or was it one of the few cases which still occur of piracy on the high seas?

Certain it was that the derelict-dweller paid no heed either to the glare of the searchlight or to the presence of strangers. Either unconscious or indifferent to both, he continued to sing in a high-pitched screaming voice, at the same time beating on the iron deck of the derelict with a hammer. This sonorous hammering was undoubtedly the "underwater signalling" which the operator of the Sonic Depth-Finder had heard, many miles away, an excellent illustration of the delicacy of the receiving instrument.

In front of this survivor of some ocean disaster stood a large glass jar, firmly lashed to a rocking cam, which, in turn, had been fixed to the stanchions of the winch; in this jar floated a collection of strange sea-forms, such as the lieutenant had never seen before.

From time to time, at pauses in his screeching song, the madman stopped to give this glass jar a rocking jerk. Immediately the whole jar glowed and sparkled with "phosphorescent" fire, so brilliant that the luminescence was visible even in the full beams of the searchlight.

The lieutenant advanced.

"Captain!" he called, giving the title at random, in order to attract attention.

The madman paid no heed.

"Captain!" the officer repeated, and, with a sign of caution to his men, he laid a hand on the unknown's shoulder.

He had expected a sudden move, but he was not in the least prepared for what followed.

Reaching back swiftly, the madman drew from inside his hiding-place an iron crowbar, and, rising to his feet with a bound, he commenced to thresh the deck with this formidable weapon, the iron ringing upon iron making a hideous clatter in the night. He did not seem to see the lieutenant at all and did not turn his weapon on him, but continued to beat at the deck in fury and evidently in terror, leaping actively from side to side despite the handicap of the attached chain, as though he really were in combat with some fearful foe, an octopus, or such.

For a moment the lieutenant determined to tell the sailors to grapple the madman and to take the crowbar from him. Second thought suggested that such action might simply bring about more violence, and, after all, the poor fellow's madness must be due to suffering. It might be both kinder and wiser to try the effects of suggestion.

"There, Captain!" he said loudly. "The beast's gone!"

The madman seemed to have heard the words yet not to have realized that he heard them, for he stopped his tragic fight with the invisible, wiped the sweat off his forehead with the remains of a sleeve, thrust the crowbar back into the shelter and spoke for the first time.

"Ay, he's gone!"

Whereupon he settled down into exactly the same crouching position as before, and recommenced to sing and to rock the luminescent jar.

The lieutenant spoke to him again and again, but nothing that was said seemed to penetrate. Failing in this, he took the man by the shoulders and shook him vigorously. This time, touch seemed to be as paralyzed as hearing, or, more probably, the brain centres of both senses were numbed. Yet the fact that the sufferer had acted upon the former phrase showed that the brain could be reached by some words. A dozen further phrases failed to evoke response.

"Crew?" he suggested, at last.

"Gone!" came the prompt answer, in a thick but perfectly intelligible voice. "Gone, the swabs! Deserted the ship!"

"Why?"

This question-word, not reawakening any picture, seemed not to be heard.

"Rescue?" hazarded the lieutenant, thinking that this idea must have been long in the sufferer's mind.

"That chance has petered out, long ago!"

It was evident that the survivor of the wreck was talking to himself, and that the words suggested did not reach him as though coming from the outside. The officer racked his brain to think of some word which would serve.

"I have it!" he ejaculated.

Then, turning to the crouching man, he said, sharply:

"Salvage!"

Slowly, the wreck-survivor turned his head.

A troubled look came into the glaring eyes, and this very indecision proved that the reasoning power was not entirely extinct. It was not yet consciousness, but the dawn of it. He put up one hand to shade his eyes from the dazzle of the searchlight, which, before, he had not noticed at all.

After some moments, he spoke:

"Ship?"

"United States Navy Scout Cruiser *Kittiwake,*" the lieutenant answered, speaking slowly.

"Tow? Give a tow?"

"Maybe. Come on board!"

"Eh! How much?"

"Come on board," the lieutenant repeated. "See the captain. Talk salvage."

Very slowly the words penetrated. The shipwrecked man rose to his feet and commenced to walk across the deck. He was brought up suddenly and almost tripped by the heavy chain attached to his foot.

The jerk and the clank of the chain unhappily switched back the dawning reason to its old grooves. The derelict-dweller slumped straightway to the deck and once more commenced to sing.

Bernard, who had been able to follow a good deal of this conversation, for the lieutenant had been forced to shout the key words, realized that the madman was not dangerous, and he clambered on board the derelict. Forbidden or no, he was not going to lose such a chance of visiting a drifting hulk in mid-ocean, lit only by the white glare of the searchlight stabbing across the black night.

The lieutenant cast him a disapproving glance for this disobedience, but, after all, the boy belonged to the scientific group, and was not under naval discipline.

"Since you are aboard, youngster," he said, "you might take a look at that jar; that's more in your line than it is in mine. It seems to be full of sea fireflies; evidently that's where the light came from."

Bernard needed no farther hint. The condition of the madman was exciting enough, but the origin of the weird blue light was a more thrilling mystery, still.

A few steps took him to the jar. He gave it a little rocking shake. Instantly sparkles rose through the water; a second later, a globe began to gleam; and, quite suddenly, a cylinder of fire blazed out in a brilliant glow.

"Glory!" exclaimed Bernard, in sheer amazement. "This goes aboard, whatever happens!"

And he set himself to unlash the treasure from the winch.

Meantime one of the sailors was quickly freeing the wreck-survivor's foot from the chain, for it had not escaped the lieutenant's notice that the shackle was close by the ankle. It was a screw shackle, quite easy to unloose, and the chain had apparently been fastened to the foot by the man himself.

This chain unshackled, the lieutenant took the man by the arm, lifted him to his feet and led him to the boat—not without difficulty—explaining, as he went, that they would discuss towing and salvage on board the *Kittiwake,* for this was the only subject to which the wandering mind would respond.

No sooner had the boat reached the vessel than Bernard clambered on board, reached down for the glass jar which one of the sailors handed up to him, and rushed aft.

"Professor, Professor! This was the blue light! Look!"

The big jar, almost like a small aquarium in shape, glowed brightly, having been much shaken by the boy's impetuous rush.

"Eh! What? Bio-luminescent forms? Most interesting!"

The chief came forward eagerly.

"A *Pyrosoma,* of course, some *Ceratium tripos,* without a doubt, and a few *Pelagia noctiluca*—but hold on! Is that a *Pelagia?* Or ——"

The scientist flattened his nose against the jar to see more closely.

"Bring that into my laboratory, right away, Bernard," he said, and there was a marked note of urgency in his voice.

The boy caught the tone.

"Is it a new species, sir?"

"I'll know better what to tell you about that, a little later."

Both hurried to the laboratory, the chief of the expedition summoning Bower as he went, and the two experts settled down to a long and exhaustive examination. Bernard, who had been up since before sunrise, could not keep awake in spite of his best efforts, and he was bluntly ordered to go to bed without having learned the value of his find.

Naturally, the boy's first question, the following morning, as soon as Professor McDree entered the laboratory, was:

"Oh, Professor! Was there a new species in the glass jar?"

"We think so," was the cautious reply, "in fact, we are almost sure."

"You promised, once ——" the boy began hesitatingly, but his chief interrupted him.

"I know exactly what you're going to say. I thought of that, last night, and, indeed, I mentioned it to Mr. Bower. But we felt we couldn't very well call it after you. After all, you didn't catch the medusa. It was Captain Ropet of the derelict steamer who picked up the specimen, and, certainly, its blue light is more closely connected with his tragic story than with the chance fact that you happened to be in the boat which rescued him. Bower and I decided that, should it prove to be a new species, as seems most probable, we will call it *Pelagia Ropeti*."

"I suppose that's only fair," admitted Bernard, gulping down his disappointment.

"But you shall be the very first to make a sketch of it, at least," the chief of the expedition said encouragingly. "Get out your colors and work as quickly as you can. I've had the water carefully changed every hour, all through the night, but the creature doesn't seem to be any too happy, just the same!"

Bernard set to work with ardor, determined not to show his chagrin.

"Put your very best into it," the chief advised, "and, I'll tell you what, Bernard: as this seems surely a new species, your sketch will probably be reproduced in a good many scientific journals, and there's a chance for you! I'll give you leave to sign your drawing—if it's good enough—and, that way, your name will be associated with this luminescent jellyfish, almost as much as if it had been named after you."

"Oh, thanks ever so much, Professor McDree! You bet I'll do my best!" and he settled down to work.

"Jellyfish come in between Protozoa and Sponges in the zoological scale, don't they?" the boy queried, a few minutes later, washing in the very faint groundwork tints as he spoke.

"No, lad; they come after Sponges! They're not on the same line of development, though. Sponges may be regarded, in a general sense, as colonies of one-celled animals, closely related to the Flagellata, or whip-forms.

"The Cœlentera—which includes all the various kinds of jellyfish—have two different sets of cells possessing different functions, and arranged in two layers, to form the ectoderm or skin, and the endoderm, or stomach lining. These two layers of skin go to make up a single individual, such as a jellyfish or a sea-anemone; 'a sponge' is never an individual, but a colony of individual cells, each one profiting from the community action of his neighbors."

"They're on entirely different systems, then!"

"Absolutely different. Sponge colonies," the scientist went on, "remind one of the whip-celled Protozoa in a good many curious ways, and, in what might be called the baby stage, these cells swim around and get their food individually, just as the Flagellate Protozoa do. When they settle down in life and become fixed—there are no free-swimming adult sponges—the colony habit gets hold of them immediately.

"Often by simple budding, as well as by more advanced methods of reproduction, the sponge-cells grow and arrange themselves to form a cup or tube or hollow, open at the top and pierced with pores on the sides. The inside of this hollow is a very simple kind of stomach.

"By the lashing of the flagellæ or whips, the water is drawn through the pores of the sides into the stomach hollow, where other cells digest the microscopic organic matter. The used-up water flows—or is ejected—from the opening of the stomach, which, therefore, is not a mouth. This arrangement shows a big advance on the Protozoa, where each cell has its skin and its stomach all in one.

"Many Sponges form skeletons—as the Protozoa do—either chalky, horny, flint-like or ——"

"Excuse my interrupting, Professor," put in Bernard, "but if Sponges make skeletons, why don't we find them in the deep sea ooze?"

"We do! In Globigerina Ooze, for example, you're apt to run across the giant spicule of *Monoraphis,* three feet long and as thick as a lead-pencil. Three-pronged spicules of deep-living forms are even found occasionally in Radiolaria Ooze, though sponges do not like extreme depths. There are any number of spicules in the Neritic Deposits of the Marginal Seas."

"Those things like daggers, tridents, and cross-road sign-posts, which I came across once in a while when making those ooze drawings, were they sponge spicules?"

"They were, and I'm pleased to see that you noticed them. But if we'd happened to dredge up one of the larger forms, like 'Neptune's Cup' or 'Venus Flower-Basket,' you'd have had a thing of great beauty to draw.

"Some forms, of course, are quite irregular. The horny skeleton of the bath-sponge, for example—in which the stomach hollow takes the character of a series of intricate canals—may be most ragged in its general contour, yet the arrangement of the tiny sponge-cells which make up the colony is fascinatingly exact.

"Many sponges, too, in addition to their bizarre forms, possess the most startling colors: crimson, blue, rich purple, bright green, yellow and light red. There's plenty of work for your pencil and brush, Bernard, if ever any one should ask you to make color-drawings of the thousands of different kinds of sponges to be found in the sea.

"But, to go back to your first question, it's a serious mistake to regard the Sponges as leading up to the jellyfish, in the biological scale. Sponges don't lead anywhere!

"It looks as though Nature hadn't been able to make up her mind how to go about making many-celled animals, or Metazoa, from the one-celled animals, or Protozoa. So she tried two different ways: one, through the Sponges, which went no farther; and the other, through the Cœlentera, from which the whole line of development, up to the highest animals, can be traced."

For a few moments, Bernard put no further questions, for he was engaged on the copying of some very delicate bluish markings, only faintly to be seen on the transparent texture of the pulsating jellyfish, a task which demanded his utmost concentration. A profound silence fell upon the laboratory.

"Some of these days, you'll have to do quite a bit of work on the Cœlentera," the Professor continued, when he noticed that Bernard had pushed his sketch aside for a moment, waiting for the albumen paint to dry, "for jellyfish, sea-anemones, ctenophores and their likes are always in demand for designs."

"Do jellyfish and sea-anemones belong together, then?"

"They're in the same zoological branch. Montgomery gave you some idea of the fourteen Classes or Letters of the Protozoa, though, except for the Foraminifera and the Radiolaria, you didn't do much more than skip over the rest.

"In the zoological alphabet, the Sponges come next, and they have only five Classes or Letters, very easy to remember: Calcarea, or sponges with a chalky skeleton; Myxospongida, those without a skeleton; Triaxonida, glassy sponges with spicules arranged on three (or six) axes, at right angles to each other like a cross-roads sign-post—though there are many variations; Tetraxonida, with four or eight axes; and Euceratosa with a horny fibrous skeleton, such as the bath-sponges."

"Whew! The names are stiff enough!"

"But their classification is easy, much easier than the Cœlentera, though that division has only fou

Classes or Letters. After them come ten Classes of worm-like forms, principally Planarians—simplest of all creeping things—tape-worms, thread-worms, the transparent arrow-worms which you've seen in such quantities in our nets, and the ribbon-worms of the coral-reefs and sand, a procession of forms in which one can trace the gradual development of all the organs found in the Molluscs, which follow them directly in the zoological scale. The divisions of the Molluscs you know already.

"The Cœlentera—jellyfish and such—are the first big upward step from the one-celled animals to the Molluscs. Just a few words about them may help to give you an idea of their place in biology and their importance in the life of the sea.

"You remember I told you that a characteristic of the Cœlentera was their possession of a skin and a stomach-lining?"

"Ectoderm and endoderm; yes, I remember."

"Now, between those two, is a layer of jelly-like structureless substance, known as the 'mesoglœa.' As the ectoderm and endoderm generally consist of a single layer of cells, it follows that, in a good many cases, this jelly-like mesoglœa forms the bulk of the organism."

"As in the jellyfish, then?"

"Just so! You will find this mesoglœa more or less developed in every species of this vast zoological division. The simpler forms of Cœlentera come under the Class Hydromedusæ, and this Class includes the hydroids, which grow even in fresh water and which look so much like plants; the hydrocorallines, which have a stony skeleton and resemble corals; the jellyfish without a throat (stomodæum), of which there are several thousand species; and the siphonophores, or jellyfish with feeding-tubes, to which belongs the big and brightly-colored *Physalia,* or 'Portuguese man-of-war' so dreaded for its terrible stinging powers."

"But even ordinary jellyfish can sting like the mischief!"

"All jellyfish—except the Ctenophores—sting to a greater or a lesser extent, some of them dangerously. Even the hydroids, innocent-looking and plant-like as they are, have definite stinging-cells and can give a worse rash than nettles. The big jellyfish surely knew how to make themselves respected! I've known one fatal case, where an American sailor, diving deep, chanced to come up right under a big Scyphomedusa, and the tentacles, with their hundreds of stinging-cells, whipped across his face and eyes. He died next day!"

"I'll take care not to handle any tropical jellyfish!" declared the boy.

"But they're as fascinating as they are irritating, and even more queer! They have the most astonishing habit of living two entirely different lives, in different kinds of bodies, a most amazing process which biologists call an 'alternation of generations.'

"In a great many of the Cœlentera, each species has two shapes. First of all, the hydroid grows like a seeming plant, attached to the sea-bottom, puts out polyps with tentacles—something like a sea-anemone—the whole polypal development looking not unlike a flower, and then these 'flowers' detach themselves from the plant-like parent, and swim away, full-fledged jellyfish or medusæ. Then the medusa sends off free-swimming babies, which sink to the bottom, and turn into hydroids."

"What? Jellyfish grow on a hydroid, like flowers, and then float off? I thought they came from eggs!"

"So they do, my boy, so they do. So does the hydroid, for all its plant-like look. The egg turns into an oval larva which swims around by cilia, like a protozoon. This simple type quickly develops into a 'gastrula,' in which form the skin and the stomach lining are already separated. Around the opening of the stomach (or blastophore) some tube-like outgrowths appear, the beginnings of a ring of tentacles, and this stage is then called an 'actinula.' It looks rather like a pouch or bag, gathered at the neck with a string, but not quite closed.

"It is at this point that different species begin to behave in different ways. One kind of actinula sinks to the sea-floor, becomes fixed by the bottom of the pouch and the bag-like form lengthens upward into a tube or hollow stalk. Next, branchings put out in many directions, some of these branchings giving rise to the medusa-forms, as I just told you. Another kind of actinula continues to float in the water and expands horizontally until it looks like an umbrella upside down; when the tentacles are well grown, the whole form turns over and commences its life as a properly constructed jellyfish. Hydroids and medusæ resemble each other a good deal, though one has the mouth uppermost and the other has the mouth down.

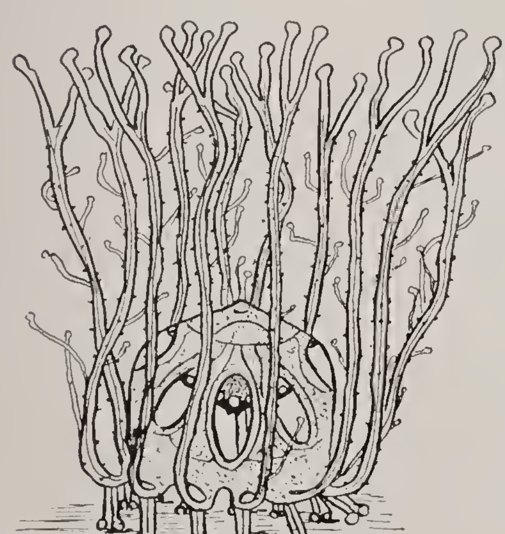
"And, if that wasn't queer enough already," the Professor went on, "there are jellyfish that walk, actually walk!"

"Walk? Like animals? But jellyfish don't have legs!"

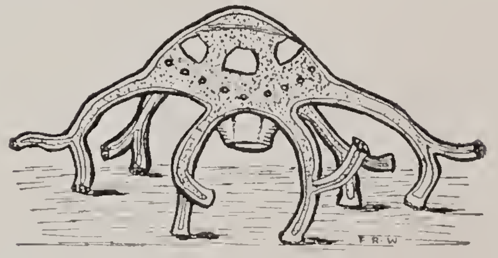
"You'd think they had if you saw them travel!

Hydroid colony, with Medusa or jellyfish almost ready to depart.

Medusa (*Synecoryne Pulchella*) just after leaving colony to start an independent free-swimming life.



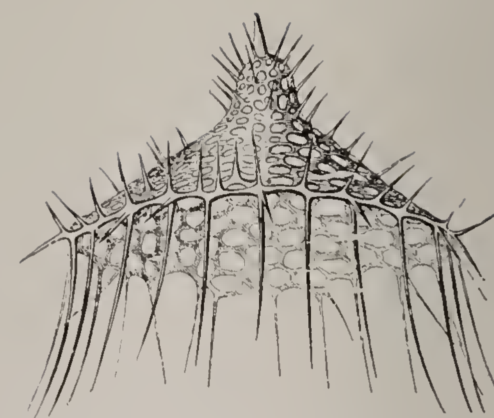
The Medusa (*Eladomena Radiatum*) walking on the basal branches of its tentacles.



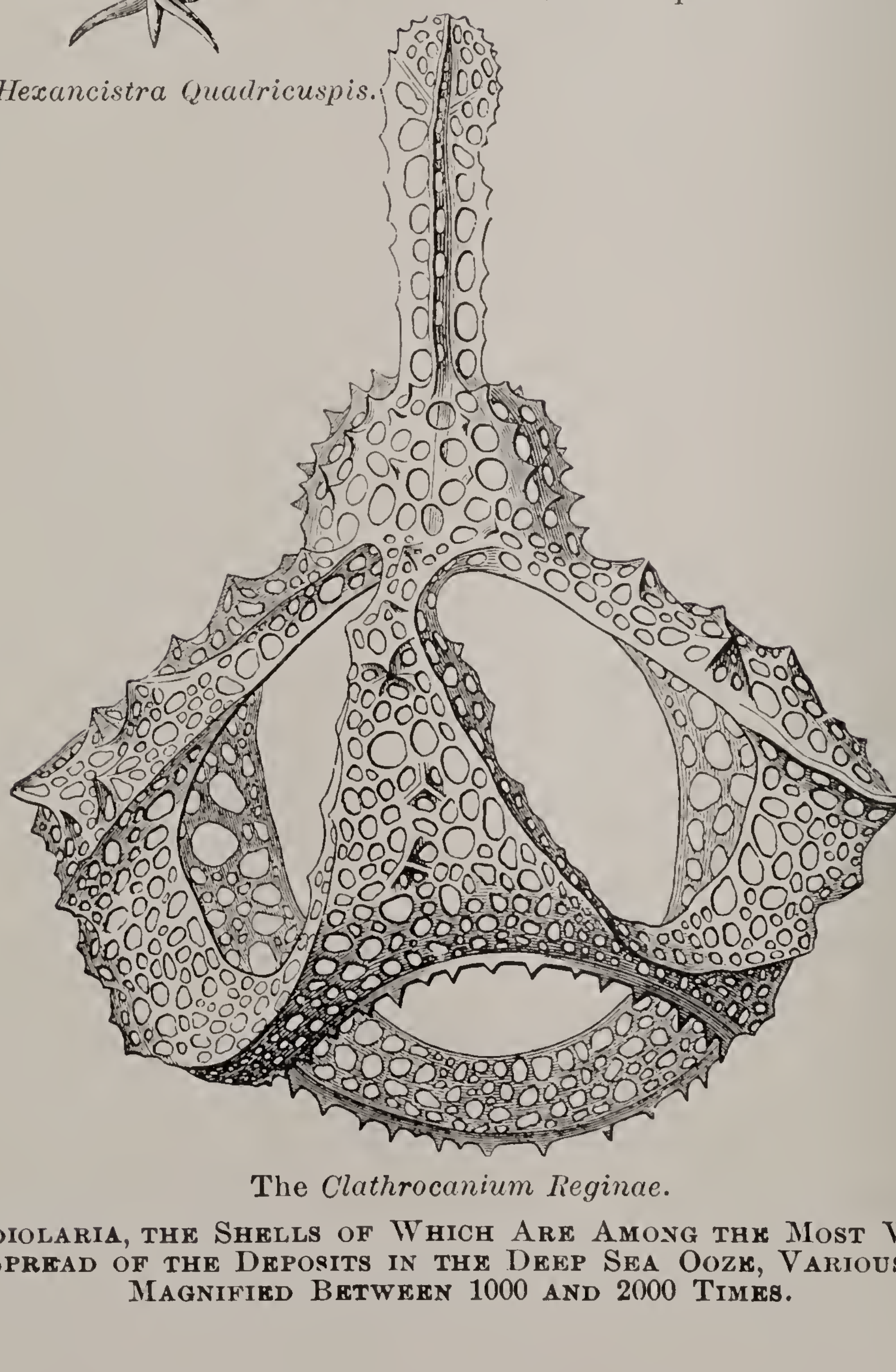
The Walking Jellyfish (*Clovatella Prolifera*) using its tentacles as feet.

STRANGE FORMS OF A STRANGE WORLD—THE WORLD OF JELLYFISH.

The *Hexancistra Quadricuspis.*



The *Lampromitra Huxleyi.*



The *Clathrocanium Reginae.*

RADIOLARIA, THE SHELLS OF WHICH ARE AMONG THE MOST WIDE-SPREAD OF THE DEPOSITS IN THE DEEP SEA OOZE, VARIOUSLY MAGNIFIED BETWEEN 1000 AND 2000 TIMES.

Why, one of the ambulatory genera, *Clavatella,* has become so confirmed a walker that it has forgotten how to swim; the tentacles have become like six solid legs, each with two feet. Another genus, *Cladonema,* which rejoices in twelve tentacles, turns the outer ends of these tentacles high over its body but lets the first 'joint' of them—it isn't a true joint, of course—drop downward, so that it can either swim freely or walk about on its knees, as you might say, just as it pleases. And these belong to the simplest of the jellyfish forms!

"The Hydrocorallines are colonies of hydroids on which the skeletons form stony masses. You may happen to know them better by the name of millepores. In this group, the hydroid gives rise to a tiny medusa which, apparently, only lives long enough as a jellyfish to start another hydroid.

"The Trachylinea have abandoned the hydroid phase entirely, and the jellyfish give off actinulæ which develop directly into other jellyfish.

"The Narcomedusæ possess fringes below the umbrella, and while these are of importance in biological development, you don't need to take up the details now.

"The Siphonophores are much more advanced in structure, having siphons for food-channels and palpons with a sense of touch. They form swimming colonies. The 'Portuguese man-of-war' and the 'By-the-wind Sailor,' with their formidable stinging powers, are not single jellyfish but well-armed colonies, able to paralyze any small fish or crustacean that they touch with their stinging-cells, and, by the contractile power of their tentacles, to bring the numbed prey to the siphon-mouths.

"It is quite important, Bernard, to know that even the simplest medusæ possess 'eyes' and 'ears.' These are not truly developed organs of that kind, obviously, but 'ocelli,' which are sensitive to light, and 'otocysts,' which serve the jellyfish for the sense of balance. The internal organs of our ears do the same, and seasickness—though it is partly produced by the sight and has its most annoying effect on the stomach—probably has its origin in the succession of shocks to the nervous system caused by involuntary disturbance of the sense of balance which is found in the inner ear."

"Could you make a jellyfish seasick by disturbing its otoliths, then?"

Professor McDree smiled at the question.

"I'm sure no one has ever attempted to find out! It might be interesting to try. But, if you had the time, my boy, it would surely interest you to trace the development of the earliest eye and ear through all the various genera of the Cœlenterates. That is, if you like the subject as well as I think you do.

"The Scyphomedusæ, the second phylum and Class, greatly resemble the simpler jellyfish, and, at first, you might not notice the difference. For the development of your drawing, however, Bernard, you've got to learn the trick of noticing the simplest differences, and so I'll point the main ones out to you, for a scientific draughtsman has got to know the way that science works, even though he isn't a scientist himself.

"First of all, the umbrella has a lobed or indented margin; second, the mouth projects forward as though to make a throat; third, the reproductive cells originate in the stomach lining instead of the skin; fourth, and very important, the velum, which is a ring of muscles running circularly around the under edge of the hydromedusa, is absent in the scyphomedusa, the muscles in the latter Order running longitudinally.

"The effect of this last change is that, when a hydromedusa wants to swim, he contracts the rim of his umbrella-body, forcing water out, so that he rises or advances—backwards, of course; when a scyphomedusa wants to swim, he contracts his longitudinal muscles, which narrows the umbrella, also forcing out water and moving astern in that way."

"They can both get ahead, though!"

"Yes, but by a different muscular action. The Scyphomedusæ, too, are much more advanced in structure. The pouch-like stomach modifies into canals which may radiate through the body, giving a firmer substance and a better nourishment. The simple 'ocelli' develop a vitreous substance which foreshadows the coming of the true eye; and the primitive form of reproduction which is known as 'budding' disappears entirely.

"The third Phylum and Class of the Cœlenterates is known as the Anthozoa. It consists of the various coral-polyps and the sea-anemones. These forms show an advance over the higher jellyfish in that the throat is more sharply distinct from the radially folded stomach and that it is compressed into an oval or a slit. This gives rise to the most important structural change known as bilateral symmetry, which you traced in the Molluscs and which prevails in all the higher animals. The digestive powers of a sea-anemone are stronger than those of a jellyfish, the mesoglœa or 'jelly' possesses cells and becomes more flesh-like, and, in addition to the stinging-cells, a nervous system begins to appear."

"H'm! One really does begin to climb in the scale!"

"Decidedly! The Anthozoa divide into two sub-classes, the Alcyonaria and the Zoantheria. In the first sub-class you will find the sea-fans (*Gorgonia*), the Pennatulids or sea-pens, looking like great colored feathers, two and three yards high, the pink 'dead-men's fingers' (*Alcyonium digitatum*), the sea-tree (*Paragorgia*) which grows taller than a man and has many branches, as well as the precious red coral used for jewelry, and the less-known blue coral.

"The Zoantheria differ mainly in the arrangement of the stomach, and the most important forms are the tube-like zoantherians, the sea-anemones—a strongly modified form, very stable, known to live for fifty years and more—and the madrepores or reef-building corals, divided into a number of groups by details too technical to interest you.

"Higher than the sea-anemones—though not so modified in some ways—come the Ctenophora. While some forms of this Class are exceedingly simple at first sight, they show developments which link up in the zoological scale. They resemble jellyfish in outward appearance, most of them looking like a girdle or ribbon of jelly but they show bilateral symmetry, and they have eight rows of paddles formed of fused cilia; this, as you see, Bernard, is a considerable advance upon the pumping method of locomotion of the simple jellyfish.

"Even more striking is the fact that the sense-organs appear at the opposite 'end' from the mouth. There are also excretory organs there, giving us the first example of a creature with mouth, throat, stomach and excretory organs along the same axis, which is a very different arrangement from that of the hydro-medusa, which has to take in all its food and to eject all the undigested matter from the same opening.

"The real importance of the Ctenophores lies in two strange organisms belonging to that phylum and Class; of these *Ctenoplana* is the most important. In this creature, the line of mouth, stomach and sense-organs has been flattened so as to give a dorsal (aboral) surface on which lie the sense-organs, and a ventral (oral) surface, whereon lies the mouth and on which it is able to squirm along the mud.

"From *Ctenoplana* to the Planarians, or the most primitive of the Cœlomocœla (creatures possessing a well-developed body-cavity from the mouth to the organs of excretion) is a very short step. Yet it is the all-important step which leads from the pouch-stomached jellyfish to the higher animals; to take another aspect of this biological advance, it leads from the two-layered creature possessing a skin and a stomach-lining, with jelly between, to the three-layered animal possessing flesh, with all the amazing array of developments that arise therefrom. With Ctenophora, we bid good-bye to the jellyfish, and zoology takes on an entirely different character, in which sea-forms play a much smaller part."

"I've been wondering ——" began Bernard, and then hesitated.

"Yes?"

"You've told me about stinging-cells and all sorts of other things in jellyfish," the boy said, "and I'm ever so much obliged—but you haven't said a word about their light-organs! And it's because of its power of giving light that we first got hold of this thing which I'm drawing, this new species which you've called *Pelagia ropeti.* Just how is that blue light made? Don't we know?"

"The sea is full of ghostly lights!" the chief of the expedition replied. "Both in shallow waters and deep, strange luminosities gleam in the depths, and not from jellyfish alone. That's one of the recently discovered marvels of science.

"But, before I start to tell you about them, we ought to go and see if the doctor will allow Captain

Ropet to talk. That was a most extraordinary collection of luminescent animals which you found in that glass jar on the derelict. How did that man, alone and abandoned on a drifting hulk, find these creatures? From what depth did he fish them up? How could he have managed it single-handed? There lies an unsolved mystery! "

Noctiluca Scintillans, magnified 30 times.

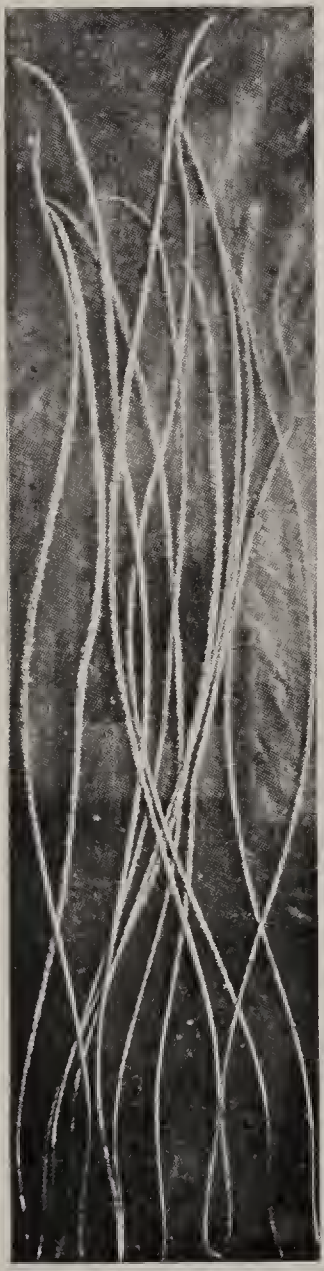
Ceratium Tripos, magnified 30 times.

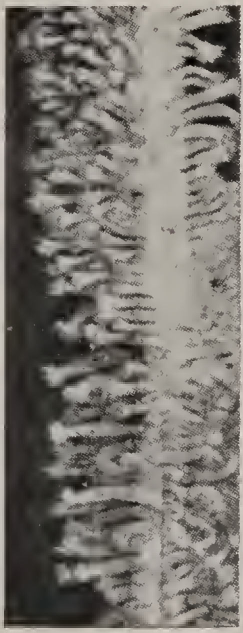
Courtesy of Edward Arnold & Co.

Some Ctenophore jellyfish (*Pleurobranchia*) about four times natural size.

THE TINY CREATURES, WHICH BY THEIR OWN TRUE LIGHT-POWERS, SET THE OCEAN AGLEAM WITH FIRE ON THE DARKEST NIGHT.

The blazing wonder, *Pyrosoma Spinosum*, which grows to twelve feet long, a cylinder of sea-fire





Funiculina, with polyps expanded. Natural size.

The flaming bright lilac Sea-Pen, *Funiculina Quadrangularis*, reduced to one-twelfth natural size.

The *Permatula Phosphorea*, which flames with green and blue light.

A Sea-Pen, *Umbellula*, from 4860 fathoms, the deepest luminescent life yet discovered, shining silver and violet.

Some Brilliant Light-Givers of the Deep.

CHAPTER X

IN THE HOT RIVER

THE captain of the *Kittiwake,* in no wise concerned with the details of the mysterious blue light, once he had learned that it was produced by "phosphorescence," gave all his attention to the fate of the derelict and of its half-mad commander.

A large flag had been fastened to the stump of the broken mainmast, so that the *Kittiwake* could keep the derelict in sight without danger of ramming herself on it, and the little naval vessel stood by. Having found, from a perusal of the papers in the wreck-survivor's pocket that the cargo was valuable and would repay salvage, the wireless operator had been ordered to send a message to Norfolk, Virginia, asking for a powerful sea-going tug.

The ship's surgeon, who had imperatively forbidden any communication with his patient at the time the latter was helped aboard the *Kittiwake,* kept the exhausted man asleep for twenty hours. He only admitted Professor McDree to the sick-bay when at last the awakening came, and then only because the Professor was as renowned in experimental psychology as he was in biology, generally.

The brain of the captain of the derelict was still a long way from being restored to balance, but Professor McDree and the ship's surgeon were agreed that a few weeks of nursing and of careful attention to auto-suggestion would bring about a cure. Under the Professor's skilful handling, the main facts of the story were elicited without plunging the sufferer's mind back into the channels of unhappy memory.

The cause of the tragedy was simple enough in its details. The tail end of a typical West Indian hurricane, wheeling from the northwestward to the eastward just off Cape Hatteras, had nipped the steamer *White Prince* on the inside of its roaring curve, just where the pressure of the whirl drove before it a wall of water.

This terrific billow—almost like a tidal wave—had caught the steamer on the quarter, had wrenched off the rudder and bent the propeller shaft with a single crash, the torsion of the shaft twisting the propeller off, after a few revolutions. As the crippled vessel turned helplessly before the hurricane, a second huge wave came over green and the tons of water smashed down the bridge and chart-house, the captain being pinned deep under the wreckage and the helmsman being instantly crushed.

The *White Prince* was not very far from the lane of Atlantic travel, and the mate and chief engineer, believing that the captain had been washed overboard—for he was not to be seen under the débris and was unable to cry out—took to the boats. They put out sea-anchors and oil-bags, the first to keep them from being driven to less frequented parts of the ocean, and the second to mitigate the fury of the waves. The steamer, practically wrecked by those first two billows, drifted fast before the tempest and soon left the boats astern.

The hurricane raged steadily, the driving seas crashing over the vessel, breaking in the hatches, flooding the companionways and cabins, breaking through into the hold, and, at last, bursting up the decks from below by the compression of air.

The steamer, sunk in the water until she was nearly awash, was absolutely at the mercy of the waves, but the pounding seas fortunately shifted some of the wreckage which pinned the captain down, and enabled him to escape, though with a broken rib and some bone contusions. Unable to keep his footing, he had chained himself to the cargo winch until the storm should abate.

When at last the sea calmed down, from visual observation of the stars the captain judged that he had drifted a long distance south and west, and therefore that he was out of the line of travel either of American coast steamers or of the transatlantic liners. Strange as it may seem in these days of steam, the ocean to-day has far more deserted spaces than when sailing-ships were the rulers of the sea, for "liners" keep to their lines, whereas the sailing-ships were compelled to reach their ports by tacking or by any slant of course that the vagaries of the wind would allow.

The *White Prince,* bound from Rio Grande do Sul, Brazil, to Hoboken, was partly loaded with coffee, a light and valuable cargo, and this just kept her afloat. Moreover, as much of this coffee was in air-tight packages to retain the aroma, a good part of the cargo could be salvaged. Even if Captain Ropet had been able to escape, his duty to his command and his loyalty to the owners would have made him stick to the ship.

Deserted and abandoned on a hulk awash on a little-travelled stretch of sea, the outlook was desperate. Salt water, of course, had penetrated everywhere, but one of the fresh-water tanks was whole. Although this was under sea level, the captain had managed to wire two rubber tubes to the tap, one to suck the water out as through a straw, the other to let the air in. This had taken several hours' work—especially as the hurts of the injured man were so sore than he could move only with great pain—but thirst is a stern tyrant, and it meant either succeed or die!

Owing to the weight of water in the cabin, he could not open the lazaret hatch to the provisions, but, in the ruins of the steward's galley, he had found a small supply of various foods, including a bag of ships'-biscuit—unfortunately soaked with salt water. This was dangerous food, as the captain knew well, for the salts in sea-water provoke an intense thirst which leads to madness. Some dried peas which he found were better, for the salt could be soaked out of them in fresh water. Even so, this was barely enough to live on.

The salt-meat barrels, even if he could have reached them, would not have helped him much, for he could not cook without fire, and, search as he would by diving into the cabin, or by more dangerous dives into the fo'c'sle, he could not lay his hand on a single box of matches. This seemed absurd, but so it was. As for making fire by striking steel on steel—he had no flint—a couple of hundred useless efforts convinced him that while this system might be of use in a forest, with dry tinder, it was useless as a means of setting fire to half-dry and salt-impregnated wood.

Born in a fishing village on the Massachusetts coast, the captain's mind had turned naturally to the idea of fish for food, for fresh fish may be eaten raw. But he had neither fishing-line nor fish-hooks, and the latter cannot be made from soft wire. As for line, he could find nothing but several rolls of the tarred marline used for whipping the wire ropes of mast-shrouds and the lower part of the derrick stays. This could, at least, be used for making a net, and patiently he had knotted it, mesh by mesh, using a ball of fine sail-twine for the pouch at the end of the net to hold smaller fish.

Being made of such coarse line, the net was of great weight, too heavy to be pulled up by hand. But Captain Ropet had sailed the seas for many years—he had got his master's certificate on a wind-jammer, when sailors had to be sailors—and he was fertile of ideas. He disconnected all the steam connections of the winch, and, taking some twisted bits of iron bar from the débris, made shift to use it as a windlass.

Since the thinnest of the wire cables was already wound on the winch, he attached the net to it, first having fastened a three-plaited sennet of marline through the doubled upper meshes of the net for a draw-string. To the mouth of the net he attached small bits of metal—such as the lock of a broken door—so that the net would sink mouth-downward.

At the coming of darkness he let down the net, adjusting it to sink downward slowly just at the time of the upward vertical migration, when all kinds of sea creatures swim upwards, for, since the derelict was not moving—save for a faint wind-drift and the current—there could be no actual towing of the net. When the end of the cable was reached, a pull on the draw-string closed the mouth of the net, and then came ten weary hours of work at the windlass bringing the net to the surface. But, once raised, he found provisions enough for a week, and, by leaving the net in the sea, with the mouth out, the captured fish remained alive.

The luminescent forms had come up in different hauls in the fine-meshed pouch of this net, and Captain Ropet had carefully collected them, large and small, for he did his fishing at night; and, without lantern or fire, the bluish gleam was not only of assistance, but was company as well. Indeed he had come to attach a superstitious importance to it.

All this had happened more than two months ago! For sixty-four days Captain Ropet had lived on raw fish, ships'-biscuit, dried peas, and gulf-weed, which latter, he admitted, had neither taste nor nourishment, but which, he hoped, might keep scurvy away. Professor McDree was unable to find out at what date in this long period of suffering the derelict-dweller had abandoned all hope of rescue, but it was evident that he could not have endured much longer; the attachment of the rubber tubes to the water-tank could not be made absolutely tight, the sea-water had seeped in gradually, making the drinking-water brackish. This it was, among other things, which was beginning to affect his brain.

It appeared, from some of Captain Ropet's confused answers, that the capture of these luminous creatures had become the chief aim of his solitary life. Almost it seemed as though he had some unconscious prevision that they would prove to be the means of saving his life. That this was so, there was no doubt, for it was the wireless message from the sailing ship *Trig* declaring that a light had been seen on the derelict, which had sent the *Kittiwake* to the rescue.

Indeed, it seemed probable that the exhausted and disheartened man would have abandoned the labor of raising the great net—which, after the last biscuit was gone, had become his sole source of food

—had it not been for this superstitious feeling that, as long as he had light, he was not alone.

"There's not much doubt in my mind, Bernard," the Professor concluded, after he had summarized to the boy the outcome of his scrappy conversation with the derelict-dweller, "that these luminescent creatures of the sea have saved Captain Ropet's reason, as well as his life, and I think you'll agree with me that we've been right in naming the new species after him."

"I should say so! But he must often have wondered, Professor, on those long nights alone, how it happened that things like jellyfish and prawns can shine with a light of their own."

"He doesn't seem to have wondered at all. He's a religious man, and seems to think that these 'sea-angels,' as he calls them, were sent specially to cheer him up. He spoke of them as 'the pillar of fire by night' which would lead him to safety, if only he had faith. Well, frankly, they did!

"I saw no reason for disabusing his mind of so kindly a belief, especially in his present state. Moreover, when he gets better, I'd rather that no one should talk science to him about them. I'm going to drop a word to that effect at the 'Chin Club' to-night. Faith—in no matter what—is too easy to break and too difficult to replace. In any case that he should have found that glass aquarium unbroken and that it should have remained so is miracle enough!

"But that wasn't what was in your mind, my boy. What you really meant to say was that you are doing the wondering about these 'shining ones,' eh?"

"Well, yes! I asked Mr. Bower about it, and though he seemed to know a lot about them, especially among the invertebrates, he referred me to you, saying you were the world's authority on bio-luminescence."

"There's an example of Bower's love of big phrases!" came the disapproving answer. "I have published several papers on the subject, though. Suppose I give them to you to read?"

"When you tell me, yourself, Professor McDree, you make things so much more simple! Just what is it that makes some creatures phosphorescent, and others not?"

"Luminescent, you mean, for there's no question of phosphorus. I'll answer your question just as you put it, though I don't think you've asked what you want to know. Bio-luminescence comes from two essential substances, luciferine and luciferase, which produce light when brought into contact with certain salts in sea-water; certain creatures excrete these substances and others don't. That's the chemical side of it."

"No, I didn't mean that. What I wanted to ask was why some forms are luminescent, while others aren't. What use is the light to them? Is it to light up the bottom of the sea, down where the rays of the sun don't penetrate?"

"Like a deep-sea Broadway? No, my boy, it certainly is not! In truth, though it is only lately that the fact has become generally known, the largest and most powerful light-organs—among fishes, at least—are not found in the deepest-dwelling forms. Among the light-bearing Cyclothones, for example, the size of the photophore decreases—not increases—with the depth; in another genus—Gonostoma—the species of the surface is much better endowed with light organs than his cousin of the depths; and *Gastrostomus bairdii,* the most characteristic of all abyssal fishes, has no light-organs at all, except, perhaps, for an undetermined spot at the tip of the tail. It is in the upper 500 fathoms of tropical waters that luminescence appears most strongly."

"But I didn't mean fishes, only, Professor. I meant all sorts of light-producing forms, like this new species of medusa, for example. What can a jellyfish use a lantern for?"

"Oh, if you want to begin at the very beginning, you'll find the question all the harder to understand, my boy, for luminescence doesn't always exist for the same reason nor serve the same purpose. The same holds true on land. As you may know, there are luminous centipedes as well as the two species of luminous beetles known as 'fireflies' and 'glow-worms'; but, while the flashings of the male firefly and that of the female glowworm are of assistance to mating, in their respective species, the gleam of the centipede seems to have nothing to do with this function.

"Perhaps the simplest of all the luminous creatures of sea and shore are the microscopic plants known as bacteria, two forms of which (*Photobacterium* and *Microspira*) are well known for the light which they produce on dead fish."

"I thought that was phosphorus produced by rotting!"

"It isn't. When a fish really begins to putrefy, the photobacteria can no longer live, and the light goes out, for the diseased and the forms just dead are the favorite habitat of these bacteria. Have you ever noticed, when walking on a sandy beach at night, that, just within the range of the wet sand surrounding the print of your foot, little luminous 'sand-hoppers' would jump away?"

"Oh, yes! I've seen that often! Shining little chaps they were, too!"

"Those tiny Crustacea weren't bright in themselves at all. They were all diseased with a form of photobacterium, which kills very slowly. The light you saw came from a microscopic parasitic one-celled plant, and if you'd examined this cell under the microscope, you'd have seen that the whole surface was covered with a thin slime, and that it was this slime which was luminous, and not the dying amphipods.

"The 'milky sea,' so often seen in tropical waters, is also due to the masses of a one-celled plant, *Pyrocystis,* though a closely similar effect has been traced to a group of one-celled animals called Flagellata ——"

"I know about those!" put in Bernard, glad to show his knowledge. "They have long things like whips to push themselves through the water with."

"Quite right. The little creature which, sometimes, in shoals of unnumbered billions, turns the sea red by day and luminous by night, is a small *Peridinium.* The three-horned dinoflagellate *Cera-*

tium tripos gives the bright sparkles to the sea, and the silvery sheen seen around the bows of a boat or ship is a very abundant form of a distant relative of the same Class, known as *Noctiluca scintillans.* This last form has been found in such quantities that infested water near shore was of the color and thickness of tomato soup, while a drop of it contained so many Noctiluca as to be beyond the possibility of microscopic counting. Though not always in such quantities, they are always to be found in the sea, and some of the sparkles in Captain Ropet's jar were flashes from this protozoon. Several species of Radiolaria, also, are luminescent.

" Leaving the Protozoa, and coming to the Cœlenterates, of which I was talking to you yesterday, there are a score or two of forms which give off light. A great many of the hydroid polyps show tiny gleaming lamps. As for the Medusæ, or jellyfish, at times they can produce the most startling effects.

" Once, when Sir William Herdman, the famous oceanographer was at anchor in a native boat on the pearl banks of the Gulf of Manaar, in an intensely dark night, he saw the sea in every direction lit up by uncounted thousands of globes of fire, waxing and waning in brightness, all simultaneously glowing and then fading away into darkness, and after a few seconds lighting up once more. The display lasted for over an hour. The effect was as if one of the globes lit up and then another and another in rapid succession, suggesting that the luminescence of one was stimulating the others to similar action.

"The most brilliant light-producing Medusa in the North Atlantic is *Pelagia noctiluca,* perhaps even brighter than the new species *Pelagia ropeti,* though, it's true, we don't know how long the specimen you brought on board had been in the glass jar aboard the derelict. I've seen them, when first taken out of the sea, every bit as bright as a ball of incandescent metal, and it was difficult to believe that they would not burn the fingers, if touched. Some of the Ctenophore jellyfish (such as *Pleurobrachia pileus*) which are as big as full-grown grains of corn, may dot the sea with points of emerald green light, extending for miles."

"Were there any of those in the jar?"

"I didn't see any. Of course, being out in deep water, Captain Ropet had no chance to get any of the littoral-dwelling Anthozoa. The sea-pen, *Pennatula phosphorea,* is one of the most beautiful sights in nature, when at the slightest irritating touch every branch and polyp springs into an illumination display, each being outlined with light like a series of fairy lamps, hyacinth in color. The giant sea-pen (*Funiculina quadrangularis*) is even more astounding. Imagine a waving feather, six feet high, which, when touched, sends great waves of vivid lilac light pulsing up and down its stem, as brilliant as the flame of cyanogen gas.

"Some of the Alcyonarian corals fall but little short of this luminous glory. If one should touch *Renilla,* at night, waves of golden-green travel over the entire surface of the reef like wind over a field of ripe corn. It is quite important to observe that *Renilla* cannot be stimulated to action in the daytime, even in a darkened room, showing that the illumination must be under nerve control, whereas, in all lower forms, the light is evidently a response to mechanical stimulation only.

"A good many of the Annelid worms are luminescent, and, among Polynoids, the light-secretion is on detachable scales which glow after being thrown off from the body, being possibly a 'sacrifice lure,' intended to set a crab or other enemy chasing the scales while the worm escapes. Among the Syllid worms, the light is definitely a recognition mark, and enables the male to find his mate on the surface of the sea during the periodic swarming; a mystery as yet unsolved among the Syllids is why the light is sometimes violet and sometimes a greenish-blue.

"The most brilliantly luminescent of all marine worms is the tube-building *Chætopterus,* whose light is also either violet or greenish-blue. The light-giving substance is evidently an external secretion, as it can be rubbed off and spread through the surrounding water, but its purpose remains a mystery. If it serves as a lure to the minute organisms on which the worm feeds and brings them to the mouth of the tube, at the same time it certainly betrays the worm's whereabouts to its chief enemy, the eel, which hunts for the light and then pulls the worm out of its tube for a tasty mouthful.

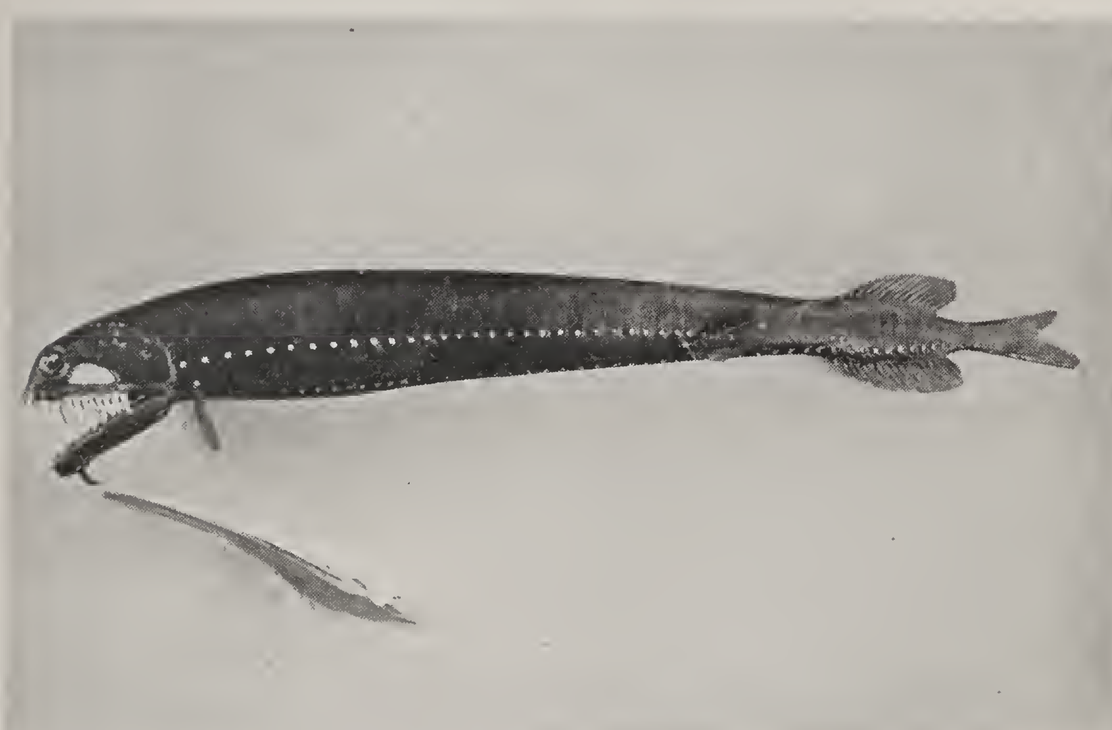
"Among Molluscs, there is quite a variety of luminescent forms, chief of which are the Cephalopoda or cuttlefishes. Before we go on to them, however, it's perhaps wise to take a look at *Pholas,* that brilliantly-shining bivalve which bores deep holes in stiff clay or soft rocks along the seashore, and which so puzzled Pliny and Aristotle a couple of thousand years ago. This creature, which is about the length of one's finger, lives buried in the hole which it has bored, putting out only its long foot-head; but, from five different spots along this projecting body-part, it pours out quantities of a luminous secretion, thereby attracting minute organisms to the mouth of the tube, whence they will be pulled down by suction."

"A sort of marine 'moth and the flame'!" the boy commented.

"So it would seem. What is important in *Pholas* is that this secretion no longer appears as a mere slime exuded from or forming on the skin, but is produced by organs definitely specialized for the purpose. With this difference viewed as a step onward, we can begin to see how it comes about that, among the cuttlefishes and squids, the light-organs become specialized, distinctive, and under the control of the animal.

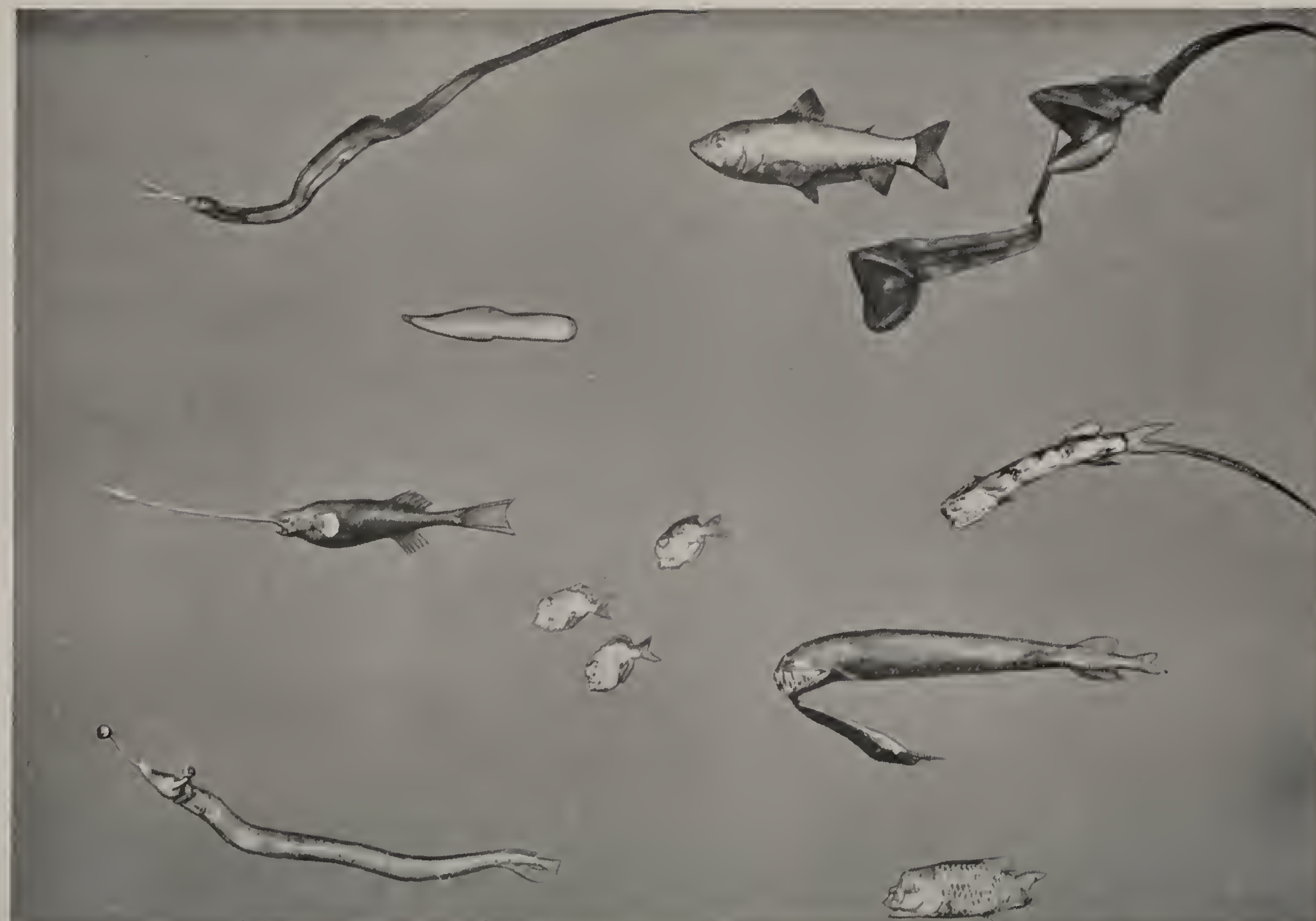
"A good deal of study has been done on the light-organs of the Cephalopods, and it would take me several hours to describe the peculiarities of the thirty-three species in which I have found light-organs. The development of luminescence among the Mollusca is most marked, passing from forms merely possessing primitive light-producing glands —such as those of *Pholas*—in which the secretion comes in direct contact with the water, to those where the light-organs are deeply placed and where there is a special system for admitting the oxygen of the water to the luciferine and luciferase, and, fur-

He Carries His Own Electric Light.
The deep-sea fish, *Gigantaclis Vanhoeffeni*, from two miles down.



Courtesy of Am. Mus. of Nat. His., N. Y. C.

Lit Up Like an Atlantic Liner.
The abyssal fish, *Melanostomias Melanops*, with rows of light organs shining out on either side of and beneath the body.



Courtesy of Am. Mus. of Nat. Hist., N. Y. C.

DEEP-SEA FISH WITH LUMINOUS ORGANS.

Abyssal forms, living in the perpetual dark, three and four miles down in the ocean.

ther, among the higher cuttlefish, to complex specialized photogenous organs, with a cornea, a lens, and reflectors, the whole protected by a translucent capsule and bearing a curious structural resemblance to an eye.

"As might be expected from what has gone before, the cuttlefish need not confine himself to any special color of light. In the deep-sea form *Thaumatolampas diadema,* which has no less than twenty-two light organs scattered over the body, ten give a clear white light, seven are pale green, the two anal lights are ruby-red, the largest light on the under side of the body is ultra-marine, and the two lights close to the eyes are sky-blue."

"Has the Giant Squid any light-organs?"

"Very probably, for several smaller members of his Family have them, but a living Giant Squid has never yet been seen—except by the artist's eye of Chu Ting. The only complete specimen of a young *Architeuthis* ever found, which was discovered on an isolated beach in Iceland, was so shrivelled and dried up that no definite determination of its photogenous organs could be made.

"Going higher up in the zoological scale, it is found that many Crustacea are light-producing. the phenomenon being observable both in the simpler and the more complex forms. The little Ostracod, *Cypridina,* gives out a most brilliant blue glow. Many of the Copepods (such as *Pseudocalanus elongatus*) emit a 'sacrifice lure' secretion of a bluish-white color, which trails like a glowing cloud behind the little creature when pursued by an enemy.

"Among the Schizopods the light-organs have developed into regular bull's-eye lanterns, with a reflector behind the gland producing the light and with a lens in front. Until the *Challenger* Expedition, and the exhaustive study made at that time, these organs were supposed to be eyes.

"These shrimp-like Schizopods, an inch or two long, have no less than twelve of these bull's-eyes, and half a dozen of them give light enough to see to read a newspaper. In several species the light-organs are well supplied with blood and have a nerve system of their own.

"Some of the larger crabs, too, have small light-organs, but these need not detain us. Among the insects—which belong to the same phylum—we find the luminous fireflies and the glowworms, as well as some luminescent tropical spiders, but you can afford to let terrestrial forms alone, for a while.

"Going up the zoological scale, we come to light-organs among the Echinodermata ——"

"Sea-urchins and starfish? You mean to say, Professor, that such things are higher up than crabs and lobsters, than insects like ants, and bees and spiders?"

"Certainly! That word 'higher' is a deceptive term, though, Bernard, and may lead you astray. If you mean biological complexity, for example, then it must be admitted that a spider is more 'highly' organized than a starfish, but the system of its organization, none the less, is lower. The spider is the end of his own line. Insect development is something like the sponges, where colonial protozoic development reached a high point, but then came to a full stop because it had taken a form which led no further.

"The crabs and the insects belong to the phylum Appendiculata, next in order above the Molluscs. All the creatures in this phylum are segmented, and, in the typical form, have a pair of hollow appendages to each segment. You can see this arrangement easily, in a centipede or millipede; the grub or caterpillar of a fly, moth, or beetle shows the same plan in the group popularly called 'insects'; and it's not difficult to follow a similar segmentation in the numerous joints of a shrimp or a lobster, nor yet, for example, in the long body of the hermit-crab, by which he holds himself in spiral shell which he has chosen for his house.

"The eighteen segments of a scorpion tell the same story, and no one who has seen the quickness with which a scorpion can use the dart in his tail, will deny the musculature of those 'joints,' though it may take a little anatomical study to distinguish the six segments which are combined into the head and legs. In the spiders known as pseudo-scorpions, the segmentation is equally easy to see. Even in ordinary spiders, there is no great difficulty in following the six first segments, including the jaws, pincers, and four pairs of walking legs; the rest of the body is often segmented—like a shortened centipede—by what are known as somites, and, in spiders which spin webs, the appendages of the hindermost are retained as spinnerets or spinning organs.

"All these appendages, however wonderfully they may be modified and jointed, are nothing more in origin than hollow pushings out of skin, and it is important to notice that spiracles or breathing-mouths may appear on every somite. This definitely portrays the character of segment added to segment instead of showing us a creature with all its parts subordinated to form a single individual. Even the 'highest' adult insect—including such social groups as the ants and the bees—has the characteristic marks of a centipede or even of a chætopod worm.

"The real point in the zoological scale is that never could the external shell of any of the Appendiculata—such as the crab—become the bony system of a vertebrate. The anatomy of the echinoderm shows no such obstacle."

"But starfishes and sea-urchins are such slow and primitive things!"

"As for being slow, a starfish can easily cover a mile a day and stop long enough to eat a couple of hundred mussels on the way; and as for the structure, that is not as primitive as you seem to think. The intestine is complex, the blood system is centralized, and breathing is by a form of external gills. What is more, the skin takes on the character of a true skin, not shell, and the cartilaginous arm-bones of the Brittle-Stars are inside.

"Now, there is a queer worm-like creature, which may reach the length of two feet, which burrows in the sand something like an earthworm, and, with its fixed-open mouth, eats as it goes along; this creature rejoices in the name of *Balanoglossus*. For a long time scientists supposed it to be an off-type of a Holothurian or sea-cucumber, and therefore one of the Echinoderms. Later study showed that it possessed gill-slits, and therefore *Balanoglossus* was classed among the Worms (a classification now abandoned). Still further study revealed skeletal and nerve peculiarities bringing it within measurable distance of *Amphioxus,* the lancelet. Now, *Amphioxus* unquestionably possesses a notochord, which is the forerunner of the backbone, and is classed among the lower vertebrates.

"So you see, Bernard, from a starfish to a brittle-star or a sea-cucumber, thence to *Balanoglossus,* thence to the lancelet *Amphioxus,* thence to the lampreys and hagfish which have ever-open jawless mouths but possess a notochord, thence to the skates and sharks with their cartilaginous backbone, and so on to the true fishes and the higher vertebrates, is a fairly regular ascending scale. Even the first step in the ascent is not such a great jump, but it is one which could not have been made by beginning with the crabs, though the Chætopod worms, very simple Crustacea, reveal a lower step.

"Let us say that the starfish are modified forms on a line of development, which is higher than that of the Appendiculata, even though the manner in which they are organized is less complex than the insects. Remember, once for all, the zoological scale never mounts through forms which have been highly modified for special adaptation, and where distinctive characters have become fixed, but through primitive and rudimentary forms.

"With this clearly in mind, Bernard, we can go back to the question of luminescence among the Echinoderms. They are not specially distinguished as light-givers, though some of the vividly-colored red starfish do give a roseate glow at night, but there is no doubt that such light-organs as they do possess are closely linked up with the nervous system.

"The Brittle-Stars, especially, do themselves proud in this particular. Sir Wyville Thomson, describing a deep-water form, once wrote, 'The light from *Ophiacantha spinulosa,* as I saw it on many occasions, was of a brilliant uranium green, corruscating from the centre of the disc, now along one arm, now along another, and sometimes vividly illuminating the whole outline of the starfish.'

"But the greatest light-giver of all the seas, Bernard, is *Pyrosoma.* This is a free-swimming colony of ascidians, or ascidiozooids, a degenerated group of the Chordata, coming in between your new friends Balanoglossus and Amphioxus in the zoological scale. You know the simple ascidian, probably, but the compound ascidian, or sea-squirt—of which *Pyrosoma* is an example—may grow to the extreme length of ten or twelve feet long, with hundreds of ascidiozooids to the inch, each one bearing two brilliant light-organs close to the mouth, thus giving tens of thousands of sparkling points, some blue and some red. If you should write your name on the *Pyrosoma* in that jar with your finger, in a few seconds the letters would come out in thousands of sparks of light so close together that they would look like lines of writing.

"Perhaps, before passing on to the true fish, I might mention that the abyssal shark (*Spinax niger*) is believed to possess a luminous slime.

"Only four Families of fish possess light-organs, and one of the most extraordinary things about these is the manner in which they may be placed anywhere on the body. In a few cases (such as *Melanocetus johnsoni,* one of the angler-fish) the light is found on the extremity of a long flexible process which sways from the top of the head and hangs over the big mouth, so that it is probably a lure to attract prey.

"One of the blind fishes of the deeps, *Ipnops murrayi,* has two large photogenous organs covering the top of the head. Its blindness is a most interesting fact, since its cousin (also one of the Scopelidæ) which lives a little higher up in the water has rudimentary eyes, another cousin swimming in a still higher layer has perfect but small eyes, while a relative whose habitat is on the surface has large eyes. Yet it is the eyeless fish which possesses the light-organs; they certainly cannot be recognition marks, for he cannot see, and they cannot serve him as an illumination to help him catch his prey, for the same reason.

"Other fishes may have light-organs on the back or the sides, on the head or on the tail, some of them large and some small, and, as yet, science cannot explain either their utility nor their irregular distribution. Recent study, by proving that luminosity is not at its strongest in the darker regions of the sea but rather prevails in the surface layers of tropical waters, has only made the mystery more obscure.

"So you see, Bernard, how necessary it is for us not to lose any chance to study these luminescent forms. You can realize, too, how helpful your pencil and brushes may be, if, when these creatures are still living, you can catch the exact markings and shades of luminosity for later study and comparison."

While awaiting the coming of the ocean-going tug, for which a wireless message had been sent, the *Kittiwake* stood by the derelict, and Professor McDree took advantage of the halt to make a series of special hauls for the taking of further luminescent forms. Captain Ropet's captures with his home-made net from the deck of the derelict had shown that the section of the sea where he had been drifting, south and east of the Gulf Stream, was particularly rich in these light-bearing types.

As fast as they were found, Chu Ting set the boy to work on them. He showed him how to use fine crystals of a radio-active material mixed with powdered glass of different colors, the rays given off by the radio-active crystals being reflected on and from the glass crowding them on all sides. This device, when superimposed on the old-fashioned phosphorescent luminous paint, could be made to give a picture of almost any luminous deep-sea form, a picture which, when seen in a darkened room, gave a fair representation of the colors and luminosity of the original.

Three days later, the ocean-going tug appeared, bringing wire cables and everything needed for a tow. The captain of the tugboat had made all arrangements to take Captain Ropet with him, and had even given up his own cabin for the purpose. But the commander of the derelict, although still very shaky and easily given to lapses of mind-control, could not be persuaded to go on board the tug.

When boats from the *Kittiwake* aided the tugboat's crew to put the tow-lines aboard the derelict, Captain Ropet insisted on going also, and, once there, he refused to leave the hulk. Persuasion and reasoning had no effect.

" I stood it nine weeks without much food, savin' what I could fish up," he declared. " I can stand it another week or so, when I've got everything I want. I'm aboard my own craft, an' I command her, still. Thankin' you, Cap'n, but I reckon I'll reach port on the deck o' my own ship! "

Bernard's former comrade, Brown, volunteered to accompany the plucky skipper, if he could get permission from the captain of the *Kittiwake,* which was readily granted; one of the tugboat's crew offered to do the same. So, under favorable skies and with fair weather, the derelict ploughed off under tow, her nose barely clear of water, Captain Ropet standing by the shelter beside the cargo-winch, and the Stars and Stripes, attached to the stump of the mast, floating just above the undaunted sailor's head. It was a very different picture from that which the *Kittiwake's* searchlight had first disclosed —the madman crouched on the deck, singing wildly, and rocking a glass jar of luminescent sea-creatures for his only comfort and his only light.

Shortly before noon, next day, the *Kittiwake's* engines stopped.

Bernard looked up from his drawing with surprise, for he knew that, because of the delays which had been caused by the finding of the derelict and the waiting until the arrival of the tugboat, the expedition was several days behind schedule. It had been planned, therefore, to drive on steadily into the northern seas, or, at least, into the immediate neighborhood of icebergs.

Professor McDree was anxious to make a special study of the question whether floating bergs, bringing cold water with them, also brought northern species of plankton and of fish with them into the warmer seas. Such a fact, if it could be proved, might help to settle some of the problems concerning the irregular distribution of plankton in the North Atlantic Ocean. For this purpose, systematic net-hauling was necessary, and that at fair depths, for many icebergs have their bases 400 to 500 feet under water.

What did this stoppage of the *Kittiwake* signify? Always curious for novelty, Bernard burst out of the laboratory and went on deck, to find most of the scientists gathered on deck. Clearly, there was some reason for this.

" Want to take a swim? " queried Professor McDree, as soon as he saw the boy.

" What for, sir? "

" I thought you were fond of swimming! You seemed so, in the Sargasso Sea."

Bernard made a grimace at the remembrance.

" I wasn't exactly swimming for the fun of it, then! " said he.

" Do it for the fun of it, now. Just strip and jump in."

" And after? "

" Swim 'round to the other side of the ship—either by the bow or the stern, as you choose—and come aboard again."

Bernard looked around doubtfully, thinking that the chief of the expedition must be chaffing, but Montgomery and Bower, who were standing near, nodded in agreement.

" Go ahead, lad! " urged Montgomery. " We won't leave you behind! "

" Queer deal! " muttered Bernard to himself, but he slipped off his clothes, as desired, and dived from the rail.

The water was a good deal colder than he had anticipated, a great deal lower in temperature than that of the Sargasso Sea, surprisingly cold, in fact.

He was glad to strike out strongly to keep himself from getting chilled. A score or so of strokes took him to the ship's bow, and, glancing up, the boy noticed that several of the scientists, on deck, were following him around.

Just as he crossed in front of the cutwater, he struck what seemed like a dense but invisible curtain in the water, barring his way. He gasped with the shock and the surprise of it, for this unseen resistance certainly felt uncanny. The water had a viscous feel as though it were in process of becoming thick like molasses, and yet it suggested a wall. It was curious and extremely unpleasant, like some effect of evil sorcery.

But he had been told to swim around the ship, so Bernard lowered his head, swung his right arm over, and put all the force of his muscles into a couple of sweeping strokes of the "Australian crawl," in order to overcome this invisible obstacle.

At the same instant, it seemed as though a hand pushed him up from beneath, and, as he crossed the line, his body rose as if he were going over a hurdle; his head was burning, his feet, ice-cold.

A couple more vigorous strokes brought him clear round the bow and out on the starboard side of the ship.

Looking up, he saw the Professor gazing down with a smile of interest and curiosity.

"Why!" called Bernard, spluttering, "it's boiling hot!"

"Not boiling, hardly," the scientist corrected. "But I wanted to see if you'd find it hot exactly on the line of demarcation. You've just swum into the Gulf Stream!"

CHAPTER XI

THE ICEBERG BEAR

"My word!" ejaculated Bernard, as he clambered on board, "I hadn't any idea that the edge of the Gulf Stream was so sharply marked!"

"And the line of temperature difference is even sharper on the northern edge!" Professor McDree declared. "Once, coming from the Labrador Current, I lowered two thermometers over the side simultaneously, and registered fifty-six degrees (Fahr.) at the bow, and only thirty-four degrees at the stern, a difference of twenty-two degrees in less than the ship's length. That's on the surface. At a depth of 100 fathoms, I've registered below freezing (thirty-two degrees Fahr.) and, twenty minutes later, after crossing the 'cold wall' between the two currents, at the same depth the thermometer has registered nearly seventy degrees."

"And the Gulf Stream runs, as hot as that, all the way to Europe?"

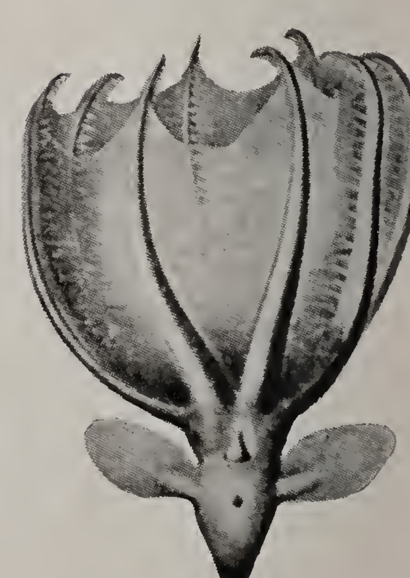
"By no means! After leaving the Newfoundland Banks, it decreases a great deal both in speed and temperature. Tides and ocean currents form a very

Courtesy of U. S. Coast Guard.

Very Rare Photograph of the "Cold Wall."

View of the exact edge between the Arctic Drift and the Gulf Stream. The cold water at 34° Fahr. (two degrees above freezing) is smooth and glassy; the warm water at 56°, is choppy and rippled.

A Stalk-Eyed Form.



A Swift-Swimming Predatory Form. A Blind Vampire Form.

SOME SWIMMING SQUIDS FROM MIDDLE AND LOWER OCEAN DEPTHS.

complicated part of oceanography, and, since they afford no food for your pencil, Bernard, I wouldn't bother about them, if I were you.

"The main principles of oceanic circulation, which are all that you need to know, are simple. There is the Tidal Wave, caused by the attraction of the sun and the moon, which rises and falls every twelve and one-half hours, causing tidal currents near land or over oceanic shoals; such currents have been detected as far down as 400 fathoms. There are the Wind Waves, generally the result of steady air currents, such as the trade winds or monsoons, the effect of which may be felt 100 fathoms down. There are the Seiches, or oscillation currents, due to the juxtaposition of layers of water of different temperatures.

"Finally, there are the true Oceanic Currents, such as the Gulf Stream, which are caused by the heating of the sea in the tropics, by the differing density and salinity of the water in differing regions—of which the high evaporation and great salinity of the Gulf of Mexico, and the freshening of oceanic water where the Amazon pours out its mighty flood, may be taken as examples.

"All these are modified and changed in direction by the rotation of the Earth, since the sea, being a liquid, drags behind the rigidly compressed interior. Such are the main principles, but, the minute you want details, you find yourself in a maze of astronomical calculation to explain the causes, and you require some hundreds of charts to portray the effects."

"I think I'd rather paint luminous jellyfish!" the boy declared.

"Personally, I'd rather dissect them," the Professor agreed, smiling, "but every man to his own bent. Montgomery, for instance, is far happier with his charts and his calculations.

"For purposes of navigation, an exact knowledge of ocean currents—far more exact than we have now —is all-important. Such disasters as the loss of the *Titanic* are due to icebergs brought down into the Gulf Stream by ocean currents from the north, and if the Ice Patrol had existed at that time, that fearful loss of life would never have happened.

"Even now, it is estimated that sixty per cent. of the vessels wrecked in the open sea go down from striking derelicts—just such derelicts as the one on which we found Captain Ropet."

"But do wrecks really drift so fast?"

"Fast enough to be a real peril. Taking the North Atlantic, alone, the Equatorial Stream flows westward at nearly three miles per hour, the Gulf Stream flows northeastward four miles an hour, and the Labrador Current flows southward two miles an hour. Each of these acts and counteracts on the other, not to speak of the minor currents, of water movements brought about by protracted tempests, and of the changes of the seasons.

"Notice, Bernard, even if a derelict drifts only two miles an hour, that's close to fifteen hundred miles a month, or enough to carry a submerged wreck across the Atlantic in two months, if it went in a straight line."

"As much as that?"

"Fully! Now, suppose a berg or a derelict is reported at a certain latitude and longitude. A vessel coming three days later in a direction opposite to that of the drift of the berg or wreck, might strike it at 150 miles from the point where it was last reported, in other words, several hours before it would be thought necessary to reduce speed and to establish special lookouts. Whereas, if the strength and direction of every vagary of every ocean current was exactly known, the captain of the vessel would have been able to figure out how far that menace to navigation would have drifted, and he would have been able to steer a course of safety.

"Unfortunately, the courses of such derelicts are extremely erratic. Take a couple of examples. The *Fannie Wolston,* wrecked off the coast of Florida, drifted half-way to Africa, made a complicated 'figure 8' in mid-Atlantic, drifted south, doubled back on its course, did the 'outside edge' in a complete circle north of the West Indies, struck up northward, and was finally destroyed by a Coast Guard Cutter, not far from Bermuda, about three hundred miles from where it had started, having travelled more than four thousand miles meanwhile.

"The *W. L. White,* wrecked off New York, drifted to within a hundred miles of the place where the *Fannie Wolston* had been abandoned, and then, instead of following the former derelict's track, as might have been expected, got snapped into the Gulf Stream. In this it kept a general northeastward course to mid-Atlantic, made an equilateral triangle of about two hundred miles to each side, came back to its course, made a small 'figure 8' farther on, and then a larger 'lovers'-knot,' struck due east towards the Azores, bent its course sharply northeastward, just grazed the coast of Ireland, and finally stranded on the beach of one of the Hebrides Islands; the distance covered was over five thousand miles, and the voyage took ten months and a half."

" And, during all that time, the wreck of the *W. L. White* was a menace to ships? "

" Every minute of the time. It is estimated that, counting all the oceans, there are never less than two hundred icebergs, derelicts, mines, spars, or masses of floating wreckage large enough to sink a ship which strikes them, and nearly a hundred of these are in the North Atlantic, alone. That is why wireless warnings are constantly being sent through the air, every shipmaster warning his fellow-mariners of a danger he has seen and escaped. These are listed by the U. S. Navy Radio Stations, and a broadcast message, enumerating the exact location of all such ocean dangers, is sent out every day."

" Good thing, too! "

" The International Ice Patrol, conducted by the United States, under international support and assistance, has, for its special work, not only the location of icebergs brought down into the lanes of travel, but also the detailed study of the currents which have brought them there. Ocean currents are so complex, and the difference of drift between a deep and a surface berg are so great, that the Coast Guard cutters detailed to this service have to dodge here and there, constantly watching the five or six most southerly and most dangerous bergs, like a little goose-girl trying to keep track of half a dozen restless geese that won't keep together."

"And are there any icebergs in the Gulf Stream, now?"

"Several. The Coast Guard Cutter *Modoc* has just sent out a warning of a pinnacle berg which is well down into the Gulf Stream, and which is of good size though melting fast. We ought to sight her, the day after to-morrow."

The prophecy was justified. Early in the morning, sea-gulls and petrels of various species were seen, among them dovekies, fulmars, black-backs, and murres. The last was accepted as a clear sign of ice, for the murre is exclusively a cold-water bird, and is rarely seen below the limit of the Gulf Stream, except in attendance on a berg. In the early summer, or "iceberg season," careful ship-captains keep a shrewd eye on the species of sea-gulls seen around a ship.

Just before noon, the berg was seen. It was evidently a large one and must have been broken off one of the main Greenland glaciers. On one side, it had a towering pinnacle, 125 feet high, and this was much eaten out and honeycombed near the edge of the water; there was also a much larger, flattened berg, scalene-triangled in shape, about ninety feet

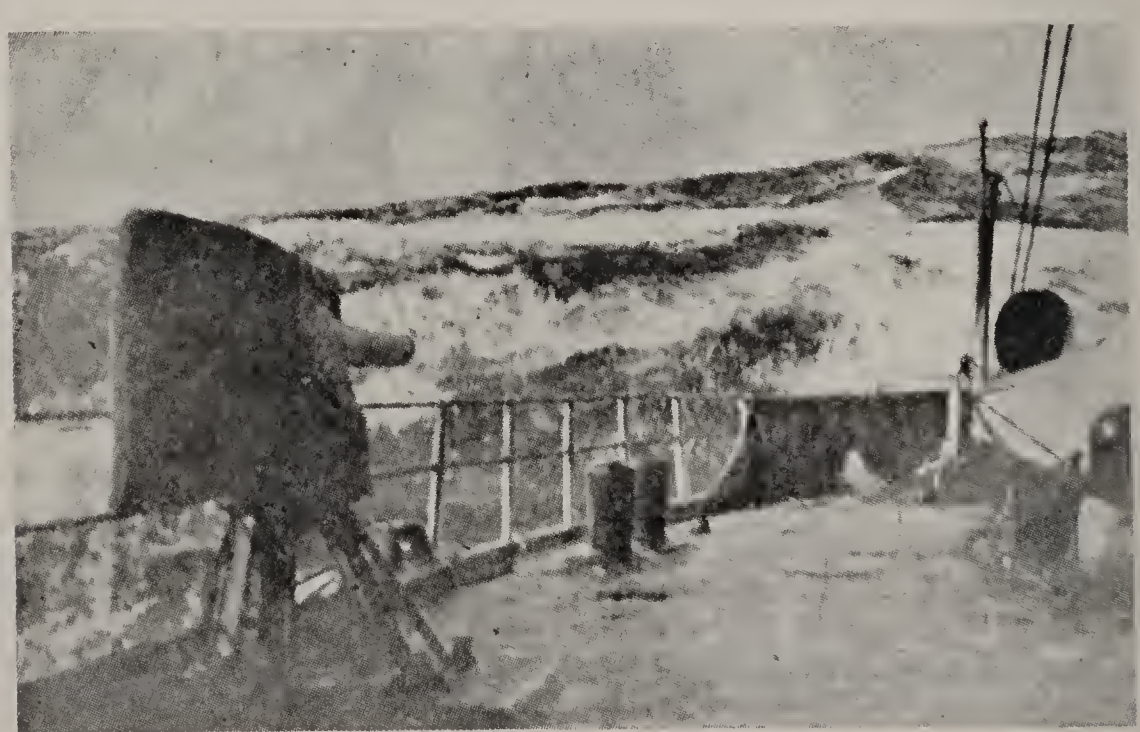
THE FIRST ICEBERG OF THE SEASON.
The *U. S. S. Seneca* locating the advance of these menaces to navigation and mapping the ocean currents that bring them.

Courtesy of U. S. Coast Guard.

STILL A MONSTER, THOUGH IN WARM WATER.
Pinnacle berg on the edge of the Gulf Stream, having a large underwater "ram," photographed from the deck of the *U. S. S. Tampa.*

Courtesy of U. S. Coast Guard.

OCEANOGRAPHIC WORK IN WINTER.
Soundings being taken over the Newfoundland Banks in bitter weather.



HOVE TO IN A FULL GALE.
U. S. S. Seneca battling against an Arctic tempest, ice making on deck; the oceanographic tests were taken, none the less.

high, the lower part sheer to the water, the upper part being a series of flattened but sloping planes. It was, perhaps, an eighth of a mile across. These looked like two bergs, yet were but one, connected under water, though how far the deadly "ice-ram" projected on every side, it was impossible to say. Several blackfish, or "ca'ing whales" were seen near it, evidently visitors from the far north.

Extremely careful observations of changes in the water temperature and in the air temperature were taken, the *Kittiwake* approaching at a snail's pace. The scientific observers found, definitely, that neither of these temperature forewarnings would be of the slightest service to a ship advancing even at the half-speed of ten knots, since the first indication of temperature change, either of air or water, could not be secured more than a minute before striking, therefore much too late to be of use.

The *Kittiwake* sidled up slowly, a few revolutions at a time, to make sure not to strike, threaded her way through the "growlers" or small blocks of ice broken off from the parent mass, and found deep water on the triangular side of the berg. As the study of marine life-forms in the cold water immediately surrounding an iceberg was one of the purposes of the expedition, the vessel was made fast to the ice with specially prepared grapple-hooks and long lines, careful examination of the triangular berg having been made, to make sure that it would not "calve," or turn over suddenly.

No sooner had the ship made fast, when, to the amazement of every one on board, a half-grown polar bear cub came round a corner of the berg, and peered down curiously at the ship. It at once caught the eager attention of Bernard.

"What a jolly little chap!" cried the lad. "Oh, Professor McDree, do let's go and get it for a mascot!"

"And have Mamma Bear swallow you down in about two bites?"

"There isn't any mother bear around! I'm sure there isn't! If there had been, she'd have come first!"

"She'd have done nothing of the kind. She'd have taken to the water long ago. Maybe, as you say, the cub is all alone. Perhaps it got stranded on the berg when it drifted away from Greenland, and was too small to swim back."

"Please—can I go get it?"

"You mean—just pick it up in your arms, like that?"

"Why not? It isn't any bigger than my Newfoundland dog, at home, and I've carried him, often!"

"But it's got longer claws, my boy, and even a half-grown cub's bite will reach to the bone! No, that's no task for a lad like you. Take a rifle, and get the fur, if you like."

"A little orphan bear cub! Oh, Professor!"

Bernard protested no farther, but disappeared forward.

At eight bells, when the watch was relieved, one of the men came aft to the officer of the watch, and respectfully asked that a party might be allowed to capture the polar bear cub as a mascot for the crew. The question was referred to the captain of the *Kittiwake,* who had already been told of Bernard's urgent demand. It was not difficult to guess where the sailor's idea had come from, and the captain replied, with a twinkle in his eye:

"Very good. Perhaps it may be found to be a 'new species!'"

And the chase was on.

With four sturdy sailors, each armed with a rope, the chase of the polar bear cub did not seem dangerous, and Bernard secured permission to accompany them, the men being strictly warned to keep the impetuous lad from risking himself too close.

At first, it seemed nothing but a romp. The four sailors and Bernard dropped on the ice from a rope swung from the fore-yard, and started to pursue the little bear. The berg was of good size, and the half-grown cub, with his padded hairy feet, could run and climb about the slippery ice as if it were a level floor, while the sailors slid, and slipped, and scrambled about, amid shouts of laughter from the crew on deck who were watching the ludicrous tumbles.

At last, one rope fell fair over the head of the cub, but, before the noose could be drawn tight, the bear put one foot through it. At the tightening, therefore, the rope was around one shoulder, instead of getting the expected choking hold about the neck. Frightened, the cub tore to the ice-cliff's edge, and dived into the water. The sailor, who had thrown the rope, tripped and fell, and the trailing line swished past Bernard's feet. Instinctively he grabbed at it, and, an instant later, found himself pulled over the edge and falling into the icy water.

This was a very different matter from the warm waters of the Sargasso Sea, and Bernard gasped with the shock. For a second or two, it took his breath away.

He had no intention of being towed off by a polar bear as he had been by a turtle, and, remembering his former predicament, he let go the rope. After all, he thought quickly, the cub could not escape very far.

Burdened with his heavy clothing, and with his shoes laced on, the boy turned to swim for the ship, for a single glance sufficed to show him that there was no way of climbing up the sheer sides of the triangular berg, from which he had been pulled. This course towards the ship took him out of sight of the sailors on the berg, who, knowing that the boy was a first-class swimmer, were laughing at his ducking. In a few strokes he rounded the corner of the berg, in full view of the ship.

Suddenly, he heard a startled cry from the deck:

"Look alive! He's after you!"

And Bernard, casting a glance over his shoulder, saw the polar bear cub, its long neck outstretched, in full pursuit, its speed fortunately checked by the long trailing rope.

Undoubtedly famished, marooned as it had been on the berg, with, perhaps, only an occasional foray for fish, the young bear was desperate with hunger and ready for anything. The idea had not occurred to it to make any attack on the ice-floe, for instinct had suggested nothing but fear of its biped pursuers;

but Bernard, in the water, in his dark clothes, looked enough like a swimming seal to awaken the bear's hunting instinct.

The boy heard a crisp order in the captain's authoritative voice:

"Tell the gunner's mate to bring a rifle! Lively, now!"

Then, like a flash, a lean yellow body leapt from ship's stern, plunging full into the water between pursuer and pursued, startling the bear for a second and halting it in its course.

It was Chu Ting!

He came up a second later, his pigtail trailing behind him, his narrow eyes glittering, a long thin knife in his hand.

"Dodge back through the growlers to the other berg," he cried; "the rope may catch and give you a chance! When you reach the berg, the men will throw you a rope!"

"But you ——" began the boy.

"Do what you are told!"

Not even the captain of the *Kittiwake* could put such absolute authority in his voice as the Chinaman, when he wished to do so. That he was of mandarin stock, no one ever doubted.

Bernard, terribly handicapped by his clothing, turned and swam back, twisting and turning among the small blocks of ice and the larger growlers, so that, in case the bear were following, the rope might become entangled.

At the same time that the captain had called for a rifle, the sailors on the berg had been warned by shouts from their comrades on board. One of them had started to swim for the pinnacle berg, which, in spite of its height, afforded several easy landing-places, where Bernard could be helped up.

Another of them, who had scrambled round the edge of the berg, to find out if he could be of service, saw the bear, after a moment's hesitation, give up the chase of Bernard and turn upon its new foe. The Chinaman was treading water, waiting, knife in hand.

In such an uneven duel, the peril was extreme, and the sailor saw a way to help. Launching himself into space, with a violent leap, he landed full on the bear's neck with both feet. The jolt was terrific, for a moment or two paralyzing both legs of the heroic rescuer, but, at the same time, it half-stunned the bear, which swam around in circles, as though dazed. Presently, it came to itself and again lunged forward. The situation was critical for the half-grown cub, absolutely aquatic in its habits, was a match for half a dozen men, in the water. But the trailing rope annoyed it and distracted its attention. Deeming it an enemy—possibly a serpent of some kind—it wasted time and energy snapping at the rope and trying to free itself.

Once the bear came near enough to make a snap at Chu Ting, but the sailor yanked on the rope in time, to pull the jaw away; again, it lunged open-mouthed at the sailor, but Chu Ting drove his keen thin knife into the muscles of the neck, taking care not to give a mortal injury.

At the same moment, one of the sharpshooters appeared at the ship's rail, rifle in hand, awaiting the command to fire.

Chu Ting looked up calmly, and his voice was as unimpassioned and measured as ever.

" There is no need to shoot, as yet," said he; " wait until there is danger! "

And the bear, while he thus spoke, was not more than five yards away!

All this happened with extreme quickness, and the Chinaman had hardly finished speaking, when the boat shot round the stern of the ship. This decided the combat, and instantly! Two men with boat-hooks easily kept the bear cub off while Chu Ting and the bruised sailor climbed into the gig. The end of the rope with which the cub had been lassoed was hitched to the end of a rope thrown from the ship, making it a prisoner.

Scarcely had this been achieved, when there was heard a grinding rip, a crackle, and an enormous splash.

The part of the pinnacle berg, on which Bernard had just climbed in an exhausted state, and which was already undercut and out of balance by the proximity of the warm Gulf Stream water, could not support the sudden weight of Bernard and the sailor, and the berg "calved." A huge piece from the side split, cracked away from its base, and crumbled, altering the gravity of the higher pinnacle; this, in turn, began to totter, and then turned over with a crash, flinging the boy once more into the water, amid a churning riot of huge ice-fragments and brash.

Scarcely able to keep afloat, almost with a drowning grasp, Bernard snatched at one of the numerous pieces of driftwood which are usually to be found around icebergs, and which looked like a piece of a "trade" canoe-paddle as sold to the Eskimos. He had scarcely done more than seize it, when a block of ice, threshing up behind, struck him on the back of the head. The blow stunned him, and he would have sunk, then and there, with all the weight of his clothing, had it not been for his drowning grip on the driftwood he had seized.

The boat came round the corner of the triangular berg, just in time to see the second smash.

As before, it was Chu Ting who moved the fastest. Already stripped, he plunged in again, cleaving the water like a swordfish. In a few strokes he was beside the boy, and had gripped him by the hair. It was but the work of a moment to bring up the boat, and to lift the insensible lad in it, and to hurry him back on board.

In fact, the polar bear cub and the boy reached the deck of the *Kittiwake* at about the same moment, the bear swaying his long neck, and snapping silently at any one who came near. The boy remained unconscious.

It had been a nasty blow, though not a dangerous one. In less than an hour the lad came to, but sleepily, for the doctor had already given him a stiff dose to counteract the shock of the cold and the exhaustion. By evening, Bernard woke, refreshed, and, except for a big lump on the back of his head and a general sense of lassitude and fatigue, he felt none the worse for his misadventure.

He woke to find Chu Ting and Professor McDree standing beside his bunk, the latter with an enigmatic smile of welcome and satisfaction, the Chinaman as impassive as ever. In the Professor's hand was the half of the Eskimo paddle, worm-eaten and covered with weeds and barnacles, which the boy had clutched at the moment of the calving of the berg.

On seeing the boy's eyes open, and wakefulness come into them, Chu Ting took his hand from behind his back, and displayed a drawing of a stalk-like creature, with a milky-white double shell, splotched with orange, and with long hair-like legs, striped black and white.

"What's that?" queried the boy. "It looks like a barnacle."

"It is one! That," said the Professor, pointing to a colored spot on the piece of driftwood which he held in his hand, "is '*Lepas Bernardi*'!"

The boy leaped out of his bunk in his excitement.

"A new species? Is it? And I found it? Honest?"

"Unquestionably! Even if it took a polar bear cub to show you how, Bernard, you've put your name forever on the Zoological list of fame!"

THE END