

The wide and deep sea.

Publication/Creation

London : Jarrold, [between 1850 and 1859?]

Persistent URL

<https://wellcomecollection.org/works/xf6sgqn7>

License and attribution

This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

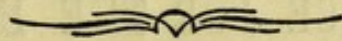




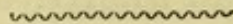
Digitized by the Internet Archive
in 2014

<https://archive.org/details/b20421394>

SCIENCE FOR THE
HOUSEHOLD.



THE WIDE AND DEEP SEA.



“They that go down to the sea in ships, that do business
in great waters; these see the works of the Lord, and his
wonders in the dee ”

Second Edition. Tenth Thousand.

LONDON:
JARROLD & SONS, 47, ST. PAUL'S CHURCHYARD.

Price Two Shillings per dozen.

33386231

SCIENCE FOR THE HOUSEHOLD.

THE GREAT ROUND WORLD.

THE WIDE AND DEEP SEA.

BUSY-BODY OXYGEN.

THE INVISIBLE AIR.

THE INCONSTANT WIND.

THE REFRESHING RAIN.

Also, by the same Author,

HEALTH FOR THE HOUSEHOLD.

Based on a Knowledge of THE WORTH OF FRESH AIR—
THE USE OF PURE WATER—THE VALUE OF GOOD FOOD—
THE INFLUENCE OF WHOLESOME DRINK—THE ADVANTAGE
OF WARM CLOTHING—THE GAIN OF A WELL-TRAINED
MIND. Embossed cloth, price 1s. 6d.



THE WIDE AND DEEP SEA.



OF the habitable land of the earth there is such a vast extent spread out, that if a man were able to set his foot upon a fresh square mile of it every successive minute of time, he would be seventy-six years before he had trodden upon every square mile. The wide sea, however, is so much more extensive, that if a man were able to drop a stone into a fresh square mile of it every successive minute, it would be two centuries and twenty-eight years before every square mile of the great waters would have its stone. There are about thirty-eight millions of square miles of land upon the earth, but there are 114 millions of square miles of water. The wide sea is three times as large as the broad land.

The relative sizes of the land and sea depend upon the way in which the hollows and projections of the earth's solid surface are arranged, and upon the actual quantity of the liquid which has to be accommodated in the deepest parts of the hollows. The cause of the presence of a sea is merely this;—the liquid substance of water cannot cohere, and hang together as stones, and the rocks and hills, do. Consequently water cannot be laid on the earth's surface in a lump. Its particles tumble over and over each other until all are equally sustained from beneath, and at the sides. The earth's natural liquid—water—thus invariably runs down until it has got as near as it can to the attracting centre, the middle of the earth. If there were enough of this natural liquid belonging to the earth, it would fill up all the hollows and depressions until it rose above the tops of the highest mountains, and the whole surface of the globe would be sea. As

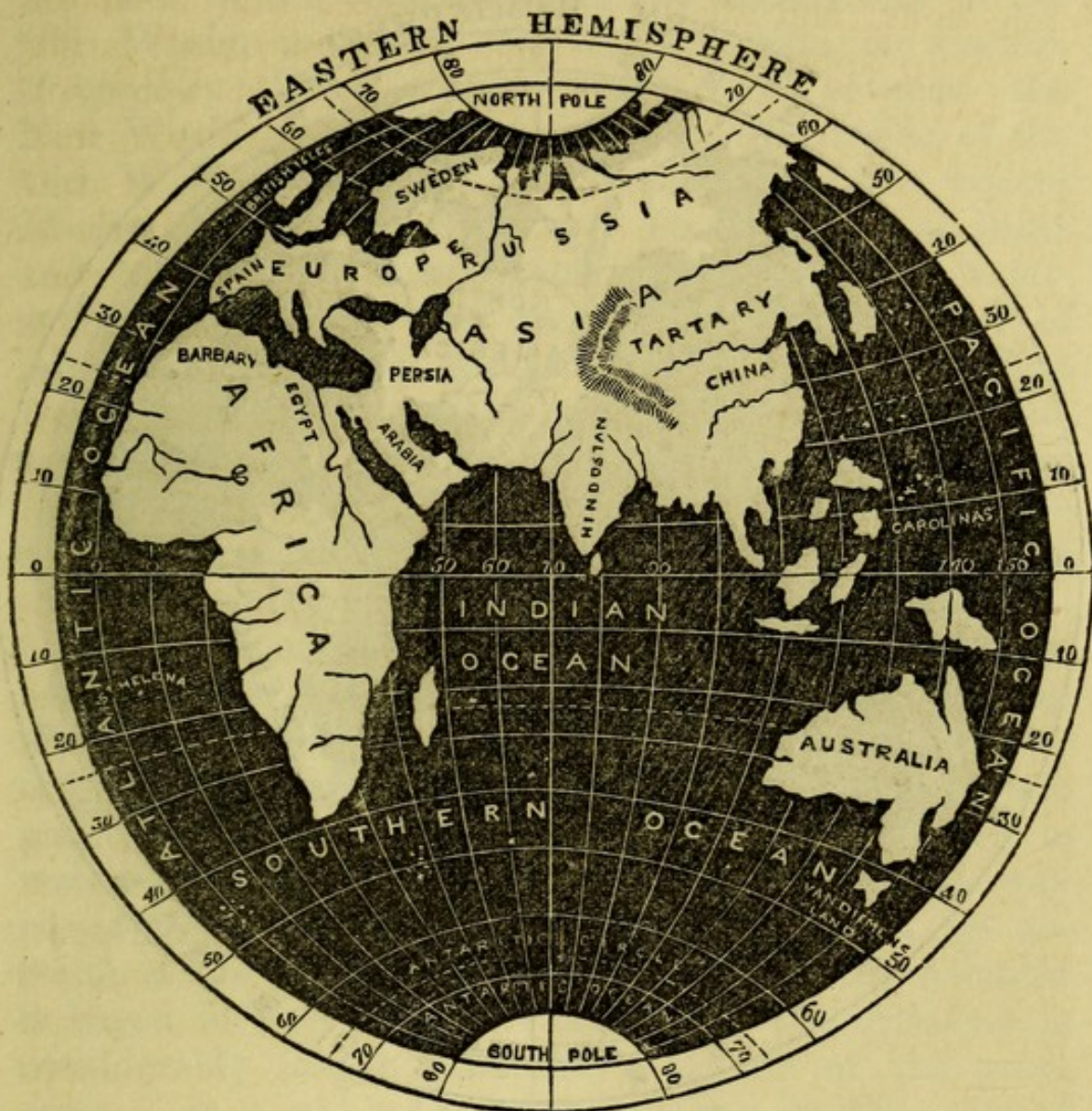
matters stand, it rises some way up the sides of the projections, and all the solid substance that is above its reach, appears as dry land, while the rest forms the bed of the ocean. If there were more water, or if the depressions of the sea-bed were shallower, that water would then rise higher, and there would be even more sea, and less land than there now is. If there were less water, or the depressions of the sea-bed were deeper, then this would have the effect of making the land larger and the sea less.

When men sail in ships over the wide ocean, and look down upon its mysterious surface surging and heaving beneath them, it is impossible for them not to wonder how far that liquid mass goes down under their vessel. There are some places in which a sounding line seems to reach the bottom with tolerable quickness; in others it will not touch the sea-bed until more than five miles beneath the surface. In some spots no bottom can be found. It thus appears that there are hills and valleys down at the bottom of the deep sea. The sea-bed is not like the bottom of a smooth basin; it is reared into peaks and ridges, and ploughed with furrows and grooves, and smoothed into slopes and plains, just like the high land which appears above the waters. The average or main depth of the wide sea, or ocean, is probably about three miles.

There must be a quantity of water in the wide and deep sea, which is far too great for any form of numbers to be able to convey a fair idea of its immensity. Imagine an enormous basin nearly three thousand times as large as England, and every where three miles deep; such a basin would but just contain the waters which are actually poured around the earth.

The wide and deep sea is commonly known as "The Ocean." This name was conferred upon the great waters by the old Greeks, many centuries ago. It signifies the "Swiftly flowing." These old Greeks imagined that the wide sea was a large river, which ran with great speed quite round the earth, and it

Fig. 1.



will be seen presently that their imagination was not a long way from the truth, and that the ocean is such a swiftly flowing stream.

But the wide and deep sea is not all in one basin, so to speak. The dry land of the earth is chiefly contained in two large, distinct stretches, or continents, known as "the Old World," with which civilized men have been familiarly acquainted from the earliest periods of history, and "the New World," which was first made known to the civilized races of mankind, about three centuries and a half ago. Between these stretches of land, or continents, two

Fig. 2.



subdivisions of the wide sea are contained, on either hand. They really communicate with each other both to the north and the south. They are not actually in separate basins. Ships sail straight on from the one into the other, by making their way round the projecting ends of the continents of land. But these spaces of the wide sea are divided from each other by the intervening continents through many thousand miles of length.

At *Figure 1*, page 5, the form and position of the continental stretch of the Old World is shown.

At *Figure 2*, the continental stretch of the New World is represented.

That portion of the wide sea which lies between the New World continent, and the Asiatic side of the Old World, is called the Great Ocean, or Pacific. (*Peaceable*). That portion which lies between the New World and the European or African side of the Old World, is called the Atlantic, (*the sea beyond Mount Atlas of the Ancients*). To the south of India and between Africa and Australia, there is a water-space cut off from the great ocean by a cluster of large islands: that is distinguished as the Indian Ocean. That part of the wide sea which lies to the south of the great continents of the Old and the New World, and which seems to belong partly to the Atlantic, and partly to the Pacific, is commonly called the Southern Ocean.

The basin of the great ocean, or Pacific, is as large again as the basin of the Atlantic. Its surface contains fifty millions of square miles, which is more than all the land of the earth put together. In one part it is as far again across as the earth itself is wide; that is, it stretches two-thirds of the way *round* the globe. But, notwithstanding this, on account of the remarkable manner in which the Atlantic is bayed in and out, the coast-line of the Atlantic is considerably longer than the coast-line of the great ocean. It would take a ship, sailing at the rate of one thousand miles a week, eleven months to entirely skirt along the Atlantic coasts. A ship, moving at the same rate, would be able to do the same thing with the Pacific coasts in six weeks' less time.

The wide and deep sea is constantly fed by thousands of great streams pouring down into it from mountain grooves and valleys. Some of these river-streams are of enormous size, and furnish incalculable floods of water every day as their tribute to the ocean. Altogether the ocean receives from these sources, hour by hour, so vast an addition, that the liquid added would suffice in the course of a year to make a new sea by itself. This, too, has been going

on for thousands of years. Yet the wide and deep sea does not grow. Its vast basins are no fuller at this moment than they were six thousand years ago. The reason for this is, that the sea loses every day as much water as it receives. Vapour steams away from its surface, up into the air, as fast as rivers run down from the hills into its depths. The vapours of the sea go to form the clouds and feed the rains. The clouds and the rain feed the rivers. Thus the great sea continually loses what it receives, and then again receives what it loses. It consequently neither wastes nor grows.

But the thousands of rivers which flow down into the ocean are not formed only of simple water. These streams naturally carry down with them into the bed of the ocean whatever matters they can dissolve in their course as they run along. River-water is never entirely pure. It always contains solid matters which the chemist can extract from it by his magical proceedings, although the eye and the other senses fail altogether to discover their presence. If a tea-kettle be filled with river-water, and be then placed upon a fire, and the water be allowed to boil entirely away there, passing out from the spout as steam, small quantities of solid matters, which could not be turned into steam, will be found remaining in the kettle. It is out of such solid remainders, left behind by steaming water, that the fur which gathers round the inside of kettles, is formed.

The wide and deep sea is in precise reality a steaming kettle, furnished constantly with fresh supplies of water. The water of the sea is kept at a gentle boil by the heat of the sun, and the steam rises up from its surface to soar away to the clouds. But as the hard or solid parts of the water cannot be sent off with the steam, what is it that becomes of them? Where is the fur which ought to collect upon the great ocean kettle? Why, this fur, instead of being deposited as a hard layer on the sides of the basin, remains mixed

up with the water which is still contained in the basin. The water of the sea is never diminished, as has been already seen; it is never all steamed away to the forming point, because fresh water is added as fast as the steam is removed. Sea-water is *salt*, instead of being fresh.

The sea contains so much solid substance in its clear-looking water, that if this were all taken out from the water and dried, there would be enough of it to cover up to the depth of one mile, a land, one hundred and forty times as large as England! In every pint of sea-water there is more than half an ounce of solid substance dissolved and hidden away. Three quarters of this solid are common salt. The rest is principally lime, magnesia, potash, soda, and iron. Sea-water is therefore brine rather than water.

A considerable quantity of these solid matters, which are dissolved and hidden away in sea-water, and which so convert that water into brine, are the materials which are brought down, day by day, by the running rivers into its basin, and which then must remain there, because they cannot escape with the vapour that is steamed up into the atmosphere. They are the impurities which would form a fur on the sides and bottoms of the basin, if the entire supply of liquid were steamed away. It is probable that the waters of the ocean were salt from the very beginning. But however this may be, there can be no doubt that there is quite a sufficient reason for their saltness, in the combined influences of these operations. They must have become salt from these causes, if they had been ever so fresh at the first.

More and more solid matter is being carried down into the sea by the rivers every day and every year. Yet, strange to say, its water does not become *more salt*. There is just the same half-ounce of solid substance in every pint of sea-water now, which there was when this liquid was first carefully examined by man. There are *now* multitudes of living workmen

labouring to prevent the saltness of the ocean from increasing beyond the amount which it has reached. Fishes take their bones from the solid substance of the sea. Shell-fish derive from it the material of their shells. Sea-weeds extract from it the ashes which are mingled with their textures. In the warmer parts of the ocean, creatures too small to be seen by the naked eye, swarm by countless millions, and make for themselves, out of the same elements, hard coats, which remain as enduring structures when the creatures themselves have passed away. In parts of the Great Ocean, industrious many-armed builders rear coral rocks, and depend upon the salt water entirely for the ingredients of their work. All these dense matters, having been once withdrawn from the water of the ocean, remain apart from it, and are finally strewn in beds upon the sea-bottom, when their direct connection with the operations of life has ceased.

Fresh water is steamed away from the surface of the ocean most abundantly where that surface is most exposed to the blaze of the hot sunshine. There is a broad belt of the equinoctial region of the earth, nearly three thousand miles wide, over which the perpendicular noon-tide sun travels backwards and forwards, and in which the greatest degree of solar heat is consequently experienced. From this broad region, three thousand miles wide, and some eighteen or twenty thousand miles long, a depth of not less than fifteen feet of fresh water is steamed up to the sky in a year. In this hot, steaming region, very little rain falls, so that here the ocean-water does get *a little* more salt. It loses fresh water without receiving an equal supply in return. In this part of the sea the greater thickness and strength of the brine are marked to the eye by the liquid being of a deep blue colour, a hue which is altogether different from the bright green that is presented in temperate and colder regions. In the temperate and colder regions of the sea, rain falls from the clouds in great

abundance. Here, therefore, the brine gets to be diluted with fresh water, until the deep blue colour is softened away into a half-transparent green. The Baltic Sea, an arm of the Atlantic to the North of Europe, loses comparatively little water from evaporation into the air, on account of the coolness of the portion of the earth in which it lies; and it receives no less than 250 streams of fresh water, forming the drainage of a fifth-part of Europe. The consequence is that the water of the Baltic has scarcely more than half the salt of the water of the Equinoctial ocean. A pound of the Baltic water yields about 97 grains of salt, whilst a pound of sea-water from the German Ocean yields 186 grains. The water of the North Sea contains generally but three-quarters of the proportion of salt that is found in the water of the Mid-Atlantic.

Thick brine is, of course, heavier, bulk for bulk, than a thinner liquid. If a square block of sea-water measuring one inch all ways, were taken from the Baltic, and a similar block were taken from the Atlantic, and the two were weighed against each other, it would be found that the latter weighed several grains more than the former. But what happens when fluids of unequal weight are left in the same receptacle pressing against each other? This happens;—the weakest “goes to the wall,” and allows the strongest to take its place.* A moving stream is set up, which continues to run so long as the difference of weight and pressure is sustained.

The water which occupies the surface of the sea in the temperate regions of the earth, is circumstanced in the same way as air contained in a room which has a fire burning in it. The water in the cold regions of the North and South is like air contained in the heated chimney;—that is, it is *lighter* than the general bulk of the fluid with which it is in connection; not,

* See “The Inconstant Wind,” page 8.

in this case, because it is heated and expanded, but because it is deluged with streams of fresh rain-water, and so made less salt. The water in the hot tropical regions is like heavy air which comes in at the windows and doors of the room; it is *heavy* because its lighter part, vapour, is steamed away, and its denser parts are left behind. The water in the temperate regions accordingly yields to the pressure of the heavier brine, and moves off before it, towards the cold regions, where the pressure made upon it sideways is less. The temperate water is driven out of the temperate regions, towards the poles, by the tropical water, just as the air in the room is driven out of the room up the chimney by the air from the window and door. A water-current is set going, which flows continuously from the tropics towards the poles. But the light water beyond the temperate regions, being in its turn displaced, must go somewhere. What is to become of it? It flows back towards the tropics, mingling with the sea-brine, and becoming gradually heavier and heavier as it advances. Both the large sea-spaces of the earth,—the Great Ocean and the Atlantic,—extend from pole to pole, and cross the equator. In this particular they are therefore both alike. In both, there is a constant tendency of the dense brine of the tropics to run towards the poles, and of the light fresh water of the poles to run towards the tropics.

The great round world, which carries the deep and wide sea in the hollows of its surface, is, however, not at rest. It is constantly whirling round, not in the direction of the water-flow alluded to—from tropics to poles—but in the transverse direction from west to east. North America chases Europe, and South America chases Africa in an endless circle. As then the cold, polar waters advance from their comparatively small circles of rotatory motion to the wide tropical belt of the earth, which in its mid region has a girdle twenty-five thousand miles in extent, they keep getting into spots where the eastward rush of

the earth's surface is pressed on with ever-increasing speed. In the latitude of England the water of the sea is carried along, in consequence of the earth's rotation, with a speed of five or six hundred miles in an hour. In the Mid-Atlantic and Pacific, the water is carried along with a speed exceeding a thousand miles in an hour. But water, being a liquid capable of flowing, and not a hard and solid substance, does not lie passive, like a stone, on the surface of the whirling earth; in virtue of its flowing power, it hangs back a little in the basin in which it is contained. Thus the water from the polos bringing with it but the slower velocity of the small circles which it has left, is unable at first to keep pace with the more impetuously moving solid which forms the ocean-bed within the tropics. The earth consequently slips away from under it towards the east, and it lags back in an *apparent* current towards the west. The water on the coast of Morocco thus moves not directly along the African coast towards Sierra Leone, but obliquely across the Atlantic towards the north shore of the South American continent.

With the dense tropical brine moving towards the pole, exactly the opposite thing occurs. It arrives in continued succession at spots where the sea-bed has less eastward movement, in consequence of the earth's whirl, than itself. It brings the speed of a thousand miles an hour to places which turn with a velocity of only four or five hundred miles an hour, and so, by its own impetuosity, goes faster than the solid substance which is beneath it. It flows towards the east, as well as towards the pole. The water off the north coast of South America, and in the Gulf of Mexico, in this way sets, not towards Greenland, but obliquely across the Atlantic towards the British Isles. The mere rotatory movement of the earth thus favours the return of the cold, light water of the poles towards the tropics, and shows it the way it is to go. It bends the great ocean-stream into an enor-

mous eddy or whirlpool, which is for ever circling round and round. The heavy salt water advances towards the pole along one side of the ocean basin, and the light, fresher water advances from the poles towards the tropics, along the other side of the basin; and the stream crosses eastwards, by overshooting the earth towards the poles, and it crosses westwards by allowing the earth to overshoot and pass by it within the tropics and near to the equator. There is thus a vast ocean-whirlpool, circling round and round, on each side of the equator, both in the Great Ocean and in the Atlantic. But, in consequence of the peculiar circumstances in which it is placed, the ocean-whirlpool of the North Atlantic is more marked than the others; it is also more interesting and better known, because it extends its influences to the British Isles.

When the westward current of the Mid-Atlantic has traversed the basin of this ocean, it passes to the north of Cape St. Roque, and encounters the northern coast of South America, which here crosses the equator obliquely, facing towards the north-east. Having been turned somewhat northwards by the general slope of the coast, it flows along several hundred miles, until at length it passes between the Island of St. Domingo and the South American shore, and so enters the Caribbean Sea. From the Caribbean Sea, it sweeps past the Promontory of Yucatan, and is caught in the Gulf of Mexico, which is formed like a great reaping-hook, and moves along, in consequence of the earth's rotation, in the opposite direction—that is, towards the east.

Having been thus embayed in the Gulf of Mexico, this current escapes to the north of the island of Cuba, rushing forth like a mighty salt-water-river 120 miles wide and three thousand feet deep, and moving with the speed of four miles and a half in the hour. This ocean-river here has a volume one thousand times as large as the mightiest of river-streams, the great Amazon. Before anything was known concerning

Fig. 3.



the true nature or cause of this remarkable ocean-stream, its deep blue current was observed pouring forth from the Gulf of Mexico, and this Gulf was very naturally conceived to be, in some mysterious way, the source of the flow. The current hence received the name of "The Gulf-stream," which it still retains. The Gulf-stream is, however, nothing but a part of the great oceanic whirlpool of the north Atlantic, where it is condensed, and made more striking and obvious as a current by the form of the land which it is compelled to pass.

The Gulf-stream having issued from the Gulf of Mexico, between Florida and Cuba, proceeds along the American coast nearly as far as Newfoundland; it then bends to the east and crosses the ocean, passing the Western Isles, and falling with diminished force even on the shores of Ireland. From the Western Isles it turns towards the south, flowing past the

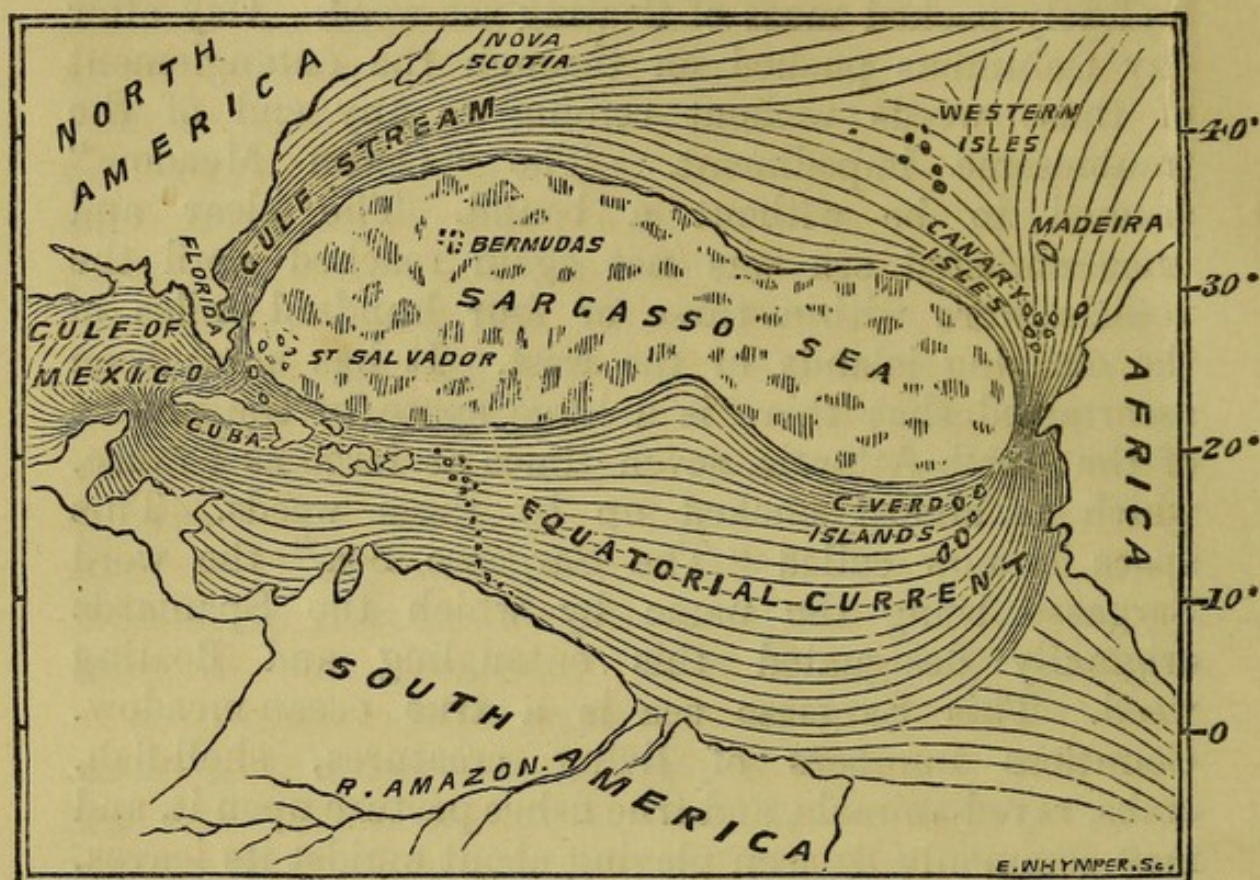
Cape de Verde Islands, and then again directing its course to the American shore. The stream, with a breadth varying in different places from 50 to 250 miles, thus performs a circular voyage of about 3800 miles.

Towards the end of the fifteenth century, an Italian navigator, Christopher Columbus, sailed from Spain with three small ships, bent upon a very bold and novel expedition. He had frequently before been at the Canary Isles, and had stood gazing from their shores, out upon the wide sea to the west. Occasionally, while doing this, and while reflecting upon the figure of the earth, he had observed that fragments of drift-wood, the seeds of plants, and other productions of land, were thrown upon the coast, as if brought from some distant country, lying far out of sight in that direction. After long pondering on these things, and weighing many suggestions that came in connection with them, the conviction was at last forced upon his mind that the place from which they came must be the eastern land of India, and that it would be possible to get to India by sailing over this western sea. Having, after much perseverance and labour, brought first a rich Spaniard, Alonzo Pinzon by name, and then the King of Spain himself, to think favourably of his views, a little fleet was fitted out under his command, and made over to his guidance. Columbus went first to the Canary Isles, and then started off boldly to the west, pushing forward into the open and hitherto untraversed ocean, in the certainty that, if he persevered long enough, he must at length find a shore on its further side. After a voyage of five weeks he found not the expected land, but first the West India Islands, and afterwards the New World—the great American Continent. While, however, he was sailing westward towards these places, and was yet only a few days from the Canaries, he saw ahead of his vessels what he believed to be a part of the land he was looking for. It had the appearance of being a broad green

meadow. But when the ships were brought cautiously up to this imagined land, it proved to be nothing but a closely packed mass of floating sea-weed. Day after day Columbus pushed on through the entanglement of these weeds without coming to any end of the troublesome impediment. The "Ocean Meadow" seemed to be without a bound. The clear and unencumbered sea was not again reached until the vessels were within three or four hundred miles of the outlying islands of the west. It has since been ascertained that there is a large space in the middle of the North Atlantic, seven times as large as France, which is almost choked up by these weeds. This space is now called "The Sargasso Sea," the word Sargasso being the name by which the Spaniards originally designated this entangling and floating weed. This Sargasso sea is a true ocean-meadow. Countless numbers of living creatures, shell-fish, crabs, rayed-animals, and true fishes pasture upon it, and may commonly be seen playing about amidst its leaves.

The question then here occurs, as it did to Columbus and his companions, How is this Ocean-meadow formed? Why is this large quantity of floating seaweed always gathered together in this precise spot of the ocean? If the form and position of the Sargasso sea be drawn upon paper, and the situation of the great circular whirlpool of the North Atlantic, already described, be also laid down on the same paper, the meaning of its presence becomes plain enough. The circular stream surrounds the Sargasso sea like a border. The Sargasso sea is the centre of the great Ocean-whirlpool. It is the middle of the eddy into which all floating substances are drawn. If small fragments of cork or wood, and bits of straw, be scattered over the surface of a basin of water, and the water in the basin be then made to whirl rapidly round, the floating fragments will all be seen to collect in the middle of the basin, where the force of the whirling motion has the least effect. The moving

Fig. 4.



water pushes the fragments in out of its way, by the friction it exerts, as its particles rush past them. As the water in the Atlantic basin is in rapid whirling motion, floating bodies are driven in to the centre of the whirl in the same way, and hence the Ocean-meadow of green, tangled gulf-weed in the midst of the gulf-stream eddy. In the above figure the position of the North Atlantic eddy, and of the Sargasso sea, is represented to the eye.

Columbus and his companions, on their first voyage across the Atlantic, sailed from the Canary Isles to San Salvador, in the Bahama group. Consequently they passed directly through the centre of the great Ocean-whirlpool, as will be seen by reference to the sketch given above.

It has been discovered by ingenious men that dwelling-houses can be very economically and effectually warmed during cold weather by the agency of

hot water. The plan, which is pursued when houses are thus warmed, is this. A boiler is placed over a fire in some convenient position in the offices, and iron pipes are led from the boiler to the various rooms to be heated. The boiler and the pipes are then completely filled with water, and carefully and strongly closed, and a fire is lit beneath the former. As the water gets hot there, the cold water from the pipes rushes down into the boiler, and pushes the heated water out before it. The heated water flows, under this pressure, through the pipes, giving warmth to the rooms as it passes; it thus becomes chilled itself, and returns to the boiler as cool water for a fresh supply of heat. A constantly circling current is in this way established, from the boiler through the pipes to the rooms, and from the pipes back to the boiler. By the simple expedient of furnishing a water-passage, and leaving the water free to render obedience to the rule to which it is subjected, when warm and cool portions of the liquid are placed in close relation with each other, the heat of the fire is thus carried to the rooms where it is required, without any other instrumentality being necessary to make it go.

What men have thus learned to do with their houses, God has done from the first with that great dwelling-place of the human race, the earth. He has arranged a hot-water apparatus for warming the colder parts in the colder seasons. The tropical sunshine is His fire. The great whirlpool-currents of the ocean are His pipes. The temperate lands are His principal apartments, where living men assemble,—“Man being the fruit which ripens in the Northern Sky.” The sea-water, which lies daily under twelve hours’ direct sunshine, midway between the tropics, maintains day and night an even warmth of 80 degrees; that is, it is four degrees warmer than what is known as the “summer-heat” of the air in England. This, therefore, is the temperature of the great Ocean-current which crosses the Mid-Atlantic westward. But when

this current has entered the Mexican Gulf, and is caught there in the sickle-like bay, it gets heated up, under the influence of the Mexican sun, and the close neighbourhood of scorching land, six degrees higher. The Gulf-stream, which pours out northwards between Florida and Cuba, has a heat of 86 degrees. The greater portion of this heat it retains a long while, as it runs to the north, giving out only small quantities of it at a time to the regions which it passes. For three thousand miles the water of the Gulf-stream is many degrees warmer than that of the surrounding ocean. It crosses the latitude of the south of France in winter-time, having the mild temperature of the summer of that region. The ocean to the north of Ireland, to which the set of the Gulf-stream extends, is altogether as warm in the winter as the sea twenty degrees further to the south is on the opposite side of the Atlantic. It has been calculated that the heat carried off from the Gulf of Mexico by the Gulf-stream, to be distributed to colder regions, would be sufficient to raise a mountainous mass of iron to the melting point, and to keep a stream of the molten metal, as large as one of the chief rivers of the earth, flowing continually! This warm current occasionally conveys fishes of the mild tropical sea to the British coasts. The British Islands enjoy a climate very much milder than would otherwise belong to the latitude in which they are placed, on account of the heat which is brought by the great Atlantic-eddy setting towards their shores from Central America. In winter time they, indeed, are especially benefitted by Nature's warm-water apparatus. Every one knows the difference between a west and east wind in England during the winter and spring. This difference is entirely due to the fact, that the west wind blows over the termination of the Gulf-stream before it reaches the island, and so imbibes the mildness of its waters. It comes to England, so to speak, by blowing over Nature's warm-water pipes. The east wind, on the

other hand, comes over land, where no such apparatus is in play, and where the whole force of the position in latitude is felt. Central Europe depends for its warmth entirely upon the heat of its own sunshine. The British Isles, on the other hand, depend both upon their own sunshine and upon the warm-water apparatus furnished by Nature. Great Britain receives Mexican, as well as British, solar warmth.

One remarkable circumstance illustrates the movement of the North Atlantic Eddy. The tropical waters contain, among other things, a great abundance of minute living creatures, which are so small they can scarcely be seen, unless the eye be aided by a powerful microscope, but which nevertheless make for themselves coats-of-mail of the nature of hard limestone. The figure represents, greatly magnified, the

Fig. 5.



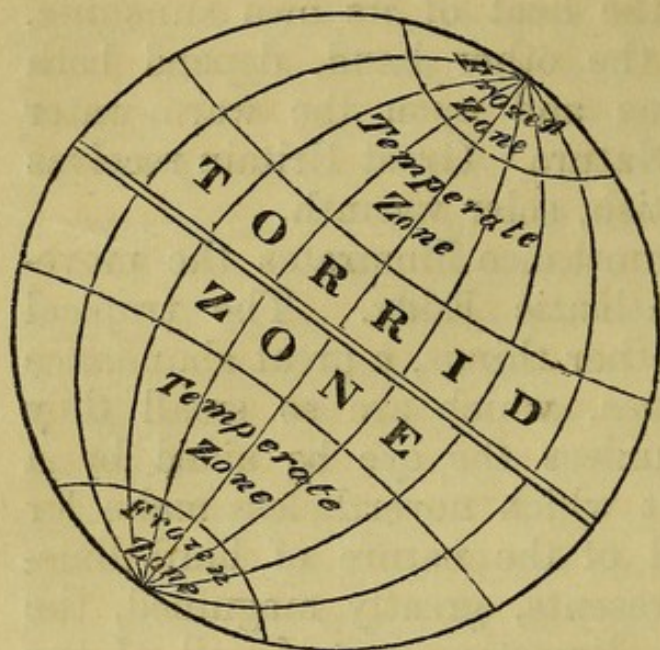
limestone coat-of-mail of one of these tropical creatures. The water of the Gulf-stream hurries along crowds of these indestructible tropical shells in its current. The shells are sustained by the moving-force of the water so long as the current is flowing briskly along, but where the water

spreads out towards the northern edge of the whirlpool, and joins the southwardly flowing stream of cool water from the pole, the sustaining power of motion being in a degree lost, the shells fall to the bottom of the sea. All along the northern edge of the gulf-stream, a perpetual gentle shower of these delicate limestone-coats is falling. The sea-bed is literally sanded with them from side to side of the Atlantic, so that for a broad space between Newfoundland and Ireland the floor of the Atlantic basin is as soft, and almost as level, as a sandy sea-shore.

The surface of the great round world is commonly considered to be divided into belts or zones, marked

by the very different degrees of heat which are experienced therein.

Fig. 6.

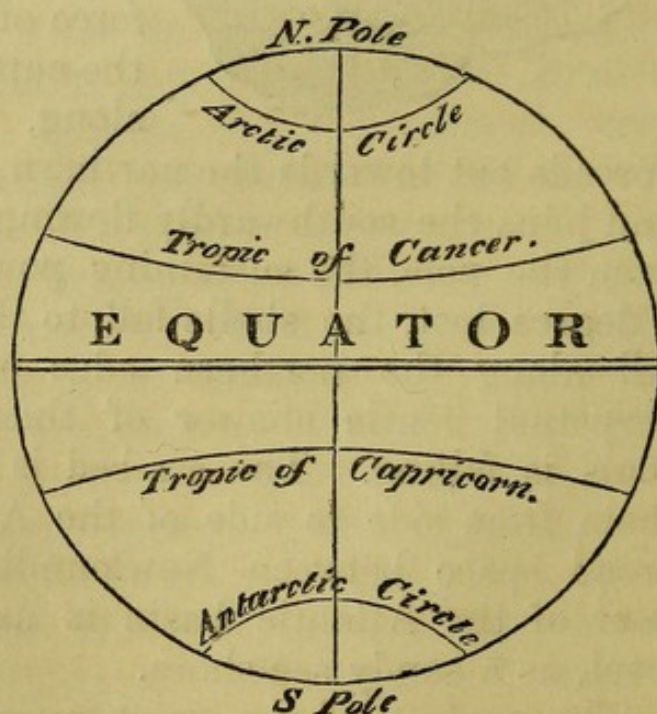


All that portion which has the sun shining perpendicularly over it at noon at some time or other of the year, is called the burning or TORRID zone. This zone comprises a breadth of nearly three thousand miles, and has the equator, or circle of greatest rotatory motion, passing through its midst. It is con-

ceived to be bounded on either hand by circles which are called the tropics, because the overhead noontide sun having travelled so far, *turns back* into the torrid zone, instead of advancing further onward; beyond them the sun is never seen directly over-head at noon.

The word tropic means simply the turning circle, or line. On either side of the torrid zone, for a breadth of two thousand and five hundred miles, the earth's surface is called the *Temperate* zone. Over these portions of the earth, the sun never shines perpendicularly even at noon, but at the same time it there never altogether cea-

Fig. 7.



ses to appear at noon, as it does nearer the poles.

Beyond the temperate zones, both to the south and the north, there is a circular space of the earth's surface some two thousand six hundred miles across, where the sun during the depth of winter does not rise above the horizon day after day, and where consequently cold and frost are all powerful for a great part of the year. These spaces are accordingly called the FROZEN or FRIGID zones, and they are divided from the temperate zones by imaginary lines, which are named the Arctic and Antarctic circles.

Since the two large oceans of the earth stretch nearly from pole to pole, each of them traverses the whole of these zones. Sailors, who pass from place to place on the ocean, rarely, however, have cause to enter the frigid zones. But they move continually from one temperate zone to the other, and so have to cross the torrid zone on the wide sea. The southern extremities of the great continents, Cape Horn, and the Cape of Good Hope, which have to be rounded in going from the Atlantic to the Indian or Pacific oceans, project far into the temperate regions. Calcutta and Canton lie near the southern boundary of the north temperate zone; therefore, as the British Isles are in the same zone, a voyage to either of these places carries the ship twice across the entire breadth of the torrid zone. The torrid zone of the wide sea, which thus has of necessity to be traversed twice during an Indian or China voyage, and once, at least, during a voyage to South Africa, or any spot lying in the Pacific or Indian Ocean, is peculiarly circumstanced. On account of the heat-carrying and heat-equalizing power of the water, the temperature is never so high there as it occasionally is in the same latitudes upon land. Towards the middle of the region, the air and the water remain steadily, day and night, at about eighty degrees of warmth. On account of this steadiness and evenness of temperature, the weather in the torrid zone of the ocean is commonly very fine. Near the equator itself, there is

scarcely any wind blowing, because the heated air is there rising up rapidly into the higher regions of the atmosphere. In this equatorial calm-belt, which is about two hundred miles wide, heavy rain falls frequently; the warm, vapour-laden air, being chilled in the higher regions, as it rises, drops a considerable part of the moisture which it before contained. On each side of the calm-belt, winds blow steadily in one unvarying direction all the year round. These unvarying winds are currents of heavy air advancing from the poles towards the calm-belt, to displace and drive up the warm and expanded air there found. As, however, the air-currents advance towards the equator, they get constantly to spots of the earth which are travelling, in consequence of its rotatory movement, more rapidly than the spots they have just left. The earth's solid surface therefore flies on somewhat more rapidly than they can go, and the wind lags behind it, or seems to persons fixed on the earth to be going the opposite way. To the north of the equator the wind therefore blows over the torrid zone from the north-east. To the south of the equator it blows from the south-east. Navigators can reckon upon finding these steady winds in these regions with absolute certainty; and the winds, on account of the service they render to men engaged in commercial transactions, have come to be called "TRADE-WINDS." In the district of the trade-winds, rain scarcely ever falls. But on the outer border of the trades, to the north and south, two other belts of calm, and frequent rain, are found. These are known as the calm-belts of the tropics of Cancer and of Capricorn. Beyond the tropical calm-belts, in the temperate sea, the wind is continually shifting about, now blowing from this quarter, and now from that; but upon the whole, it comes more frequently from the western side of the ocean than from the eastern.

The three calm-belts, and the districts of the trade-winds, are not actually fixed as regards their position

upon the ocean. They follow, to a small extent, the seasonal motion of the sun. When the noon-day sun shines perpendicularly over the latitudes near to the northern tropic, these belts of calm and constant winds all advance further towards the north. When the perpendicular sun is near to the southern tropic, they are all drawn further towards the south. They move backward and forward this way over the ocean to the extent of nearly a thousand miles; that is to say, a vessel sailing from England southward in the month of June, will enter the calm-belts and trade winds a thousand miles before a vessel sailing in the month of December. The equatorial calm-belt is *always* a little to the north of the equator. Its edge is sometimes not more than 120 miles to the north; it is sometimes 350 miles to the north.

Men are able to drive their great ships over the wide sea in the exact direction in which they wish to go, even through varying winds, for this reason. When the wind is directly behind them, they spread broad canvass-wings directly across the ship, and the ship is forced through the water before the wind by its pressure. When the wind is foul, they stretch the sails *obliquely* across the ship, and then the wind, rushing past the oblique sails, forces the ship ahead the opposite way, that is, nearly in the teeth of the wind. Ships can easily advance, in this way, within 60 degrees of the direction from which the wind is blowing; that is to say, with a head-wind, they can still go within two-thirds of the right way; and by inclining alternately from side to side, or tacking, as it is called, they can neutralize and render of no effect even this deviation. Once in the wide open ocean, skilful captains manage to drive their ships forward, however the wind may be. It is a tolerably common thing in long Indian voyages to find that no single day has been passed without a certain number of miles of real progress having been made.

A ship, then, sailing from England for the south,

by these tactics makes its way out of the English channel well to the south of Ireland to get sea-room, and shapes its course across the mouth of the Bay of Biscay, along the coast of Portugal some three hundred miles out to sea; it next proceeds just outside Madeira and the Canary Isles, and either between the Cape de Verde Islands and Africa, or outside these islands also. After some 18 or 20 days of varied progress, upon a sea becoming more warm and pleasant every day, the wind gradually fails, and the ship ceases to move through the water. It is now upon the calm-belt of the northern tropic. It must not, however, be imagined that a "calm at sea" means lying still upon smooth water. Of all the disagreeable movements landsmen have to endure when they commit themselves to the deep, to be tossed to and fro upon its restless surface, the knocking about of the "calm" is the worst. The crisp billows of the sea entirely disappear, but a huge lazy swell rolls incessantly under the ship, swinging it from side to side, and turning every unfastened object out of its place. At each swing the loose sails flap back against the masts and spars with a loud report. The ship itself turns round, as if on a pivot, entirely deprived of the steadying pressure of the wind, her head now towards the north and now towards the south, now towards the east and now towards the west. The captain walks restlessly to and fro upon the deck, muttering and grumbling to himself, and casting his eyes from the compass to the mast-head vane, and from the mast-head vane to the horizon. In these calm-belts, short squalls of wind every now and then burst across the face of the ocean, and the captain knows that if the squall bursts upon him from the wrong quarter, his ship is altogether helpless, and he himself powerless to bring her into trim. Ships have been, upon such occasions, driven down backwards into the sea, or turned over sideways while attempting to get before the wind. At length a grey cloud-curtain is seen

on some spot of the horizon; a "cat's-paw" of ruffled water advances along upon the glassy rollers, and a blast of wind and shower of rain sweep over the vessel. In the midst of much bustle, the sails are trimmed, the ocean once again is lively with white foam, and the ship is leaping along its course with a speed of some eight or nine knots in the hour. This lasts two or three hours. Then the calm returns, and the helpless vessel waits for another squall.

After three or four days stumbling along amidst alternate calms and squalls, the wind all at once freshens from the east, with a little northing in it. The surface of the sea becomes covered with short lively waves. The sky is mottled with beautiful white heaps of fleece-cloud (cumulus), coursing each other across the light greyish-blue field. These are the vapour-reservoirs in process of being transported from the warm regions where the vapour has been bred, to the colder regions, where it will have to fall as rain. Every sail in the ship is now outstretched on the spars, and fastened in its place. For days scarcely a rope will need to be stirred. The ship with bellying canvass, is scudding before the north-east trade-wind, some nine knots in the hour, rolling from side to side as the outstripping waves pass under its keel from stem to stern.

The evening in the trade-wind sea is a period of surpassing beauty, and of almost unalloyed enjoyment. The air is soft and balmy, without having the slightest trace of chillness. The round red sun sinks about six o'clock beneath a clear dark line on the horizon. Then the sky above is tinted with exquisite rosy and pale lilac hues, which pass down through a clear transparent green, looking like the deep infinity itself, until the green is lost in great masses of orange and flame-coloured red. In about twenty minutes these colours all fade, and suddenly there bursts forth from the sky, above the western horizon, what looks like the ghost of the just departed twilight. It is a

thin, but clear, white glare, in shape something like the top of a pointed gothic window, mounting two-thirds of the way to the zenith overhead. This glare is the "Zodiacal Light," so called because it shines along the tract of the star-zodiac; it is the thinner and more distant atmosphere of the sun, seen in the transparent air and deepening darkness, as it follows that luminary to its nightly eclipse. Next, a little on the left hand of the stern, and low down, a twinkling star reveals itself fitfully to the watching and regretful eye, now and then hiding itself in cloud-streaks and mist, and now and then peeping bashfully forth. That is the familiar pole-star dipping towards the north. But the sea has its stars, as well as the sky. Look deep down over the stern of the poop-deck, and mark how star after star flashes up from the unseen abysses of the brine, and joins itself with its comrades into serried ranks, which charge back impetuously into the darkness. The crest of the pursuing wave resembles a rising hillock of light as they mount upon its ridge. These sea-stars are the phosphorescence of the ocean. They are the flashes sent forth from the fire-flies, or glow-worms of the deep; curious minute creatures, with soft pear-shaped bodies and single wavy tentacles, or arm-tails, and known among naturalists under the name of the *Noctiluca*. The light sent forth by these sea glow-worms is seen in the trade-wind regions night after night, and is often of surprising brilliancy.

The equatorial calm-belt is passed much in the same way as that of the northern tropic, excepting that more of misty and rainy weather is experienced. The air near the equator is generally very disagreeable, in consequence of its closeness and moisture. But towards the African shore scarcely any real calm is encountered, owing to the breeze-producing influence of the land. Off the coast of Sierra Leone, or a little further south, the clouded sky begins to clear. The deep blue of the tropical brine is crested with white

foamy billows, and cumulus clouds again course each other from horizon to horizon. The wind now freshens steadily from the south-east, getting more easterly each succeeding day. The sails of the ship are accordingly braced tight, as obliquely to the line of the keel as they can be brought, and the head of the ship, looking over towards the American coast, is kept up as nearly into the eye of the wind as it can be forced. The wind, rather than the compass, is now the guide. The captain only strives to press the ship to the south as much as he can. The ship lies over upon its side under the firm pressure of the breeze, and goes pitching over the waves, having almost entirely lost the roll with which it moves when before the wind. Shoals of silver-grey flying-fish, surprised by its rapid movement, dash off with a skimming duck-and-drake sound from under its quarter. The pale green shark keeps a wary eye upon the proceedings of the sailors at the bows, or leads a brood of two or three immature sharklings, rising and falling in the half-transparent water of the wake. In this way the vessel is driven by the south-eastern trade-wind to within four or five hundred miles of the South American coast, passing to the westward of the Island of Trinidad. Then losing the trades, a little beyond the tropic, and getting into the temperate zone of variable, but chiefly strong westerly winds, it turns its bows towards the east, and bounds along, with a free sail, before the gale; huge rolling waves, twenty feet high, pursuing and outstripping it, as it goes. The observer who watches these magnificent waves from the high poop-deck of an Indiaman, as they course after the ship, sees their pointed crests rising clear against the sky, above the horizon. The vessel is kept well down to the south, in a wide curve, proceeding as far as the 40th south parallel if bound for India or the Pacific, or as far as the 36th parallel if bound for the Cape of Good Hope. The 40th parallel is familiarly known among sailors as the "rolling forty," on account of the great

waves which are continually raised here by the strong westerly wind. In this part of the Atlantic the advancing vessel is constantly beset with beautiful birds, now rising and falling on the waves in flocks, and now wheeling round the sails and spars. The butterfly-plumaged Cape pigeons settle down in a cluster upon the wave every time any waste morsel is thrown from the ports. The hawk-moth-like Cape-hen sweeps backwards and forwards, with its sharp dark wings, never relaxing into a flap. The snipe-like Whale bird every now and then starts out of the foam with its sudden zig-zag flight. The white Molly-mawk looks like a swan on the green billows half a mile to the stern; and ever and anon two specks mount into the sky over the western horizon, then dip, then rise again, and in a few seconds a pair of the monarchs of this wave-region, the noble Albatross, are seen with hooked beak, bright lustrous eye, and narrow crescentic wing, circling nearer and nearer, and paying considerate attention to the doings of the smaller fry. Nothing tends more to give a correct notion of the vastness of the scene which surrounds the mariner on these wide seas, than the appearance of these interesting birds on the wing. A bird which measures more than ten feet across, from tip to tip of the outspread wings, and which proves to have a body more bulky than the swan's when it is hooked and dragged on board, while flitting about the ship in its native air, seems no larger than a crow.

When the Indiaman has been some eight weeks at sea, and is staggering along over the vast ocean rollers before the heavy westerly breeze, it is nearing the Cape of Good Hope (if it have to touch at this port). For forty days no land has been seen. The last glimpse of firm ground was the Island of Madeira, now six thousand miles away. Since the vessel left England, it has sailed eight thousand miles over these watery wastes. All this way the captain has been keeping an account of his progress, with as much

accuracy and precision as if he had to do with roads and milestones, instead of having only the trackless ocean behind him. Every day, at noon, he has found out how far he has gone south, by noting, with his sextant, how high the sun is above the horizon. He knows how high it ought to be each day for each latitude; and so, by reversal of the process, he observes its height, and thence infers the latitude. But *early each morning* he also takes the sun's height above the horizon, that he may learn how far he has gone to the east or to the west. He knows, when he does this, how high the sun ought to be for each minute of the day at this latitude. Therefore the sun acts as a clock, and tells him the time of the place. But down in his cabin he has also a chronometer which tells him what time it is in London. For every hour of difference between his sun-clock, and his chronometer, or London clock, he has gone 15 degrees to the east or to the west. For every minute of difference he has gone in these latitudes, about twelve miles to the east or the west. With such delicacy and precision have these guides answered in the hands of the skilful captain, the purpose of pointing out the ship's place on the wide and trackless sea, that he now ventures, on his approach to the Cape, to promise land shall be seen at some particular hour, as for instance, at the dinner hour of four o'clock in the afternoon. A few minutes before the time a curious and anxious group of sea-weary passengers collects with him on the forecastle of the ship, and within five minutes of the appointed hour two little mound-shaped clouds appear over the right bow; these the captain at once pronounces to be high land near Hang-lip, the further shore of False Bay. The ship's course is not altered a hair's breadth, and half an hour afterwards the cloudy form of the Lion Mountain, backed by the square summit of "The Table," and edged on the left by the Devil's Peak, looms into sight. By five o'clock, as the ship dips and heaves,

the flag-staff of the signal station on the Lion's back is clearly conspicuous by the light reflected from the setting-sun, *directly in front of the bowsprit*. For six thousand miles the huge floating machine, impelled by its sails and directed by science, has followed an unseen track in the waste of waters, and now is coming in for the visible goal at the end, without having deviated by the slightest perceptible breadth from the required line. The tanned quarter-masters at the wheel continue to steer as they have been steering all day. The sun goes down over the stern. A clear double-star appears ahead, and grows in brightness and size. In another hour the double-star is abreast of the vessel on the right; it is the lighthouse on Green Point, the southern projection of the bay. Soon after, bare masts and spars can be traced in the dim starlight in all directions, the anchor is let go, and the vessel swings round in safe moorings in the midst of Table Bay, to see with the first blush of dawn the white houses of Cape Town nestling in their snug nook between the two advanced buttresses of the Table Mountain. A more impressive and complete illustration of the certainty and infallibility of science cannot be met, than is found when sea-faring men in this way strike the very spot on the firm land which they desire to reach after long long weeks of struggle, and after thousands of miles of wandering in the wide trackless wastes of the capricious ocean;—when “They that go down to the sea in ships, and occupy their business in great waters, are glad because they are at rest,” and are brought “into the haven where they would be.”

The End.

JARROLD AND SONS, PRINTERS, NORWICH.



