THE MIGHTY·DEEP

AND·WHAT·WE·KNOW·OF·IT

AGNES·GIBERNE

THE MIGHTY DEEP

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BURST OF THE SOUTH-WEST MONSOON AGAINST THE COLOMBO BREAKWATER

Frontispiece

THE MIGHTY DEEP

AND WHAT WE KNOW OF IT

BY

AGNES GIBERNE

AUTHOR OF "SUN, MOON, AND STARS"; "RADIANT SUNS"; "ROY, A TALE OF THE DAYS OF SIR JOHN MOORE"; ETC., ETC.

"If I had asked thee, saying, How many dwellings are there in the heart of the Sea? . . . peradventure thou wouldst say unto me, I never went down into the Deep."

2 *Esdras* iv. 7.

WITH ILLUSTRATIONS

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DEDICATED

TO THE REVERED MEMORY OF

VICTORIA THE GREAT, R.I.

SOVEREIGN LADY OF THE BRITISH EMPIRE

QUEEN OF THE OCEAN

AND

MOTHER OF HER PEOPLE

PREFACE

THIS little book makes no profession to be a systematic text-book of Oceanography, or to contain exhaustive discussions of the latest discoveries and theories. The subject is far too vast to be so dealt with in one small volume. A library would almost be needed for the purpose.

Much information has been gained within the last decade or two of years about the Ocean, its make, the laws which govern its movements, its dark and mysterious depths, the various deposits upon its bed, and the innumerable living creatures by which it is inhabited. All that I have attempted has been to cull a certain number of leading facts from the great storehouse of knowledge, and to put them in order, for the many who love sea-breezes and ocean-waves, and who may like to know a little more about the friend whom they so often visit.

With regard to Authorities, I must acknowledge my indebtedness to the following books, among many others: *The Realm of Nature*, by Dr. H. R. Mill; *Report of the Scientific Results of the Voyage of H.M.S. Challenger—Deep Sea; Coral Reefs*, by Professor Dana; *Standard Natural History*, edited by J. S. Kingsley; *The Microscope*, by Carpenter, revised edition; *British Merchant Service*, by R. J. Cornwall-Jones; *Resources of the Sea*, by McIntosh; *Harvest of the Sea*, by J. G. Bertram; also numerous papers and articles in the *Geographical Magazine*, *National Geographical Magazine*, *Scottish Geographical Magazine*, *Proceedings of Royal Society of Edinburgh*, *Annual Report of Smithsonian Institution*, *Natural Science*, etc., etc., by such writers as Sir John Murray, Dr. H. R. Mill, Professor James Geikie, Albert Prince of Monaco, Admiral Sir W. H. L. Wharton, Mr. John Milne, Mr. A. Günther, Mr. John Aitkin, etc.

In conclusion, I beg heartily to thank the Librarians of the Royal Geographical Society and the Zoological Society of London for the generous courtesy with which they have lent me books and supplied latest information, without which this little book could never have been written; also to express my warm gratitude for the invaluable help afforded by the criticisms and suggestions of the kind and able friends who have read my MS. and proofs.

WORTON HOUSE, EASTBOURNE.

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THE MIGHTY DEEP

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"THE SEA! THE OPEN SEA!"

> "How cheery are the mariners,
> Those lovers of the sea,
> Their hearts are like its yesty waves,
> As bounding and as free."—P. BENJAMEN.

> "Therefore also do men entrust their lives to a little piece of wood."
> *Wisd. of Sol.* xiv. 5.

ONCE upon a time, over two thousand years ago, our ancestors lived in a country smaller than ours, to the north-east.

They had not yet taken possession of two Isles, which in the then distant future were to become the Headquarters of a world-wide Empire. Already one characteristic of the race was prominent; they delighted in the Sea. Within their small limits of power they ranged the Ocean, they wrestled with its fury, they subdued it to their will, they rejoiced in its strength, they found often their graves beneath its surface. The English then, as now, were Ocean-folk.

May it not be that we in modern days love the sea, and flock to its shores, and carry our Flag to its furthest bounds, because our forefathers, the Norsemen, the Angles, the ancient Vikings, found their joy in it? Their march, like ours, was on the mountain-wave; their Home, like ours, was on the deep.

Probably with them, as with us, it was not always an unchastened joy. Even a hardy Viking might know the unpleasant consequences of Ocean's rougher moods. But no such discomforts drove him to stay ashore.

Had our forefathers been made of feebler stuff, had they been easily checked in their enterprises, centuries of history must have been changed. The development of English nature would have followed other lines.

In those days the fight could not but be severe. No mighty ironclads, no huge three-deckers, existed. No P. and O. liners, no great merchant ships ranged the seas. Our forefathers tackled the waste of waters with what we should consider the merest cockleshells. Even in these days we know what is meant by "perils of the seas;" but in those days the term must have carried a hundred-fold deeper meaning, both to the brave fellows who ventured on the stormy main, and to the waiting wives and mothers on land.

All the more honour to them that they were not daunted. Each man's victory or failure in life's battle cannot but help to shape the course which his descendants in future ages will pursue.

The Sea for us has a vivid personality. We know grand old Neptune so well, with his trident and his snowy hair, his dashing waves and his impenetrable depths, his gentle breezes and his furious gales, his moods of mild serenity and his fits of vehement wrath. He has his faults; but in spite of all we love him.

At one time the Sea was for men a type of the Infinite, of the Immeasurable, of the Boundless. We use still the same words; but they have lost some of their force.

In these days the whole ocean has been mapped out from shore to shore. We know exactly what countries lie round each part of it. We can tell how long and how wide it is in any direction. As we stand on the shore, and talk of the "boundless ocean," we are perfectly well aware that we are looking across to France or

Spain, to Germany or Ireland or America. Grand and far-reaching the sea still is, but to us no longer "boundless."

In ages gone by, those who stood upon the coasts of Palestine or Egypt, of Greece or Italy, gazed towards unknown horizons, across what was to them an illimitable ocean. The civilised world consisted of a few countries bordering the Mediterranean on the east; and those countries shaded off into unexplored barbaric regions. As for the "great Sea," as they called that which we regard as hardly more than a huge inland lake, it was in their eyes the embodiment of Infinitude.

At a very early period, long before the English Nation was dreamt of, before the Roman Empire had grown into being, while the polished Greek of the future was still a semi-savage, a nation of Ocean-lovers already existed. These were the Phenicians, foreshadowing in their pluck and enterprise the sea-going British of later times.

They, unlike the sailors of other nations, did not merely hug the shore, but ventured out into the trackless ocean. They, unlike the sailors of other nations, did not go upon the sea only in daylight, but they traversed it also in the dark hours of night.

At first they were content with the nearer reaches of the Indian Ocean, and with the more eastern parts of the Mediterranean. But gradually they wandered farther. Colony after colony was planted beyond Egypt, till they reached the Pillars of Hercules, known to us as the Straits of Gibraltar, to face a wild and strange Ocean, full of mystery.

There they made a startling discovery, enough to impress the more thoughtful minds among them. Far to the east, in the "Indian Ocean" of our days, their sailors had been acquainted with high and low tides; while throughout the Mediterranean scarcely any tides existed. But in the open sea, outside the narrow Channel, they found the very same tidal changes as in the eastern ocean.

It is hardly to be supposed that any one of them had a mind of such far-seeing grasp that he should be able to conjecture the grand truth of eastern and western oceans being ONE—swayed by the same influences, governed by the same laws.

A Phenician of those days, catching a glimpse of this truth, would have been worthy to take rank beside our Sir Isaac Newton of after days. They are believed to have observed the coincidence; no doubt with a feeling of wonder; and probably it was to them merely a coincidence. Very little was then understood of the most everyday and commonplace workings of Nature.

Not much, indeed, can be said with certainty of what the Phenicians did truly discover. Some observations they must have made of the heavenly constellations; and the Pole-star at least must have been known to them, otherwise it is impossible to imagine how they could have steered their vessels at night, in an age when the Mariner's Compass was unknown. They are supposed to have sailed far south on the west coast of Africa, if they did not actually round the Cape of Good Hope.

It does not appear that their knowledge was passed on to the Greek nation. Either they were curiously reticent of what they knew, or else such records as they may have left were destroyed and forgotten.

In after times the Carthaginians, descendants of Phenician Colonists, were, like their forefathers, sea-lovers, sea-explorers, searching the main, not as travellers search now from pure love of knowledge, or from a liking for adventure, but for the sake of commerce. The Carthaginians, however, instead of being able to make use of previous discoveries, and to work onwards from a point already gained, had to start afresh and to find their way—just as if it had never been found before—to and beyond the Pillars of Hercules.

To the Greek imagination that wide mysterious Ocean, opening out from the narrow Strait, was unattractive and terrible. It was a sea of limitless distances, of fog and gloom, of blackness and death; not an unexplored Ocean of possible glory and beauty and wealth.

Time glided by, and man advanced in his acquaintance with Land and Sea; but with the latter slowly. It was not until five centuries ago—and five centuries are but as a day, compared with the full stretch of history—that two weighty steps were taken.

One step was southward. One step was westward.

The African Continent, all along its northern region, had been the scene of very old-world history. But the south was shrouded in darkness. A brief glimmer of light, perhaps thrown there in Phenician days, had been long long lost sight of.

In the year A.D. 1486, a far leap from Phenician and Grecian days, Bartholomew Diaz made discovery of the Cape of Good Hope, and one year later Vasco de Gama sailed round it. These two explorers were only a little in advance of two greater voyagers. In 1492 Christopher Columbus started on his first cruise into the unknown West—and touched Land. Less than thirty years later, Magellan's famous voyage was accomplished to those Straits, between Patagonia and Tierra del Fuego, which bear his name. By that time the existence of the American Continent had become an established fact.

But that Continent had to be searched out. And the Ocean, though its limits were widened in men's imaginations, was very far from being mapped and fenced around with definite boundaries. Years of exploration still lay ahead; and many a valiant explorer had to fall a martyr in the cause of Science, before mystery should yield to knowledge.

Doubtless, in those days as in these, there was always somebody to ask, "But what is the use? What good can it do to us to learn that there are lands beyond the sea? What shall we gain by it all?"

Time alone, with its developments, with the growth of the human race, with the enormous possibilities then undreamt-of, could answer such questionings. Happily, brave explorers have seldom been lacking, who loving knowledge for its own sake have been content to labour patiently, not for money, not for fame, not for immediate results, but for the simple delight of better understanding the world around them, and for the benefit of future generations.

And indeed, if once we begin clearly to realise that the things which we see and hear, the wonders of Land and Ocean, are the outcome and expression of Divine Thought, we shall scarcely deem time wasted, which is spent in trying to find out a little more about those wonders.

CHAPTER II.

SALT WATER

"The new sight, the new wondrous sight,
The waters around me turbulent."
E. B. BROWNING.

"Water, water, everywhere,
And not a drop to drink."—S. T. COLERIDGE.

THE annual stampede of Britons to the coast says much for our National belief in Sea-breezes. In other countries also people go to the sea for change; but perhaps nowhere does the rush excel that on our Island. This re-vivifying gift, though partly due to the wide and free expanse through which the breezes have travelled, is largely owing to the briny ocean with which they have been in contact.

Sea-water differs from rain-water, well-water, river-water. True, it is made up of all these, since sooner or later and in one mode or another all water on Earth finds its way to the Ocean. Water may travel openly by river-routes; it may creep silently by dark and devious underground passages; it may float lightly *viâ* cloudland; but in any case its goal is the sea.

Still, though the ocean includes in its composition every kind of land-water, Sea-water as such is different from them all. Not only in its vast extent, in its enormous depth, but in its strong flavour of Salt.

One of the commonest of substances is Salt. It is in the ground, in air, in water. We even know that it does not belong to our earth alone, but to many heavenly bodies also.

Perhaps one reason for this abundance, at least upon our Earth, is that it is necessary for life. There is salt in the make of blood and of brain, of muscle and of tendon. Salt is perpetually passing out of a man's body; therefore continual fresh supplies of it are needed. Without a certain amount of salt in his food, he cannot keep in good health.

This at one time was not understood; and salt was looked upon as a mere luxury, easily to be dispensed with. Condemned criminals were forbidden that luxury; and they went through a good deal of suffering, the reason for which was not guessed. If plenty of animal and vegetable food was given to them, they managed to get along, since both contain salt; but if they were kept on purely farinaceous fare, they broke down.

Where all the salt in the Ocean comes from, is a complex question. Large supplies are brought down annually by rivers and streams, from various minerals in their beds, as well as from rock-salt regions. But if we ask, "How comes the rock-salt to be there?" we are told that it is a deposit, once formed beneath ocean-waters, or at least left by the drying up of salt lakes and seas. A proof of the latter theory is found in multitudes of sea-shells, often distributed through layers of rock-salt.

If much sea-salt came originally from rock-salt on land, and if rock-salt came originally from ocean-deposits, we are led into a curious circle of cause and effect—not unlike that of oak and acorn, or of hen and egg, with the attendant puzzle of—Which first? It is a query which we are not able to answer.

In former days the salt used for household and mercantile purposes was almost entirely prepared by the evaporation of sea-water. We no longer depend on this, however; and in England the sea-salt trade has gone down greatly before that of rock-salt, which is found to be the better for table use. It has not the same tendency to stick together in lumps, after being packed in sacks.

Great districts of rock-salt are found in many places—such as those in the Carpathian Mountains, in the Swiss Alps, in Germany, and in Great Britain. One huge mine in Galicia has been worked for six hundred years; and this supply is said to reach through about five hundred miles. From British works alone the quantity carried away every year amounts to a cubic mile of salt.

But land-supplies grow pale and insignificant before the quantities which float in the ocean. It has been reckoned that, if the waters of the whole ocean could be dried up, the amount of salt left lying on the ocean-bed would be something like four-and-a-half millions of cubic miles.

Such an enormous mass hardly conveys a clear idea. Let us think of one single cubic mile of sea-water, separated from the ocean, and see how much it would contain. First, the whole of that cubic mile of water has to be dried up; and then the materials left behind have to be weighed. We should find about thirty-three millions of tons of various kinds of substances, the names of which need not be given. We should also find of common salt a supply which, when weighed, would reach the great figure of *one hundred and seventeen millions of tons.* All this, be it remembered, floating unseen in a single cubic mile of water. No wonder the sea tastes salt.

In its make Water is always the same. Whether it be cold or hot, freezing or boiling, causes no difference. It consists of two gases, united; and the union is remarkable in kind. The two gases are not merely mixed together, as sand and sugar may be mixed. They are by the union changed into a fresh substance. For the time the gases exist no longer. In their stead, water has been formed.

And when the gases enter into this very close relationship, they do it always in the same manner. There is just so much of the one, and just so much of the other. One portion of hydrogen has to join with eight times as much by weight of oxygen—neither more nor less of either. The same is true, whether we are speaking of a great mass of water, or of the tiniest speck.

It is not actually correct to say, as is said above, that water "consists" of the two gases. So long as the water exists, the gases do not exist. And when, through the action of heat or electricity, the water is broken up and the gases reappear, then the water no longer exists. But at least we may say that it is the result of the uniting of those two gases, and that it can be made in no other way.

An interesting experiment has been tried. A certain amount of hydrogen gas and eight times as much of oxygen gas were weighed separately, by means of very delicate instruments. Then through great heat the two were caused to unite into water, and the water also was weighed. It was found to be just as heavy as the two gases together had been; and quite naturally so, since neither of the two gases had lost or gained in weight. This kind of union is called "chemical."

French people are fond of "eau sucré." A lump of sugar is dropped into a glass of water, and it disappears. But it has not been destroyed. It has not ceased to be sugar. No mysterious union has taken place between the sugar and the water. Neither water nor sugar has changed its nature; and no fresh substance has come into existence in their stead. The water is there, as it was before. The sugar is there too, not visible, but to be found out by our sense of taste. It has only been separated by the water into such minute particles that we cannot see them. This is a case of mixing, not of chemical union.

When we think of the characteristics of Sea Water, as compared with Fresh Water, we have to do with simple mixing. As sugar floats, unseen but not untasted, in tea or coffee; so salt floats, unseen but not untasted, in ocean waters.

Such a thing as absolutely pure water is very rare. No matter how clear a stream may seem to us, it holds a vast number of specks of material, collected from earth and air. Once a scientific man had some, most carefully distilled, which seemed to be of crystal purity. But he put it under the strong beam of an electric lamp, and, alas, for human powers! after so doing he could only declare that the idea of purity was ludicrous. If it is so with distilled water, the less said the better about common drinking-water. It may be well for our peace of mind that we have not stronger sight.

Ocean-water holds about two hundred times as much dissolved material as ordinary fresh water. The different kinds of substances found in any particular water-supply determine the character of that water, making it sweet or sour or salt, rendering it health-giving or death-dealing.

Something has been said about the drying away of sea-water, and the leaving of salt behind. A remarkable instance of salt thus left is seen in the Rann of Cutch, a flat Indian plain, about a hundred and ninety miles long, and half as wide.

During the south-west monsoon the ocean waters are forced by powerful winds up the Gulf of Cutch to a considerable height, over-spreading the Rann, which for a time is turned into a shallow lake. When dry weather comes, the water vanishes, partly retiring, partly evaporating; and a salt-strewn desert is left, varied by sand-ridges, green spots, and little lakes, but covered principally by "sheets of salt crust." My father, when there many years ago with his Regiment, noted down his impressions of the scene.

"From this spot"—the spot on which he stood—"the water is about eight miles distant, the intermediate space being a flat surface, entirely covered a quarter of an inch thick with salt in crystals, looking much like snow, in such quantities that it can be scraped up by the hand perfectly free from earth; and on all this space not a blade of grass to be seen."

The same task is carried on by the working of sun-heat, as by the fire under a kettle. All day long in a warm climate the sun's rays are busily at work, lifting from the ocean-surface a continuous stream of fine invisible vapour. The water is drawn up particle by particle, not in masses; and the sun's rays have no power to lift the ocean-salt, which remains behind, floating still in the sea.

But when a strong wind lashes the surface into waves, and rends the tops of billows into fine spray, it often carries a great deal of salt to a distance. We know how salt may be tasted on the lips miles inland, and how windows near the coast become encrusted with it in stormy weather. Moving air, like moving water, can carry weight; and it is thus, through the action of moving air, and not through the heat of the sun, that we have our health-giving breezes off the sea, laden with salt.

CHAPTER III.

EARTH'S VAST OCEAN

"Thou great strong sea."—AUBERON HERBERT.

"Drop by drop He counts
The flood of Ocean as it mounts."—C. ROSSETTI.

IN these days we know the Ocean as one vast whole. Not like our early forefathers, standing on the brink, to gaze with awe-stricken eyes into mysterious distances, and to speculate upon the unknown.

Minor oceans do exist, certainly. We have the Atlantic, North and South; the Pacific, North and South; the Arctic, the Antarctic, and the Indian. Yet for us there is but one great world-wide OCEAN, encircling the Earth, every part being in connection with every other part.

A drop of water which to-day floats in southern seas may, months or years hence, have found its way by currents into the far north. A speck of ice, at this moment fast in the rigid embrace of polar berg or floe, may, months or years hence, be washing to and fro in tropical waters.

A much greater area of water than of land is found upon the Earth's surface. So vast is the amount of the former that, if the whole had to be put into separate vessels, each vessel being one cubic mile in size, the number of such vessels required would amount to no less than *three hundred and thirty-five millions*. This very large order speaks for itself.

The outer Crust of our Earth, taking land and sea together, may be divided into three distinct parts. Like most such divisions in Nature, the one is often found to glide by gentle stages into another.

We have, first, Land, rising above the sea-level, and consisting of plains, undulations, hills, mountains. It covers altogether less than one-third of the Earth's surface, and it is called The Continental Area, though Islands as well as Continents belong to it.

We have, secondly, the Ocean-floor under deeper parts of the Ocean; that which lies beyond a depth of about two miles. This division has been described as the "great submerged plain," and it comprises about one-half of the Earth's surface. It is known as The Abysmal Area.

We have, thirdly, a middle region, which may be spoken of as a kind of borderland under the sea, connecting the dry land with the greater ocean-depths. It amounts to about one-sixth of the Earth's surface, and it has been named The Transitional Area.

By "connecting" the two, I do not mean that it must always be between the two. It does very generally so lie, but there are exceptions. Some deeper portions of the sea are close to land, and some parts of the Transitional Area are found far out at sea.

The meaning of the word "Continental" needs no explanation; and the very word "Abysmal" carries its own sense. More, however, will be said in future chapters about those reaches of ocean known as the "Transitional Area."

A curious law seems to have governed the grouping of land and water. Putting aside innumerable small islands, scattered about, we find that the great mass of land clusters towards and round the north pole, with a water-and-ice-filled hollow for its centre. While, on the contrary, the greater mass of water may be said to cluster towards and round the south pole, with—so far as we can conjecture—a large extent of land for its centre. The conditions of north and south thus seem to be exactly reversed.

Not long ago it was believed that the ocean's floor might be a fairly close imitation of that which we see on land. The differences, however, have been found to be greater than was expected. Perhaps it is not surprising, when one thinks of the immense levelling power of water.

That must be a firm make of rock which can permanently resist the effect of sea waves breaking upon or near the shore. And even deeper down, where waves are not and currents may be slow, some movement must still exist, since the ocean is nowhere quite stagnant. Such movements, no matter how gentle, would tend to shift all loose and soft substances.

The ocean-bed is held to be generally flat, though with gradual slopes here and there, leading up or down to higher or lower levels. Many submarine mountains rear their heads, sometimes near the surface, sometimes above it. In places high mountain-ridges run for a long distance below the sea, with profound depths on either side; and these again often show their peaks, forming groups of islands.

Broad reaches of the ocean are between two and three miles deep, and here and there spots are found where the sounding-line goes sheer down three miles, four miles, five miles, even six miles, before touching bottom. These greater depressions have been named "Deeps."

At least fifteen of them are known in the Atlantic, and twenty-four in the Pacific; many of the latter lying close to islands. Some are long in shape, some short; some are broad, some narrow. One of the most profound, and almost the only one known to exceed five thousand fathoms, lies towards the south-east of the Friendly Islands. A depth there has been found five hundred and thirty feet beyond five geographical miles; and five geographical miles are equal to almost six of our common miles.

For a good while the notion was entertained that, probably, the loftiest mountain-peak on land, and the deepest depth in the ocean, would about match one another, reckoned from the sea-level. But this particular "deep" in the Pacific sinks two thousand feet lower than the topmost peak on Earth rises. Mount Everest, in the Himalayas, is twenty-nine thousand feet high; and this ocean-depth is about thirty-one thousand feet deep. Only one other equal to it has yet been discovered.

No abyss divides England from France. The "silver streak," though sufficient for purposes of defence, is comparatively shallow. All West Europe, indeed, rises from a plateau, reaching from Norway into the Atlantic, on no part of which is the water more than six hundred feet in depth. The "transitional area" in this case makes a true stepping-stone or ledge between dry land and ocean's abyss.

But another great plateau in the Atlantic, which may be called the "backbone" of that Ocean, is far from land, running roughly from north to south. It follows the outlines of the eastern and western shores, and rises often to within a mile and a half of the surface. On either side of the "backbone," which seems to be largely volcanic, is a deep trough, lying north and south, and varying in depth from two to four miles. This plateau unites Europe with Iceland; and it forms a bond between the Islands of the Azores, Ascension, and Tristan D'Acunha.

If by any means the whole ocean-surface could be lowered six hundred feet, remarkable results would be seen.

At once the British Isles would cease to be Islands. They would become a part of the Continent of Europe, joined thereto by dry land. The Hebrides, the Orkneys, the Shetlands, would share in this change. The Continents of Asia and North America would be united at the Behring Straits; Ceylon would find itself a part of India; Papua and Tasmania would be one with Australia; and all places hitherto on the coasts of different countries would find themselves six hundred feet above the sea.

Such a change in the position of the British Isles, transforming them into a Continental Country, would mean far-reaching consequences to ourselves as a People. One such consequence may be briefly given in the words of a recent newspaper article: "Dry up the Atlantic to the 100-fathom line, and in six months we should bear the load of Conscription as cheerfully and more efficiently than any nation in Europe."

Suppose that another great fall in the ocean-surface could follow. Not this time to six hundred feet, but to three thousand feet, below its present level. The resulting alterations would be still more sweeping. Not only Iceland and the Färoe Islands, but Greenland also—and not only Greenland, but the Continent of North America itself—would become one with the Continent of Europe, no longer cut off from the Old World.

A word as to measurements. Two kinds of

"miles" have been mentioned. There is the ordinary "Statute mile," used in common conversation, which is 880 fathoms, or 1,760 yards, in length. There is also the "Geographical" or "Nautical" mile—the "knot" of our Navy—which is 1,013 fathoms or 2,026 yards in length.

The difference between the two is not far from one-eighth of a statute mile. Roughly, seven miles are equal to six knots. A fathom is six feet or two yards.

CHAPTER IV.

SUBJECT TO LAW

"THOU rulest the raging of the Sea."—PSALM lxxxix. 9.

"Nothing useless is or low,
Each thing in its place is best,
And what seems but idle show
Strengthens and supports the rest."—LONGFELLOW.

THINGS are what they are in this world very largely because of the pull of opposing forces, and among such forces not one is more universal than that of Gravity. Many causes beside Weight have their share in making our Earth what it is; but if Weight were banished from our midst, the Earth as we know it would exist no longer.

The only way to get rid of weight would be by getting rid of Gravity. And since no force in Nature acts more steadily and incessantly than this, we are no more likely to get rid of it than we are to get rid of the world itself.

Gravity, or Gravitation, or Attraction—it is known by all these names. Sometimes it is called a Law; sometimes a Force. Neither term may be counted amiss. No law is worth anything without a sufficient force to back it up; and no force is worth anything unless it acts according to law. But we might almost as reasonably call this behaviour of things "an Obedience" as "a Law."

Each particle of each substance draws and is drawn by each other particle of every substance. And each body in the Universe, from a grain of sand to a sun, draws and is drawn by each other body, whether far or near. All these drawings are in obedience to that mysterious something—that force, or power, or influence—which has been named Attraction or Gravitation. So much we know; and beyond it we know very little as to the nature of the said "Attraction;" but we find that the outcome of it is Weight.

By means of weight, the sun, the moon, the planets, yes, and even the countless multitudes of stars, are kept in their paths; in each case the inward pulling being counterbalanced by the impetus and outward pulling of a rapid rush. By means of weight, houses, rocks, stones rest firmly on the earth; by means of weight, the atmosphere is bound to the earth, the Ocean to its bed. Had sea-water no weight it might be scattered as fine water-dust through Space.

A larger and heavier Earth would bind down the ocean yet more strongly, while a smaller and lighter Earth would have a weaker grip. Easily as the sea is now stirred by every passing breeze, an ocean such as ours on a little world like the Moon or Mercury would be more rapidly agitated. The waves would leap higher with less cause.

So the Ocean, like the Land, is subject to law, knowing neither repose nor action except in obedience to Nature's forces.

When ocean-waters lie still as a mill-pond, they do so through an exact *poise* of contending powers. When waves rush high and currents pour strongly, each movement is still in strict obedience to governing forces, which are themselves governed by law. Each movement is due to a long series of past movements; and each in turn helps to bring about a long series of future movements. There are no breaks in the chain. Every effect is also a cause.

Currents here and drifts there; breezes here and hurricanes there; all these disturb the calm of the sea. Only for a brief spell, in one part or another, is the pull of opposing forces so far balanced that the water can lie still. And at most the stillness is comparative. Even in a so-called "dead calm" gentle heavings to and fro will be found. Absolute placidity in the ocean is a thing unknown.

Even when the waters are at their stillest they are always being drawn steadily towards Earth's centre. A perfectly level ocean would mean each portion of its surface being equally distant from that centre. The ocean ever strives after this ideal, but never attains to it; yet, century after century that aim is pursued, with a perseverance which might afford a lesson to ourselves.

Despite all this change and restlessness, we talk of the ocean having a "level" surface. We picture it to our minds as being in outer shape the same as that of the Earth—a sphere. But this is not strictly true to fact.

If we could look upon the Earth, with large far-seeing eyes, from a few thousands of miles off, we should find curious irregularities in the watery outline. Instead of showing all round a smooth surface, the ocean would be found to rise here and sink there, to be in one part higher, in another part lower. A man roving over the ocean, all about the Earth, would have in places to ascend undulations like hills, almost high enough sometimes to be called mountains, in other parts to descend declivities.

Most of us have noticed in a cup filled with water, that the water-surface is not perfectly flat. Close to the sides of the cup may be noticed a distinct rise. It is the same in a tumbler, in a basin, in a slender glass tube. For the sides of the cup or tumbler or tube attract the water, drawing it upward; and this is known as Capillary Attraction.

With the ocean the very same thing is seen. If high land borders on deep water, the extra attraction of mountain-masses will act just as the sides of a cup or tumbler will act. They draw upward the water of the ocean to a higher level. When I say that this is "seen," I do not mean that any careless looker-on will be aware of the fact. It has to be discovered by careful measurement.

In some cases a marked difference has been found. The enormous masses of the Himalayas, for instance, exert a powerful drawing upon the neighbouring sea; and at the delta of the Indus the ocean-level, in consequence of that attraction, is actually three hundred feet higher than on the coast of Ceylon.

Besides land attraction, winds have an extraordinary power to heap up waters in one place more than in another. To some slight extent this may be seen upon English shores, when a strong gale happens to blow landward at high tide. On such occasions the waters often rise far beyond their usual mark.

Mention was made earlier of those Phenicians who, having known an eastern ocean with tides, and a Mediterranean Sea without tides, must have been perplexed to find a western ocean which corresponded with the eastern in its ebb and flow.

We all know for ourselves in these later days, how the tides rise and fall around our coast, twice in twenty-four hours. Each high-water is twelve hours and twenty-five minutes later than the last; so each succeeding day sees a difference of fifty minutes in the time of high or of low tide.

To a very large extent Tides are due to the attractive power of the moon. They are due also to the sun, but in a much less degree, which at first sight seems singular, since the attraction of the sun, by reason of its greater size, far exceeds that of the moon. From the fact, however, that the powerful drawing of the sun comes from an immense distance, it follows that it has much less effect than the small attraction of the moon, which comes from very near at hand.

Her influence over our earth is exerted far more strongly with respect to those ocean-waters lying just under herself, and far less with respect to those waters on the farther side of the globe. The effect of these different pullings is to raise a double wave or swell,—one on the surface of the ocean just below the moon, and one on the opposite side of the earth. The waves mean high tides; and low tides occur at places half-way between them.

Were the whole Earth covered by one continuous sheet of water, these tidal waves would travel round and round the globe, in a fashion easy and pleasant for students of the subject. Unfortunately for the said students, their motions are very complicated. In the northern hemisphere, where land is abundant, the tidal waves are greatly interfered with by continents and islands. Often the most that each can do, as it sweeps along, is to send side-waves and currents journeying northward into channels and bays, estuaries and lesser seas.

Through the open ocean the tidal wave has no great height. Probably in central regions of the Pacific it rises only some three or four feet above the usual sea-level. But when the flow enters narrowing bays and channels, a very different result is seen; and the waters are often piled up in a wonderful manner,—as in the Bristol Channel, where the level at high tide is sometimes nearly forty feet above that at low tide.

A marked contrast to this is seen in the Mediterranean. There, as already said, practically no tides exist. The rise and fall amount at most to only a few inches. Instead of a wide entrance and a narrowing estuary, we have just the opposite — a narrow entrance and a widening sea beyond. Connection with the outside ocean is too restricted to admit of any full flow of the tidal wave.

Solar tides, or tides brought about by the sun's attraction, are much the same in cause and effect as lunar tides, only far smaller in degree. When Sun and Moon happen to be on the same side of the Earth, or on different sides but in the same line, so that their combined pull is exerted in one direction, we have Spring Tides. These are always at the time of New Moon and Full Moon. Sun and Moon then work together, each helping the other in a common aim; and the

BORE OF THE TSIEN TANG KIANG

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ocean-waters rise higher and sink lower than at other times.

When Sun and Moon are so placed with regard to the Earth, that they exercise their pull in a cross direction, Neap Tides result,—that is tides which have small ebb and flow. In this case the sun hinders instead of helping the moon, and the moon does the same for the sun, each tending to counteract the work of the other.

Connected with and partly caused by the rise of the tide is the curious phenomenon known as a "Bore"—a single high wave, moving onward like a wall of water, with great rapidity and a roaring noise. More usually this belongs to a river, and thus it has not much connection with the subject of the ocean; but it is also sometimes seen in sharply narrowing estuaries or ocean inlets.

To the inhabitants of a flat and unprotected country, bordering on river or estuary, the bore is often a thing of terror, for its advent is uncertain and abrupt, and in its upward rush it sweeps everything before it. The entering of such a wave into the Severn is an almost daily event, and it reaches often a height of many feet. Bores are usual, too, in the River St. Lawrence, in the Hoogly, in an estuary of the Bay of Fundy, and in other places innumerable; and they vary in height from two or three feet to over twelve feet. The effect of such a wall of water as this, deluging low lands, carrying away trees and houses and living creatures, may be easily imagined.

CHAPTER V.

IN OCEAN DEPTHS

"My soul is full of longing
For the secret of the Sea."—LONGFELLOW.

"Of the old Sea some reverential fear
Is with me."—WORDSWORTH.

THROUGH ages of the world's history, man knew nothing of the Ocean beyond its surface.

He could sail on the sea; he could bathe in the shallow waters near land. If a good swimmer, he might go farther out, and might even dive for one or two minutes out of sight. In more recent times, with the help of a diving-bell, he could descend thirty or forty feet; and in a diving-dress he might even, if experienced, get from one to two hundred feet down.

But that was all. Of the vast depths beyond he was sublimely ignorant. He did not so much as know of their existence. Until the late scientific expedition made in the vessel *Challenger*, that great world of the Under-Ocean was swathed in mystery.

Nothing is known of it now by direct personal observation. No living man may penetrate those depths. The only mode in which we can learn what is, what lives, what happens there, is by means of "soundings," by sending down and drawing up specially prepared instruments, the reading of which gives us information about that Under-world.

Soundings made in earlier times did little more than tell navigators how deep the sea thereabout might be. Such instruments as were then used could neither work beyond a limited depth, nor say their say with accuracy.

Of late years immense improvements have taken place, both in the make of the machines employed, and in the methods of working them. Past soundings were few and unsystematic; whereas now they are many and by rule. Thermometers have been made which bring up from the bottom of the sea reports of the prevailing heat or cold, moving unaffected through warm or cold layers between. Specimens of the materials which lie on the ocean-floor have been brought to light, and analysed. Living creatures in great numbers have been hauled from their own domains, examined and classified.

All this means progress. And though, no doubt, fifty or a hundred years hence, that which we now know will be looked upon as the barest A B C of the science, still our knowledge is growing year by year. The Under-Ocean is no longer a vague fairy-land of possible mermaids, or a waste region of death.

A region of death in one sense it is and must be. All living creatures that die in the sea, unless devoured by other creatures, sink to the bottom, there to find a tomb. Covered at first by a vast winding-sheet of water, they may be slowly buried under the shifting mud and sand. But in this sense the whole Crust of Earth may be called one vast sepulchre, wherein all animals that die are entombed.

People are slow to realise how modern is our knowledge of ocean-depths. About three hundred years ago a famous navigator made the first sounding which went below two hundred fathoms —that is, about one hundred feet deeper than the height of Beachy Head from the shore. He at once decided that, by a happy chance, he had alighted upon the uttermost depth in the ocean.

To him it was an awe-inspiring profundity. Yet, when viewed beside such abysses as have been recently discovered, depths of five and six miles, his little "deep" was as a saucer beside a lake.

It is not easy to picture to ourselves the changeless calm of those abysses—those five or six miles of under-water, with nothing from sea-level to sea-floor to break the dead monotony.

Throughout such regions storms, no matter how terrible, have no power. Winds cannot reach them. When Ocean's surface is lashed by a hurricane into wild commotion, that commotion is superficial. It means a furious stirring and flurry of upper layers ; and it means no more.

If at the height of some fierce tornado, a sailor could leave his tossing straining ship, and could dive far into the sea, keeping breath and sense and life, he would soon quit the turmoil, and would find himself in a scene of deep repose. Strange to say, the idea of submarine ships actually doing this has been mooted, as one of the new projects in the beginning of the Twentieth Century.

Wave-motion does not descend much below the surface. It is believed that the depth of water affected by a wave is usually about equal to the space which divides crest from crest. So, if we are looking at little ripples, flowing one after another, with crests perhaps one foot apart, we may suppose that the water is disturbed by those ripples to a depth of about one foot. Or, if we are watching larger waves, with crests twenty feet apart, we may suppose the disturbance to reach down to a depth of some twenty feet. And if our gaze is fixed on dignified Atlantic rollers, with crests six or eight hundred feet apart, we may suppose that the sea is affected to a depth of six or eight hundred feet—less and less affected the deeper we go down.

Six or eight hundred feet, compared with six miles, are hardly more than a man's skin compared with his body. And beyond the shallow depths where wind and wave have sway, we come to a region of profound calm.

This repose does not mean stagnation. Ocean's waters are ever on the move, travelling this way and that way. Currents exist far below, as well as at the surface; but they are generally slow and placid, not rough and hurrying. Old Ocean's excitability lies all outside. Superficially he is soon upset; but deep down he is composed.

A great deal of discussion has taken place as to possibilities of Light in those depths. Are they black with midnight darkness? or do faint glimmers of daylight creep through?

Ocean-water, like other water, is transparent. Any substance is transparent, when thin enough, —even gold. A very thin film of water is not, however, needed for transparency. Many feet, even many yards, may be seen through, if clear and pure. Few of us have not, at one time or another, looked down from a boat, to see golden sand, variegated pebbles, small fishes swimming about, at a considerable depth.

Thus with water, as with denser materials, transparency is merely a question of thickness. As the thickness increases, more and more rays of sunlight are taken captive, and the water becomes less and less translucent, till at length, if we could get deep enough, we should find ourselves to be surrounded with blackness.

Another feature of ocean-depths is that of immense pressure.

We bear a certain degree of it in that other and lighter ocean—the Atmosphere. A man of medium size has upon his body about thirty thousand pounds' weight, or some fifteen pounds to the square inch. But this is nothing to what he would have to endure down in ocean-waters. At a depth of one mile, an extra ton would be piled upon each square inch of his body; two miles down, would mean two extra tons on each square inch; three miles down, three extra tons; and so on. The load would soon become intolerable.

For many years scientists maintained that in such depths no life could exist, since no bodies could withstand the awful pressure. Yet we now know that frail jelly-fish, fragile shell-inhabitants, do withstand it, flourishing there by myriads.

Perhaps the fact was somewhat overlooked, that the pressure upon a living creature is not only inwards from without, but also is outwards from within. This is true of ourselves in the ocean of air, breathing air. It is true of creatures in the ocean of water, breathing water.

Much less than the weight of thirty thousand pounds might crush a man flat, were it not for the resisting pressure from within. If for one instant he could empty his body of all inner air and liquids, and could so harden his skin that no air should squeeze through its pores, he would be pressed as flat as a pancake by the surrounding atmosphere.

A story has been told, illustrative of this. Once upon a time a clever fellow started an original idea. He proposed to make a balloon, which should mount skywards, not from being full of hydrogen gas, but from being emptied of air. Being then lighter than the atmosphere, it would, he said, of course rise.

So far as the reasoning went, it was faultless. It only did not go far enough.

The balloon being made, he named a day for its ascent, and asked many friends to witness his triumph. At the last moment, all air was withdrawn; and everybody waited in expectation, hoping to see the novel balloon skim lightly above their heads.

But the inventor, while using strong materials, had failed to make full allowance for the tremendous pressure of the air, when counteractive pressure from within should have been done away with. As the air was drawn out, the sides of the balloon collapsed, being crushed together as an empty egg-shell may be smashed in a boy's hand. Instead of soaring gaily upward, the would-be aeronaut stood on earth, scanning with disappointed eyes a flattened and useless shell.

A diver going down into the sea has a much increased weight upon his body; but he does not suffer from it to a serious extent, provided that he is not raised or lowered too fast. Much depends upon this. Both men and beasts can endure a good deal of alteration in the degree of pressure, whether from air or from water; but they cannot bear very abrupt changes. Hearts and lungs need time for growing accustomed to a fresh condition. In early days of diving this was not understood, and some divers lost their lives through being too hurriedly hauled up.

The same has been noticed in animals brought quickly from great depths. They have been constantly found in the net or trawl, dying or dead, their bodies swollen and even bursting from the lessening of pressure. It was natural that at first the belief should arise of Life being in those parts impossible. Now we know that animals die in the act of being drawn up, and that they live and flourish in profound depths, unaffected by the vast load of water.

The weight that a man can endure is not to be compared with what fragile sea-creatures thrive under. Beyond a depth of some two hundred feet or more, the pressure becomes too great for any human beings; yet animals are found at depths of three or four miles. But the fact that man breathes air, and that animals in the sea breathe, in a sense, water, makes an enormous difference in their power to resist pressure.

One might suppose that the terrific weight of miles of water would squeeze lower layers to a smaller bulk. Water is, however, very difficult to compress; unlike air.

At the bottom of the sea, four or five miles deep, the weight is said to be equal to about four tons upon the square inch. If this tremendous load were pressing upon a mass of air, eleven thousand cubic feet in quantity, the whole would be crushed together into only twenty-two cubic feet. But the same weight pressing upon the same quantity of sea-water, would merely reduce its size to ten thousand cubic feet. So there is not much difference between the make of sea-water near the surface and sea-water at a great depth.

Not only are ocean's depths calm and free from storms; not only are they black with midnight darkness; not only are they heavy with the weight of miles of water overhead; but also for the most part they are cold.

Changes from season to season, like changes of weather, are superficial. At a depth of about six hundred feet, Seasons have ceased to be. There, summer and winter, autumn and spring, exist no longer. The dead level of calm and darkness is also a dead level of uniform weather and unalterable climate. Where changes of cold and heat do come about, they are very uncertain, and usually they are due to other causes than those which bring about the succession of seasons upon Earth.

Many remarkable facts have lately come to light with respect to Ocean's temperatures. In far northern and far southern regions, near the two poles, the whole sea is very cold. One might expect the converse of this in tropical regions—a whole sea intensely warm. But this we do not find. The shallower parts—those included in the hundred-fathom limit—may be nearly as warm below as above. When, however, deep-sea soundings are made, when the registering thermometer is despatched on its mission of inquiry miles below the surface, then the report brought up is generally of great cold.

In almost all deeper parts, the tale is told of a frigid under-layer,—of water nearly and sometimes quite down to the freezing-point of fresh water. This, not only in Polar Seas, not only in Temperate Oceans, but in the hottest portions of the Tropics. The Atlantic, near the equator, is icy in its depths.

A reckoning has been made that, if the floor of the whole ocean, omitting shallower parts, could be divided into one hundred equal portions, ninety-two of those portions would be found covered by water at a temperature of less than 40°; and only eight of them would lie under warm water. The vast mass of the ocean is cold, with a thin warm layer over certain districts.

Little doubt can there be that this under-layer is largely fed from polar regions.

We know that cold ocean-rivers pour from north-polar regions to the south, both in the Atlantic and in the Pacific. A general creeping under-flow of icy waters towards the equator evidently balances the general surface drift of warm waters towards the poles. Since cold water is heavier than warm, it would naturally find its way to lower depths, leaving the warm light liquid to float on the top.

In the Mediterranean Sea a marked contrast is found. There no ice-cold layer is spread over the bottom; and the water in its uttermost depths —over two miles and a quarter—does not sink below the temperature of 54° F. The heat of the sun in South Europe can hardly be compared with the heat of the sun over the Indian Ocean. Yet the latter has water far below the surface down to at least 35°.

Practically the Mediterranean, despite its depth, may be looked upon as an inland sea. The one opening which connects it with the open ocean is not only comparatively narrow, but also is shallow, being less than two hundred fathoms deep. The water on this dividing ridge remains at about 55°, and the Mediterranean throughout, to its greatest depths, keeps to about that same degree of warmth. No entrance is afforded to the heavy cold currents from polar regions.

The Red Sea is separated from the Indian Ocean by a similar ridge, and the same result is seen there. Over the floor of the Indian Ocean lies a carpet of chill water. But the whole body of the Red Sea never sinks, in summer or winter, below 70° F. Here, too, the cold streams are not able to surmount the barrier.

In many deep mid-ocean hollows, cut off by surrounding sub-ocean walls of rock, the same is found again—warm water within the hollow, cold water on the ocean-bed outside.

CHAPTER VI.

RIVERS IN THE SEA

"Sinuous or straight, now rapid and now slow."—COWPER.

"As winds that coerce the sea."—C. G. ROSSETTI.

ACTUAL Rivers in the Ocean; distinct streams of water, flowing over a bed of water, with banks of water. Not merely one or two such rivers, but scores of them, hundreds of them, great and small, in all parts of the world.

Chief perhaps in importance is the Gulf Stream, that vast flood which pours out of the Gulf of Mexico, and acts as a winter heating apparatus for the west of Europe. Though by no means the largest of ocean streams, it is one of the most useful to man.

After quitting the Gulf, it hurries at speed through the Straits of Florida; then spreads out into a river, about fifty miles wide and over two thousand feet deep, journeying at a rate of some sixty miles in twelve hours.

For a while it hugs the American coast; but, happily for Europe, it forsakes this friend of its youth, and wanders to the north-eastward across the Atlantic.

To call it a "river" is no mere fiction of speech. Near Halifax the separation between warm and cold water is so sharp, that those on board a ship may know what latitude they have reached, on entering or leaving the stream, by simply dipping a bucket in the water and taking the temperature. Literally the Gulf Stream is a warm river, flowing over a bed of cold water, with cold-water banks.

So far as Cape Hatteras the stream clings to its early friend; and after that the American coast knows it no more, being left to the mercies of a very different acquaintance. An icy stream flows southward from the far north, clinging to the coast of North America, while we in western Europe benefit by the presence of the warm current which travels over to us. This stream has been described as forming a "cold wall" to the mild Gulf Stream.

Fan-like, the Gulf Stream spreads as it journeys, growing gradually wider and wider, shallower and shallower, cooler and cooler—yet the last so slowly that, even off the coast of

Scotland, water nine hundred fathoms deep is found to be at 40° F.

How strongly this mass of warm water affects the air above it is well known to sailors. When passing from the stream to the outside ocean, or from the ocean to the stream, they often change in a few hours from a warm to a cool or from a cool to a warm climate. The atmosphere is ever ready to tune its mood sympathetically to that of the ocean over which it sweeps.

We know well in Great Britain that our soft south-west breezes seldom fail to bring us warmth; though we do not always remember the debt that we owe to our friend the Gulf Stream.

But for the immense stores of heat carried northward, and given over to us, our Island climate would be different indeed from what it now is. That is why our fellow-subjects in eastern and central Canada, living no farther from the equator than we do ourselves, suffer from an intensity of cold in winter which we never endure. It is difficult to realise that parts of ice-bound Labrador and of Canada, where the thermometer often drops to 40° below zero, are no farther north than London and Paris; while

Newfoundland lies actually more to the south than Erin's green Isle.

Turning to the Pacific Ocean, we find there a corresponding river, again flowing to the north-east. Just as the Gulf Stream wanders across the Atlantic, so this river wanders over the Pacific, carrying stores of tropical warmth to opposite coasts. At its quickest, it is less rapid than the Gulf Stream, and about three times as wide. It too, as it journeys, becomes gradually broader, shallower, slower, colder.

This "Kuro Sivo" or "Black Stream," so named from its dark colour, flows outside Japan, and then strikes freely for the northern coasts of North America. And because of its work as a winter heating apparatus in Alaska, the humming bird is found at a latitude which, on the other side of the American Continent, means, not the play and whirr of humming-birds in a soft air, but the disporting of walruses among ice-floes.

As in the Atlantic, so in the Pacific, the warm northward-travelling current is balanced by a cold southward-travelling current. The Arctic stream of the Pacific is not so marked as that of the Atlantic, perhaps partly because of the much shallower outlet from the Arctic Ocean;

still it is quite chilly enough in its effects upon the Siberian climate. Here again the cold stream acts as a "wall" to the warm river flowing the other way.

More reasons than one may help to explain why these two currents slant off to the eastward instead of pouring due north. The shape of the various coastlines has something to do with it; also the presence of ridges and hollows in the ocean-beds, and the resistance of other contending currents. A river, either on land or in the sea, will always travel where it finds least opposition.

One main cause, however, is the whirl of our Earth upon its axis. This, which greatly affects the directions of prevailing winds, alters also the lines followed by ocean rivers.

A current starting from near the equator for the north shares in the rapid rush of the Earth's surface, which at the equator spins eastward at a rate of about one thousand miles each hour. As the volume of water gets farther north, it reaches parts of the Earth which are whirling more slowly, while it has not lost much of its own eastward whirl. A sideways flow is the result, changing the northward into a north-eastward direction.

But a stream starting from the far north for the south is affected in the opposite way. Near the north pole the Earth's surface hardly moves at all; and the southward-flowing current, being weighted with northern inertia, takes a contrary course to the current flowing north. It lags more and more *behind* the faster-revolving surface, and so wanders westward instead of eastward. Or, if prevented by the land from so doing, it hugs the coast which hinders it.

So the *pull* of the two great streams in the Atlantic is exactly opposed, each to the other. That of the Gulf Stream is towards the east; that of the Labrador Stream is towards the west; and the resolute manner in which the two refuse to mingle may be partly due to this fact.

If our Earth could be made to change the present whirl from west to east, and to revolve instead from east to west, those two great currents would alter their directions. The Gulf Stream would hug the American coasts, and the Labrador would find its way over to Europe. Then the British Isles in winter would know a temperature of 30° or 40° below zero, and the Canadians would experience soft damp winters and moderate summers. Perhaps they would no more welcome the exchange than we should.

Then, too, the Black Stream would cling to the Asiatic side, transforming the climate of western Siberia, and the cold Arctic river would put a speedy end to humming birds in Alaska. But abundance of ice floes would soon be awaiting the walruses which would have to emigrate from the other side of the continent.

A good deal of discussion has been held as to whether we do truly owe our mildness to the Gulf Stream alone, or whether that Gulf Stream is merely part of a general northward movement of Atlantic waters from the tropics towards the pole. The question has been warmly contested; and no doubt on both sides, as generally is the case, truth has been mixed with error.

The Gulf Stream cannot be viewed as a separate entity. Its very birth in the Gulf of Mexico depends on a great mass of water ever flowing from the south-east into the Caribbean Sea. Since so much water pours in, the same volume must pour out, and as it does so it gains the name of the "Gulf Stream."

But after quitting the Gulf of Mexico the stream does not exist alone. It becomes a leading part of the North Atlantic circulation. The whole surface of that ocean is slowly turning round and round—"whirling as if stirred in the direction of the hands of a watch,"* and the Gulf Stream occupies one side or more of the vast *maelström.* In the centre of this revolving mass of water lies a district where the motion is slight, and at that centre floats an enormous collection of drift and seaweed called the Sargasso Sea.

Suppose we pour some water in a large basin, drop into it a handful of small leaves and chips, and make the whole spin gently with one hand. We shall then see how the chips and leaves will collect at the centre, and will float there, almost stationary. That is what happens, on a large scale, in the North Atlantic Ocean.

Other Oceans also have this steady circular movement, not of the whole body of water, but of the surface-water, down to a greater or less depth—precisely how deep one cannot say; it lessens gradually with increasing depth. The same is found also in the South Atlantic,

* Dr. H. R. Mill.

in the North and South Pacific, and doubtless in the Indian Ocean.

To find its direction in any part, one need only lay a watch, face upwards, upon a map of the North Atlantic or the North Pacific. In both cases the water travels round *with* the watch-hands. In the South Atlantic and the South Pacific the flow is just in the opposite direction.

So both the Gulf Stream and the Black Stream are merely parts of a big oceanic whirlpool. Each ocean on Earth has its own system of circulation; and that system is part of a world-wide system. The waters are in perpetual and complicated motion. Streams pour incessantly hither and thither, to north and south, to east and west.

Two vast streams, known as the Equatorial Currents, nominally pour round the world, but really are best seen in the open Pacific, where for long distances no land meddles with their career. They flow steadily westward, one to the north and one to the south of the equator.

Between them flows a reverse stream, called the "Equatorial Counter Current." If a certain amount of water travels north, an equal quantity must travel south. Or if, as in this case, so much water runs in a westerly direction, a corresponding amount has to run in an easterly direction. Water may be marvellously piled up here or there, by influences of land or of wind, but it cannot remain piled up, without efforts on the part of the ocean to restore the equilibrium.

Were the whole Earth covered by a single unbroken sheet of water, these drift currents might circle round and round the globe for ever, undisturbed in their working. But the Earth has lands as well as oceans; and when a current strikes a coast its course is altered, part at least being turned in a fresh direction.

Much discussion has taken place about the causes which bring these great Drift Currents into being.

Disturbing elements, many in number, may have had a hand in the matter. So soon as one part of the sea-surface becomes warmer than another part, movements are set going; the heavy cold water sinks, the light warm water rises, and streams are started from the one place to the other. There are also countless rivers pouring into the ocean, each helping to upset its equilibrium. Heavy downpours of rain raise the level of the sea here or there, inducing more currents.

But these are lesser causes. It is now recognised, as a fact beyond question, that the main power in starting and sustaining ocean-currents is that of Wind.

CHAPTER VII.

OF WIND AND WATER

"He commandeth and raiseth the stormy wind, which lifteth up the waves thereof."—PSALM cvii. 20.

"Measure me a measure of wind."—2 ESDRAS.

OVER the great Deep of blue water lies the greater Deep of blue air. And between these two—the Ocean of Air and the Ocean of Water, both dragged earthward by the perpetual pull of gravitation—endless intercourse takes place. Each finds its way in small fragments into the other. There is always water present in the air. There is always air present in the water.

Perhaps the latter fact is not so widely recognised as the former; yet it is equally true. Sea-water contains large supplies of dissolved gases, absorbed by the ocean-surface from the atmosphere, and passed on into lower depths, for the use of creatures living there.

But the presence of water in air is known to us all. When we casually remark, "What a damp day it is!" we mean, "What an amount of water to-day is in the atmosphere!"

Water-vapour, drawn up from Ocean's broad bosom, is carried far and wide "on the wings of the wind," to fall as rain where needed; and drying winds in their turn pass over regions where much rain has fallen, to bear away superfluous moisture.

A good deal was said in the last chapter about oceanic currents; and mention was made of Winds as their chief cause.

That the power of wind over water is great, anybody may know who has watched the lashing of the ocean into fury by a gale. But the degree of that power was scarcely grasped, until within the last few years. Rivers and streams in the sea were long ascribed to any cause, except the most weighty of all. No one supposed *the* immense current-producing force to be that of Wind—not of mere local breezes or gales here and there, but of strong constant winds, which prevail month after month over wide ocean-districts.

When a storm-wind pours up a narrowing gulf, where the sea has no outlet, it often piles the water up in an extraordinary manner. Hurricanes have been known to turn the entire Gulf

Stream for a while out of its course, and even to force the waters back so as actually to reverse the current. Once the volume of water, thus checked by a terrific gale, was heaped up some thirty feet above the proper level, which of course caused a fearful deluging of the land.

The above words had not been long written, when papers told us of the awful hurricane of September, 1900, in U.S. Texas. A deep cyclone passed over the devoted town of Galveston, the direction of the wind suddenly changing as the centre of the cyclone went by : and the heaped-up waters from either side coming together poured their united volume over the land.

That was a flood which "turned the city into a raging sea." Buildings were levelled ; houses fell like packs of cards ; vessels were carried miles inland ; men and women and children perished by thousands. When the lessening wind allowed the waters to retire, an inch-deep layer of slime was found over everything.

Such facts as these help to show how vast is the power of moving air over the ocean.

As a strong wind blows, the upper layer of water slips along in obedience to its push ; and fresh lower surfaces are bared to the same influence. Also, the movement of the upper layer tends to drag on the layer just below, which again affects the one lower still. By influence thus exerted and passed from one to another, the result of a long-continued wind-pressure in one direction is to set going powerful streams, which in the first instance were due chiefly or only to wind.

Round the Earth, where fairly open sea permits them to develop, are two wide belts of very persistent winds—the Trades—which remain practically the same all the year round ; only shifting their limits with the changing seasons.

They blow from the north-east and from the south-east slanting towards the equator. So, speaking roughly, they are easterly winds travelling towards the west. As a consequence of their steady pressure, we have the great Equatorial Current of the tropics, pouring from east to west in two halves, north and south of the equator. This vast ocean-river, started and kept going by the trade-winds, has been described in the more important part of its course as a "magnificent surface-current of hot water, four thousand miles long by four hundred and fifty broad," moving "at an average rate of thirty miles a day"—and, it may be added, at least over six hundred feet in depth.

Between the Trade-wind belts is a belt of dead calms, known to sailors as "The Doldrums." This belt divides in two the Equatorial Current; and in it is found the inevitable "Counter Current," mentioned earlier, flowing from west to east.

Another belt of steadfast winds is that of the "Roaring Forties," in the Southern Ocean; a wide stretch of all but landless sea, between 40° and 50° south latitude. These "Brave West Winds," as they are called, being again the reverse of the easterly Trades, blow all the year round, and nearly all the world round, since only the southern extremity of South America interferes with them.

They too give birth to a powerful current, flowing from west to east; and this mighty stream, almost encircling the Earth, has a mission to fulfil.

Already it has been said that each lesser ocean in the world has its own separate circulation-system. This southern stream, with the Roaring Forties for its parent, has for its especial task to unite all those smaller systems into one. It has to refuse to the minor oceans a lonely and self-absorbed policy, and to insist on the great truth of a world-wide Ocean unity. It has to carry gifts from the Pacific to the Atlantic, from the

Atlantic to the Indian, from the Indian to the Pacific again. It has to despatch streams northward into more distant regions, with messages of goodwill to all.

Is this somewhat imaginative? Well, be it so. The facts are scientifically true. Suggested meanings, gathered therefrom, may be accepted or rejected, according to the reader's pleasure.

We see, at all events, that from the vast Drift-Currents of the Ocean, born of the Winds, spring the Grandchildren of the Winds, such powerful rivers as the Gulf Stream and the Black Stream; they in their turn giving birth to an infinite number of lesser currents, Great-grandchildren of the Winds;—one and all taking their share in a world-wide circulation of Ocean-waters.

The southern belt of westerly winds, with its resulting westerly current, would be repeated in the northern hemisphere, but for the presence of great masses of land. Continents work havoc with schemes of ocean circulation.

That westerly winds do greatly prevail in corresponding latitudes to the north is a well-known fact, though we cannot boast the possession of anything like the "Roaring Forties." No broad belts of unchanging air-currents can exist in the neighbourhood of so much land, for the counter-influences are too many.

From steadfast Wind-belts, giving birth to steadfast Ocean-streams, we pass naturally to those fitful storms which lash the ocean into passing passions, and to the uncertain breezes of temperate climes.

There are currents and counter-currents, breezes and contrary breezes, winds from north and south and east and west, over the whole earth. Each separate movement of air helps to stir the waters of the sea into renewed restlessness.

Though few things are more wonderful than those vast rivers of air and water, pouring always in the same direction, century after century, they are perhaps less impressive from a man's point of view than many a mere whirling eddy, which flings itself along, rousing a huge flurry of water, and soon dying out of existence. A man cannot grasp as a whole the Trades or the Roaring Forties, with their companion ocean rivers. Practically he knows only that little portion of each which happens to be near his ship. If he is overtaken by a hurricane, the whole life of which is compressed into a few miles of space and a few hours of time, he feels a greater awe.

Small wonder that he should. Those impetuous and short-lived eddies are terrible in their fury. Their winds blow with a fierceness never approached by the stiffest Trade. A hurricane, tearing over Earth's surface at the rate of one hundred and twenty miles an hour, reduces the most muscular of men to helplessness.

None the less, such a hurricane is in itself a mere accident, a mere passing incident, a mere swirl of air, coming into being to adjust a lost balance, and vanishing so soon as its work is done. We have seen tiny swirls of air dancing along the road, on a windy day, sweeping up bits of straw or dried leaves into their embrace. Such little swirls are hurricanes in miniature. The real thing levels forests, wrecks towns, lashes the ocean into mountainous heights of water, sinks gallant ships, destroys human lives. Yet the little swirl and the hurricane are closely akin.

Only in recent years has the circular—more strictly, the oval—shape of a hurricane become known. It may be described as a revolving eddy of air, the winds pouring in a corkscrew-like fashion round the centre, inwards from without, and upwards from within. Another kind of air-eddy, called an anti-cyclone, gyrates just the other way, downward and outward. This usually brings light winds and dry weather, instead of storms and rain.

One might imagine that in the centre of a wild cyclone a ship could find safety, because there calm reigns. But the furious whirl of winds all around raises tumultuous billows; and towards the centre, although the winds themselves die down, the state of the sea is a perfect "chaos" of tempestuous waves converging from all sides. Sailors strive their utmost to avoid that central chaos.

CHAPTER VIII.

AN OCEAN OF AZURE

"The boom of the waves on the shingle."—LEWIS MORRIS.

"Roll on, thou deep and dark-blue Ocean, roll!"—BYRON.

NOT that the Ocean is always and everywhere blue. In a certain "arm of the sea," the Bristol Channel, it is commonly any tint that you please rather than blue—brown, green, yellow, chocolate, only not the colour that we love. If by chance it dons for a few hours a robe of azure, that robe is merely a passing loan from the sky. And in dull weather it can only be described as a huge puddle of muddy liquid.

People often grow to like best that to which they are accustomed. A lady, who had spent most of her life on the borders of that brown Channel, once assured me that she infinitely preferred it to the "deep blue sea." She had been to stay by the latter, and had found its monotony of tint so uninteresting that she was charmed to get back to her old friend.

Tastes differ, certainly. Not many would agree with her. Yet it is a fact that the great Turner went to the Bristol Channel, with all its mud, for many of his marvellous sea and cloud effects.

"Deeply, darkly, beautifully blue," sang Byron of the ocean, and he sang truly, even though the ocean itself, putting aside the Bristol Channel, is not always and uniformly azure. Near land the tint is often greenish. Sometimes it is pure green. Often it is a pale and watery blue. At other times we have a leaden grey. The genuine ocean-blue, which resembles nothing else on Earth, can seldom be enjoyed till one gets on really deep water, far from land. Or—till one is looking at the Mediterranean.

Why should the sea be blue? And why should the sky be blue? For the matter of that, why should anything be blue? What do we mean by colour?—whether blue or green, red or yellow?

We mean that particular tint—or sensation—which the object in question causes us to see—or feel. The object receives sunlight, and reflects it to our eyes. And since sunlight is white or yellowish-white, one might expect that everything we look upon would appear to us white or yellowish-white.

But everything does not. And the reason is that a ray of sunlight is really a bundle of lesser rays, each of which has its own colour. If a ray of light is made to pass through a prism, these lesser sub-rays are spread out upon wall or floor, always in the same order, from violet at one end to red at the other end. Light is believed to be due to enormous numbers of most minute wavelets; and for each colour the wavelets have a definite but different size. They are smallest at the violet end, and largest at the red end.

Now when a ray of sunlight falls upon anything—leaf or flower, earth or water—some of the sub-rays are absorbed or taken in, and some are rejected or refused admission. A healthy leaf, for instance, absorbs the red, the yellow, the blue, the violet, and refuses the green, which is therefore thrown back from the leaf-surface to our eyes, making it green to us. A ripe tomato absorbs the yellow and green, the blue and violet, and reflects the red. A lump of blacklead absorbs greedily all the rays, reflecting none, and so to our eyes it is black or without colour. The petals of a white rose, on the contrary, absorb so little colour of any kind, that practically the entire ray is sent again to us as white light.

If this is the manner in which the ocean is blue, it means that sea-water, and indeed water generally, must in itself be actually blue, as a cake of ultramarine, a sapphire, a corn-flower, a forget-me-not, are blue.

Could that be the case? For a long while men decisively answered—No. Everybody knew that water was colourless, so the idea was flung aside as impossible. Another explanation came up instead.

The sea is full of fine dust; and it was suggested that, as vast multitudes of these floating dust-particles are exceedingly small, they might be able to reflect only the smaller blue light-waves, and not the larger yellow or the still larger red waves. Thus the sea would naturally seem to be blue.

After much discussion, careful experiments were made. Different objects were lowered to various depths, and the effect upon their colouring was noted. The outcome of these and other tests went far to prove that the old certainty was wrong, and that water is in itself blue.

Somebody may feel inclined to protest. "Water blue! But that is out of the question. I have good sight, and I assure you there isn't the least sign of colour in water. Not the faintest. If you dip a bucket in the sea, you will see for yourself."

Yet all the while the colour may be there, actually existent, though not to be detected by your eyes or mine in a pailful.

A short time ago I had to buy a piece of lace; and my intention was to choose a pale straw or deep cream. The lace was wound in many folds round a large cardboard, and it seemed to be exactly the right hue—a rich yellow-cream, almost butter colour. Without further demur, I ordered about a yard to be cut off.

On reaching home, I found myself in possession of a piece of wide dead-white lace—or all but dead-white. It was actually a very pale cream; and when a great many folds lay one over another the combined effect was rich and yellow. But a single thickness of the material showed no colouring.

The same may be seen with a single piece of very pale blue muslin. It will appear to be white. But yards upon yards of the same, folded together, will become quite a deep blue.

A single thin layer of ocean-water, in like manner, has too faint a hue to be visible to ordinary eyesight. It is only when layers are piled upon layers that the blue becomes distinct; and the deeper the water, the deeper generally will be the colour. Some yards of water-thickness may be said to correspond to a single thickness of lace or muslin.

While, however, we may say with tolerable confidence that the blue of the ocean is a "True Blue," this alone will not explain all the varieties of tinting, seen at different times and in different places.

Sea-water is sometimes a rich profound blue, and sometimes a pale sickly blue. It is sometimes dull, sometimes brilliant. It is sometimes green, and sometimes almost black. For these variations, even while accepting the new explanation, it has been found needful to revert to the old theory in quest of added help. The sea is blue, because it really and truly *is* blue. But that is not all. It is a deeper or less deep blue, a duller or brighter blue, a greenish blue or even a dull yellow, because of the vast supplies of dust floating in it.

The Mediterranean was particularly examined, on account of its remarkable depth and brilliancy of colouring; and it was found to be exceptionally laden with dust, both fine and coarse, brought from land by innumerable rivers, and also pounded by breaking waves on the long surrounding coast-lines.

Such floating particles, at all events the bigger ones, are no longer supposed, as once they were, to reflect only the tiny blue light-waves. On the contrary, they are believed to reflect all the waves of light indiscriminately, whether large or small; while the sea, by virtue of its own power as a Blue material, captures all those reflected waves except the blue, and allows the latter alone to reach our eyes.

Near British shores the water has often a strongly green tint; and this may be due in part to floating particles of sand. The yellow of the sand, combining with the blue of the water, would naturally form green. Possibly also the sea, near shore, is sometimes affected in colour by floating seaweeds, green-tinted.

The blue of the sky is often reflected on the sea-surface, and sometimes so powerfully as to overcome the real ocean-colour. One hardly understands how intense such a sky-reflection may be, until one has watched the whole sea transformed into glowing crimson or gold from a radiant sunset.

Much the same perplexity has been felt about the blue colour of air, as about the blue colour of the ocean; and much the same course of explanation has been followed. Its blueness was long maintained to be due only or mainly to the "scattering of sunlight" by infinite numbers of floating dust-specks, which also serve to account for the golden and crimson tints of sunset. It now appears that oxygen, an important element in the atmosphere, has a faint blue tint of its own, like water, which at least helps to answer for the blue of the air.

We may therefore say of Water that it is believed to be transparently and intrinsically blue; and that its colour, though not actually due to floating specks of dust and other impurities, is a good deal affected by them. Such materials in the Ocean help to modify its colouring, sometimes deepening it, sometimes adding to its brilliance, sometimes deadening its brightness, sometimes turning it green or yellow. Careful observation has also shown that, when water is especially free from dust-specks, it is of a darker and duller hue than when they are present in large quantities to capture and reflect the sunbeams.

CHAPTER IX.

ICE-NEEDLES TO ICE-MOUNTAINS

"In all time,
Calm or convulsed,—in breeze or gale or storm,
Icing the pole, or in the torrid clime
Dark-heaving;—boundless, endless, and sublime—
The image of Eternity,—the throne
Of the Invisible."—BYRON.

SO far most of our thoughts have been given to Earth's milder regions; where, indeed, the warm ocean water is at best but a thin slice laid over vast depths of cold water, yet where, so far as man is concerned, heat has the upper hand. In other parts, far to north and south, the Reign of Frost is a dire reality; and that chill monarch "rules the roost" in a masterful fashion, lording it over land and sea for months together, with none to resist his sway.

Wherever King Frost waves his sceptre, one result always follows. Water changes from a liquid to a solid.

Nor is water the only liquid which so changes.

Quicksilver, known to us usually as a liquid, may be frozen, though not without a greater amount of cold than that which freezes water. Then, again, molten iron — that is, iron made soft through great heat—is a liquid which when cold hardens into a solid. Iron as we most often see it is simply in its frozen state; just as much the frozen form of iron as ice is the frozen form of water.

And the freezing of the two comes about in the same mode. As molten iron cools and hardens it crystallizes. Minute needles, far too minute to be seen, take shape, crossing and re-crossing at various angles, till the whole becomes a solid mass of interlaced iron needles, held in position by attraction. When water changes into ice, the same thing happens. The water-particles shape themselves into tiny needles, and these ice-needles cross and re-cross, till they are knitted into a compact mass, something like the mass of iron needles.

Nor are needles alone found in ice. Exquisite forms resembling ice-flowers are there also, commonly invisible, but composed of ice-needles woven into various shapes, which again are woven into the fabric of the solid ice. So a block of ice may perhaps be said to be formed of ice-flowers, and the ice-flowers to be formed of ice-needles.

Such flowers are of many shapes, but more generally they have six petals each. If a ray of sunlight is thrown upon a slab of ice, through a lens, so as to concentrate the heat, then, as the ice melts, the sparkling of these tiny florets can be seen; and when their magnified image is cast upon a sheet, the six-petalled flowers become clearly visible.

Even more beautiful than the ice-flowers embedded in solid ice are the ice-flowers embedded in snow. They too are made of tiny spicules or needles of ice; and they too, while varying much in shape, are commonly six-petalled.

Solid blocks of ice are at first sight so unlike masses of feathery snow that a child would be surprised to hear a snowflake spoken of as "ice." Yet the difference between the two lies mainly in the arrangement of the little ice-needles, in the way they are put together. Those of hard ice are more densely packed; those of snow are more loosely joined, with open spaces between, full of air. It is the abundance of air, mixed in with ice-needles, catching and reflecting light, which gives to snow its whiteness.

In some cases, however, as with glacier-ice, the texture is so close—like that of glass—that neither flowers nor needles are discernible.

The fact that snow may be, through hard pressure, actually transformed into firm ice—and this is an everyday occurrence in the high Alps—shows how closely akin the two are.

Every country in the world has, at a certain height, that which is called "the line of perpetual snow," or, more briefly, "the snow-line." Below that limit snow may fall in winter, and water may freeze, but both vanish in the summer. Above that limit snow and ice are found all the year round, lessening to some extent in summer months, but never disappearing.

Over the equator the snow-line is about sixteen thousand feet high, or higher than Mont Blanc; so if Mont Blanc were situated on the equator it would not be a snow-clad mountain. At the north and south poles the snow-line is down at the sea-level. Summer warmth there does not suffice to get rid of winter ice and snow. Between the equator and the poles the snow-line varies in each country, according to that country's position and climate.

Above the snow-line on lofty Swiss mountains heavy falls add perpetually to the mass of snow. During the summer a certain degree of thawing goes on, but never anything like enough to balance the wintry additions. Exactly at the snow-line the quantity of snow which falls and the quantity which thaws in the year are about equal. Lower down the yearly thawing exceeds the yearly snowfall.

But if, above that line, more snow is being added year by year than can thaw and flow away, must it not be that those mountains which wear perpetual snow are always growing higher?

It certainly would be so *if* the snow heaped upon those summits had no other outlet, no other means of escape to the Ocean—the goal of all Earth's waters. But another mode of escape is found. Superabundant snow on mountain heights gets away by means of glaciers.

We have had to think about liquid rivers flowing in the ocean, and here are solid rivers flowing on the land. Liquid rivers with liquid banks; solid rivers with solid banks. A curious anomaly in either case.

The higher levels of land are drained by rivers pouring down to lower levels and thence into the sea; and it is the same with the mighty snowfields of Switzerland as with any gentle range of English hills, only here we have rivers of ice instead of rivers of water.

But why not rivers of snow, if a glacier means the draining away of snowfields?

Well, so they are—rivers of snow. But the heavy weight of overlying snow above, and the great pressure of descending masses later, welds the light and delicate snow into hard ice. Those tiny needles, of which the falling snow was made, are crushed closer and closer, till they form a solid block, which loses all resemblance to snow. In summer the melting of the surface by day, and its freezing again by night, help forward this transformation.

Thus a glacier is literally an Ice-River, a huge long tongue of ice, squeezed from beneath snow-fields, and creeping down a valley.

Such rivers vary much in size. Some of the Swiss glaciers are between twenty and thirty miles long, in parts two or three miles wide, and often hundreds of feet deep. Starting above the snow-line they sometimes reach thousands of feet below it, the milder air failing to end their existence sooner. So enormous are the ice-masses, that not all the strength of the summer sun can make away with them. Of course, each square yard in turn does melt, and does help to feed the river of water which rushes away from the lower end of the glacier—sooner or later to reach the ocean.

Switzerland's grandest glaciers dwindle into insignificance beside the enormous ice-rivers of the frozen north. When the "Humboldt Glacier" of Greenland gets to the ocean it is about forty-five miles in width. A generous gift of water indeed, from land to ocean. Another monster glacier ends in a cliff of solid ice, rising in parts to four hundred feet of height. Greenland lies under one unbroken shield of snow and ice; and the weight of this tremendous "ice-cap" presses out numberless rivers of ice from its shores into the sea.

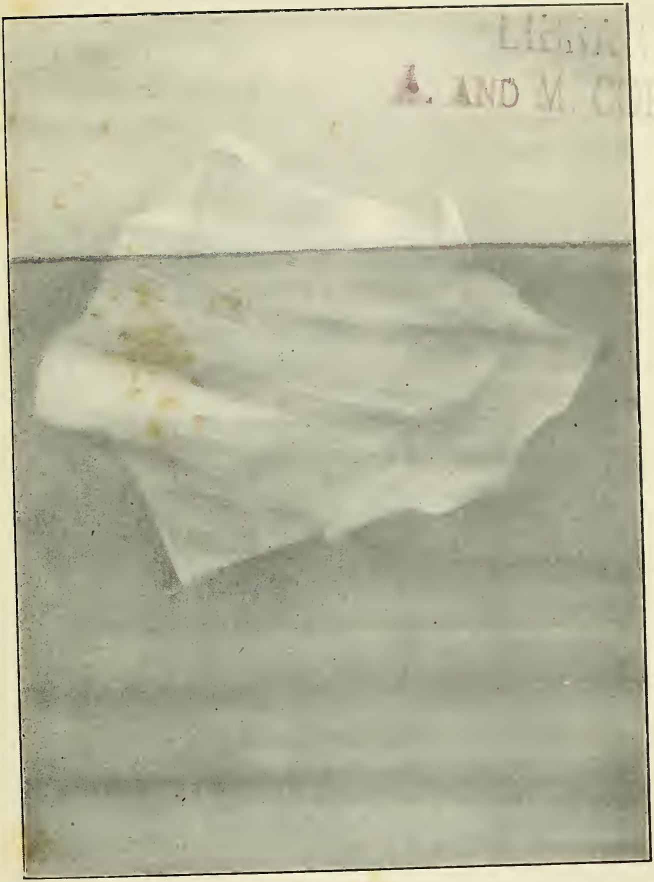
These do not, like Alpine glaciers, end in rivers of water, flowing through milder climates to the ocean. The Greenland glaciers themselves reach the sea, each thrusting an enormous "foot" far into deep water. For a while, as it does so, the glacier-ice holds firmly together in a solid mass, gliding slowly over the ocean-bed, getting deeper and deeper, till only a small part of it shows above the surface.

But ice naturally floats. The upward pressure of the sea becomes increasingly great, fighting against the tenacity of the ice, and in the end old Ocean has the best of the contest. A huge mass of ice snaps off from the glacier-foot and springs to the surface, making the waters seethe and swirl with the shock, and sending heavy waves in all directions. Then the buoyant mass floats away as a newly made Iceberg.

Some Icebergs, broken thus from a Greenland glacier, are two or three hundred feet high. That is to say, a sailor on board a ship can see two or three hundred feet of solid ice above the surface of the sea. But this is by no means the true iceberg height.

When we talk of ice "floating," we do not mean that the whole piece of ice rests upon the top of the water. It floats *in* the water. Only about one-eighth of it is visible above, and the other seven-eighths are hidden below. So in the case of an iceberg rising two or three hundred feet above the sea, we may be sure that at least seven times as much ice is underneath the ocean-surface. This shows what an enormous mass the whole of a floating ice-mountain must be.

No wonder that a certain iceberg, which held its head one hundred and fifty feet high, should have run aground in water five hundred feet deep! No wonder, either, that when two such



AN ICEBERG, SHOWING THE SECTION UNDER WATER

For every cubic foot of ice above water there are seven cubic feet below

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bergs come together, and an unfortunate ship happens to lie between, it should be smashed like an egg-shell. In Baffin's Bay Dr. Kane once counted a pack of two hundred and eighty bergs, most of them being between two and three hundred feet high.

The "birth" of such oceanic hills has been watched by travellers, at the moment of their breaking off from a glacier-foot, with no small interest, and also with no small danger, if they chanced to be within reach of the terrific billows started by such an event.

Sometimes icebergs come into existence differently. If the glacier comes to an end, not in but above the sea, the mass breaks off above with its own weight, and plunges downward, to float away on its new career. This was lately witnessed in far southern seas, and the travellers barely escaped with their lives, so tremendous was the rush of the ocean-wave following the plunge of the new mountain.

A great deal of carrying work is done by icebergs. Many and many a block of stone or rock—not to speak of supplies of gravel and sand and mud—is borne by them to mid-ocean, and there dropped. In the Atlantic they seldom get further south than the neighbourhood of

Newfoundland. As they journey, they slowly weep and trickle out of existence.

In the Antarctic both glaciers and icebergs are abundant. The northern bergs are generally higher and more sharply peaked; the southern bergs of a flatter shape, but much larger and of a deeper blue.

Sea-water does not freeze so quickly as fresh water. On account of the salt which it contains, it does not become solid until it is four degrees colder than fresh water needs to be. The freezing-point of fresh water is 32° F.; that of salt water is 28° F. As ocean-water freezes, most of the salt is separated from it; and the ice formed is practically fresh, though often it holds unfrozen salt water in tiny hollows.

CHAPTER X.

RECEIVING—TO GIVE AGAIN

"O end to which our currents tend,
Inevitable Sea!"—A. H. Clough.

"ALL the rivers run into the sea; yet the sea is not full."

So wrote the wisest of men, long centuries ago; and the words are true in a world-wide sense, which the writer with all his wisdom could not then have fully grasped.

"All the rivers" meant to him a great many streams, large and small, in southern Asia, and in southern Europe, with some in northern Africa. "All the rivers" of the world *now*—— Let us see what it means.

The chief work of a river is to drain the land; to bear superfluous waters into the great deep. Water lying stagnant on land becomes harmful. Immense supplies are perpetually needed; but it must be fresh water, clear water, running water, water newly fallen from the skies, or newly received from ever fresh because ever renewed springs. Never stagnant water.

So Earth's rivers—we are talking of land-rivers now—gathering to themselves the multitude of lesser streams and tributaries, which in their turn have been earlier fed by an infinite number of burns and runnels in country and town, hurry downward to the Ocean, with rich presents from the Land. But all the while, Land expects "to receive as much again."

When we stand beside a broad river, watching the steady flow, hearing the little murmurs of sound and the soft suck and "swish" against the banks, we do not often realise the greatness of the task which that river may have in hand.

Suppose we are on the banks of the Seine, the mother-stream of gay Paris. Many a century has Paris lived; but the Seine existed countless centuries before Paris was ever heard of. Year by year the Seine drains away surplus water from some twenty-three thousand square miles of French territory. Year by year the Seine carries down to the Ocean a gift of more than five cubic miles of water. Five hundred cubic miles in the course of a century!

Or suppose we turn to the Rhine, that river of castles and legends, which starts with the meltings of over one hundred and fifty glaciers, and is said to be fed in its course by something like twelve thousand lesser streams. The Rhine drains, at the very least, between thirty and forty thousand square miles of country; and it pays to the Ocean an annual tribute of more than ten cubic miles of water. More than a thousand cubic miles each hundred years.

Let us take a look at the Yangtsekiang—a Chinese river of special interest for British trade. It drains over six hundred and fifty thousand square miles of land; and each year it hands over to the Ocean more than one hundred and twenty-five cubic miles of water.

See the Mississippi. More than a million square miles of American territory are drained by it; and its annual gift to the Ocean amounts, like that of the great Chinese river, to over one hundred and twenty-five cubic miles of water.

Or once more—take the Amazon. By that mighty stream more than two million square miles of land are drained; and more than five hundred cubic miles of water are poured annually into the sea. So the Amazon presents to the Ocean in the course of a year what the Seine presents in the course of a century.

It has been reckoned that "all the rivers" of

Earth combined pour every year into the sea a mass of water equal to about six thousand five hundred cubic miles. This would suffice to fill a vast tank, one mile broad, one mile deep, reaching the whole way from the north of Scotland to the south of Africa.

"All the rivers run into the sea; yet the sea is not full." It does not overflow its limits. And long ago as King Solomon wrote these words, he was able to give the reason. "*Unto the place from whence the rivers come, thither they return again.*"

The ocean receives these generous gifts from the land, only to be generous in return. That which the ocean freely accepts she gives again, lavishly and royally, Enormous supplies of water are needed on land, and it is the work of the ocean to meet that need.

Throughout the world, and especially within the tropics, a constant drying up of the sea-surface is going on. This passing away of visible water out of sight is, like countless other everyday events, very extraordinary; though we think nothing of it because of its familiarity.

A tumbler of water is spilt upon a boarded floor. "Oh, never mind," says a careless voice. "It will soon dry up." Yes, of course it will;

and who troubles himself to think what the "drying up" means? Particle by particle the spilt water will creep softly away, not as a liquid but as a vapour, into the atmosphere, there to float, hidden from sight, and to be carried hither and thither wherever the air may be moving.

Had such a thing never been seen before, it would arouse the wonderment of every thoughtful mind in Europe. But miracles of daily occurrence cease to be miracles.

Some few solids, such as camphor, have the same property of passing slowly out of sight into the air, though it is a much slower process with camphor than with water. Snow and ice also, when there is no thaw, dry off gradually. I have known a whole slight fall of snow disappear thus, without any thaw.

Vapour is always present in the air; sometimes a large amount, as much as the atmosphere is able at that particular temperature to hold; sometimes a less amount, not so much as the air could contain. In the latter case "drying" goes on briskly; in the former case it languishes, and wet clothes, wet pavements, remain long damp.

Warm air can hide away a much more abundant supply of vapour than cold air; so the hotter and drier the air, the quicker is the evaporation or drying-up of water-surfaces. This is remarkably seen in the Red Sea. An amount of water passes away from that sea in a single year, sufficient to bring down its level some fifteen or twenty feet,—which it would do, but for a powerful current always flowing in from the Indian Ocean.

When sea-water thus passes off in vapour, it leaves the salt behind. Were this amount of evaporation to go on steadily in the Red Sea, without any fresh supplies of water being received, about two thousand years would suffice to dry up the whole Sea, nothing but a great mass of salt remaining in its bed.

If the Red Sea alone loses in one year a slice of water, fifteen or twenty feet thick, imagine what the enormous quantity must be which is raised, year by year, from the surfaces of all tropical oceans, and in a less degree from the seas in colder regions. The weight of the whole could only be told in hundreds of millions of millions of tons. And this vast mass is drawn up, gently and mildly, particle by particle; to be wafted by breezes to regions where water is urgently required, and there to be poured down as rain upon the thirsty ground. Thus the great exchange is carried on, with steady sequence, between Land and Ocean, Ocean and Land.

When showers come to gladden the hearts of our farmers, and to provide food for the people, they might sometimes give a thought to the Ocean—to the manner in which, with Sun and Air as helpers, he sends aloft millions of tons of water, for the use of those on land.

For "unto the place from whence the rivers come, thither they return again."

There are parts of the world where rains, like winds, come at regular and almost unfailing dates. In disappointing years, when they fail, an Empire may be disorganised in consequence.

But in our British Isles no such regularity has sway; and a pleasing uncertainty prevails about Weather in general. This gives scope for something to talk about, and something to grumble at. What the average Briton would do without these perpetual possibilities is a serious question.

No doubt our Weather *is* a very uncertain quantity to be reckoned with. Yet it may be that we are unfair to our friend the Ocean, who does so much for us in the weather-line—ever at work as he is, night and day, sending upward supplies of water, bringing to our shore stores of tropical heat, softening the westerly breezes which excel.

Is English weather really so bad as is popularly supposed? There are climates and climates in the world; some worse, some better. May it not be that ours really is, in many respects, not worse but better? Perhaps a slight digression here will be pardoned, for the sake of Old Ocean's good name, in his dealings with the British Isles.

Foggy days, dull and damp days, are apt to make a more lasting impression upon some people's memories than sunny days. One reason for the generally mournful idea of British weather may be due to the fact that foreigners, Frenchmen especially, are by nature more light-hearted than Englishmen, and that they keep chiefly in mind their sunny days, while we perhaps keep chiefly in mind our dull days.

To gain a fair estimate of average British weather, long and careful observation is necessary. There is absolutely no safe criterion, save that of record-keeping. Not many people have the perseverance to do this for any length of time, and few non-scientific people have the fairness of mind and judgment to do it dependably.

It is in my power to tell of a record which has been kept, steadily, carefully, perseveringly, by an English lady during many years, and to give the results at which she arrived. Without being strictly scientific she was—I have to say "was," since she has passed from our midst—accurate, regular, conscientious, and fair-minded. For all this I can vouch from personal knowledge. At the same time that she kept records of the weather, she registered day by day the readings of her thermometer and the daily amount of rainfall. With the two latter we are not now concerned.

Her method as to weather-registration was as follows. Four marks were used: **X** for a thoroughly fine day; **V** for a day in which fine and dull mingled, but in which the fine predominated; **I** for a day in which again the two mingled, but in which the dull or rain had the best of the matter; and **O** for a day which could only be described as decidedly bad.

Of course many days occur which it is difficult to assign to either class, especially of the two middle divisions. But a constant endeavour was made to keep a fair proportion. If one doubtful day were placed, for instance, in the **V** division, the next equally doubtful day would be carefully placed in the **I** division, to ensure accuracy.

At the end of each month all these four classes were added up separately. Also, to simplify results, the Good and the Half-good, the Bad and the Half-bad, were classed in two columns as comprehensively Good and Bad. From these two columns curious results were obtained.

It should be stated that the lady in question lived at Reigate, and was seldom absent from home, never more than for a few weeks at a time. The record is thus mainly of one place. Now and again a short absence occurred, and her observations were then carried on wherever she might be; but the absences were so few and generally so short as to be unimportant.

Before going farther, it is worth while for the reader to ask himself, perhaps also to ask one or two friends, what might be the proportions of "Good" and "Bad" days that he or they would expect to find in the English climate, as the result of such a computation?

Would it be three-quarters bad and one-quarter good? Or could it be possibly half bad and half good?

Here is the actual result:—

A.D.	Bad Days.	Good Days.
1886	89	276
1887	59	306
1888	85	280
1889	107	258
1890	85	280
1891	91	274
1892	77	288
1893	71	294
1894	109	242
1895	88	277
1896	86	282

If the second column be added up, the sum-total amounts to three thousand and fifty-seven days. If the first column be also added up, the sum-total amounts to nine hundred and forty-seven days. A very simple calculation, which anybody may work out, will show that the proportion of "Good" days towards "Bad" days is that of about Three to One.

Who would have thought it? Not certainly the majority of friends to whom I have appealed for an opinion. Not even an able scientific man, who frankly confessed his astonishment.

Over three-quarters of fairly Good Weather, as opposed to under one-quarter of fairly Bad Weather—and this the average of eleven years!

Have we not given the rein too freely to our National grumbling tendencies? Would it not be better if we thought more of the sunshine, less of the clouds and rain?

It may perhaps be of interest to some to know more exactly the proportions of the four classes during those years. Both in these and in the former columns it will be noted that one year of the eleven is a few days short of the full length—the year 1894. This seems to have been the only lapse in regularity.

Here is the fuller statement:—

A.D.	Bad.	Half-bad.	Half-good.	Good.
1886	15	74	86	190
1887	16	43	116	190
1888	18	67	110	171
1889	12	95	113	145
1890	19	66	110	170
1891	21	70	107	167
1892	17	60	95	193
1893	17	54	87	207
1894	19	90	106	136
1895	19	69	84	193
1896	22	64	115	165

So if we owe our weather to the Ocean's influences, it appears that we have more to be thankful for than to complain of.

King Charles II., wise in word though not in deed, is reported to have said that in England a man could work more days in the open air than in any other country. Whether this be so or not, it at least shows that the Merry Monarch was not one in the army of weather-complainers.

CHAPTER XI.

A STORY OF CONFLICT

"Thou Sea, who wast to me a prophet deep,
Through all thy restless waves and wasting shores,
Of silent labour and eternal change."—KINGSLEY.

BETWEEN Land and Ocean a ceaseless contest is carried on.

The land is always endeavouring to keep its present state unchanged. The ocean is ever trying to tear down and demolish the land. Yet the very object of the ocean in so doing seems to be that new land may be raised up with the stolen materials.

There are Continents and Islands, moulded long ago, which we see as finished structures, that have reached the meridian of their existence and entered upon their decadence. With many of these Ocean's efforts are chiefly employed for destruction. Indeed, in all cases, the power which once erected an island or a continent is at work upon it still, not always and only for destruction, but sometimes for modification, altering its shape, making it larger or smaller, rounding a curve here, adding a protuberance there, giving finishing touches, and in the end, if not from the beginning, acting also as spoliator.

But the work of building has not ceased; it never does cease. Through the ages it has gone on, and it goes on yet. There are embryo islands, perhaps embryo continents, being now slowly fashioned in Ocean's workshops, not ready for use.

A great part of the work of land-building takes place in darkness. It is carried on, not merely from day to day, but from century to century, never hasting, never pausing. The materials are brought often from far distances, not by men, but by streams, by rivers, by glaciers, by ocean-waters; and the weight of those waters helps to weld the gathered materials into a solid whole.

Anybody who watches the results of even one heavy downpour of rain on land may gain some notion of what is going on everywhere.

If your house has a soft-water tank, you can hardly have failed to note how black the water becomes, after a pelting shower, following upon a drought.

No wonder, for the rain has washed the roof, and has carried off a supply of collected dust and soot. Not the roofs of houses alone, but the streets, the walls, the pavements, in a town—the trees, hedges, grass, roads, in the country—are all relieved of dusty layers, while, if the rain be heavy enough, sand and soil also are swept away.

Sometimes they are only taken to a lower level in the same neighbourhood, but large quantities find their way into the drains or streamlets, which join bigger brooks, and thus reach the nearest river, finally joining the sea.

Any moving stream is able to carry along floating materials, which in still water would sink to the bottom. The faster the current the heavier is the weight which it can support. A mountain torrent conveys pebbles, grinding them to a smaller size as it rushes along; and some of the more powerful torrents transport even great stones.

If one is sceptical about this lifting power of water, and if one cannot go to the mountains to see for oneself, the next best thing is to watch the breaking of waves upon a shingly beach.

The pebbles in rough weather are caught up and whirled about like grains of sand; and after a severe gale the whole look of a beach is often completely changed. The shingle may have been piled to an unusual height, or it may have been borne away. So it is easy to recognise that water has no mean carrying strength.

In the last chapter we saw what huge gifts of water are handed over, year by year, from the Land to the Ocean. But the Rivers, acting as handmaidens to carry these offerings, do not bestow water only. The water-gifts are laden with solid materials, to be used for building purposes.

A river tears earth and sand from its own banks, and wears down the stones and rocks in its bed; and to this growing collection, as it flows, it adds contributions of earth and sand, brought from higher reaches by its tributary streams. Most of those materials are kept afloat.

To make sure that they are so, we only have to examine the mouth of a river. Floating mud and sand may not be apparent in the river itself; but just where the river joins the sea, just where the outflowing stream encounters the inflowing ocean-tides, a bank or banks of mud and sand may be seen. These are a common feature of river-mouths.

Many a larger river has at its mouth an enormous network of banks, divided by streams, and the whole is described as the "delta" of that river; its shape being roughly like the Greek letter "delta," or like an opened fan. Everybody has heard of the Delta of the Nile, the Delta of the Ganges, the Delta of the Mississippi. But hardly a river exists, no matter how small, which on joining the sea does not make its own little delta.

And the formation of these deltas comes about in a very simple manner.

So long as a river flows onward, at a fair pace, it is able to hold up its floating materials, to keep the earth and sand in its embrace from sinking to the bottom. But when it reaches the sea, its progress is checked; and no sooner does it slacken speed, than some of its buoyed-up materials begin to sink. The heavier kinds are the first to touch bottom, getting piled up so as to form a bar or bank; and farther out, as the stream grows yet more slow, lighter substances find their way downward, making another bank.

In fact, the river, with Ocean's help, is busily building Land, forming an island or a group of islands, either of pebbles or sand or mud. In the case of a great river such islands are often very extensive.

The flow of a small river is quickly stopped by the sea, but such powerful streams as the Ganges or the Nile pour onward for many many miles, before they begin to mingle with the salt water, their speed slackening gradually. Not only do they form great deltas of islands, but they carry vast supplies of material far into the ocean.

Recently an examination was made into the waters of nineteen important rivers, to discover what quantity of material was carried by each. The result of this examination was somewhat startling.

We have seen already how many cubic miles of water a river may give over yearly to the great deep. It was found that, on an average, these rivers may be reckoned to give over also, *with each cubic mile of water*, more than *seven hundred and sixty thousand tons of material*, torn from the land. These enormous collections, together with vast quantities which the waves have dug and wrenched from beaches and cliffs, are dropped to Ocean's floor.

Not indeed generally to her deepest parts. So far as we yet know, the Ocean does not build continents in those black profound abysses, miles deep, flat-floored, calm, unchangeable. No traces have been there discovered of such strata as form the Continental parts of Earth's Crust. Ocean's main work, as builder, goes on in "The Transitional Area;" and most so in that part of it which is called "The Continental Shelf," where the depth does not exceed about six hundred feet.

"Transitional" regions are so named because it is believed that some of them may once have been Continents, that others of them may yet become Continents. There was a time, in the long past, when ocean-waters flowed over all those parts of Earth which now are known to us as dry land. There may be a time, in the far future, when areas of comparatively shallow water will become dry land.

Through ages the task of taking materials from the land for building purposes has been carried on by the Ocean, and it goes on still. The Continents are being steadily worn away; the Islands are becoming continually smaller.

Were this to continue always, with no counter-acting forces, islands and continents must in the end disappear. It would take a very long time; probably well over six millions of years, at the present rate of demolition. Still, however long deferred, the end would be sure.

But counteracting forces exist.

CHAPTER XII.

ABOUT THE LONG PAST

"The cold and silent past."—WHITTIER.

"Thou coveredst it with the Deep as with a garment; the waters stood above the mountains."—Ps. civ. 6.

THE very long past—how long no man can say. Some rash attempts have been made to name the numbers of thousands of years which may have elapsed since this or that particular stage in the world's geological history. Such reckonings can possess little or no true value. It is better to confess frankly that we cannot fix dates. We only know that certain changes did come about—very long ago.

Our Earth has not always been as she is now. She has altered greatly. She is altering still. Development has gone on through the ages. Development goes on still.

Continents and parts of Ocean have, so to speak, changed places. Mountains have risen; and tablelands, high uplifted, have sunk low.

Sea-beds have become dry land; and dry lands have become sea-beds. Rivers have carved new paths for themselves; and cataracts have worn away vast masses of rock, carrying the débris to the sea. Ocean-waves have battered down lines of cliffs, and new cliffs have emerged from under water. All these things have come about, not in a few years, but in hundreds of years, in thousands of years, some say in millions of years.

Such time-possibilities are not, however, without limits. Sooner or later the Astronomer steps in with a—"Hold! Enough! The Sun as a light and heat giver could not have existed then."

But we may leave such perplexing comparisons and calculations, and may content ourselves with a general—"Very long since!"

There was a time when men believed our Earth to be at rest, in the centre of a revolving Universe. That notion had to be given up as knowledge grew. There was a time, far more recent, when we all felt confident that this firm ground, on which we live and move, stand and work, was solidly calm and immovable. That notion too has had to be abandoned.

For the Earth-crust itself is in motion; certainly in parts; probably as a whole. Here it is gently heaving upward ; there it is slowly sinking downward. True, we do not see or feel such movements. But neither do we feel the whirl of our Earth upon her axis, or her rush around the sun. Neither do we see from hour to hour the growing of a boy into a man, or the change from a sapling into a tree.

Straight through from side to side, the Earth measures some eight thousand miles ; and of those eight thousand a very slight "skin" is all that we can study, by anything approaching to direct observation. No wells or mines on land can be sunk so deep as the sailor's plumbline in the ocean. If we add the six miles or more of the ocean's greater depths to the five miles or more of Earth's higher mountains, we have at most twelve miles, which, compared with the whole diameter of the Earth, must be looked upon as a mere nothing.

By one means we are able to learn something of what lies deeper in the earth-crust.

Half a dozen deep wells may be sunk in different places, the same boring apparatus being used, and the same methods being followed. But the same results would not be obtained. Earth's crust is not one solid continuous substance, like a shell of iron. It is made up of different substances, lying one upon another, or mixed confusedly together. When men work their way downwards, in well-sinking or in mine-sinking, they come across a great variety of layers, each unlike the rest.

Here perhaps is a stratum of stiff clay, and there is a deposit of sandstone. Here hard granite bars the path, and there an easy road is found through crumbling chalk. Here a great thickness of pebbles appears, bound together into a rock-like conglomerate; and there seams of coal alternate with limestone.

Each whispers a tale of Earth's past history; and not the same tale. They were not all made in the same workshop, or after the same mode. Each has its own separate biography.

And the various layers do not lie flat and even, one upon another. Once upon a time they may so have lain, but since those days they have been moved and shoved about, tilted and lowered, heaved up and dragged down, so that some of the upper layers have in places disappeared below the pile, and in other places some of the undermost layers have been pushed to the top. It is by studying the latter, where they happen to crop up within reach, that the geologist can learn a little about deeper portions of the earth-crust and about the rocks of which it is made.

By that word "rock" must be understood, not only such hard kinds as granite and marble, but softer materials, such as chalks, clays, sands, and even muds.

Rocks generally have been roughly divided into two classes—the Stratified and the Unstratified.

Stratified Rocks, known also as Sedimentary, have been put together in the past, grain by grain, layer by layer, under water, built gradually through ages, and slowly welded into firmness.

Unstratified Rocks, known also as Igneous, from the Latin word for "fire," have been melted down by great heat into a liquid state, and have then cooled into solid crystallized masses.

When these fire-made rocks have been heaved up from lower depths and are exposed to the wearing effects of rain and wind, rivers and waves, they too have to part with much of their material, like stratified rocks, only more slowly, owing to their harder make. These materials are carried seaward, to be used in the building of fresh stratified rocks. Then again, some kinds of stratified rocks, when exposed to intense heat, will crystallize into igneous rocks. So the one kind may be the child of the other; and many rocks partake of the charactertistics of both.

With regard to the wearing away of rocks, the destruction of land by water, it was said in the close of the last chapter that, but for certain "counteracting forces," the whole of the Continents might in the course of ages be slowly carried off by the Ocean, and be buried in the mighty deep.

This sounds like what, in modern parlance, may be termed "a very large order." Who could imagine a feeble substance like water having any effect upon massive granite cliffs?

Few people grasp the tremendous battering force of ocean-waves upon a rocky coast, and fewer still realise the wasting power of running rivers, or of endless successions of raindrops.

Here is a fact as to the strength of ocean-waves. Some of us may have watched the majestic ground-swell which beats upon the western coast of Scotland. It is said that, upon a rough average, taking smooth and tempestuous weather together, each summer wave that breaks upon that shore from the Atlantic does so with a force of over six hundred pounds upon the square foot. For winter months alone, when gales have sway, the average blow rises to about one ton; and some mighty billows are known to batter with a weight of three tons.

Such a fierce assault as this, continued through thousands of years, might well in time wear away the hardest rocks, demolish the loftiest cliffs.

A counteracting force, however, exists, and has already been named. Our earth-crust is in motion. Parts of it are sinking, and in those regions the ocean has the best of the contest; for fight as man may, raise walls and bulwarks and breakwaters as he will, he can but retard the inevitable. If the sinking continue, no matter how sluggishly, he must in the end be beaten, and the persistent sea will encroach upon the land's domain. But many coasts are slowly rising, slowly lifting themselves out of the sea, slowly shaking themselves free from Ocean's dominion; and in those regions, no less inevitably, the action of the sea is thwarted.

As to the why and the wherefore of such Crust-movements, science suggests explanations.

Once upon a time, long ago, our Earth was a glowing molten mass. Since that period it has been cooling, and it is cooling still. Many facts point to the great probability of a still molten centre.

Not only do we find volcanoes scattered over the Earth, on land and under the ocean; but numberless hot-water springs exist, some of them a thousand miles away from any known volcano. Then again, when deep mining or boring operations take place, it is noted that the degree of warmth for a while corresponds to the state of the weather above, but that beyond the limits of seasonal change the temperature rises with increase of depth. This looks like greater heat below.

Many scientists have held strongly that, as above suggested, the whole inside of our Earth is so far heated as to be in a molten condition, contained within a cool hard crust, which may be from twenty to fifty miles in thickness.

Others have maintained that the said crust cannot be less than two thousand miles thick, with a small molten core.

Others believe that the entire Earth is actually solid throughout; the outer parts from coolness; the inner parts from great pressure.

Again, a theory has been started of a solid centre and a solid crust, with an intervening "fire-sea" of molten rocks; and another of a gaseous inner globe, surrounded first by molten layers, then by a firm inclosing crust.

All these different explanations rest upon one foundation—that of a steadily cooling Earth—that of a more or less heated interior, and of a hardened crust.

The cooling of the inside goes on slowly, and not uniformly, since conditions differ in different places. As the heated materials become cooler they lessen in size. Thus the nucleus is constantly getting a little too small for the inclosing crust.

If the said crust were a solid shell, compact and strong enough in all its parts to resist the strain of its enormous weight, it might be expected to keep its shape and position unchanged, holding loosely within itself the shrinking centre. But it is formed of a great number of materials, some hard, some soft and yielding. Therefore, as the central parts lessen in size, the crust sinks downwards, and in so doing it wrinkles into huge folds, like the rind of a shrivelling orange or the skin of a very old man's face. A ridge is pushed up here; a furrow extends there. Here a long range of mountains is found; there we see a succession of valleys.

By these movements the Ocean is both helped and hindered in its "building." As new land is formed under water, the "crust-creep" perhaps raises it gently, and a strip of sea becomes dry land. But another portion of the work, that of pulling land to pieces, is checked; for let the waves strive as they may to wear away a coast-line, a very slight upheaval is enough to counterbalance their utmost exertions.

Such changes are usually gradual—so quiet, so deliberate, as only to become apparent in the course of centuries.

Not that crust-movements are always sluggish. The ceaseless sinking and crinkling of vast extents of country, the crowding together into a smaller space of immense masses of material, cannot but cause enormous pressure; and here or there a portion suddenly *gives* under the strain. Then the ground shakes and heaves, or some terrible landslip takes place.

Earthquakes are now looked upon generally as signs of abrupt yielding to intense pressure. Sometimes they indicate that a huge weight of material deep down has slid to a lower level, packing more closely or pushing aside other masses, and causing what miners call "a fault" —that is a break or dislocation in the regular lines of the stratified rocks. Or slip after slip may take place, one mass being disturbed by the movements of a neighbouring mass; and so the ground above may tremble again and again with recurring shocks.

Such shocks are fearfully common in some parts. In Japan, for instance, it was noted that nine thousand had been felt in the course of only eight years; and in one great earthquake alone—that of October 26th, 1891—almost ten thousand human beings perished.

Movements of the crust, whether slow or rapid, are not due always and only to the shrinkage of the central portions of our globe, and to the sinking and re-adjustment of the strata.

There are mighty fire-forces below; molten materials pent up, waiting for the slightest yielding of the solid crust to fight their way out; heated and imprisoned gases struggling for freedom. Sometimes these captive giants escape through what may be termed the orthodox safety-valves, old volcanic vents. Sometimes they break open new craters for themselves. Sometimes they fail to get out, and only shake the ground, or force it gently upward. Though earthquakes are more usually ascribed to the effects of a steady "crust-creep," they are sometimes caused by heated gases seeking liberty.

These heavings and twistings, these crumplings and swayings, of the earth-crust do not belong only to land, but go on in the same manner under the ocean. Many an earthquake felt on land has its origin under the sea; and others are so far out as to be felt only by passing ships. In the Pacific alone it is said that about two thousand five hundred shocks occur in the course of a year. Of the eight or ten thousand shocks, believed to be about the average number throughout the world annually, fully half have their origin beneath ocean-waters.

CHAPTER XIII.

OLD OCEAN AS A BUILDER

"Grain by grain His Hand
 Numbers the unmeasurable sand."—C. G. ROSSETTI.

". . . The ever changing strand
 Of shifting and unstable sand
Which wastes beneath the steady chime
 And beating of the waves."—WHITTIER.

AS a vast Cathedral is made of separate blocks of stone, laid one upon another and cemented together, so a stratified rock is formed of tiny particles of substance, placed one over another and pressed into solidity.

Let us scoop up a little sand from the sea-shore, and look at it under a magnifying-glass.

We shall find a number of loose yellow grains, not all alike in shape, but all somewhat rounded. Most of them are characterised by a glittering hardness, and probably some are transparent.

For the most part these grains are of a substance called *quartz*, which may be almost any colour from white to black. Some beautiful forms of it are known to us, such as amethyst, agate, and jasper. But we have now to do with the humbler relatives of those aristocratic gems; with the more commonplace kinds of quartz, such as sandstone.

Sandstone rock is chiefly made of grains of sand, firmly compacted together. An especial interest belongs to the rounded shape of these little grains. Like many voiceless things in the world of inanimate Nature, it tells its own tale, if only we will pause to hear.

Why should grains of sand be rounded? Why not square, or pointed, or angular?

That is just what they were, not very long ago. Each sand-speck, when first detached from rock or stone, had its angles and corners. But these have been gradually rubbed away; and by the very same process which, in the course of years, rubs away angularities and eccentricities from the characters of human beings.

The work has been done through contact with its neighbours—not by an occasional rub, but by steady friction, long continued. Each grain of sand, rubbing against and being rubbed by its companion-grains, has been rounded, smoothed, polished, till it has grown into the finished specimen, without any obtrusive points or disagreeable angles remaining.

An unpleasant discipline, perhaps; yet, in the case of sand-grains and also of human beings, worth undergoing for the sake of results.

Looked upon from a geological point of view, this shape of the sand-grains means merely the wearing and wasting away of substance, with no pretty explanation attached, though with a very definite underlying story of their past history.

"No workman ever manufactured a half-worn article, and the stones were all worn." So wrote Hugh Miller when describing his first boyish experience of toil in a Scotch quarry twenty years earlier. Boy as he then was, his keen eyes noted the stones, "rounded and water-worn, as if they had been tossed in the sea or in the bed of a river for hundreds of years." Boy as he was, he knew that stones, broken off from larger stones or rocks, have at first their irregular shapes, their corners and jagged points, which can only be worked into smoothness by the action of water. Boy as he was, he realised that these quarry inland stones had once been rubbed and shaped by ocean-waves.

He made a mistake in his assertion. Some workmen do manufacture articles, not indeed really half-worn, but with the look of being half-worn though actually new, for mercantile purposes—to pass off the new, as if it were old, when the old has greater value. But it may safely and with confidence be declared that the Divine Architect of Earth and Heaven never so puts forth His mighty power. When we see in Nature a thing *worn* in appearance we know that it has been worn in reality.

In his first day of quarry work Hugh Miller saw more than this. He noted surfaces of sandstone rock, laid bare by blasting, all "ridged and furrowed, like a bank of sand that had been left by the tide an hour before." He had seen the latter hundreds of times when sailing over shallows near the shore. But here the ridges and furrows were petrified, changeless, and on dry land, where no ocean-waves could reach. No wonder he was puzzled.

Such ripple-marked sandstone is far from uncommon. It gives a perfect reproduction of the little sand-ripples or rounded ridges and hollows, often to be found on a sandy shore, either visible through a thin layer of water or left bare after the tide goes down. And it shows us how the sandstone rock must originally have been put together, under water. Soft undulations were made in the wet sand by one high tide, becoming in a measure hardened before the next high tide, and so keeping their shapes, while a fresh supply of sand was dropped upon them, partaking of the same outlines.

As time passed, more and more sand would be thus deposited, the ground probably sinking and the weight of sand increasing, until the lower layers had stiffened into rock. In after days a slow upheaval of the ground came about, and where ocean waters had flowed would be dry land.

By-and-by—who can say how long after?—the ripple-marked slabs of sandstone, petrified memorials of the past, would be found; perhaps far inland, if the country had risen much; perhaps in a quarry by a young Scotch working-lad, to be marvelled over as a specimen of old Ocean's bygone work.

Another such token of the past is found in hardened raindrop traces, impressed on solid sandstone.

The rain fell on a soft sandy shore, making tiny holes in the sand, with splashed-up ridges round each small hole. Have we not all seen this? If not, we might have used our eyes better. Before the coming in of the next tide the surface hardened, like the sand-ridges already described, and so, being covered over by new layers of sand and gradually transformed into rock, it was later uplifted above the sea, and the holes have lasted intact until now.

It may be objected that the time between one high tide and another is hardly long enough for any such hardening process—even on the hottest and driest of summer days.

Then the hardening may have taken place only on that slender belt of sand, which is covered for a day or two by the spring tides, and is not again reached by ocean-waves for nearly a fortnight.

In earlier chapters it was shown—first, how the Ocean is ever striving to keep a level surface; and secondly, how the object sought is never attained to.

Not only are the waters in ceaseless motion, heaving to and fro under the influence of every passing breeze, borne hither and thither by mighty streams, disturbed by innumerable storms. But also the powerful attraction of the land, particularly of great mountain ranges, lifts the sea-surface in some regions hundreds of feet higher than in others. So that a ship, passing from the neighbourhood of a mountainous coast to mid-ocean, may be actually sailing or steaming downhill, actually descending a vast gentle watery slope.

Another question as to Ocean's level has much exercised the minds of men.

Throughout the world, remains of sea-creatures in countless multitudes are found embedded in the substance of water-built rocks: sometimes the very rocks being made up of them. This, not only on the tops of lesser hills, but at the summits of mountains eight thousand feet high, twelve thousand feet high, sixteen or eighteen thousand feet high.

Very ancient remains they often are, certainly many tens of thousands of years old. But whatever their age may be, they echo and add to the story which is told by the rocks themselves.

From the rocks we learn that, once upon a time, long ago, they were put together, scrap by scrap, under water, not upon dry land. And from the fossil remains in those rocks we learn with equal certainty that, once upon a time, they lay under ocean-waters.

Fossil remains, buried in rocks, are of many kinds.

Not only relics of animals, or of parts of animals, such as teeth and bones and shells.

Not only relics of sea-weeds and other ocean vegetation. Not merely the actual remains, hardened into stone; but also the casts or shapes of all such remains, found impressed in the substance of the rocks. The whole of these various records of the past must be included under the term "fossils."

Firmer substances, like shells and bones, have become often transformed into actual solid stone. But softer living substances have more frequently passed out of existence, leaving only an impress or *cast*, which is filled up later by some other substance.

When upon high mountain-tops such fossils are found—the remains of sea-weeds and sea-creatures embedded in rock—the question must naturally arise, How could these ocean-inhabitants have found their way to such a height?

That the sea must once have flowed over them cannot be doubted. But how did it come about? Were those water-built heights under the sea, because in those times the land lay lower, or because the sea-surface stood higher?

That the earth-crust is restless, heaving, disposed to rise and sink, to crumple into furrows, to fold into ravines and mountain ranges, we now know. Yet this may not be the whole explanation of sea-shells upon high summits. It may be also that the surface of the sea itself—the general level of the ocean—has not been always the same. It too may have risen and sunk ; not once only, but many times.

Between one and two hundred years ago there was a theory that the sea had as a whole sunk lower, on account of the enormous drying up of its surface. Of course the surface does dry up very much and very rapidly. Yet this deficit in ocean-waters being met by equally enormous down-pourings of rain and gifts of river-water, evaporation will not serve to account for a lowered ocean-level all over the earth. So the notion had to be given up ; and in later years it was looked upon as certain that the land must have risen, and that the ocean-level must have been changeless.

Until recently this was regarded as established ; but in the curious see-saw of scientific theories the pendulum has begun to swing back.

Not all the way. That the land has risen in parts, shaking its skirts free from ocean-tides, is not doubted. Scientists are, however, maintaining that while this is true, the other need not be untrue. They hold that, while land in many places has undoubtedly risen and sunk, the ocean-surface may have risen and sunk also.

The ocean could not, indeed, like the land have risen or sunk only in parts. Except where it is forcibly held at a higher level by some strong force of local attraction, this would be impossible. Yet causes might exist which should affect the whole ocean-surface.

One such may be mentioned. The rising or sinking of great tracts of land could not fail to affect the ocean-level.

That it must do so may be easily understood. Let us fill a basin with water, to within an inch of the brim, and then slowly lower into the water a ball, or any other solid body. As the ball enters, the level of the water rises—*must* rise. Then let us slowly lift the ball out again; and as it leaves the water, the level of the latter sinks—*must* sink.

Precisely the same result would follow upon the rising or sinking of some great continental mass. When it rises, the ocean contains less land, and the water-level must go down. When it sinks, the ocean contains more land, and the water-level must go up.

This question has been long under discussion. For many years, as with other questions, each side looked upon its own view for the time being as the only right one. But—as again with many difficult problems—the fairer and wider view recognises the possibility of truth in both explanations, and probably in the end both will prove to be in a measure right.

Many other kinds of rock, as well as sandstone, have been built under ocean-waters in past ages, constructed of minute particles, piled together, and hardened. Some sorts, like sandstone, are only or chiefly mineral; while others are only or chiefly "organic"—that is, are mainly composed of the remains of "organised" or living beings. About the latter much has to be said in future chapters.

A very few words in the close of this chapter, as to the classifying of different kinds of Rocks, may not be amiss.

Ocean-deposits, or Ocean-buildings, are often roughly divided into three groups.

In "Deep-Sea Deposits" are included all that lie beyond the Hundred-fathom Line, or a depth of six hundred feet.

In "Shallow-water Deposits" are included all that lie between six hundred feet deep and low-water mark.

In "Littoral Deposits"—the word coming from the Latin for "shore"—are included all deposits that lie on shore-lines, between the highest and the lowest tides.

At first sight the tide-deposits might seem to be but a small matter. Not so small, really! Earth's coast-lines reach to something like one hundred and twenty-five thousand miles in length. Since the medium breadth of ground affected by tides is about half-a-mile, the whole tidal area amounts to over sixty thousand square miles.

No mean workshop this, under the auspices of crushing and grinding billows. On shore-lines building takes place rapidly.

The "Shallow" zone is much more extensive, reaching to some ten millions of square miles. Its principal deposits are much the same as those of the tidal zone—muds, sands, gravels, pebbles. In parts of the Earth they also include volcanic and coral muds.

Greater, far greater, far more widely reaching, are the regions of "Deep-Sea Deposits," which cover more than one-half of the whole surface of our globe.

In those cold and dark and silent workshops, hidden from the eyes of men, building goes on, very quietly, very slowly, through interminable ages. In those workshops are deposited divers materials—Red Clay, Red Mud, Blue Mud, Green Mud, Volcanic Mud, Diatom Ooze, Globigerina Ooze, and many others, forming Ocean's carpet.

Almost any of these muds and oozes may occasionally be found in the second division, but they more generally belong to the "Deep Sea."

CHAPTER XIV.

HOW CHALK IS MADE

> "Peace, moaning Sea, what tale have you to tell,
> What mystic tidings, all unknown before?
> Whether you break and thunder on the shore,
> Or whisper like the voice within the shell,
> O moaning Sea, I know your burden well!"
>
> LEWIS MORRIS.

> "The tiny cell is forlorn,
> Void of the little living will."—TENNYSON.

ONE of the tasks carried on in Ocean waters is Chalk-Building.

The "White Cliffs of Albion" and those also of Gaul are vast masses of chalk, containing layers of flint, and mixed with many other materials, but chiefly composed of the crumbling white substance, which is familiar to all who live near the North and South Downs.

This formation stretches a long way. The heights of Salisbury are of chalk. The Chiltern Hills are of chalk. The Yorkshire Wolds are of chalk. It is found in Norfolk; it is found in Kent; it is found in Surrey; it is found in

Sussex. There are chalk-beds in France, in Germany, in other parts of Europe—not to speak of Asia—which, with those of Great Britain, extend through many hundreds of miles.

And wherever these masses of chalk are found, there we know that, once upon a time, the land lay under ocean-waves.

For Chalk, like Sandstone, was not formed on dry land. It could not be formed on dry land. It was built—it could only be built—under the sea, to be in later ages uplifted as dry land.

During those far-back days, when the chalk-beds of Europe were being made, a different state of things prevailed from that of the present. By far the greater part of Europe must have lain under water, from which the summits of the Alps, the Pyrenees, and other mountains emerged as groups of islands. Great Britain must have been chiefly or entirely hidden.

So far I have spoken of sandstone and chalk together. But a marked distinction—a *vital* distinction—exists between the two.

In the mode of their building they may be alike. In the materials of which they are built they are utterly different.

How Chalk is Made

If a lump of chalk is examined by the chemist, its principal substance is found to be Carbonate of Lime.

Now there is something very remarkable about Carbonate of Lime. It is absolutely different from the materials of which sandstone and granite are made. Wherever we stumble upon carbonate-of-lime, there we are on the track of LIFE. And the moment that we touch upon LIFE, even in its simplest and lowest forms, we rise to a higher level.

Hitherto, in this subject of the Mighty Deep, we have had to do with things inanimate; things without consciousness; things blindly controlled by the forces of nature. In the story of ocean-waters, of ocean-salt, of ocean-rivers, of ice-bergs and ice-floes, Life has no part. There is no life in a grain of sand, no life in a granite rock.

But here, suddenly, we are arrested. Here, in the composition of Chalk, we come across a difference. Here, at one step, we pass over a vast dividing chasm, and stand face to face with that which has Life.

Not indeed that which lives now, but with that which did live, the signs of which may better help us to understand Life in the present.

Is this so new? Have we not already in former chapters found tokens of creatures which once existed, of fossil remains embedded in rock?

Yes; but that was not the same. Fossil remains are discovered in many kinds of stratified rock. Here we are not concerned with separate remains, buried in masses of chalk, but with the actual substance of chalk itself. The mere building of it, as earlier told, closely resembles the building of sandstone. Chalk, like sandstone, was formed in past ages out of tiny particles, carried by ocean-waves, dropped upon ocean's bed, slowly consolidated, then gradually upheaved. Particles of——

Ah, there we reach the great distinction!

Not particles of inanimate mineral substances, such as grains of quartz. No; but particles which once formed the habitation of living creatures. More than this—particles which once shared in the Life of the beings with which for the time they were in touch. Infinitesimal specks, often so minute as to appear only as fine dust to man's unaided sight; yet real organic remains, each one of which has been the home of an active animal.

A lump of chalk is a mass of densely packed tiny fossil shells, more or less crushed and broken. It has been reckoned that a cubic inch of chalk probably holds at least one million shells.

Try to imagine what this means. The work of the Ocean in building solid sandstone, from unnumbered myriads of myriads of grains of sand, is marvellous enough. But here we have something far more wonderful.

Here we have rocks and cliffs, ranges of hills and extents of country, to a great degree composed of almost invisible sea-shells, so small, so numerous, that a million or more of them may be packed into one little cubic inch of space, while the chalk-beds lie through hundreds of miles.

Think of continuous piles of these shells, many hundreds of feet in thickness, all built out of the dead shells of dying millions of tiny creatures. Deep, deep below the surface, where waves had no power, where currents were sluggish, fell a ceaseless gentle rain of these minute shells. Life had fled from each jelly inhabitant; its brief day was over; and the empty shell went quietly down, whether from near the surface or from lower depths, till it reached the ocean-bed. There it lay, forming part of a gathering sticky ooze or mud, which in later times should be slowly hardened into chalk.

But the greater wonder has yet to be told about these shells—these tiny highly-finished constructions.

Not only did a speck of living jelly once inhabit each shell. That speck of living jelly actually MADE the shell.

Not deliberately. Not with intention. Not even consciously. The "making" is in no sense to be confounded with voluntary effort, with the labour which means exertion and fatigue. It was as instinctive, as involuntary, as the "making" of bones in your body and mine.

"But we do not make our bones," somebody may protest, with a touch of indignation.

Undoubtedly, in a sense, we do. The jelly-speck does not more surely "secrete" its shell, than a man "secretes" his skeleton. Personal will has not to do with the task in either case, beyond the taking in of necessary food; and neither man nor jelly-speck may claim any credit on the score of the pattern worked out.

We have all seen a garden-snail, carrying lightly upon its back its shell or "house," or outside skeleton. That shell is formed of carbonate-of-lime. In the snail's slimy body exists a small manufactory for producing or "secreting" carbonate-of-lime. The materials are obtained by the snail through its food. The deposits of it—made as the snail's nature, certainly not the snail's reason—dictates, grow into a sheltering framework for its protection.

In a Dictionary we may find the strict meaning of this word "secrete." It is given as—"to hide; to conceal; to deposit in some secret or private place; to separate from the blood in animals, or from the sap in vegetables, and elaborate into a new product."

One cannot deny that the word, though used for all such "elaborations," is more appropriate in the case of a man's hidden and private framework of bones, than in a snail's or jelly-creature's outside shell.

That which the garden-snail so deftly does, is done also by countless billions of minute jelly-specks in the ocean; though with the latter the mechanism is far simpler, because the animal belongs to a far lower and more primitive type.

Still, simple though the apparatus may be, the tiniest of these jelly-specks has power to separate lime from ocean-waters, to unite it with carbonic acid in its own frame, to form carbonate-of-lime from the two, and to build of the manufactured carbonate-of-lime a shell for its own use.

Thenceforward, for a little space, the jelly-speck lives in that shell, and feeds in that shell, and then it dies in that shell. When it exists no longer, down sinks the lifeless skeleton, to serve a new purpose at the bottom of the sea.

No mere shapeless lumps are these shells, flung together without care or plan. Each one, however infinitesimal in size, is a delicate and elaborate construction; each one shows the carrying out of a definite and beautiful plan. A different design serves for each species and kind of jelly-speck—not for each individual.

Such Design we must ascribe to a MIND lying beyond that which we see; not to the jelly-speck itself, which acts as an unconscious architect, working automatically, as you and I work in the early growth and later renewal of our bony frameworks, the "secreting" of our skeletons.

No chance tossing together of particles of carbonate-of-lime could result in the exquisite forms, the intricate patterns, of these little shells; still less, in such patterns being faithfully reproduced by millions of living jelly-specks, each according to its own class or variety.

For all this the present tense is as true as the past tense.

Those white cliffs along the coast were formed ages ago. But the ocean is working still, building still, piling grains of sand together still, heaping specks of mud together still, and laying shells, shells, shells, together still, in amounts beyond all reckoning.

Chalk-building went on in ages past; it goes on now; and doubtless it will go on in centuries to come.

Not only beyond reckoning, but beyond imagination, are the enormous multitudes of these creatures, which live and die in the ocean, forming their shells, and adding their skeletons to the ever-growing pile below.

Over a large part of the Atlantic bed, as over other Ocean-beds too, lies a thick ooze. When this was first brought to the surface, in soundings that were made before the laying of the earliest Atlantic cable, it was supposed to mean a thin deposit of no particular importance.

Then a deep-sea dredge, plunged into the ooze, carried away half-a-ton of it, and men began to realise what its presence might mean. By a long succession of soundings, its true nature became slowly manifest.

The ooze was found to be composed chiefly of tiny rounded shells, called "Globigerina," which belong to a larger class, known as "Foraminifera." And the white chalk of our British cliffs is made principally of Foraminifera shells.

This last name springs from two Latin words, meaning "I bear a hole." The Foraminifera shells bear many holes. Each is in shape a tiny collection of rounded compartments, usually not more than sixteen in number; and each compartment has numerous minute holes in its walls.

Its inhabitant, a speck of jelly, is one of the least of living creatures, belonging to the great Division of "Protozoa," or "First Animals." None rank below them, for they are on the first or lowest rung in the ladder of life.

A jelly-speck has no head, no limbs, no stomach, not even a mouth. It can take in food at any part of its soft body. When it wishes—and apparently even a jelly-speck can *wish*, which at once separates it from inanimate materials—it makes a temporary tentacle or "foot," by pushing out a slender filament of its own substance through one of the tiny holes in its shell. Whence the name "Rhizopod."

Not all the Foraminifera specks live in the same kind of sheltering skeletons. Some construct delicate domes or many-chambered discs of sand-grains, joined together with enough carbonate-of-lime to act as building-cement. Such skeletons are called "tests," to distinguish them from "shells" proper.

Hardly anything can be more remarkable than the way in which these tests are put together by mere specks of jelly, alive indeed, but without parts, without development, without understanding. How and why they should choose from one place, each the especial materials which go to form its own kind of "test," is one of the mysteries in Nature for which Science has no explanation. We can but look and marvel.

One kind of jelly-speck will use the larger grains of quartz, arranging them, and joining them into a bottle-shaped test or shelter.

Another, in the same spot, belonging to a different species, will select tinier grains of the same substance, and will build out of them a rounded sphere, exquisitely modelled, with tiny holes at intervals for the protruding "limbs."

Another, of yet a different species, picks out the minutest of sand-grains and of bits of sponge-spicules, and knits them together, without any cement, into delicate white globes, "like homœopathic globules," giving to each a single opening.

And still another, of again a different species, forms a test of divers compartments, with a tiny doorway leading from each into the next.

Behind all these extraordinary constructions lies a MIND. But—*not* the mind of the jelly-speck!

Soft oozes, formed chiefly of Foraminifera and other shells, varying in size from a pin's head to almost invisible specks—though some few kinds are larger—cover immense reaches of the ocean-bed, extending, it is said, over fifty millions of square miles.

Yet they are not found everywhere below the sea. Near to Continents, if they exist they are lost sight of amid the masses of sand and mud carried down from the land. And in the profounder abysses of the ocean they are lacking.

This last fact was long a puzzle. If the waters above were swarming with live Foraminifera, the dead shells of which must be ever pouring in a quiet rain to the ocean-bed, why should not the same ooze be found there, as elsewhere?

That the waters above, at least in all warmer climates, do swarm thus, is certain. Towards north and south, in colder seas, they rapidly lessen; but in tropical regions, and in warm ocean-streams their numbers are legion. Yet, from depths beyond about two miles, the ooze was not brought up.

One explanation can be given; and it is that of the strong dissolving power of sea-water. After a depth of about two miles, the delicate little shells fail to resist that power. Once at the bottom, they might be covered up and preserved; but they cease to exist *en route* thither.

So in this as in many other instances, we see opposite forces at work. The one force is perpetually undoing what the other force is perpetually doing. Innumerable multitudes of living creatures are at work, taking lime from the water, and constructing carbonate-of-lime. But the ocean is ever seeking to re-dissolve that carbonate-of-lime.

Another difficult question as to the ooze was—whether the shells of which it is mainly made were those of Foraminifera living in the deep sea, far down below the surface, or of Foraminifera living near the surface. Able men took both sides of the discussion, some ascribing the ooze entirely to deep-sea jelly-specks, others ascribing it entirely to surface jelly-specks.

The question cannot be said yet to have met with complete settlement. But here once more it seems that both sides have been partly in the right.

There are Foraminifera which live only at great depths, and there are Foraminifera which live only near the surface. The ooze is found to consist of shells belonging to both kinds, though it may be that the surface species carry away the palm in point of greater multitudes.

CHAPTER XV.

OF OCEAN-WEEDS

"Have hung
My dank and dripping weeds."—Trans. HORACE.

"The tide is full, the moon lies fair
Upon the Straits; on the French Coast the light
Gleams, and is gone; the Cliffs of England stand,
Glimmering and vast, out in the tranquil bay."
MATTHEW ARNOLD.

SCATTERED through the vast Chalk-beds of Great Britain and the Continent are thousands of layers of FLINT, such layers as any of us may have seen intersecting the smooth white face of Chalk Cliffs. And as with Chalk, so with Flint—we at once find ourselves upon the track of Life.

Not indeed always of animal life. Sometimes vegetable life takes its place. Though the highest Vegetables stand on a lower level than the lowest Animals, they too have Life, and thereby they are entirely apart from the whole world of inanimate Nature.

Widely distinct are the Animal Kingdom and the Vegetable Kingdom; yet on the borderland between the two is found a hazy belt of uncertainty.

So gently does the one glide into the other that, though a line of demarcation does exist, it is not always easily made out. But the transition from the lowest form of that which *lives* to any and every form of that which has no Life is abrupt, absolute, precipitous. Here we see no quiet sliding of the one into the other, no wavering hesitancy as to whether a certain something may belong to this or that side of the dividing parapet.

The term "Vegetables," used scientifically about Land Vegetation, includes all manner of growths, from the lichen to the forest tree. But by that word, used in connection with the Ocean, is meant, *not* cabbages and cauliflowers, *not* garden-plants or forest-trees, but an enormous variety of Sea-Weeds.

And among ocean-vegetables of humblest form, flourishing in salt water, is that of Diatoms—Flint-makers.

It need not be imagined that the manufacture of Flint is a monopoly of the Diatom tribe. That would be a mistake.

We have had to do in the last chapter with small carbonate-of-lime building jelly-specks. We shall have to do in the next chapter with carbonate-of-lime building jelly-polyps. But there are also little vegetable-growths in the sea which form carbonate-of-lime, and some of these add their quota to the work of rearing Coral-reefs.

We have to do in the present chapter with small flint-building vegetable-growths. But there are also little animal jelly-specks in the sea which form flint.

So neither Carbonate-of-lime nor Flint can be spoken of as belonging *only* to Animal or *only* to Vegetable Life. They must both be described in general terms as the outcome of that which Lives.

Among other Flint-builders in the ocean are the Radiolarians; living jelly-specks, and makers of the most exquisite shells, so tiny in size that millions of them may be packed into one cubic inch. These belong to the Animal Kingdom. They rank with the Foraminifera, differing from them chiefly in the fact that their shells or skeletons are formed of silica, not carbonate-of-lime.

But in this chapter we are concerned with the Vegetable Life of the ocean, and we must therefore let the wonderful Radiolarians alone.

Properly the chapter on Vegetables ought to have come before any chapter on Animals, since we have been climbing upward from inanimate Nature, and since all vegetables rank below all animals. When on the topic of Ocean-building, however, the subject of Chalk seemed to follow naturally after that of Sandstone. And this little volume makes no pretensions to stiff classification.

No surprise need be felt at vegetables being able to make or "secrete" flint and chalk. This making is, as we have seen, an unconscious work. The living jelly-speck secretes automatically, not with intention.

Such secreting is not confined to ocean vegetables. Trees and plants on land manufacture a host of substances—sweet oil, cocoa-nut milk, indiarubber, and countless others.* Forest trees in like manner grow their own framework of hard wood, which may be said to take the place with them of a skeleton.

All this is a part of Life. Inanimate rocks and stones may lie for centuries unchanged,

* The spicules of silica may be seen on coarse grass, secreted by the grass.

except through friction with other rocks and stones, or with running water. But where Life reigns, though it be of the simplest kind, there growth and development must follow.

Life, from its very nature, cannot mean stagnation, or standing still. It must always be assimilating. It must always be expanding. It must always be doing. When these things cease, death has begun.

So much alike are the lower forms of life in the two classes, that many an animal has been for a time mistakenly called a vegetable, and many a vegetable has been for a while supposed to be an animal. The foraminifera were once ranked as vegetables, and the diatoms were ranked as animals.

In deep-sea regions, dark and cold, no vegetable life can possibly exist, not even the almost ubiquitous diatoms. But their remains are present in vast multitudes. As the tiny plant-life dies out, the little hard vegetable-cases sink to the ocean-bed, there to mingle with gathering muds and oozes—there, too, in the course of ages, to be transformed into Flint.

Diatoms flourish on land as well as in the ocean; in cold climates as well as in warm. On the whole they prefer the colder regions, therein differing from the warmth-loving foraminifera. Sometimes immense floating banks of these microscopic plants are found, reaching through many miles. A net, lowered into such a bank and then drawn up, is filled with a "brown-coloured slimy and felt-like mass," made up chiefly of uncountable myriads of diatoms.

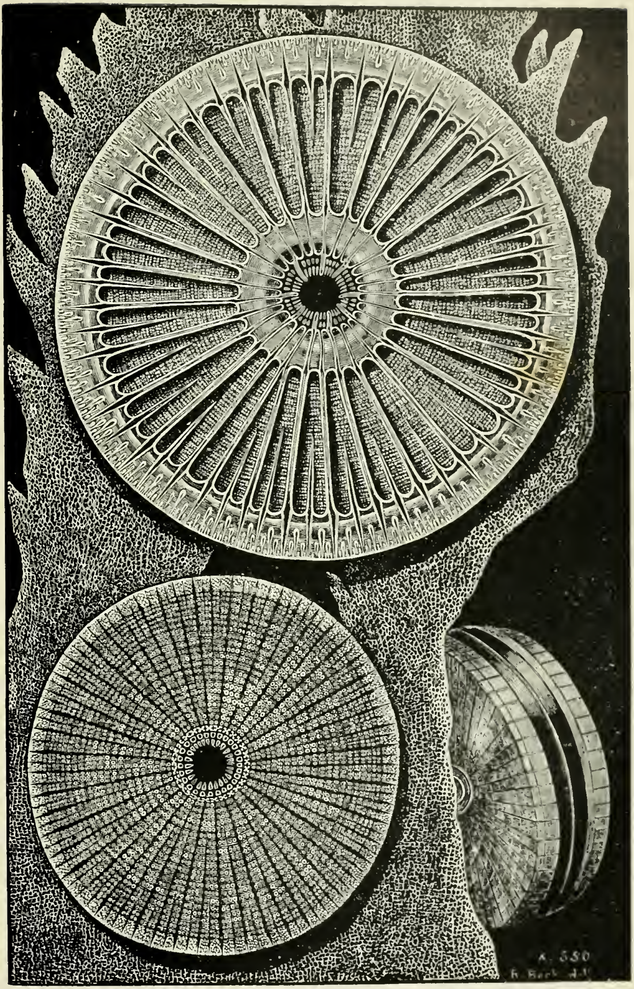
Such masses are held together by a kind of sticky jelly, and if the hand is passed through it a very slight roughness may be perceptible, caused by the flinty diatom shells or cases.

Mere specks indeed they are, individually too minute to be seen by a human eye, unaided. Yet how marvellous in their make!

A Diatom plant or vegetable or sea-weed, whichever we choose to call it, is like a Foraminifer of the simplest possible structure. It consists of a single cell, with an outside flinty coating or inclosure, answering to the wood of a tree or the skeleton of an animal.

This flint casing, though infinitely small and delicate, is yet firm enough to prevent the passage of water through it; and also it is practically indestructible by ordinary forces. Diatom-cases, dropping to the ocean-bed, may lie there for ages.

The living cell is inclosed in the said "case,"



DIATOM CASES (ARACHNOIDISCUS JAPONICUS)

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which is a kind of box, consisting of two halves or "frustules," neatly joined together by a ring or girdle.

Diatoms increase in numbers, like many of the Foraminifera, by simply dividing into two. When the living cell thus parts, each half takes as its share one side of the box, and each then makes another side, or "frustule," to complete itself. For this operation, the tiny ring or hoop doubles into a pair of hoops, one of which clings to each half of the case.

Perhaps in all the world no greater marvels are to be seen than these extraordinary minute vegetable-cases.

Minute! Yes. A mass of millions upon millions, held together, may be perceived and felt. But let a light scattering of them be dropped upon a slip of glass in broad daylight, and let a man of keen eyesight set himself to examine them. He will see—nothing! Not even an appearance of delicate dust. The diatoms are to him as if they did not exist.

Then let him put that fine scattering under a good microscope, changing lens after lens, to higher powers. A world of beauty, of finish, of originality, of unbounded variety in construction, will open out before him.

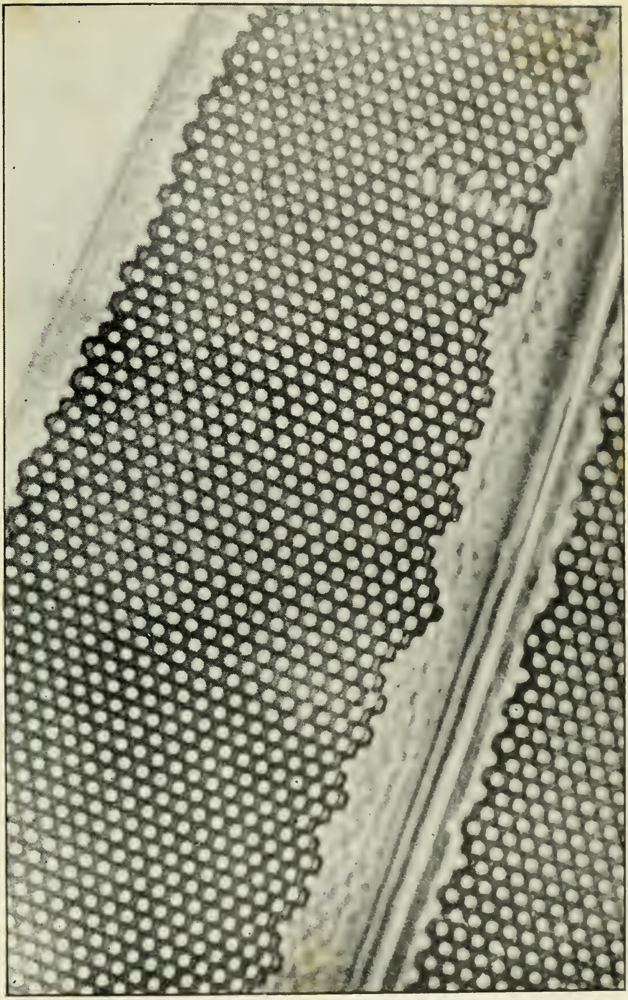
Each little shell is exquisitely shaped, exquisitely put together, exquisitely ornamented. Though thousands, nay, millions, of them might be packed into a cubic inch, yet there has been no carelessness, no scamping, in the work, no saying, "Nobody will see, so anything will do."

The different kinds of Diatoms are innumerable; and each kind, each species, even each variety, has its own especial form, its own complex design, followed out and faithfully reproduced in hundreds of millions of individuals.

Pattern-markings, by which each variety is distinguished, formed of an infinitude of delicate lines and dots, arranged in every imaginable fashion, vary to an extent almost beyond conception. There are cases round, triangular, lengthy, many-sided, chain-like—but to picture them in words is hopeless. They have to be studied in their own wonderful minuteness and delicacy, complexity, and loveliness, before they can be known.

In all this again we surely find unmistakable evidence of a MIND, hidden, out of sight, inventing and designing.

Not the mind of the vegetable-speck, which for a brief space is sheltered in the ornate little



PART OF DIATOM CASE (PLEUROSIGMA ANGULATUM)

Magnified 4,900 diams.

From a photo-micrograph by Dr. R. Zeiss

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flint-box, but of a Higher Intelligence—whether that of the Creator Himself directly, or whether, as may seem to some more probable, the mind of some intermediate Worker, Divinely appointed to the task.

Why should not Angelic or other beings, in the Unseen World, be allowed to exercise their powers in such wise, even as man upon Earth is allowed to think, to plan, to discover, to devise, to invent, according to his mental gifts?

Some such possibility may well suggest itself to a thoughtful imagination, as the variety of developments in these tiny sea-shells or cases becomes apparent. All the more, because the developments are not found scattered, haphazard, in single specimens, but—as above stated—are accurately followed out by the multitudes belonging to each variety.

It seems that every individual of every separate kind has power to form certain shapes, with certain markings, and no more. It is as if upon each minute speck of vegetable life had been originally impressed its own—not *individual* character, but *class* character. This character unconsciously expresses itself in such and such a form of shell, just as with men the individual character expresses itself in such and such outlines of face. The same may be said of Foraminifera and Radiolarian shells.

Some Diatoms have a singular power of movement; and from this sprang early mistakes, through which they were wrongly classed as animals.

Many of them grow, like ordinary plants, fixed in one spot. But many others are in continuous and regular motion. Careful study has, however, made it clear that the movements of Diatoms are purely mechanical, purely involuntary, like those of some sensitive land-plants. It is probably due to the working of food, taken into the little organism, and not obedient to any *Will* on its part.

It may be that herein lies the great difference between a Diatom and a Foraminifer. The one exists, but has no approach to consciousness; or, at least, probably no approach to any power of choice. The other, though of the very lowest and feeblest type of Animal-life, may yet be supposed in its infinitesimal measure to have a *wish*, and to be able to act upon that wish. But here we do not get beyond conjecture. Where Life exists, it *may* be that in all cases some dim form of consciousness exists also, which *may* involve some faint power of choice.

Flint-making, like Chalk-making, is not only an old-world and long-past operation, but a present one. Diatoms lived and died in ages gone by, and their remains are found hardened into flint. Diatoms live and die in these days; and their remains may yet, in centuries to come, be transformed into the same substance.

From Diatoms one might range upward through an enormous variety of Ocean-weeds, of all kinds and descriptions.

Though they are the "last and lowest of all the tribes of plants," yet it is a wide step from the undermost to the uppermost of even this humble Vegetable Tribe.

At least five or six thousand species of Sea-weeds are known to Naturalists. Each ocean, each lesser sea, has its own particular vegetation, largely affected by the varying degrees of saltness, the warmth or coldness of the water, and the faster or slower currents which happen there to prevail.

Sea-weeds of all sizes are found, from the invisible diatoms to enormous growths in Pacific waters, reaching to yards upon yards in length, with solid trunk-like stems, and huge fronds like those of a tropical palm.

Near Tierra del Fuego immense growths have been seen, with stems between three and four hundred feet in length. Great sub-ocean forests of kelp are there, and floating fucus-islands, with leaves or fronds seven or eight feet from base to tip, covered with living animals, and having air-vessels several inches long.

In the matter of colour no great variety exists. Sea-weeds are generally either grass-green, olive-brown, or red. The green are usually close to land, and they never grow beyond touch with direct sun-light. The olive-brown are the more abundant; and the red belong, perhaps, more often to deep water.

A large majority grow attached either to stones or to the shallow sea-bottom, but some kinds float unattached. To this last class belong the masses of weed in the Sargasso Sea—the centre of the North Atlantic currents.

Round that huge collection of weeds and drift, which reaches over something like two hundred and sixty thousand square miles, the entire North Atlantic slowly revolves. And of these weeds—called "Sargassum"—none are attached to rock or ground, but all float loosely in mid-ocean. They seem to flourish thus, though the fact that fructification is not found upon them points to a somewhat unusual condition of things.

Sea-weeds more often multiply by means of spores, which is a form of vegetable-growth inferior to that of seeds. All spore-growing plants, whether on land or in the sea, take a lower rank than seed-growing plants.

A still lower and humbler method has been earlier described—that of simply dividing into half.

There is yet another way by which ocean-weeds increase, and it reminds one curiously of the gardener's plan of growth by cuttings.

In rough weather, on shallow reaches not far from land, the waves tear quantities of sea-weed fronds from their moorings, and carry them to shore or to rocky parts, where they become entangled, and are held fast.

There, if later waves do not again dislodge them, and if other circumstances are favourable, the wandering fronds settle down, attach themselves, and become fresh plants. So in this case the waves act as gardeners, and make cuttings of ocean-plants.

While plant-life in the ocean is plentiful in amount and abundant in variety, it is confined within limits. By far the greater part of Sea-weed existence is contained in the Hundred-fathom limit—that is, within six hundred feet of the surface. Not many kinds, indeed, can grow in anything like as much depth as five or six hundred feet.

Sea-weeds in abundance are found on shallow shores, near continents and islands; on the zone between high and low tides; and on gently-shelving slopes beyond that zone. Floating unattached sea-weeds, of the type which belongs to the Sargasso Sea, may be anywhere, over the deepest depths of the ocean. These, however, are not found living and growing very far beneath the surface: and Ocean's depths are without any kind of vegetable-life, except probably bacteria.

CHAPTER XVI.

CORAL ARCHITECTS

"Who layeth the beams of His chambers in the waters."—Ps. civ. 3.

"And surges roaring from below."—DIBDEN.

CORAL is a familiar enough object with us all, whether in the shape of a child's first plaything, or a girl's first trinket, or a Museum curiosity. It may be red or pink or white; it may be polished into smoothness or left in its natural state of jagged roughness, dotted over with tiny pits. In any case, it is a thing of interest and beauty. In any case, it is the dead skeleton of a once-living animal.

In the Red Sea alone about one hundred and twenty kinds of Coral are found, and in Ocean waters the numbers rise rapidly.

Perhaps one of the species best known to us is the small red coral of the Mediterranean, usually gathered from shallow parts, though sometimes fished up from a thousand feet deep.

This kind seldom exceeds ten or twelve inches in length; and when alive, the pretty branching skeleton is clothed in a thin tinted jelly-like vesture, which, though in a sense one, is yet no "single individual." It is formed of many polyps, all united together, while each has its own separate mouth, and each holds out its own tiny feelers for food. Once let the branch be taken from the water, and only one result can follow. Life quickly fades; the enfolding vesture disappears; and a bare red skeleton is left for use in the market, to be made into toy or ornament.

The word Coral has other associations. It carries our thoughts far from home to fair isles in tropical seas—isles connected in our memories with tales of shipwrecked mariners and hair-breadth escapes, of dashing waves and peaceful lagoons, of breadfruit trees and waving palms, of perpetual sunshine and endless holidays, of Robinson Crusoe adventures and interesting islanders, of poisoned arrows and ferocious sharks.

Such islands do exist, and in numbers far greater than we commonly realise.

At this moment I have before me a map of the world, made for the express purpose of showing "Coral Seas," or the regions where Coral islands are constructed. And the red patches are astonishingly plentiful, dotting a broad belt of ocean all round the world, except where that belt is interrupted by Continents, within the limits, roughly, of 30° north latitude and 30° south latitude.

In the West Indies coral islands abound. Travelling westward from America we come across the same material, in extensive regions to the north-east, the north, and the north-west of Australia. Tahiti, Samoa, the Fijis, the Solomons, the New Hebrides, the Carolines, the Marshall Islands, the Seychelles, and innumerable others, are literally made of coral.

Not made as sandstone and chalk are made, put together by the slow action of the sea, far below the surface. This is another kind of making.

Coral is built by living creatures, near the surface of the water. All that the waves have to do is, firstly, to bring abundance of food to the polyps, when alive, since by reason of their ponderous rock-skeletons they cannot go in search of food; and secondly, after the death of the polyps, to break and grind and heap together the skeleton-remains.

We have seen something of ocean "stone-makers," in the story of Chalk. Here we have the same thing again. As the tiny shells, which go to the building of chalk, are the dead remains of once-living jelly-specks, so these great masses of coral, forming islands and reefs in southern seas, are largely the skeletons of once-living polyps.

A coral-polyp, like a jelly-speck, has power to take lime from sea-water. It has power to secrete carbonate-of-lime. It has power to deposit that carbonate-of-lime in solid masses.

But whereas the jelly-speck lives inside its shell, putting out tiny temporary limbs through holes for food, the coral-polyp more often lives outside its skeleton, clothing the dry bones with translucent jelly. This is rather more after the fashion in which man clothes his skeleton. Yet because of its make the coral-polyp cannot properly, in the full sense of the word, "secrete" or hide its internal framework.

It is hardly fair to speak of "the polyp" and of "it" in this connection. "Polyps" and "they" are more correct.

For the coral-polyps live in close communities, in very near fellowship, acting on co-operative principles of the most advanced kind. Each individual may, it is true, have its own mouth, its own tentacles, and even its own small stomach. But the latter at least can hardly be reckoned as personal property, since all are so connected that liquids pass freely from one to another, and the food which is taken in by one polyp helps to nourish its neighbours.

And again, while we speak of coral as being "built," that really is not the right word; unless we may also talk of the "building" of a man's skeleton, or of an elephant's framework.

"Built" undeniably it is; but the building implies no conscious effort, no deliberate intention, no praiseworthy exertions, on the part of the builder. Coral is simply "secreted"—is unknowingly and without choice put together by the polyps.

There *is* invention; there *is* plan; there *is* design. But these belong to a Mind, above and beyond and out of sight; not in anywise to the live jelly which clothes the coral-skeleton, or to the extremely limited understanding of that co-operative jelly-sheet.

Not all polyps have stony skeletons. On our sea-shores we have species many, and individuals by tens of thousands, which secrete no coral. They are known to us as Sea-Anemones: and the first-cousins of these dainty flower-like beings, inhabiting British salt-pools, construct miles and miles of coral far off in southern seas.

Some few even among coral polyps live individual lives, but the greater number follow the community-system. This must always be looked upon as an inferior way of existence.

The most usual way in which polyps increase is by "budding"—not unlike the growth of a plant by buds. A small lump appears on one side of the parent, which increases fast in size, develops a mouth and tentacles, and by-and-by gives birth itself to other buds. The increase of numbers is enormous. One polyp may produce in a short time thousands or even tens of thousands of descendants.

But in the case of coral-polyps the children do not leave the parents or go out into the world. They cling to the old stock; they partake of the united family-life; and each little mouth and stomach works for the benefit of all the little stomachs of the whole community.

Some polyps, instead of budding like a plant, increase by division. One polyp separates into two parts, each of which becomes a full-grown animal; and each then divides anew; this plan continuing *ad infinitum.* Here again the growth of numbers is not slow.

Occasionally, in place of spreading in branch-like shapes, they grow in solid rounded masses. Such a sphere-like mass in tropical waters of the Pacific may be twenty feet in diameter—one huge family of united beings, each perhaps under a twentieth of an inch across, and all together clothing a skeleton common to the entire clan.

In these cases the tips of the branches or the outer edges of the rounded mass are the *young* polyps, while the older ones lie lower down or more inward.

As the tree or ball of coral grows, spreading farther, giving birth to fresh generations of polyps, the old ones die off. So the living and the dead are found in one community, in close touch, on a single branch or a single mound of coral. At the tip of each twig may be the brightly-coloured active jelly, while the stem below is a dead skeleton. On a solid mass of coral, twenty feet in diameter, the whole outside may be alive, down perhaps to a depth of half-an-inch, while the whole inside is lifeless bone. That is how the coral grows.

Living coral is seldom found at any greater depth in the sea than about twenty fathoms, and the limits of temperature which the polyps can endure are narrow. Their growth is quickly checked by water a little too deep or a little too cold, and by water not very pure. Abundance of lime also is needful.

An "atoll" is a coral-reef standing alone, generally of a round or oval shape, with a lake of calm sea-water in its centre, while ocean-billows thunder on the outer margin. The polyps love those waves; but they fade and die in the inclosed lagoon, where the water is not often enough renewed to supply them with food.

Much the same in make are the Fringing Reefs and Barrier Reefs, except that the former skirt the shore more closely, while the latter may lie at a distance of many miles from island or mainland.

It is impossible for the polyps to raise their stony structure above the sea. Some kinds can endure exposure to the air for a short time without dying, but only for a short time. A coral island, when first built, is merely level with the ocean-surface at low tide.

But old Ocean carries on the work which the polyps have begun. Heavy rollers break incessantly against the reef, loosening blocks of coral, some of which are flung bodily upon it, while others are pounded into sand, which fills up holes and crevices. Gradually thus the whole becomes cemented into hard reef-rock.

As this goes on the low island slowly rises, until it has climbed above high-tide level.

Then the task can only be completed by waves of exceptional reach. Still the grinding of coral to fine sand goes on; and in time it gains a depth of some inches. And the waves carry seeds and cocoa-nuts to the spot; and shrubs and trees spring up, to sow again their own seeds, and by gradual decay to form mould. Thus it comes about that a little island is made ready for man to live on.

One might expect these stages to be very slow indeed, but such events march at the double in tropical climates. In the Low Archipelago one atoll was found, in the space of only thirty-four years, to have been transformed from a mere rock-reef to a lagoon island, fourteen miles in length, with tall trees growing along almost the whole of one side.

As a specimen of the sizes to which coral-buildings reach, the Maldive Archipelago may be named. It is a vast collection of islands and reefs, stretching to a length of four hundred and seventy miles, and in parts fifty miles broad. Barrier-reefs, reaching through many hundreds of miles, are even more remarkable.

Travellers write stirring descriptions of the beauty of these erections. The vivid pen of Miss Gordon-Cumming, for instance, has painted many a picture of Pacific reefs, of thundering breakers, and dazzling white surf.

We are told by her of "the patches of coral, sea-weed, and sometimes white sand, lying at irregular depths beneath a shallow covering of the most crystalline emerald-green water," producing "every shade of aqua-marine, mauve, sienna, and orange, all marvellously blended." And, again, of the wonderful masses of living coral which grow like garden-plants below the clear water, and of branching shrubs of all imaginable tints, such as pink, blue, mauve, and primrose.

To pluck and carry off these ocean-blossoms would be a vain attempt, for the "gelatinous slime" to which the colours belong "drips away, as the living creatures melt and die, when exposed to the upper air."

From the pen of another eye-witness* we have a description of a visit at low-tide to the barrier-

* The Hon. Ralph Abercromby.

reef of Levuka, the old Fiji capital. We learn that the reef itself consists mainly of dead coral—"rough, uninteresting, shapeless limestones, with a very small covering of seaweed." But after about a quarter of a mile of difficult walking, the travellers drew near to the "roaring surf on the outside," where "fingery lumps of beautiful live coral began to appear, of the palest lavender-blue colour." By the time that they were nearly within touch of the spray, "the whole floor was one mass of living branches of coral."

It was not, however, until they ventured actually into the water, beyond the outer verge of the "great sea-wall," that they could see for themselves the true nature of the reef.

This was the description given. "You look down, and see a steep irregular wall, extending deeper into the ocean than the eye can follow, and broken into lovely grottoes and holes and canals, through which small resplendent fishes of the brightest blue or gold flit fitfully between the lumps of coral. The sides of the natural grottoes are entirely covered with endless forms of tender-coloured coral, but all beautiful, and all more or less of the fingery or branching species, known as madrepores. It is really impossible to draw or describe the sight."

Equally impossible was it to photograph these fairy grottoes, "seen through twenty feet of surging water," though some snapshots were taken in moments when the vast billows withdrew themselves.

One difficult question in connection with coral reefs has been—How can they rise, as they do, out of considerable depths, when coral-polyps cannot live below some twenty fathoms from the surface?

Two chief explanations have been offered, each of which has been warmly taken up and defended.

One meets the difficulty by means of the theory of a rising and sinking earth-crust. A mountain-top might have been first heaved up to within twenty fathoms of the surface. Then later, while the polyps were building upon it, the mountain might have slowly sunk. In that case the polyps below would die, as the water deepened; but the wall of dead coral would remain, reaching in time very far down.

The other explanation also admits that coral-reefs have been generally built upon sub-ocean heights. But it supposes that height to have been partly raised by volcanic forces, and afterwards built up to the needed height by a growing collection of oozes and animal-remains, deposited through ages.

Many proofs have been found in recent years of the probable truth of the latter theory. Still, it does not of necessity do away with the earlier explanation. Here, once more, the question may be asked—Why should not both be true? If some submarine peaks have been lifted to just the right level by gradual building up of sediment, others may have been so raised by volcanic action or crust-crinkling.

Either way, it is a marvellous tale.

Thousands of miles of solid reef-rocks; hundreds of substantial inhabited islands, all reared, inch after inch, by a mere "gelatinous slime," by soft-bodied jelly-like creatures, first cousins to the dull though pretty anemone of our shores!

The thing sounds incredible! A stranger from some far-off world—a stranger even from polar regions on our Earth, unlearned in the lore of warmer oceans—might scout the story as absurd.

Yet no fact in Natural History is better attested, or stands on a firmer foundation. There is a good deal more in the philosophy of this small world than appears at first sight.

CHAPTER XVII.

OVER THE OCEAN-BED

"The wrecks dissolve above us: their dust drops down from afar;—
Down to the dark, the utter dark, where the blind white sea-snakes are.
There is no sound, no echo of sound, in the deserts of the deep,
O'er the great grey level plains of ooze, where the shell-burred cables creep."—RUDYARD KIPLING.

BY way of variety, shall we take a little excursion together, you and I, into those under-sea regions of which so much has been said in past chapters? Regions which the foot of man has never trod; which the eye of man has never seen; which, except in death, the hand of man has never touched.

Shall we leave behind the fair Earth that we love, the sunshine, the bright sky, the fields and hedgerows, the blue sparkles of Ocean's surface, and go down and down, through a waste of lonely waters, till our feet rest upon firm ground below?

"Eh, but it's eerie!" we might say, were we of Scots descent. Sunlight is at once lost sight of, and twilight deepens fast.

A heavy cyclone may be raging above, but the troublous turmoil soon ceases to affect us. Stormy billows, with their showers of spray, cannot disturb the calm of these depths. As we sink lower, we find ourselves enwrapped in stillness. A creeping current is around us, yet with movement so gentle that we are not aware of it.

During the early part of our descent we come across innumerable sea-weeds; delicate floating red fronds, and long brown ribbons tangled together.

Presently we pass through a sticky slimy mass of Diatoms, reaching far to right and left, and of great depth. Untold millions of those tiny vegetables are living and growing together, in one enormous floating bank.

Now we have reached the "hundred-fathom limit," and as we go beyond it, we find marked changes from the life we have known above.

No seasons here. No variations from summer to winter, from spring to autumn. Only one dead level of perpetual chill, becoming colder and colder.

No light here. No variations from night to day, from evening to morning. Nothing but continuous midnight blackness, unrelieved by the faintest gleam of sunshine.

No plant-life here. No ocean-weeds of any kind. Those things we have left behind us, far above.

Dead sea-weed fronds are indeed abundant, sinking slowly downward, in company with ourselves; and dead Diatoms, with dead microscopic creatures of many kinds, rain incessantly from the surface waters to the ocean's bed. But they are far too minute for us to feel them, as they slip noiselessly past. *Seeing* anything, small or large, is out of the question.

No light; no waves; no colour; no beauty. Only unbroken stretches of silent water, with intense and penetrating cold.

A mile or more below we find ourselves on firm ground. This is the topmost peak of a sub-ocean mountain range, rising from the bottom of the sea. In the darkness we grope our way to the verge, then slowly walk down its sloping side, under a ponderous weight of water, while our feet are upon a sticky unpleasant ooze, which seems to be everywhere.

Only not quite everywhere. The nature of the ocean-floor varies.

Here, for instance, we come to a patch of hard ground, reaching some little way. But the sticky ooze mainly prevails, varied by less sticky mud. And neither ooze nor mud is always of the same description, as we should discover if we walked far and examined specimens from each district. There are muds and muds—oozes and oozes.

Crabs in abundance scuttle over the ground, as we may know by feeling, if we have left our boots behind. And slimy creatures of various kinds flourish, none of them precisely the same as those which inhabit our sea-beaches in regions of light, yet their near relatives. Stooping down, we touch a rough-coated hedgehog ; and then our fingers come into contact with a mass of slimy tentacles, which sting sharply.

One would like to be able to see, as well as to feel. But into these depths no gleam of sunlight may ever penetrate.

Yet, as we stroll onward, plodding through the thick plastic ooze, in the pitchy darkness we become aware of a light, a hazy light, drawing near.

One does not expect to find a lantern down here in the deep ocean-waters. It positively seems to be a lantern, moving as if it had a will of its own. And about the small living lantern, during its approach, we see many creatures congregated, swimming and whisking round, evidently making use of the glimmer to catch their prey.

When it has come close, we find the light to proceed from a soft-bodied jelly-like animal, which, as it travels, carries its own illumination with it. Had we in upper regions such power to shine for ourselves, we should be delightfully independent of artificial light after dark.

At first our impression is that the sub-ocean lamp must be a very uncommon phenomenon. But as we go on we encounter another and another—different indeed in species, yet alike in the possession of natural light-giving organs.

It dawns upon our minds gradually that, even in ocean-depths, the law of compensation is not unrepresented. Even those dark regions, cut off though they are from all rays of sunlight, do not lie under total midnight blackness unrelieved. Even here, in these desolate nethermost parts of the ocean, creatures with eyes may live, and may find a good use for those eyes.

For glimmer after glimmer is seen; and jelly-like animals under our feet, when accidentally touched, give forth rays, sometimes rays of many colours; and fishes, as they flash past, lend occasional gleams; and larger uncouth monsters do the same—all helping to light up a world beyond reach of the sun.

Talk of depths! We are in them at last, and no mistake. Down—down! Deeper and deeper! Above our heads are piled three or four miles of water, and the pressure upon our unfortunate bodies is terrific.

Here creatures of simplest form abound,—Protozoa, or First Animals, tiny jelly-like specks, mere living cells, too small by far for us to see, even with the help of animated deep-sea lanterns, unless we have carried with us a powerful microscope. But we know them to be there. The ooze and mud alone, when carefully examined, prove the fact.

Here are foraminifera, living and dead; and skeletons of reef-coral, all dead; and specimens of deep-sea coral, both living and dead; and remains of bigger creatures innumerable, which have disported themselves in the waters above. Yet not so many of these last as one might have expected, because of the destructive power of sea-water.

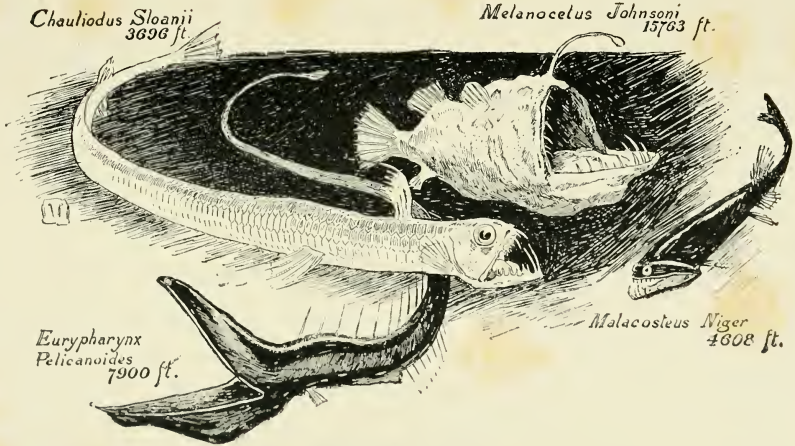
There are also plant-like zoophytes, and disc-shaped jelly-fishes. There are sea-urchins and starfishes. There are sponges in great numbers, wandering young ones and old ones settled down for life, once looked upon as vegetables, now known to be animals. There are molluscs of various kinds. There are long slimy wriggling worms. There are the inevitable crabs, large and small. There are countless fishes swimming about, not in the least embarrassed by the astounding fact that they have something like three and a half miles of water between them and fresh air and sunlight.

Unexpectedly we come upon a great ship, lying where it has lately sunk.

The busy sea, always busy even when most quiet, is hard at work demolishing the structure of the vessel; though still in the darkness we can feel the tall mast, the solid sides, of the noble craft, which once floated buoyantly far above, in light of day. Now it reposes on the ocean-bed, never again to be of service to man. Its race is run; its tale is told. Alas! good ship! which, but for one fatal storm, might still be actively engaged in its country's service.

But we find no human remains. If they be there, our searching has failed to alight on them.

Small wonder, in the great space and the blackness. A medusa gleam of light has little power to aid us in this search.



DEEP-SEA FISHES

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Perhaps slow currents have carried elsewhere the bodies of men who went down with the ship. Or perhaps the bones have succumbed already to the destructive working of ocean-waters. Or perhaps all on board were saved, when the gallant vessel sank. Let us hope that it was so.

We are leaving the sticky ooze and getting into a region of stiff clay. If there were light enough, we should find it to be of a reddish tint. Here we do find bones—remains of creatures of a higher class, though not of man, the highest of all. Here are sharks' teeth in great abundance, and many earbones of whales. Not much, after all, but something that tells of Life.

Another lofty mountain height under water, rising from the ocean-bed. Shall we climb it, and see whither it may lead us? Have we not had enough of these black mysterious depths?

Now up and up, cautiously feeling our way and using any such glimmers of living light as we come across. By-and-by we find ourselves getting into shallower water. Evidently this sub-ocean mountain approaches near to the surface. It will not end, like the last, a mile or more beneath.

Here is a region of solid limestone rocks, made of reef-coral, which has been ground and pounded by the waves, and afterwards cemented firmly together. We are getting into levels where the waves have power.

Presently the firm limestone is exchanged for coral mud, and later that gives place to reef-sand. By this time we have around us, not only living animals but living sea-weeds, which fact tells of our nearness to sunlight. It may still seem dark to us, but some light must be able to filter through, or plant-life could not exist.

A few more fathoms of ascent, and we too are aware of light—dim and faint at first, yet steadily increasing.

Shall we step out into the fresh air, the radiant sunshine, of a South-Sea coral island—into a world of light and life and beauty, all the fairer and the sweeter in its contrast with those gloomy under-ocean regions through which we have been wandering?

CHAPTER XVIII.

MULTITUDINOUS LIFE

"This great and wide sea, wherein are things creeping innumerable, both small and great beasts."—Ps. civ. 25.

"The dense immensity
Of ever-stirring Life, in thy strange forms
Of fish and shell and worm and oozy mud."—KINGSLEY.

SOME thirty or forty years ago the knowledge which man had of the "Great Deep" was practically *nil.*

We know a good deal more now, thanks to the famous voyage of the *Challenger*, and to many other observations, though still the full sum of our information is small compared with the much that we do not know.

In the year 1872 the good ship *Challenger* quitted British shores for her long tour of discovery. During nearly three years and a half she cruised about the world, dipping her instruments into the water at frequent intervals, measuring the depths, studying the temperatures, making note of other conditions, and bringing up from the ocean - bed materials whereby to judge of the state of that dark nether-world, hidden from our eyes by intervening miles of water.

Three and a half years of steady work; hundreds upon hundreds of soundings; thousands upon thousands of miles traversed; tens of thousands of specimens hauled up; days and weeks and months devoted to unremitting study of those specimens! This is what the *Challenger* Expedition meant. No wonder our knowledge of the Under-Ocean has grown by leaps.

And yet no wonder it is still confined within narrow limits. So enormous is the extent of the Ocean,—so few comparatively are the parts which have been under close examination!

Imagine a monster giant striding with vast steps over the sea, and at intervals of a mile or two dipping a long arm into the depth, to bring away a handful of whatever might lie upon the bed below. No doubt he might and would thus learn a good deal that he had not known before. Still, at the best, tens of thousands of square miles would lie around in all directions, untouched by his searching fingers.

This is very much what the Expedition was able to do. A handful here and a handful there was brought up, as a specimen of what might be found below. But tens of thousands of square miles, to north and south and east and west, remained untouched.

None the less, from these occasional "dips," however few by comparison with reaches not examined, we know far more than our forefathers could have dreamt of as within the bounds of possibility.

Instruments, many and complicated, are used in deep-sea researches—far too many and too complicated to be described here. Two or three may be mentioned.

Sounding-machines proper are largely employed, sometimes carrying water-bottles, and always brass tubes, weighed down by "sinkers," which remain behind when the tubes are drawn up full of mud or ooze.

Small dredges are dragged along the sea-bottom, gathering whatever may lie there loosely, and bringing it to the surface.

Trawls also are necessary, with beams from ten to seventeen feet in length. Such trawls, held by strong steel cables thousands of fathoms long, can often lift seven tons of material.

Into the bottom of a dredge-bag and of a trawl-net fine cloth is frequently sewn, so that mud and small animals may not slip through and be lost.

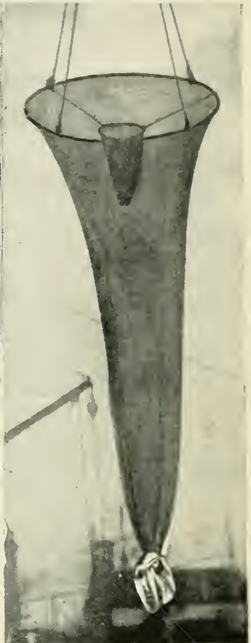
Immense supplies have been thus dredged and hauled up from the bottom of the sea. Muds and oozes, sands and pebbles, stones and rocks, shelly deposits, volcanic deposits, remains innumerable of dead plants, remains still more abundant of animals, including earbones of whales and teeth of sharks, and more rarely other parts of animal-skeletons — large, small, microscopic, these all have been, with infinite care, with infinite patience, sorted and examined and classified.

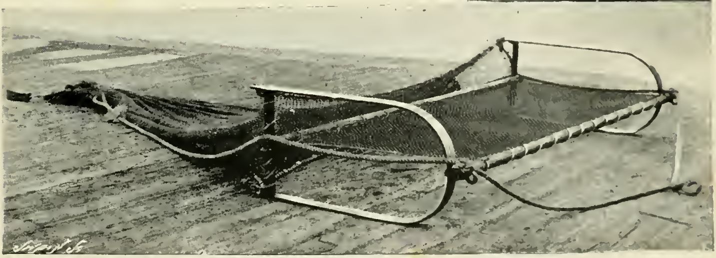
Teeth and earbones! But where are the great shark-skeletons? Where are the mighty bone frameworks of whales?

If a whale's earbones lie here, surely here also must have sunk the enormous carcase. Yet all the rest has vanished. All has been dissolved —disintegrated—eaten up, as it were, by the black and silent waste of water. Sea-water has an extraordinary dissolving power, much intensified by added pressure at great depths, and few substances can long withstand that power. Not even the massive skeletons of sharks and whales, with the exception of the teeth and

DRAGGING THE TOW-NET TO CATCH MINUTE SURFACE ANIMALS

Note sailors with small nets





BEAM-TRAWL AND TOW-NET EMPLOYED IN DEEP-SEA RESEARCH

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earbones, which are formed of peculiarly hard material.

And never once, throughout the whole cruise, was any single bone of Man brought up from the ocean-bed.

After all is this surprising? Where even whale-skeletons are mastered, small chance can remain for a human skeleton to stand out long against absorption.

The marvel is how tiny foraminifer shells can last as they do. The majority no doubt disappear. Unless they reach the bottom quickly, and are there covered up and protected, they must soon be dissolved.

Yet that vast numbers do thus escape we know by the masses of ooze found over the sea-bottom; by the fifty millions or more of square miles of the ocean-floor carpeted with coral muds and sands, and with oozes of foraminifera and kindred shells.

Only down to a depth of about two miles. Beyond that, carbonate-of-lime shells are seldom found. It is believed that these light shells take as much as three or four days to sink one mile; and in about two miles they all succumb to the power of sea-water. But the hard little diatom cases are present in all depths, more especially in Earth's colder regions, where they abound most freely.

The ocean-bed has been described as one huge sepulchre, full of the remains of once-living creatures. And this is true; yet by itself it gives a very one-sided view. Not less is the ocean-bed to be described as a world of abounding Life.

Everywhere, throughout the whole sea, in all parts, above and below and between—near the surface, on the floor, in all intermediate reaches—living creatures flourish in numbers past imagination.

Not everywhere equally. Here may be found a wonderful richness of animal-life. There the explorer may alight on a barren region. Yet even those parts more scantily supplied need not be always thus. Living creatures in vast hordes, in enormous companies, drift to and fro, rise upwards and sink downwards; and the district which to-day seems almost devoid of life may to-morrow be thronged with active beings.

The Ocean's inhabitants have been roughly divided into three Classes — Deep-Sea Life, Intermediate Ocean Life, and Surface Ocean Life.

The first of these includes all animals which crawl upon the sea-bed, or which live within about three hundred fathoms of it.

The second includes all animals which live between about three hundred fathoms of the sea-bottom and three hundred fathoms of the ocean-surface.

The third includes all animals which live within three hundred fathoms of the surface, and those on shallow shores.

By far the greater number of living creatures appear to inhabit the surface regions; and it may be that the next in number are those on and near the ocean-bed. This, however, is uncertain. It is difficult to judge about the intermediate depths. All creatures living there must be extremely good swimmers, and they are very shy of nets.

We cannot readily picture to ourselves the manner of life which goes on in those intermediate parts. Creatures there have, as it seems, no connection with either the ocean-bed or with shallow shores—no resting-place to which they may turn—in short, no home. Though one may not realise the fact, few animals within our ken have not something in the shape of a home, a *pied à terre*, to use a familiar term, though that "terre" may be under water.

The very idea of a life spent always in swimming or floating through boundless depths, never touching firm ground, having no kind of home or retreat, suggests vagabondage, and sounds disconsolate.

It may be that the difficulty is at least partly met by those great floating banks of living creatures which are often found.

Diatom-Banks have been already spoken of. But other animals of larger growth also band together, forming vast companies. To each individual in such a congeries the Floating Bank would be a home. It would matter little to that individual whether the bank as a whole floated here or drifted there, whether it rose at night to the surface of the sea, or whether in daytime it sank lower to escape from the sun's glare.

Many such banks of life belong strictly to the Surface Class rather than to the Intermediate. But the want of a home applies equally to all creatures who live a free and roving life in the Ocean, unattached to shore or to sea-bed, whether they live above or below the three-hundred fathom limit.

Another puzzling question has been as to how deep-sea creatures are fed.

In Life on *terra firma*, generally, the work of plants is to make ready food for animals. Many substances, which are needful for animal-structure, cannot be taken in by them until broken up and re-made by plants. And plants can only carry out this task in sunlight. Where the light of the sun fails, there plant-life fails also.

But direct vegetable food is not always necessary. Arctic animals—bears, seals, walruses,—cannot get it except at second or third hand, through the bodies of other animals. Perhaps this was forgotten by some who maintained that no animals could, by any possibility, flourish in ocean's greater depths.

Numberless observations have now thrust that theory on one side. By the dredgings and trawlings of the *Challenger*, not to speak of later explorations, it has been conclusively proved that, even down to great depths, animal life is marvellously plentiful.

Two or three examples may be given. A single haul, made in water more than a mile deep, brought up animals of two hundred different kinds. Another haul, in a depth of two miles, had the same result. Another, in a depth of three miles, brought up fifty different kinds. All these it was known, by tokens learnt from close study and much experience, had certainly lived near the bottom. Again, from depths of four miles many creatures, including fishes, appeared. Even in a depth of over five miles, signs of life were not lacking.

Who, after this, may venture to name a depth at which Life is altogether impossible?

Although plants cannot live and grow in the darkness of nether ocean, their decaying remains are incessantly raining downward from higher levels. Animals in the intermediate parts, and perhaps also near the sea-bed, can feed largely upon these falling sea-weeds. Immense quantities are doubtless snapped up *en route;* but many also reach the ocean-floor undevoured, since vegetable-remains often figure in the muds and oozes brought up thence.

Deep-sea animals are very extensively eaters of mud and ooze and clay. It does not sound like appetising fare, or what our grandparents used to describe as "palatable." But the palate of a deep-sea fish or crab differs from that of a man; and since no better vegetable-food offers itself, they are probably content.

That the said creatures do really subsist in a measure upon such materials, is known for a fact. When drawn up to the surface, they are found often to have their stomachs full of the mud or ooze or clay which in that particular place carpets the ocean-bed.

Even in far shallower waters, not much removed from the "hundred-fathom line," though still beyond the region of living sea-weed, crabs dredged up are found to have indulged freely in the same frugal rations.

There is of course no difficulty as to animal-food in any depth. The fight for life goes on below, as above; and the weaker succumbs to the stronger, or the less cunning to the more subtle, in the deep as within reach of sunlight.

CHAPTER XIX.

OCEAN FLOWERS AND LAMPS

"These are the works of the Lord and His wonders in the Deep."
Ps. civ. 24.

"Every track
Was a flash of living fire."—Coleridge.

"WE have already learned," wrote Albert, Prince of Monaco, not long since, in reference to recent Ocean researches—"that a whole world of Fishes, Molluscs, Annelids, Medusæ, Cephalopoda, and Crustaceans, come to the surface at night, and return before day to a depth of some hundreds of fathoms, forming a living tide which ebbs and flows in every sea."

Letting alone for the moment other creatures mentioned in the above list, let us think about the vast world of Medusæ—of Jelly-fishes and their relatives—with which the Ocean is largely peopled.

Whether Hydroids, Jelly-fishes proper, Coral-polyps, or Sea-Anemones, they all belong to a low order in the Animal Kingdom. Higher, certainly, than the minute specks of life described in past chapters; higher than Foraminifers; higher than Sponges; but lower than Sea-urchins and Starfishes; very much lower than Worms and Oysters.

They vary immensely in size, ranging from minute jelly-bags, without limbs or heads, mouths or stomachs, to great masses of jelly-like substance, with eyes and mouths and powerful stinging apparatus.

All these are included in the circle of near relatives to the "Medusæ," which name was first bestowed upon the anemones from a supposed likeness between the snaky tresses of the mythological Medusa and the tentacles of these soft-bodied animals.

"Ocean-flowers," many of them may truly be called, since they live and grow, rooted like a plant to one spot; since also they put forth veritable buds and blossoms. Only they are in nature not vegetable, but animal. Many of these ocean blooms are exquisitely beautiful; but they may not always be gathered with impunity.

"Ocean-lamps," too, many may with truth be named. Large numbers of the coral-polyps, large numbers of the hydroids, and perhaps all of the free-swimming medusæ or jelly-fishes, carry with them their own little lanterns, wherewith at night to make bright the surface of the sea—wherewith also to bear glimmers of light downward into those black depths where sunlight cannot reach.

That Jelly-fish which "swam in a tropical sea," and said, "This world it consists of ME!" must have been an unusually intelligent specimen of its kind. Jelly-fishes in general are not credited with even much bodily sensation, far less with mental originality.

Coral-polyps have had their meed of attention in an earlier chapter. There is a near relationship between the reef-builders of equatorial seas and the anemones of British sea-beaches. But the anemone is a creature of distinctly higher development than the co-operative coral-polyp. It has at least the great gift of individuality, which its reef-cousins have not.

Sea-anemones have been compared to garden asters, and indeed the resemblance is not slight. The living tentacles of the one might almost be taken for a rough copy of the thick petals of the other.

In general form sea-anemones are round soft disc-like bodies, surrounded or trimmed by a border of fleshy tentacles, and mounted on a thick fleshy stalk or cylinder, which is usually either fastened to a rock or buried in the sand.

They vary in size between half-an-inch and more than a foot in diameter. A splendid specimen, to be found in the Pacific, is fourteen inches across the disc.

These creatures are not without a limited power of moving from place to place; though, in the case of most "attached" anemones, movement is extremely slow. A few kinds do not attach themselves at all, but rove freely through ocean-waters, after the fashion of their cousins the jelly-fishes.

One particular species, which seems to approve of change of scene, and yet not to love exertion, has hit upon a clever dodge.

When quite young it fixes itself upon the shell of a certain kind of crab; and as it grows larger, it gradually covers the whole back of the crab. Where the crab goes, the anemone goes; when the crab rests, the anemone rests. Oddly enough, the crab does not appear to object to his burden.

This is no mere accidental comradeship, seen only in rare cases; for that special description of crab is never seen without its friend the anemone perched confidingly upon its back; and that special description of anemone is never seen without its friend the crab for a steed.

A sea-anemone, like a coral-polyp, has a mouth and a stomach. But unlike the coral-polyp, it has the mouth and stomach for its own use, not merely in trust for the benefit of the whole community.

When the pretty flower-like creature wishes to open itself out, it takes in a quantity of salt water. When it wishes to shut itself up, it spurts the water out, drawing its tentacles close.

Both mouth and stomach are elastic; and it is able to swallow animals that are very little smaller than itself. Sometimes it gulps up greedily a whole crab or bivalve, digesting the soft animal parts, and getting rid of the useless shell as easily as it gets rid of water, when about to close.

Soft and mild and helpless as a sea-anemone may seem, it is really far from being defenceless. Within that plump body, around the mouth, in the skin, about the tentacles, and along the slender hanging white cords, lie concealed thousands, even millions, of weapons. Each weapon is a very fine and delicate thread of hollow make, curled tightly up in a minute cell, ready for use.

When a sea-anemone desires to injure or to kill, either in defence or in attack, it darts out a number of these little "lassos" as they are called.

Each lasso is not merely unwound, but is actually turned inside out, as you may turn a stocking inside out, when drawing it off. And as the instantaneous process takes place, poison flows with the tiny dart into the wound that is made. Small though each lasso may be, when dozens or hundreds of them are launched together, the result is not contemptible, even as regards man; and ocean creatures die fast from the poison.

A cell which contains a lasso is about one five-thousandth of an inch across; and two hundred lassos, placed end to end, would reach to about an inch in length. When once a lasso has been darted forth, it can never again be used, because it cannot be returned to the cell. But so great are the supplies of them, that a sea-anemone never gets to the end of its armoury. Even if all were used, others would speedily grow in their place.

Some kinds of animals, living in the sea and of service to man, are in danger of being thinned out of existence by the incessant ravages of net and trawl, of hook and harpoon. Not so the world of Anemones. So vast are their numbers, so rapid is their increase, that no antagonistic forces can annihilate them.

It has been said that if every anemone on British shores were one day swept away, carried off by an army of ardent naturalists, or destroyed by waves in some tremendous tempest, the next inflowing tide would bring a fresh supply, sufficient to fill all gaps.

Not less numerous, perhaps far more numerous, are the countless hordes of Jelly-fishes, so called, though they are not fishes—of Sea-nettles, so-called, though they are not nettles.

They travel freely through the ocean depths, like fishes; and they sting sharply, like nettles. Yet they are neither.

Another name given to them is that of "Sun-fishes," because in calm weather they often float close to the surface of the sea, as if delighting to bask in sunshine. One could almost imagine that, after the fashion of modern "luminous paint," they are taking in sunlight, to carry stores thereof later into dark depths, for the benefit of less favoured comrades. But let a heavy storm arise, and swiftly these fragile creatures wend their way into the placid depths, beyond reach of wind and wave.

Many years ago a story was told of a certain farmer, who had heard that medusæ were particularly good as manure. He had large supplies of them carted to his land, with much expense and trouble. Not till later did he learn how small a part of the creatures consisted of anything but water; how easily he might have had the whole mass of them dried, and then carried by hand, at almost no cost.

Medusæ, as earlier stated, are of all sizes, from tiny translucent bags of liquid to huge discs of jelly-like substance, rivalling a man's umbrella in diameter.

They are also of all kinds and shapes. Many of umbrella-shape have, in place of a handle, bundles of fleshy tentacles hanging down below, and thin streamers reaching to a length of a hundred feet. Some are more like saucers or bowls. Others of longer and narrower make have been likened to large thimbles. Some are ribbon-like beings, moving in graceful serpentine folds. Others have the outlines of elegant tubes. Many, again, are like little inverted delicate shrubs, or fairy-seaweed fronds, hanging downward. Some carry sail upon the surface of the water.

While all are of a more or less jelly-like substance, some are so frail and watery that they can only be lifted out of the sea in a pail. Any other mode causes them to drop to pieces.

But the most wonderful and beautiful characteristic of the jelly-fish is that of its self-illuminating power.

Here is a description of one kind, found in the Atlantic, near the coast of North America:—

"Objects of more exquisite beauty than some of these hydroid-medusæ do not perhaps exist. Each minute crystal chalice, with its beautifully curved outline, elongated delicate tentacles, gently coiling and uncoiling, and its slender proboscis which hangs like a lamp in the centre, lighting it with a soft phosphorescent glow, is the very type of delicate beauty, suggesting the wonders of fairyland." *

And here is another description, no less striking; not this time of a floating medusa, but of a small coral-zoophyte, about ten inches long, common in the Mediterranean and in the Atlantic:—

"Nothing can exceed the beauty of the elegant opaline polyps of this zoophyte when fully expanded, and clustered like flowers on their orange-coloured stalk; a beauty, however,

* J. S. Kingsley.

almost equalled by night when, on the slightest irritation, the whole colony glows from one extremity to the other with undulating waves of pale green phosphoric light. A large bucketful of these Alcyonaria was experimentally stirred up one evening, and the luminosity evolved produced a spectacle too brilliant for words to describe. The supporting stem appeared always to be the chief seat of these phosphorescent properties, and from thence the scintillations travelled onward to the bodies of the polyps themselves." *

Travellers in all ages have described the marvellous illuminations seen at night on the ocean surface; illuminations long a mystery to those who gazed with admiration. At times the whole sea is one blaze of light; and the ship cleaves her way through liquid silver, or crimson glory, through milky whiteness or flames of blue and red.

And the greater part, if not the whole, as we now know, is due to uncountable multitudes of jelly-creatures, floating close to the surface, each contributing its tiny share to the radiant sheen. Sometimes they are large enough to be visible to the naked eye, but more generally

* *Corals and Coral Islands*, by DANA.

they are minute microscopic beings, far too small individually to be seen by us, yet apparent in the mass by their united brilliance.

If millions of their glowing lamps shine in ocean's deeper parts, we need no longer marvel to find deep-sea animals with large and well-developed eyes.

While on this subject, it should be added that the Medusæ have not a monopoly of ocean-lamps. Other creatures share in the task of lighting up those midnight depths.

Not long since two new species of fishes were discovered off the Azores, both of which possessed delicate organs of light-giving power. In one of them the rows of tiny lamps could be used or hidden "at will"—allowed to shine upon the world around, or shut off by a thick dark skin, somewhat after the fashion of a policeman's "dark lantern." Cuttle-fishes too have been found carrying natural lamps for sub-ocean use.

CHAPTER XX.

ARMOURED MYRIADS AND MONSTERS

"The Sea hath its Pearls."—LONGFELLOW.

"From out thy slime
The Monsters of the Deep are made."—BYRON.

AMONG the multitudinous hosts of living creatures which throng the Ocean, vast hordes are furnished with some kind of protective armour, the better to take their part in the ceaseless warfare for existence.

Though the armour differs widely in different kinds of animals, they offer one and all a great contrast to the soft jelly-like Medusæ.

Starfishes and Sea-urchins, for example, are guarded by tough or hard skins, with actual plated armour and sharp prickles. Limpets are sheltered behind single firm shields, and in any moment of peril become instantly glued by suction to a rock. Oysters dwell within stout bivalve shells. Hermit-crabs carry with them empty purloined shells, of other creatures' construction. Crabs and Lobsters wear strong suits of sheltering armour, joined together bit by bit, as knights and squires of old were clothed from head to foot in the many "pieces" of a mediæval soldier's military suit.

The armoured hosts belong to various divisions in the Animal Kingdom,—starfishes and sea-urchins to one; limpets and oysters to another; crabs and lobsters to a third. And all three, together with microscopic jelly-specks and sponges and coral-polyps and medusæ, belong to a much greater Division, which embraces all "Invertebrate" or Backboneless creatures.

If they have not backbones and ribs, they have skeletons of a kind. Only, as a general rule, the skeletons lie outside or are visible through the transparent body, instead of being hidden away inside, as in most fishes.

The prickly-skinned starfishes and sea-urchins are familiar objects with most of us.

Both belong to a Division in the Animal Kingdom which is well above the level of jelly-fishes. Both have arms or rays, proceeding from a central disc. But in the starfish the rays are separated; in the sea-urchin they are joined together.

Starfishes and sea-urchins are able to move and even to travel, though in most cases with extreme deliberation. Both can put out little tube-feet suckers, by means of which they can change their position, and can even slowly right themselves, when turned the wrong way up.

Sometimes the sea-urchin uses its sharp spines as an additional means of getting along. And while the common starfish can seldom advance faster than at a rate of about one half-inch per minute, there is a species which flings itself forward in a more reckless and rapid style, by using its rays as limbs.

Starfish and sea-urchin are alike protected by an armour of hard little plates, arranged in neat rows upon the skin. Not plates made in a workshop, and purchased by the owner for its use, but unknowingly secreted by the animal itself; formed, like Foraminifera shells, from lime drawn out of the water.

Between these plates are tiny openings; and through those openings are put out the minute tube-feet. Even in armour made by skilled workmen for human beings, joints have always been necessary; and we know from history how many a gallant fighter in past centuries was slain by an arrow piercing where a joint allowed it to enter.

Certain members of the immense Worm Family, living in the sea, wear protective scales and bristles; but these can only be named in passing.

The great Mollusc Family is found throughout the whole Ocean, from sea to sea, from shore to shore, from the surface to the utmost depths. It includes numberless subdivisions, and enormous varieties in shape and size, in colouring and kind. It contains millions of the tiniest little fragile shells, such as those described by the poet in well-known lines:—

> "Slight, to be crushed with a tap
> Of my finger-nail on the sand."

It contains also the giant clams of southern seas, the hugest bivalves ever seen, one pair of which may weigh five hundred pounds.

A Mollusc is usually a soft-bodied creature, with a so-called "foot," a nervous system, a mouth, a "mantle," and a protecting one-valve or two-valve shell.

The "mantle"—a peculiarity of this family—is a curious loose fold of the skin or wall of the body, wrapped round like a mantle. From the "mantle" is formed or secreted the hard shell, largely composed of carbonate-of-lime. In the shell itself there are no blood-vessels, there is no actual life; and it cannot grow, as the creature within it grows. Yet in a sense it grows, since by the addition of constant fresh layers to the edges it becomes larger and larger, thus accommodating itself to the increased size of its inhabitant.

Mollusc shells are of all imaginable shapes and kinds; and often they are of extraordinary beauty.

Sometimes they are thick and hard, so as to refuse the passage of light. Sometimes they are so thin as to be translucent. Sometimes they are exquisitely pearly or iridescent. The latter effect, seen in the mother-of-pearl lining of oyster shells, is due to enormous numbers of most fine and delicate lines, close together, which reflect and break up the rays of sunlight, much after the manner of a prism.

Perhaps in the whole Mollusc Family none of the members are so interesting to man as the oyster—partly as a much-relished food, partly as the manufacturer of pearls.

Among gems worn by women few are fairer, none more emblematic of purity and grace, than these. Yet, so far as relates to any intention on the part of the oyster, any idea of forming that which is lovely and valuable, no thanks whatever are due to the producer.

An oyster makes pearls simply for its own convenience. As in the case of other bivalves, if any foreign substance happens to get inside the shell, and cannot be pushed out, it is straightway covered over, and thereby rendered harmless. Sometimes the intruder is a grain of sand, sometimes a parasite. Oftener yet, it is an oyster-egg which has proved a failure. In any event, the oyster promptly clothes it in that beautiful material—pearl—which it secretes by nature, and because it cannot do otherwise.

We know well enough the ordinary size of "edible" oysters. The pearl-forming relatives are often much larger, having shells from eight to twelve inches in diameter.

One does not commonly associate the idea of Mind with a Limpet. Yet it appears that even limpets are not without the organ of locality.

Human beings, brilliant in other respects, are sometimes woefully deficient in this quality. But a limpet knows what he is about as to the geography of his own locality. He chooses his resting-place with care, much preferring a smooth rock-surface to one that is broken or dented. Then he clings fast, and the shell in its growth is studiously adjusted to the outlines of that selected surface. When the limpet "excursionises" in search of sea-weeds, vegetables being a needful part of his diet, it is remarkable that he returns to the same spot. Evidently he prefers his own home to new quarters.

These lower Molluscs have to be passed over quickly. A whole volume might be filled in merely indicating the different species and varieties of them.

At the top of the Mollusc ladder, cousin to limpets, whelks, oysters, clams, and shell-fish innumerable, but in status far above them all, we find the powerful Cuttlefish. A "fish" in popular language; yet no fish truly, but a very highly developed Mollusc.

"Cephalopod" or "Head-footed" is the distinguishing name for this sub-class of Molluscs.

Very unpleasant creatures they are to tackle—more particularly those described by the familiar titles of "Octopus," "Squid," and "Devil-fish." More particularly too when an individual of large dimensions has to be reckoned with.

The species that make their home near British shores seldom reach any great size. They cannot for a moment be compared with the great creatures of warmer climes; still less with the monsters of Ocean's depths. Yet it is not desirable to have a hand or a foot in their tenacious grip.

Most of us have seen small specimens in an aquarium—evil-looking at the best. Sometimes individuals of the large species visit us from a distance, though they probably do not take up their abode by choice in our neighbourhood.

The body of a cuttlefish, like the bodies of most Molluscs, is enwrapped in a loose mantle, which in this instance is of strong and muscular make, perpetually enlarging and contracting. From the one opening in the mantle emerges the head, with two large eyes and a mouth; and round the latter, which generally boasts a sharp beak like that of a parrot, spring eight or ten long lissom powerful "arms" or limb-like tentacles, each furnished with a row of suckers, which in the smaller kinds look rather like buttons.

Through the opening at its neck the creature draws in and pours out water—*breathes* it in and out, in fact. When in repose, this breathing goes on quietly and automatically. But if the animal wishes to move, it forces the water out in a violent spurt through what is called the "siphon," always in a direction opposite to that in which it intends to go. So great is the force thus employed that the cuttlefish rushes with wonderful speed, often with lightning-like rapidity, through the water.

While not protected by outside armour, like limpets and oysters, it really does secrete a shell; but the shell is inside instead of outside the mantle, stiffening the latter, though not protecting it from injury. In its case, however, the weapons of offence are sufficient, and there is less need for defensive armour.

In the cuttlefish we have a very tiger of the ocean, haunting vast areas in numbers which cannot be calculated.

One or two kinds are known which prefer to live solitary lives, but usually they herd together. Woe betide all weaker creatures where they abound! Once caught in those powerful arms, within reach of the fierce beak, no chance for them remains. Molluscs, crabs, fishes, all alike fall victims to this ruthless destroyer. It is said that the cuttlefish, like its striped prototype on land, will kill when not hungry for the pure pleasure of killing.

The smaller species are a principal article in the diet of dolphins and of codfishes. But the giants of the race would be in all cases too much for these puny foes.

Even a Bengal tiger, however, may be mastered by an elephant; and the mightiest of squids has to succumb before the yet mightier sperm whale.

"The monsters vast of ages past" received attention in a well-known poem. But the monsters vast of ocean-depths in the present may surely compete with them. Happily for mankind, these awful creatures do not frequently come out of their "ocean-caves" to be interviewed.

Now and again one is caught, or is flung ashore by a storm, or its dead remains are found and examined.

One huge creature, captured near Labrador, was reported to have a body thirteen feet long, with arms reaching to a distance from the head of thirty-seven feet. Another, left by the retreating tide on a Newfoundland beach, had a body twenty feet long, and arms about the same in length as those last mentioned.

But no more striking description has been given than that of Mr. Frank Bullen, in his fascinating volume,* when he tells of the tremendous midnight

* *Cruise of the Cachalot.*

conflict between a large sperm whale and, surely, the monarch of the squids, "almost as large as himself, whose interminable tentacles seemed to embrace the whole of his great body." The whale's head "seemed a perfect network of writhing arms," and by its side "appeared the head of the great squid, as awful an object as one could well imagine even in a fevered dream, with immense black eyes, at least a foot in diameter." As the "titanic struggle went on," the whale, "in a business-like methodical way," munched at his huge enemy, gradually overcoming its resistance.

Such a battle-royal as this is perhaps very seldom to be seen, even by those who spend their lives upon the sea. It may be that these terrible creatures rarely come to the surface, unless compelled to do so by a hungry whale.

What they must be to the denizens of the deep, ever watching for prey, or pursuing it with swift determination in the darkness—"every cup-shaped disc of the hundreds with which the restless tentacles are furnished ready at the slightest touch to grip whatever is near, not only by suction, but by the great claws set all round within its circle—and in the centre of this network of living traps . . . the chasm-like mouth, with its enormous parrot-beak"—all this and more has been pictured by Mr. Bullen, from personal observation, in words which cannot be strengthened. No tale of monsters in bygone ages can well exceed it.

If further proof be needed of the part played by cuttlefishes in the larder of Sperm whales, it is given by those whales, which, when harpooned and in their dying agonies, throw up the contents of their vast stomachs. Out of the stomachs come great masses of undigested cuttlefish, cubic blocks many feet in diameter, swallowed whole and not yet broken up.

In 1895 an immense cuttlefish was thus disgorged by a whale, and was found on examination to belong to a new and unknown species. The head had vanished; but the body was clothed in a strong armour of neatly arranged scales. So this was veritably an "armoured" kind.

Another monster, ejected from the stomach of another whale, had great suckers, each sucker being supplied with "claws as powerful as those of a tiger."* This last also had ocean-lamps, or "phosphorescent organs," doubtless a help to himself in ocean depredations, and an added terror to myriads of fleeing fishes.

* *Geographical Journal*, Nov., 1898.

Yet neither strength nor speed, nor grasping arms, nor clinging suckers, nor tiger-like claws, nor parrot-like beak, can protect the cuttlefish against its supreme foe, the Sperm whale.

But it has a method of defence, or rather of escape, often efficacious even here. When in danger, it is able to pour forth a copious stream of black liquid, which so thickens and darkens the water around, that the wily creature is hidden, and slips away beyond reach of its pursuer.

The nervous system of the Cuttlefish is more developed than that of other Molluscs. Indeed, from the remarkable changes of colour seen when it is excited, and the tubercles which spring to view on its skin if it is made angry, one would be inclined to speak of its temperament as "highly irritable." It also shows much more understanding than its cousins, the oysters and the clams.

CHAPTER XXI.

A GOODLY COMPANY OF CRABS

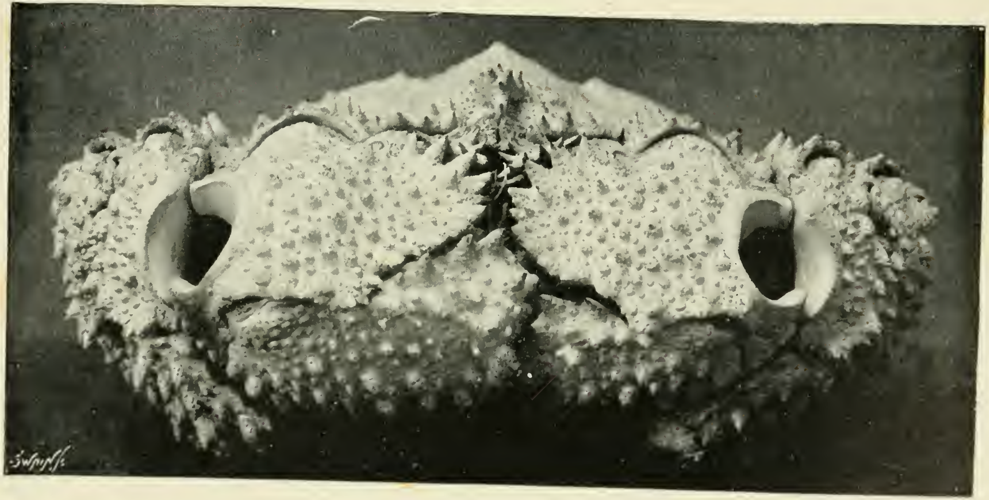
"The slimy bottom of the Deep."—*King Richard III.*

IN all the wealth of Ocean-life, perhaps no creature flourishes more abundantly than do Crabs and their relatives.

We still talk of Jelly-fishes, Starfishes, Craw-fishes, Cuttle-fishes, but no longer of Crab-fishes.

Once upon a time that name was equally common. Everything that had its home in the sea was popularly supposed to be a fish. We know now that not one of the above belongs to any Fish tribe; yet in Conservative style we keep the old titles going.

Crabs and Lobsters, Shrimps and Prawns, are members of the vast CRUSTACEAN division or family. They are so called on account of the hard protecting *crust*, or armour, by which their soft bodies are guarded. Chief and foremost among the numberless kinds included



A DEEP-SEA CRAB

The holes in front are for the admission of water containing nutritious animal food

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under this head is the busy vigorous sidling Crab.

And very important animals are crabs, in the economy of the Ocean. Not only from their enormous numbers; not only from the wide extents of land and sea which own to their presence; not only from the fact that they form a principal item of food to fishes and even to whales; but also because at least one species is reckoned excellent eating for man.

There are land-crabs as well as sea-crabs. There are deep-sea crabs, as well as shallow-water and shore crabs.

There are crabs much less than half-an-inch across; and there are giant Japanese crabs, carrying heavy back-armour or "carapace," about a foot in length and breadth, while the sprawling limbs extend to a yard and a half or more on either side.

Those of ordinary sizes are found everywhere; in numbers beyond reckoning. Not only in tropic waters, but in moderate climes, and in frigid zones; alike near the poles and under the equator. Different species, of course, in different parts, but all connected.

Moreover, they are quite as much at home in the depths of the sea, with miles of water piled over their heads, as on shelving beaches near to land.

During the *Challenger* Expedition crabs were fished up from all depths—from one mile, two miles, three miles, even between three and four miles. In those dark and icy regions the cold must be great, the pressure tremendous; still crabs innumerable are there.

Some sub-ocean kinds have displayed what may be looked upon as an inquiring disposition.

A ship passing near the Azores brought up in a trap many large ones, belonging to a then new species. And the curious part of the matter was that not all of them need have come. Some were entrapped, and could not get away; but others rose to the surface of their own free will, clinging to the outside of the trap, and not attempting to escape, even when drawn out of the water, and on deck.

Perhaps they were dazzled by the unaccustomed brightness of light, after the few and feeble glimmers below. But the puzzle remains—why, in the beginning, they should have chosen to leave their home, and to journey upward into unknown regions? Were they of an aspiring character? Had they friends caught in the net, from whom they would not be parted?

Or was the attraction merely that of the appetising food which those friends were enjoying?

An interesting haul was one day made by the *Challenger* while crossing the Bay of Biscay; not indeed from a great depth, since the Bay is in no part very profound, but from the sea-bed. More than five thousand small sharp-clawed crabs came up in company; and they took quite kindly to the new conditions of life on board. They cheerfully explored the whole vessel, turning up in every direction, during the next few days.

Something in the nature of a love for home has been shown by crabs, at least in one instance. Many years ago a singular story to this effect was told in a scientific paper.*

The fishermen of Falmouth, capturing crabs off the rocks at Lizard Point, brought them by boat to Falmouth Harbour, and kept them there till needed, in a box sunk under water, some four miles out. Each crab had been branded on the back with its owner's mark.

By accident one of these boxes was broken; and all the prisoners made good their escape. Naturally, no one expected to see them again.

But only two or three days later those very

* *Nature*, April 3rd, 1873.

same crabs—with branded carapaces—were caught anew by the fishermen; not near Falmouth, but as before, off the Lizard. How they had managed to get there, how they had first found their way to Falmouth Harbour, a distance of four miles, and then for miles more along the coast, are questions more easily put than answered. The word "instinct" fails to meet the difficulty.

One thing only is clear, that they preferred the neighbourhood to which they were accustomed.

Very fearless creatures are small crabs, generally; brave, no doubt, partly because of their numbers.

In nets and trawls, where animals of many kinds are together for long hours of captivity, the weak are often destroyed by the strong, before they can be drawn up.

But sometimes the weak combine together, and prove too much for the strong. Notably this was the case, when a dog-fish, brought up from a depth of over fourteen hundred fathoms, was entirely disposed of in twenty hours by crowds of hungry little crustaceans.

Most of the crabs and lobsters, shrimps and prawns, which live on or near the bottom, send their young ones up into higher levels for education. There for a while the juveniles swim and develop, till old enough in their turn to take to the ocean-bed. Great numbers have meanwhile been preyed upon by multitudes of fishes in those upper levels.

Crabs undergo curious changes in the course of their growth from infancy to adult age. At certain stages they are so utterly unlike in appearance to what they become later, that for a long while they were classed by naturalists under separate names, being actually reckoned as different creatures.

Since the protecting armour of a crab is far too rigid to admit of its stretching, it becomes from time to time too tight for the growing body within. When it can no longer be endured, it has to be cast off, and a new suit, larger in size, has to form in its place.

This armour, like the shells of foraminifers, and the skeletons of coral-polyps, is unconsciously secreted by the crab; and during the formation of a new suit of armour the crab has a time of weakness, of delicate health, and also of dangerous exposure to the attacks of enemies.

Some kinds of crabs have sunk to the miserable level of parasites, living on the exertions of others, and refusing to exert themselves. One prefers to think of the active and independent and intelligent kinds; and really, crabs have a good deal of intelligence. Quite as much as an average insect; though perhaps few of them could compete in an examination with ants or bees.

If any might do so successfully, it would be in all probability some member of the Spider-crab family.

To this slender-limbed untidy class belongs the unwieldy Giant-crab of Japan. But it is his smaller relatives who excel in sense. The spider-crab has a slovenly appearance, because he attaches to himself stray bits of sea-weed and scraps of sponge or other growths, with the plain intention of becoming less easily seen.

He keeps to no regular or permanent style of adornment. The nature of his trimmings depends entirely on the character of his surroundings.

Many years ago my father had been for a short dredging excursion, near Worthing; and he brought home with him one of these small creatures, elaborately ornamented with slim strips of bright-red sea-weed.

He placed the crab in a basin of water, which contained a supply of green sea-weed. And next morning a change was seen. The crab had cast aside his red ribbons, and had decked himself out with a smart array of green ribbons instead. Such conduct may, if we choose, be accounted for by the magic word "instinct;" but it certainly wears the aspect of deliberate intention, and even of some dim consciousness of cause and effect, not to speak of a knowledge of colour.

This habit of the spider-crab is now well known and recognised; and he has been closely watched during the "dressing" process.

It has been noted that he always puts each slip of sea-weed or scrap of sponge, or aught else that he uses for the purpose, to his mouth, before fastening it to his body or limbs. A suggestion has been made that his object in so doing is to lick it and render it sticky.

Perhaps in some cases it could not otherwise be attached; but many of the spider-crabs have hooked hairs, exactly adapted for holding fast such objects as they love to adorn themselves with.

Nor are the adornments always merely stuck on. Both sea-weeds and sponges frequently take root, and flourish as healthy growths upon the crab's back. It is an extraordinary fact that the crabs seem to know perfectly well from which kinds of sea-weed or zoophyte they may snip off little bits, with a prospect of not killing them.

So unerring, indeed, is their knowledge in this respect, that, as an authority on the subject has stated, "the keepers of Aquaria have only to consult the crabs to learn what kinds of sea-animals will bear being thus transplanted piece-meal."*

Is this too merely "instinct"?

Many a time baits were lowered in the nets of the *Challenger* to attract victims. Oddly enough, it was found that no more effective bait could be used for crabs and their kindred than—pieces of looking-glass! May one imagine that some friendly Medusa lent her little glimmer, far below, to enable the Hermit-crabs, when putting on fresh ribbons, to see their reflections, and judge of the effect? It reads rather like a page of *Alice in Wonderland.*

Hermit-crabs or Soldier-crabs, having an insufficient protective armour of their own, are in the habit of using empty Mollusc shells to shelter that part of their bodies which is not guarded. One of these crabs, when young, chooses a shell, fitted to its size; and when grown too

* *Crustacea*, by STEBBING.

large for it, that shell is discarded in favour of a new one.

But whether the said crab commonly contents himself with an empty habitation, the occupant of which has died earlier, or whether he first kills and eats the live Mollusc, and then "commandeers" the shell, does not seem to be known with certainty.

CHAPTER XXII.

THE WORLD OF FISHES

"He giveth food to all flesh."—Ps. cxxxvi.

"Which giveth food to the hungry."—Ps. cxlvi. 7.

A WORLD abundantly peopled. A world which holds its myriads, uncountable in kinds, beyond reckoning in numbers.

No part of the wide Ocean may be found where fishes are not, and in places, at seasons, the water positively teems with them, so that they may be said almost to hustle one another for want of space. Fishes, taken by themselves, letting alone jelly-inhabitants and shell-inhabitants and crab-inhabitants, would suffice to keep the whole sea alive.

No picture of the Great Deep would be, even in the humblest sense, complete without some little description of the world of Fish-life contained therein.

But the subject is one of hopeless magnitude to be dealt with in a couple of short chapters.

A mere list of the names and chief characteristics of the principal "Orders" of Fishes, putting on one side the immense array of "sub-orders" and "varieties," would speedily outrun the limits of these pages. Besides, such a list would be to the ordinary reader unreadable. Natural History *savants* have not troubled themselves to curtail syllables in titles so used.

On land we have beasts and birds, which serve as food for man; beasts and birds of prey; beasts and birds that are simply harmless, attractive, pretty, or interesting.

In the Ocean also we find fishes good for food; fishes of prey; fishes which may be classed as merely pretty, or curious, or remarkable.

This rough classification will do well enough for our present purpose. Many fishes belong of course to more than one of the divisions. That which is good for food may be also curious. That which acts as an ocean "beast of prey" may be also beautiful.

The speed with which fishes can dart along is often very great. Both fins and tails are used as a means of advance; and the smooth scale-clothed skin glides with the least possible friction through the water. No better form than the "boat-shaped" outline could be devised for rapid progress in a heavy element.

Not only are fishes light in make, often weighing hardly more than the water which upholds them; but also, unlike most backboned animals, they are cold-blooded. A few deep-sea kinds have no eyes, though commonly they can see and hear and smell well.

In the sense of feeling they are believed to be very deficient, and it is doubtful whether they suffer any pain at all, in the true sense of the word. Probably they can be conscious of discomfort.

One of their unfailing characteristics is the possession of a stupendous appetite, and with it of a superlatively good digestion. They live to eat; and they are at it incessantly. Perhaps in their case it does not always mean greediness, but only a due satisfying of Nature's needs.

Certainly, as a race, they are not troubled with daintiness; and if they love variety of fare, they can have the same with ease. Pretty much whatever comes in their path is gulped down without hesitation—"gobbled up in the twink of an eye." Most of them, in cannibalistic style, feed without compunction upon other fishes.

While they may be popularly said to "breathe water," because they take in water instead of air, they depend upon life-sustaining oxygen every whit as much as do land animals, only in a different mode.

Large quantities of oxygen are ever present, dissolved, in the sea. It is not the *water* flowing through the fish's gills, but the *oxygen* dissolved in that water, which carries on combustion in the body, and so keeps it in life and health.

The amount of oxygen thus obtained is small; therefore the combustion is slow; therefore the blood is cold. But if, for a very short time, all oxygen could be withdrawn from the ocean, the whole multitude of fishes therein would fast die of suffocation. Sea-water alone, without oxygen, could not keep them alive.

The gills are, however, so constructed that, while they can use small supplies of oxygen dissolved in water, they cannot use large supplies of oxygen forming part of the free air. So when a fish out of water draws in atmospheric air, its gills become dry and useless, and it dies of suffocation.

A world of rapid living and dying is this which we have now in view—of killing and being killed—of an incessant struggle for existence.

Many of its inhabitants have no means of defence, save by flight; and these feed only on beings weaker than themselves; largely on the vast hordes of the young of crabs and jelly-fishes. Others are furnished with formidable weapons, wherewith they can actively attack powerful foes.

Cold-blooded though they be, and probably without the sense of physical pain, they yet have their little range of emotions.

According to one thoughtful and competent observer,* they can be frightened, they can be angry, they can endure pangs of jealousy, they can be excited by a spirit of curiosity. And though one may perhaps hardly go so far as to speak of "fishy" affection, shown by one to another, yet some faint reflection of maternal anxiety seems occasionally to exist.

They also display a real enjoyment of life, a pleasure in "being," a delight in playing with water and wave, and even a sportiveness, such as one might imagine to belong only to creatures of a higher grade.

On the whole, the brain of a fish is better developed than the brains of any other animals of low rank, excepting only that of the Cuttle-fish.

Some instances have been known of tame

* ROMANES.

fishes recognising, or seeming to recognise, human beings. It is open to doubt how far the "recognition" meant more than an expectation of something to eat, following upon certain familiar sounds.

Fishes good for food—these are and have been through ages by far the most important to man. Other kinds may be dangerous or interesting. But without the "Food-fishes" of the Ocean the difficulties of feeding mankind would be largely increased.

For they are always there. They come without exertion on our part. No sowing, no digging, no tending of the waters, is needed to bring forth the mighty harvest. Year after year, multitudes past imagination come into existence, and any number of them may be had for the trouble of taking.

All that man did in the past was his level best, by reckless destruction, to kill the goose which lays the golden eggs, to exterminate the creatures which are to him of so incalculable a value.

Of late years some steps have been taken in the other direction, some efforts have been made towards the preservation of fish and the culture of spawn. But much more remains to be done. The incessant use of line and net and trawl through centuries has thinned the multitudes of some species very greatly, and in the course of time they may even cease to exist.

That the harm done thus far has not been far greater must be ascribed to the enormous numbers of each kind, and to the vastness of those ocean-regions, where they may at any time retreat beyond man's reach. For this we have to be thankful. It would be an ill day for us, on which the chief food-fishes should fail.

Herrings, for example. What would the poorer throngs of our large cities do, without that useful little cheap dish?

The amount of herrings caught yearly around British shores almost exceeds belief. They appear often in mighty shoals, swimming closely packed throughout a mile or more, being devoured as they swim, to the tune of millions, and being captured by fishermen in masses.

Yet year by year the supply goes on, apparently undiminished.

One fisherman alone, at work near the French coast, reckoned that in the course of a single night he had taken over five hundred thousand herrings, half which he threw back into the sea. An unusual amount, of course. But what must be the sum-total captured in a year by the combined efforts of all fishermen?

In a year, however, a herring produces somewhere about thirty thousand eggs. What, then, must be the sum-total of eggs produced by all herrings in the ocean?

True, vast numbers of the eggs come to nothing; vast numbers serve as food for other creatures. Yet enormous supplies escape countless dangers, and succeed. Thus the poor man's food is bountifully given, in an ever-recurring harvest.

Among "Food-fishes" the "White" kinds are prominent, belonging mainly to two large families. One of these families includes Cod, Whiting, and Haddock. The other consists of Flat Fishes, such as Turbot, Halibut, Sole, Dab, Plaice.

At the head of the first family stands the Cod, that most useful and abundant creature, found throughout the deeper waters of northern seas.

During particular seasons the multitudes of cod are accompanied by multitudes of cuttle-fishes—rather singularly, since cuttlefish are the favourite food of cod. But perhaps it would be more correct to say that the cuttlefish are accompanied by the cod—the latter doubtless going where they can find the food that they like. At these seasons millions of cuttlefish are caught, to be used as bait, by means of which enormous supplies of cod are taken for the market.

A calculation has been made that, in the course of a single spring, on the banks not far from Newfoundland, something like one hundred and twenty millions of cod are the result of combined British and American and French exertions.

Happily, this fish also is very prolific. An individual often produces three or four millions of eggs in a season; and as many as eight millions have been found on one fish. Here, again, immense numbers of the eggs fail to develop, immense numbers are devoured. Yet multitudes come to perfection, and the ocean is still furnished with cod.

There is, however, a very serious danger, beginning to be recognised, in the case of cod and yet more of some other "white-fish" kinds; and this is that in time the reckless havoc worked may outrun even these wonderful sources of renewal. Fishing has been carried on in the past, without thought for the future. Little or no attention has been paid to sparing the young; and the valuable roe itself has been used as an article of food. Man may by-and-by have to pay dearly for his lack of foresight and common-sense.

As an illustration of the numbers of fishes in the sea, a curious tale is told about a deep-water kind of Mullet, known as the Tile-fish.

This particular species had not been discovered before the year 1879. A few specimens were then taken from over a bank about eighty miles from the coast of Massachusetts — large and brightly coloured. Near that bank, where they had made their home, they could at any time be easily caught.

But in the spring of 1882 a heavy gale took place; after which these fishes were seen in enormous quantities, floating at the surface of the water, covering a space of three hundred miles in length and fifty in breadth. One who saw the singular sight reckoned that something like fourteen hundred millions of them must have been there—enough to have supplied every man and woman and child in the United States with between two and three hundred pounds' weight of fish.

In the following autumn, when fishermen went again to the bank for tile-fish, they found none. Not a single specimen turned up. The storm, probably by shifting the direction of the Gulf-stream and its "cold wall," had either destroyed them all, or had slain so many as to frighten the survivors to a distance. In that particular district they had not, when the story was written, been seen again.

CHAPTER XXIII.

SOME ODDITIES OF FISH-LIFE

"3 FISH. Master, I marvel how the fishes live in the sea.
1 FISH. Why, as men do a-land; the great ones eat up the little ones."
PERICLES.

OF fishes which are remarkable for beauty names might be mentioned by the hundred; alike of food-fishes, of powerful and fierce-tempered kinds, and of those which may be described as purely ornamental. Not all are graceful in shape; but vast numbers are exquisite in colouring, especially when first drawn from the water. As they gasp out their lives, the brilliant tinting fades.

Among harmless and lovely kinds, perhaps not many could vie with the small radiant creatures of Coral-reefs, described by many a traveller in terms which tell of a lack of sufficient variety in adjectives. But words in these cases convey a dim impression of the reality. Fish-beauty must be seen, and seen at its best, to be appreciated.

Among curiosities of Fish-existence, too many to name, a few may be cited in passing.

Flying-fishes, with their blue bodies and wing-like fins of silver, are well known to voyagers.

They rise from the water with a vigorous upward spring, which will bear them to a height of fifteen feet or more above the surface; and there they skim lightly along, with apparently thorough enjoyment. Sometimes thousands are seen at once, all leaping out of their native element, and taking to the air for a variety.

Often they do this to escape from a pursuing foe below; but the plan is not always successful, since they have other enemies above. Many a flying-fish in its aerial career is snapped up by a hungry gull.

One uncouth specimen is the "Frog-fish," known also as the "Fishing-frog" or "Goose-fish,"—a flat thick rounded creature, with a cocked-up tail, an enormous mouth nearly as wide as its whole body, and knowing eyes. It bears a certain resemblance to a frog.

Many instances are related of fishes "imitating" or "copying"—to use very inadequate terms—different land animals. The Bat-fish, for example, bears a curious likeness to a Bat. The

Snipe-fish might be mistaken for first cousin to a Snipe.

There is also the Pelican-fish, an inhabitant of deep-water. It has a mouth of portentous dimensions, with a huge pelican-like pouch hanging loosely below. Little is known of its habits; but it is supposed to swim about near the ocean-bed, with its enormous jaws extended in a stereotyped yawn, taking food in a vast and wholesale fashion.

Another oddity, known as the Spook, though not interesting in its ways, has a most "bizarre" look. Its body is long and winding, almost like that of an eel; its fins are large; its eyes are big; and, judging from its picture, its head seems to be a cross between that of a fish and that of a quadruped.

Among innumerable fish gormandisers one particular specimen carries off the palm, and might win the first prize in a world-wide competition for excellence in voracity.

The Black Swallower, most appropriately named, manages, at least now and then, to accomplish the rare feat of swallowing a morsel many times larger than itself. It is a fish of slender make; but after such a meal the slenderness disappears.

It seizes upon a fish, perhaps six or eight times as large as its own body, and "*gradually climbs over it with its jaws*"—a truly marvellous exploit! Its mouth and stomach stretch elastically during this process, till the whole of the large fish has passed inside the little fish, and a vast pouch hangs below, filled with the meal just taken. This bag is the distended stomach.

But the tale carries its own moral. The greediness of the fish—and apparently it is a case of individual greediness, though it springs from a family tendency—is punished as it deserves by death. As the swallowed "mouthful" decomposes, it loads the bag with gases, like an inflated balloon; and like a balloon the stomach acts, bearing the unhappy victim to the sea-surface, where it floats wrong way up. A sufficiently tragic ending!

A stout-built animal is the Wolf-fish, varying in length from three to seven feet; and in his ways a veritable "wild beast," powerful and savage, with strong jaws, teeth fashioned like those of a tiger, a vicious temper, and a ferocious scowl. An abnormal appetite too is his, though hardly equal to that of the Black Swallower. In Maine these brutes have been known to attack fiercely human beings wading in the sea at low tide.

Sometimes the above is called also the "Sea Cat-fish;" but true Cat-fishes belong to quite another family; and they can hardly be described as more desirable acquaintances. With their solemn Grimalkin-like expression, their love of fighting, their sharp serrated spines, with which they can give most painful wounds, the Cat of the Ocean is not likely to be transformed into a domestic pet, for at least some time to come.

These two last quarrelsome creatures may lead us from "interesting" specimens of Fish-life to those which have been roughly classed above as "Fishes of Prey."

Prominent among the latter stands the dreaded Shark. In common parlance we speak of a shark as a fish. Yet scientifically the description is incorrect. Sharks and Skates are now looked upon as apart from Fishes proper, being described rather as "Fish-like Vertebrates,"—not true fishes.

One very marked difference is found in the numbers of their young. With true fishes, as already shown, eggs are produced in enormous quantities. But with sharks and skates, only one or two or at most a very few young ones are brought into existence at a time, as with higher animals.

If among wild beasts of the Ocean cuttle-fishes represent tigers, then perhaps we may say that sharks represent lions or panthers. But the reputed nobility of the lion is never found in sharks.

Fearsome creatures they are; often huge in size, long-shaped, flat-tailed, with cavernous mouths, cruel teeth, immense strength, and bloodthirsty dispositions. Cannibals too, since they feed largely on lesser fishes. To the bigger kinds a human being is merely a tasty morsel, which may be disposed of in two snaps and a couple of gulps.

Though exclusively inhabitants of the salt sea, they sometimes chase their prey into a river, putting up with fresh water for the nonce.

Sharks are found nearly all over the world, but much more abundantly in hot climates. Their numbers gradually diminish, farther and farther from the equator. In tropical waters they are often present in overwhelming multitudes; and a man who should venture to bathe in such parts, would be as a scrap of bread flung to a horde of hungry little fishes. In less than a minute nothing of him would remain.

Off Kurrachee, where the catching of them is systematically carried on, about forty thousand are slain every year. This is for the sake of their fins, from which gelatine is obtained for the Chinese. That so many are killed, as a regular thing, says much with respect to the vast hordes which are *not* killed.

Of small shallow-water sharks, the most widely known are varieties of Dog-fishes. Though not large enough to be a terror to man, they are an endless trouble to fishermen, destroying great numbers of captured fish in the nets, and biting off the hooks from fishing-lines.

Among larger species, one kind found in the North Atlantic is the huge mild-mannered Basking Shark, which at times lies long and lazily close to the surface of the water, in company with a school of comrades. Its teeth are unimportant, and it feeds on smaller creatures, not attempting to include man among its eatables. But since it often has a length of thirty feet, and, like most sluggish natures, is capable of being roused, it becomes dangerous when excited. A blow of its tail may easily smash in the side of a whaling boat.

The largest of these creatures is the vast Whale-shark, belonging to the Indo-Pacific Seas, sometimes over fifty feet in length, and stated even to reach seventy feet.

However, if accounts be correct, this giant is much less of an enemy to the whale than the Greenland Shark. In the fashion of some savage nations, the latter feeds deliberately upon the live whale, biting raw steaks at pleasure from the worried leviathan—"scooping and gorging lump after lump," so long as it feels "dispoged."

The Greenland Shark is credited with feeling no pain, and it is extremely difficult to kill, as the unfortunate whale attacked by it finds to his cost.

Worse than all, so far as human beings are concerned, are the famous Man-eating Sharks of tropical waters, which occasionally, but not very often, find their way to colder latitudes.

Among them, the Great Blue Shark, from fifteen to twenty-five feet long, and the awful White Shark, known sometimes to reach a length of thirty-seven feet, have an undesirable pre-eminence.

These monsters are furnished with teeth, the reverse of "unimportant." In shape they are generally triangular, serrated, and sharply pointed.

In arrangement they occupy rows, the foremost only of which is in actual use. Other rows are folded back and kept in reserve, to be brought forward when required. Thus a shark is never without a ready supply of his formidable weapons.

White sharks are much given to keeping in the wake of ocean-ships, on the look-out for scraps thrown overboard. One such persistent follower having been killed, an inventory was made of the contents of its stomach, as follows—"A tin can, a number of mutton bones, the hinder quarters of a pig, the head and forequarters of a bull-dog, and other and smaller things, as the auction-bill says, too numerous to mention."*

Closely related to the Sharks are those savage creatures known as Rays or Skates.

The larger number of them live usually at the bottom of the sea, in somewhat shallow waters, lying on the ocean-floor, or swimming about just above it. Thus they do not so often come into contact with man as do sharks. But it is want of opportunity, not want of will, which keeps them from doing harm. When they have a chance they seldom fail to use it.

Among different branches of the "Ray"

* *Standard Natural History*, ii. p. 83.

division is found the tropical Saw-fish, with its long sharp teeth-laden snout, ever ready to fight the whale. In youth the saw-fish has a strong resemblance to a shark.

Then there are the Sting-rays, with barbed spines, a mere touch from which causes a man terrible suffering, as if from poison; while a severe sting may end in death. These are found in South America.

There is also the family of Torpedo Rays, quite distinct from the better-known South American Electric Eel, but able to administer electric shocks strong enough to render a man for the time helpless. They are found in many waters—large creatures, rounded in shape, smooth-bodied, thick, with longish tails.

Worst of all are the huge ungainly Eagle-Rays and Sea-devils, with their powerful grinding teeth. These grow to an enormous size; and the larger ones are quite capable of upsetting a big boat. Nor would they hesitate so to do, if attacked.

One such creature was said to be fifteen feet in breadth, with a tail several feet long; another to have been twenty feet in length; another to have been three or four feet in thickness; another to have weighed well over twelve hundred pounds;

another to have needed fourteen oxen to drag its dead body. They sometimes share with Cuttlefish the distinction of being called "Devil-fishes."

These monstrosities are found off Barbadoes, off Jamaica, and in the tropical waters of the Atlantic and Pacific.

A particularly vicious kind hovers about the Pearl Fisheries near Panama, to the terror of the divers. The creature is reported to fold its vast "wings" about any unfortunate man within reach, and then to devour him. This answers to the usual method of ground-rays in feeding. They glide *over* the object they wish to devour, settle down upon it, hold it fast by the grip of a broad and heavy body, and deliberately tear it to pieces.

CHAPTER XXIV.

BEHEMOTHS OF THE OCEAN

"There is that leviathan, whom Thou hast formed to take his pastime therein."—Ps. civ. 26, R.V.

"Canst thou draw out Leviathan with a fish hook?
Or press down his tongue with a cord?
Canst thou put a rope into his nose?
Or pierce his jaw through with a hook?"—Job xli. 1, R.V.

FROM the company of hungry merciless Sharks and their relatives, an easy transition carries us to the largest of Ocean-inhabitants—the Whale.

Not that sharks and whales belong to the same division in the Animal Kingdom. Not that they have aught in common beyond the possession of great size and power. But because of that size and power, they naturally come together at the close of a sketch of Ocean Life.

Sharks, if not in every respect to be regarded as fully and entirely Fishes, are yet in most essentials "fish-like." But Whales belong to a higher level.

When we reach Whales we leave lower animals behind us; we step upon the uppermost rungs of the Ladder of Life; we are in the society of Mammals.

At the bottom of that ladder we found microscopic beings, specks of living jelly, so minute as to be invisible, so primitive as to be without development, without separate organs. At the top of that ladder stands Man; far more than animal, by virtue of his mental and spiritual being; and yet an animal, by virtue of his bodily development.

The physical part of a man marks him as a Mammal. To Mammals belong all Quadrupeds; but not Birds, not Reptiles, not Fishes.

A whale is not a fish. He is a Mammal. He is warm-blooded. He breathes air through lungs. He—or rather, she—feeds the young of the race, as they are fed by quadrupeds and human beings on land. A whale-mother will fight to the death in defence of her little one.

Nor is the whale the only Mammal of ocean-waters. To this highest division of backboned creatures belong also the Porpoise, a near relative of the Whale; and the fierce Walrus, met often by Arctic travellers; and the gentle Seal, with its pathetic human eyes, and its warm soft coat, for the sake of which it suffers too frequently cruel treatment at the hand of man.

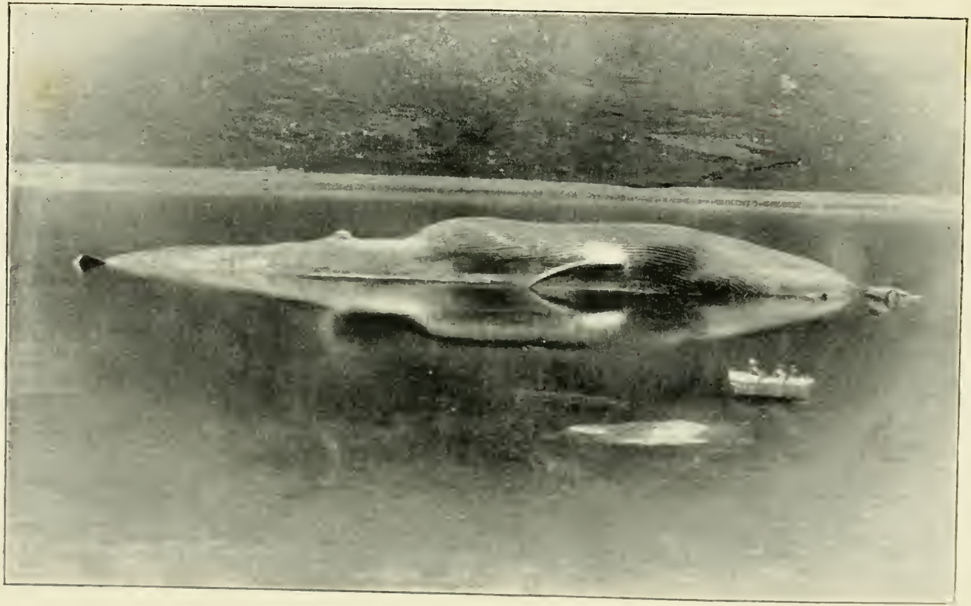
Many different kinds of whales inhabit the sea,—such as the Rorqual, the Hump-backed, the Ziphoid. The two which are most widely known, and which may be regarded as foremost though unconscious rivals in human favour, are—the Right Whale, of higher latitudes, and the Sperm Whale of tropical regions.

There is a Right Whale of Atlantic waters, closely related to the Right or Greenland Whale of Arctic Seas, though in some respects different. But the Greenland Whale may be taken as the typical specimen of its race.

And a mighty creature it is; often fifty feet, and sometimes sixty or seventy, in length. A ribbon passed belt-wise around that massive form, at its thickest, would need to be something like forty feet in length. So the Right Whale does not boast a slim waist.

The enormous head, with its capacious cavern of a mouth, takes up about one-third of the whole body.

An individual of this size weighs some seventy tons. And yet so light is its make—partly due to the construction of its bones, partly no doubt to its great lung capacity—that it actually weighs



A BLUE WHALE

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less than water, and can with the utmost ease float close to the surface.

Indeed, a Greenland whale seldom by choice wanders very far below. He much prefers to come up and breathe every ten or fifteen minutes; though, when fleeing from the deadly harpoon, he has been known to stay under water at a stretch more than three-quarters of an hour. But this is exceptional.

At the top of the head are a couple of "blow-holes," through which, when he rises to the surface, he breathes.

In colouring he is black above, white below. A skin about one inch thick covers enormous masses of fat, more than a foot in thickness; a fine warm blanket to guard him from cold, but also, unfortunately for the whale, an attraction to human beings, for the sake of the oil which it yields. The outer skin is often thickly overgrown with masses of barnacles.

Perhaps the most singular thing about this great creature is that it has no teeth, and that it feeds in consequence upon the lightest possible fare.

In place of teeth, inside the mouth are massive fringes of whalebone plates, side by side, smooth on the outer side towards the lips, but covered within by long dense supplies of hair. Similar horny plates depend from the roof of the mouth. Since the plates of this "baleen," as it is called, are often ten or twelve feet long, and amount in number to many hundreds, one cannot but imagine that the whale's mouth must be packed unpleasantly full of furniture. But they have their use.

As he swims he holds his mouth habitually open—somewhat after the fashion of the Pelican-fish—and into the vast cave flow multitudes of small creatures of every kind and description.

Presently a good supply has been collected, all lying on the enormous tongue, a mass of flesh often as big as a room, some eighteen feet long by ten wide.

He then nearly closes his jaws, and forces out the water. But the dense hairy fringes hold back the living creatures, which he proceeds to swallow. After which he again goes forward, open-mouthed, as before.

In a good many respects the Sperm Whale is a contrast to the Greenland Whale.

He too is of leviathan-like dimensions; generally from sixty to seventy feet in length, and not more slender as to his waist. But only the male Sperm boasts these proportions. The female is, by comparison, a dainty little being, seldom more than thirty or thirty-five feet long.

A Sperm has one spout-hole, instead of two; and in colour he is black above, grey below.

In his outlines a marked difference is visible. Looked upon sideways, the form of the huge square head is precisely like the trunk of an immense forest tree, cut off short; and the "blow-hole" is situated close to the end or front of this "truncated" head. The latter is really a reservoir, containing a large supply of valuable spermaceti oil, for the sake of which the creature is killed by man.

Instead of a mouth full of hair-fringed "baleen," these whales have proper teeth, better suited, one would think, to their size. Their food too is of a far more substantial kind.

It was told in an earlier chapter how Sperm Whales live mainly on cuttlefishes; and how sometimes, in midnight combat, they fight and conquer even the mightiest of those loathsome monsters of the deep.

Sperms are found through wide ranges of the ocean, in most tropical waters, as far north and as far south as 60° in each direction from the equator.

But whereas Right Whales of colder seas prefer to hunt in couples only, Sperm Whales crowd together in large companies. Sometimes, it is true, lonely specimens are found. They, however, are usually morose and ill-conditioned brutes, ready to fight even men. It has been suggested that perhaps they are thus solitary *because* of their morose temperament, which has made it impossible for their fellows to put up with their presence.

Both these huge whales have powerful fluked tails and small flippers. It is curious that inside the flippers are separate branching bones, not unlike the bones of a human hand, only covered with thick skin in one piece, like a fingerless glove.

This rather seems to indicate that the flippers may be of the nature of hands in embryo.

The Sperm does not come to the surface for air nearly so often as his Greenland cousin. Regularly once in each hour and ten minutes is the plan he follows; and then he remains for several minutes at the surface, going through a series of sixty or seventy mighty puffings and blowings. After which he vanishes for another hour and ten minutes.

Some pathetic tales have been told of the devotion of a mother-whale to her infant—she usually has but one at a time.

Early in the present century a harpooner deliberately sent his harpoon into an infant-whale, hoping thus to take the mother. And he had not miscalculated the strength of maternal love.

No thought had that poor mother of saving herself by flight. She came fearlessly close to the boat, seized her wounded little one, and dragged it away with extraordinary rapidity, using up six hundred feet of line.

Then she rose again, dashing to and fro in such evident "extreme agony" that one can only marvel at the men who were able to watch it unmoved. Two harpoons were flung at her, and failed to strike. A third succeeded; but still, absorbed in her little one's peril, she paid no heed to her own injury, made no effort to get away, and "in the course of an hour" she was killed.

That was in 1811. The same deed has been lately described by Mr. Bullen—the slaying of a mother-whale, which, with her infant by her side, refused to use her great strength in self-defence, lest she might hurt that little one. Such love as this should surely be respected, even by rough fishermen.

If not in pity to the whale, another reason would suggest the same line of conduct. The folly of recklessly slaying the rising generation is beginning to be apparent. Already the supply of whales threatens to run short.

Although one may speak of "little ones," and although they are genuinely "little," compared with grown-up specimens, one must not be led astray by the term. One very young baby-whale, when measured, was found to be about twenty feet long. A fine strapping infant!

CHAPTER XXV.

"DOWN TO THE SEA IN SHIPS"

"With Ships the Sea was sprinkled far and wide."—WORDSWORTH.

"Fair is our lot—O goodly is our heritage!
(Humble ye, my people, and be fearful in your mirth!)
For the Lord our God Most High,
He hath made the Deep as dry,
He hath smote for us a pathway to the ends of all the Earth."
RUDYARD KIPLING.

WITH Whales we have reached the highest class among Ocean creatures. Yet it is impossible to end here. Some few pages must be given to those among men who "go down to the Sea in ships," who "do business in great waters."

Not that in any sense can Man be reckoned as an inhabitant of the "Mighty Deep." But thousands of men spend the greater part of their lives upon the Deep; tens of thousands more continually pass and repass over its surface.

In the beginning of history ships became soon a necessity, partly as a means of going from place to place along the coasts or of travelling to other Continents and Islands, and partly for the purpose of catching fish. Those early vessels were crude and ramshackle affairs, from a modern point of view.

Unclothed and woad-stained Britons, ancestors to the Welsh of our day, had their boats, wood-ribbed and skin-covered, or osier-framed and hide-clothed. Rickety constructions at the best. Yet in them half-savage sailors went over the stormy Channels, to Ireland and to France, and even ventured into the Bay of Biscay.

Enterprising Romans, with better ships, did more; and before the close of the First Century they had made their way round Great Britain. No light feat this, in days when lighthouses and buoys existed not; when the geography of sand-banks and rocks was unknown.

The boats in which our Saxon and Viking ancestors came to invade the wild little Island of Britain, though of light structure, were superior to the primitive British skiffs; and in the contest which followed they had the upper hand.

Later on the Danes, with vessels sixty or seventy feet long, built of heavy timbers and rowed by thirty men apiece, proved in their turn too much for Saxon resistance, at a time when the Saxons had become established as the people of the Island.

King Alfred, of noble memory, coming to the throne, found his country a prey to these marauding Danes. He then and there grasped the principle, which still has sway in England's counsels, that the very existence of Britain as a Nation rests upon the strength of her Navy. With all possible despatch he had a new fleet built, composed of vessels which were for the most part double the size of the largest Danish boats. They were longer, wider, stouter, and were rowed each by from forty to sixty men.

The first Naval battle which followed may be looked upon as a foreshadowing of Trafalgar; for the English boats gained a complete victory over those of the enemy, and thereby England obtained command of the sea.

In those times no clear distinction existed between war-ships and merchant-ships. All were prepared to defend themselves when need arose; and any might be used, either to carry fighting-men, or to convey merchandise.

Not until the reign of Edward I. did a difference grow up, separating those vessels which as a rule kept to more peaceful occupations, merely fighting in self-defence when attacked, —and those vessels which devoted themselves to aggressive warfare. From that date, gradually, the Royal Navy grew into being.

Even in the time of Queen Elizabeth the separating line was not very marked.

There *was* a Royal Navy, which took its share in repelling the Spanish invasion; and the whole of that Navy in tonnage was far from equalling one huge ship of modern days, the *Celtic*, White Star Liner.

Of the hundred and ninety-seven vessels, however, which met the vast array of the Armada, only thirty-four were in any sense strictly Men-of-War; and of those thirty-four one alone was over a thousand tons in weight. The remaining hundred and sixty-three were Merchant-ships, fitted up as best they might be for warlike purposes; most of them being under four hundred tons.

But no mistake existed about the way in which these pigmies set to work, like bulldogs, to worry the great Spanish ships.

Century after century the Navy grew, adding in each generation to its size and strength. English sailors found their way hither and thither, in the interests of their country, for war, for exploration, for purposes of trade, discovering unknown lands, penetrating towards the North Pole, mapping out the Ocean.

Other Nations took their part in these explorations, and the honour of finding a New World did not rest with our ancestors. But in more recent days the Lion's share of research has undoubtedly fallen to the British; and the coast-lines of the world have been surveyed and mapped out chiefly by ships of the British Royal Navy.

Up to the beginning of the Nineteenth Century, all vessels, small or large, moved by means of the wind or by oars.

Then began a change of immense importance, due to the use of steam for carrying ships across the sea, not only with but in the teeth of the wind.

This method took hold and prevailed, though at first very slowly. Even in the present day hosts of merchant-ships still travel by means of sails only, making systematic use of the Trades and other steadfast winds. When time is not a prime consideration, sailing is of course far cheaper than steaming. On the other hand, the carrying power of a steamer is about three times that of a sailing-vessel of the same size, since it can generally perform three journeys in the same time that a sailing-vessel can manage one.

All over the world, in every sea, are thousands upon thousands of ships of every kind and description, night and day speeding onward, each to its destined port. Lines of Passenger-ships regularly plough the main, starting on fixed days, and seldom failing to arrive on fixed days. Merchant ships innumerable follow certain routes, going from country to country over the Ocean, carrying the world's produce. Mighty Navies of war-vessels, huge in bulk and terrible in possibilities, rest like sleeping leviathans upon the bosom of the deep, or steam from point to point with resistless energy.

All this denotes a wonderful change since the days, when a few roughly-made boats used to creep round the coasts of a few inhabited countries.

Wide though the ocean be, with thousands of miles of water unbroken save by occasional islands, the number of ships now always at sea is so great, that the perils of collisions are much increased. But this, of course, is chiefly in the more frequented routes, not in Ocean's lonelier wastes.

Definite rules are laid down for the avoidance of collisions. When two vessels meet, each must steer "to the right." All ships have to carry, after dark, two powerful lights: a green one on the starboard or right side; a red one on the port or left side; and in the case of steamers, a white light also must be seen upon the mast.

The gradual development of ships, in the course of centuries, from rude skin-covered coracles to top-heavy mediæval vessels; from them to the stately Wooden Walls of Old England,—and, lastly, to the massive Ironclads of the Empire; is full of interest. By far the more rapid part of this development was witnessed in the years of the Nineteenth Century.

Perhaps a slight comparison between past and present sizes of ships may be worth giving.

To begin with Passenger Vessels.

In 1829 the Cunard wooden paddle steamers, of about two hundred tons, perhaps from one to two hundred feet in length, carrying sails as well as using steam, and able to advance at the rate of eight knots an hour, were counted good enough for the Atlantic.

By about the middle of the century the same Line had taken to screw-steamers, built of iron, some three hundred and forty feet in length, of four thousand tons burden, and able to get along at the rate of twelve knots.

In 1893 steel-built vessels replaced the iron-built; the length had grown to four hundred and seventy feet; and the speed had increased to seventeen or eighteen knots.

The *Celtic*, mentioned above, launched in 1901, of over twenty thousand tons, is seven hundred feet in length, and though not equal to many modern ships in speed, can do her seventeen knots with ease.

The same advance was seen in another line of steamers, plying their way to and from the Cape.

Before the middle of the century, ships two hundred feet in length, and going at the rate of seven knots an hour, were reckoned sufficiently up to the mark. *Now* vessels five hundred feet in length, steaming at a pace of twenty or more knots, are in use. One cannot but question how long it would have taken, under the old *régime*, to transfer two hundred thousand soldiers from Great Britain to South Africa. Under the new order of things that feat was lately accomplished in less than eight months.

The same steady growth is apparent in Merchant vessels generally—in their gradual increase from small to large, from slow to fast.

Again, the same development is seen in Men-of-War.

Up to the year 1860, twelve or thirteen knots for the best speed of a battleship was regarded as eminently satisfactory. By 1870 this had risen to nearly fifteen knots. There for many years it stood still; but since 1880 the outside speed of battleships has arrived at nineteen knots.

Fast Cruisers have exceeded the Battleships. Up to 1870 they had reached nearly nineteen knots; and since 1880 they have risen to twenty-three knots. These, again, have been excelled by Torpedo Destroyers, which can go at the rate of twenty-six or twenty-seven knots.

Together with increase of speed has come growth in size. A modern fast Cruiser has often from ten to fourteen thousand tons displacement; a modern Battleship from thirteen to fifteen thousand tons.

But the popular notion, that Men-of-War exceed in size and weight all Passenger and Merchant vessels, is a delusion. It arises from a difference in the mode of measurement.

The "tonnage" of a Man-of-War refers to its actual and literal weight. The "tonnage" of a merchant-ship refers to its space for goods or passengers—its "carrying power," in short. The two can no more be fairly compared by mere figures, than could a measurement by pounds and one by quarts.

Many a first-class merchant or passenger ship actually weighs more and exceeds in length the largest battleship. With the latter, size and space cannot be the principal aim, but rather strength and endurance, with speed.

A vessel lately constructed may have a most important bearing on warships of the future.

This "turbo-motor," as it is called, with a new kind of engine, has reached the unexampled speed of thirty-four knots an hour; and there seems to be no reason why in time it should not do much more. Such a success threatens to revolutionise the life of ships at sea.

Thus far British ships have been mainly spoken of; and naturally so. Not only because a British subject might be expected to put them first, but because of their enormous preponderance in numbers and tonnage over the ships of all other Nations.

American and German merchant-shipping has, it is true, of late years made huge strides; and the last thing to be done is to underrate their diligence and energy, or to wish them nonsuccess. Yet still we, Children of the Empire which dominates the Ocean, must desire our Empire to hold her own, must strive our utmost to keep ahead of all competitors in the race.

Perhaps not everybody realises how far ahead we have been up to the present day.

Other nations indeed have made great advance. What the future may mean for them and for us, Time alone can show. But as yet they do not seem likely to outstrip us, unless Great Britain grows lazy and lies upon her oars.

In the year 1900, the Merchant Shipping of the whole world, including all vessels of more than one hundred tons, was reckoned to amount in round numbers to over Twenty-eight Thousand Ships, and in burden to over Twenty-nine Millions of Tons.

Of that vast world-fleet Eleven Thousand vessels were British. And since the British ships were, on an average, larger than the foreign ships, it meant that *nearly one-half of the tonnage of the whole world's merchant shipping sailed under the Red Ensign.*

To put the matter differently. In 1892 another reckoning was made; the comparison being expressed by numbers, for the Merchant-Navies of several Nations. It stood as follows:—

The Merchant fleet of Italy was taken as slightly over One. Then, in proportion, the French fleet was represented by something over Two; the Norwegian, by the same; the United States, by Three; the German, by something over Three; and the British, by something over Twenty-two! This included the whole tonnage or carrying power of the fleets in question, both sailing and steam-driven vessels.

The figures speak for themselves.

Or, again, let us take all the steam fleets of the world, reckoning only vessels over one hundred tons, and only those used for merchandise; not Men-of-War.

These steam-fleets shall be pictured in our minds or on paper by broad black lines, one-tenth of an inch wide. Now let us see how long such lines would have to be, at two different dates, for a few of the leading fleets.

In the year 1889 they would have been given thus:—

Japanese.—Less than one-tenth of an inch long.

American.—Three and a half tenths of an inch long.

French.—Four and a half tenths of an inch long.

German.—Six and a half tenths of an inch long.

And next, after a great dividing gap—

British.—Fifty-one tenths of an inch, or over five inches long.

Once more, the figures speak for themselves. But this was a good many years ago. Let us have the same plan repeated for the year 1897, or eight years later, noting the advance made in each case.

Here, again, the tonnage of the whole steam-driven fleet of each Nation may be represented by a black line, one-tenth of an inch in width, and varying in length according to the size of the particular fleet. Some changes have taken place in those few years. The Japanese, instead of being quite at the end of the list, rank above the Spanish and the Norwegian; and the Americans have outstripped the French.

The results now stand thus:—

Japanese.—Nearly three-tenths of an inch.

French.—Five-tenths of an inch.

American.—Over five-tenths of an inch.

German.—Over a whole inch, or more than ten-tenths.

And once more, after another big dividing gap:—

British.—About sixty-seven tenths of an inch; or over six inches and a quarter.

We hear a good deal of the rapid growth of the German and American Merchant fleets, and not so much of the growth of our own. Yet certainly we have not stood still.

According to the above comparison, which is taken from an American, not a British report,* we have not held our own badly during recent years. British transport has actually grown the most. True, we have merely added sixteen tenths to an already great length; whereas, in the same period, the German fleet, adding three and a half tenths, has nearly doubled itself, and the Japanese, adding about two-tenths, has trebled itself. But a very small amount is easily doubled or trebled; and the nearest is still a long way behind the British total.

This should not be allowed to induce a spirit of over-confidence, which might probably mean in time the tortoises overtaking the hare. And although our Merchant fleet is still almost the double of all other Merchant fleets upon Earth put together, yet the proportionate difference has begun to grow less than it once was. Other countries are straining every nerve in the race;

* *Merchant Marine of Foreign Countries*, vol. xviii.

and if Great Britain would keep her present position, this is no time for slackening of effort.

Powerful though our Royal Navy undoubtedly is, it has not that vast preponderance over other Fleets of War which our Merchant Navy has over other Mercantile Fleets.

The aim generally set before Great Britain of late years has been to make and to keep the Royal Navy strong enough to be able to cope with any two other War Navies existing.

But if we had a War Navy proportioned to our Merchant Service, which might seem only reasonable, it would have to be nearly equal in tonnage to *all* the other fighting Navies in *all* the world.

Is our present aim high enough, in view of the tremendous interests, the enormous risks, involved?

CHAPTER XXVI.

AN EMPIRE: OCEAN-WIDE

"This Royal throne of kings; this sceptred Isle;
This earth of majesty; this seat of Mars;
. . . .
This happy breed of men; this little world;
This precious stone, set in a silver sea."
King Richard II.

"Never was isle so little, never was sea so lone,
But over the scud and the palm trees an English flag was flown."
RUDYARD KIPLING.

"See what a glorious throng they come,
Turned to their ancient Home,
The Children of our England."—LEWIS MORRIS.

DEEP down under the sea, on the sloping ocean-floor, amid dead vegetable and animal remains, lie strange snake-like forms. Not natural creations, but made by man and placed there for his own benefit.

Up to the year 1840 anything in the shape of a submarine telegraph was not only non-existent, but, so far as is known, it had not even been thought of.

Some wild dreams may have been indulged in here or there; but if so, the dreamers kept their dreams to themselves. On land the electric telegraph was getting into wider and wider use. The bare idea, however, of so uniting lands separated by the ocean had not been brought forward.

Between 1840 and 1850 the notion did come up, and was discussed. A small attempt was made in America, with what may be called a baby-cable, across a slight extent of water, near land. The Professor who made this experiment * ventured on a prediction that, in days to come, an electric cable might unite Great Britain and America. His friends probably pitied him as a visionary.

Through that decade there was no further advance. But in 1850 another step was taken. The first "open-sea" submarine cable was laid down between Dover and Calais; one of copper wire, covered with gutta-percha, outside which was a thick leaden tube.

For the moment a slender line joined England to the Continent.

Then an enterprising French fisherman, in quest of conger-eels, caught the cable in his powerful hook, and hauled it up. He took it for a stout sea-weed stem, and tried the effect of a

* Professor S. F. B. MORSE.

nibble. It was not appetising, and he flung it back into the water. Somewhat later, however, he hooked it up again; and this time he secured his spoil, cutting off a length, which he carried to his native town, as a rare ocean-curiosity.

Naturally, no further telegraphic messages could be exchanged between the two countries.

Nothing daunted, the projectors started afresh; made another cable; and put that down. This time they met with good success; and since 1851 England and France have talked in confidential whispers below the Channel.

Many more cables under the sea were laid in different places with success. But all these were short ones.

A great scheme, dimly foretold in 1842 by one far-sighted American, was stirring. Why should not the New World be united to the Old, even as Great Britain was united to the Continent? Why not bind Europe and America together by cables beneath the Ocean?

Not twenty or forty or sixty miles would this require, but two thousand miles of cable. And in any part of those two thousand miles, one slight break, one little flaw, would undo the whole. The plan meant thousands of pounds risked, with perhaps no return.

Yet it was persevered in. Before the close of 1857, that year of Indian Mutiny horrors, the first attempt was made. Four hundred miles of cable slid safely down, and lay upon the ocean-bed. Then as it ran out from the ship, it snapped. That was a failure.

Next year another attempt was made. Two ships, each bearing half of the great coil, came together in the middle of the Atlantic, and "spliced" the ends. After which they parted, one going east, one going west, each laying its own share. But again the cable broke.

Enough remained on hand to supply the place of the lost length. A third effort followed quickly. For a while success seemed to crown perseverance. The whole cable was safely down; and messages were exchanged. Whispers from the Old World to the New went under two thousand miles of ocean, and answers came back. Then the wire ceased to speak. In some manner, connection was severed.

Time passed, and for a space no more was done. But in 1864 the *Great Eastern* started, carrying the whole of a new and much stronger cable—more than two thousand two hundred miles long; and of so solid a make that each mile of it weighed three thousand pounds.

Once again disappointment lay ahead. More than half the task had been accomplished, when the cable broke anew, the lower end as usual vanishing.

Many days the great ship hovered round, hunting for that lost line; but she had to give up the quest, and to go home. A year later, however, the search was resumed; and the cable, lying quietly upon the ocean-bed more than two miles below, was found and pulled up by powerful grapnels.

Not yet was man beaten in his contest with the Ocean. It takes a good deal of beating to make the Anglo-Saxon give in. Wind and wave, depth and distance, all were against him; but he went on. The plan had to be carried out. He meant to see this thing through. He had made up his mind to have his verbal under-sea intercourse, between Continent and Continent.

And at last he had his way. A new cable was manufactured; and this time, not only was it laid safely, but it held good.

Side by side with the new was laid also the old lost cable, which had been fished up from the deep. So a double line of connection existed between Great Britain and her Daughter-land across the Atlantic.

That aim fulfilled, after so much of failure and discouragement, other cables were put down in many other parts of the world. Beneath the sea in all directions they lie, joining countries widely separated.

A year or two ago it was reckoned that the full extent of all submarine cables in the world had already reached a grand total of about two hundred thousand miles. Not much more will bring it to a length which might span the distance between Earth and Moon.

Lately a splendid new scheme has come up, and has been adopted. This is—to unite the entire British Empire by one vast "All-British" telegraphic system. As is the nervous system to a man, so will be the said telegraphic system to the Empire.

At present many telegrams have to be sent to outlying parts through foreign dominions—which is much as though a man's brain should have to send messages to his fingers through another man's arm. But when once this scheme has become a reality, the Mother-land will be able to convey, under the broadest ocean-reaches, to any of her Children in distant parts, her requests, her warnings, her sympathy, her secrets, her congratulations, without fear of being heard by outsiders; without risk of having her utterances stopped by perhaps "unfriendly" hands, at some critical moment.

In this vast plan the chief cable will cover a distance of nearly nine thousand miles; and that will include a single stretch from Vancouver to Fanning Island, more than half as long again as the wire between Ireland and the United States, or about three thousand five hundred miles.

No surprise need be felt at the frequent breaking of cables, strong though they may be.

The great depth of water into which they have to be lowered, their own weight, the increased difficulties attendant upon stormy weather, and—when once they are down—the uneven character of the ocean-bed, have all to be reckoned with.

Careful previous soundings are of course made, with a view to avoiding, if possible, abrupt descents and precipitous breaks in the line where the cable is to be. One can easily understand how, if a cable lies taut across from one ridge to another, it may snap with its own weight.

But even upon a fairly smooth bed, other dangers exist. Sometimes, deep down, a big "landslip" takes place, and a vast mass of débris slides to a lower level. If such a mass happens to descend upon a cable, the breakage of the latter is no unlikely event.

A hundred years ago, and less, Englishmen living and toiling in India reckoned themselves happy if, when they wrote "home," a reply came by return of post in ten or twelve months.

Now answers to questions can be obtained in a few weeks, by post; and in cases of emergency, news of life or death, of safe arrival or recovery from illness, within a few hours.

Before the close of the Eighteenth Century, a British Embassy was sent to China, to interview the then Emperor of that always difficult country. The Ambassador and his suite were received with elaborate politeness, at the end of their tedious voyage. China was verbally polite then, as now. But an intimation followed, warning the visitors that, if they wished to escape unpleasant consequences, they had better take themselves off so soon as might be. Which they had to do, since no Army was at hand to back them up against a good many millions of yellow barbarians.

The story of all this reached England, and was given in the *Times*, exactly one year after it happened.

Now the contrast! We know at breakfast one morning what has gone on, the previous afternoon, in China, in India, in Australia, in America, in Africa.

During the days of the Peninsular War, battles were fought, reverses took place, victories were won — and the news filtered slowly home by hand. Larger items of information arrived generally in the course of a few weeks; particulars as to individuals often not for months.

Now, not only does a check or a success on one day become known to the Empire at large on the day following; but even while a hard-fought battle is being carried on, we at home sometimes hear of it, and strain our mental vision, and watch in suspense for the ending.

What would our forefathers have thought of that historic day, when the beleaguered garrison of Ladysmith was fiercely assaulted, and we—seven thousand miles distant—knew what was being done; hearing that the heroic defenders were "hard-pressed," and no more? Hours of agonised impatience were lived through; not only in England, but in many a far-off Colony beyond the Ocean, all waiting for the result. Not that the news might not have been sooner sent from South Africa. Delay was due to the cutting short of local sunshine, so that a heliographic message could not be flashed across a few miles of veldt.

This great advance has come about, not by improvements in the world's shipping, though such improvements have not been small, but by means of the Electric Cable.

Not over the Ocean, but *under* the Ocean, messages are despatched with lightning speed, from man to man, in all parts of the civilised Earth.

Nor is this all. Quite lately another and still more marvellous means of communication has been discovered; a means which, if successfully followed out, as seems now probable, will tend still further to revolutionise the life of ships at sea.

By means of Wireless Telegraphy man can exchange thoughts with man, when the two are separated by many miles of distance. Watchers on a lonely lightship, far from land, can appeal in trouble to their friends on shore. The Admiral of a great war fleet can send his voiceless commands through space, unhampered by wire or cable, unhindered by fog or storm.

Not under the water, but *through* or *above* the water these messages journey; and in the course of time, this last new method of signalling may even largely supersede the use of submarine cables. Smaller and smaller grows our world, as greater and greater become the possibilities of intercourse between places and countries, the inhabitants of which, not very long ago, were cut off from one another by months of arduous travel. Distance is a matter of time, not of miles. England is nearer now to her Indian Dominions than she was two hundred years ago to Italy.

The enormous importance of the command of the sea to the inhabitants of Great Britain is, perhaps, more fully realised at the present time by Britons generally than ever before.

Other Nationalities are compact, homogeneous, self-contained, self-supporting. They have sometimes their Colonies over the water, more or less mere excrescences, additions hooked on for a purpose, separation from which would entail no vital loss to the ruling country. The word "Mother-country" would be a misnomer in such cases.

But with Great Britain her over-sea Colonies are an essential part of the "body-politic"—no more to be lopped off without injury and peril to the whole Empire, than a man's limbs can be lopped off without suffering, and loss of blood, and danger to his life.

This great Empire of modern days is reckoned to contain "between eleven and twelve millions of square miles" of land; and "in round numbers four hundred millions" of subjects.

The four hundred millions are not, like the hundreds of millions of Chinese, all together in one part, all surrounded by a single containing border.

They are everywhere; in every clime; on every ocean; under tropical skies; around temperate seas; amid frozen plains. Each fraction of the Empire is divided from other fractions by the Ocean; and this makes needful, as an absolute essential to the integrity of the Empire, the command of leading Ocean-highways, by which the different portions are united.

From England to India; from England to Canada; from England to Australia; from England to South Africa; from England to Gibraltar and Malta and Egypt; from England to lesser Dependencies innumerable—always the "roadway" is over-sea; always the route is across the ocean-waters. Those ocean highways are thronged by the Empire's ships; and under those seas thousands of miles of stout cable in all directions serve as do the "speaking tubes" in some large business establishment.

As surely as the existence of Great Britain depended in earlier days upon the strength of her Navy, so surely does the existence of the British Empire depend in these later days upon her command of the sea. Once let that vanish, and the Empire must fall to pieces.

A little Island in northern waters, clothed often in fogs, small in extent, crowded in population, without the means "aboard" of feeding its own people;—yet, from that same little Island are extended wide sheltering Wings around the whole globe, guarding her Dependencies, warning off interference on the part of other Powers. So that, in the infancy of many a young Daughter-land, and even in later more vigorous growth, the Children have been protected; and no man, no potentate, whatever his ambitions might be, has dared to lay a finger on them.

But the benefit is not all or only on one side.

As years go by, children repay their parents' care. These young sheltered lands across the Ocean are growing strong. And in the day when the Mother-land found herself in difficulties, they joyously sprang one and all to her help, giving freely of their time, their money, their strength, their bravest and best, their very life-blood, in her service.

God-given, surely, is this mighty Empire into the hands of the Anglo-Saxon Race, to be used for God and for the good of Man, to be governed in the Name and in the Spirit of Christ.

It is a marvellous and unique sight. A world-wide Empire of modern days; divided by broad extents of Ocean; held together, not by fear, not by the sword, not by the iron heel of despotism, not even primarily by self-interest, but by Bonds of Love.

A congeries of free Nations, Mother and Children, united into ONE, by the noblest and purest of all ties; having had through over sixty years for its centre, for the controlling idea and motive of Empire, a Woman of tender heart and Royal spirit, a Queenly figure on Her Throne, to whom those hundreds of millions in many Lands were dear, since one and all they were to Her—"My People." And though She has passed away, that thought has been taken up by Her Royal successor, one of whose first Kingly utterances was in the form of letters addressed—not only to "My People," but to "My People beyond the Seas."

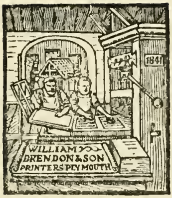
Thus around the whole world, in every zone, through both hemispheres, about every ocean, the Union Jack never ceases to flutter in the breeze.

A Frenchman lately, speaking in public, described half humorously how, as he journeyed round our globe, at each halting-place, at each coaling-station, he found invariably "that bit of Rag," so dear to the Briton.

And no wonder! for it is the RAG which stands for Freedom.

In the lower Creation, under ocean-waters, we have seen how the fierce perpetual struggle for existence goes on; how, with scarcely more than one exception, that of the mother for her little one, each creature lives and thinks and fights for itself alone. But man is capable of better things. A man may forget self for his Country's sake. He may lose sight of ease and gain, in thought for the poorer, the weaker, the darker tribes of Earth—under that protecting Flag.

Wherever it goes, north or south, east or west, there go also Freedom, Justice, and a liberal recognition of the rights of Man, even of the feeblest, even of the blackest-skinned. For the first time in the World's History this grand and high ideal rules in the counsels of an Empire wide as the Ocean itself.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