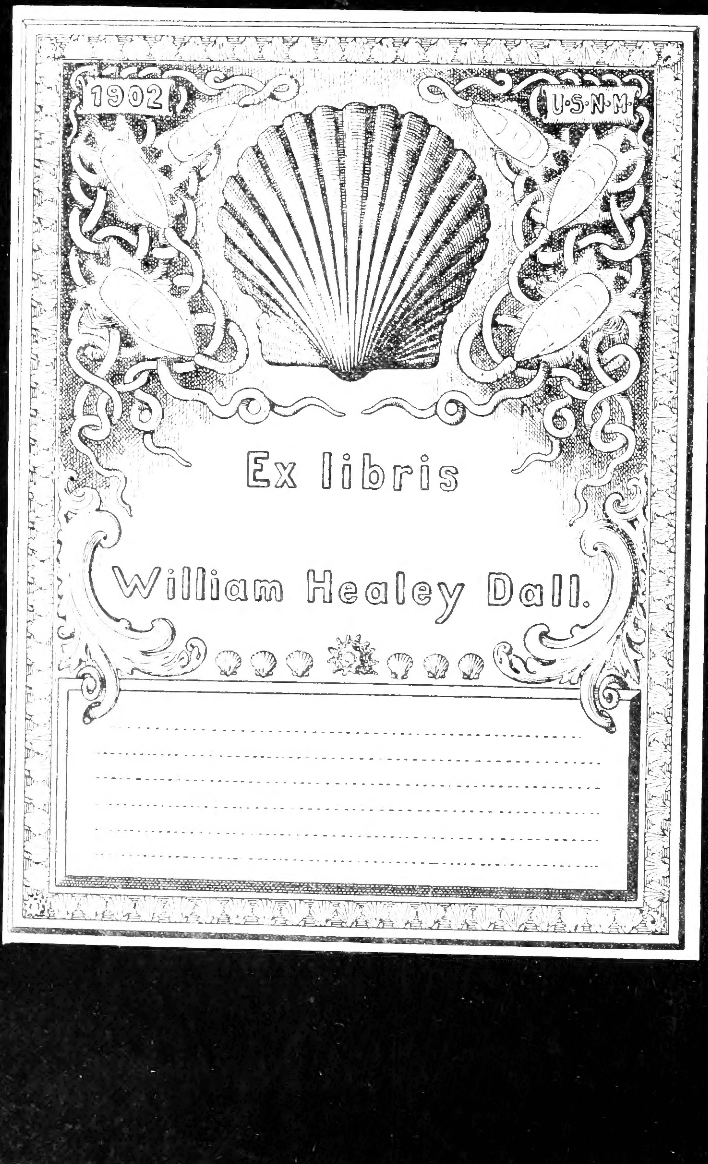
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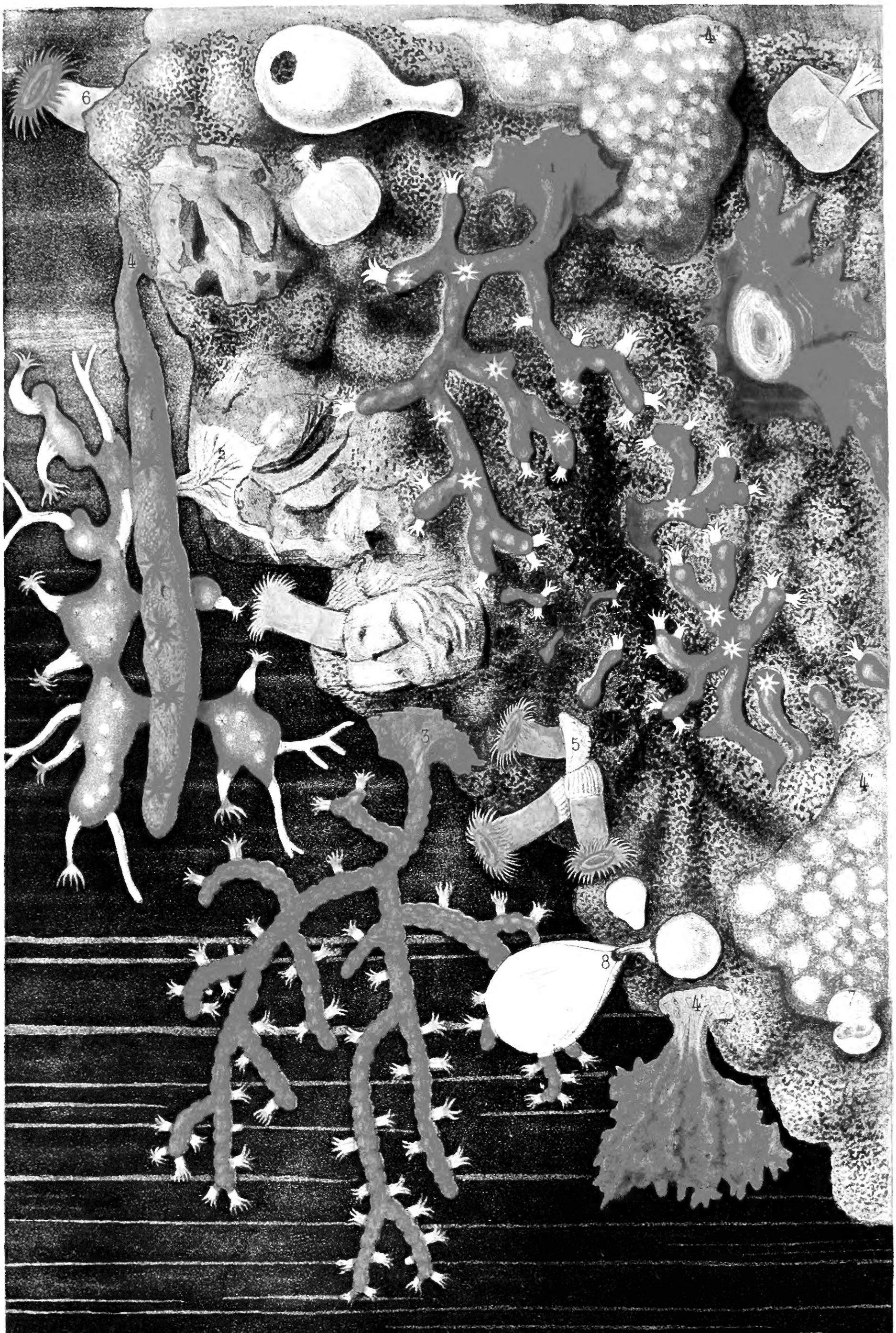
Wm. H. Dall
Smithsonian Inst.
Washington D.C.
June 8. 1875

THE

WORLD OF THE SEA.



V.

CORALS

Piece of [illegible] fished up from 80 fathoms depth in the neighbourhood of Calle

[illegible]

5 Balanophyllia italica [illegible]

6 Flabellum anthophyllum [illegible]

7 Thecidia Mediterranea [illegible]

8 Turbinolium caput serpentis [illegible]

THE

WORLD OF THE SEA.

TRANSLATED AND ENLARGED BY

THE REV. H. MARTYN HART, M.A.,

FROM

"*Le Monde de la Mer*,"

BY MONS. MOQUIN TANDON, Alfred

Membre de l'Institut, &c.

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

LONDON:
CASSELL, PETTER, AND GALPIN:
AND 596, BROADWAY, NEW YORK.

I

CONTENTS.

PREFACE.

"LE MONDE DE LA MER" was published in Paris some years ago; it was the work of M. Moquin Tandon, but for sundry reasons he substituted the pseudonyme of Frédol for his own name. The most prominent of those reasons no longer now remaining, we are not betraying a trust in divulging the author's real name.

The work is not intended to be exhaustive, but it is an ample review of the ocean world. At every point of interest in the submarine landscape the pen of the author has lingered. The reader is not led into this wondrous world by the hand of rigid Science, to find all strictly classified and labelled with a technical nomenclature; but the guide, as he passes through the mazes of the watery depths, points out everything which can arrest the attention: describing the habits and instincts of the denizens of the sea, entering into their home-life, examining the process of their development, the work assigned to them in the great scheme of life, and the connection they have with man.

Neither does life itself absorb all his attention, for he fails not to enter into the physical history of an element so totally different to that in which we exist. The waves, the currents, the tides, find a place in his description; and, passing northward, he leads us to the land of silence, where the sea, at the touch of the Wintry King, has congealed into fields of ice and stately bergs.

Then the illustrations—each one so accurate, so artistic, so admirably executed; and the coloured plates—so bright and natural; all conduce to make the work of M. Moquin Tandon difficult to equal, much less to surpass.

In translating "Le Monde de la Mer," I fear I have frequently failed to render its lucid and elegant language with the full force it merits; but I trust the blame I deserve in this respect may be somewhat palliated by the fact that I have not hesitated to add much new matter. Since the publishing of the work, naturalists have not been idle, and some of the later results of observation, together with certain points perhaps more interesting to us than to our neighbours across the Channel, have been incorporated in this translation.

Another book on the same subject was published a few months ago, "The Ocean World," a translation of a work of M. Figuier, who has not scrupled to copy verbatim frequently three or four consecutive pages at a time from "Le Monde de la Mer." I mention this to secure for M. Moquin Tandon a proper portion of the credit M. Figuier may perchance acquire.

H. MARTYN HART.

Blackheath, Sept., 1869.

LIST OF PLATES.

THE

WORLD OF THE SEA.

CHAPTER I.

INTRODUCTION.

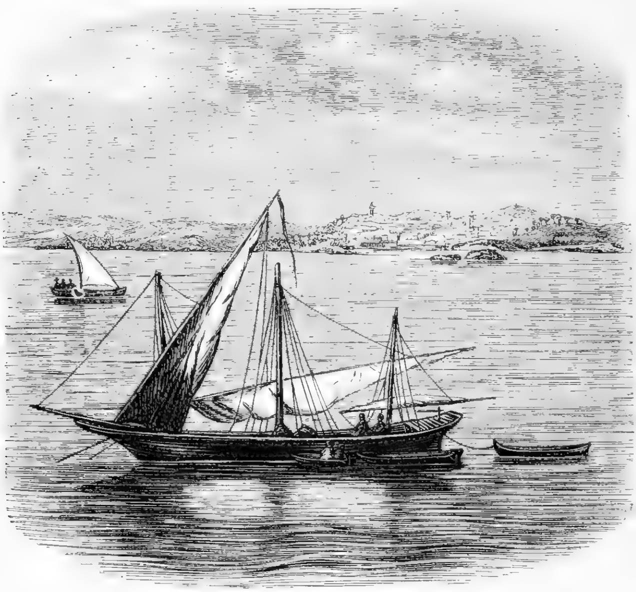
OUR world may well nigh be called a world of waters, for on the surface of our planet water is the rule and land the exception. No apology, then, is needed for describing the plants and animals which pass their existence in an element covering two-thirds of the globe, an element whose presence confines man, though he boast of his lordship over creation, to a third of his domain. Speaking more accurately, the waters stretch themselves over an area of 145,500,000 square miles, whilst the land which rises above their level occupies the remaining 51,500,000—or, to reduce the unwieldy numbers to something comprehensible, if the surface of our globe were divided into 1,000 parts, 266 would be land and 734 water.

This vast extent of watery area is divided by geographers into five oceans—the *Arctic*, *Atlantic*, *Indian*, *Pacific*, and *Antarctic*. The Arctic extends from the North Pole as far south as the Arctic Circle. Its waters freeze upon the northern shores of three continents, Europe, Asia, and America.

The Atlantic separates the Old and New Worlds. Its northern and southern boundaries are the Arctic and Antarctic Circles, while the Americas on the one side, and Europe and Africa on the other, form its lateral shores. It is the most important of the oceans. Through it pass the great highways of the sea. Its waters are not lifeless, dreary wastes, but thousands of mariners people its surface, and sails of every nation enliven its bosom. The South Atlantic also is famous for the birth-place of the tidal wave, a wave which sweeps round the world, disturbing what otherwise would be stagnant pools, cleansing the river estuaries, and carrying food and salubrity to the fixed inhabitants of the ocean bed.

The Indian Ocean is enclosed by Asia on the north, by Africa on the west, and on the east by Malacca, the East Indian Islands, and Australia.

The Pacific is the great ocean; with the exception of the



A CALM SEA.

Antarctic, it claims all the rest of the waters. It offers many peculiar and striking contrasts to its neighbour the Atlantic. The one has its greatest dimensions from east to west, the other from north to south. The currents in the Pacific are broad and slow, while those in the Atlantic are narrow and swift. In the one the tidal wave rises to an all but inappreciable height, in the other it heaves the whole breast of the waters, and dashes against the obstructing shores with wondrous force. And lastly, the Pacific, as its name would denote, is calm and tranquil, while the Atlantic is treacherous and stormy.

Referring again to the distribution of land and water on the surface of the globe, we must be struck with the fact that the land seems all gathered about the North Pole. Indeed, geologists tell us that the heaving and uplifting force which elevated the northern continents above their overflowing seas is still in action, and that the shores of the northern lands are still rising. This fact is ascertained by observing and marking the level of the water in the fiords of Norway and on the shores of the Baltic. The conclusion has been reached that there is a rise in the land at the rate of four feet a century. At the same time the bed of the southern oceans must be ever sinking; for the coral polype cannot live, as we shall find, at a greater depth than 120 fathoms, and yet the ocean around the coral islands is of an enormous depth. What this upheaving force is, and why it should act only in the neighbourhood of the North Pole, is still a mystery.

The line where land and water meet is the *coast.* Sometimes the continent pushes back the advancing waves with a rampart of rocks, sometimes boulders detached from the main cliff lie out in the sea breaking the force of the waves; these rocky and serrated coasts are found in Norway, Scotland, and other countries. The low coasts slope down with gentle declivities, and the land, as it were, glides beneath the surface of the water. These coasts are only found on the shores of countries whose soil is clay, or mud, or some post-pliocene deposit.

Thrusting off from the land and sailing on the surface of the water, as we peer down into its clear bosom, we naturally ask, What is the depth of the ocean? The question is more difficult of solution than it at first appears. It would seem an easy task to let down a leaden weight attached to a line, and at once measure the depth; but when the line is perhaps two miles in length, the density of the water is such that the lead is comparatively lighter, and has now much less inclination to sink than it had at the surface, so that it is easily carried away by the undercurrents, and when the explorer of the ocean bottom fancies his sounding-lead is perpendicularly beneath him, it is perhaps half a mile distant, and thus the depth he registers is much greater than it ought to be. Laplace, from astronomical considerations, concluded the mean depth of the ocean to be 1,600 fathoms. Humboldt gives his assent to this calculation. Dr. Young, another eminent authority, affirms that the Atlantic has a mean depth of 550 fathoms and the Pacific of 2,000 fathoms. Of course there are places in all seas unusually deep—the valleys and defiles in the ocean bed. The American, Lieutenant Walsh, in the Atlantic, off the shore of the United States, sounded the enormous depth of 5,640 fathoms. This is the deepest ocean valley yet discovered. The highest mountain in the world immersed in that watery abyss would not rear its summit above the waves.

From actual measurement as well as from theoretical expectation it appears that the Southern Ocean is the deepest. Professor Haughton, of Dublin, concluded, from the enormous volume of the tidal wave, that the waters which lie in the neighbourhood of the Antarctic Circle must have a depth of eight or ten miles, and this seems not improbable. The Baltic is the shallowest of all the seas, its depth not exceeding 108 fathoms.

We may form some idea of the enormous quantity of water occupying the bed of the ocean, when we find that were the seas emptied, it would require the flow of all the rivers in the world for 40,000 years to refill them. The *weight* of this accumulation of water is $\frac{1}{1786}$ of that of the globe. Every one knows that salt water is heavier than fresh. A ship laden in a river until the water all but laps over her gunwales will sail safely on the sea, the superior density of the water bearing her up. The specific gravity of fresh water to that of salt is as 1,000 is to 1,027. The heaviest water in the world is that which is supposed to cover the site of the Cities of the Plain, the Dead Sea; the weight of its water is to that of the ocean as 1,228 is to 1,027.

The colour of pure water is *blue*. To this fact we owe the beautiful tint of the sky over our heads, and the prevailing shade of the clear waters "under the firmament." The waters of the sea, however, are not always blue. The proximity of land, their depth, the colour of the bottom, all affect the shade. Far out at sea the ocean may well be called *cæruleum mare*, for there a plain of azure blue stretches away on every side until it blends imperceptibly with the sky at the horizon. Nearer the shore the blue tint assumes a greener shade, and this shade is less pure as the land is neared, for the erosion of the waves disturbs the mud at the bottom, besides mingling with their waters particles of the cliffs against which they dash. In some localities the colour of the sea is exceptional. The water appears white in the Gulf of Guinea; yellow near Japan; a grass-green to the west of the Canaries; and black round the Maldive Islands. The Mediterranean, towards the Archipelago, becomes more or less red; the Vermille Sea, near California, presents a similar tint. The names of the White Sea and the Black Sea appear to be derived solely from the ice of the one and the frequent storms of the other.

The sea has a peculiar saline taste, slightly acid, mixed with a bitter which is somewhat nauseous. It possesses an odour peculiar to itself, and is feebly viscid. We know that pure water is a compound of one volume of oxygen and two of hydrogen; or by weight, eight of oxygen and one of hydrogen. The water of the sea has a like composition; but, besides these gases, the presence of other ingredients has been discovered by chemists. An analysis of 100 grains of the water of the Atlantic is as follows:—

	Grains.
Water	96·470
Sodium Chloride	2·700
Magnesium	0·360
Potassium	0·070
Magnesium Bromide	0·002
Magnesium Sulphate	0·230
Calcium Sulphate	0·140
Carbonate of Lime	0·003
Residue	0·025
	100·000

Besides these substances, the ocean contains—in very small quantities, it is true—iodine, sulphur, silica, ammonia, iron, and copper. On examining, at Valparaiso, sheets of copper stripped from the keel of a vessel which had been long submerged, it was ascertained that traces of silver had been deposited upon it by the sea. And lastly, we find, in solution in sea water, a peculiar mucous matter, which seems to be of a vegeto-animal nature—organic matter arising from the decomposition of innumerable successive generations of living things which have appeared and disappeared since the creation of the world. This matter has been well described by Count Marsigli, who sometimes calls it *glue,* and sometimes *onctuosité*. The numerous salts which are present in the sea can never be deposited upon its bed, nor yet drawn up with the vapours to be returned to the earth with the rain; for certain agents are in action which retain, transform, and prevent them from accumulating. In this manner the waters always possess the same degree of saltness and bitterness, and to-day the ocean presents the same chemical and physical characters as it did in ages long past.

If all the salts which are in solution in the sea were taken from the water and dried, the quantity is so enormous that, if spread on the surface of North America, it would cover that vast continent with a layer half a mile thick! The common salt (sodium chloride) alone would form a mass only one-third less than the Himalayas, and five times the size of the Alps!

The saltness of the Mediterranean is greater than that of the ocean, probably because this sea loses more by evaporation than it receives from its rivers. On the contrary, the Black and Caspian Seas are less saline. The quantity of salt contained in the Dead Sea is so great that its density will enable a man to rest upon its surface like a piece of cork on fresh water.

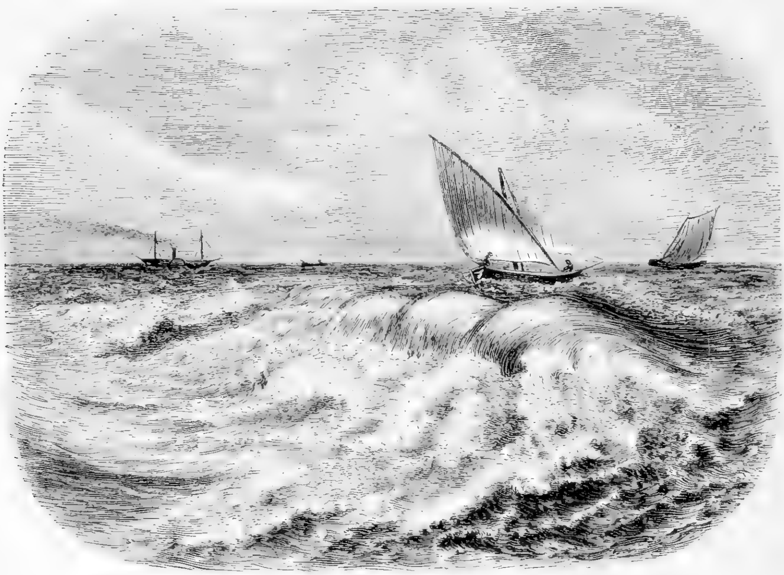
The sea appears generally less saline towards the poles than at the equator; yet there are exceptions in certain localities. In the Irish Sea, off the coast of Cumberland, the water contains $\frac{1}{40}$ of its weight of salt; off the French coasts, $\frac{1}{32}$; the water of the Baltic, $\frac{1}{30}$; at Teneriffe, $\frac{1}{28}$; and in the neighbourhood of Spain, $\frac{1}{16}$. In many places the sea is less salt at the surface than at the bottom. In the Straits of Constantinople the proportion is as 72 is to 62; in the Mediterranean, as 32 is to 29. It is said that at a certain depth where the saltness increases, the bitterness decreases. At the mouths of great rivers, it is scarcely necessary to say, the water is always less saline than upon coasts which do not receive currents of fresh water.

The ocean is in ceaseless motion; its extended surface rises and falls, as if softly breathing; its movements, gentle or violent, slow or rapid, are determined by the variations of temperature. Heat affects the volume, and, consequently, the weight of the water as it expands or contracts. As the temperature falls, the water becomes gradually heavier, and descends into the depths until it reaches 4°·25 Cent., the point of its maximum density, which temperature is found in every clime at the depth of 550 fathoms. If the water continue to cool until it arrives at zero, it is lighter than it was at 4°·25, and therefore begins to rise; so that freezing, by a wonderful provision, can only take place at the surface. When the temperature is above 4°·25, the light and warm water rises to the surface and the cold water descends to the bottom. If it be under 4°·25, the opposite process takes place: the cold layers of water rise, and the warm in their turn sink. The former phenomenon takes place in the temperate and tropic zones, the latter in the polar regions; and so it happens, whether in the warmest or coldest seas, the temperature at great depths is the same. The continual ascent of these warm layers furthers evaporation, by which clouds are formed. The loss the sea thus sustains in the warm latitudes is compensated by currents of cold water, which flow in from the poles.

Again, the rain formed by the condensation of the clouds is either warmer or colder than the surface of the sea on which it falls: in the first case it will remain on the top, in the second case it will sink beneath.

The waters of the rivers have an effect upon the sea by their temperature, their specific gravity, and their impetus, while the movements of the air, the winds and storms, have a still more manifest influence upon it.

And lastly, the combined attraction of the sun and moon draw daily around the globe two immense waves, which, at the periods of the full and new moon, rise to their greatest height, and sweep over parts of the shores which are usually dry. These great sea movements are known by the name of *the tides.* During one half of the year the highest tides occur during the day, and in the other half during the night. The tides in the mid-ocean do not rise three feet; but when the tidal wave encounters a continent which opposes its onward roll, it rushes up its shores with the velocity of a torrent, rising to heights which vary from ten to sixty feet. These currents sweep and purify our shores, our roadsteads, our ports, and the mouths of our rivers, carrying everywhere a vivifying and salutary freshness. Under the influence of celestial bodies which are thousands of miles away the tides preserve, in their periodical return, as strict a mathematical regularity as the movements of those bodies themselves. The enormous volume of water which they raise, and which could sweep down the mightiest barriers, gently subsides at the appointed moment, without passing its prescribed limits.



A HOLLOW WAVE.

Foremost among the beauties of the sea are the *waves*, with their constant and regular progression, their everlasting and monotonous roar, their dancing, flying foam which rises and falls, and rises again only to disappear upon the shore. Sometimes the billow lashes itself against the cliffs; but on low shores it sweeps back again to its bed, forming a thousand cascades, a thousand rivulets, a thousand sinuous rills. The volume and the height of the waves increase with the depth of the water; it is possible indeed, from a knowledge of their size and velocity at any place, to calculate the depth of the sea which gives them birth. The height of ordinary waves may reach twelve yards; their force wears down the hardest rocks, rounds off the edges of the *débris*, tosses about the pebbles, rubs them against each other, polishes them, degrades and reduces them to fine sand, which is deposited upon the lowest areas of the ocean, or accumulates upon the beach. The most violent waves batter the submarine escarpments, and aid in splitting them into fragments; but, arrested and turned by the layers of water which cover them, the ascending currents become *ground waves*, which move with appalling rapidity, and break against the shore with irresistible force. During the tempest of 1822 the waves in the Bay of Biscay, at the rocks of Orta, were 1,200 feet long, and rolled with a velocity of sixty-six feet a second; that is, twice the velocity of a locomotive going at thirty miles an hour. According to Colonel Emy, the ground waves operate at a depth of 400 feet, and are capable of lifting the water above them in columns, more than 150 feet above the surface, heaving up a mass of water from 20,000 to 30,000 cubic feet in volume, and weighing two or three thousand tons.

These ground waves play a prominent part in many of the ocean phenomena. They are found in every sea; and it is they, and not the surface waves, which carry towards the shore the pebbles, sand, and *débris* of shells and other submarine objects. They again, upon the submarine banks, produce those *breakers* so dreaded by sailors, and which render the navigation of certain bays impracticable even in the calmest weather. It is by these ground waves that that singular phenomenon is explained which is seen at the mouths of great rivers, called by the mariners of the Seine the *barre; mascaret* by the sailors of the Dordogne; and *pororora* by the boatmen of the Amazon. At the mouth of this last river, when it is spring-tide, the sea, instead of taking six hours to rise, attains its full height in two or three minutes. A wave fourteen or sixteen feet high, spreads itself over the whole breadth of the river. It is soon followed by two or three similar ones, and all rush up the stream with a deafening roar, and such a rapidity that they sweep away every obstacle in their course, uprooting trees and tearing away acres of the shore. The pororora affects the waters of the river for 600 miles into the interior.

Another terrible whirlpool of the sea has been called the *mäström* or *mälström.* It is a kind of permanent and eternal trough, which is to be seen in the North Sea, between Mosken and the southern extremity of the Loffoden Islands, off the coast of Norway.

When the storms from the west set in motion a rough sea, and when a stiff land-breeze blows at the same time, great waves, as high as the hills, run together from every point of the horizon, throw themselves one over the other with an unheard-of fury, disappearing as if swallowed up in an abyss. The mäström draws in vessels from a great distance, and from the moment its current is felt all hope is gone.* It was very much dreaded by the ancients, who called it "*nombril de la mer.*"

Earthquakes sometimes give rise to gigantic waves. On the 23rd of December, 1854, at twenty-five minutes past nine in the morning, the Russian frigate *Diana*, which was lying at anchor in the Bay of Simoda, near Yèddo, Japan, felt the first shocks of an earthquake. Some minutes after an immense wave entered the bay, the level of the water suddenly rose, and the town appeared submerged; a second wave followed the first, and when both retired not a house was left standing! The frigate itself touched the ground several times, and at last was cast up high upon the beach. On the same day, some hours later, upon the Californian coast, more than 12,000 miles from Japan, the tidal scales preserve the register of many waves of excessive height. It is believed that these were the same waves which stranded the *Diana*, and would, according to calculation, have a length of 620 miles, and a velocity of about 1,000 miles an hour.

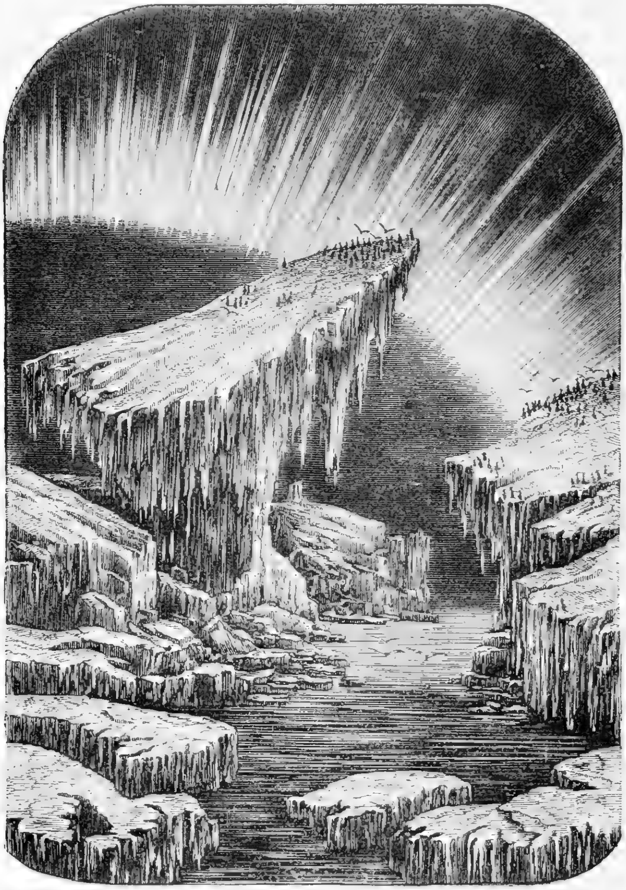
There are in the sea three great currents; one of which takes its rise in the Pacific, one in the Atlantic, and the third in the Indian Ocean. These currents are immense rivers in the sea, which cause great alterations in the temperature of many regions. The first has received the name of *Humboldt's Current.* Starting from the South Pole it runs along the coast of Chili and Peru. This current is cold. The current of the Atlantic Ocean touches the southern extremity of Africa, when it divides into two. The western portion leaves the coast, and runs parallel with it for some distance. The northern branch follows the eastern coast line of the continent, and runs from south to north. Reaching the equator,

* In times of calm the mälström is but a strong current, which even strangers may with safety navigate.

it changes its direction, crosses the Atlantic at its widest part, from east to west, and runs up the Brazil coast, where it divides into two parts. The branch current is called the *Equinoctial.* The main stream continues its northerly course along the coasts of Brazil and Guiana, enters the sea of the Antilles, turns towards the Bay of Honduras, and sweeps round the Gulf of Mexico. Taking then the name of the *Gulf Stream,* it comes out of the Bahama Channel, and flows, much enlarged and with greater velocity, towards the north east. The rapidity of its current exceeds that of either the Mississippi or the Amazon. It is said that it runs at the rate of fifty miles an hour. There is not upon earth a more majestic stream of water. The Gulf Stream casts itself into the Atlantic Ocean, and the last of its waters are found on the eastern coasts of Spitzbergen. The current is warm. By cleverly steering his vessel along the margin of this marine river, a seaman can dip one hand into the warm water of the current, and the other into the cold water of the ocean. Remarkable instances of pieces of wrecks transported from very distant scenes of the disaster by the Gulf Streams are recorded. Some portions of the *Tilbury,* an English man-of-war which was burnt near Jamaica, were cast upon the shores of Scotland! General Sabine, in 1822, saw a vessel wrecked at Cape Lopez, in Africa, near the equator, and when visiting Hammerfest, in Norway, the next year, casks of palm oil, part of that vessel's cargo, were cast ashore! The current of the Indian Ocean flows towards the east, until it encounters the coast of New Holland. Part of its waters run along the south of that continent, and joins the current which flows in the Pacific Ocean. The other part turns to the north, and, following the equator from east to west, bends to the southward, passes between Africa and Madagascar, rounds the Cape of Good Hope, and enters the current of the Atlantic. The power of these currents cannot be estimated, for, as Pindar rightly says, "Water, in motion, is not only the most important, but also the most powerful and terrible of the elements."

The sea freezes at the Poles, and assumes then a peculiar aspect. This phenomenon takes place as the sea becomes less salt, and the rotatory movement of the earth less rapid. As low as the fortieth degree of latitude masses of floating ice are found.

These icebergs must have been launched in the Arctic regions, and brought down by the currents which are flowing towards the equator. At 50° latitude, the shores are frequently covered



THE APPEARANCE OF ICE AT THE POLE.

with ice. Ten degrees further north the gulfs and inland seas begin to be frozen all over their surfaces. At 70° pieces of floating ice become numerous and large, frequently forming islands a mile and a half in diameter, and, at last, 10° higher, the sea is ice-bound, the ice-bergs piled one upon the other, fixed and motionless. These mountains of ice are tinted with vivid colours. They seem blocks of precious stones, lustrous with the brilliance of the diamond and the sparkling colours of the sapphire and the emerald. Sometimes these majestic masses stretch away in vast fields of ice—sometimes they rise into high mountains. These fields of ice form plateaux, which are perfectly uniform, without fissure, crevasse, or elevation. Scoresby saw one floating, upon which a carriage could have driven 100 miles without the least impediment, and Cook found another which joined in a straight line Asia with North America. When these huge masses come against each other, the sound of the terrible shock is like thunder.

The mountains of ice are produced by the islands, which slide one upon each other, and at last accumulate in such vast quantities as to form a mountain 130 feet high. These floating masses are continually eaten away by the sea, and thus their figure is altered almost every moment. They strike against each other—splitting, shattering, or freezing to each other. The icebergs have generally an angular surface, rising perpendicularly out of the ocean. At a distance they look like gigantic white transparencies which pierce the blue sky. When examined closely their surface is found either smooth or mammillated. They might be likened to pyramids of crystal or of diamond, with slender columns and pointed minarets, or enchanted and majestic edifices, with their arcades, their façades, and their domes. But soon the pyramids fall and crumble away; column after column bends and sinks; a minaret now becomes a staircase, and the whole mansion, as if by enchantment, is transformed. The sight must be ever imposing where the inconstancy of their forms is only rivalled by their variety, and the grandeur of the bergs by their fantastic shapes.

Scoresby often astonished his sailors by lighting his pipe by means of a lens of ice. He split off a piece with a hatchet, shaped it with a knife, and polished it by the heat of the hand, and then held it with a glove of wool. One day he procured in this way a wonderfully transparent lens, fourteen inches in diameter.

CHAPTER II.

THE LIFE IN THE SEA.

At the sight of the boundless, shoreless sea, he who loves to create for himself a world in which his spirit may roam without let or hindrance, is filled with sublime thoughts of the Infinite. He looks out on the distant horizon where the sky and the waters mingle in the hazy distance; where the stars rise and set, appear and disappear in turn. But soon this ever-changing scene awakes in his heart that feeling of sadness which is ever mingled with our deepest joys. Feelings of another kind, though quite as serious, are evoked by the contemplation and by the study of the innumerable organisms which people the world of waters. In truth, that immense mass of water which we call the sea is no dreary liquid waste. Its depths are as pregnant with life as the land. In it life reigns in sovereign grandeur, with all its vigour, its profuseness, and its changes! The Almighty delights in life. It is the most beautiful, the most glorious, the most noble, the most incomprehensible of his works.

Long ago it was said that life was everywhere, and that life was essential to the existence of the world. Beings who enjoy life faithfully transmit it to others, their children and their successors, who become in their turn its guardians and progenitors. This most marvellous inheritance is thus handed down through years and ages, without degeneration or perversion. The globe always possesses the same amount of life with which it was at the beginning so liberally endowed. We know what produces life, but we are ignorant as to what life is, and this very ignorance is the powerful stimulus which excites our curiosity and provokes our research.

In every living thing there is an incessant and silent struggle between life which builds up and death which destroys. The first is the most powerful: it controls matter, but its reign is limited; it gradually grows weak with age, and in time dies out. Then physical and chemical laws come into action and destroy the organisation it built up. But the elements which composed the body are soon employed again and used in another organisation. So each plant and animal is allied with the past, and blends with the future; for every generation which springs up is but the corollary of that which has expired and the prelude of that which is coming. Life is the vestibule of death, and death the replenisher of life.

Life did not appear on the globe immediately it was created: it was produced at a later epoch, after the formation of inanimate nature. For the reception of life a soil fit for its exercise must have been prepared, and certain physical and chemical conditions established. Neither did the appearance and distribution of living beings take place by chance; but the dictates of rigorous laws were obeyed.

The knowledge of fossil remains has thrown much light upon the regular and progressive development of life. The appearance of living creatures began with the most elementary forms. The most ancient beds of rock afford no signs of life. Traces of organic bodies exist only in comparatively recent formations. Vegetable life appears first in various forms of the lowest orders; then the earliest animal remains are those most nearly allied to the vegetable kingdom, and which consequently possess the least perfect organisms. Thus life, at first simple, gradually became more and more complicated, until man, the masterpiece of creation, was called into existence.

If, in the spring-time, some pure water be exposed to the light and air, a yellowish-green mistiness will soon cloud it. Examined by the microscope this cloudiness is found to be millions of vegetable organisms. Presently animalcules are seen swimming in this living cloud and being nourished by its substance; then others are formed, which pursue and devour the first. Thus we find life transforms inanimate matter into organised bodies; first vegetables, then herbivorous animals, and lastly carnivorous animals. Life sustains life: the death of one affording material for the growth of another. So all are linked together, all aid each other. In the organic world there is the same interchange of matter as in the mineral world; and there is a universal harmony never disturbed, ever the same, and always worthy of our admiration. God alone is everlasting; all else is transitory!

The waters teem with more life than the land. Beneath a surface less varied than that of the continents, the sea enfolds in its bosom an exuberance of life of which no other region of the globe can afford the faintest idea. Its life extends from the poles to the equator, from east to west. Everywhere the sea is peopled; everywhere, down to its unfathomable depths, live and sport creatures suited to the locality. In every spot of its vast expanse the naturalist finds instruction, and the philosopher meditation; while the very varieties of life tend to impress upon our souls a feeling of gratitude to the Creator of the universe. Yes, the shores of the ocean and its depths, its plains and its mountains, its valleys and its precipices, even its *débris*, are enlivened and beautified by thousands of living beings. There are the solitary or sociable plants, upright or pendant, stretching in prairies, grouped in oases, or growing in immense forests. These plants give a cover to and feed millions of animals which creep, run, swim, fly, burrow in the sand, attach themselves to roots, lodge in the crevices, or build for themselves shelters, which seek or fly from one another, which pursue or fight each other, which caress each other with affection or devour each other without pity. Charles Darwin truly says that the terrestrial forests do not contain anything like the number of animals as those of the sea. The ocean, which is for man the element of death, is for myriads of animals a home of life and health. There is joy in its waves, there is happiness upon its shores, and heavenly blue everywhere.

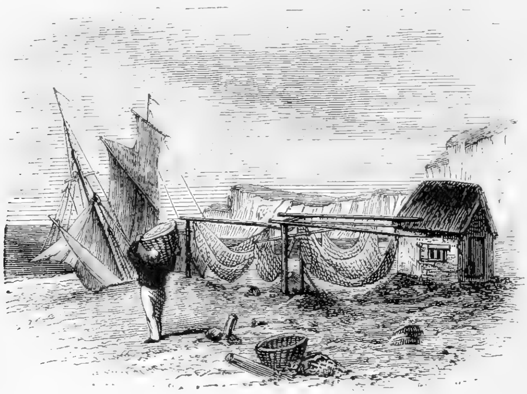
The sea influences its numerous inhabitants, vegetable and animal, by its temperature, its density, its saltness, its bitterness, the motion of its waves, and the rapidity of its currents. We have seen in the preceding chapter that the waters of the sea only freeze upon their surface, and that at a depth of 550 fathoms there is a uniform temperature which is the same for all latitudes. On the other hand, it is to be borne in mind that the effect of the most tremendous storms, even of the most furious hurricanes, is not felt at a depth below thirteen or fourteen fathoms, so that the vegetables and animals by descending more or less, according to the cold or the motions which disturb them, can always reach a position suitable to their tastes.

The inhabitants of the sea are characterised by a peculiar softness. Certain marine plants possess not only a feeble but a very feeble consistency; a great number of them are transformed by boiling in water into a kind of glue. The flesh of marine animals is more or less flabby, seemingly composed of transparent mucilage. The skeleton of the most perfect species is more or less flexible and more or less cartilaginous; it rarely bears any comparison, as to weight and consistency, with the bones of terrestrial animals. Yet the shells and the corals are remarkable for their stony solidity. Thus amongst the marine animals there are found at the same time the softest and the hardest organisations.

The localities in which the beings nourished in the ocean exist are fixed by definite laws. We never find upon the coasts the same species as we meet with out at sea; nor at the surface do we find those which are hidden in the depths beneath. A wonderful world! Every variety of shape, of form, and of colour; from the almost invisible vegetation upon which the small shell-fish feed to the immense sea-weeds more than fifty yards long; from the microscopic infusoria to the gigantic whale! We find in the ocean-world similarity and diversity, which constitute beauty; grandeur and simplicity, which form the sublime; power and size, which command respect.

We have described and figured many plants and many animals, but how many yet remain. For two thousand years researches have been pursued without interruption, but how much is there still left for science to discover, so as to gain that degree of perfection to which these researches may be carried.

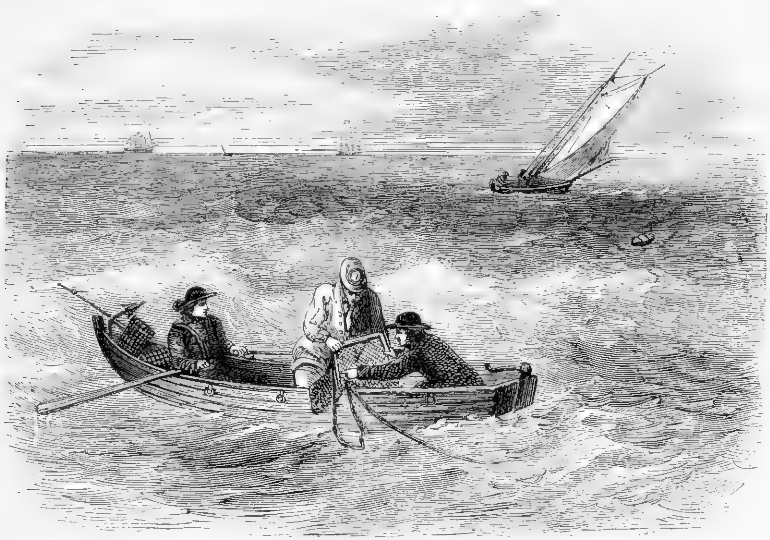
When the tide retires from the shore, the waters leave upon the beach many of the numerous beings which they shelter. The naturalist, immediately after the waters have retired, can collect a host of vegetables and animals, all possessing peculiar characters, colours, and properties. The people who live near the shore find here their food, their commerce, and their occupation, and accordingly they hurry to the shore when the tide goes out. The villages and the neighbouring hamlets all send their contingents; men and women, old and young, every one fit for the work undertakes some portion, according to his strength and activity. They are armed with sticks, poles, and mattocks, carrying baskets and panniers, sacks and nets, dragging also wheelbarrows and carts. Some gather the ribboned wrack (*zostera*), the membranous *ulva*, the brown *fucus*, which used to be a source of much wealth to the dwellers by the sea; others collect the small shells scattered over the strand. The boys mount the rocks and pick off the whelks, the mussels,



FISHING NETS.

the sea ear-shells, and the limpets; the girls seek the mactra, the cytherea, the bucardia, and other edible marine animals; the women wade in the water knee-deep, and secure considerable quantities of shells, which are sold as ornaments. They overturn the stones, or probe the cracks in the rocks with a hook attached to a stick. Here they find polypes and cuttle-fish, and sometimes sea-eels or congers which have taken refuge here. They sound the little pools which the ebbing tide has left here and there, using a small-sized net with a long handle, or they drag the pool with a small-meshed net, and so take the animals which are left behind by the sea—mollusks, crustaceans, or fish. The men dig the sand, and turn up the sea-hedgehogs, the donaces, and the cockles.

In the Mediterranean, and in the small seas where there are either no tides at all or only such as to be hardly perceptible, there exist a number of vegetables and animals which belong to the open sea, which the waves or currents seldom or never cast upon the beach. There are others so fugitive or so firmly attached to the rocks, that they never can be examined except in the places where they live. It is therefore necessary to catch them floating on the surface of the water or to follow them into their native depths. This is why naturalists who are seriously intent upon studying the life of the sea must carry on their researches on the bosom of the



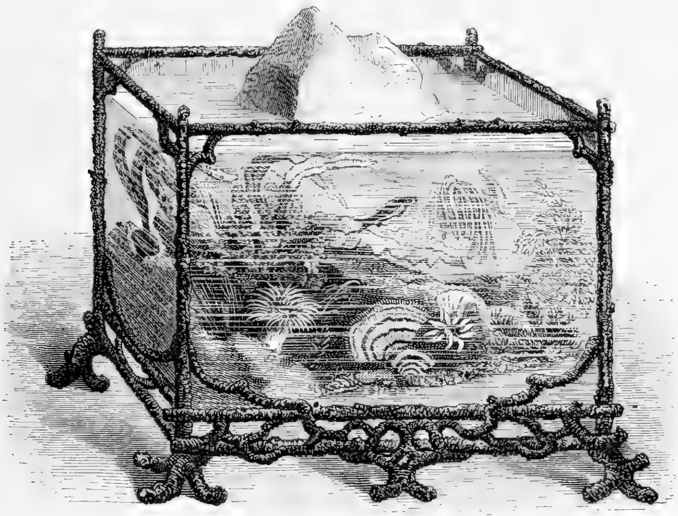
DREDGERS.

water, and not on the shores. Many of these explorers use for this purpose dredges, sounding lines, and other proper instruments for scraping and breaking the hard rocks. In his voyage round the coasts of Sicily, Milne Edwards hit upon the excellent idea of using the apparatus invented by Colonel Paulin, the veteran chief of the Paris fire brigade. This apparatus consists of a metal helmet provided with a glass visor, which is fixed to a padded collar by means of a leathern fringe. This helmet is really a diving-bell in miniature. It communicates with a forcing-pump by means of a flexible tube. Four men are employed to work the pump, two at a time; other two hold the end of a rope, which passes over a pulley fixed at a higher elevation. By this the diver is let down or pulled up. A watchful assistant holds in his hand the little cord used as a signal. The diver is sunk by wearing shoes of lead, which aid him at the same time in keeping an upright position when at the bottom. It only takes about two minutes to draw the diver out of the water, and take off his helmet. Mr. Edwards descended with this apparatus twenty-eight or thirty feet, and his undertaking was crowned with complete success. In these submarine excursions, this clever naturalist could study on the spot in their most secluded retreats, and in seemingly inaccessible places, radiate animals, mollusks, crustaceans—especially their larvæ and eggs, and by his descriptions has contributed largely to make known the developments, the functions, and the habits, of a number of the sea inhabitants, whose manner of life appeared to baffle all our efforts at their investigation. It has been proposed in all researches which require a long sojourn beneath the surface, to use the diving vessel of Lamiral and Payerne. This vessel is a reservoir of compressed air. It furnishes the means of respiration without communication with the surface; it facilitates direct contact with submerged objects, and permits easy locomotion at the bottom of the sea.

It is even possible to study the living beings which are sheltered by the sea, by preserving them in convenient reservoirs. It is to M. Charles des Moulins of Bordeaux we are indebted for the possibility of carrying on this study at home (1830).

When we place some mollusks, crustaceans, or fish, in a bowl of fresh water, the liquid loses its transparency at the end of a few days, and little by little becomes impure, so as to render it necessary to change this water from time to time, a process which not only disturbs the creatures, but causes them much suffering, and even sometimes is the means of their death; in addition to which the fresh water has not always the same composition, the same temperature, nor the same quantity of air mixed with it as the old liquid had. M. Charles des Moulins proposed to put into the vase a certain number of aquatic plants, floating or submerged, such as duck-weed, for example, since these plants affect the water in the very opposite way to animals. We know that vegetables decompose carbonic acid gas which animals exhale, retaining the carbon, and giving off the oxygen which animals breathe. Accordingly by this plan the necessity of changing the water of the aquarium is obviated, and the animals never need be disturbed.

M. Dujardin (in 1838), M. Thysme (in 1846), and Mr. Warrington (in 1849), conceived the ingenious idea of substituting salt water for the fresh which M. Charles des Moulins first devised. It is hardly necessary to say that the plants in use are ulvæ and fuci.



AQUARIUM.

Latterly Messrs. Goss and Bowerbank constructed reservoirs on a large scale, to which they gave the name of *aquariums.* Aquariums are for the study of aquatic life, just as aviaries are for birds, only instead of cages of iron they are cages of glass, and instead of air there is water. Cabinet aquariums have usually a rectangular form. In the one in the figure the bottom is either a slate or a sheet of zinc; four columns of bronze, or iron, hold four sheets of glass in a vertical position, surmounted by a metal frame. This glass house reveals the marine life, with all its secrets, its movements, its customs, and its habits.

In order to rear a great number of animals and to imitate to a certain degree the motion of the waters and their continual aëration, a means has been devised by which water is added in a constant stream, entering the aquarium either in a fine jet, or drop by drop, whilst the overflow is conveyed away by a waste-pipe. It is requisite to build in the reservoir a miniature rockery of stones and pipes, in order that those creatures who shun the light may have a retreat; or a screen may be used, which may be a piece of board, or a sheet of cardboard, or a piece of cloth or ground glass. Small holes are made in the screen, through which may be seen what is going on inside, and by this means the animals may be observed without being disturbed, and we can learn all the details of their domestic life. It is beneficial to fit a cover to the aquarium, which prevents the creatures from getting out either by jumping or crawling, and also which preserves the dust from falling into it, which otherwise would collect on the surface and sink down through the water.

In 1853, Mr. Mitchell, the Secretary of the Zoological Society of London, constructed an aquarium in the Zoological Gardens, Regent's Park, of a size previously unattempted. The success of this little museum of sea life produced in England quite a sensation. The largest, the most beautiful, and the most complete of aquariums up to the present time, is that constructed in the Zoological Gardens in the Bois de Boulogne, at Paris. It was inaugurated on the 1st of October, 1861. The building is solidly constructed of stone, forty yards long and ten broad, showing a range of fourteen reservoirs, of Angers slate, facing the north. These reservoirs are nearly cubic, and have a front of strong glass, through which the interior can be examined. It is lit from above, by which a greenish, uniformly dispersed twilight, is secured, which is an exact imitation of the feeble light which illumines the submarine world. Each reservoir contains about 160 gallons of water, and in each is a rockery picturesquely arranged in the form of an amphitheatre; upon these rocks spread and grow different species of aquatic plants, the floor is shingled with pebbles, gravel, and sand, which affords sufficient cover for many animals. Ten of these reservoirs are appropriated to marine animals. The quantity of water used is about 4,000 gallons; it is never changed, but is continually flowing. The means by which the flow is secured are as follows :—Advantage is taken of the current of water which is brought by the pipe which waters the Bois de Boulogne. This water is under great pressure, and is brought to act upon air confined in an inverted cylinder. This air is admitted into another cylinder below the level of the aquarium, in which is some sea-water; this it forces up with great power into each of the reservoirs, which it enters by a little jet. The compressed sea-water contains a great deal of air, which it carries with it into the reservoirs. A pipe in the corner of each carries off the overflow into a well-packed carbon filter, from whence it passes into an underground reservoir, made of iron, lined with gutta-percha. From this the water is returned into the closed cylinder; is submitted again to the pressure of the air, and is again injected into the aquarium. The cylinders, being all underground, keep a uniform temperature of about 16° Cent., which is nearly the general temperature of the sea. In winter the walls of the aquarium are artificially heated. By means of a very simple contrivance in each reservoir the quantity of water can be diminished, and the ebb and flow of the sea thus imitated. At the same time, by considerably lowering the level of the liquid, certain creatures can be periodically exposed to the air. In this circulation and movement of the water, its volume is diminished by evaporation, and the inorganic matters remaining in the liquid, at last it would become too salt. To remedy this, by means of a special apparatus, a certain quantity of rain water which comes from the roof of the building is passed into the great reservoir. An hydrometer indicates the time when this addition of fresh water is necessary.

CHAPTER III.

THE PHOSPHORESCENCE OF THE SEA.

THE infusoria are the principal cause of that beautiful phenomenon exhibited by the seas of tropical countries, which we call phosphorescence. When the sun has sunk beneath the horizon, innumerable swarms of luminous animalcules are drawn up to the surface of the sea by certain meteorological causes. A new light dances upon the bosom of the waves. It seems as though the ocean were intent upon giving back the floods of light which it had received during the day. But this peculiar light does not shine uniformly throughout the medium in which it is produced. It is emitted here and there in a crowd of star-like points, which suddenly burst into a scintillating glow.

When the sea is calm, we can see upon its surface millions of twinkling stars, clouds of which seem to rest upon the watery mirror; now they are motionless, now they tremble with a luminous quiver, now they are disturbed by lambent tongues of flame, which chase each other through their midst. Again they re-unite only to separate as quickly, and again to mingle; forming at last a vast sheet of phosphorescence, now blue, now a silvery white, now shining steadily, now wavering; while here and there, brighter than the surrounding light, shine out sparkling points—suns in this ocean firmament.

When the water is rough the waves seem burnished; and as they rise, and roll, and boil, and dash themselves into flakes of foam, it seems like the glow and flying sparks of molten metal as it flows from the furnace. As they break upon the shore, the waves fringe the land with a border of light. The smallest pebble is encircled with fiery ripples.

Nothing is more beautiful than to see a shoal of dolphins sporting in a phosphorescent sea. In their gambols they fling hither and thither the starry spray, and surge the water into seething light. Every stroke of an oar makes the ocean fling out jets of light—here feeble and motionless, there blazing and scattered, like sparkling seed pearls. The paddle-wheels of a steamer lift out of the water, and toss back again sheaves of light, and as the vessel ploughs its way through the sea it pushes before it two waves of phosphorescent liquid, leaving behind it a long track of fire, like the tail of a comet, which gradually fades away. What a splendid subject for the study of the naturalist! What an inspiring theme for the poet!

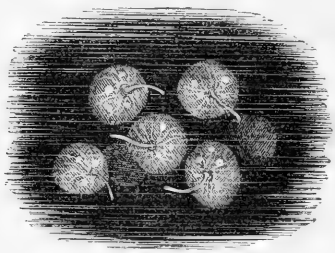
When the *Venus* was at anchor off Simon's Town, the sea was so phosphorescent that the cabin of the naturalists was lit as with a lamp. The water, when poured from one bucket into another, was like molten lead, and when the hand was plunged into it, it came out covered with luminous corpuscles, glittering like diamonds full of light.

Certain animalcules, which do not possess this phosphorescence in so marked a degree, frequently, when very numerous, render the waters white. This phenomenon is called by the Dutch sailors the *Milky Sea*, or the *Sea of Snow.* The minute creatures from whom this light originates are not the breadth of a hair, and the united lengths of 300 of these would hardly be an inch; and yet these are the giants in the nation of the infusoria! They stick to each other by their extremities, and so form countless threads, often of a great length.

In 1854, in the Bay of Bengal, Captain Kingmann passed for thirty miles through the midst of a large patch of sea white with these creatures. During the night of the 20th of August, 1860, M. Trébuchet, commander of the frigate *La Capricieuse,* which was in the roadstead of Amboine, witnessed a magnificent spectacle of the same kind, which continued all night, until the daybreak. The sea resembled a white, chalky plain, upon which the moon was shedding her silvery light.

The *Noctiluca miliaris* is one of those infusoria which chiefly contributes to the phosphorescence of the sea. This animalcule, omitted by Cuvier in his "Animal Kingdom," has been classed by naturalists sometimes with the anemones, sometimes with the medusæ, and sometimes with the foraminifera. They are very small; 50,000 of them can live with the greatest comfort in a wine-glass of water!

The noctiluca appears at first sight to be nothing but a small globule of transparent jelly. When under the microscope, it is found to have a spherical form, more or less regular, a little flat, and slightly umbilical beneath. In the centre of this protruding part is the mouth, which opens into a funnel-shaped œsophagus. Out of this opening comes a filiform tentacle, or feeler, like the stalk of an apple, which is very slender and mobile. This tentacle appears to be tubular. Blainville supposes that it terminates in a sucker, so that it has something the shape of a trumpet. In some of its contractions the creature becomes reniform, or kidney-shaped, and



NOCTILUCA MILIARIS.

in others the tentacle disappears. The noctiluca exhibits here and there in its substance granules which are probably germs, and also some points of light. These appear and disappear with great rapidity; the least agitation makes them shine. Altogether these corpuscles of light form $\frac{1}{25}$th or $\frac{1}{30}$th of the diameter of the creature. The noctiluca enamel the surface of the ocean as the constellations stud the firmament.

The infusoria, as is now well known, are not the only animals which contribute to the phosphorescence of the ocean. This luminous state of the sea may also be caused by the medusæ, star-fish, mollusks, nereidæ, crustaceans, and also certain fish, all which creatures evolve light just as the torpedo generates electricity. They multiply and diversify the effects of the phenomenon. The light which they produce is sometimes of a greenish tint; sometimes it appears red. Looking down into the dark depths, fantastic forms are seen, luminous circles, starry plumes, or lambent fringes. A mass of these creatures at a distance looks like a globe of red hot metal or fiery bouquets, flinging off sparks or green festoons, decorating the dark waters with the wreaths of illumination. And now, like incandescent meteors, they glide through the waves, rising to the surface, diving to the bottom, grouping themselves, again to separate as quickly; describing in their flight a thousand curves, and now, as if to elude some pursuer, extinguishing their light, only again to re-light it, and again to be pursued.

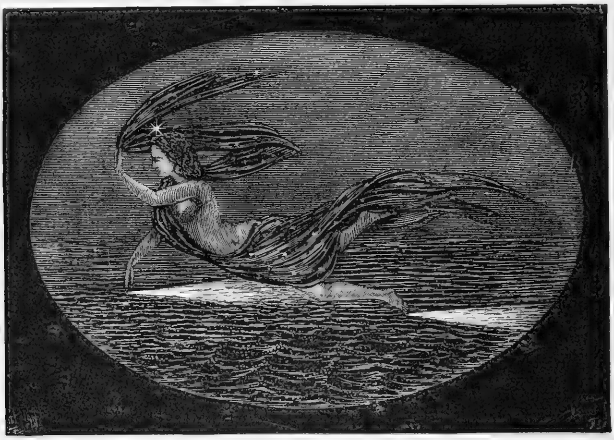
Spallanzani made numerous experiments upon the light of the medusæ, particularly the *Aurelia phosphorica.* He found that the phosphorescent power lay in their great arms or tentacles, in the muscular zone of the body, and in the cavity of the stomach. The rest of the body of the animal emitted no light when agitated. The source of the phosphorescence resides in a viscous liquid, which is secreted and oozes to the surface from these organs. If this liquid be mixed with other liquids it exhibits its luminosity. One single aurelia squeezed in twenty-seven ounces of milk made the whole so luminous that a letter could be read by its light at a yard's distance!

Pliny observed that the *Pholas dactylus,* a little bivalve of which we shall presently speak, possessed such a phosphorescence that the lips of the persons who ate it became luminous. He also noticed that this light appeared on the clothes, if any of the liquid from the animal fell upon them.

Réaumur, having experimented some time with a *Pholas,* washed his hands in a basin of water, which, when taken into a dark room, exhibited a bluish phosphorescence. Milne Edwards, having put some living *Pholadidæ* in alcohol, the light-giving fluid which oozes from the pores of the body of these mollusks sank to the bottom of the glass, and there emitted its light as it would have done had it been in contact with the air.

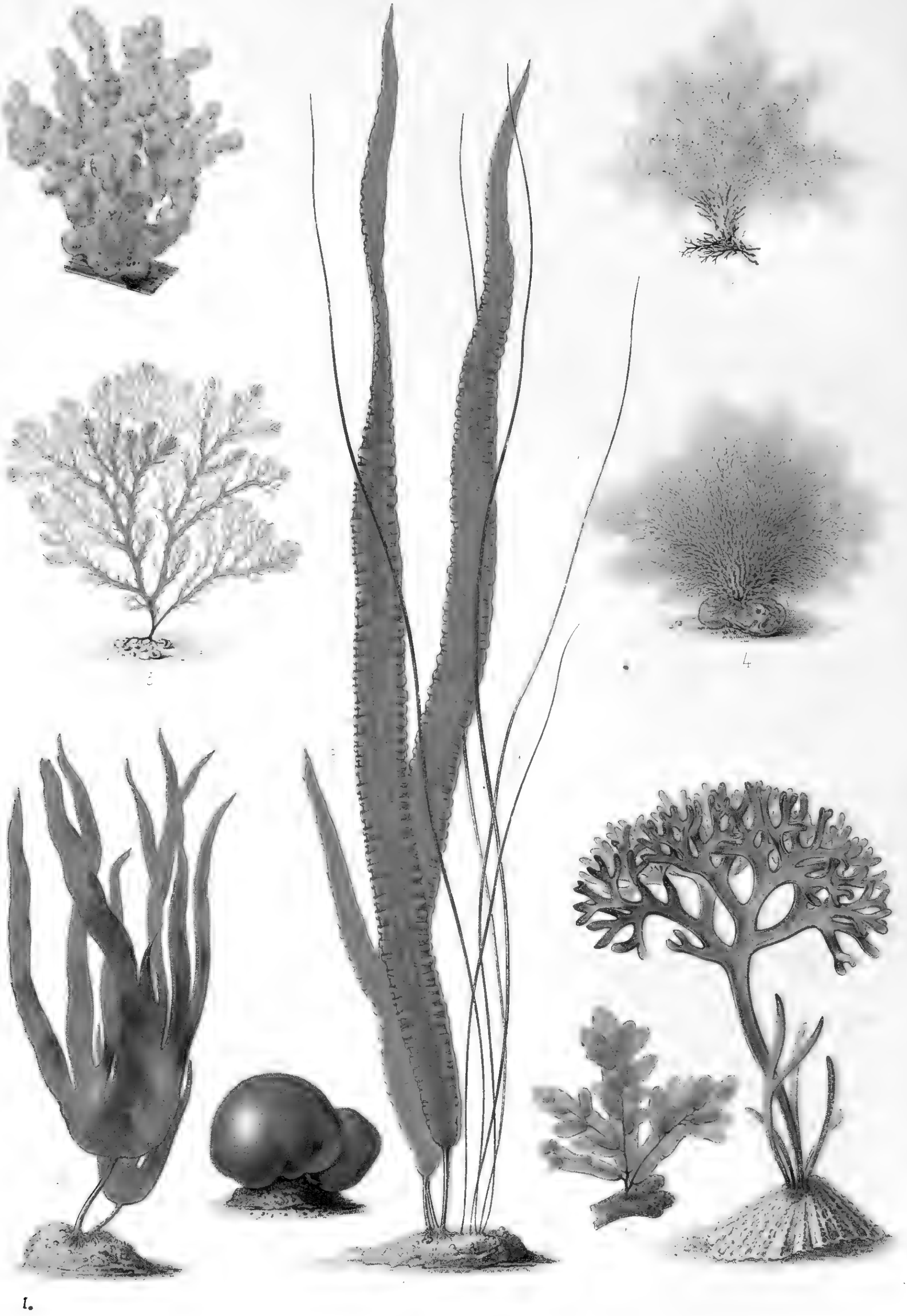
The greater number of these luminous creatures appear to have their phosphorescence at their command, like the glow-worm with his tiny lantern, for most of them are able to augment or diminish their light according to circumstances, or to extinguish it altogether. At the seasons of their reproduction, this marvellous light shows itself in all its splendour. It seems as though their exuberant life, unable to be held within its prison, burst its fetters, and radiated out in beams of glowing light.

Plants also are found which contribute to this resplendent condition of the sea. Meyen describes one of the *Oscillaria* which



PHOSPHORESCENCE.

affords phosphorescence. All sailors know that during warm weather, when certain sea-weeds are taken from the water and rubbed or beaten, they become more or less phosphorescent. Many naturalists believe that this magnificent phenomenon may be caused by animal and vegetable matters suspended in the water, and especially when they are undergoing decomposition. The ancients erroneously attributed phosphorescence to the saltness of the sea, or to the *Spirit of Salt.*



SEA WEEDS.

1. Tetraspora gelatinosa. (*Agardh.*)
2. Callithamnium corymbosum. (*Lyngbye.*)
3. Plocamium vulgare. (*Lamouroux.*)
4. Polysiphonia fibrata. (*Harvey.*)
5. Rivularia nitida. (*Agardh.*)
6. Delesseria hypoglossum. (*Lamouroux.*)
7. Chondrus crispus. (*Lyngbye.*)
8. Laminaria saccharina. (*Lamouroux.*)
9. Chorda filum. (*Stackhouse.*)
10. Laminaria digitata. (*Lamouroux.*)

CHAPTER IV.

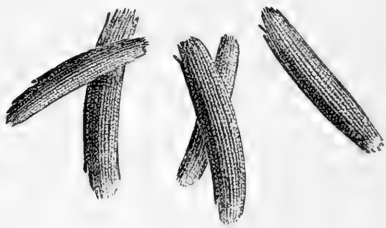
THE PLANTS OF THE SEA.

THE flora of the ocean well deserves the attention of the botanist, the philosopher, and the artist, equally with that of the land. There exist in the midst of the waters, whether salt or fresh, numbers of plants curious, useful, or picturesque, which present such a great variety of forms, that the landscape, if we may be allowed the word, is neither less interesting nor less diversified than that of countries where the sun has induced a luxuriant tropical vegetation. However, the vegetable kingdom has fewer representatives in the sea than upon the land, and the size of the terrestrial vegetation is incomparably grander than that of the ocean. But nature has given to the sea a compensation for this, as we shall see, in creating polypi, which are animalcules living in colonies, and are more or less of a vegetable character. Thus another kind of flora is produced, more complicated, more animated, and more astonishing. These existences are, so to speak, animals in the shape of plants, and minerals in the form of animals.

The marine flora belongs almost exclusively to one class of vegetables: that of the *algæ*, or sea-weeds. Linnæus only enumerated fifty of these plants, but we now are acquainted with more than 2,000. In the seas around this island alone 105 genera, including 370 species, are known.

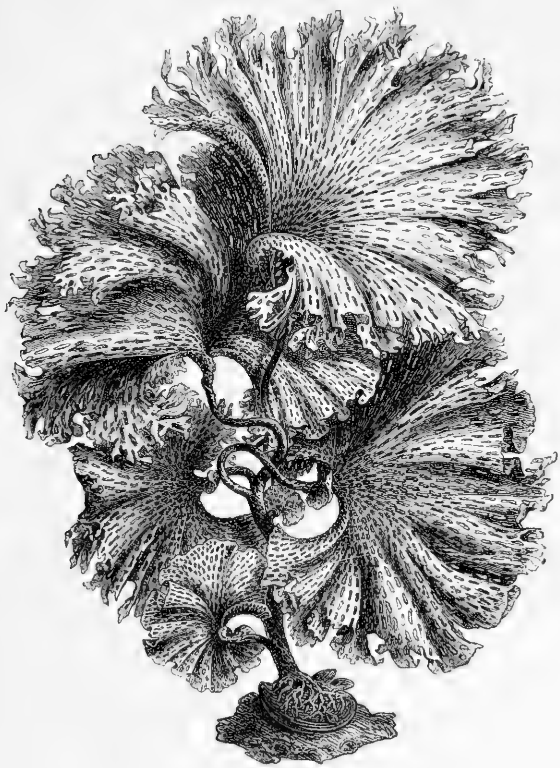
The sea flora is most numerous and most brilliant in these temperate zones, and gradually loses its richness as we approach the equator or the poles.

The plants of the sea are often of a size altogether microscopical. Freycinet and Turrel, when on board the corvette *La Créole*, in the neighbourhood of Tajo, in the isle of Luçon, observed an extent of thirty-five square miles tinted a bright red. This colour proved to be due to the presence of a minute plant, so small that in a square inch there were 25,000,000 individuals. As this coloration extended to a considerable depth, it would be impossible to calculate the number of living creatures. In the Red Sea this coloration is seen under certain circumstances, and hence its name. In this case, as in the other, the colour is due to a microscopic sea-weed. "On the 10th of December," says M. Ehrenberg, "I saw from Tor, near Mount Sinai, the whole bay, of which the village is the port, red as blood; the open sea, beyond the coral reef which fringes the shore, kept its ordinary colour. The wavelets carried to the shore during the heat of the day a purple mucilaginous matter and left it upon the sand, so that in about half an hour the whole bay at low tide was surrounded by a red fringe. I took some of the water to my tent in a glass. It was easy to see that



TRICHODESMIUM EHRENBERGII.

the coloration was due to little flocks, scarcely visible, often greenish, and sometimes of an intense green, but for the most part a deep red, the water in which they were swimming being perfectly colourless. Upon examining them with a microscope, I found that the flocks were formed of bundles of fibres. These bundles were rarely as much as one-twelfth of an inch long. They were spindle-shaped and were contained in a kind of mucilaginous envelope. During the day they remained upon the surface of the water, but at night they sank to the bottom of the glass; some time after they came up again." This sea-weed is called the *Red Trichodesmium.* M. Evenot Dupont, a noted barrister in the Mauritius, recounts that on the 15th of July, 1843, the sea, as far as the eye could reach, was tinted with red. The surface seemed covered with a material of a brick-dust colour; a little mahogany dust would have produced the very effect. M. Dupont attached a basket to a cord, and drew up some of the water containing this substance, and with a spoon he filled a glass. The following day it had become a deep violet, and the water a rose tint. By straining the water through linen, the substance adhered to the cloth ; when dry it became green. This M. Montague examined, and pronounced it to be a minute sea-weed of the same kind as the preceding one. He named it

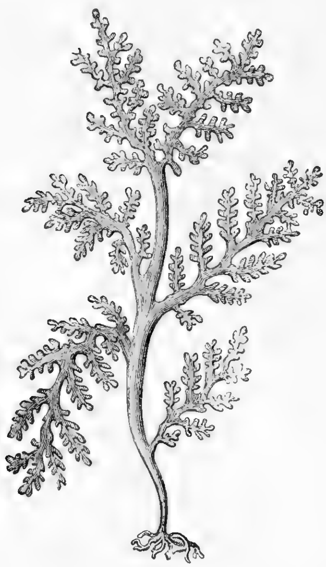


THE PERFORATED THALASSIOPHYLLUM.

Trichodesmium Ehrenbergii. This algæ is composed of articulated fibres, placed side by side, varying from $\frac{1}{250}$th to $\frac{1}{500}$th of an inch in length. The microscope shows that the fibres are built up of cells fastened regularly end by end, firmly pressed together, and slightly four-sided. Other marine plants, on the contrary, present a gigantic size. Humboldt saw a fucus taken out of the water more than 500 yards long !

The ocean plants do not bear much resemblance to those which adorn our woods and valleys. To begin with, they have no roots. Those which float are globular or ovoid, tubular or membranous, without any appearance of roots. Those which adhere are fastened by a sticky surface, more or less lobed and divided. They derive no nourishment from the earth; their growth is entirely from the exterior. Their whole existence they owe to the water: they receive everything from it, and return everything to it.

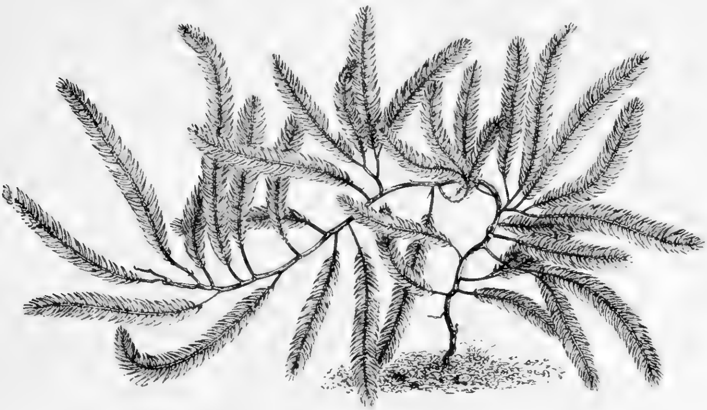
The terrestrial plants take up from the earth, by means of their



LAURENCIA PINNATIFIDA.

CLADOSTEPHUS VERTICILLATUS.

roots, certain nutritious matter, and they do not thrive unless the soil be suitable. Marine plants are utterly indifferent as to what they adhere to. It may be limestone or granite, it is all the same to them; hence they are found indiscriminately mixed. The same may be said of corals and shell-fish. These hydrophytes possess neither true stems nor leaves; they expand by means of layers or lamels, broad or straight and narrow; of only one piece, or of many pieces, which take the place of leaves. They sometimes resemble wavy thongs, sometimes crumpled threads; some are thick and tough, others are thin and membranous. Some might be taken for little transparent balloons; some for fabrics, regularly frilled; some for shreds of quivering jelly; some for ribbons of yellow horn; some for belts of tanned



CAULERPA WITH YEW LEAVES, ONE-FOURTH THE SIZE OF NATURE.
(*Caulerpa taxifolia.*—Agardh.)

leather; some for fans of green paper! Their surface is sometimes glossy, polished, and even glittering; sometimes rough

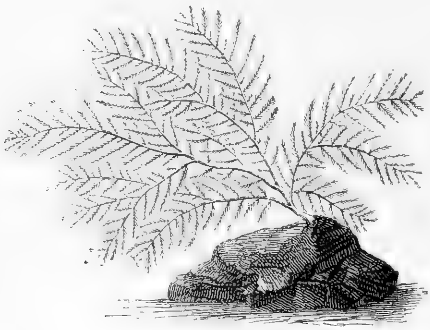
PADINA PAVONIA.

RED DOCK-LEAVED DELESSERIA.
(*Delesseria sanguinea.*)

with worts or with real hair. Here one is found covered with a viscous slime; another with a saline dust; a third with a sweet efflorescence; and sometimes they are found with a shelly surface.

Their colour is olive, fawn, yellow, brown, more or less dark; green, more or less bright; pink, more or less delicate; carmine, more or less rich.

Some authors have divided them, according to their predominant colours, into three great sections :—The *Browns*, or *Blacks* (*Melanosperms*); the *Greens* (*Chlorosperms*); the *Reds* (*Rhodosperms*). The first are the most numerous. They can grow in a wider range of depth, and appear to occupy three distinct regions, forming the



PLOCAMIUM PLUMOSUM.

greatest part of the submarine forests. The green exist nearer the surface, often floating; the red are met with in shallow water, on the rocks near the shore.

If from the bottom of the ocean a submarine volcano heaved up an island of barren rocks and scoriæ, the power of life would soon cover its surface with organisms. Almost as soon as the stone came in contact with the air it would become covered with little plants which, adhering to it, would round it, and little by little alter its shape. At first they appear only yellow or grey spots; then their colour changes to blue or green, and their construction alters, becoming more complex. As they grow older, the colour of these patches deepens, and their thickness increases. After the lapse of a certain time, they are covered with velvety threads; then they die, and from their decay spring other plants of larger size, a less stunted vegetation, and possessing more decided characteristics.

Those plants of the ocean which vegetate upon the surface of the water without adhering to any fixed body, frequently interlace and form islands of vegetable matter, which the currents transport and at length strand on some unknown shores, or the storms scatter.

To the south-east of Newfoundland, not far from the Azores,

THE GULF WEED.
Sargassum bacciferum.

there is an immense bank of sea-plants, composed of floating wrack, one of the most common of the marine fuci. This bank is named the *Sargasso Sea,* for the weed belongs to the genus Sargassum. This gigantic mass astonished Columbus, who thought it marked the limits of navigation. It was called by Oviédo, the *Prairie of Weeds.* These beds of floating plants sometimes gather round ships in an alarming manner. The Gulf weed occupies a triangular area equal in extent to the valley of the Mississippi.

Many of the algæ float upon the surface of the sea, sometimes joined together, sometimes in a small number, at other times forming broad bands or oases in the desert of waters. Amongst these plants we ought to mention the *sea lettuce* (ulva), with its large and thin leaves, which have a greenish tint sometimes shading off into dark violet. One species resembles a long flat pipe, another a fine twisted thread. With these floating algæ many marine plants which grow on the ocean bed are mixed. They become detached by the waves, and their air-cells cause the loosened branches to rise to the surface. M. de Martius thinks that

ULVA.

many of the floating sea-weeds are uprooted by the whales. When once at the surface, the fuci throw out branches and lobes and interlace with each other in every direction. These plants at the surface have such an exuberant growth that they may even be said to surpass in development the *Anacharis Canadensis*, a weed indigenous to the waters of the North American continent. It was accidentally transported to this country about the year 1842; it has already spread over the greater part of England

and Scotland, and grows in such thick masses that the navigation of many of the rivers and canals threatens to be impeded.

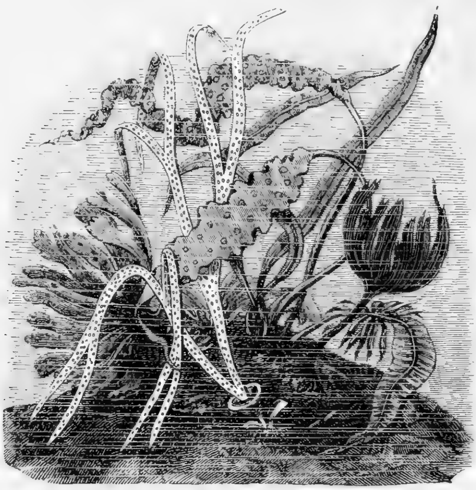
One of the characteristics of these ocean prairies is the simplicity of their composition. On land it is very different. Here we find a great number of different plants; but in an ocean prairie there are seldom more than two or three species, and very often only one. But these floating prairies are less numerous and less remarkable than the land prairies.

The bottom of the sea is overspread with a covering of rich vegetation; the plants are close together, and mingling their varied

CALLITHAMNION.

tints, they cover the ocean floor with a many-coloured carpet. Here are thickets and groves, gardens and woods. Upon the land there are but few virgin forests, but beneath the waves none are trodden by the foot of man. The marine vegetation is better preserved, better protected than that on land. Terrestrial forests men mutilate, explore, root up, and burn, but they approach very timidly, with many precautions, and only for a few minutes at a time, the woods of the ocean. The submerged hydrophytes mingle their foliage loosely or interlace with each other firmly; now they form arched grottoes, winding galleries, or impenetrable thickets. There is in the harmony of the vegetation of the sea a splendour which compensates for the magnificence of the terrestrial foliage. Some of these submarine plants are scarcely covered with water, whereas others hide themselves in the profundity of the ocean depths. In the neighbourhood of the Canary Islands, Humboldt and Bonpland drew up from a depth of 200 feet a *Caulerpa* which had leaves like the vine; it possessed a beautiful green colour.

Between the Isle of France and Madagascar, Bory de Saint-Vincent gathered a bunch of *ribboned wrack* (*Sargassum turbinatum*), from a depth of 650 feet. The *Callithamnions* are very



LAMINARIA.

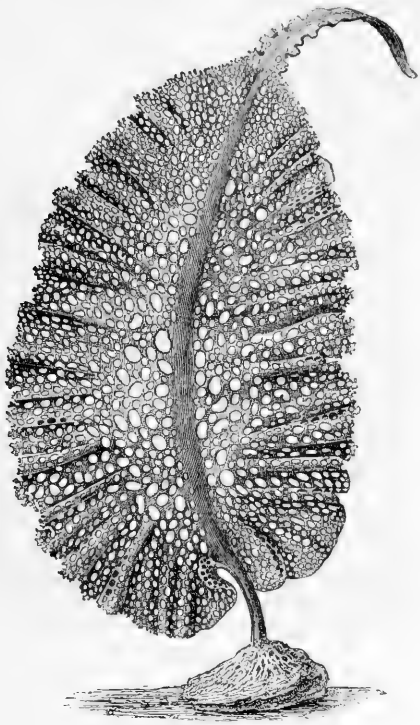
remarkable amongst the marine plants for the marvellous delicacy of their structure, the elegance of their branches, and the beauty of their scarlet or violet tints.

The *Laminaria* stretch themselves out like immense, long straps, often fringed and pleated, which float gracefully upon the currents, and bend to the winds and the tempests.

The *Agara* spread abroad their waving tongues, or large fans, shrivelled and jagged.

The *Alaria* shoot out into the water from their slender yet stiff stems, which are surrounded at their top by a beautiful collar of short and sinuous ribbons, from the centre of which rises a thong-like leaf, fifteen or twenty yards long, which at its commencement is narrow, then continues an equal size, and at last gradually narrows into a point.

The *pear-bearing wrack* (*Macrocystis pyrifera*) of Terra del Fuego grows in large ramified bushes; each branch ends in a hollow bag, a kind of inflated swimming bladder, which might well



AGARUM.
(*Agarum Gmelini.*)

be taken for a fruit. This fucus may be found rooted at a depth of 150 fathoms (G. Forster), and, consequently, is higher than the highest of our trees.

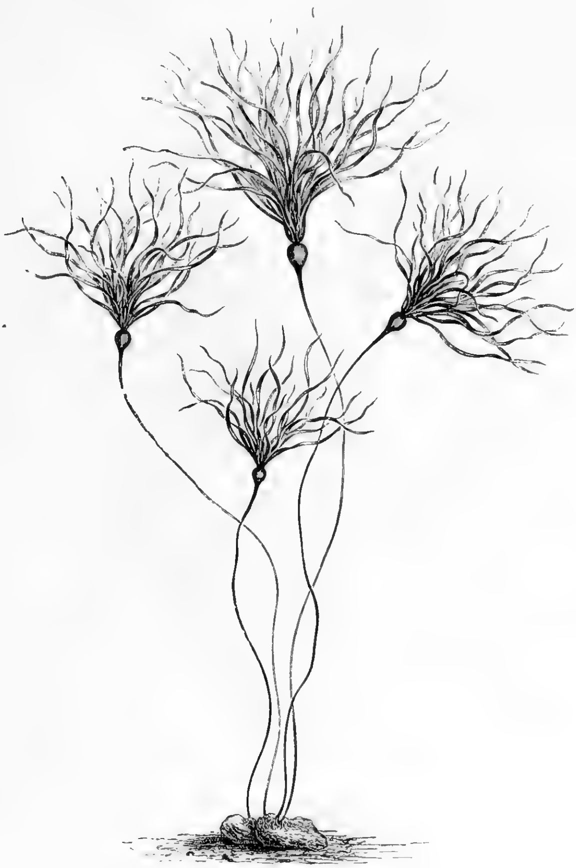
The *Nereocystis* has a false filiform stem, which is flexible, and some thirty yards high; towards its extremity it gradually thickens, where it suddenly dilates into a little pear, out of the eye of which springs a tuft of dichotomous appendages, ten or twelve yards long, flexible and straight, forming an immense bouquet.

We have forgotten to mention the *Acetabulum;* they are beautiful formations, though for a long time we knew but little about them. They were regarded by Tournefort as algæ, and by Linnæus as polypes. They are small, round, thin plates, like very flat parasols.

ALARIA.
(*Alaria fistulosa.*)

They are striated in rays, and more or less like the top of certain fungi; for example, that of *Agaricus androsaceus.* To the centre of this round top the stalk upon which it is supported is attached. This stalk is very slender, long, and jointed. The rays are hollow and thin. Tubes communicate with the great cavity of the head; the whole vegetable forming a single cell. The skin of the plant contains carbonate of lime, deposited in fine grains and in concentric layers.

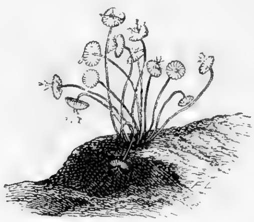
Delile has left among his papers an unpublished monograph upon this vegetable wonder. M. Woronine has just published the



NEREOCYSTIS.
(*Nereocystis Lütkeana.*)

results of his examination of its organisation. He writes: "The stalks enlarge at the summit, and produce many successive whorls of confervoid branches. The lower ones, decaying, drop off, and their points of attachment become obliterated. New and higher whorls continue to grow; at last it reaches a stage of its growth when it seems a bundle of whorled tubes formed into a circular button. The disc, or cellular plate, has radiating compartments; this plate, at first semi-transparent, thickening as it ages. The lower confervoid whorls sometimes remain in fragments, or leave their traces in rings, so that, when they reach the top, circles of tufts are formed, which surround the centre of the head." Sometimes two of these hat-like expansions are found one above the other.

Marine plants form neither calyx nor corolla; they have no true stamens nor yet true pistils; but by a marvellous compensation, as we shall find in the following chapters, many marine animals



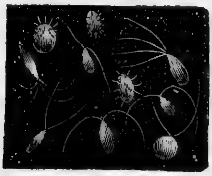
ACETABULUM.

are organised, and very often grouped, like real flowers. Wonderful element, where animals flower and vegetables bear no flowers!

For a long time botanists were totally ignorant of the mode in which marine plants were propagated. They were classed among the *cryptogamic* plants, or plants that have no visible seed organs. We now know that the algæ are reproduced by corpuscles, male and female, which are often endowed with wonderful rapidity of motion. If marine animals have borrowed from the land vegetation the form of their flowers, the marine vegetables in their turn have borrowed from the land animals something of their independent motion. In 1793 Girod-Chantrans first pointed out, but without any attempt at explanation, the kind of spontaneous movement of the green granular matter of certain of the algæ. He erroneously supposed that this matter was an agglomeration of animalcules, similar to those found in some polypes. In 1817 Bory de Saint-Vincent discovered beyond all doubt, and showed in a most clear manner, that the granules possessed a locomotive power. His observations were confirmed by Gaillon, of Paris, and Agardh, of

Stockholm. The more recent studies of Derbès and Solier, and especially of Thuret and Pringsheim, have thrown the greatest light upon the propagation of marine vegetables.

Red sea-weeds are propagated by two kinds of spores. The first kind, or *tetraspores*, bears long pods containing masses of four seeds or spores. These pods, or bulbs, carry within themselves the means of germination. The spores properly so called are found in groups in proper conceptacles or *polyspores.* For their perfect development, the action of the *antheridia* (transparent cells) seems necessary. In these cells granular bodies are moved about by means of vibratile hairs or *cilia.* These bodies are



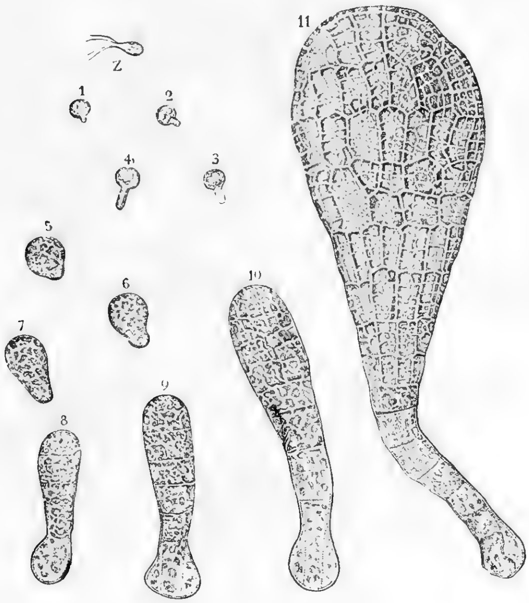
ZOOSPORES.

true seeds. The antheridia pass through many different forms, and finally break up into numerous cellules. These cellules become detached ; they do not germinate, but it is probable that their action upon the polyspores is analogous to that which the green algæ exhibit. It more frequently happens that each of these organs belongs to a distinct plant, so that the species comprehends three individual forms, which is even more complicated than the fructification of the date palm, the male and female flowers of which bloom on separate trees. The green algæ are chiefly propagated by *zoosperms* and by *spores.* The *zoosperms,* or *zoospores,* are minute microscopical corpuscles about $\frac{1}{2000}$th of an inch long, of an ovoid or top-shaped form, and two-thirds full of a green liquid called *chlorophylle.* One end of the minute body thins out to a point or beak, and out of this issue two or four threads longer than the whole corpuscles. In some of the algæ these threads are unequal. The longer one is stretched out in front, while the other is trailed behind as a sort of rudder. Near the end of the beak is frequently seen a reddish spot, which remains some time after the germination has commenced, The *Myrionema*, a parasite which grows on the surface of other algæ in small brown patches, and the *Haligenia*, whose extended frond is almost twelve feet in diameter, are reproduced by similar zoospores, which are both very small and both possess the same simple organisation. Analogy would lead us to suppose that the immense tree-like *Lessonia* of the Southern Ocean was propagated by zoospores whose length was scarcely $\frac{1}{2000}$th of an inch. Some sea-weeds have the property of producing zoospores in

FORMATION AND EMISSION OF ZOOSPORES.
(*Bryopsis hynoides.*)

all parts of their tissue; in others this production is confined to certain parts of the fronds. The corpuscles always seem to be produced by a species of coagulation of matter contained in the cellules. This matter coalesces with grains more or less numerous; at first indistinct (fig. 1), then they become well defined (fig. 2), and at last the zoospores separate (fig. 3). The emission of the zoospores nearly always takes place by force, which is due to the expansion of the mucilaginous liquid with which the cellules are filled.

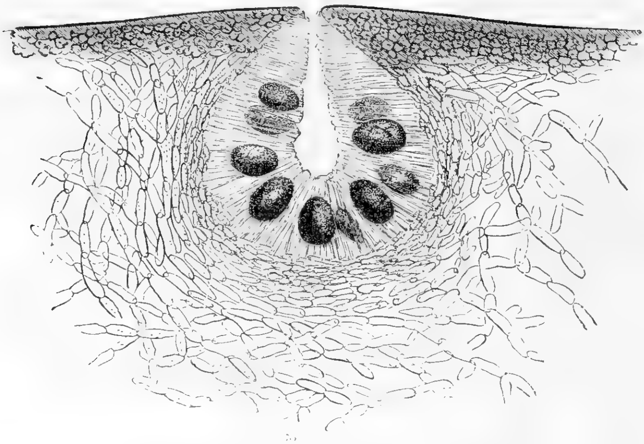
This liquid accumulates gradually by endosmose, and at last ruptures the walls. As soon as they are free (fig. Z), the zoospores spread about in every direction, always moving with the point or *rostro* foremost. Their movements are lively and curious; sometimes they abruptly stop, at other times they are seen twisting round on their longest axes with great rapidity. If the vase which contains them is placed near a window they always make their way towards the light. After they have thus been kicking about for hours or days, according to the species, the zoospores (fig. Z)



DEVELOPMENT OF THE ZOOSPORE AND THE FORMATION OF THE YOUNG PLANT.
(*Haligenia bulbosa.*)

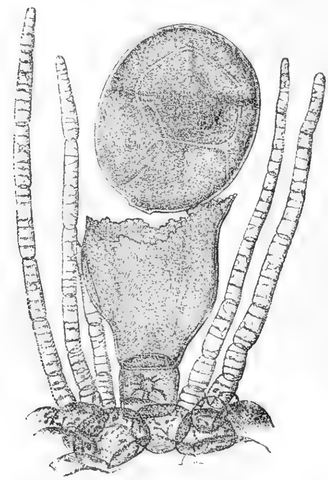
fix themselves by their rostro by means of a mucilaginous secretion; their bodies become round, the threads or hairs disappear, they either decompose or drop off. At the same time the opposite extremity grows thick and lengthens into a tube; in a short time secretions appear in this tube, and often the growth is so rapid that in a few days the young frond can be distinguished (fig. 11).

The *spore* is a little round body filled with an olive-green fluid, and which receives from the *cilia* the property of reproducing an individual like itself. It is contained in a bag (sporange), which is fixed by a short pedicle to the side of a cavity (conceptacle), which opens to the surface of the plant by a little orifice (ostiole).



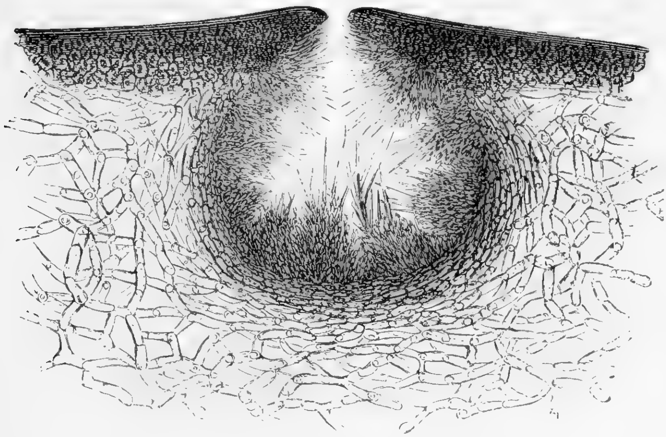
CONCEPTACLE ENCLOSING THE SPORANGES.
(*Fucus vesiculosus.*)

The sporange contains, according to the species, one or more spores.



INSERTION OF THE SPORANGE, EMISSION OF THE OCTOSPORE.
(*Fucus vesiculosus.*)

The antherozoïds are microscopic corpuscles about the $\frac{1}{2000}$th of an inch in length, enclosing a coloured granule which seems to endeavour to come to the surface, and is furnished with two moving cilia. A great number of them are contained in little transparent



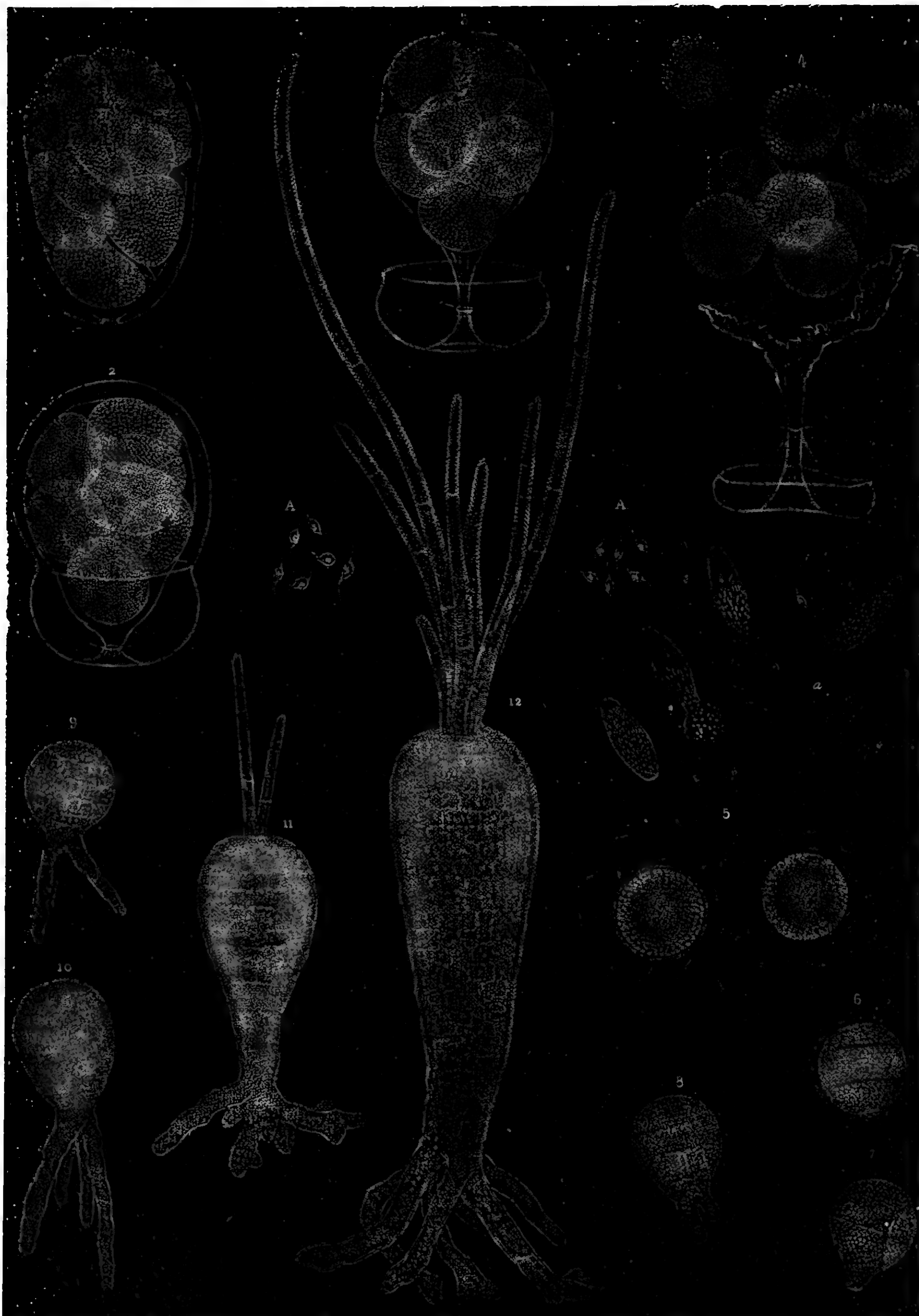
CONCEPTACLE ENCLOSING THE ANTHERIDIA.
(*Fucus vesiculosus.*)

ovoid bags (antheridia) fastened by their base upon branching and articulated hairs; these hairs spring from the walls of the con-

1. INSERTION OF THE ANTHERIDIA.—2. EMISSION OF THE ANTHEROZOÏDS.
(*Fucus vesiculosus.*)

ceptacle and converge towards the ostiole, as if to guide the antherozoïds in their exit from its cavity. The spore-cases and the antheridia are very often, according to the species, contained in the same conceptacle; or sometimes they are separated, and distinct conceptacles contain each.

According to the beautiful researches of M. Thuret, the following phenomena take place in the reproduction of the *Fucus vesiculosus*. The spore-cases take their origin from the cellules of the conceptulary cavity. Some of these cellules rise above the others, forming a little projection, which is cut in two by a transversal partition. The lower division ceases to grow, and forms from that time the pedicle; the upper one continues to increase, is gradually filled with olive-green matter, and becomes a spore-case. In due time this matter divides itself into eight parts, which become so many spores. In this, their united state, they form an *octospore*. This body appears as an opaque or brown mass, enclosed by two transparent membranes. The exterior membrane (*perispore*) belongs to the spore-case, and remains united to the pedicle when the latter has burst. The interior membrane (*epispore*) adheres to the enclosed mass, and holds the spores tightly together. At their birth the octospores slip out of the orifice of the conceptacle, and disperse themselves through the water. Soon they increase in volume, and in time the enveloping membrane (epispore) begins to give way at the upper part, and then it is seen (fig. 1, Plate II.) that the spores are still held together by a third very fine membrane. The lower part of the epispore, which is not broken up, is folded back upon itself, to allow the spores (fig. 2) to issue out; it separates completely, only holding by the base of the interior membrane (fig. 3); finally this third membrane breaks, and the spores escape (fig. 4). All this takes place in less than an hour. The liberated spores are perfectly round, of a yellowish olive-green tint, utterly destitute of teguments. This is the moment that the action of the antherozoïds interferes to impregnate the spores now disengaged from their envelope. It is only necessary that some antherides should be in the water which contains these reproductive bodies. Under the influence of moisture the antherozoïds become liberated from their antherides (fig. *a*), surround the spore, and attach themselves to its surface (fig. 5), and, by means of their vibratile cilia they communicate to them a very rapid revolving motion. This movement gradually becomes slower, and in about half an hour ceases altogether. In some hours the spore becomes covered with a membrane, and in a still longer time a partition appears, which divides it into two cellules (fig. 6). At the same time (fig. 7) a



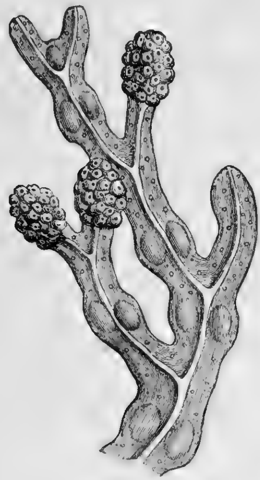
II.

REPRODUCTION AND GERMINATION OF ALGÆ.

(Fucus vesiculosus.)

1, 2, 3. Formation of the ovules. 4. Their emission. [illegible] Antherozoides. [illegible] Their emission. 5. Union of the antherozoides and the [illegible] 7 [illegible] germination and development of the young plant.

little protuberance shows itself, which continues to elongate, and at last is converted into a transparent filament, containing no green matter, and only enclosing some yellowish grains at its extremity. Soon many of these roots are formed at the base of the spore, and by these the young frond is fixed (figs. 7, 8, 9, 10). In this the cells are multiplied by partitions, dividing those which already exist; little by little it lengthens and expands to a pear-like shape, and of a brown colour. The young frond is presently formed. It already shows, very slightly, it is true, the main features of the parent plant. Some day or other it will reach its full development, and in its turn propagate individuals of its species.



BLADDER WRACK.
(*Fucus vesiculosus.*)

Every storm casts up upon the shores of eastern Europe vast heaps of wrack and other sea-weeds. These are collected, and carried inland to serve as manure. The poor people dry it for their fuel. Formerly from these marine plants soda was prepared. These sea-weeds cover the shore and submerged rocks. They form upon the sand a line showing the height to which the waves wash. The principal of them are the *knobbed wrack* (*Fucus nodusus*), which floats out upon the water, buoyed up by large air vessels placed singly in the stem; the *bladder wrack* (*Fucus vesiculosus*), which is known by its air vessels, which are as large as nuts, and in pairs; the *serrated sea-weed* (*Fucus serratus*), whose thongs have their edges jagged, and whose surface is frequently covered with the most delicate lacework, which was the handiwork of a parasitical zoophyte, the *Membraniposa*. The *Fucus siliquosus* is also found, which has long flattened capsules, marked by transversal partitions. On some shores there are as many as 30,000 persons who go down to the beach to gather these fuci thrown up by the waves, or to cut those which grow upon the rocks, and which the ebbing tide has uncovered. Since in this harvest, or rather pillage, the rich, who have the greatest number of teams, and can employ the most hands, would take the greatest share, the Catholic priests of the middle ages established a worthy custom. No one was allowed to gather the sea-weed the first day of the "harvest," except the poorer inhabitants of the parish. These borrowed their neighbours' horses and carts, and thus were enabled to collect sufficient for their wants. In the neighbourhood of Finisterre this ancient custom is still preserved. The first day of cutting the sea-weed is called "the day of the poor." The priest comes down to the beach in the morning, and if one of the rich come to gather the weeds, the village Nestor prevents him with the rebuke, "Let the poor gather their bread."

The labourers who make soda from the wrack go to the most favourable spots for collecting the weed, in bodies of six together, and construct a kind of cabin, where they pass the night. When the sea is "out," the men spread themselves over the rocks, tear off the wrack, and throw it into heaps. It is then carried to a spot on the shore beyond the reach of the waves, either on rafts or hurdles or on their backs. Here they spread it out to dry. When it is sufficiently dry, they pile it in kilns, which are rude structures made of four flags laid in a rectangle, and in this they set it on fire. The combustion is very slow, and a dense and very disagreeable smoke rises from the burning heap. The sea-weeds, which are constantly stirred about with an iron bar, give out great heat. The ashes undergo a kind of vitrification and run together into a mass; this is *kelp*. Every year 20,000 men used to be engaged in making kelp in the Orkneys; at the present time the making of soda, which the kelp was subsequently treated for, has been superseded by the extraction of iodine, which is more profitable.

Another product of the sea is the *marine zostera*, a remarkable plant with large ribboned leaves of a dark-green. This plant is not a true algæ. It belongs to the *Naiadaceæ*, the pond-weed family. They have very slender roots and attach themselves to the moving sands. They possess true flowers, although they are small. The zostera is employed in many places for mattresses and cushions, and for packing. In Holland, at the entrance of the Zuyder Zee, they use it under the name of *wier* for the construction of dykes.

Truly we must be struck with admiration when we reflect on the enormous masses of marine vegetation which every tide and every storm casts up in heaps on every shore, throughout every year and month and day, without appearing in the least to lessen the quantity which clothes the ocean bed.

CHAPTER V.

INFUSORIAL ANIMALS.

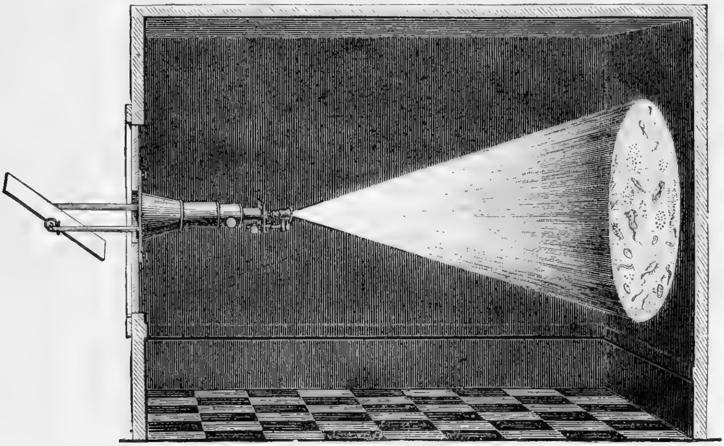
THE Creator has distributed with marvellous profusion the species and individuals of the lower grades of the animal kingdom. He seems to have wished to console the silent abysses of the sea and at the same time to enliven them by crowding their waters with millions, countless millions, of beings which possess a wonderful versatility of life.

The ocean is inhabited by innumerable nations of the infinitely

MICROSCOPE.

little. This diminutive life would have remained utterly unknown to us to this day had we not possessed *the microscope*—the sixth sense of man, as Michelet well called it. The microscope! marvellous instrument, which penetrates the depths of life as the telescope roams in the endless space above us! The knowledge of the infusoria, without any question, is the most beautiful of the achievements of optics. A perfectly new world is revealed to us, a world which fills us with astonishment and wonder at the resources of creative power. Well says Belon, "There is nothing in the world which we may call small or trivial, which does not bear witness to the grandeur and unapproached excellence of the Almighty Creator."

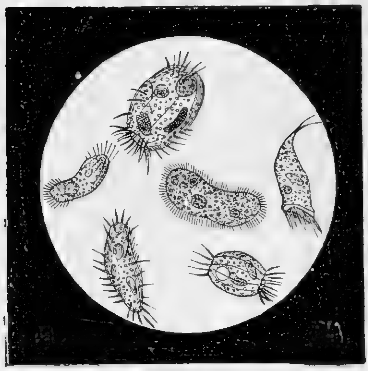
The infusorial animalcules are so minute that a single drop of water may contain many millions of them. They exist in all waters, the fresh as well as salt, the cold as well as hot. The great



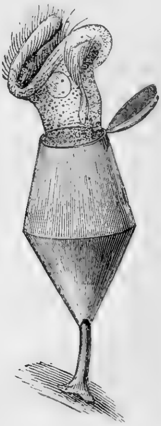
SOLAR MICROSCOPE.

rivers teem vast quantities of them hourly into the ocean. The Ganges, in the course of one year, transports a mass of invisible infusoria equal in volume to six or eight of the great pyramids of Egypt. Among these animalcules, according to Ehrenberg, may be counted seventy-one different species. The water brought up from a depth of 21,600 feet between the Philippine and Marianne Islands, was found to contain 116 species. In the Arctic regions, where beings of a higher organisation cannot exist, the infusoria are still met with in myriads. Those which were observed in the Antarctic seas during the voyages of Captain Sir James Ross, offer a richness of organisation often accompanied by elegance of form quite unknown in more northern regions. In the residuum of the blocks of ice floating about in latitude 78° 10′, nearly fifty different species were found. At a depth of the sea which exceeds the height of the loftiest mountain, Humboldt asserts that each bed of water is animated by an innumerable phalanx of inhabitants imperceptible to the human eye. These microscopic creatures are, in short, the smallest and the most numerous creatures in nature. They constitute, with human beings, one of the wheels of that very complicated machine, the globe. They fill that rank and station willed for them by the great first Thought! Suppress these beings and the world would be incomplete. And so the old saying comes true, "There is nothing so small but may become great by reflection."

These infusoria are more or less transparent. They have not



INFUSORIA.

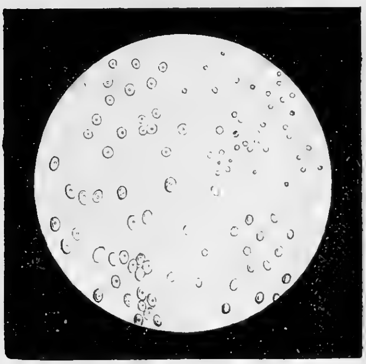


COTHURNIA.
(*Cothurnia pyxidiformis.*)

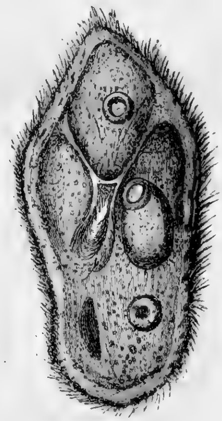
enough substance to be opaque. Their bodies are generally globular or ovoid; sometimes they are oblong, sometimes blister-like, sometimes a flattened disc, and even thin as a leaf. They are found resembling a tadpole, a thimble, a little bell, a shoe, a rose-bud, a flower, a grain of wheat.

The *Monads,* the least of the least, appear only to be molecules of an absorbing substance, live atoms, points which exist. These tiny creatures are in diameter about the $\frac{1}{25000000000}$th of an inch!

At first it was supposed that the infusoria were utterly destitute of any kind of organisation. They were thought to be fed by absorption, and by absorption only, but it has lately been discovered that certain species are complicated enough. There are some—the *Polygastrica*—which have not less than four distinct stomachs, thus bringing these minute creatures into a comparison with the ruminants. Ehrenberg asserts that he has seen infusoria provided with 200 stomachs! What appetites they must have! To study the organs of these microscopic creatures it is necessary to colour the liquid in which they exist with carmine or indigo. Then place a drop of this coloured water on a slip glass, and near to it a drop of clean water. Now cause the two drops to communicate at one point with a needle. The animalcules approach the coloured drop and imbibe the molecules of carmine, thus affording the observer the



MONADS.



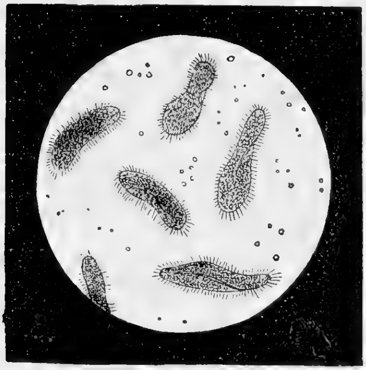
AN INFUSORE MAGNIFIED.
(*Paramecium bursaria.*)

opportunity of watching the progress of the particle through the system of the creature.

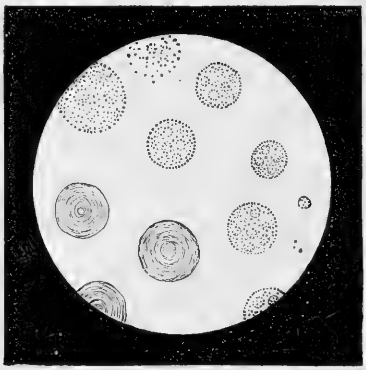
The difficulties which lay in the way of this delicate observation, together with the strong imagination of many of the observers, for a long while prevented any reliable information about them to be gathered. Leuwenhoeck, who first noticed the existence of these infusoria in 1676, was so elated with his discovery, and so certain of the wonderful power of the microscope which he had made, that he always supposed he saw more than he really did. He was enraptured with the complexity and the perfection of these microscopical beings, and wished to suppose their internal organism was complete, with stomach, alimentary canal, vessels, nerves, and muscles. Jablot even outstripped his predecessor. He saw among them animated bag-pipes, tufted hens, and gold and silver fish! We now know that infusoria are neither so complicated as some authors have asserted, nor yet so simple as others have imagined.

It is to the learned Berlin professor, Ehrenberg, and latterly to MM. de Siebold, Claparède, Lachmann, Lieberkühn, and Balbiani, that we owe the most complete and interesting works in the possession of science upon these lovely dwarfs of nature, these atoms of existence.

The infusoria are furnished on all parts of their bodies with vibratory cilia, hair-like prominences, not all of the same thickness,



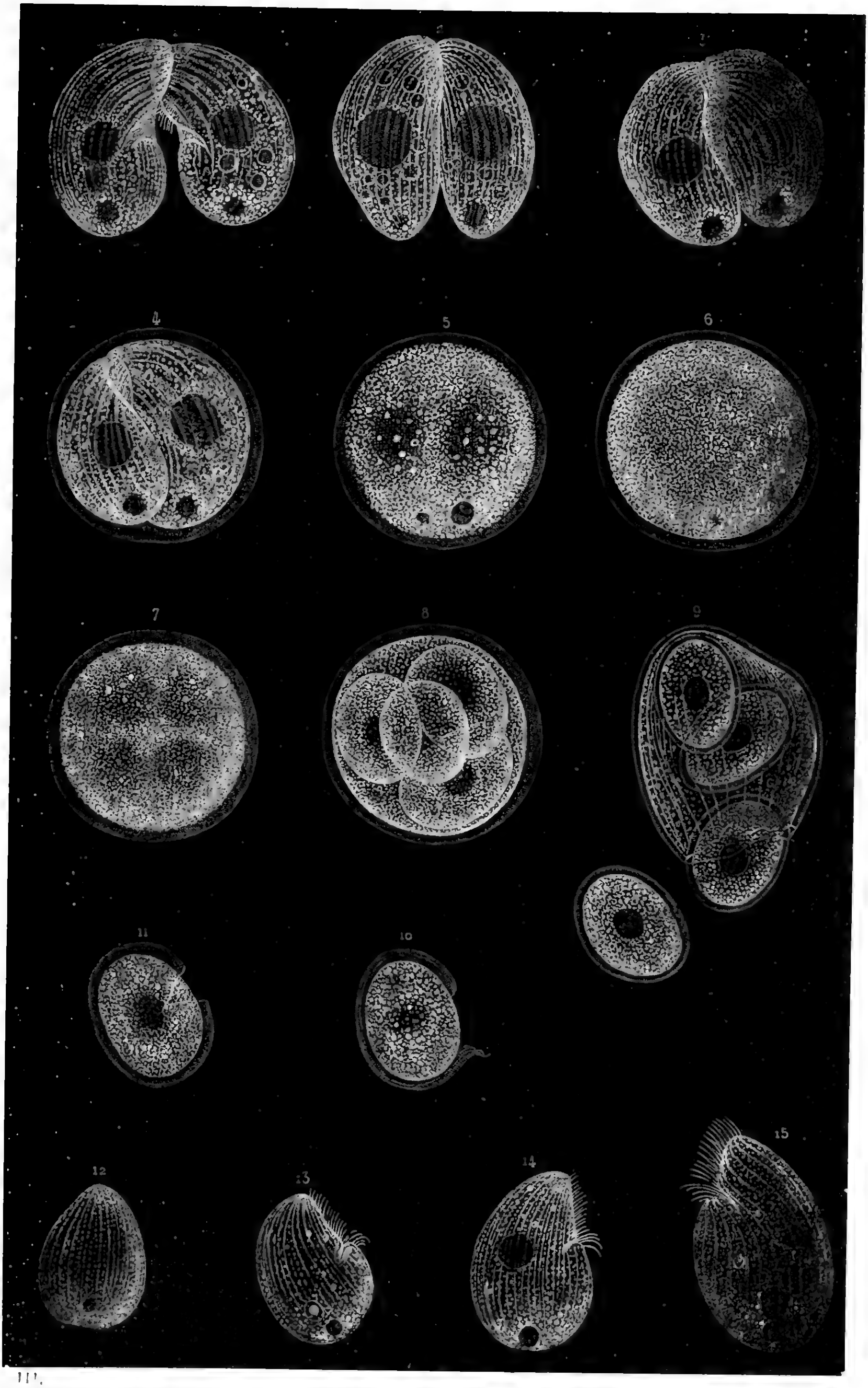
PARAMECIUM BURSARIA.



VOLVOCEÆ.

neither of the same length. They are ever in motion, thus causing currents in the water which lead the organic particles on which they subsist to the entrance of their digestive apparatus. These cilia not only serve as the providers of their food, but at the same time they seem to be their organs of respiration and of locomotion. The infusoria do not possess members in the usual sense of the term; some, however, have tails. These miniature animals swim as fish, glide like serpents, and twist like worms.

The *Volvoceæ* roll round, constantly revolving round their centres, like a ball running about on a slightly sloping, smooth surface. The smallest creature which moves, as well as the smallest flower which blooms, awakens within us feelings of surprise and joy. We are mute with astonishment and can but dream in our wonder.

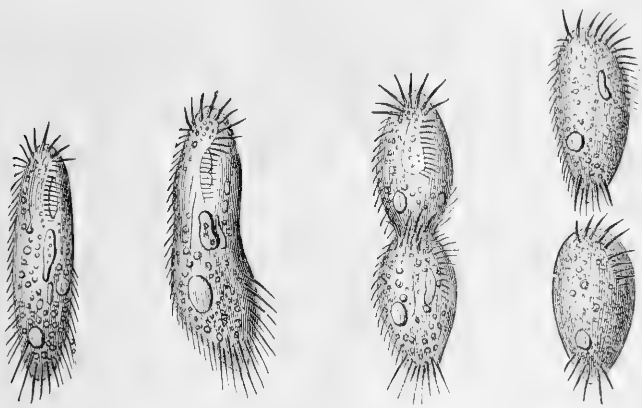


III.

REPRODUCTION AND DEVELOPMENT OF AN INFUSORE.

1, 2, 3, 4, 5. Different phases of the fusion of two individuals. 6. Complete fusion. 7, 8. Division of the common mass into oviform bodies. 9. Their emission. 10, 11. Liberated oviform bodies. 12, 13, 14. Young animalcules produced from these bodies; their development. 15. The adult animalcule.

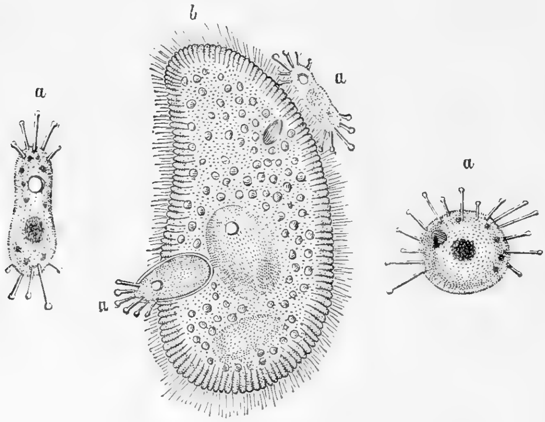
The infusoria reproduce each other in different ways. First, there is *spontaneous division,* technically called *fissiparism,* or *fission.* By this process the animal divides itself into two equal parts, each part becoming an exact resemblance of the original and primitive individual, so that literally the child is half its mother, and the grandson a quarter of its grandfather! A second mode is by *gemmæ,* or budding, something after the manner of plants, or perhaps more like the emission of an egg which in due time develops into an adult animalcule. Who can imagine the size of such an egg? Both these processes may be watched



PROPAGATION OF AN INFUSORE BY SPONTANEOUS DIVISION, OR FISSIPARISM.

going on in sea water, by any one who has patience enough. The whole operation is completed in a very short space of time. Very lately it has been discovered that there is a difference between the male and female infusore, and this is the origin of a third mode of reproduction. Two of the animalcules in the course of their wandering through their liquid world—a drop of water—meet each other. By some strange force they become attached by their anteriors (Plate III., fig. 1), gradually they become fused into each other (figs. 2, 3, 4, 5), and at last appear one homogeneous mass (fig. 6). This then becomes surrounded by a transparent envelope, and in the interior of the mass four nebulous points begin to appear (fig. 7). These gradually extend until the whole is divided into four egg-shaped bodies (fig. 8). Soon the envelope breaks and allows these oviform particles to escape (fig. 9). These, like seeds, may remain for years before they find themselves in positions favourable for their development. When the surrounding circumstances are favourable, the germ begins to grow (figs. 10, 11). The infusore is formed (fig. 12), and grows rapidly (figs. 13, 14), and thus reaches its full development (fig. 15), and immediately sets out to find some other of its kind with which it may join its destiny and aid in the propagation of its species. Wonderful operations in a drop of water!

Life is spread over nature in such well-nigh prodigal abundance that the smallest infusore has its parasite a little smaller, these



INFUSORE AND ITS PARASITES.

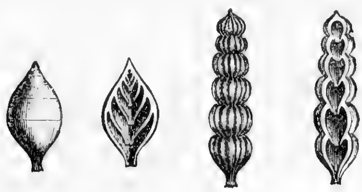
serving in their turn as "dwellings and pasture grounds," to use Humboldt's expression, for other animalculæ still less. The parasites, *a*, of the *Paramecium aurelia*, *b*, are small creatures cylindrical in form, furnished with short suckers, swimming in the water by natatory cils. Sometimes they are spherical, and although wanting in cilia, yet they preserve their suckers. Swimming vigorously, they devote themselves to chasing the paramecium. Another of the parasites which also preys upon the paramecium remains perfectly quiet until one of them approaches, when it throws itself upon its victim and is carried along with it. It buries itself in the body, and in a short time multiplies to such a degree that sometimes fifty of them are found in a single individual!

One of the most surprising phenomena which we meet with in the study of infusoria is their disorganisation by *diffluence.* This decomposition is either entire or partial. Müller has seen a kalpode (*Kolpoda meleagris*) melt away until scarcely $\frac{1}{16}$th of his body remained; the rest continuing to swim about as if nothing had happened. The infusoria present still another kind of decomposition. If we approach the drop of water in which the animalcule lives with the barb of a feather wet with ammonia, the animal ceases its swimming motion instantly, although its cilia still vibrate rapidly. Suddenly, at some point of its circumference, a notch is formed which increases more and more until the whole animal is dissolved. If, while this process be going on, a drop of pure water be added, the decomposition is at once arrested, and that which remains of the animalcule begins to move and swim as if the ammonia had never been in its neighbourhood, and had not dissolved the greater part of its substance.

CHAPTER VI.

THE FORAMINIFERA.

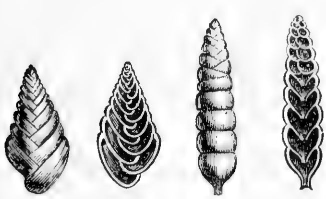
WHEN we examine sea-weed under a microscope we observe many particles, apparently solid, which have a regular and often geometrical structure. Beccaria seems to have been the first observer who gave any attention to these small, and all but invisible, grains. He discovered them in the sand of Ravenna. For a long time it was erroneously supposed that they were only to be found on the shores of the Adriatic; they have, however, since been discovered in England, France, Germany, and in fact upon the shores of every sea. Patient researches have been prosecuted by Bianchi, Soldani, Walker, Fichtel, and Moll, and especially by Alcide d'Orbigny, which have revealed to us a great number of these minute bodies. These grains are nothing else than the solid carapace or shell of a species of marine animalcules which constitute an entire order among the inhabitants of sea water. The beach is so covered in certain localities that they form nearly half of its sand. Bianchi found 6,000 of these shells in thirty grammes of the sand from the Adriatic. D'Orbigny computed that there were 3,840,000 in the same quantity of sand from the Antilles. The number contained in a cubic yard would exceed all our powers of computation. These little shells have a variety of forms. Their observers have noted 2,000 different organisations, symmetrical or otherwise, but always remarkable for their curious, but ever beautiful and elegant forms. They are globular, discoid, star-like, wreathed, spiralled, and club-like. Some have a wide orifice, others possess a very narrow one. They are generally divided into many chambers, which communicate with each other by means of little holes. They also have pores opening to their exterior. To this fact they are indebted for their name foraminifera (*foramen*, a hole), which was bestowed upon them by D'Orbigny. Advantage has been taken of their general forms, and the number and disposition of their chambers, to group them into families. D'Orbigny's classification is good, and deserves to be generally adopted, although his names are not so euphonious as they might be. This clever naturalist, who ought to be regarded as the great historian of this minute people, divides them into five families which contain about sixty species:—Shells of a single



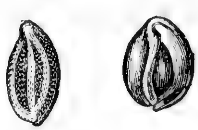
STICHOSTEGA.

chamber, and those superimposed linearly on a straight or curved axis (*Stichostega*); those composed of alternate chambers (*Enallostega*); those which have chambers on a common axis, each investing half the circumference (*Agathistega*). In another family the chambers are arranged in spirals (*Helixostega*).

In this case either the folds of the spiral wind round each other



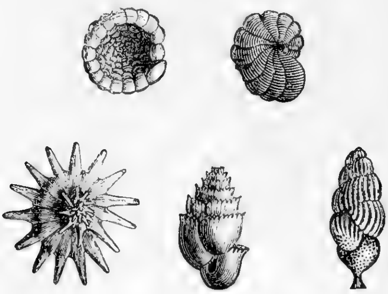
ENALLOSTEGA.



AGATHISTEGA.

like a coiled rope, or rise above each other in a corkscrew fashion. In certain species the chambers are subdivided by partitions, so that a section of the shell shows a kind of trellis work, as in the *Entomostega*. What geometry, what mechanism, what harmony, in the very meanest of organised beings! The resemblance which these little shells bear to those of the nautilus at first led naturalists to believe that the animals themselves were of the same species, and therefore place the foraminifera with the molluscous cephalopods.

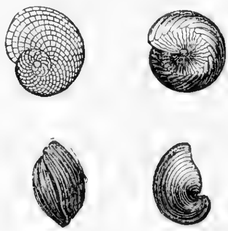
They were regarded as microscopic nautili but of a lower development; but the discovery of some living specimens, and a careful examination of their characters, proved that they belonged to a



HELIXOSTEGA.

class of animals which had a very much more simple construction than the last-named mollusks.

Dujardin considered them to be infusoria; other naturalists are inclined to place them in alliance with the medusæ. Cuvier says nothing more about the inhabitants of these shells than that they have oblong bodies, surmounted by numerous red tentaculæ.

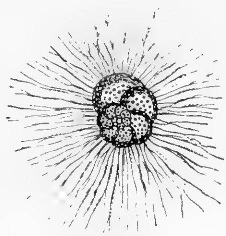


ENTOMOSTEGA.

Modern observers have noted that they are formed of a gelatinous substance which fills the chambers of which we have spoken, each chamber communicating by pores in its walls. Out of these pores issue long and slender capillary filaments, which have no particular shape and are always changing. They are like threads of glass which extend all round the animal. In some species there are only eight or ten of these filaments; in others a much larger number.

They move in all ways with the greatest rapidity. They are the feet and arms of these wonderful creatures; by their means they succeed in catching their prey. These filaments appear to contain something poisonous. Dr. Schultze noticed that the prey seized suddenly and entirely lost all movement as soon as it was touched by them. It is probable that thus the foraminifera live upon other animals. It is no mean wonder that these creatures, despite

DISCORBINA.



MILIOLA.

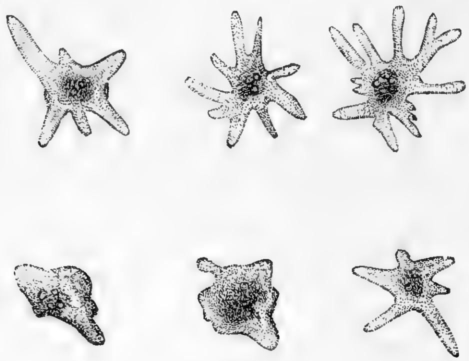
the smallness of their size and slightness of their form, are unpitying flesh-eaters. The smallest, the weakest, the most microscopic animal in existence thus becomes, by means of a homœopathic dose of poison, a most formidable destroyer!

Dujardin observed that when a *Miliola* attempted to climb up the sides of a vase, it could improvise, as it were, on the instant and at the expense of its own substance, a provisional foot, which stretched itself out rapidly and performed all the functions of a permanent member. The occasion served, this temporary foot was seen once more to return to the common mass, and was absorbed into the body. Thus, with these wonderful creatures the presence of a necessity gives the power to create an organ by the mere will of the creature; while man, with all his genius, cannot create a hair! Is not this humiliating? Thus it appears that the filaments of all the species can be completely drawn in and lost in the rest of their substance. How marvellous are nature's combinations!

The foraminifera have no stomach properly so called. They are gifted with a peculiar tissue, at once gelatinous, contractile, and essentially assimilative, which Dujardin has shown is also found in all infusorial animalculæ.

Pseudopods are not only met with in foraminifera, but this kind of foraging threads are the important characteristics of a whole class of animalcules. Since these organs resemble hairy roots, these animals are classed under the name of *Rhizopods* (root-footed). The rhizopods contain besides the foraminifera, whose outside tegument is calcareous, animals who have no semblance of a shell, like the *Amœbinæ*, whose covering is siliceous or flinty. These latter are the *Radiolaria*.

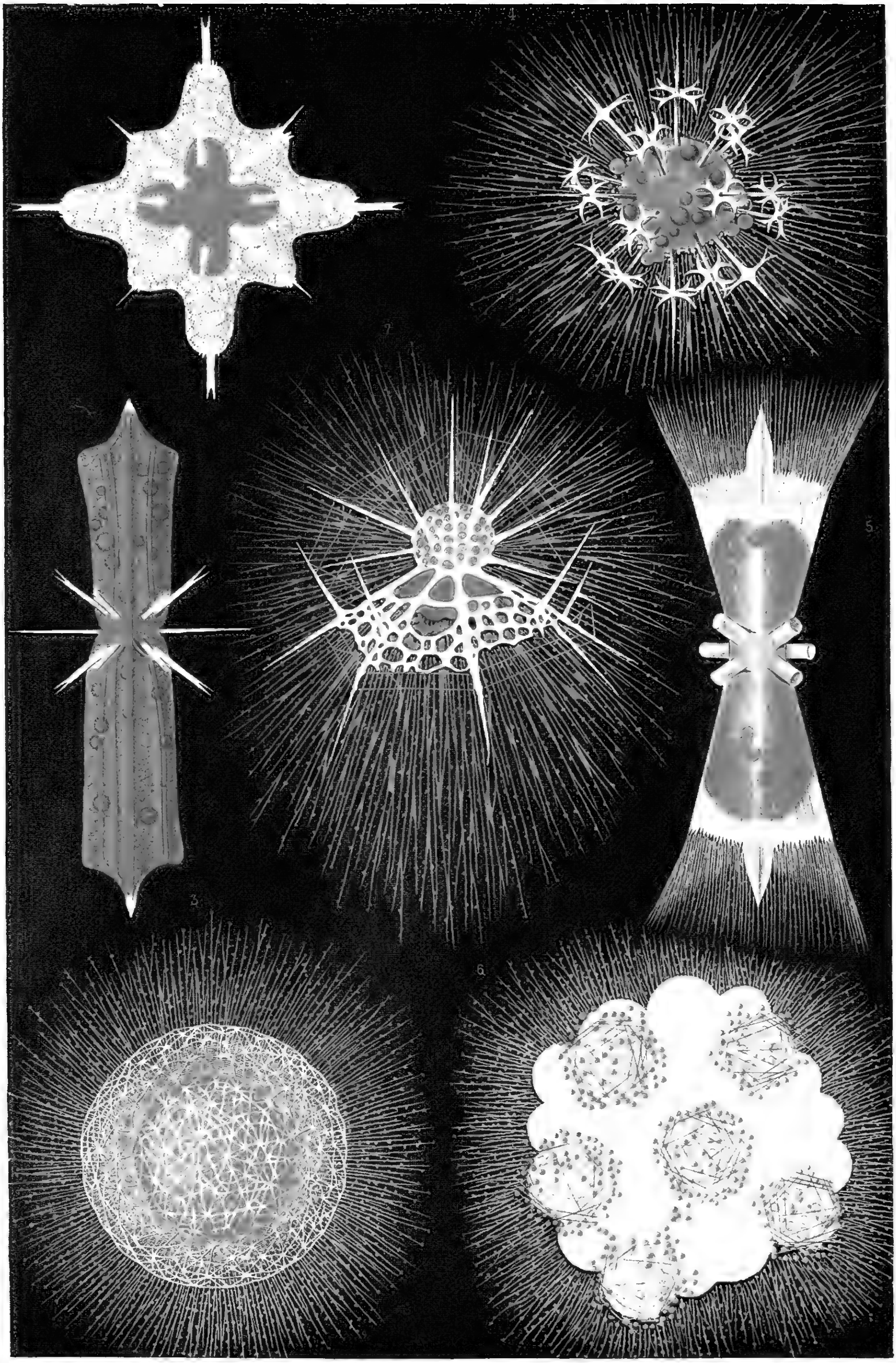
The *Amœbinæ* are infusoria possessing the fishing filament of rhizopod infusoria. They may be regarded as animals which have not yet reached their perfect organisation. They are unformed



PROTEUS.
(*Amiba divergens.*)

microscopic masses, which are capable of expansion and contraction. We take the *Amiba divergens* for an example of the class. Conceive a tiny drop of matter, semi-solid, semi-transparent, semi-gelatinous, homogeneous, possessing voluntary motion. It can move itself in different ways, dilate or contract, and appear in extraordinary or irregular figures. When the animalcule is placed on the object-glass of the microscope it glides like a drop of oil, separating and reforming itself, a veritable Proteus. In succeeding moments it is circular, oblong, hollow, sinuous, lobed, star-like, and even branched.

The *Lieberkuhnia* of Wagener is also an amœbina. It possesses a great number of pseudopods, which roll about in every direction, now joining themselves together; now separating, now



IV.

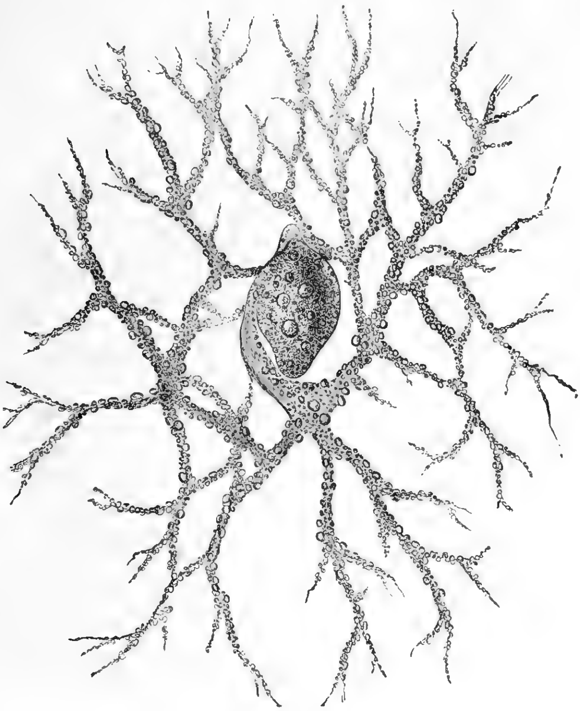
RADIATED ANIMALS.

E. holaria. (Hcl.)

1. Acanthostaurus purpurascens. (*Hcl.*)
2. Amphilonche anomala. (*Hcl.*)
3. Dyctiosoma trigonizon. (*Hcl.*)
4. Dorataspis polyancistra. (*Hcl.*)
5. Diploconus fasces. (*Hcl.*)
6. Sphærozoum italicum. (*Hcl.*)
7. Arachnocorys circumtexta. (*Hcl.*)

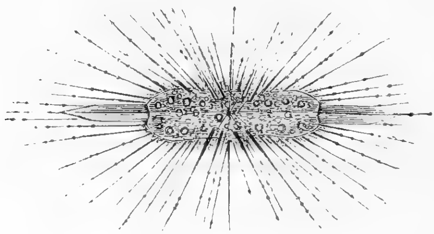
elongating themselves; and now again contracting, appearing, and disappearing.

The *Radiolaria* float in abundance on the surface of the sea under the beautiful sky of Messina. They may be seen moving



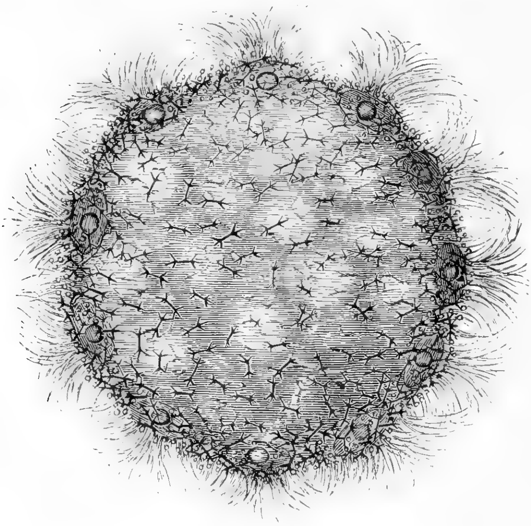
THE LIEBERKUHNIA OF WAGENER.

on the blue water in such numbers that they appear like a scum of mobile, transparent, colourless jelly. Their forms vary from a point to a line, they may be spherical, or elliptical, or cylindrical, and sometimes the creature is wreathed into a crown. If you try to take them with the forceps, they tear; if you lift them from the water with a net, they adhere to the meshes, and you mutilate them in endeavouring to detach them. They can only be procured intact by taking them from the sea in a glass, so that they can swim in the water at liberty. When seen in the light, these jellies lie upon the water in no determined shape, and the eye is just able to distinguish upon their surface dark and light specks. Under a



RADIOLARIA MONOZOA.
(*Amphilonche heteracantha.*—Haeckel.)

strong magnifying power all the delicacy and beauty of these wonderful organisms are exhibited. In the splendid work of



RADIOLARIA POLYZOA.
(*Sphærozoum ovodimare.*—Haeckel.)

M. Haeckel, the variety of forms, the fantastic shapes of these innumerable legions of minute creatures are given. He has distinguished the Radiolaria into those which live in isolation, which he calls *Monozoa,* and those which form associations, floating colonies which are carried on the breast of the currents; these latter are termed *Polyzoa.* The monozoa are very numerous, and form twenty-nine species. The polyzoa only comprehend four species.

The researches of D'Orbigny, relative to these microscopic organisations, tend to prove that the débris of the foraminifera constitutes with that of the polypiers a great part of the submarine banks, whose accumulations obstruct the navigation in gulfs and straits, fill up ports, and give rise to those reefs and islands which rise up in the warm regions of the Pacific. These creatures, apparently without any stamina, and of such low organisation, are found in all latitudes, and in all depths.

What in comparison to the necropolis of the foraminifera are the cemeteries of the elephants and whales? Does it not seem that the smaller the animal the more enormous the accumulation of its remains? The shells of the foraminifera are often found—far more than we at all imagine—in a fossil state. They form whole ranges of hills, and immense deposits of building stone. The chalk so abundant in the Paris basin is full of them; a cubic inch from the quarries of Chantilly was found to contain about 20,000; that is, a block rather more than a yard each way, would be the mausoleum of the enormous number of 20,000,000,000 creatures. When passing by a house which is being pulled down, or one which is in course of construction, we are enveloped in a cloud of dust; and when we draw in our breath, we swallow hundreds of these little creatures. As the chalk from these quarries has served to build Paris, as well as the towns and villages of the neighbouring departments, it may be said that Paris and other great centres of population which surround it, are built with the shells of microscopic animals. The pyramids of Egypt are made of the same stone, based upon rocks of the same kind. The foraminifera are the great agents in forming the very ground we tread on, the houses we build, and the edifices we hand down to posterity. Each animalcule has furnished its solid grain, each race has deposited an all but imperceptible bed, and God, who rules over the work, has gathered

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up the deposits of centuries, and formed of them these mighty masses. The species which are living to-day, are silently preparing in the bosom of the ocean wrought stone for the works of future generations.

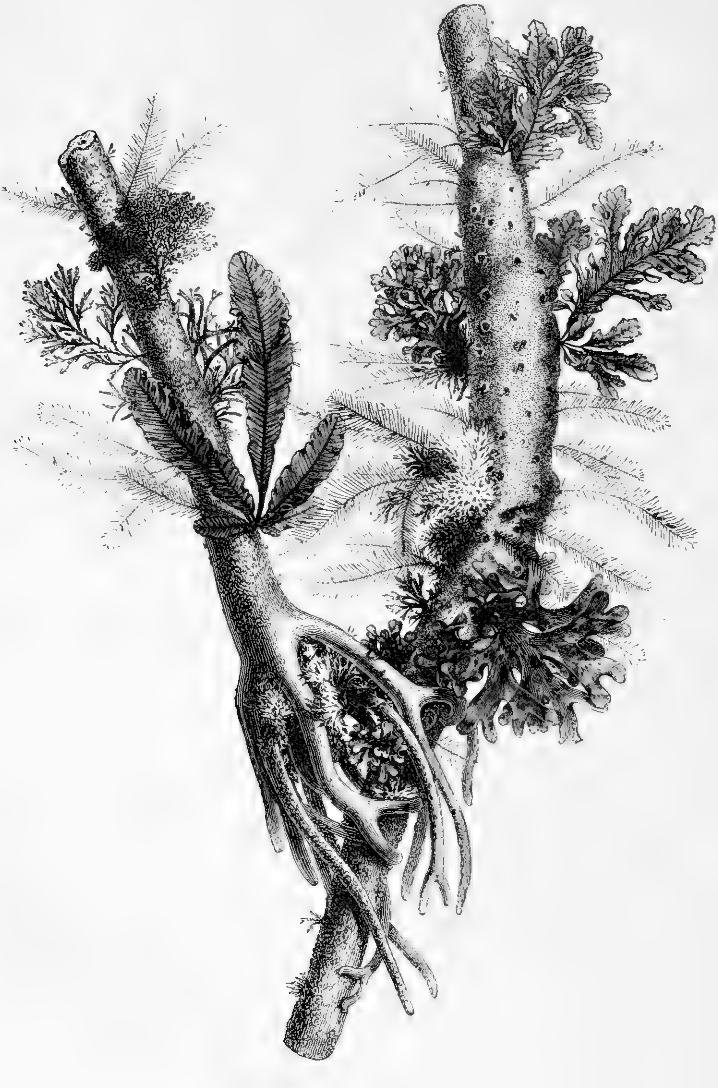
"It would be unreasonable to despise these animals, since the Almighty has compensated for their size and insignificance by granting to them such strength and industry. He has shown in this way that there is greatness in the least as well as strength in the weakest things. Let us learn, then, to admire the Creator in the meanest of his works." (Tertullian.)

CHAPTER VII.

THE SPONGES.

THE bosom of the ocean is full of mysteries. Among the animal organisations which it encloses and nourishes, perhaps few are so little understood as those peculiar creatures we call *sponges*. This production appears a mass of light, resisting, elastic tissue; the colour is a light brown or yellow, sometimes verging on red. The most varied opinions have been held by scientific men as to the exact nature of sponges. The ancients were as much divided as to the position in nature they ought to occupy as more modern observers. One opinion ranked them in the animal kingdom, another classed them with the vegetables, while a third prescribed them an intermediate place, and considered them as the nests of polypes; the owners of the nests were not attached to their homes, but were able to go in and out as they pleased. The coral polype is not so fortunate.

Pliny, Dioscorides, and their commentators, believed that sponges were capable of feeling, that they adhered to their native rock by a vital force, and that they shrunk from the hand which tried to seize them. They even distinguished in them a male and female formation. But we may say, in passing, that the early naturalists invariably saw males and females in everything; man has ever wished to find resemblances to himself in the most obscure organisations. Erasmus, however, criticising Pliny, concludes that he may safely omit all that the historian wrote on the sponge. More recently Nuremberg, Peyssonnel, and Trembley have maintained, with some reason, that sponges are animals, and their views have been adopted by Linnæus, Guettard, Donati, and Lamouroux, on the Continent, and by Ellis, Fleming, and Grant, in England. Sponges are found in every sea, though the Mediterranean is the chief region of their growth in Europe. The Red Sea and the Gulf of Mexico are also noted for them. They love warm or temperate waters, and places not exposed to the action of waves and currents. Their colonies live at the bottom of the seas, in five to twenty-five



SPONGE UPON A SEA-WEED.
(Fished up from a depth of sixty fathoms.)

fathoms of water, among the clefts and crevices of the rocks, to which they are always attached. They are, however, found not only on inorganic bodies, but also on vegetables and animals.

They grow, erect or pendant, according to the body which supports them and their natural habit. This fixed position of certain animals is a very peculiar character. Most people imagine that animals have the power of moving from one place to another; but this is not always the case; there are numerous species which live and die attached to the same place, such as polypes and sponges. The adherence of animals to a fixed position causes them to be more under the influence of external agents than others which are endowed with locomotion; these can frequently escape those changes, which would otherwise affect them, by moving from that particular position, or sometimes by periodical migrations. Hence there is the greatest difference in the habits and powers of fixed and moving animals.

Three hundred species of sponges are known. They are classed as *Pedicellated*, *Non-pedicellated*, *Foliaceous*, *Globular*, *Concave*, and *Digitated.* Their various forms account for the singular names given them by sailors; for instance, the *Feather Sponge*, the *Fan*, the *Bell*, the *Lyre*, the *Trumpet*, the *Distaff*, the *Peacock's Tail*, and *Neptune's Glove.*

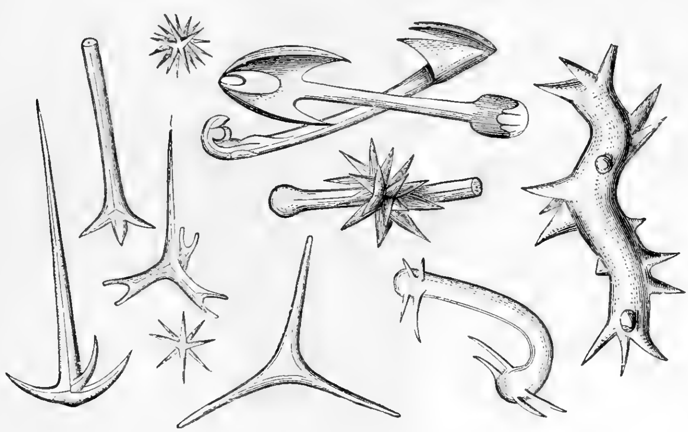
Nature has been as careful in the construction of the humblest inhabitants of the water, as of those beings which belong to the higher orders of creation. The touches of the great Master's hand are always perfect.

The common sponge is an irregular round mass, often a little concave. On examining its tissue with a lens, we find it is composed of fine, flexible fibres, interlacing each other, and forming a vast number of orifices, some of which are very small (*pores*), and are found spreading over the whole surface of the sponge, while some much larger (*oscules*), are generally situated on the upper surface. In the interior, irregular canals of all dimensions lead into each other, and make a communication with the pores and the orifices. The tissue is, as it were, stuffed with hard bodies called *spiculæ*, calcareous or siliceous. Some are straight, like needles; others are divided into two or three branches. In the living state this mass is surrounded by a layer of mucous matter, which becomes sticky when the polype is taken from the water. Strong currents are found to pour forth from each orifice, living fountains which never seem to cease. The poor creatures receive their nourishment from the wave which washes past them; they inhale and respire the bitter waters all their lives; and are insensible to that which is only one-hundredth part of an inch from their mouths.

NEPTUNE'S GLOVE.

In the months of April and May these animalcules engender germs, round bodies, yellow and white, from which proceed *ovoid granular embryos,* furnished at their largest extremity with *vibratile cils.* These embryos are thrown out by the currents which come from the stomach, and they form swarms of larvæ round the polypier. These larvæ swim with that part which is expanded foremost, like the larvæ of the coral. They move with a gliding wavy motion. After remaining some time in the water they generally come to the surface; but they are frequently swept away by the currents. For two or three days they appear to search for a suitable place where they may affix themselves. When once fixed, the larva loses its *vibratile cils*,* spreads itself out, and takes the form of a very flat gelatinous disc. Its interior organisation consists of *contractile cellules* and numerous spiculæ. The exact time taken by a sponge to develop is not exactly known; but the sponge-gatherers return in three years to the place which they had cleared.

Fishing for sponges is principally carried on by the Greeks and the Syrians in that part of the Mediterranean which washes the



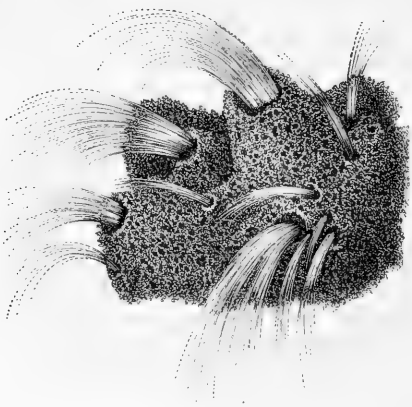
THE SPICULÆ OF SPONGES.

shores of their countries. The Greeks commence their fishing in May and end in August, the Syrians continue to the end of September. The boat's crew consists of four or five men. Each diver is armed with a strong-bladed knife, or a three-pronged trident, curved, and a net-pouch fastened to it. The boats having arrived at the rocks where the sponges grow—when the sea is calm the polypiers are easily seen—the men commence diving for them

* Cils or Cilia (*cilium*, a hair or eyelash) are microscopic filaments, like hairs, found chiefly upon the surface of tissues which are in contact with water. These peculiar organs are distributed throughout the whole animal kingdom. They possess two kinds of motion, *vibrating* and *rotating;* but the movement is not produced by muscular action. In very small animals the cilia act as organs of locomotion, and in the larger animals, such as the mollusca, they produce currents of water, which bring to the creature its food.

or dredging them up. This latter plan is liable to tear the sponge, and therefore those which are so collected are sold at a much cheaper rate than those which are brought up by hand.

In the Gulf of Mexico, where they grow in shallow water, the fishermen drive down a long pole into the water and fasten it to the side of the boat. They slide down this to the sponges, and easily detach them. After they are taken from the water they are cleaned, to separate them from the glutinous matter and the spiculæ and other foreign bodies which they contain. When so prepared



A PIECE OF SPONGE, GREATLY MAGNIFIED.

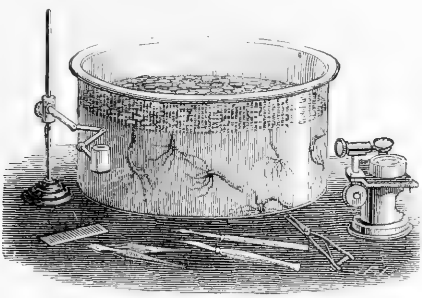
the tissue is of a russet colour, more or less golden. Its elasticity and its porosity are well known. Some kinds are always dark-coloured, others gradually lighten their shade and in time become almost white.

M. Lamiral has published an excellent memoir upon the acclimatisation of sponges in the French waters of the Mediterranean. He avers that unless this is done and there is some regularity in their gathering, sponges will become very scarce, for at present the demand is increasing and the supply decreasing. The French Acclimatisation Society gave M. Lamiral a commission in 1862 to gather Syrian sponges full of germs, and plant them in suitable localities on the French coast, but as yet no results have rewarded the undertaking.

CHAPTER VIII.

THE POLYPES.

THE polypes are mighty people! Some of them have been known to attain the gigantic size of one-third of an inch! They are by no means rare. Their organisation and the homes which they build for themselves are very favourite subjects with naturalists, and



POLYPES.

the polypes are decidedly popular. Whenever we want to express a comparison between one finely developed species, and another whose organisation is of the simplest, we are in the habit of saying, what is well nigh a proverb, "*From a polype to a man!*" and yet the quasi-popularity of this curious animal is confined almost to a knowledge of its name! For instance, ask a person if a polype be an animal which inhabits the seas or rivers? if it possess a head or a tail? you will see what the answer will be! Nothing is more common than the name, and for this reason we dedicate a chapter to the polypes.

The most prominent member of this group is the *Fresh-water polype*, or *Hydra viridis.* It looks like a little straight bag, tubular, semi-transparent, greenish, open at one end, and fashioned like a trumpet's mouth, having round the opening six, occasionally eight or ten, tentaculæ—fine, filiform, and flexible arms—arranged round the mouth in the form of a crown. Thus the bag is the body, the opening is the mouth, the cavity is the stomach, and the tentaculæ the arms. This, then, is the whole polype!

If we compare this simple organisation with the wonderful creation man, or even with a much less eminent member of the animal kingdom, we should be inclined to say that the polype was *imperfect*. Yet this is by no means the case. Surely an animal which possesses all the members necessary to its existence is not an imperfect animal! The want of organs which are absolutely

AN ISOLATED POLYPE.

necessary to existence would constitute imperfection. In reality perfection consists not in the number of parts, but in their unity, and their capability of performing those functions for which they were designed. Every polype is just as perfect in its way as a larger and more finely developed animal; and it would as absurd to deny this as to assert that an elephant was not perfect without wings, or a horse without fins.

Naturalists often employ the term "imperfect," but only relatively. It implies that such and such a species presents an organisation less complicated than some other. In this sense we shall use the term.

The polype seeks the light, and is sensible of the least noise. It attaches itself to aquatic plants and other submerged bodies by the closed end of its bag-like body. Trembley saw a long plank which was so perfectly edged with them that it appeared as though it were ornamented with living fringe. Nearly all the river snails carry some on their shells. The mollusk is their carriage, and whether it swim or crawl, with its lazy motion it transports its passenger farther in a few minutes than ever the polype could have travelled in a single day. Other polypes travel by express upon the sheath of a caddice fly, that quick-moving and lively aquatic larva, which darts along the beds of pools and rivulets. The polypes balance themselves easily and gracefully, stretching out in every direction their hair-like arms. These organs are as long as, and sometimes longer, than the body of the animal; they are covered with vibratile cilia which are microscopic, and make 250 movements in one minute!

When an unfortunate animalcule comes near enough the polype to touch its arms, it is immediately seized and drawn to its mouth; the tentaculæ wrap round it, the bag contracts, and the animal digests its food in peace. When its repast is finished, it gets rid of all that is useless by a species of vomiting. This is the case with all animals constructed on this principle. They have only one opening through which the food is taken into the system, and from which also is thrown out that which is no longer useful.

Sometimes the polypes fasten themselves together in a long line. If a worm happen to find itself among them, it is instantly garrotted by a thousand arms in every part of its body. In whatever confusion the polypes were, instantly all is order, and the multitude which were interlaced like tangled threads, all stretch themselves straight and separate from each other without the slightest effort.

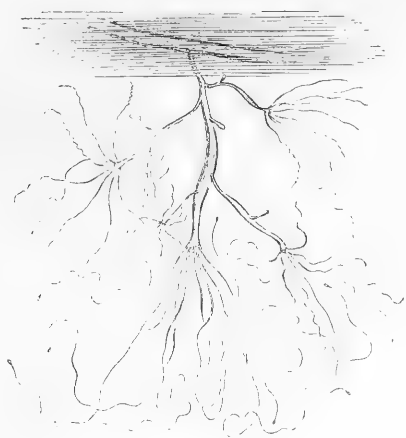
The hydra sometimes manages to swallow a quantity of food three or four times larger than its own body. It can enclose in its long stomach as many as a dozen water-bugs, one after the other, its distended body bulging with each insect. When a hydra has gorged too much, it falls to the bottom of the water. What else can it do? Sometimes it ejects a part, so that it may be able to digest the rest—surely a wise determination! This voracity of the polypes proves that St. Francis de Sales said a little too much when he urged men to follow the example of the brute creation in their moderation. The righteously indignant saint, pointing to the lower animals, exclaimed: "They are sober and temperate, and never eat more than their appetites demand." Evidently the worthy father had not made the acquaintance of the nation of the polypes!

It is generally said that animals with soft teeth have soft manners. The polypes have not only no teeth but no jaws; their whole body is soft enough—they surely ought to be the very perfection of gentleness. How little we can judge by appearances! Sometimes the little worms swallowed by the hydra try to escape, a very natural instinct, whereupon the ravisher retains them by plunging one of his arms into his stomach, and holds his wriggling prey until the solvent fluids take effect. How wonderful a provision which permits the worm to be dissolved but the arm left untouched! When the end of the hydra is cut off, the polype is of course deprived of the bottom of his stomach; heedless, however, of his loss, he still captures and swallows the animalcules, but deriving no nourishment—for the creatures simply pass out of the other end of the tube—the hydra eats and eats for ever; he becomes utterly insatiable, like M. de Crac's horse or the cask of the Danaïdes.

The food of the fresh-water hydra influences the colour of their bodies. The reddish matter of the wood-louse tints them pink; when feeding on water-bugs they are green, and black when on tadpoles. The external surface of the digestive bag is frequently seen to be covered with tubercles which increase and lengthen, and gradually develop into miniature polypes (*polypules*). When they are able to provide for themselves, the point of attachment becomes attenuated and gives way. So the infant polype is born. Those buds which are produced in autumn are detached without reaching their full development, and falling to the bottom, are preserved in the water during winter. Upon the return of spring their development proceeds.

While the young polype is still attached to the parent, upon its body a new little one is often observed to grow. This may give birth to a third, and the third even to a fourth! So that the parent hydra carries at the same time its son, its grandson, and its great-grandson—a living genealogical tree!

If a polype be divided into seven or eight pieces, at the end of two days each fragment will have become a perfect creature. Rœsel assures us that he has seen the arms cut into tiny pieces, each piece becoming, in due time, a perfect hydra. Thus one individual can produce a whole family by the sacrifice of one of its arms; neither does it suffer by the mutilation, for it at once reproduces the member it lost. This wonderful property of reproduction does not reside in the arm alone, but the whole body may be cut into pieces, and each section will soon form a new individual, in



A POLYPE WITH BUDS.
(A living genealogical tree.)

all respects like the creature divided. Another strange peculiarity this polype exhibits is, that it can be turned inside out like the finger of a glove, and yet continue to live as though nothing had happened! The exterior skin, which did respire, now digests; and the interior surface, which but lately carried on the digestion, now performs the breathing functions. If there be any polypules on the surface of a hydra thus unceremoniously treated, they will continue to increase if they have reached a sufficiently advanced stage of development; and although they find themselves imprisoned in an internal cavity when they separate from their parent, yet they re-issue by the mouth. Those, on the other hand, which are not sufficiently advanced, *turn themselves inside out*, and so appear on the outside, where they complete their development. A polype can be thus turned many times, without ceasing to perform any of its functions; and more than this, one may be divided, then turned, then divided again, and again turned, and yet appear to suffer little or no inconvenience from such usage (Trembley). We must, however, admit that the poor creature does not like to live inside out. It would indeed be strange if it did. The polype uses every endeavour to return to its natural state, and is generally successful. If it be wished to prevent the creature succeeding, a needle should be run through it near its mouth. Very naturally this kind of transfixing cannot be pleasant, yet it does not seriously affect its functions.

The first experiments upon polypes greatly astonished naturalists; nothing at all to be compared with them was known in the many wonders of the animal kingdom. "We can only judge of things by comparison," writes Charles Bonnet; "all our ideas of animal life have been taken from the larger animals; and a creature which we can cut and turn inside out, and then cut again, and it still seems to be none the worse, astonishes us; and who can tell how many facts are still unknown which one day will upset all our present notions? We just know enough not to be surprised at anything; and indeed a philosopher ought not to be surprised at anything; his duty is to observe, to forget his ignorance, and to attend to everything around him."

When we reflect upon the history of the polypes, it is truly confounding. We have seen they have no heart, no lungs, no liver, no intestines; and they have neither head nor brains. Six greyish and simple filaments supply the place of arms, and feet, and lips, and of all the organs of sense. When they are on the watch for their prey, they perceive its approach, they recognise it, and they devour it. They never make a mistake as to its nature and size, and they rarely fail to capture it. They fight among themselves; they thrust each other away, or they chase each other; they know how to escape, or where to find shelter when a danger threatens. They bring up their progeny after their manner, and faithfully perform all their duties in that state of life to which they have been consigned. How can they possibly accomplish such varied acts? God has endowed them with that strange sense, *instinct,* a power independent of perception, of experience, of education, which to them supplies the place of every intelligence. Instinct and intelligence are two faculties which compensate each other, the one supplies the place of the other. Instinct is the intelligence of the lower animals.

The marine polypes resemble those of the fresh water. The animals of these species are always composed of a sack-like body, which possesses an opening surrounded by many arms. The body may be long or short; sometimes it is narrow like a quill pen, sometimes round like a purse, and occasionally funnel-shaped. The opening varies in size, but always serves the double purpose of admitting the food and ejecting the excrement. A diversified construction of the sac renders the creature somewhat more or less complicated. In some of the higher forms it is often a distinct tube surrounded by vertical canals, into which open curious organs in the form of intestines. The arms are variable as to their number; sometimes twelve are found, but generally not more than eight; they resemble the cilia of the infusoria, or bear a comparison to tendrils or petals; their edges are often barbed. Taking this organisation of the green hydra as a type, and varying it in every conceivable manner, nature has peopled the ocean with those animals which are termed *imperfect.*

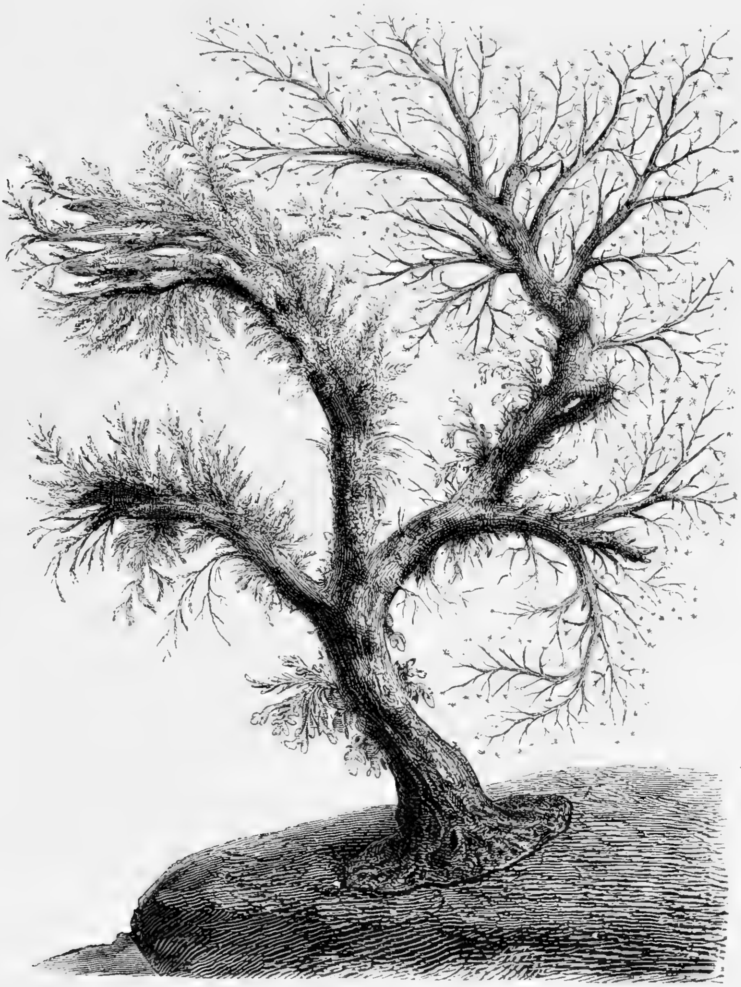
CHAPTER IX.

THE POLYPIERS.

POLYPES do not always live in an isolated state; they are frequently gregarious; the temporary genealogical tree we mentioned in the last chapter becomes permanent, and the family has received the name of *polypier.* Linnæus called the association a *compound animal (Animalia composita).* These members of the same colony live in perfect harmony; they are a nation of relatives, united together by the closest of physical bonds! They occupy the same house, each possessing in it a chamber, but as no member of the community can on any account leave his room, they never can visit or annoy one another. Attached to their little chamber, these semi-recluses watch for the food which chance—or rather we should say Providence—never fails to provide, and what is eaten by one mouth profits the whole community.

Impelled by a marvellous instinct, the polypes all labour together at the same work. Isolated they would be well nigh powerless; united they are strong. They have a life which belongs to the community as well as an individual life. They have the same wants, the same tastes, the same ideas—and truly wonderful ideas! They share their joys and their sorrows; and if it be true that troubles are lightened when they are told, and that pleasures are increased when they are enjoyed with others, then, indeed, the polypes ought to be the happiest of animalcules.

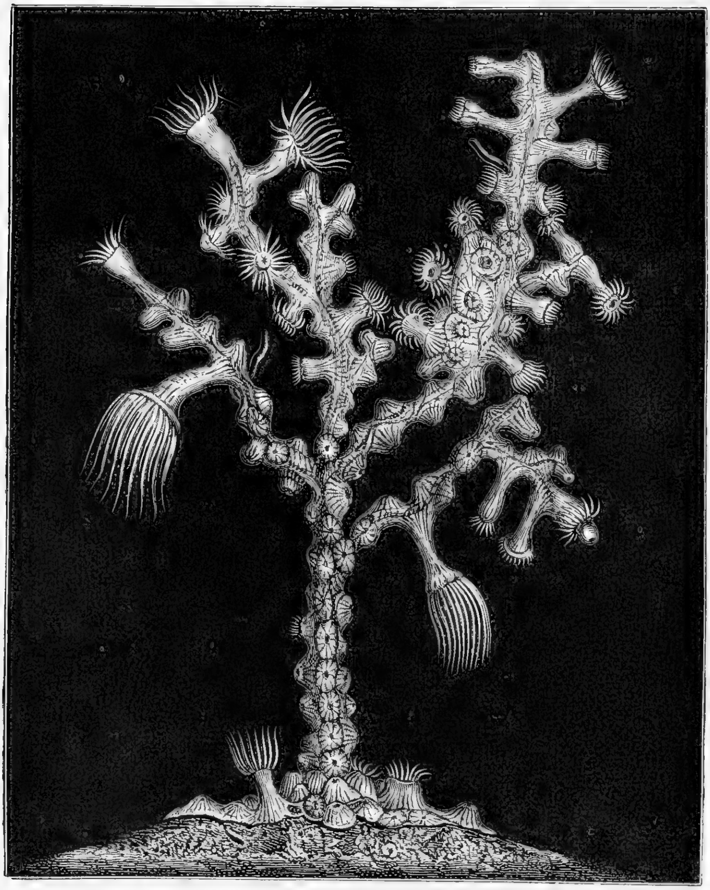
The polypiers are not thoroughly understood. It is only by the help of the microscope, and by the study of the living individuals, that we can learn their organisation, or their mode of life, or how to classify them in their species and varieties. We are beginning to understand them better, but there is yet much to discover. M. Lacaze-Duthiers, for instance, found the *Antipathes glaberrima* and the *Gorgonia tuberculata* (Lamarck), the *Leiopathes glaberrima* (Grey), and the *Leiopathes Lamarckii* (Haime), all on one and the same polypier, the *Gerardia Lamarckii.* This shows the unsettled state of affairs. Under the general term Polypier are included distinct groups of animals, some constructed upon the type of the



AN HYDRARIA.
(*Sertularia ramea.*)

Hydra, others upon that of the Actinaria; a third, like the Plumularia, follow a totally different plan of organisation. The first of these are the *Polypier hydraria*, the second the *Polypier actinaria*, and to the last belong many classes of animals.

The *Polypier hydraria* are not true polypiers. Modern researches have discovered that these tree-like structures are for the most part a degraded and transitory form of the medusa. The



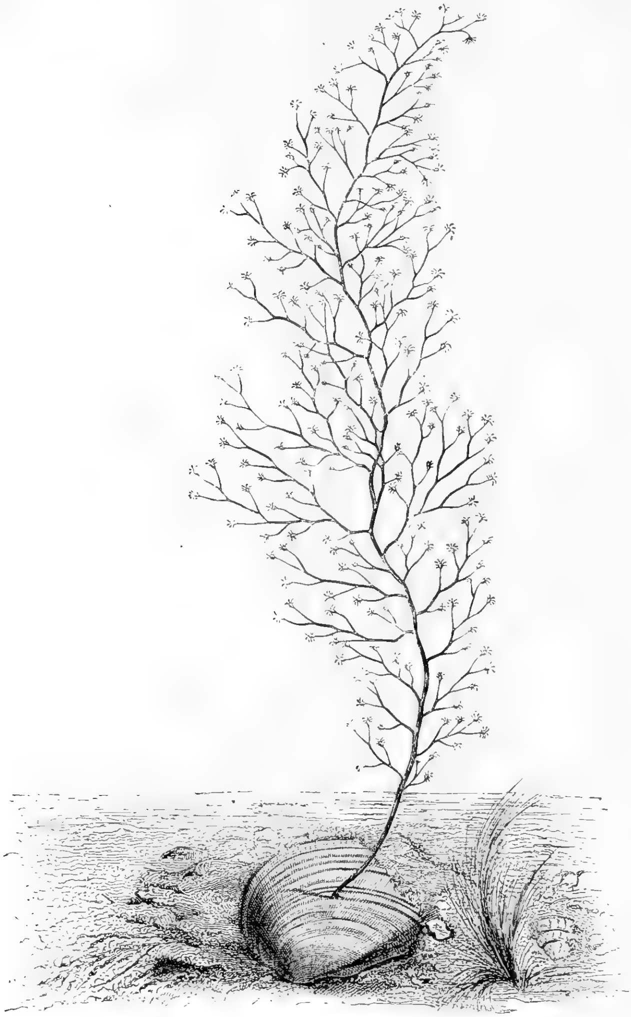
AN ACTINARIA.
(*Gerardia Lamarckii.*)

medusa gives birth to the polypier, and in time the polypier will become a medusa. They are very common on our coast, and include the *Tubularia*, the *Campanularia*, and the *Sertularia*.

The *Tubularia indivisa* is a very curious specimen of the class. Its numerous stems are horny and yellow, and marked with unequal knots, like the stem of the oat straw. Its lower extremity is tortuous, attaching itself readily to shells and stones. The upper part is straight and slightly flexible, appearing like a flowering vegetable without either leaves or branches. At the top of

THE STRAW TUBULARIA.
(*Tubularia indivisa.*)

each stem a double scarlet corolla is developed, exhibiting from five to thirty-five petals, the exterior ones spreading, the interior ones rising in a tuft. A little below appears the ovarium, drooping when ripe like a bunch of orange-coloured grapes. After a time the petals of the corolla fade, fall, and die, and a bud takes their place which produces a new polype, and so on. This succession determines the length of the stem. Each apparent flower throws out a



A CAMPANULARIA
(*Campanularia dichotoma.*)

small tube in which it terminates, and each addition adds one more joint to the axis, which it thus increases in length.

The *Tubularia ramea* is an animal production of the most singular and interesting kind. Sometimes it perfectly resembles an old ruined tree stripped of its leaves; sometimes it is like a little shrub in full bloom, rising from the summit of a brown

A SERTULARIA.
(*Sertularia* [*Plumularia*] *falcata*.)

spotted stem, with many branches and tufted shoots terminating in so many hydras of a beautiful yellow or brilliant red.

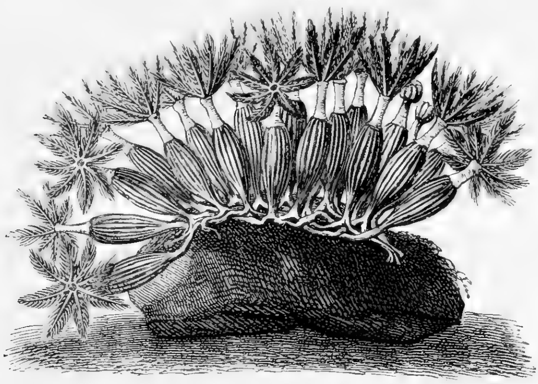
The *Campanularia* differ considerably from the above, the ends of the branches whence the polypes issue being enlarged, into a bell-like form; hence the name. The species *Campanularia dichotoma* is at once the most delicate and the most elegant of its kind. It has a brownish stem, thin as a thread of silk, and still firm and

THE SILVER SERTULARIA.
(Sertularia Argentea.)

elastic. The polypes are very numerous; upon a stem eight or nine inches high there are several hundreds.

The *Sertularia* are also hydra polypiers. These have a horny stem, sometimes simple, sometimes branching. They might readily be mistaken for small plants, their twigs being flexible, semi-transparent, and yellow. Their name is derived from the Latin *sertum*, a bouquet. Each Sertularia has seven, eight, twelve, or twenty small panicles, each containing as many as 500 animalcules, thus sometimes forming an association of 10,000 polypes. The *Sertularia falcata* reminds one, from the elegance and delicacy of its branches, of the beautiful Mimosa. This polypier is now classed with the Bryozoas.

The little cells in which the polypes lodge are not always arranged in the same manner. Sometimes they are on one side of



ZOANTHA THALASSANTHOS.

the stem only, sometimes on both; now they stand like the pipes of an organ, now they wind in spirals, or arrange themselves in rings about a common axis.

The Actiniform polypes are divided into two tribes according to the number of their tentacles. In the one the number is six, or a multiple of six; these are the *Zoantharia*. In the other, the *Alcyonidæ*, the characteristic number is eight.

The *Zoantharia* comprehend three distinct classes: the *Antipathidæ*, the *Madreporidæ*, and the *Actinidæ*, which constitute the zoanths proper. These Zoantharia are elegant zoophytes, which occupy an intermediate rank between the polypiers and the sea anemones, of which we shall speak in a future chapter. They are often joined together in considerable numbers to the same base;

this base is sometimes spread out into a large surface, and sometimes becomes like a piece of detached root.

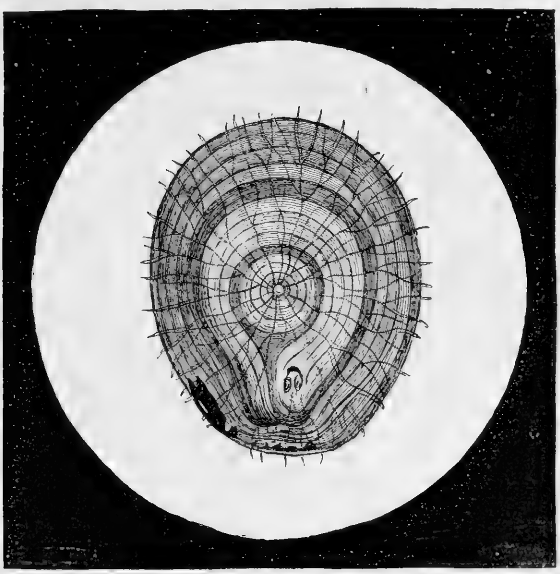
Zoantha thalassanthos consists of large turf-like tufts of coral attached to the rocks. Its animalcules are packed closely together, and their expanded heads have a curious resemblance to a bunch of

AN ANTIPATHIDA.
(*Antipathida arborea.*)

flowers in full bloom. They are borne on bending, root-like stems, of a pure white, which interlace each other. Their bodies are fusiform or spindle-shaped, pediculate and truncated at the summit, of a reddish brown colour, marked with longitudinal stripes still more coloured; the matter of which the polypier is composed is firm and parchment-like. From the body issues a tube, narrow, muscular, contractile, and red in colour, terminating at the summit in eight elongated arms or tentaculæ of a yellow colour traversed by a rib of the same shade. The sides of the arms

A POLYPE OF THE ANTIPATHES, MAGNIFIED.

are fringed with fine pinnæ, parallel to each other, of a bright maroon colour, and resembling the barbs of a feather. The arms of this zoantha are unceasingly in motion, which produces in the

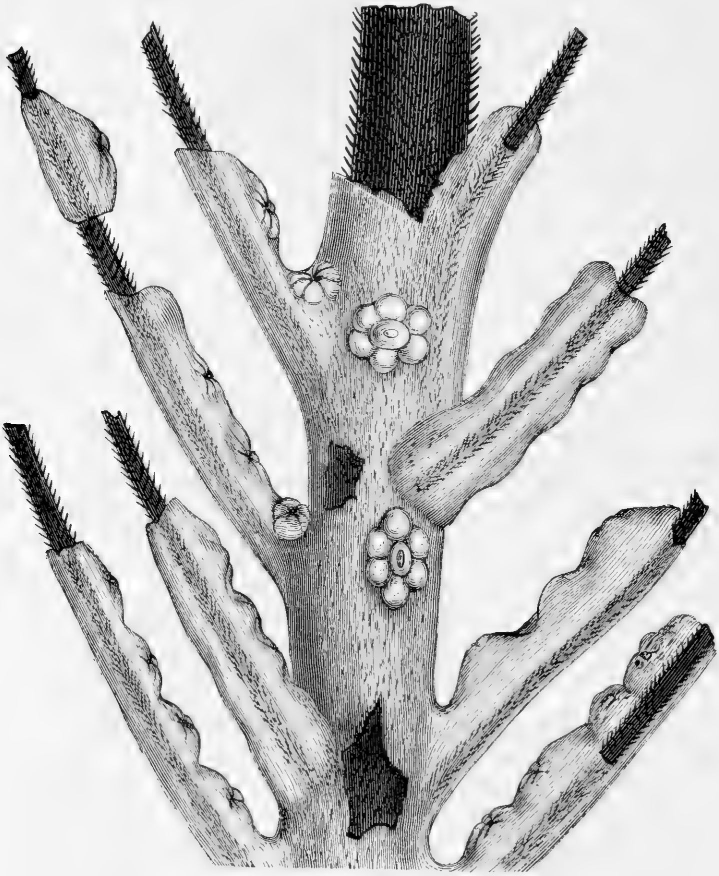


SECTION OF THE BODY OF THE POLYPE, HIGHLY MAGNIFIED.

water small oscillating currents, which sweep the animalcules, on which the polypes feed, into their mouths. The slightest motion makes the zoophyte close its arms.

The *Antipathida,* or Antipathes, is a fragile and brittle polypier.

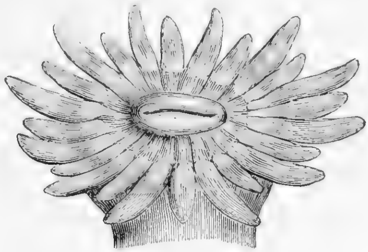
When dry, the branches, always slender and delicate, resemble the barbs of a feather. The colour is of a deep black, inclining to brown. Under the microscope, or with a powerful lens, the ends of the branches appear covered with small spines, and the



AN ANTIPATHES, MAGNIFIED TO SHOW THE SPINES.
(*Antipathes subpinnita.*)

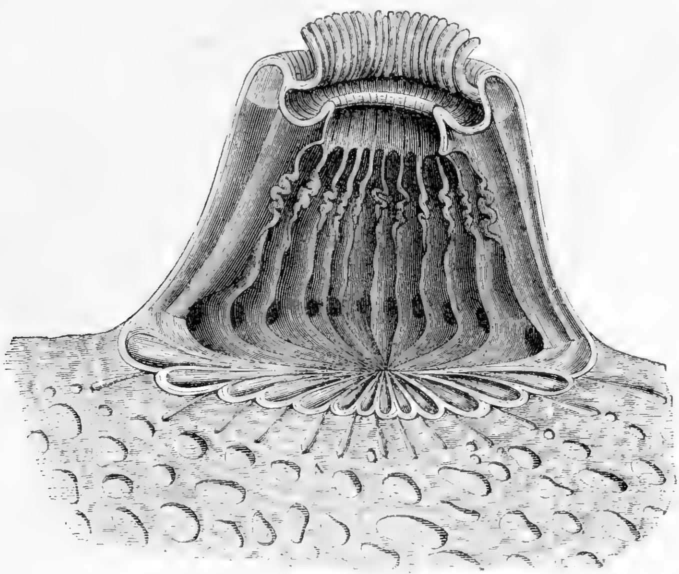
trunk is formed of oval, irregular, concentric beds, which are zones of growth. Its consistence is so firm that it can be worked up for chaplets of pearls and other bijouterie. It is known in commerce as *Black coral.* The bark is soft, not possessing calcareous or siliceous matter, and decays when the coral is dead. Its polypes are long, and generally yellow.

The *Gerardia* dredged up by M. Lacaze-Duthiers from the Algerine coast, is a kindred and very peculiar species, upon which he has written a fine memoir, and has kindly supplied us with the



A POLYPE OF THE GERARDIA.

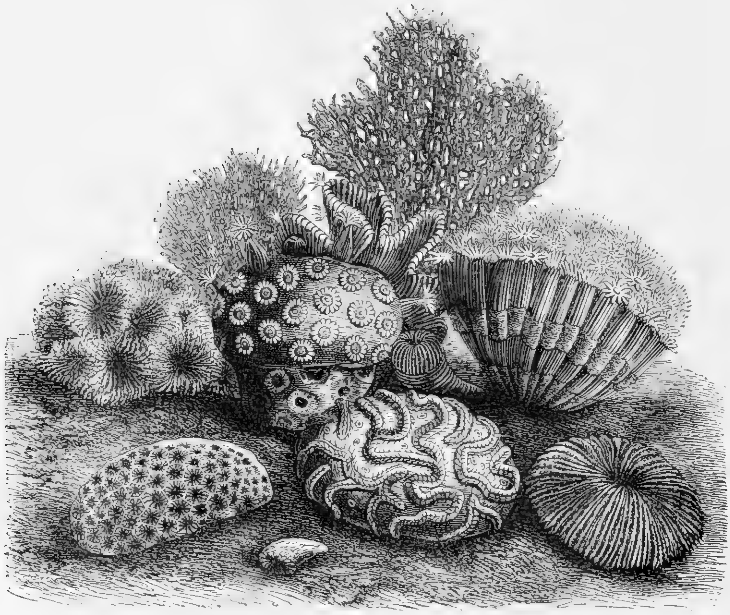
original designs. The living Gerardia is covered with yellow or orange-coloured flowers having twenty-four petals, frequently long and pendant.



SECTION OF A POLYPE OF THE GERARDIA.

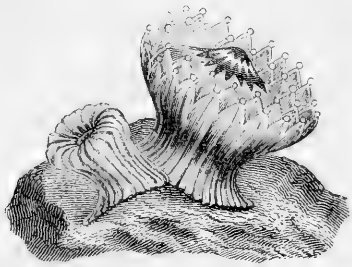
The interior of the polype presents just as many divisions as it has tentacles. When old, the polypier is very arborescent and thin. In the early days of its existence the cortex or bark was developed more rapidly than the substance of the stem. The Gerardia grafts itself on all bodies within its reach; it is very frequently found upon the Gorgonia, which is sometimes strangled by the exuberant growth of its parasite. From this often arises the gorgonian appearance which the young polypiers present. M. Lacaze-Duthiers found one of these colonies which had grown on the egg of a dog-fish.

The *Madreporæa* are very numerous. They form the most



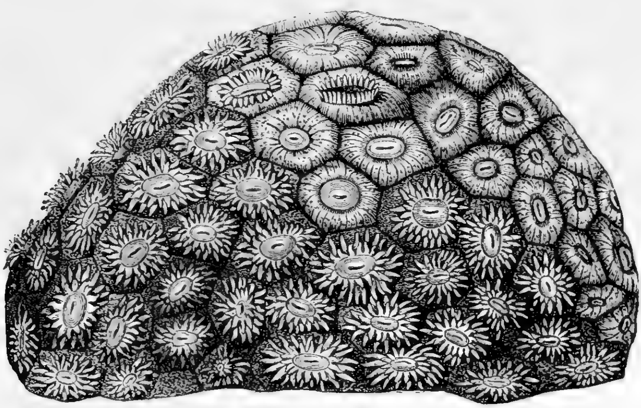
MADREPORES.

important group of the Actinaria polypiers. They are all stony. Of these the coral reefs and islands are generally composed. Little is known of polypes which inhabit these vast cities. Amongst the most curious we may mention the *Caryophylliæ*—the madrepores proper—the *Astræa*, the *Meandrinæ*, and the *Poritidæ*. The Caryophylliæ possess tubular cells, partly isolated from each other like branches, each of these tubes being the home of a polype. The most beautiful of these is the *Caryophyllia Smithii.* It is covered with a yellow robe, chequered with white, which grows paler towards the base and summit. Its disc, at first brown, becomes white, and then green. The tentaculæ, which are somewhat triangular, are nearly transparent, and resemble festoons of fine lace, fringed with a light border, and each terminated by a white pea.



CARYOPHYLLIA SMITHII.

The Madrepores proper are a most wonderful association of polypes, most varied and most interesting. If we conceive a honeycomb turned into stone, and a polype in each cell, we shall have a fair idea of the most common of the madrepores—the Astrea. The

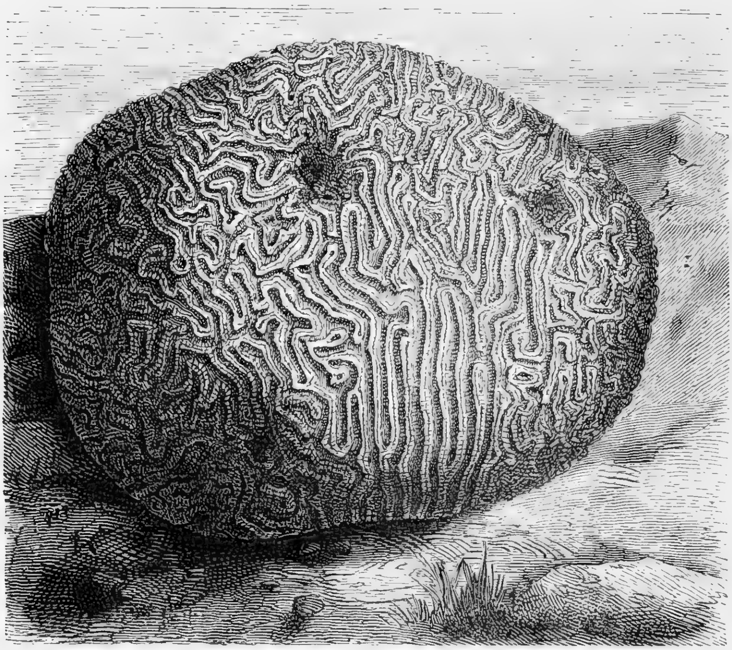


THE ASTRÆA.
(*Astræa pallida.*)

Meandrinæ differ from the Astræa in having the surface hollowed out into shallow, sinuous, elongated channels. The cells are arranged regularly in these valley-channels.

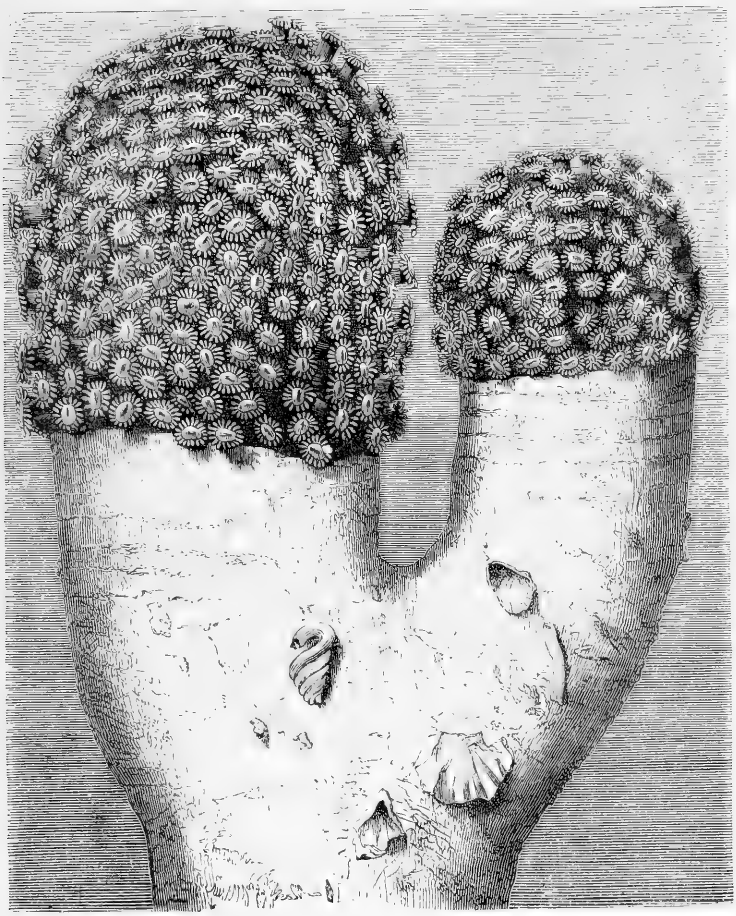
The Porites have their stems a little raised; they are generally dichotomous with obtuse lobes. The polypes are miniature anemones, having round their mouth twelve radiate tentacles.

The polypidom, the structure raised by the polype, is stony, fixed, branched, or lobed, having a free surface covered with a great number of regular stars which are either above or below the general surface. These stars are very characteristic and cannot be confounded with those of an astrea or a madrepore. The *Alcyonaria polypiers* combine the *Alcyonidæ*, the *Tubiporidæ*, the *Gorgoniæ*, and the *Pennatulæ*, to which we shall devote a chapter. The Alcyonidæ



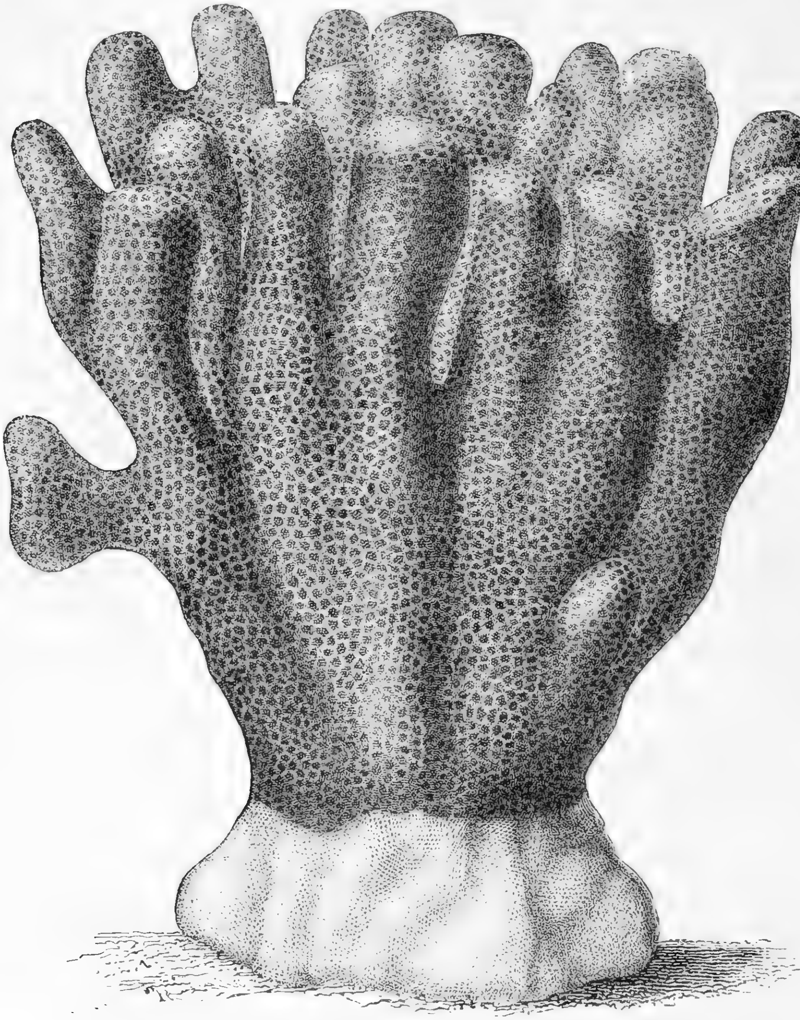
A MEANDRINA.
(*Meandrina cerebriformis.*)

are very common. They are often found on shells like pieces of flesh, irregular in shape, and of a red colour. This mass is a colony. When placed in pure and fresh sea water, very soon opal or yellow points begin to appear, which gradually swell out little by little, until they spread into a transparent and animated coral. Each polype has eight petals, jagged at the edge, which radiate themselves about the mouth. The body of the polype is tubular; the exterior part varies in length; the interior is crossed by red spiculæ, and furrowed with vessels. Down to the very base, the whole mass, which is not usually the case, is an amalgamation of all the individuals of the association joined by a common tissue. The *Bebryce mollis* is an alcyonium. It is incomplete as all the alcyons are, for it does not possess a bark or cortex which holds together



A PORITIDÆ, WITH ITS POLYPES SPREAD.
(*Goniopora columna.*)

the polypes; and the axis which gives it stability is a borrowed support. Among the *Tubiporinæ* is found the "Musical coral" or "sea organ." It is composed of a great number of stony tubes, most usually straight and slightly radiating. Its colour is a purple red; at certain distances the mass is crossed by layers, which are lamellar expansions of the same material. It owes its popular name to a fancied resemblance to organ pipes. (See engraving, page 100.)



A PORITIDÆ.
(*Porites mordax.*)

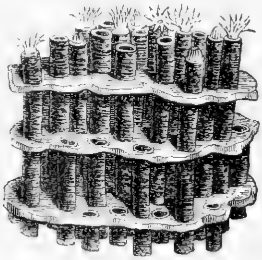
The polypes themselves are a grass green. Their tentacles are furnished on each edge with sixty or eighty pulpy, tongue-like papillæ.

The *Gorgonidæ* have their cortex so filled with calcareous and siliceous grains (spiculæ) that it remains in the form of a crust when they are dried. This crust is crumbly, and often preserves the brilliant colours which characterise this polypier. Their cells are hollow, sometimes indented in an even surface, sometimes they produce mamillary risings. They are generally smooth, though they are found sometimes rough and shelly, and drooping one over the

AN ALCYONIDÆ.
(*Xenia elongata.*)

other. The *Isis* and the *Coral* belong to this group, and all those black, smooth, and flexible tree-like growths which we find on our coasts, to whose consideration we shall devote the following chapter. Side by side with the Gorgons, M. Deshayes has placed the beautiful parasite polypier found at Calle—the *Anthozoanthus*—a magnificent upright shrub, with an axis of a dark brown, the cortex of a bright, delicate rose colour, and polypes of a golden yellow.

The polypiers are fixed to solid bodies; sometimes they attach themselves one to another, hooked on and interlaced in every direction. Some of them are whitish, others quite white, some yellow, and some apple green ; in some the tints pass from olive-brown to dark blue, from vermillion to violet, and from pale yellow to pearly grey. Each tube or cell contains a polype, its depth varying in the several species. The animals are composed of two parts, one which remains in the cell, and the other is the starry termination which is visible; from the latter radiate eight or twelve projecting arms, sometimes quite soft and pliable, at other times granular. They can expand themselves like the petals of a blossoming flower, and when outspread, their length is often greater than that of the whole body of the polype; they are transparent, save just at the tips. The polypes extend or contract their feelers,



TUBIPORINE, OR MUSICAL CORAL.
(*Tubipora musica.*)

and open and shut their mouths at will, but their digestive tube is fastened to the walls of the cell, and the stem, upon which the cells are built, is condemned to immovability. Thus, although they can put their heads out of the door of their houses, yet they can never leave home. Their life is spent in moving about their arms to produce currents in the water, which bear to them the food they need; while their digestive apparatus separates from the water, as it passes through the stomach, the lime it contains, of which they construct their tube. The coral polypes thus present a singular combination—hard, insensible, stony matter, built up by and indissolubly joined to a living creature.

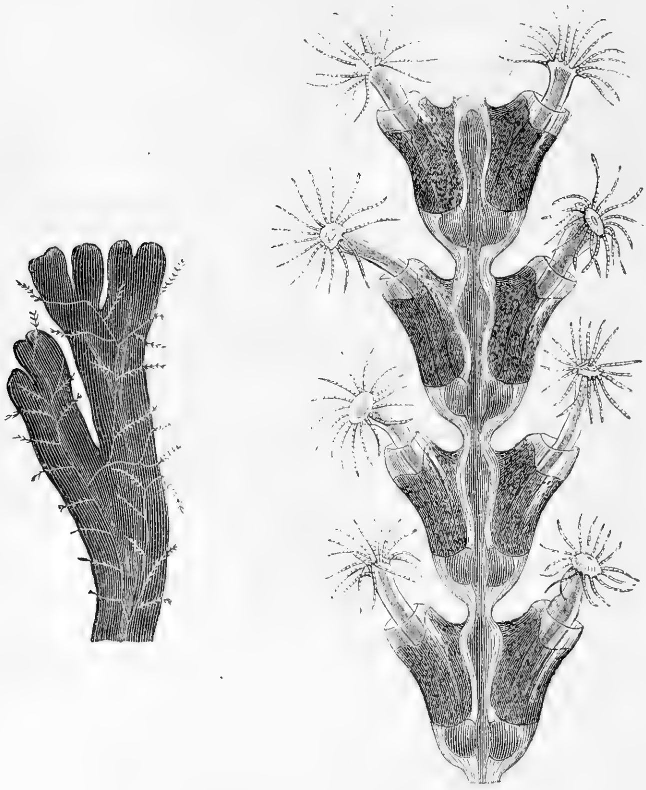
The animalcules of the polypiers are propagated by larvæ or by buds developed from the cortex of the parent. In the hydra polypes the eggs are contained in special horny capsules, which break as soon as the germs reach their maturity.

Their forms are as varying as their species. Conceive an ellipsoidal body, transparent as a crystal, whose walls are adorned with a spiral staircase, interrupted at each turn, and showing within its transparent substance five or six round eggs of a saffron yellow. Such is the ovary capsule of a *Polypier bryozoa*, or of a *Plumularia pluma*.

The *Campanulariidæ* possess male and female branches, the one

ORGONIA.
(Dredged up from 40 fathoms depth, off Cape Finisterre.)

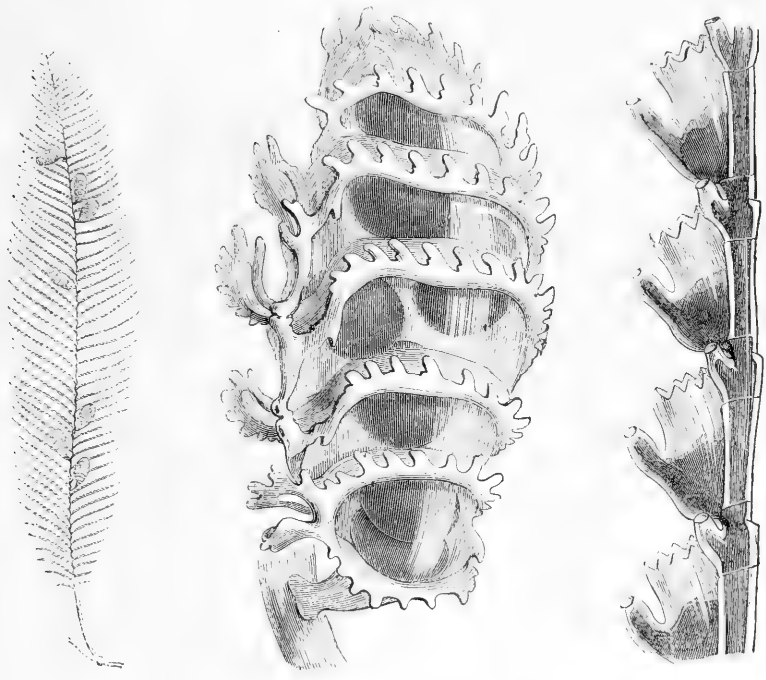
bearing cells in which are developed eggs, the other exhibiting male capsules ornamented with elegant tentaculæ. But by far the most curious phenomenon of generation is exhibited by the polypier hydra, a process which naturalists call the *generation of Medusæ* (see engraving, page 104). It appears that at a certain time of the year, some of the *Campanulariidæ*, the *Syncorinæ*, &c., have a rupture out of which issues a black liquid. This is a bud which in time becomes covered with a transparent cushion, which increases rapidly and begins to exhibit traces of an internal organisation. We can perceive the black liquid circulating through four channels; four black points begin to show themselves at the end of each canal; these are the embryos of the eyes. Gradually the bud assumes a bell-like form. Its mouth dilates, the four eyes separate, and from their vicinity four tentacles issue. The central reservoir increases, but it is limited and enclosed by a membrane, thus forming the stomach; now the animal is perfect; it is a true medusa. In a little time it will break its pedicle



EXPANDED POLYPES.
(*Sertularia pumila.*)

by violent contractions and will swim out to the open sea. The young medusa, thus liberated, in a few days becomes double its size, and at the point where its pedicle separated from the parent stem, the tentacles elongate, and there a mouth appears. In a few weeks the intestines of the young medusa increase in size. This is because eggs are being produced which gradually enlarge and at length separate themselves by a process similar to the one described.

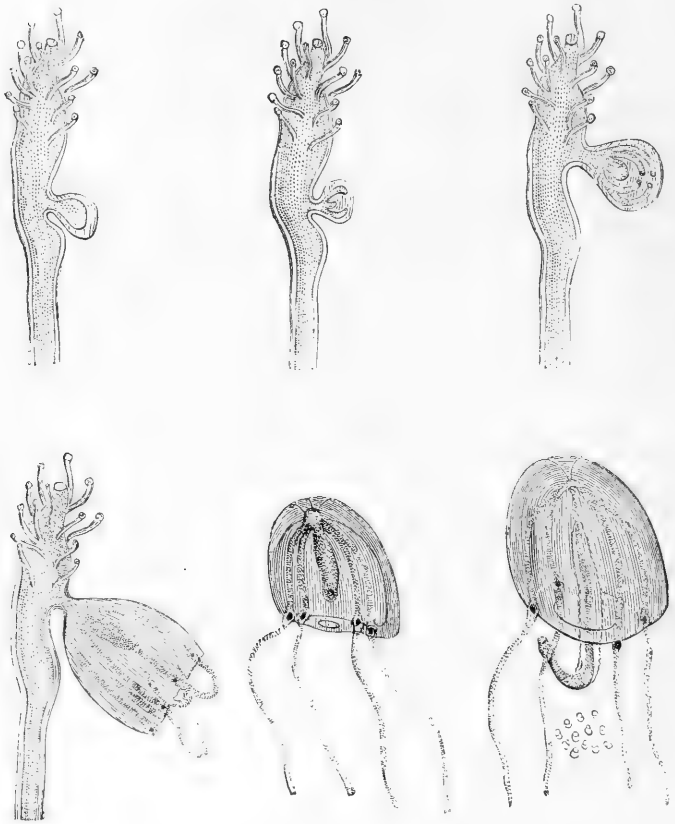
The polypes are minute silent workers, active and indefatigable. Their task is to separate chemical ingredients from the waters of the ocean, and secrete and organise the solid structure which bears their cells. Their marvellous industry well may be a ceaseless object of admiration! They are an unassuming people, worthy of the highest eulogiums, moderate in that which they consume,



A POLYPIER BRYOZOA: ITS EGG-SAC AND POLYPE-CELLS, MAGNIFIED. (*Plumularia pluma.*)

magnificent in that which they produce! They thrive best in the warmer regions of the ocean; in colder climes their fabrics are small. In temperate latitudes, they are found forming a sward of submarine life which carpets the rocks; producing animated stalactites, great shrubs, or whole forests of small trees. Portions of the submarine cable which unites Sardinia to Genoa, taken up for repairs, was so encrusted with them, that in some places it was the thickness of a small barrel.

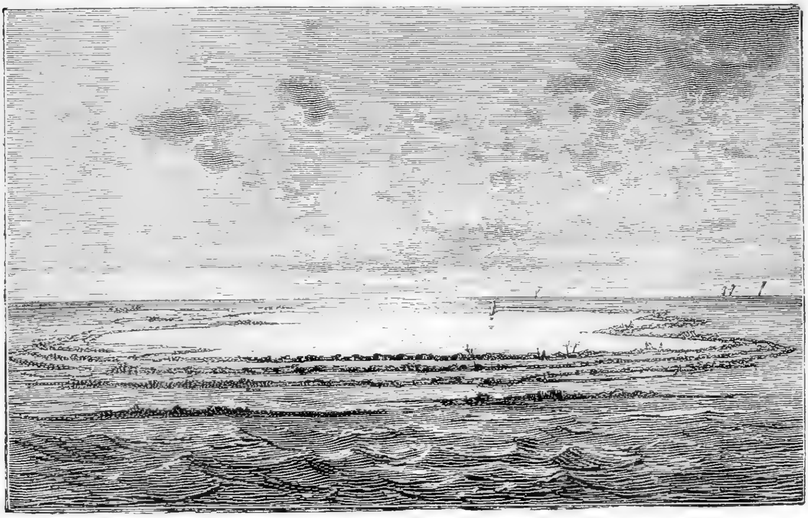
The polypiers sometimes occupy immense areas. They rise above the surface of the waves, forming reefs which surround islands, join them to each other and to their neighbouring continents, thus filling up the depths of the ocean. As long ago as 1702



A POLYPIER HYDRARIA PRODUCING A MEDUSA.

Strachan observed that the coral reefs were formed in this manner. His account was received with credulity, and it was not until 1780 that Forster, the learned companion of Captain Cook, established beyond dispute that most of the islands of the South Sea owed their existence to the excessive multiplication and compact agglomeration of the polypiers. Since that day, this has been confirmed by a great number of sailors, zoologists, and geologists.

Inhabiting the watery world in vast colonies, they absorb the limy salts of the ocean, of which they build their cells, producing frequently colossal structures. Their germs fall around them and give birth to myriads of new workers, who over-build their parents, and thus entomb their ancestry, piling up cells above cells in one vast calcareous structure of rocks which attain gigantic sizes; some of the reefs which fringe the Australian coast being nearly 1,000 miles long! It is true vast ages are required to complete this work, but Nature is never at a loss for time to complete her works.



A CORAL ISLAND.

The South Sea Archipelago almost owes its existence to the never-ceasing exertions of these minute polypes. For untold ages they have worked incessantly, and have raised great and lasting monuments to assert the power of combination.

The builders of these immense structures are animalcules which are gelatinous, fragile, small—nay, microscopical, but their number is illimitable; they live in myriads, and by the accumulation of their skeletons can produce a mass of masonry, of which the whole human family, working for 100,000 years, would only construct a very small part. When once the builders reach the surface of the water they cease to increase, for they are children of the sea. They owe their existence to the water, and they perish in the air and sun. Hence the reason that coral found above the surface is always dead. The waves as they dash against these rocky islands detach pieces of the coral, and reduce the fragments by their wearing action to dust. Thus a beach is formed, covered with rounded blocks and strewed with sand. Upon this shingle the sea casts the remains of fish, mollusks, and marine vegetables, where they decompose, mingling with the madrepore *débris*, and soon there springs up a terrestrial vegetation. Thus is it that the Creator ordains that islands should be born in the ocean's bosom, and lands rise up out of the waste of waters.

The structure, when at the level of the sea, is soon tenanted by animal and vegetable life. The waters leave seeds carried from other lands, which soon spring up, and the island is clothed with verdure. The trunks of trees borne by the currents from neighbouring islands are cast upon the beach. Worms, insects, and shells, which are in these trunks, are thus transported to the new-born island, and constitute its earliest population. Turtles swim to it; birds, attracted by the vegetation, fly hither and build their nests in safety; people from the surrounding islands, driven by stress of weather or allured by the beauty of the situation or by the abundance of its fruits, raise here their huts and establish their tribes. Thus the industry of man completes what the industry of the polypes began.

These smallest and feeblest animalcules possess in their natural state a charm and beauty of which their empty polypidoms cannot afford even a remote idea, however elegant they may be and however carefully preserved or scientifically classed.

CHAPTER X.

CORAL.

In certain regions there are growing over the rocks at the bottom of the sea little forests of purple trees. These submarine plantations are composed of *red coral*, the brightest and the most celebrated of the Polypidoms—"*the Daughter of the Sea.*" * For

RED CORAL.

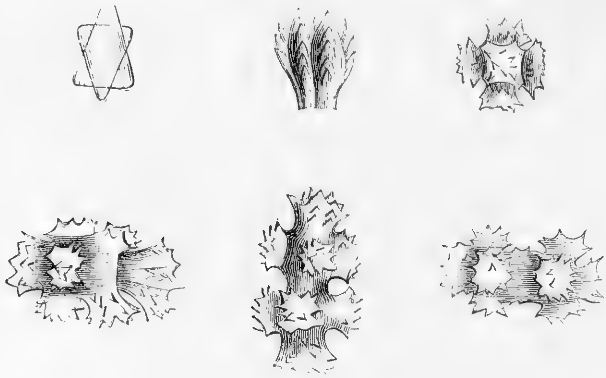
a long time coral was classed as a marine plant; until Count Marsigli placed this curious growth in the animal kingdom.

Peyssonnel, a naval surgeon, first recognised the true nature of the arborescent coral. He made known his discovery to the celebrated Réaumur, who hesitated some time before he transmitted it to the Royal Academy of Sciences, and it was not until 1727 that

* Κοράλλιον, from κόρη, a daughter, and ἁλὸς, the sea. Latinised, the word became *curalium*, and hence our word coral.

he decided to communicate the opinions of Peyssonnel; but he himself did not adopt them. The subject was in dispute up to the very time when Trembley, of Geneva, published his admirable observations upon the fresh-water polype, and then naturalists recognised the very great resemblance which existed between this curious invertebrate and the coral animalcule. Guettard, of Etampes, and Bernard, of Jussieu, undertook a voyage expressly to investigate the subject, and to verify the assertions of Peyssonnel.

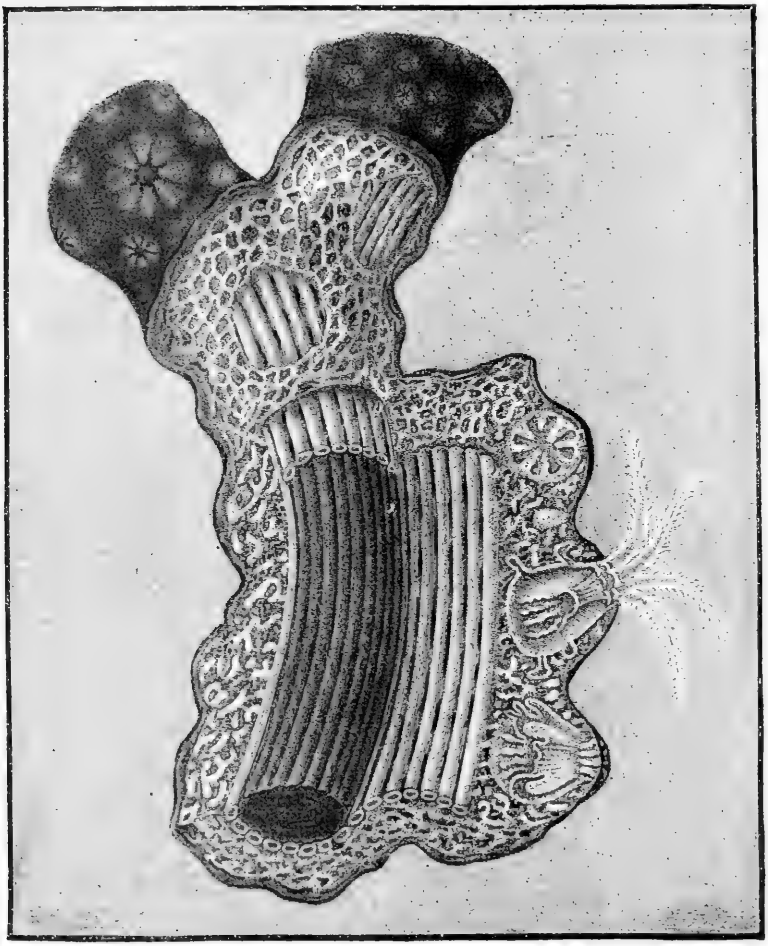
All naturalists now agree that the coral is a family of polypes, living in community, and forming by their united exertions a



SPICULÆ OF CORAL.

polypier. Coral is found in the Mediterranean and in the Red Sea at different depths, sometimes in water only ten feet deep, but never below 150 fathoms.

We may observe in passing that the coral is usually mixed with other polypiers and marine structures, so that a mass is produced, sometimes very compact and inextricable, to which the term *macciotta* has been given. Each stalk of coral resembles a pretty, red, leafless shrub, bearing little delicate star-like flowers. The stalks of this little tree are common to the association, and the flowers are the polypes. These arborescent formations generally hang from some shelf, and so grow downwards, and not like ordinary vegetation. They are found growing together in bushes or copses, or spreading out, as we have said, into veritable forests. The stems have a soft, reticulated cortex or bark, which is full of little cavities, permeated by a milky fluid; these are the chambers of the members of the association. This cortex is full of little hard bodies, called *spiculæ*, of which we have sketched



AN ENLARGED SECTION OF A STEM OF CORAL.

some specimens. Beneath the crust is the coral, properly so called: it is as hard as marble; its surface is remarkable for its stripes; its colour is a beautiful red; and it is so hard that it is capable of receiving a very fine polish. The ancients believed that coral was soft in the water, and that it became hard on exposure to the air—

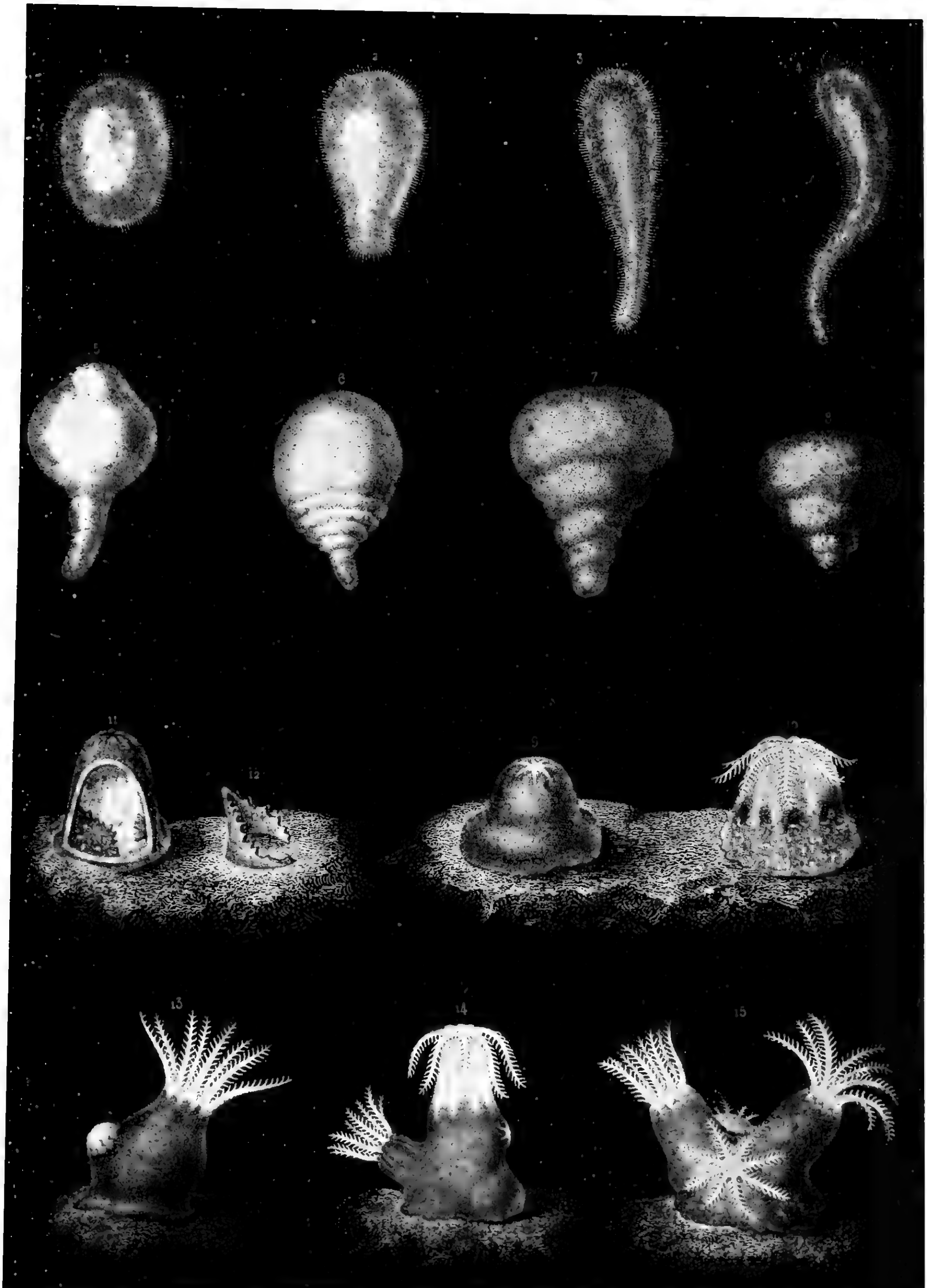
> "Sic et coralium, quo primum contigit auras
> Tempore, durescit."—OVID.

The polypes, at least those which build the most common of the polypiers, are composed of a tubular body, enclosed in a cortical cell. That part which appears beyond the walls of this cell is cylindrical, and is crowned by eight little arms, which spread themselves out like the petals of a flower. These arms are flat, and wide at the base, but gradually tapering to a point. The edges are furnished with short, hollow barbs. When expanded, they are exactly like a beautiful white and semi-transparent flower,

A RED CORAL POLYPE.

having eight petals fixed upon a mammal bud; when closed, they have the appearance of an urn. Count Marsigli, who has frequently seen these creatures, says:—"These flowers fold themselves into their cells when they are taken from the water, and become yellow as they decompose." Thus the coral is, as we have said, externally an animal, internally a rock.

M. Lacaze-Duthiers has recently studied the reproduction of the coral polype, and he has brought to light most interesting facts. From this clever naturalist we learn that the members of a coral association are either males, females, or hermaphrodites. Ordinarily the greater number of polypes on one branch are of the same sex; one branch containing almost exclusively males, another females; the hermaphrodites are the least numerous. We find in the vegetable kingdom plants which afford a similar

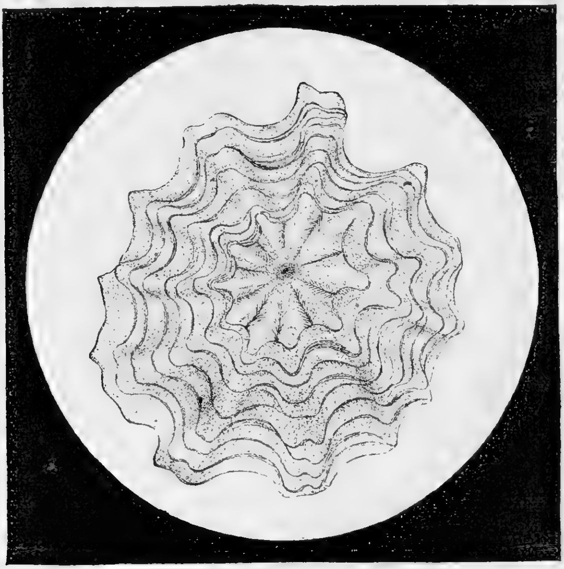


construction. The *polygams* have their flowers of a masculine, feminine, and neuter gender.

The coral polype is viviparous—that is, the eggs become embryos before they leave the parent. The eggs have long slender pedicles; they come out of the thin layers which line the digestive bag; they are spherical, opaque, and of a milk-white colour. They detach themselves by breaking their pedicles, and thus fall into the central cavity of the polype, a cavity which serves at once as a stomach and an incubating pouch. Here two very different processes are in action—the one dissolving the food and nourishing the animal, the other developing and producing a new creature. In due time, the eggs lengthen and vibratile cils appear. As soon as they are born—that is, vomited—a pore opens at one of the extremities, which is destined to become the mouth. Then they assume the form of a whitish, semi-transparent worm. These larvæ swim in all directions with the greatest agility; they rise and sink in the vases which contain them, always swimming with their thicker extremity in advance, carrying their mouths in the rear, so that they butt against anything which happens to be in their way. They have a tendency to become fixed, like their parents, and the mode of their progression greatly favours this result; thus the peculiarity of their motion is liable to shorten the period of their liberty in facilitating their adherence to any object with which they come into contact, by that part of their body which afterwards becomes the base of the polype.

When it adheres, the polype has reached another phase of its existence. As soon as it becomes fixed it changes its worm-like appearance, and thickens, gaining in breadth what it loses in length, thus shortening and becoming discoid. The thin extremity which carries the mouth gradually folds itself back by the successive stages represented in figs. 5, 6, 7, 8 (Plate VI.), until the larva assumes the shape of a pin-cushion (fig. 9), at the summit of which is the mouth. Around this orifice the rudiments of the eight tentaculæ begin to appear, which soon cover it with a pendant festoon (fig. 10). The fixed larva thus becomes the founder of a large colony. Buds form on the axis, and develop themselves into a whole nation of corals.

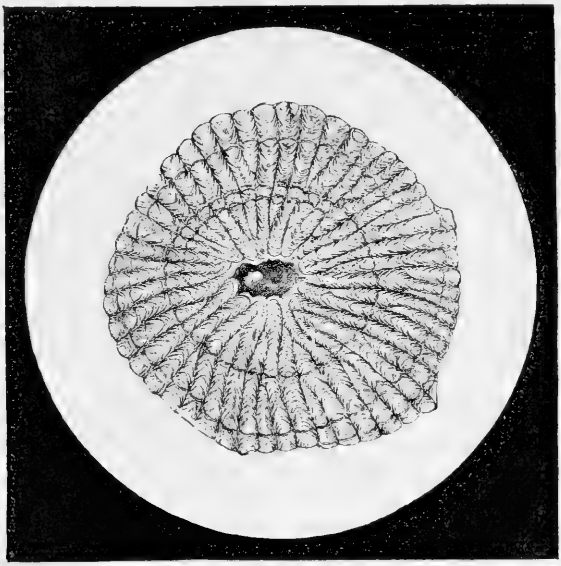
The young polypes just hatched from the egg are, as we have seen, utterly different from their parents. They must undergo many metamorphoses before they reach their perfect state. These metamorphoses are just the reverse of those through which insects pass. The chrysalis lies immovable; but finally becomes a butterfly. With the coral, the larva has the power of locomotion, whereas the full-developed polype is fixed. There is not perhaps in nature a single law whose reverse is not also found in operation.



A MAGNIFIED SECTION OF THE STEM OF THE ISIS.

The true corals are divided into the *Melitæa* and the *Isidæ*. These latter have their branches articulated, and their polypes possess six tentaculæ instead of eight; these tentaculæ being entire and not separated. In the former, the stems are gnarled here and there at intervals, and are covered with a firm and resisting cortex. In the latter, they are articulated, and the crust is horny and chippy. The material of the Melitæa is stony and homogeneous; while that of the Isidæ is composed of two substances, the compressed parts are horny and black, the articulations being calcareous and striated. The stem of the Isidæ is often sold for white coral. The structure of the two stems, however, is very different; but this is only revealed by a lens. The two drawings given here sufficiently show their apparent difference.

Every coral, whether true or false, is the manufacture of innumerable little workers, who are both clever and active, and is the result of a most wonderful combination of power and skill. Horn and marble are indispensable to the completion of their fabric;



MAGNIFIED SECTION OF THE STEM OF THE RED CORAL.

these they use in common with other animal fabricators; but they alone make of them branches and stems.

After what has been said of the corals, we may conclude that the polypiers resemble plants more than they do animals. For this reason is it that they are called *zoophytes*, that is, *animal-plants*, a term which has of late been applied to a great number of marine invertebrata. This remarkable structure forms a curious connecting link between the two great kingdoms of nature.

We find in these animals, just as we do in vegetables, stalks and branches covered with real bark; but the stems or axes of the zoophytes are horny or calcareous, while those of the vegetables are herbaceous and woody. In each case the tissue is more or less solid, striated, or fluted, and formed of concentric layers; and, moreover, the cortex of the coral is spongy and somewhat soft, like the bark of a vegetable production. The knobs represent the buds, the polypes the flowers; the feelers open themselves out in rosettes as petals, forming an animated corolla, which opens and shuts alternately. In the polypier, the individuals which contribute to the growth of the whole are situated at the extremities of the axis, or upon its sides, a position similar to that of the leaves and flowers in a plant.

And the final resemblance is found in their modes of reproducing their species. The corals and the vegetables are each produced by isolated and individual grains, eggs, and seeds, which separate themselves from a bunch and proceed to develop themselves, producing a colony of which the members remain grouped.

The principal seat of the coral fishery is at the entrance of the Adriatic Gulf, in the neighbourhoods of Bona and Calle, and also in the Straits of Bonifacio. In this occupation many people are engaged. Upon the Sicilian coast the process is very simple: three or four fishers from a boat, cast into the sea a drag made of two pieces of wood lashed tightly together in the form of a cross; at each of the four extremities is attached a strong net, which is looped up to the centre of the cross, where there is a heavy stone by which the drag is sunk and kept down on the surface of the rocks, along which it is slowly swept by a rope from the boat, which is gently rowed by the fishers over the places where the coral grows. The polypiers get entangled in the meshes of the net, break, and so are brought to the surface. Sometimes another species of drag is employed: an iron hoop which forms the mouth of a small sack, destined to receive the broken branches of coral, is fastened to the end of a long pole, and by this means crevices in the rock are fished into, which the cross-bar drag is unable to penetrate. In other places they use poles, at the extremities of which bundles of tow are fastened; these are sunk by a cannon ball and dragged along the bottom; in the rear is a net with large meshes, into which the coral branches fall as they are detached.

The corals thus fished up are always mixed with the polypidoms of other animals, and also with marine plants. In times long past coral was fished for by means of a diving-bell, in which a man was let down to the bottom of the sea; in this way it was gathered pure and unbroken.

In 1857, M. Focillon showed the possibility of using the diving-boat of Lamiral and Payerne for gathering in the coral harvest. In some places the fishers dive into great depths and gather the coral by hand.

In spite of the advantages offered by the French government, and the value of the coral, the fisheries in the Straits of Bonifacio and on the African coast are chiefly carried on by foreign sailors. In 1852, the coral gatherers in the Straits of Bonifacio were all Italians; and the proceeds of the fishery only produced £1,600. In 1853, upon the 211 boats which were engaged upon the African coast, there were only nineteen Frenchmen, the greater part being Neapolitans. According to the returns, the coasts of Bona and Calle furnished, in 1853, about 80,000 pounds weight of coral, which was chiefly bought by the merchants of Naples, at about twenty-five shillings a pound. Many of the boats, whose total expenses would not reach £320, gathered 800 to 1,000 pounds of coral, and therefore realised a profit of £800. In the same year the fishing on the west coast was taken by a Spanish company, who secured in every expedition 700 or 800 pounds of coral.

The ancients prized coral greatly, and attributed to it marvellous powers. The Gauls adorned with it their helmets, their shields, and other weapons of war. The Romans wore pieces of coral as amulets, and as ornaments pleasing to their gods. They made necklaces of it which were supposed to preserve their new-born infants from contagious diseases; and under many circumstances they believed that preparations of coral were excellent remedies for the sick. It is no great time since, even in France, this notion was held. Lémery believed that it raised the spirits. It certainly possesses one quality—it can clean the teeth; but then this is due to its physical nature. Now coral is used rather as an ornament than a remedy, being employed in jewellery, not only in Europe, but also in every part of the globe.

The coral which is found on the French coast is perhaps more choice than that of any other country, its colour is more bright and clear; though the Italian coral is scarcely inferior. That from the shores of Barbary is not so fine, and much less brilliant.

In the commercial world five varieties of coral are recognised. Rose-coloured coral is very rare, and therefore very valuable.

The coral ornaments made by the Neapolitan artists are not as light and artistic as the work of the Marseilles jewellers. In the late exhibitions the work and the elegance of the coral ornaments were beyond all criticism. In the French Exhibition there was a set of coral chessmen representing armies of Saracens and the Crusaders, the value of which was £400.

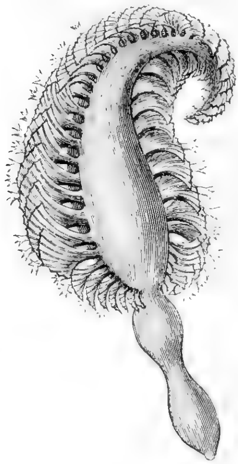
CHAPTER XI.

SEA-PENS.

WE well may be interested as we survey the occupants of another element, a world of life so different from our own, and yet the inhabitants of that world are seen to pass through all the phases of life, exhibiting peculiar habits, and showing signs of joy and sorrow. All the marine zoophytes, without exception, ought to be the object of our study and of our admiration; but amongst them all certainly the most wonderful is the *Sea-Pen*, or *Pennatula*. This polypier loves the open sea, and seldom approaches the shore; thus it is free, and not fixed, like the corals. Its organisation is complex, but in shape something like a pen. This animal association has an axis, or part common to all, and a species of barbs which grow out of it, which are inhabited by individual polypes. The axis is composed of two parts; the anterior part, to which are attached the barbs, and the posterior, which is naked. The first part is generally straight and somewhat flattened, the second has some resemblance to an elongated heart; at its obtuse end there is a cavity, which some naturalists have mistaken for the mouth. In the very centre of the polypier is a hard, flat, greyish stem, of a limy nature, which is covered by a fleshy and contractile tissue. This stem is common to the whole colony.

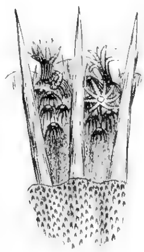
The polypes, in the genus Pennatula, are arranged in transverse rows upon the outer and inner edge; they are fleshy and white, and are provided with eight tentaculæ, which are ciliated on one edge; the mouth is angular, and surrounded by the tentaculæ. At certain times this aggregation of life inflates itself by drinking in water; and when it throws out the liquid its form collapses.

The barbs of this animated feather are larger in the middle than at the extremities. They look like wings on each side of the axis. Their under edge is divided into layers, which are covered with little, hard, white needles, of a limy substance, which easily break. These layers contain the polypes. They are near



THE THORNY SEA-PEN.

to each other, placed obliquely, and their surfaces are traced with lines. They have the form of a purse divided into two portions, in one of which is the mouth, bordered by its tentacles, and the

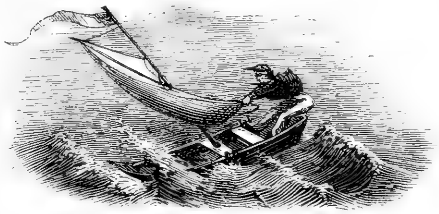


POLYPES OF THE THORNY SEA-PEN.

other contains the organs of digestion and the ovary sac. In fact these polypes resemble flowers, but flowers which quiver with sensibility, and are yet incomplete, which possess a will, and yet it is limited.

The sea-pens are prickly. One species is striped with red, another is a dark grey; in the evening they become phosphorescent. Linnæus tells us that the phosphorescent sea-pens which cover the ocean bottom cast so strong a light that it is easy to count the fishes and worms which sport around them. These polypiers often contract the lower part of their axis, and again distend it;

they have also the same power in their wings. The latter appendages appear to act also as sails and oars; but the united effort of the polypes only produces a very imperfect movement. The waters carry them hither and thither, and the currents bear them on their course. Floating involuntarily, at the sport of the winds and waves, they are driven everywhere, and wherever they



are, there they find that nourishment which is necessary for their sustenance and the reproduction of their species.

According to the recent researches of M. Lacaze-Duthiers these polypes of the pennatula are either all male or all female; so that all the members of each community are of one sex. There are vegetables organised on the same plan, that is to say, which have their male and female flowers on different stems—the Dates, for instance.

The *Umbellularia*, which are only found upon the shores of Greenland, and the *Virgularia*, of Lamarck, are Pennatulidæ. The *Virgularia mirabilis* is one of the most beautiful of marine polypes. Two series of half-moon shaped wings, obliquely horizontal, are placed symmetrically round an upright axis; they embrace the stem, clasping it alternately like two broad ribbons

UMBELLULARIA.

VIRGULARIA.

rolled round a stem in an inverse direction, thus producing the effect of two flights of stairs winding round opposite ways. The wings are wavy, deeply dentated, and of a bright yellow. These dentations are the homes of the polypes, which show occasionally their gaping mouths and their spread tentacles. These polypes are whitish, semi-transparent, and form a fringe of small diaphanous white stars.

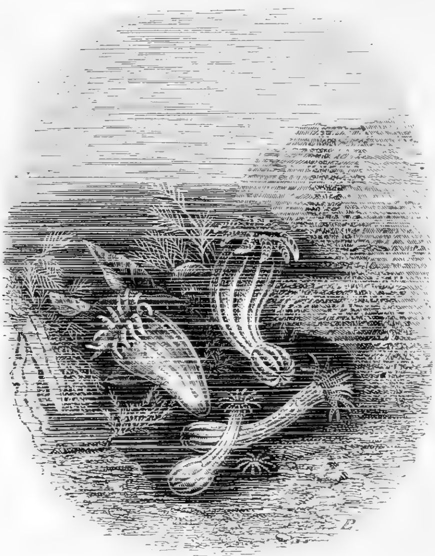
With most polypiers the elementary individual, in spite of the adhesion established among the members of the colony, possesses a vital energy all its own, and is, in some respects, quite independent. Each has its own particular will, which may or may not be in harmony with the rest, and perhaps it is on account of this insurmountable difficulty that nature has rendered these creatures fixed and sedentary. Thus the polypes are prevented from attempting to exert any common will to move, like a single individual. It is not so with the sea-pens; their colony is not fixed and stationary; they move very little, it is true, yet they move. What do we conclude from this? That the parts which they possess in common, in place of being bony or calcareous, and consequently insensitive, are fleshy, with contractile powers, and therefore capable of conveying sensation; consequently, the polypes of the sea-pens are less independent of each other than the coral polypes, having a central, perhaps a sensible organ, common to all, which binds them to each other, giving a certain unity to their acts. The coral polypiers have no will, those of the pennatula have.

The fresh-water polypiers, which are true miniatures of the marine polypiers, are also not all fixed—some are capable of moving, thus in the ponds and streams we find little imperceptible creatures, analogous to the great wandering zoophytes which the waves nourish, and which float in the world of waters.

CHAPTER XII.

SEA ANEMONES.

PICTURE to yourself a large and thick polype, having instead of the six modest feelers, a great number of brightly coloured tentacles, forming a kind of little collar—and you have an idea of



SEA ANEMONES.

the sea anemone; for the fresh-water polype seems to be a crude outline of this beautiful zoophyte.

The name anemone is well chosen; for this perfect polype much more resembles a flower than an animal. The poets looked upon them as the roses amongst zoophytes. The charming and timid creatures are also called *actiniæ,* as indicating their disposition to form rays or stars, ἀκτὶνες being the Greek for "rays." They are pulpy, more or less tough, and generally fixed by the base. The body or *column* is in the shape of a purse, flattened out into a disc at the summit, bearing many rows of tentacles, in the centre of which is the mouth.

The *base* of the anemone is generally a plain surface, by means of which the animal clings vigorously to foreign bodies. In some species it is found dilated, producing two semi-circular pinions ; in other species the opposite is the case, the *column* contracts until it is unable to serve its purpose, and the animal cannot adhere. The

THE ANEMONE OF COUCH.

THE CARNATION ANEMONE.

column more generally contracts than expands; yet sometimes it lengthens itself, becoming cylindrical and like a stem ; in this state it is very lissom, and its surface is fluted. The *disc* varies in size. The *tentacles* are hollow cones, arranged in concentric circles in many ranks; they vary greatly in length as well as in shape; they are filiform or petaloid; they are inflated or flat; they are often pointed; sometimes they are ciliated or fringed; and at other times branched, and in many species they are like white and semi-transparent worms. Charles Bonnet counted on one anemone 150 tentacles, arrayed in three rows, from which jets of water were ejected at the will of the animal. The *mouth* is always large, with thick circular lips, sometimes depressed, and sometimes raised upon a sort of protuberance. Linnæus mentions five species of actiniæ; Rapp, twenty-three; Lamarck, twenty-five; and now we can count a hundred!

These brightly coloured zoophytes exhibit well-nigh every tint; they are found white, grey, pink, red, purple, fawn, yellow, orange, lilac, azure, and green. Here is one beautiful species, with violet tentacles, pointed with white; there another, with red tentacles, slightly speckled with grey; this one spreads out its green arms, edged with a circle of dead white; while that opens a milk-white top, circled with a border of pink.

The stem, the disc, the tentacles, are not always of the same colour; this is the reason why these animated corollas have such varied hues. Here is an anemone which has a yellow body, and a disc of an apricot tint, surrounded by tentacles of a dead white. Here is a second, which has a red centre, with grey tentacles; here a third, where the centre is green, and the tentacles yellow. So Nature diversifies her numberless creations, and plays endless variations upon the same theme!

The sea anemones are found attached to the rocks, often in the crevices and clefts. Sometimes the creature takes possession of a shell which is tenantless, and filling up the cavity with its body, spreads its tentacles out of the mouth. When they are deserted by the waves, they draw in their tentacles, and dry up; but when the sea returns, they open once more, and again expand their flowery heads.

Though these animals are very adherent yet they are able to move themselves, though their progress is very slow. Their locomotion is managed by successive contraction and loosening of the part by which they are fastened to the rock. When the anemone wishes to change its place, by an imperceptible action it stretches forward one side of its base, gradually drawing in the opposite; sometimes it draws itself along by the aid of its tentacles; thus in this instance they serve as feet. Professor Forbes had an actinia which walked upon the sides of a bottle, sticking alternately by its base and by its disc. So in the kingdom of nature there are even flowers that walk!

At the approach of winter the anemones of our shores let go their hold, and leave themselves to be borne by the waves to deeper water, where they sink into a warmer clime. The instinct of these beautiful creatures is more certain in its promptings than even that of terrestrial animals; and, if we may judge by consequences, they may be said even to reason, like the higher vertebrata. The study of instinct among animals is certainly the grandest and most noble department of natural history, and ought to be pursued as much and more than those which generally gain attention.

Under the influence of daylight, the anemone spreads itself out, opening its petals like an Easter-daisy. These tentacles extend and contract, go out and in, remain perfectly stationary, or move rapidly around the open mouth. Touch the animal with a stick, or even stir the water which surrounds it—immediately everything contracts, shuts up, and shrivels. When the anemone has spread his painted collarette, if a little worm, a young crustacean, or a fish just hatched, happens to come against it, the voracious animal pulls the imprudent wanderer into its gaping mouth, forces it into its stomach—*et consummatum est!*

The life of the anemone is a continual ambush; yet the filamentous tentacles of some species appear to be true offensive arms. Mr. Gosse tore off one of these filaments just as it had seized a little fish, but the captive only struggled feebly, and soon relaxed all effort. M. Hollard has seen young mackerel roll upon their sides and die by a simple contact with an actinia.

When the tentacles are touched, according to Mr. Rymer Jones, a somewhat stinging smart is felt; for more than an hour the hand remains red and painful. If one of these organs be pulled off, and the tongue applied to the wound, a burning and corrosive sensation is experienced. This poisonous quality of the tentacles resides in minute organs which are spread out under the whole surface of the skin; these consist of innumerable capsules only visible to the microscope. They contain a thick twisted thread, breaking at the least touch; they thrust out this fibre, by which the tentacle sticks to the body—as do certain prickly fruits. This thread is ordinarily composed of one or more bands, twisted together in a spiral form, and each one is armed with little barbs. This apparatus serves to emit a very venomous fluid.

The anemones are vigorous and voracious. Nothing is too much for their gluttony. Every animal which comes within their reach is seized, engulfed, and devoured. Nevertheless, with all the power of their mouths, their insatiable stomachs cannot retain the prey they have swallowed. Sometimes it contrives to make its escape; at other times it is adroitly snatched away by a watchful marauder, more cunning and more active than the anemone. A shrimp which has seen the prey devoured from a distance will throw itself upon the anemone, and audaciously wrest his booty from him, and to his great chagrin devour it before his eyes. Even when the savoury morsel has been swallowed, the shrimp, by a great effort, succeeds in drawing it back again from the stomach; seating itself upon the extended disc of the anemone, with its small feet it prevents the approach of the tentacles, and, at the same time, inserts its claws into the digestive cavity and seizes the food. In vain does the pilfered anemone endeavour to contract and close its mouth; it is useless; the vagabond crustacean generally comes off victorious; but sometimes the conflict becomes serious when the anemone is strong and robust, the aggressor is repelled, and the shrimp runs the risk of supplementing the repast of his victim.

During the process of digestion the actiniæ appear to sleep, passing into a state of torpor; they then close their tentacles tightly, forming a pointed pinnacle above their mouth. Thus shut up they look exactly like the bud of a flower ready to open. The visceral cavity of these creatures appears large in proportion to the other part of their frames, and is divided into sections by radiating compartments. It is remarkable, that litmus paper plunged into this organ, whether the animal be fasting or whether digestion be in progress, detects no sign of acidity or the opposite alkaline state.

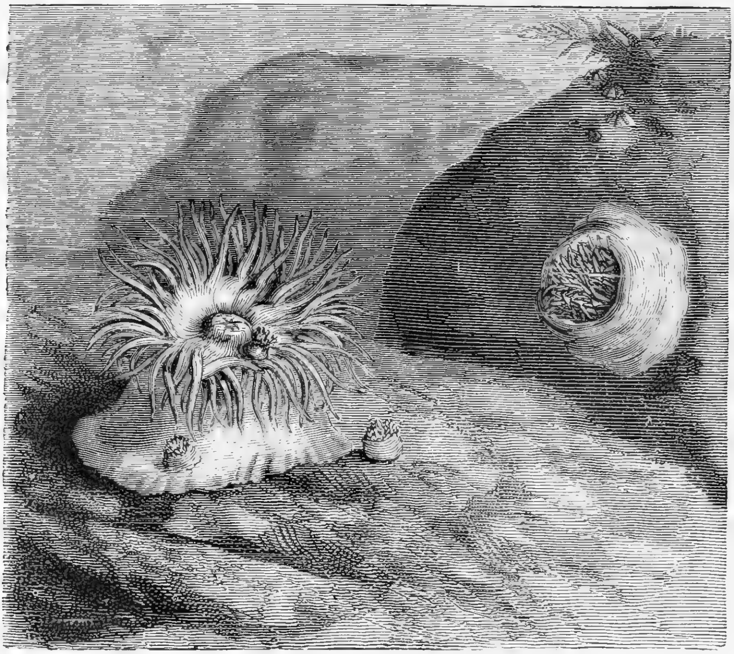
Like the fresh-water polypes, the anemones frequently swallow a quantity of food greatly disproportionate to the cavity of their stomachs. In less than an hour, one of these creatures emptied the shell of a mussel and disposed of a crab, rejecting the hardest parts by turning its stomach inside out! Dr. Johnson tells us that an *Anemone crassicornis*, from having swallowed a shell which separated it into two halves, was well-nigh perishing from hunger, when—*mirabile dictu!*—it opened at its other extremity a new mouth, provided with its proper row of tentacles; so the creature ate at both ends! An accident which to other animals would have ensured death, became in this sea anemone the source of redoubled enjoyment.

The actinia can endure long fasts. It is necessary that this should be the case with organisms which are fixed and unable to go in search of food, and, consequently, may not have it at the right moment. When our terrestrial animals do not eat they become thin; atrophy sets in, and reduces them to one-tenth of their size: but when plenty returns they fatten quickly, and soon become what they were. But an anemone can live two or three years without food!

The sea anemones have the most obtuse sense; they are not conscious of the prey which is close to them until it is actually in contact with their tentacles; they make no effort to escape from danger. Strange to say, if the very water which covers them evaporates, they have no idea of approaching neighbouring water, although they can touch it with their arms. However, as we have seen, impelled by instinct, they can then detach themselves from the rock, and allow the waves to carry them out into deeper water. The Abbé Dicquemare thinks that they feel variations in the temperature; and some naturalists assert that they ascend or descend in their localities according to the prevailing wind.

The actiniæ live for many years domesticated. A red anemone (*Actinia mesembrianthemum*) was kept by Sir John Dalyell for twenty years, and it was supposed to have been ten years old when he took it from the sea. Another he had for fourteen years. At the time their longevity was spoken of, these two patriarchs were full of life and vigour, and seemed as though they would live for many years longer.

At certain periods, germs and embryos may be seen in the tentacles of the anemones, the first stationary, the second moving. The best way of examining them is to cut off the tentacles with a sharp knife. Sir J. Dalyell, having thus operated upon a red anemone, at the end of October two corpuscles fell off; the first remained motionless, but the other had a kind of double rotatory movement, turning over with great activity; the one was the egg, the other the larva. These creatures bear their young, not *upon* their arms, but *in* their arms. The larvæ generally pass from the tentacles into the stomach, and are afterwards, at a further stage of their development, ejected from the mouth with the refuse of their food. What a wonderful formation! The larvæ are in the stomach with the digesting food, and yet are themselves uninjured.



THE BIRTH OF THE ANEMONE.
(*Actinia equina.*)

The Daisy Anemones in the Zoological Gardens of Paris frequently throw up little embryos, which are dispersed, and attach themselves to various parts of the aquarium, and gradually become miniature anemones, exactly like the parent. An actinia, which had taken a very copious repast, ejected a portion of it twenty-four hours later, and in the middle of the ejected food were found thirty-eight young individuals. The lower class of animals have, in fact, as the general basis of their organisation, a sack with a single opening, which serves a great variety of uses; it receives

VII.

SEA ANEMONES

1 Caryophyllia Smithii *Stokes and J.W.Brod.*
2 Sagartia coccinea *Gosse*
3 Phyllangia Americana *Gosse*
4 Edwardsia callimorpha *Gosse*
5 Edwardsia carnea *Gosse*
6 Sagartia viduata *Gosse*
7 Sagartia rosea *Gosse*
8, 9. Sagartia sphyrodeta *Gosse*
10 [illegible]
11 Cerianthus Lloydii *Gosse*
12 Actinoloba dianthus [illegible]
13 Sagartia rosea *Gosse*
14 [illegible]
15 [illegible]
16 Balanophyllia [illegible]
17 Sagartia [illegible]

and rejects, it swallows and it vomits. This vomiting becomes necessary and habitual—in short, it is the normal condition of the animal, and, perhaps, is a source of pleasure; it certainly is not a malady, but a function, and a function often repeated. In some species of the anemone the young are formed on the outside of the bottom of the purse; they detach themselves from the mother, and soon become individuals in all respects resembling their parent. Mr. Rymer Jones had a mutilated anemone which produced twenty larvæ in a month, and seventy in a year. But Mr. Hogg relates an instance of production extraordinary indeed! A carnation anemone in the aquarium adhered so forcibly to the sides of the case, that in detaching it he tore away some of its base; six pieces remained attached to the glass, which, for many days, indicated the place where the anemone had been. In about a week attempts were again made to detach these fragments, but with surprise it was observed that they shrank from the touch, and contracted. Each of them soon became crowned with a row of little tentacles, and finally each fragment became a new anemone! Every part of these strange creatures becomes a perfect animal when detached, while the mutilated parent continues to live as if nothing had happened.

The anemones enjoy, like the fresh-water hydra, the property of reproducing a damaged organ. If their tentacles be amputated they speedily replace them, and the experiment can be repeated *ad infinitum*. If the creature be cut in two, the lower part of the body produces a crown of tentacles, and completes itself. As for the upper half, it continues to seize and engulf its prey without seemingly being aware that the food passes out as quickly from the lower opening; but the anemone soon learns to prevent this waste. The lower opening gradually closes, and finally shuts; thus a new base is formed, round the outside of which a crown of tentacles appears, and a new mouth is produced; so the creature catches and devours its prey at both ends at once. Thus a curious animal is the result—two perfect anemones joined to each other by their bases. In due time they separate, a rupture taking place at their point of juncture, and two perfectly independent animals commence their new existence. If the section instead of being horizontal be vertical, and the anemone, by a stroke of the knife, be split into two equal parts, in a few days the separated sides join together, and two perfect creatures are thus produced, in all respects similar to the unmutilated original, save that each is somewhat narrower.

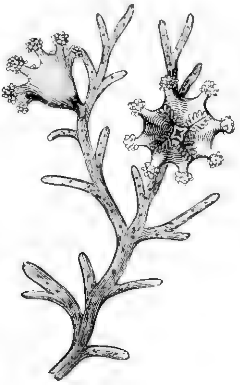
Trembley, by his experiments, rendered the fresh-water polypes celebrated, and the Abbé Dicquemare, by similar means, has brought the anemone into notoriety. He made numerous experiments upon these curious animals, both remarkable for the tenacity of their life and the brilliancy of their colours. He mutilated them in every manner. He always found the isolated fragments manfully bore the torture—if torture it were—of vivisection, and triumphantly existed through the violent operation.

"Perhaps," said this good abbé, "I may be accused of cruelty; but from what I have seen from my experiments, I believe that the happiness of the creatures was increased: for not only did I augment the duration of their lives, but I renewed the term of their youth."

The anemones are excellent food! In Provence the red and the green actinia are held in great repute. In the time of Rondelet the *A. crassicornis* was sold at Bordeaux at a high price. The Abbé Dicquemare considers this last anemone the best for the table; when boiled in sea water it becomes firm and palatable, and it has an odour very like that of warm crab. The same author also assures us that the carnation anemone is very estimable. Plancus advises that they be cooked like oysters.

The *Lucernaria* are closely allied to the anemones; they only differ in having a smoother skin, and their upper part is dilated like a parasol turned inside out. Their body is attached to a pedicle, their tentacles being joined in bunches; and four prominences, like horns, rise out of their digestive cavity, which contain a red, granular matter. They attach themselves to sea-weeds and other marine bodies.

The *Bell Lucernaria* is probably the most beautiful of its species. It well may bear a flower's name. The corolla is shaped like a bell, about an inch deep, of a uniform dark brown, and supported by a fine and slender stalk. Its cavity is closed by a concave layer, in the centre of which is a small square mouth, raised upon a little eminence. The sides of the corolla are divided into eight lobes, each carrying a bunch of miscroscopic tentacles, terminated by a glandular, rose-coloured bud. When you view



TWO BELL LUCERNARIÆ UPON A PIECE OF SEA-WEED.
(*Lucernaria octoradiata.*)

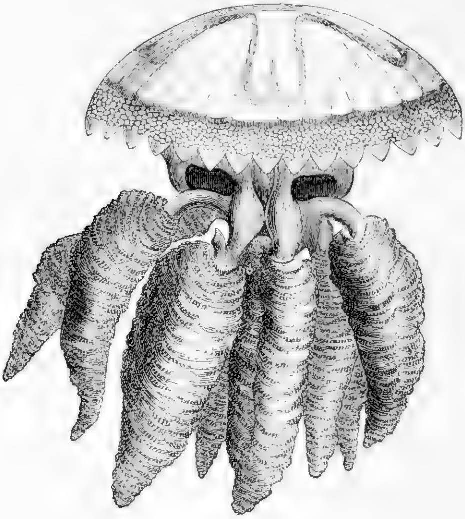
the charming creature sideways, the eight tufts of tentacles resemble the stamens of the myrtle.

Doubtless there remains much to be said of the anemones and the creatures they resemble; as Charles Bonnet says, "Natural history is a vast country, of which we scarcely know the frontiers, and we want to fill in the map." Man is always in a hurry, and will never wait. Eratosthenes and Hipparchus worked at the geography of the globe, but long centuries elapsed before Columbus and Vasco de Gama completed its survey.

CHAPTER XIII.

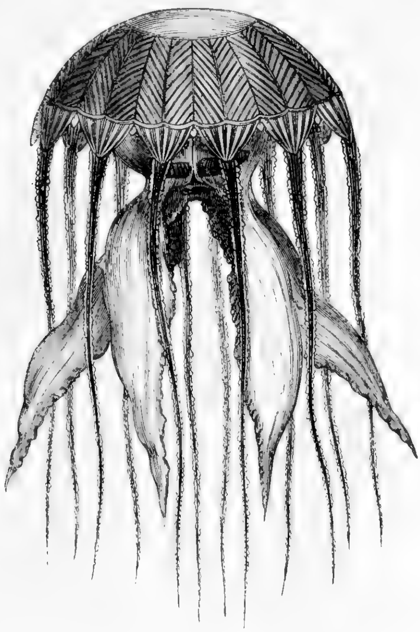
THE MEDUSÆ.

THE semi-transparent bells which float so gracefully in the sea are called the *Medusæ*—strange organisations, which constitute



THE CROSS MEDUSA.
(*Rhizostoma cruciata.*)

a large class of frail and wandering animals, to which Cuvier gave the name of *Acalephæ*. The reason for this nomenclature we shall presently state. The medusa resembles an umbrella, or a bell, or better still, an elegant floating mushroom, the stool of which has been separated into lobes more or less divergent, sinuous, twisted, shrivelled, or fringed. At first sight we might mistake them for roots. The edges of the umbrella-like tops are sometimes plain, or sometimes delicately cut; sometimes ciliated, or often provided with long thread-like appendages, which descend vertically into the water. Occasionally the creature is colourless, and as transparent as crystal; generally, however, it is slightly opaline, with a delicate blue or pink tint, and in certain species the shades are bright, and the reflections iridescent. In some medusæ the central parts only are coloured—red, yellow, blue, or violet—the remainder of its body being semi-transparent. The central mass

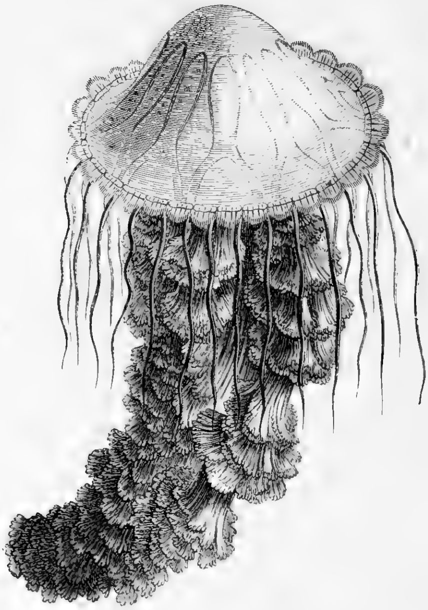


THE MEDUSA OF GAUDICHAUD.
(*Chrysaora Gaudichaudii.*)

appears covered with a thin veil, a beautiful film, showing all the colours of the rainbow, which is like a glass shade covering a bouquet of flowers.

The acalephæ are without consistence, and soaked with water. It seems quite impossible that their delicate frames can resist the force of the waves, or even the motion of the currents; yet the waves bear them tenderly, and the tempests drive them without doing them harm. When the ebbing tide leaves them on the shore, their substance dissolves, decomposition sets in, and the creature goes to nothing; if the sun be hot, this disorganisation is complete in a few hours. The retiring waves often leave upon the beach numbers of these poor medusæ, which melt like ice. Many of the large species weigh ten or twelve pounds, and yet only contain a few grains of solid matter.

Mr. Telfair, in 1819, saw on the shore near Bombay an enormous medusa, weighing several tons. Three days afterwards the creature began to putrefy. The fishermen of the neighbourhood



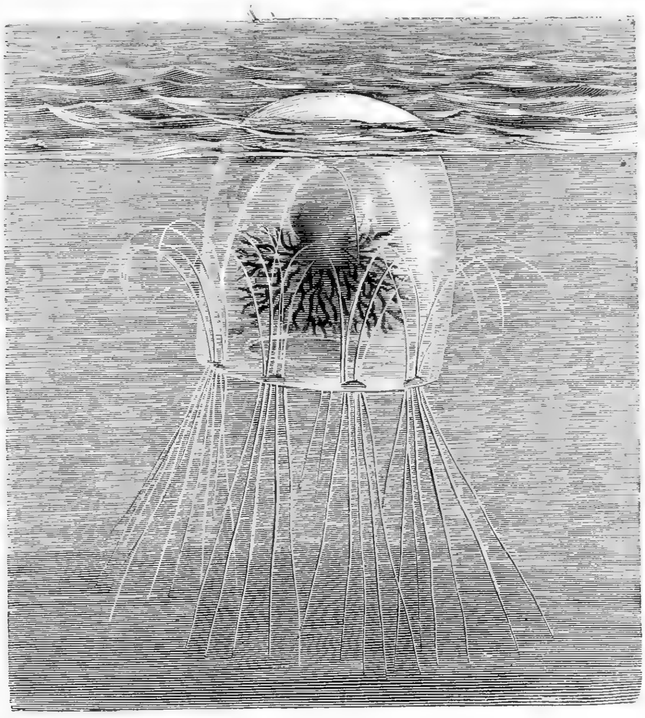
THE BEAUTIFUL-HAIRED MEDUSA.

(*Cyanæa euplocamia.*)

were employed to watch its decomposition, and to collect any bones or cartilages of this sea monster, if, perchance, it should have any; but nothing was found. It entirely disappeared, although it required nine months for its complete dissolution.

The acalephæ of our coasts never reach so gigantic a size; indeed, they are generally small. One of the most delicate is the *Turris neglecta* (the Ruined Tower), which has been described as a bell of red glass, ornamented with four transversal rays, and four white appendages, which are placed over the dome-like creature in the form of a cross. The edges of the bell have a snowy fringe, which has a remarkably pretty effect.

The acalephæ are often found together in considerable numbers. The barks which navigate Lake Thau meet at certain periods of the year with numerous colonies of a species about the size of a small melon, nearly transparent, whitish, like water mixed with a



LIZZIA KŒLLIKERI, MAGNIFIED.

little aniseed. At first sight this floating colony might be taken for a collection of muslin bonnets scattered upon the water.

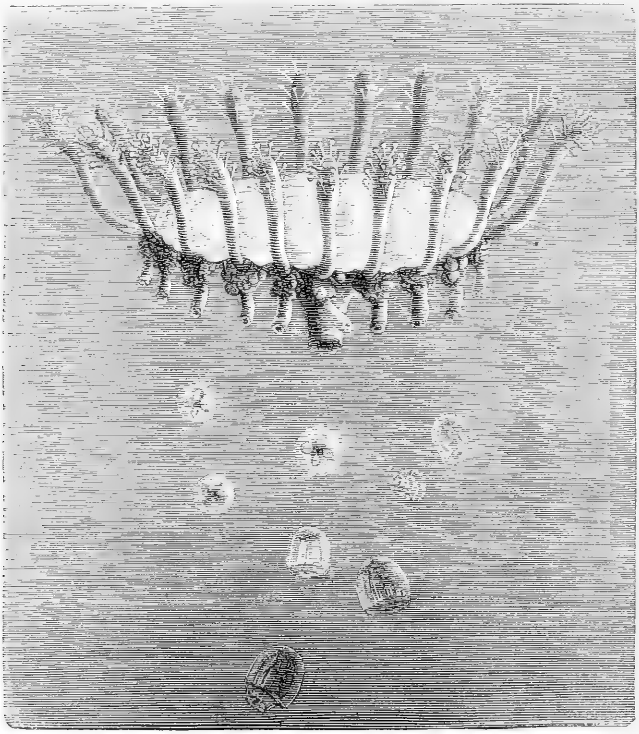
The *Lizzia* of Kölliker is so small that it can scarcely be recognised in transparent water, yet often on the coasts of Greenland large patches are seen coloured by this pretty brown medusa. A wine-glass of water can contain 3,000 of them. One of their banks, which seemed nothing in the expanse of the ocean, was calculated to contain 1,600,000,000,000,000 of these animalcules. What a fund of reflection for the philosopher does this calculation open up. The medusæ being light and floating, every current and movement of the water carries them farther and farther from the place where they were brought into existence. Some species, upon which the whales live, are swept in myriads from the coasts of Mexico to the Hebrides, one of the principal stations of these enormous Cetacea.

For a long time the acalephæ were neglected by naturalists, who, like Réaumur, took them for masses of jelly, or a kind of gelatinised water; they little suspected that they were animal organisations. Constant Duméril conceived the idea of injecting milk into their cavities. He noticed that the liquid traversed numerous channels with great regularity, and he soon discovered the organs of digestion and of circulation. Ehrenberg found in one of the Aurelia a most unexpected and complicated structure: and at last science was aroused to dive into the mysteries of their internal structure. These studies as they are pursued become more and more marvellous, as we follow these living gelatines, these rude attempts at life, as they might well be called, forming and re-forming thousands of times before nature elaborates with their substance an animal of any solid consistency.

The medusæ are the food of small marine animals, principally of the worms and mollusks. The mouth is placed in the middle of the neck, and some of them have more than one mouth. These strange creatures are very voracious, and swallow their prey without masticating it, or even dividing it. When the animal it has captured offers resistance, the acalephæ simply holds it fast and allows its victim to struggle until exhausted with fatigue. A medusa has been seen to seize an animal by its head, which, in its violent struggles to escape, completely turned its captor inside out. Some medusæ imprisoned in a vase with small fish and little crustaceans were frequently seen to devour them; though their prey had a much higher organisation, and intelligence more than sufficient to perceive and to fly from danger. Apparently, says Forbes, the medusæ have a democratic delight in destroying animals of higher classes. Thus in the ocean world there seems to exist the rivalry of caste.

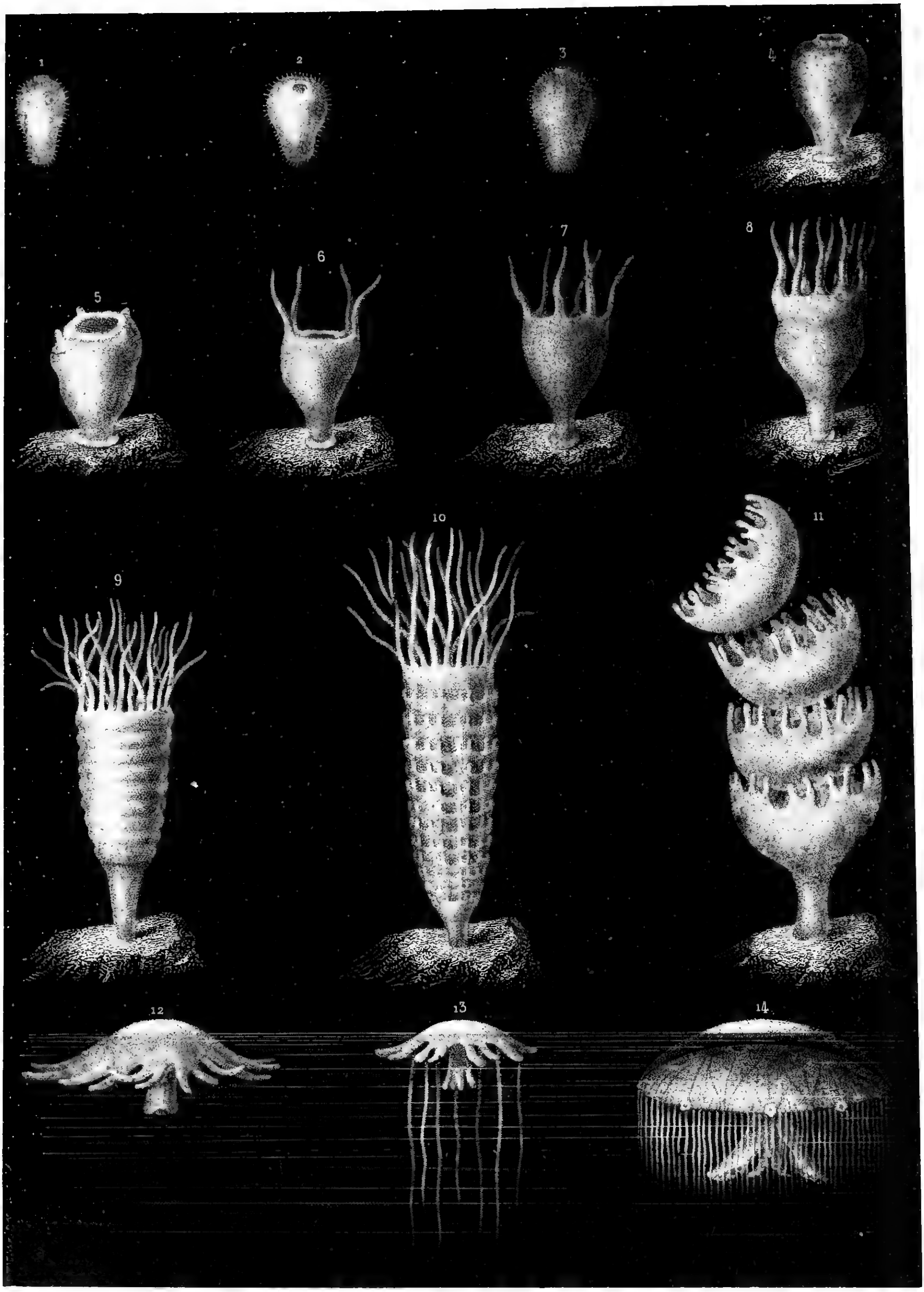
The bodies of the medusæ dilate and contract alternately. This double movement is the chief means by which they move. This was observed by the ancients, who compared it to the action of respiration in the human chest; hence their popular name of *Sea-lungs.* When they journey, their convex part is always foremost, and their course slightly oblique. If, while they are thus swimming, they be touched ever so slightly, the umbrella contracts, the tentacles are folded, and the timid creatures sink into the depths. A careful examination of the marginal portions of the acalephæ has discovered the presence of visual and auditory organs. M. Kölliker announced the existence of the first in his "Océanie." M. Gegenbauer has since found them in other classes (*Rhizostoma, Pelagia*), and he also perceived the presence of the second organs. The eyes consist of two small hemispherical masses—which are coloured and full of cells, in which are half-buried little crystalline globules—the exposed part of which is perfectly uncovered. The auditory apparatus is attached to these organs; it is composed of small vessels full of liquid. So nature produces eyes without eyelashes or eyelids, and ears without openings.

But the marvel of marvels is the process of the reproduction of these vagabond tenants of the waves. At a certain time of year the medusæ are full of eggs of most brilliant colours, suspended in large festoons over their floating bodies. These eggs are very small. In some species they appear hooked on to the body of the medusa, and do not detach themselves until they reach their full development. The larvæ produced from these eggs do not bear the slightest resemblance to their mother. They are long, worm-like forms, thicker at one end, like microscopical leeches; and they have scarcely-perceptible vibratory cils, whose movements are by no means slow. At a further stage of development they are found transformed into polypes with eight tentacles. This embryo medusa —a truly wonderful creature—rejoices in the power of reproducing itself, by buds and shoots growing on the surface of its body, and also by filaments which sprout from it here and there. Thus a single individual may become, in a little time, a large colony. The polype in this process undergoes a remarkable transformation. It folds itself upon itself; its body becomes jointed, and appears composed of a dozen discs or cups piled up one upon another. The topmost disc is thrown off; thus separating itself from the column by convulsive efforts, and becoming free. So it appears as an excessively minute medusa. In the same way, one after the other, the discs—that is, the individuals—separate, as is shown in Plate VIII.



THE BIRTH OF THE MEDUSÆ.

Thus zoophytes which have sexes distinguished propagate their kind after the ordinary manner; but their offspring, which bear no resemblance to them, have no sexual distinction—they are neuter in gender. These propagate, by *budding* and by *fissiparism*, individuals like themselves, but which may possess sexual distinction. The original creature before this process takes place itself becomes transformed from a simple to a compound animal,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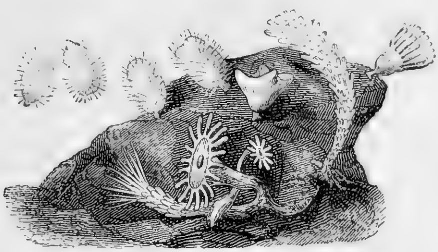
and it is from this animal in this state that those offspring come which have sexual distinction, that is, which are perfect animals.

These two modes of propagation, so different, follow each other in a regular manner, and form a combination which has received the name of *alternate generation*, a generation in which the children never resemble the parent, but always the grand-parent. These neuter individuals which produce perfect creatures are called *nurses*, a term not very happily chosen. These successive transformations which take place in the same animals appear at first sight very extraordinary, and yet similar phenomena are taking place every day around us, and we scarcely give to them any attention, either because the creatures are so common, or else it is that the changes



MEDUSA LARVÆ.

are of such frequent occurrence. For instance, the beautiful fluttering butterfiies deposit eggs which lie immovable and helpless, and which have neither beauty nor elegance. These eggs, in due time, give birth to caterpillars which are destined to crawl with difficulty, and which are coated generally in sombre hues. In their turn the caterpillars change, and the brown mummy chrysalis is condemned to a death-like slumber, until it awakes into the richly-tinted butterfly which flits from flower to flower. If now these insects were excessively rare, and inhabited the ocean depths, would it not be a long time before we learnt that the eggs, and the caterpillar, and the chrysalis, and the butterfly, were the same animal in different phases of its being? And if this insect had an organisation less complete, perhaps the caterpillar, or the chrysalis, or even the egg, might have produced offspring by germination or fissiparism; that is, by buds, or by dividing its own body into numerous parts, and then we should have phenomena exactly similar to those which are presented in the lives of the medusæ.

All medical men now know that the *Tenia*, an articulated tapeworm, has larvæ very different to the perfect creature, and which have the power of producing other larvæ like themselves. Thus these curious animals are simple at one period of their lives, compound at the second stage, and return to their simplicity at a third. Never can it be too often said that all is changeable in nature; God alone being "the same yesterday, to-day, and for ever."

It is remarkable with regard to butterflies that they pass successively through such opposite states; at one time vitality is very apparent and exuberant, at another latent and all but extinct; now they are in movement, now in repose. The egg is immovable, the caterpillar crawls, the chrysalis sleeps, the butterfly dances in the air; and each time of action is preceded by a period of repose, according to a great law in physiology. Look, for instance, at the silkworm, each time she undertakes to clothe herself in a new vesture she remains in a torpor, preparing for a new life by a semblance of death. Quatrefages remarks that the tendency to metamorphosis increases as we descend in the scale of life.

Many of the medusæ produce an acute pain when touched, like the sting of a nettle, to which property they owe their name of *sea nettles*.

One of the most remarkable of the species is the *hairy medusa*, the terror of bathers. This creature is like a pretty brown umbrella, divided and festooned, with a thick pedicle and a great number of arms, long and ribboned, carrying after them floating hair, the more dangerous since it is well nigh transparent. Any one who imprudently ventures into the midst of these poisoned filaments soon feels the most insupportable agony. The medusa, when escaping, often leaves behind it these hairs, which become detached, and, though they are separated from the creature, they still retain their stinging power, as though they would revenge themselves for their isolation. The stinging organs of the medusa are very tiny cells disseminated in their skin, upon which they form little protuberances. They may be noticed round the extremity, or along the whole length of the fine tentacles. These cells are made of a double semi-transparent membrane, which is very thin and somewhat flexible; within the cavity there is found a long thin thread, coiled up upon itself when the sting is inactive. This thread can shoot out of the bag, and then there is seen at its extremity one or more sharp points like darts. These microscopic poniards are most probably tubular, and along the canal the poison issues from the gland. It is with these little stings that the medusæ, whose tissue is so delicate and so weak,

A BEROE.
(*Beroe pileus.*)

and whose intelligence is so obtuse and so limited, can defend themselves, and even attack. The smarting sensation which they cause when touched is violent, their sting producing a blister, and an irritation which lasts for days.

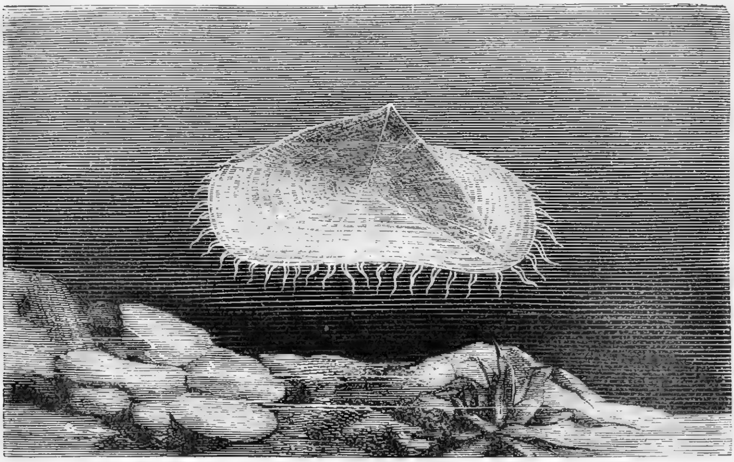
The *Medusa of Aldrovand* (*Rhizostoma Aldrovandi*), whose habitat is the Mediterranean, and the *Medusa of Cuvier*, which is found in the Straits of Dover, also possess a stinging apparatus, which produces an inflammation. We are told that one drop of the poison will inflame the whole of the muscles of the eye, and raise upon the hand pustules which itch intolerably. It is in this class of acalepha that naturalists place the *Beroes* and the *Velellæ*. The beroes are ovoid or globular bodies, whose sides are ornamented with teeth-like points and filaments. Sometimes the sides form a kind of wings. Certain of the beroes resemble castles without foundations. Their colours are bright, and frequently they look as though they were made of porcelain.

The species which is found on the coast of Ireland, the *Cydippe pomiformia,* is a little iridescent sphere of pure crystal. When they eat, the prey may be watched traversing this transparent tissue. Their sides are fringed with semi-transparent and very mobile cilia, by whose aid these beautiful little balloons glide through the waters like meteors. The rows of cilia move alternately, one resting while the other is in motion. The movements of this beroe are very capricious; sometimes it rises gently to the surface of the water, like a slowly-ascending bubble, and then it descends again as slowly; another time it comes up rapidly, and falls again like a stone into the depths. At another time it remains quite stationary, and turns round on its vertical axis, so making a number of progressing circles, like an elegant dancer.

This pretty creature is furnished with two very fine and delicate tentacles, six times longer than its body. They are flexible capillary tubes, which have lateral branches, short and arborescent. These tentacles descend from the under part of the creature, and diverge from each other; they are very wavy, and are not unlike spiders' threads. We are told that their surface is covered with microscopic vesicles, straight and upright, by which, probably, they either stupify their prey, or hold it fast. The weakest organ has always something to compensate for its weakness, and here a fine and almost imperceptible thread is a very dangerous weapon. It appears that the beroe is phosphorescent; when disturbed it produces a light which appears like a luminous twisted column, continually changing its place, because of the gyratory motion in which the animal indulges.

The *Velellæ* have an interior cartilage, which is oval and transparent, and gives consistency to the gelatinous substance of their body. This animal, shown in the accompanying figure, is like an umbrella in shape; its colour is of a dark blue, furnished on its under surface with a number of suckers, and a vertical tuft, like a sail fixed to its cartilage, crosses its back obliquely. The velellæ often float on the waves in great numbers, covering the waters with what look like little flowers, which the zephyrs, as they breathe, gently waft before them.

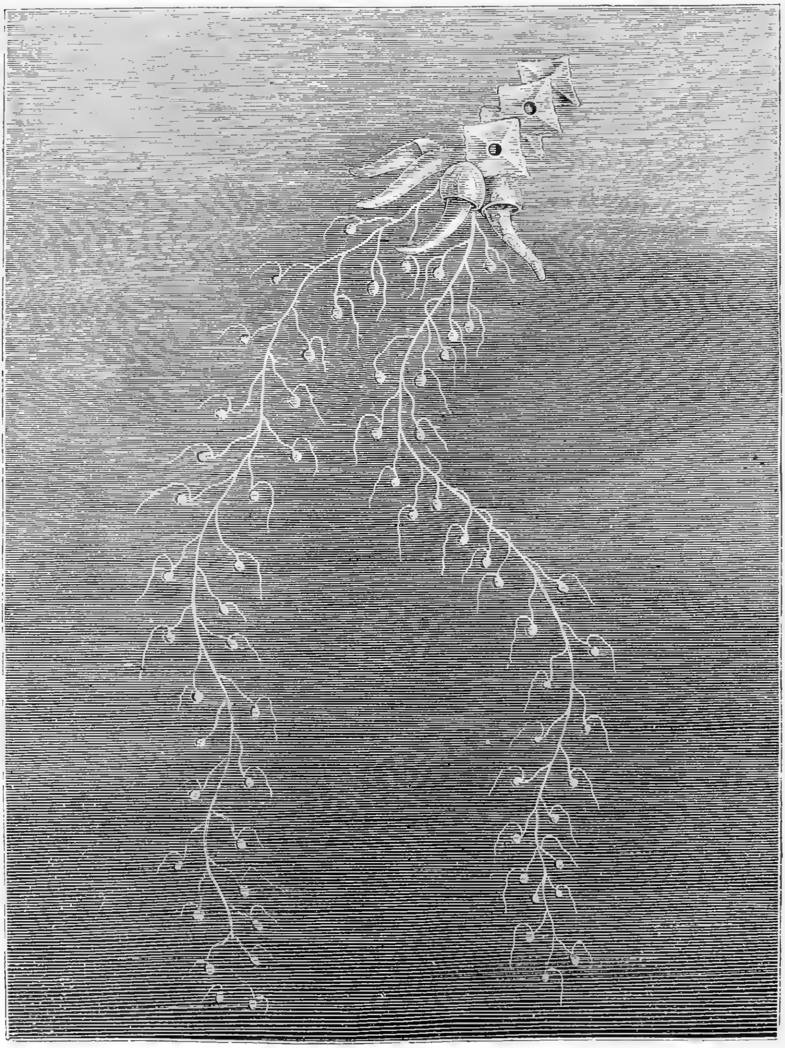
The name of *Hydrostatics* or *Hydromedusæ* is given to certain animals of this class which are essentially voyagers. They possess one or more air-vessels, little natatory bells of various forms. The elegant creatures frequently float on the waves, even when the howling tempest has lashed them into foam, like frail barks overtaken in a storm. But the sea may rage, the hydromedusa can never be submerged; nothing can force it beneath the surface. These acalephæ have generally grey tentacles or fishing threads, of



VELELLA.
(*Velella limbosa.*)

different lengths, and often very numerous and of great fineness. Their vessels or their bells hold them up in the water; their tentacles direct them in their movements; their fishing threads serve them at the same time for means of defence, for arms wherewith to seize their prey, and for organs of suction. The hydromedusæ are compound animals, a kind of travelling polypier. Their colonies form fringes, garlands, and clusters of beautiful elegance. They are often composed of three kinds of elementary animalcules: those which are nurses; those which bear young, but have no mouth; and a third class, which are both progenitors and protectors of their offspring.

These curious animals consist of a large bladder which contains all their organisation, or of floating bell-shaped bodies, which are either divided into compartments, or are of a more simple construction. There is a well-known and interesting member of this



HYDROMEDUSA.
(*Vogtia.*)

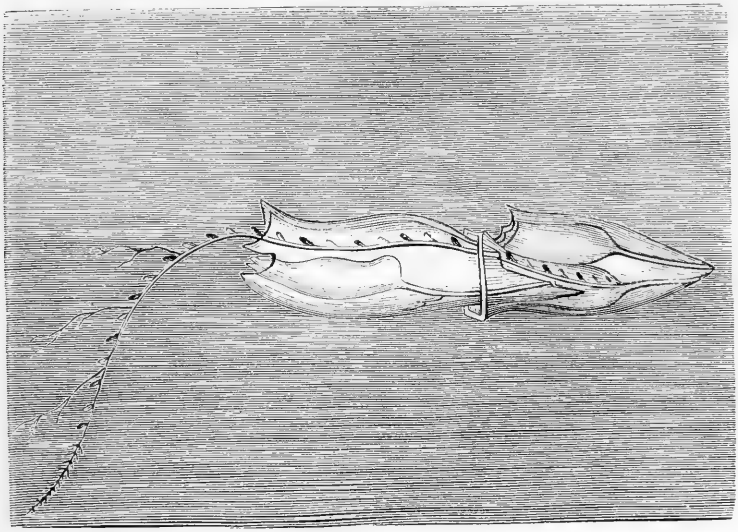
class of creatures, called in the language of science, *Physalia*, but by sailors it is designated by the more expressive names of *the sea bladder*, *the little galley*, or *the Portuguese man-of-war*. In the physalia the natatory organs are passive. When the sea is calm they may be seen floating upon its surface; their body is a cylindrical bladder, dilated in the middle, bearing a fancied resemblance to the hull of a ship. Their colour is purple, shading off to blue. Beneath the vessel are a great number of fleshy tentacles, cylindrical and twisted, which hang down perpendicularly, like tassels of blue silk. The central members of this bunch have attached to them

PHYSALIA.
(*Physalia Antarctica.*)

fine, movable, contractile threads, which hang down many feet into the water. These threads are studded with starry pearls of the colour of indigo, which form borders, and spirals, and zigzags of an elegance hardly to be conceived. "These galleys," says Lesson, "move along painted with the richest hues. The upper part is inflated with air, often to a size equal to the rest of the body, and thus forms a sail, by which they are blown over the waters. This white expansion is often tinted with blue, and shaded with purple and violet; a frill at its ridge is of bright carmine, forming a most pleasing contrast with the azure of the surrounding waters." Take care how you touch the little living vessel: a sting far more painful than that of the nettle will be inflicted on the too venturesome hand. This sensation is produced by a blue corrosive liquid, of a syrupy consistence. The pain does not readily subside, and sometimes it is attended with a disposition to faint. Generally the irritation does not extend further than the hand. "The galley," says Father Feuillée, "has occasioned me such violent pain when I have touched it that convulsions have ensued. Father Dutertre, when he was in the Antilles, was one day sailing in a small boat, when he saw one of these little vessels. Desirous of knowing the form of the animal, he tried to take it in his hand. "But I had scarcely seized it," he writes, "when all its fibres seemed to clasp my hand, covering it as with bird-lime; and I had hardly felt it in all its freshness—for it is very cold to the touch—when it seemed as if I had plunged my arm up to the shoulder in boiling oil; and this was accompanied with pains so strange that I could scarcely prevent myself from shrieking." Leblond, in his "Voyage aux Antilles," gives a figure of a *Physalia pelagica,* and narrates the following: "One day I was bathing with some friends in a bay which was in front of the house where I dwelt; while my friends fished for sardines for breakfast, I amused myself by diving, after the fashion of the native Caribbeans, under the wave as it was about to break. . . . This daring nearly cost me my life. A galley, many of which were cast up upon the beach, fastened itself to my left shoulder. As soon as the sea cast me on the shore, I quickly tore it off, but some of its filaments remained sticking to my skin. The pain I immediately experienced was so intense that I nearly fainted. I seized an oil flask which was at hand, swallowed one-half, and rubbed the affected parts with the rest, but the pain went to my heart, and I fainted. Upon coming to myself I felt well enough to return to the house; a couple of hours' rest made me better, and the pain disappeared during the night."

Meyen, during the first voyage of the *Princess Louise* round the world, saw a magnificent physalia, which passed near the ship. A young sailor, bold and courageous, leapt into the sea, naked, to secure the animal. Swimming towards it, he seized it; the creature wrapped its assailant in its thread-like filaments, which were nearly a yard in length. The young fellow, overwhelmed by a feeling of burning pain, cried out for help. He had scarcely strength to reach the ship, and to climb on board again. The pain and inflammation were so great that brain fever set in, and great fears were entertained of his safety.

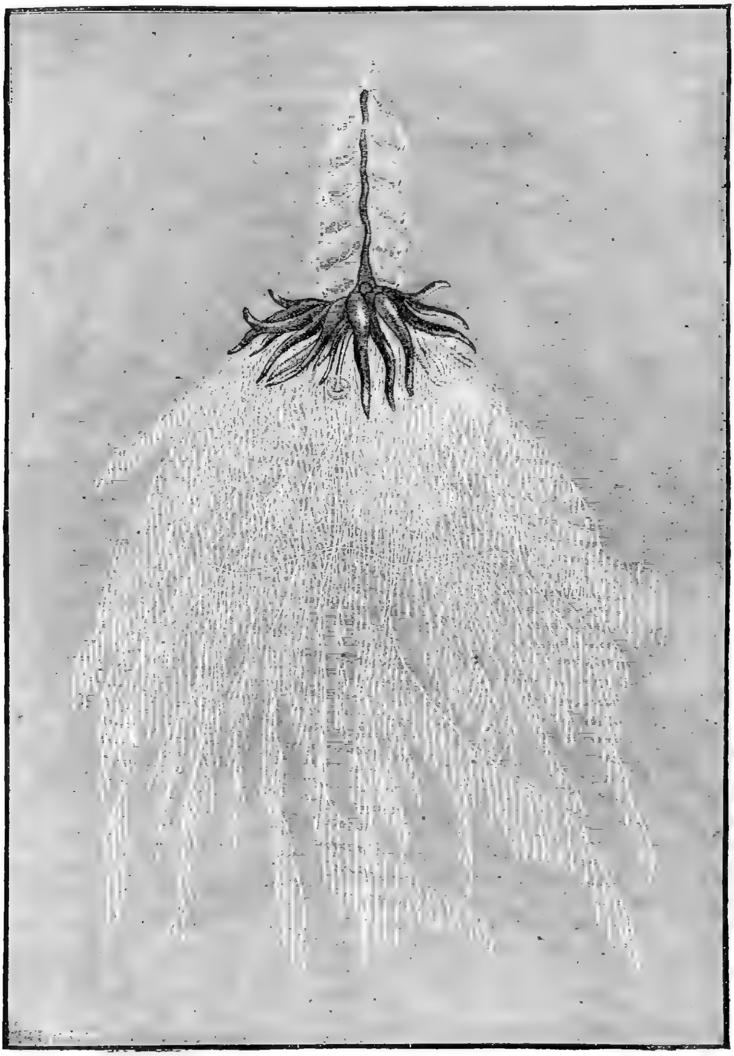
The *Diphydæ* of Cuvier, the *Physophoræ* of Forskäl, and the *Apolemiæ* of Lesson propel themselves by natatory organs. The *Diphydæ* are always found in pairs—two different individuals invariably go together, but the union between them is very



DIPHYDA.

different from that which joined Philemon and Baucis: one of the individuals is enclosed in a cavity in the other. The enclosed one forms a kind of chaplet in the interior of the other. These creatures are gelatinous, ovoid, pyramidal, and sometimes in the form of a mushroom. They can be separated without mutilation, and preserved alive; but if one of them be isolated, it is evident that it is in an unnatural state, and soon perishes. Some naturalists look upon them as male and female, joined together indissolubly; a wonderful destiny consigning them to a life-long embrace! Love is but an episode in the life of most animals, but it fills the entire existence of the diphydæ.

If from between the two lobes of a diphyda a long capillary filament takes its rise, from which hang into the water a number



PHYSOPHORA.
(*Physophora hydrostatica.*)

of parallel branches, and which also bears little pyriform, coloured bodies, we shall then have the *Galeolaria aurantiaca*, a wonderful hydrostatic colony, discovered by M. Vogt in the neighbourhood of Nice. Here the two lobes which have no sex are supposed to be natatory vessels common to the colony, and intended to support them in the water. The pyriform bodies are the individuals of this floating republic. The males are orange and the females yellow.

It seems probable that many of the diphydæ which have been captured are mutilated, that is, deprived of some of their filaments, and are, consequently, incomplete.

The *Physophoræ* possess numerous lobes.

The *Physophora disticha* is one of the prettiest and most delicate of the class. The creature is composed of a slender vertical

PHYSOPHORA DISTICHA.

axis, terminating in an oblong transparent bladder, mamillated underneath. On each side of this axis are three appendages of a saffron yellow colour, not unlike the flower of the fox-glove. From the lower extremity of the axis hang thirty tentacles, composing a perfect pendant bouquet. These tentacles are of a somewhat cartilaginous substance, semi-transparent; they are rose-coloured, shading off to white at the extremity, where they terminate in a sucker. A capillary, or hollow filament of bright purple, runs over their surface in a zigzag. Is this association perfect, or ought it to have long suspended filaments, like the *Galeolaria?*

In the *Apolemia* the lobes are still more numerous. The *Apolemia contorta* unites the most graceful form with the most delicate tissue of a wonderful transparence. As it floats it looks like a bright red plume formed of these lobes. This peculiar creature has been accurately described by Milne Edwards and C. Vogt;

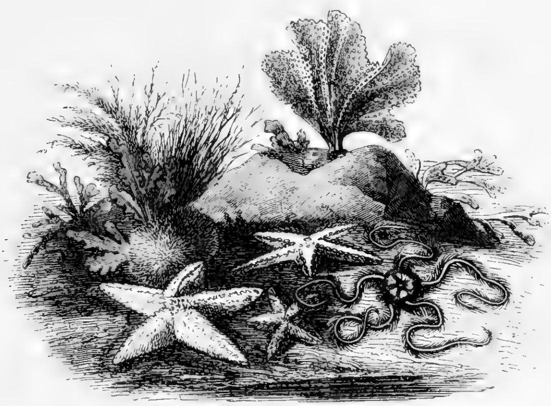
and the latter naturalist has published some beautiful illustrations of it. The air-bells are arranged in the form of an elongated egg. On the summit of this is a little air-cell, attached to it by a short collar. The air bells are crystalline fabrics, and are arranged in vertical series of twelves; they are all by their points attached to a common axis, in a spiral form; the long capillary filaments hanging from them are wavy, transparent, and scarcely visible to the naked eye; these support little oblong bodies, like ear-rings. The individual members of the colony are very small and, at first sight, are remarkable for the purple tint of their digestive cavity. They are fixed to a common trunk. The arrangement at a distance seems symmetrical, and is generally a quincunx. The anterior part of the animalcule is armed with stinging capsules. In its central zone are twelve cushions (biliary cellules) which we are tempted to take for eggs. From the bottom of the trunk the fishing threads are suspended. They are extremely thin, and are furnished with a great many stinging tendrils, which are attached to a second thread which branches from the first. These stinging organs are of two kinds; some are like little swords, placed vertically one against the other, and some are like berries, set on the borders of the red cord. The tendrils terminate in a colourless thread, twisted in a spiral, which covers the bag containing the poison. The reproductive individuals are placed between the nurses. They may be compared to elongated and expansible bags. They have no mouth, and are always disposed in pairs upon a bi-truncated pedicle, at the base of which may often be seen a shrunken fishing-thread, short, and bristling all over with stinging capsules. What complication, what variety, what wonderful arrangement to supply these minute creatures with a power to attack and defend! And yet these elegant apolemiæ have scarcely more consistence than a mass of soap bubbles!

CHAPTER XIV.

THE STAR-FISHES.

ONE of the old kings of France said with reason, "Nature se plaît en diversité."

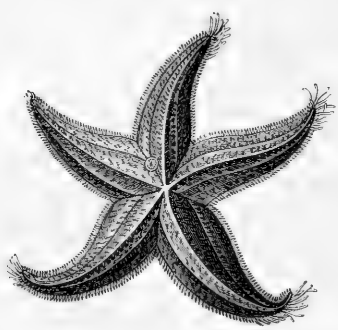
Here are creatures which seem to be constructed by geometry. They are the *Star-fish* or *Asterias*. Their resemblance to that figure which we call a star has long been recognised by amateurs as well as naturalists. The organisation of marine animals is far



STAR-FISH.

from being rigorously exact. The creative power seldom or never employed lines perfectly straight; the preference was always given to curved and wavy lines; hence the asterias are not constructed with exact geometrical accuracy. The star-fishes are animals without vertebra; they are generally flattened and pentagonal, the branches being nearly equal to each other, and arranged symmetrically as rays. These rays are more or less triangular, and are invariably five in number. The asterias strew the ground of the submarine forests. Sir L. McClintock, when exploring the route for a North Atlantic telegraph, found a living star-fish at a depth of 260 fathoms! It belonged to a species generally found only in a fossil state, and here it was living under an enormous pressure, and far out of the reach of the light of day. The asterias are peculiar to the sea; they have no fresh water representatives. Certain species are extremely numerous—so numerous, indeed, that the sea-board population cart them away to manure the land.

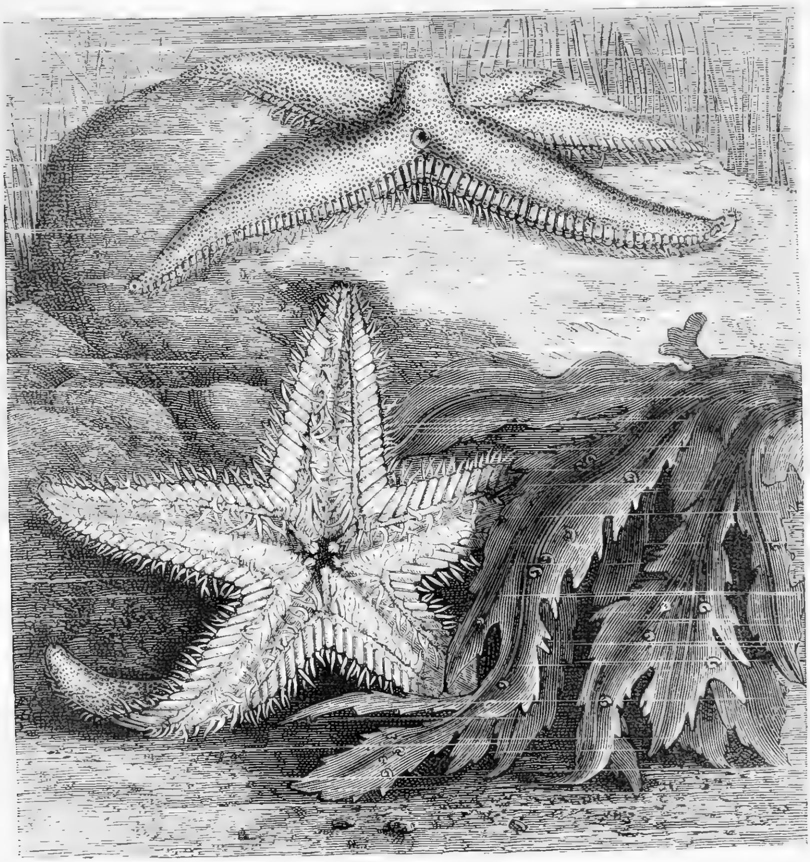
The star-fishes are variously coloured. Some are a greyish yellow, some an orange yellow, others a dull red, or a violet. Their bodies are surrounded by a calcareous envelope, composed of pieces placed side by side, united by fibres. These



THE VIOLET ASTERIA.
(*Uraster violaceus.*)

plates are armed with tubercles and pricks; M. Gaudry found more than 11,000 of them on a red star-fish—that species which is most common in Europe.

The asterias have a mouth at the centre of their lower surface. There are also upon this under surface globular drop-like protuberances, which are furnished with arm-like appendages; and it is from the globular projections that the organs are put forth, which are really the feet of the creature. These form a double or quadruple row; they consist of a fleshy cylinder of a greyish colour, and in most cases are terminated by a little globular vesicle filled with a watery liquid. This vessel is capable of great extension. When the creature wishes to push out its foot, it causes the globular vessel to contract; this forces the liquid into the cylinder, which is consequently stiffened, and can be used for the purpose of locomotion. When the pressure upon the bag of fluid is relieved, the water returns back to its receptacle, and the cylinder becomes limp, and contracts. In spite of the great number of these ambulacral organs, the star-fish does



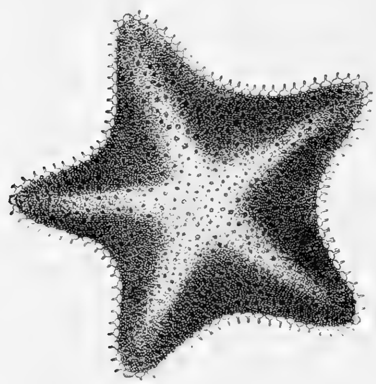
UPPER AND UNDER SURFACE OF A STAR-FISH.
(*Astropecten spinulosus.*)

not move any quicker than other inhabitants of salt water which possess only one foot or none at all.

If you turn an asteria over upon its back, at first it remains motionless, with its feet contracted; soon, however, it pushes them out like so many little worms, spreading them here and there as if feeling for the ground; it then inclines them towards the bottom of the vase, and fixes them one after the other; when it has a sufficient number attached, the animal turns itself round. It is believed that these organs also play no inconsiderable part in the process of respiration ; even during times of seeming repose, currents of corpuscles are seen traversing them.

The mouth of a star-fish opens immediately into the stomach, which is a large sack, from which a chamber passes into each arm. These prolongations of the stomach are a kind of intestines.

These animals are very voracious. They engulf their prey while still living, in a single morsel. When the victim is too large



EQUESTRIAN STAR-FISH.
(*Goniaster equestris.*)

for the mouth, the stomach inverts itself upon it. In all other animals the lips are the receivers of the food for the stomach; but here the stomach itself takes the food. The star-fish can eat even oysters. This appears at first sight impossible, for the mouth of the star-fish is but small, and an oyster is a considerable size. But according to Professor Rymer Jones, they seize the oyster by their rays, holding it by means of their suckers; they then invert their stomach, which entirely enfolds the unhappy mollusk; from the pores of the stomach there seems to exude a poisonous liquid; the oyster by this means is forced to open its shell, and thus becomes an easy prey to its captor.

The asterias play an important part as the scavengers of the sea. They love all kinds of dead flesh, and show a wondrous activity in discovering and devouring it. This necessary work of clarifying and making the waters of the ocean salubrious for its world of inhabitants is carried on silently, quietly, but continuously. How wondrous are the arrangements by which the Creator completes the compensations of life!

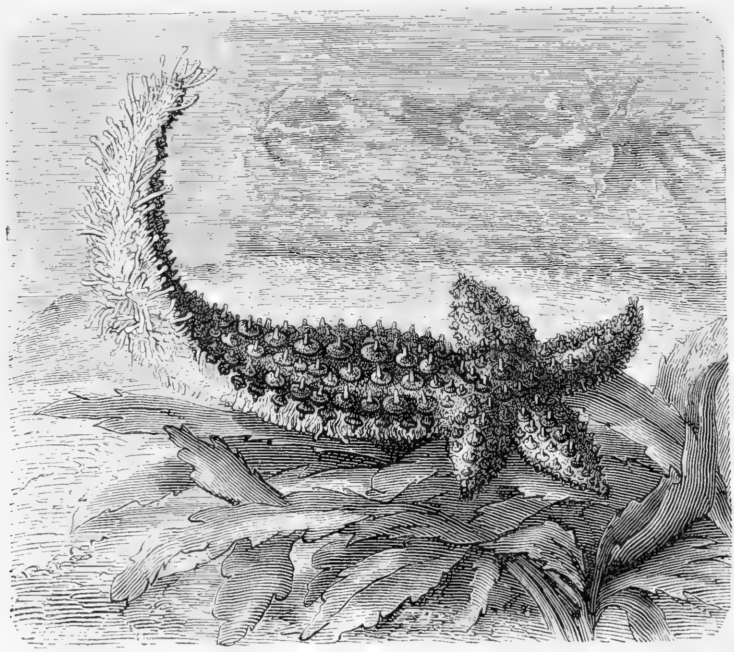
Ehrenberg first discovered that the star-fish had eyes. They are placed at the very end of the arms, and on the under surface; they are bright red globules, surrounded by a defence of spiny cilia. To use them the animal is obliged to raise up the arm. These eyes, in one sense, may be said to be very imperfect, for they possess no lens; at least, the most careful observers have not as yet discovered any.

Edward Forbes gives a most interesting account of a star-fish which is found in the Mediterranean—the *Luidia ciliaris*—which, when attacked, is able to destroy itself; first the arms break off one after the other, and then the disc breaks itself into pieces. Not being able to defend itself as a whole, it kills itself in detail. One which had thus escaped him by sacrificing its arms, opened and shut its spinous eyelid with something very like a wink!

The star-fishes propagate their species by eggs, which are produced in vast numbers; the mother carries them in a cavity formed by a curvature of the body and the rays. They are so situated that the creature cannot use its mouth, and, consequently, it has to pass the period of gestation without taking any food. An asteria has been known to remain in this state for eleven days. The eggs are yellow or red. The young come out of the egg very unlike the parent; they have no rays, are ovoid in shape, and are provided with vibratory cils, which give them the appearance of infusoria. They swim with great activity. At the end of a certain time the rays bud out of the upper part of the body in the shape of four tiny arms, by means of which the little star-fish fixes itself to its mother. As yet the members are only temporary; the body gradually flattens itself out and becomes a disc, at first round, upon the surface of which, towards the middle, spring up without any particular order, globular protuberances, which are the rudiments of the suckers; these appear to form six concentric rays. At last the body begins to become pentagonal and more or less like a star; the rays grow out at the angles, and the animal is complete.

The flesh of the star-fish is considered poisonous.

Star-fishes are capable, with wonderful facility, of reproducing any part of which they have been deprived. The individual which loses one or more arms gradually produces others in every respect similar to those which it once had. At first these new members



A STAR-FISH IN THE PROCESS OF PRODUCING ITS RAYS.

are small, and in this state there is a necessary aberration from the figure of a star. There is in the Indian Ocean a species which often has four small arms upon the extremity of the fifth; these are new productions in course of development. In this case the star takes the appearance of a comet.

Sir John Dalyell, on the 10th of June, took a ray of a star-fish which had been cut off. It then exhibited no signs of reproduction; but on the 15th the rudiments of the other four rays showed themselves as little protuberances. At night one of them had doubled its size, and the others had also increased. An orifice—that is, a mouth—began to form at the centre of this new group. The process of reproduction was then in full force, and in three days the four rays were completed; but when compared with the original arms, they were, of course, but Lilliputians. In a month's time they had reached their proper size, and thus a new star-fish was produced from the amputated limb of another.

The asterias are tormented with parasites. There is not perhaps an animal, terrestrial or marine, which does not serve as a home for another, or perhaps for many others. To live in dependence on another is a great physiological law. As a general rule, parasites belong to an inferior grade to that of the creature on which they exist; the contrary is very seldom the case. However, of this we have an instance in the parasite of the *Culcita discoidea.* Here is a little fish which passes its life in the intestinal cavity of a star-fish. This fish is called *Oxybates Brandesii.* The parasite is higher in the scale of life than the star-fish; for one is a vertebrate animal, and the other belongs to the inferior rank of the invertebrata.*

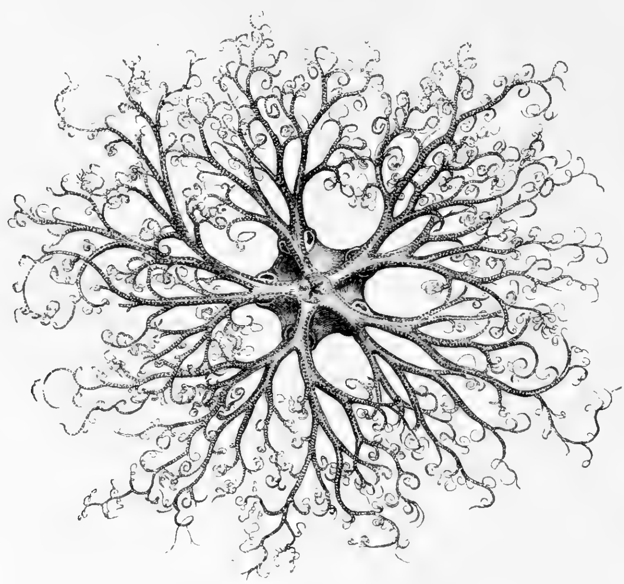
Some of the star-fishes have a body—a little round disc—from which rays extend, which are supported by a series of vertebral formations. These are the *Ophiuradæ,* so called from a fancied resemblance which the rays bear to the tail of a serpent. The arms are long, flexible, and wavy, and sometimes furnished upon their sides with spines and scales. In many species, which are termed *Astrophytes,* the arms bifurcate near their origin, and sometimes they are separated into two or three branches, which throw out again smaller rays, which are very fine and tortuous. In one individual no less than 81,920 of these have been counted.

The elegant rays of the ophiuradæ move and twist themselves as they have occasion. They seize the prey which comes within their reach, and direct it to the mouth, which is always placed at the centre of the lower surface of the star-fish. The astrophytes appear to use their numerous arms as a net in which to catch their prey, and, at the same time, to hold it until it is wanted

* Another little fish, the *Fierasfer Fontanesii,* of Risso, lives as a parasite in the great intestine of the *Holothuria royala.*

to make the repast of the animal. The visceral cavity is absolutely limited to the disc which forms the body; it does not extend into the arms, as is the case in other star-fish. When an ophiura is put into water which is not fit for its habitation, one by one, the arms drop off, until nothing remains but the disc; and still the creature lives, and eats with avidity.

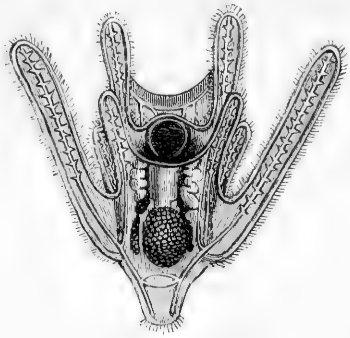
About the beginning of April the sides of the disc puff out, and the intermediate spaces between the rays become filled with



ASTROPHYTON VERRUCOSUM.

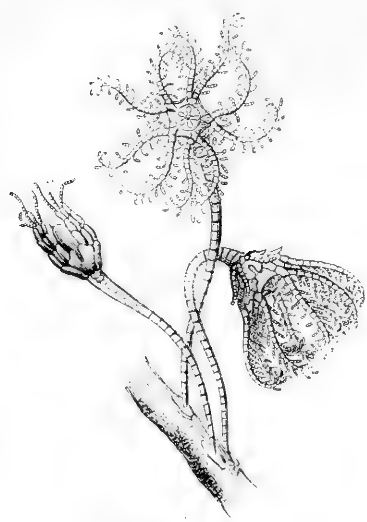
spawn. The eggs are ovoid and of a bright red. Towards the end of August, or the beginning of September, the young appear. At the moment of their birth they are nearly microscopic, almost transparent, and slightly green. Their shape is curious; they have been not inaptly likened to a painter's easel. The upper part of the body is conical. The lower part is divided into eight prolongations, disposed in two divergent groups. These prolongations are covered with cilia, and towards their extremities are slightly orange. Each is upheld by a little calcareous support. These singular larvæ have been described under the name of *Pluteus paradoxus*.

In concluding this chapter we must not omit to mention the *Medusa's head,* one of the most extraordinary productions of



THE MAGNIFIED LARVA OF THE ECHINODERM.
(*Pluteus paradoxus.*)

marine life. They belong to the *Crinoïdea,* a class of zoophytes which swarmed in the Palæozoic seas. Many of the limestones



PENTACRINUS EUROPÆUS.

are all but masses of these crinoïds. Now the great race is all but extinct, and our seas only present two species. One is fished up from great depths, in the neighbourhood of the Antilles, and is popularly known as the *marine palm.* This curious animal resembles a flower borne upon a stem, the calyx of the flower being the head of the animal. The stem has a calcareous core, which is secreted by the living tissue which surrounds it. The arms branch out from the calyx. In fact, the animal is a star-fish fixed to a stem—the fixed star of the ocean world. It has no mouth, and its digestive apparatus is very rudimentary. Its pedicle is slender, angular, and jointed. The animal can balance itself in any position, and appears to enjoy a kind of sensibility. Thus these animals occupy that position which is always found in moving from one section of the kingdom of nature to another; they are the stepping-stones between the animals which are fixed and those which are free. Nature never leaps, she always steps.

In 1823 Mr. Thompson discovered the second species in the European waters. The *Pentacrinus Europæus* is very small; the rays are deeply divided into two parts, and they appear to have ten of these tentacles; they are furnished with cilia. The pedicle is often as slender as a thread.

CHAPTER XV.

THE SEA-URCHINS.

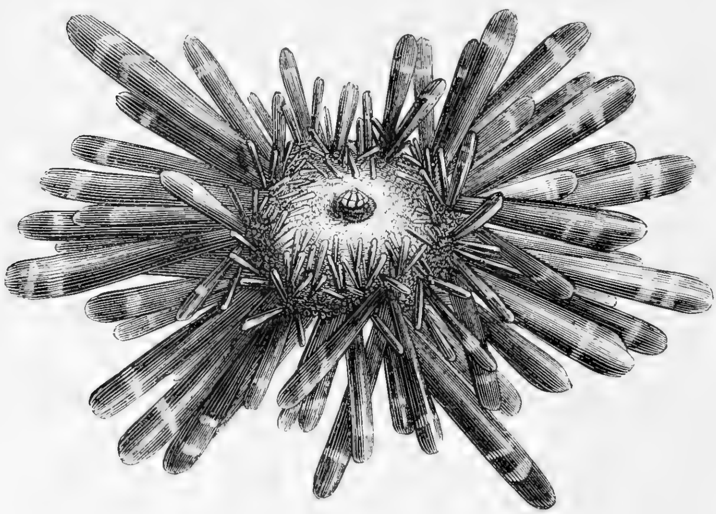
THE asterias resemble stars; the *Echini* or sea-urchins may be likened to melons; yet both belong to the same class—the *Echinoderms.*

The sea-urchins are enclosed in a calcareous kind of shell, which is generally globular or egg-shaped, but sometimes flattened. This shell, or carapace, is really built up of polygonal plates, which adhere by their edges to each other. The plates are so arranged that the shell is divided into vertical zones—hence its resemblance to the melon. These zones are of two kinds, one being very much larger than the other; the plates of the larger zones are covered with sharp spines, which are movable, and serve at once for protection and locomotion. The plates of the smaller zones are pierced with pores, from which issue filaments, by which the animal breathes and walks.

In the edible sea-urchin (*Sphærechinus esculentus*) the shell is composed of 10,000 distinct pieces, so admirably and firmly united, that the whole appears but one piece. The prickly spines are often very numerous; they cover and protect the shell. From these bristles, the animal has been named the *sea-hedgehog.* Its scientific name is derived from ἐχῖνος, which was given to the creature by Aristotle, from the evident resemblance the shell of the echinus, denuded of its spines, bears to a *vase.*

In one species as many as 2,000 bristles have been counted; in the edible sea-urchin there must be at least 3,000. These appendages entirely cover and hide the calcareous tunic which envelops the animal, like the numberless pearls which covered the famous habit of St. Simon—the material was of silk, but it could not be seen. The bristles of the sea-urchin present, at their base, a small hollow head, which has a compression on its lower surface, thus forming a cavity which fits a tubercle on the carapace. Each of the prickles, notwithstanding its extreme minuteness, is put in action by a separate muscular apparatus. They are porous, and are often grooved longitudinally—being formed of thin plates, which radiate from their centres. These are penetrated with countless holes, and are affixed to each other by prominences; so that, looking at the spine, we only see the edges of the plates which compose it. A membrane covers the whole, which is furnished with vibratory cils.

The shape and dimensions of these spines are very variable.

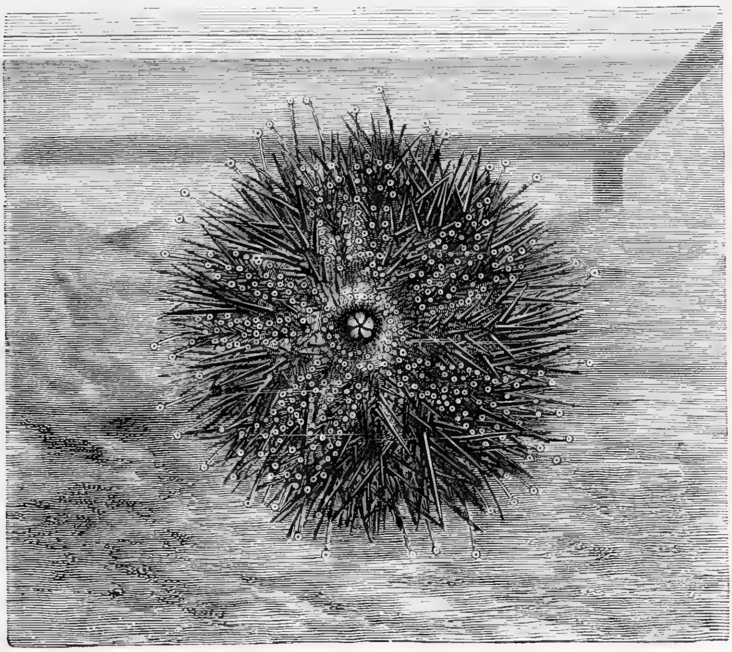


ECHINUS MAMILLATUS.

In certain of the echinoderms they are three or four times longer than the diameter of the shell; while, in others, they are only three-fourths or four-fifths of that diameter; while, in others again, they are reduced to mere protuberances from the carapace. These appendages are ordinarily awl-shaped and pointed, occasionally they are cylindrical and obtuse; and in some species they are flattened, and even have their edges truncated.

In one species which inhabits New Holland, M. Hupé found a mollusk *Gasteropod*, belonging to the genus *Stylifera*, enclosed in one of the spines, which was hollowed and greatly changed, both in form and structure, by the presence of this little parasite.

Among all the sights which Nature presents to us, there is scarcely one more interesting than that of creatures giving to each other shelter, and food, and protection, whether voluntarily or involuntarily. Is not the instinct of the stylifer marvellous? Nature has bestowed upon one creature an armour of bristling bayonets, when another animal, much smaller, seems to approve of the admirable defence, and takes up its abode in the midst—nay,



AN ECHINUS CLIMBING UP THE SIDE OF AN AQUARIUM.

actually in the spines, which, henceforth, protect itself as well as the urchin.

When the bristles fall off, the echini are found on our shores, very much like round fruit, ornamented on the sides with tubercles, symmetrically arranged. Their round form, and, perhaps, especially the limy nature of their shells, has obtained for them the name of *sea eggs*. The flattened species, denuded of their spines, are more like cakes than eggs.

The tentaculæ of the sea-urchins are hollow, very elastic, and are terminated by a sucker. The animals can inflate them by injecting into them liquid through their prickles, and by this means they can fix themselves to any foreign body. These organs are very numerous; in the ordinary urchin there are at least 1,400, and in the *melon* echinus, about 4,300. They can move by means of their tentaculæ and their spines. Professor Edward Forbes once saw one crawl up the sides of a very slippery vase.

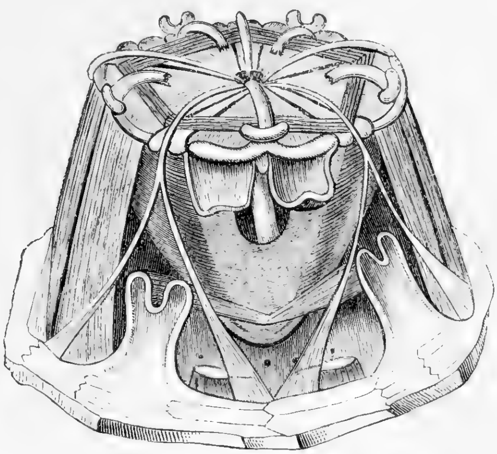
To understand better how they use their organs of locomotion, imagine one at rest. All the spines are motionless, all the filaments are contracted within the shell; when the creature wishes to move, some of these involuntarily begin to come out; they extend themselves, and feel the ground all round them; then others follow. The animal fixes some of its tentacles to the vase in the direction in which it wishes to advance, these then contract, while the hinder ones loosen their hold, and thus the shell is drawn forward. The sea-urchin can thus advance with ease and even rapidity. During the progression, the suckers are only slightly aided by the spines; indeed, the latter only serve as points, upon which the creature rolls as if it were on stilts. It can travel as well on its back as on its stomach. Whatever may be its posture, it has always a certain number of spines which are ready to carry it, and suckers which can fix it. In certain circumstances, the animal walks by turning itself round on its spines, like a wheel in motion.

The mouth of the echinus is situated underneath, and is generally at the centre. Around this orifice are fleshy tentacles, projecting from the surface, and more or less retractile. These are the organs which seize the food.

The digestive system presents a very complicated osseous apparatus, for a long time known as "*Aristotle's lantern.*" It consists of five pieces—the *teeth*, the *plumula*, the *pyramids*, the *compass*, and the *scythe*.

The teeth are five in number. They are all fixed on the same base, which is the *plumula*, and these are situated upon the edge formed by the assemblage of the pyramids, which are ten in number, and are joined in pairs. The lower part is made firm by the five scythes and the five compasses. In fine, the dental apparatus consists of no less than thirty pieces. The teeth are long, sharp, curved, and very hard. They can cut the hardest substances. However, in spite of their adamantine character, they would soon be worn down by work; but Nature has wisely provided for their renewal. They grow from the base as they are worn down at the points, like the incisors of beavers, hares, or rats; so that they are always sharp, and always in good working order.

The urchins live upon sea-weeds, worms, mollusks, and even fishes. Professor Rymer Jones saw one of these creatures seize a

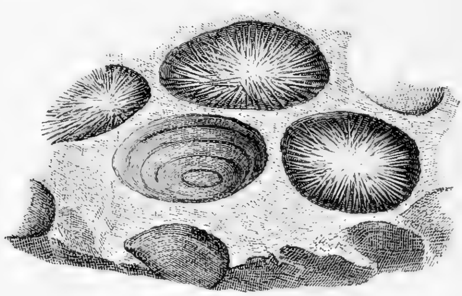


THE BUCCAL APPARATUS OF AN ECHINUS, MAGNIFIED.
(*Aristotle's lantern.*)

live crab, which appeared perfectly paralysed, and attempted no resistance. At another time, an urchin caught a *Galatea* by its buccal appendages; but the galatea, happily for itself, opened its pincers, cut off the part held by the urchin, and so escaped.

Many of these urchins, though defended by a calcareous shell, and by sharp, pointed spines, do not consider themselves sufficiently secure; for they hollow out holes in the hardest rocks in which they ensconce themselves. To effect this really difficult task, they fix themselves by their tentacles to the surface of the rock; they then make an incision by means of their powerful teeth, and remove the *débris* as it is formed by their spines. MM. Caillaud, Robert and Lory, have published some most interesting information upon this boring power of the echinus. It seems that even the young urchins, almost as soon as they are developed, commence the work, and form for themselves a hole fitted to their size. Poor little quarrymen, who pass a great part of their lives in working granite with their teeth!

When an urchin is cast up upon the shore, and left by the water, it buries itself in the sand, which it excavates with its



URCHINS IN A ROCK.

spiny appendages. The place where it is hid is easily recognised by the hole which it has left in its entombment. The fishermen pretend to foretell storms according to the depth to which the sea-hedgehogs bury themselves.

Linnæus has enumerated only seventeen species of echini; Gmelin, 107; but now many hundreds are known, and this group of animals has become the type of an entire class—the *Echinodermata*.

In many countries the sea-urchins are eaten raw; their flesh is yellow, and of a very agreeable taste. Those which are esteemed in Provence, are—the *edible*, the *granulous*,* and the *livid*.† A member of this last species is also in request at Naples, where the *melon urchin*‡ is served at table as a regular dish.

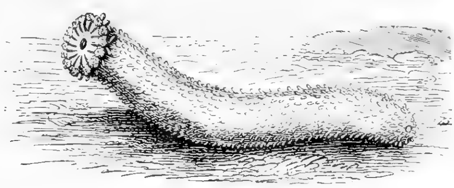
* *Toxopneustes granularis.* † *Toxopneustes lividus.* ‡ *Echinus melo.*

CHAPTER XVI.

THE HOLOTHURIDÆ.

In the same family as the sea-urchins—the *Echinodermata*—are placed the *sea cucumbers*, or, to call them by their scientific name, the *Holothuria*. These very curious animals have the form of an elongated and worm-like cylinder, sometimes straight, sometimes curved. Their size varies from one to forty inches; the larger size being the more common.

The sea cucumbers have a thick and leathery skin, which is occasionally transparent; more frequently, however, the skin is

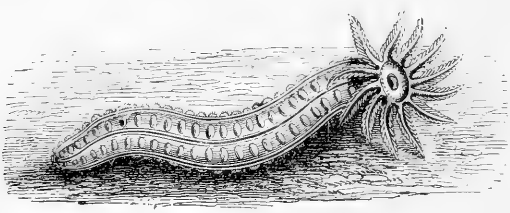


THE TUBULAR HOLOTHURIA.
(*Holothuria tubulosa.*)

granular, filled with calcareous particles. Out of this envelope appear tentacular feet, similar to those found in the echinus; they are hollow, and very expansible, and furnished at their extremities with a species of sucker. The mouth opens at the end of the cylinder, and is surrounded by a circle of tentacles. This mouth has immediately beneath it an osseous ring, composed of ten or twelve calcareous pieces; it is, in fact, the fundamental ring of *Aristotle's lantern*, described in the last chapter; at the tail end of the animal is a second orifice, from which issues, from time to time, a jet of water.

The holothurias inhabit deep waters; and, as their locomotion is very limited, they are seldom found far from their native rocks. When they do move, it is by means of a crawling motion produced by the undulation of their bodies, and by the contractions of their feet. These feet are sometimes in one place in the centre of the animal, forming a kind of disc, on which it crawls, after the fashion of a snail. Sometimes, however, they are placed all along the body, and in the *Cucumaria frondosa,* a holothuria found in the North Sea, they form five longitudinal rows. Many of the species are armed with small projecting hooks or fangs, which enable the creature to hang for a few seconds to foreign bodies. When these hooks adhere to the hand they produce an intolerable itching.

Lesson describes a holothuria, caught in the South Sea Islands, which was more than a yard long, and could contract itself into a few inches. The surface of its body was lubricated with an



HOLOTHURIA ELEGANS.

irritating fluid, which was acrid and corrosive, and when incautiously touched, the hand was affected with the burning itching to which we have alluded.

But the most remarkable feature in the sea cucumbers is the extraordinary power they possess of ejecting the whole contents of their sac when they are irritated or frightened. This phenomenon is most inexplicable, and it is well occasionally to note that there are things utterly beyond our comprehension. Dr. Johnson relates that for some days he had forgotten to supply a holothuria with fresh water. The creature became sick and dejected (we might well be the same); soon—either in prospect of death, or hurt at the doctor's neglect—it ejected its tentacles, its teeth, its digestion tubes, and a portion of its ovaries. These were laid scattered here and there at the bottom of the aquarium. The muscular effort to have had such an effect must have been terrible. Still, what was left of the creature was not dead; for its empty sac contracted at the least touch, and showed by its contortions that its irritability had in no way decreased. But what is more extraordinary, the creature, which seemed so utterly emptied of all its organs, began to reproduce them, and at the end of two or three months, all were replaced, and the holothuria seemed to be enjoying life as if it had never suffered so terrible a shock.

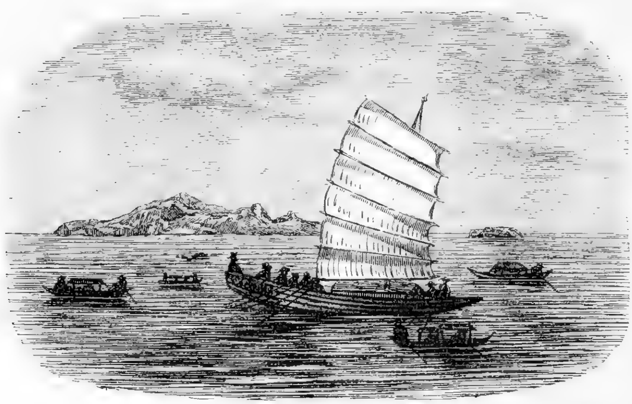
Not less worthy of notice is the singular power these remarkable animals possess of spontaneous subdivision. The commencement of this phase in their existence is marked by their becoming motionless and stationary. Each extremity begins gradually to enlarge, while the middle contracts; this contraction goes on until the central portion of the animal is reduced to a mere thread, which finally snaps, and then there are produced two perfect and complete sea cucumbers, which grow larger, and, in due time, each becomes a fac-simile of its former undivided self.

Notwithstanding the great revulsion which the very presence of these creatures causes to some people, they are esteemed by the Chinese as a delicacy, and the "*trepang*" fishing occupies yearly thousands of junks; while the preparation of this zoophyte, and its transport to market, engages the industry of a numerous population. To catch the trepang—whose scientific name is *Holothuria edulis*—a great deal of patience and much expertness is required. The Malays are the chief fishermen. Lying down in the fore part of the junk, the fisherman scans the bottom of the ocean beneath him. Aided by the clear blue sky of his country, he can see his prey at a great depth, often even thirty yards distant. In his hand he carries a long bamboo, armed at its head with a kind of harpoon. Seeing the creature crawling over the sands or the rocks beneath him, he poises his harpoon; the unerring dart speeds through the water, and seldom or never misses. When the depth is not more than four or five fathoms, divers descend, and taking the trepangs in their hands, bring up often five or six at once.

To prepare them for the Chinese markets the creatures are boiled, and flattened with stones; they are then spread out on bamboo platforms, and either dried in the sun or smoked. Thus prepared, they fetch about £70 a ton. The chief mode of using them is in soup; cut into shreds, and boiled with certain condiments suggested by culinary artists, they produce a soup not inferior in delicacy to that of the turtle.

An edible species is found in the Mediterranean, in the neighbourhood of Naples, where it is esteemed a great delicacy; it is the *Holothuria tubulosa*, which is peculiarly interesting from the little parasite fish, the *Ficrasfer Fontanesii*, which does it the honour of abiding with it.

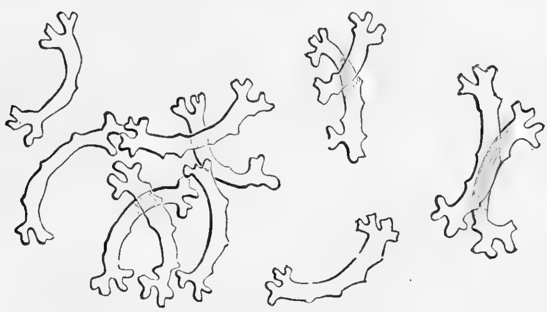
There is an animal analogous to the holothuria—indeed, it is



MALAYS FISHING FOR TREPANGS.

a member of the same family, and a very near relation—the *Synapta*. It is distinguished from the holothuria chiefly by the fact that it has no ambulacral organs—it is footless. The skin is transparent, so that we can see the internal economy of the creature. The microscope reveals a great number of spiculæ, which are peculiarly arranged in the tentacles. The synaptæ live upon peaty bottoms, and they seem to subsist upon the organic matter they find there.

The *Synapta Duvernæa*, which was discovered by Quartrefages at the Isle of Chausey, is the most singular member of the family. Imagine a cylinder of rose-coloured crystal as much as eighteen inches long, and more than an inch in diameter, traversed throughout its length by five narrow ribbons of white silk, and its head surmounted by a living flower, whose twelve tentacles, of a dead white, fall behind in graceful curves. In the centre of these ribbon tissues, which rival in their delicacy any of the products of the silk-loom, is an intestine of the finest gauze, filled—completely filled—with grains of granite, their sharp points and rugged edges plainly discernible to the eye. Fancy such rough grains contained in a tissue finer than gauze! The walls of the body are barely one-sixteenth of an inch thick, and yet Quartrefages discovered seven distinct layers of tissue, skin, muscles, and membranes. The animal is protected by a kind of mosaic work formed of minute



SPICULÆ OF THE TENTACLES OF THE SYNAPTA.

calcareous shields, each furnished with double hooks, the points of which are barbed like the arrows of the Caribbeans.

When kept in a vase of sea water, and unable to get any food, the synapta detaches portions of its own body. Below the part which is to be cast off a ring is formed, which gradually contracts, and thus the part suddenly drops off. It would appear that the animal, feeling it had not sufficient food to support its own body, was able to abridge its dimensions, by casting off the parts most easily spared, just as we should dismiss the useless mouths from a besieged city. This is a most singular mode of combating the approach of famine, and the synapta pursues the strange device to the very last moment; and, finally, nothing is left save a round ball, which is the head covered with tentacles. Thus, to preserve life in its head, it has voluntarily parted with all its other members. What marvels of animal life does the world of the sea contain!

CHAPTER XVII.

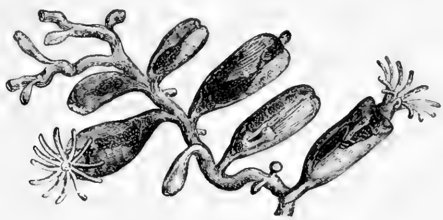
THE BRYOZOA.

MARINE plants are frequently found covered with a velvety growth, which is evidently the product of a parasite, and not naturally a part of the plant. Whether this soft covering be of vegetable or animal origin is not readily determined until it is submitted to the searching scrutiny of the microscope; all doubt is at once removed, and the moss-like growth is found to be a colony of animals, whose innumerable cells constitute the "animal moss." This resemblance to moss has given them their name of *Bryozoa* (*βρύον*, moss; *ζῶα*, animals). They are also frequently described in the pages of natural history, under the term *Polyzoa* (*πολὺς*, many), and they constitute the second group into which the extensive class of radiated animals, called *Zoophytes*, is divided. The first group—the *Anthozoa* (*ἄνθος*, a flower)—we have already considered; to this belong the corals and those animal associations which bear a striking resemblance to flowers. The term *Zoophyte* (*ζῶον*, animal; *φυτὸν*, a plant) thus comprehends all animal productions which approach to a vegetable form, and is used indiscriminately with *Polypi* (*πολὺς*, many; *ποὺς*, a foot); a word which must be long ere this familiar to our readers. The structure raised by the polypi is termed, as we have seen, a polypidom; and, on the same principle of nomenclature, "animal moss" is a *polyzoary*.

The microscope enables us to examine each of the members of the polyzoary. The animal is found to be ensconced in a cell, which is sometimes fleshy and soft; at other times, horny and calcareous. When in its native element, and undisturbed, the zoophyte extends out of the orifice of its cell a number of tiny arms, which wave about with easy, graceful movements, ever ready to enwrap the minute motes of life which form its food.

This wonderful colony has a common sense of danger; for if one of the zoophytes be touched, it instantly inclines to its neighbour, communicates the alarm, and withdraws into its cell, and, in an incredibly short time, the whole population of the colony is safely housed; however, confidence is soon restored, one by one they come out of their cells, and once more the daily life of the community is in full operation.

Ehrenberg and Thompson, who have carefully studied these animal mosses, find a considerable difference between them and the polypidoms of the anthozoa. The cell of the coral is a solid fixture, and after the polype has built its house, it has no further control over it; but this is not the case with the cell of the bryozoa and its occupant—the creature can turn its cell inside out, like the finger of a glove; and by this means the zoophyte can



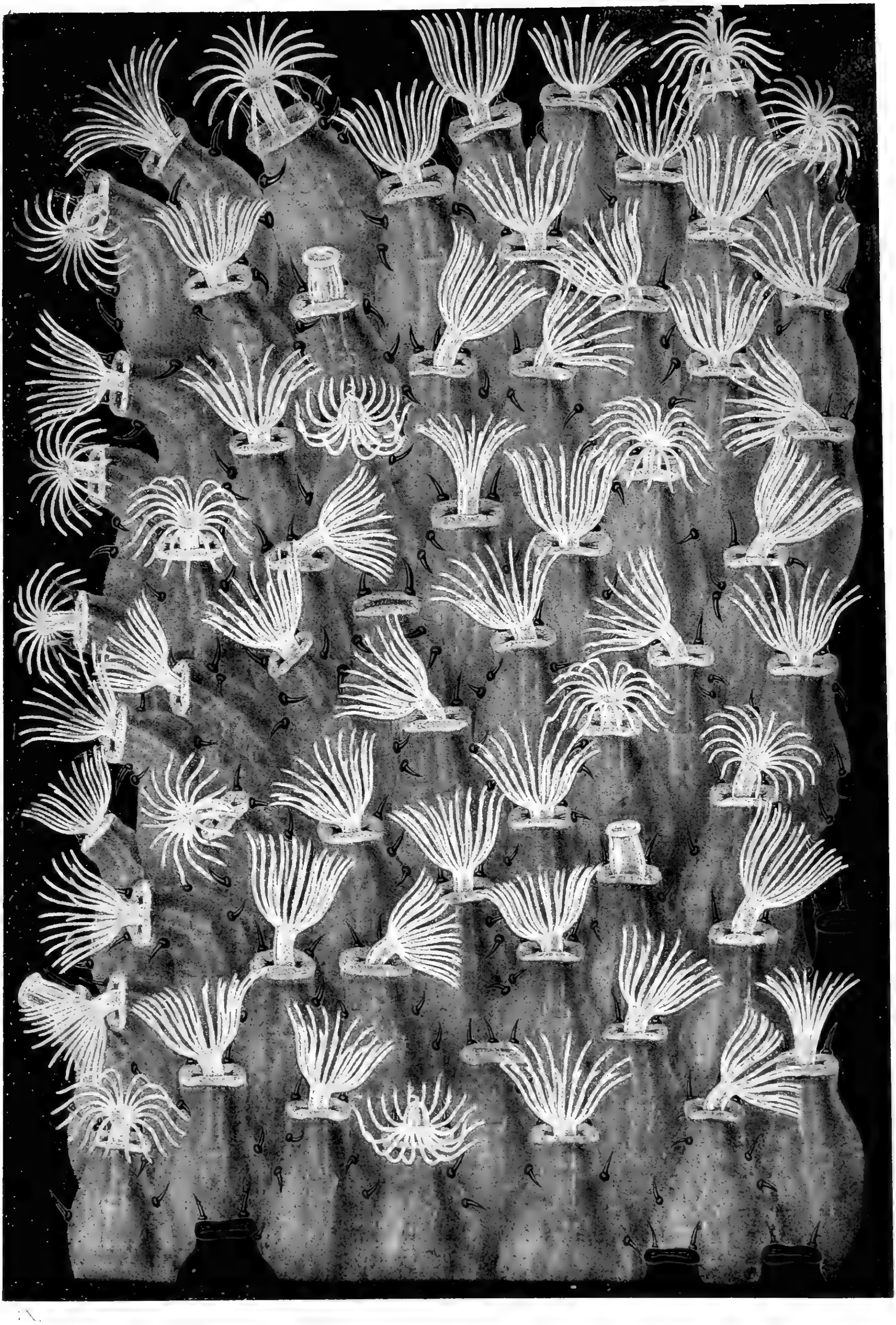
AN OPEN LAGUNCULA.

actually go out of its cell, although it cannot leave the settlement. When the animal displays itself, a circle of microscopic threads, of extreme tenuity, first show themselves above the edge of the cell; the uppermost portion of the body of the zoophyte next appears; then come the tentacles, which push the hairs aside. These tentacles have upon their surface a number of short hairs standing out at right angles, and they also are furnished with those peculiar organs—so universally distributed throughout the tribes of animalcules—vibratory cils. After the tentacles are spread, the tunic of the zoophyte unrolls itself, and the creature has reached the length of its tether, and is fully expanded. The action of its life commences; the appendages and the cils begin their rapid vibrations, by which currents are produced in the water—currents which bring within their reach the food necessary for the weal of the colony. Over the whole surface of the polyzoary eddy thousands of whirlpools, more fatal to the infusores which pass that way than ever the mälström is to northern mariners. Once within the suction of the current, nothing can save the unfortunate animalcule from a sure destruction.

Some of the species of this group are furnished with another organ, which has received the name of the *vibracule*. It is a hollow filament, situated at the upper and outer angle of each cell. It is filled with a substance which is at once fibrous and contractile, and admits of its performing some very remarkable movements, which occur regularly and at very short intervals. At first the filament inclines itself towards the base of the cell, trembles, oscillates, and seems to sink; presently it recovers itself, descends on the opposite side, and repeats the same manœuvre, in the same order, and in the same time. It is difficult to imagine what function this organ performs; it would appear that it is beyond the control of the will of the zoophyte, and is governed by involuntary muscles, for its motions continue after the creature has been injured. Perhaps the best surmise is, that it cleanses the orifice of the cell, and probably has something to do with the removal of that which the digestive organs reject.

Even from this cursive description of the bryozoa, it is evident that its organisation is superior to and more complicated than that of the anthozoa. This a closer examination of the anatomy of the two classes conclusively establishes. The digestive apparatus of the bryozoa is not merely a bag, with one orifice which serves at once for the reception of the food and the rejection of the refuse, with no distinct stomach and no intestines, like the polypes which inhabit the polypiers; but these zoophytes possess a mouth, a pharynx, a gullet, a gizzard, a membranous stomach, and intestines which have an opening of their own. There are some species known in which the gizzard is provided with a certain number of interior teeth, forming a marvellous pavement—an animated mill, which grinds the food before it passes into the second stomach. The organisation of this small and obscure creature reveals to us a wonderful series of combinations; here is indeed an ingenious adaptation, surpassing anything which human genius could devise.

Most naturalists have now agreed to class with the bryozoa



X.

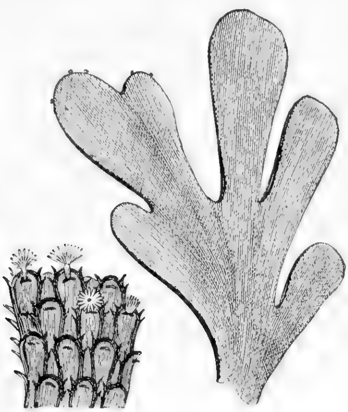
ANIMAL MOSS

[illegible]

a number of false polypiers, whose animalcules for a long time remained but very imperfectly known; such, for example, are the *Flustra* and the *Eschara*.

The *Flustra* (Plate IX.) occupy cells more or less horny, which are grouped symmetrically together, something after the fashion of the cells in a bee-hive. Sometimes they form a crust which covers the algæ and other submarine existences, and sometimes they themselves form thin leaves and ribbon-stems.

In certain species the cells are only found on one side; in other species they appear on both sides. The orifice of the cell is extremely minute, and is defended by microscopic spines. Their



A LEAF-LIKE FLUSTRA.
(*Flustra foliacea.*)

tentacles are covered with cils always vibratile, and arranged in straight lines. Their movements produce the appearance of a row of animated pearls in continual motion, rolling from the base to the point of the tentacle.

The *Eschara* form leaf-like expansions. The entrance to their cells is likewise defended by spines; and, like the flustra, they bear a resemblance to a bee-hive, the citizens of which enjoy, at the same time, a common and an independent existence. As in the polypiers, so is it here — each member of the community eats for the benefit of the common establishment, and also for its own immediate well-being; what affects the individual affects the colony.

Probably among the inhabitants of these groups there exist sentiments of brotherhood utterly unknown to us, and of the intimacy of which we can form no idea. Since that which is digested by one member of the family is, to a certain degree, beneficial to all, ought there not then to be between the different individuals, a kind of strong moral bond as well as a direct physiological communication? Such colonies as these cannot have the curse of selfishness, and with them egotism must be unknown. Happy nations, indeed! passing an unruffled existence, surrounded by the azure crystal of their watery element, unaffected by storms from without, and unagitated by internal strife.

The number of the members of these associations is not the least wonder they present. In a former chapter on sea-weeds, we mentioned the fact, that some of the fronds of the algæ were found covered with a fine lace-like structure—a colony of the *Flustra membranacea.* This flustra has been found occupying a surface eight feet in length and five in breadth; and, by a calculation, it has been established, that the silvery lace had been the handicraft, and was then the home of more than 2,000,000 of industrious and happy fabricators—a colony which counted more inhabitants than there are people in Scotland.

CHAPTER XVIII.

THE MOLLUSKS.

THE great sub-kingdom of the *Mollusca* stretches its limits from the fish on the one hand to the polypes on the other, and at each extremity glides almost imperceptibly into the adjoining classes. It is a difficult, indeed, an impossible matter, to find a definition which will include the mollusks and exclude the members of other tribes. As their name imports, the mollusks (*mollis*, soft) possess soft bodies—they have no internal skeleton. This body is enveloped in a soft elastic skin, not always fitting closely, but which often hangs in folds; and this peculiarity has probably suggested its name—the *mantle*.

The mollusks possess in general a complicated digestive and circulating apparatus. The great bulk of their bodies is made up of the stomach, the liver, and other members of the alimentary system; but the organs of sensation and motion are comparatively undeveloped. Indeed, most of the mollusks are condemned to a sedentary life; very few can move at all, and these but sluggishly. Hence the whole class is endowed with the power of sustaining long fasts; for not being able to go in search of their food, they are dependent upon the capricious bounty of the waves and currents. In the great majority of the mollusks, the mantle is capable of secreting first a horny covering, and from this exudes calcareous matter which forms the shell. This shell is thick and massive in those species which are incapable of motion, but light and fragile, and often altogether absent in those which lead a more active life.

As the shells of the mollusks are the parts of their structure by which they are most easily described, and most readily recognised, it is but natural that the first attempts at their classification should have been founded upon the difference of their shells. Linnæus divided the race into *univalves*, *bivalves*, and *multivalves*, according to the number of pieces of which the shell was composed. But further examination proved this simple division to be very unsatisfactory, inasmuch as some mollusks, very nearly allied in their characters and structures, differed widely in their shells; and, on the other hand, some whose shells were very similar, were in reality far separated by more essential differences. In addition to this, as many of the mollusks are shell-less, or naked, they were altōgether excluded from the classification.

The shell, although a very valuable adjunct, is discarded as a foundation for the divisions of which the sub-kingdom is evidently capable. The structure of the animal has finally been decided upon as the best means of subdivision. And at once the mollusks are divided into *cephalous*—those *having a head*, or a prominence in which is situated the mouth—and the *acephalous*, or those *without a head.*

The cephalous mollusks present three types:—1, the *Cephalopoda*, which have their feet or tentacles arranged around the head: to this class belong the cuttle-fish, which approaches nearest to the vertebrata, and therefore the cephalopoda are the kings of the mollusks; 2, the *Pteropoda*, a small class, which is characterised by the possession of a pair of wing-like expansions of the mantle, which supply the place of fins; and 3, the *Gasteropoda*, which is the most extensive group of the three, and derives its appellation from the fact that, from the under surface of its body is protruded a muscular *foot.*

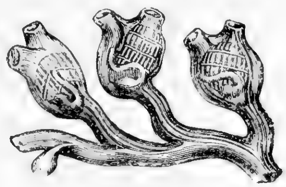
The *Acephala*, as might be expected, do not enjoy so high an organisation; they occupy the humblest position in the kingdom of the mollusks, and in their case we appeal to the shell to aid us in their subdivision. The *Conchifera* are those which are encased in a calcareous covering, whereas in the *Tunicata* the shell is wanting, but a leathery tunic encloses the whole body.

We trust that this general outline of the sub-kingdom will give the reader some idea of the territory of the ocean world which we now enter.

Mollusks are *solitary* or *gregarious*. We shall treat of the latter first, since their constitution is more simple, and they are the next link in the great chain of life to the polypiers and the polyzoaries.

The gregarious mollusks are sometimes found *agglomerated* in irregular lumps, or sometimes attached to each other singly, like the beads of a rosary. The agglomerated mollusks present the most curious combinations. The most prominent member of the group is, perhaps, the *Ascidia*, which owes its name to its shape, being not unlike a bottle (*ἀσκιδίον*, a leathern bottle). The substance of the mollusk is gelatinous, and the association is either of a sombre uniform tint, or it is painted with varied hues, which are sometimes even brilliant.

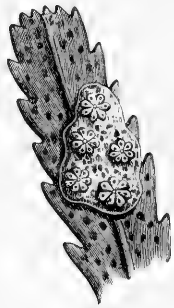
These living associations are found spreading themselves over the surface of the submarine rocks, or suspended from the overhanging ledges, like drooping icicles. Sometimes the large fronds of wrack which are thrown upon the sand by a storm, are found



SOCIAL ASCIDIÆ.
(*Perophora Listeri.*)

covered by these curious creatures, which are protected by a glassy mantle. Sometimes they bear a fancied resemblance to a starry constellation, or they are arranged like a bouquet, or are bent like graceful bows of ribbon. The individuals of the group are elongated or spherical, though occasionally they are angular. When one of these animal masses is placed in an aquarium, it appears as apathetic as a sponge; the only sign of animation it exhibits is a slight movement of the mouths of the orifices. But, upon examining it more closely, it is found to be not so inanimate as at first supposed, for currents of water go in and out of the orifices with such rapidity as to form little jets, if the mollusk be sufficiently near the surface. The larvæ of these animals are single and free. At a certain epoch of their existence they become fixed. When the little creature has been in its fixed position for some time, and has grown sufficiently large, there appear upon its surface small tubercles, which gradually increase, and in time become distinct individuals. These remain adherent to their mother, and this is the first settlement of a new colony.

The arrangement of the members of each association is very varied. But throughout this great diversity a rigorous and geometrical regularity is preserved. The inhabitants of these colonies are sometimes very numerous, though generally this is not the case. They are joined together indissolubly for weal or for woe; the same sunbeam cheers the whole; they curtsey to the same wave, and all tremble under the blast of the tempest. Each member of the colony fills its particular station, and performs its assigned duties with exactitude and zeal. No inharmonious jangling is heard, no factions strive for the rule; no divisions injure



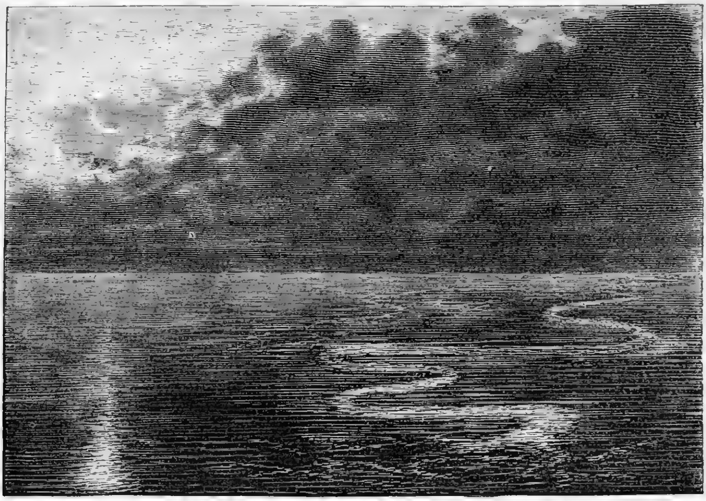
THE GILDED BOTRYLLA.
(*Botryllus gemmeus.*)

their prosperity, or threaten their peace. The ascidia furnishes us with the beau-ideal of a republic, where the citizens are intimately joined to each other, and where there is but one spirit for the common weal.

The *Botrylla* is another interesting association of mollusk life. Their colonies have seldom more than twenty members. They are somewhat flat, and adhere by their sides to some submarine body. They are so arranged as to form a kind of wheel. If we touch one of the branches, that particular mollusk contracts itself; when, however, we touch the centre, they all contract. The buccal orifice of each mollusk is placed at the outer extremity of the radius, but the intestinal openings abut on the common cavity which forms the centre of the wheel. Here is another vagary of nature—animals who eat separately, but who fulfil together as a community very singular functions. This is a kind of union of which we have no other example ; the entire star may be considered as one single animal with many mouths.

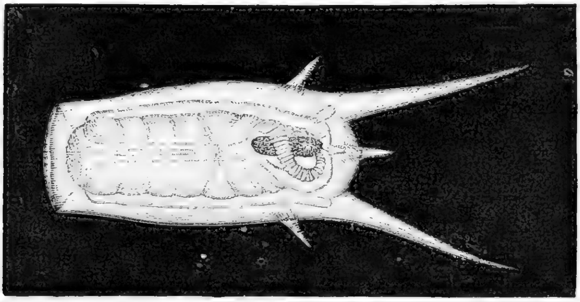
While the *Botrylla* is fixed, the *Pyrosoma* is perfectly free. This aggregation constitutes a brilliantly-coloured mass. Its form is that of a hollow cylinder, closed at one end. The creature floats and balances itself upon the water like the sea-pen. One of its species, the *Atlantica,* changes its colours like the chameleon, only much more rapidly. It quickly passes through the shades which intervene between bright red and bright yellow, and on as quickly to golden orange, and through green to azure blue. Moreover, to add to its charms, it is phosphorescent. Its name, pyrosoma, literally signifies a "body of fire." Humboldt saw a shoal of these brilliant living colonies floating by the side of his ship, and giving out circles of light not less in diameter than twenty inches. By the light of these lamps shining in the watery firmament, he was enabled to see the fish which swam in the vessel's wake down to a depth of three or four fathoms. Bibra, a Brazilian navigator, having caught seven or eight of these *Pyrosoma Atlantica,* took them into his cabin, and by their light was able to read to his friend the account he had written of these light-giving mollusks.

The *Biphora,* or *Salpa,* constitutes a group which bears a great resemblance to the polypier. These creatures are rather disposed in a series, than in an actual agglomeration; indeed, they are the transition group between the *gregarious* mollusks we have been considering, and the *solitary* mollusk. The salpas are long, transparent threads of extremely delicate tissue, composed of rows of individuals placed side by side, and grafted, as it were, transversely. This order of arrangement is not invariable, for sometimes the little mollusks are united by their extremities to each other, and two such living chains are placed side by side. These wandering societies have been met with forty miles long. The individuals are composed of a crystalline substance, tinted with red; their bodies are cylindrical, open at each extremity, and, like their relations, the pyrosoma, they are phosphorescent. These colonies of salpas glide over the surface of the waters in undulating curves. The little voyagers contract and expand simultaneously, manœuvring



CHAIN OF PHOSPHORESCENT SALPAS ON THE SURFACE OF THE SEA.

in concert, like a company of admirably-drilled soldiers; indeed, the whole line acts as one individual. Sailors call them the *sea-serpent.* They always swim upon their backs, and the mode of their



A SOLITARY SALPA.
(*Salpa Democratica.*)

locomotion is very peculiar. They drink in a quantity of water, which they squirt out from their other extremity; and so their body is pushed on by the recoil. This is a wonderful mode of locomotion, and one which no other animal possesses. Not long since a ship was constructed on this principle; its engines forced out jets of water from its stern! When a chain of salpas is taken from the water, the individuals let go their hold, and the company is dissolved—the soldiers no longer can form their line. Sometimes a *solitary* salpa is met with. This used to be regarded as a distinct species, but now we know that both the parent and the offspring of the gregarious salpas are, at one period of their existence, solitary—that is, the chain salpas do not produce chain salpas, but solitary salpas; and these in their turn do not produce the solitary species, but chain salpa. Thus a salpa is not like its mother, but takes after its grandmother. Of course the discovery of this phenomenon has solved the difficulty which was long felt by naturalists, and has at once connected the solitary and the associated salpas. But what patient research was expended upon its elucidation—research which has made eminent Milne-Edwards, Chamisso, and Krohn.

In taking leave of these associated mollusca, we cannot fail to be struck with wonder at the grand idea upon which they are constructed—myriads of individuals—a crowd of beings joined to each other, and borne upon the waves, while from one end to the other of the living chain, thrills the same feeling, and the whole tribe is actuated by the same instinct.

CHAPTER XIX.

THE ACEPHALOUS MOLLUSKS.

ALTHOUGH the gregarious mollusks are veritable members of the sub-kingdom we are considering, yet they cannot be said to be its fair representatives, seeing they have not an individual and independent life. Hence the solitary mollusks are said to be *true* mollusks.

The *Acephalas* being found at the bottom of the class, we shall consider them first. Some are naked, some have shells. The naked members of the class are generally adherent to the fuci, to the shells of better protected mollusks, or to the rocks. They have little, if any, power of locomotion. The solitary *Ascidia*, for example, is condemned to an immovable life—once fixed, it never again attempts to leave its position, and lives and dies attached to the same spot.

One of the members of the ascidian family—the *Bichus*, which cannot boast of an elegant appearance—is found in the neighbourhood of Cette, and is sold in the market for food. Its thick leathery skin having been stripped off, and its viscera taken out, the remainder is eaten. At first the taste is saltish; but when swallowed, a sharp, peppery taste remains in the mouth.

These mollusks are furnished with two openings, the margins of which are ciliated, and if the animal be pressed in the least, it ejects water from them with considerable force.

The ascidiæ have no hands nor yet lips wherewith to seize their prey; their mouth is placed very favourably, at the lower part of the sac, but not at the very extremity. Nature has not forgotten to provide the animal with the power of nourishing itself. The inner surface of the visceral cavity is furnished profusely with vibratory cils, which cause the water to pass in strong currents towards the buccal orifice. When observed under the microscope, these cils in motion appear like oval wheels delicately toothed, which continually revolve from left to right. This movement engenders minute wavelets, which cause a current of water to traverse the sac of the mollusk, carrying with it live and dead matter, upon which the creature exists. Thus these singular animals—as many others—breathe and eat by the agency of the same organs!

According to some naturalists, the ascidiæ have eyes. They think that six or eight red spots which are disposed round the orifices, are visual organs. But this is very questionable, for what possible use could eyes be to a creature which cannot move, whose prey is brought to it, and whose whole existence is involuntary? And yet we cannot tell of what sensations these mollusks are capable; they may have joys unknown to us—joys dependent upon the light of the sun, which struggles through the azure water down into the depths they inhabit.

The larvæ of the ascidiæ are of course not fixed; they are not unlike tadpoles, having large heads and short tails. Swimming away from their parent as soon as they are born, for some little time they give way to a roving propensity; but the chains of instinct are about them, and in due time they settle down in life. This, however strange it may appear, seems contrary to their inclination; for, on watching the process of this transformation, it has been observed that the larva, having placed its head against a rock or any other solid body—doubtless directed by instinct, but probably utterly unprepared for the result—becomes fixed. This is the sign for the metamorphosis to commence; the head enlarges and grows hollow, the tail—if we may be allowed the expression—is flourished in the air. But soon the flourishes give evident tokens of anything but pleasure, for the motion begins to grow so rapid that it is difficult to see the tail. The struggles of the little creature are perfectly frantic, but all effort is useless; it is a fast-bound prisoner for life; and, in time, ceasing its vain endeavours, it resigns itself to its fate. The tail drops off, a thick coating grows round it, rootlets spread like anchors from the part by which it is attached, and completely fix it; and thus, forgetting the roving propensities of its youth, the bichus settles down and becomes a staid member of marine society.

If all this be true—for we must not forget that many observers have no small powers of imagination—but if this be true, we have a very striking example of a will independent of instinct.

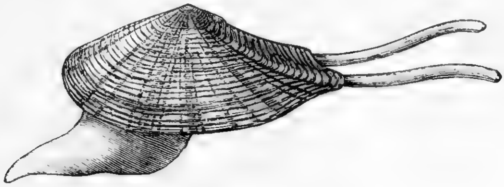
The woolly ascidia (*Ascidia ampulla*), contrary to the habits of its race, is free. Here the adult keeps the prerogative of the child. It is a species which is only dredged up with the sand from great depths. Its sac is round, and of a brown-red colour, the interior of the orifices being bright scarlet. We do not know whether this mollusk buries its lower extremity in the sand or not; when in captivity it simply lies horizontally, and makes no effort to descend lower or to change its position.

The shelled mollusks are more numerous than the naked acephala. They are termed *bivalves*, because their shell is in two parts, which are united by a hinge. Between this double carapace the creature is enclosed, as the leaves of a book between its covers. Although they have no head, yet they feed themselves; they appear to have certain feelings; and they can, of course, reproduce their kind. They have friendships and enmities, and perhaps even passions; these, probably, are not very lively, for the bivalve very rarely changes its position. Many of them are fixed to the rock on which they were hatched, and vivid sensations seem incompatible with immobility. Bivalves are found in every sea, and, as might be expected, some of their species are peculiar to certain regions. The Pandoras, for instance, people the northern seas; the Chama is a native of the southern waters. The conditions of life under which they can exist are very varied; they can live in the sand, in the aquarium, upon rocks, or in the very midst of aquatic vegetation. They can support a great pressure of water, and have been found existing at great depths. Edwards brought up an oyster upon a sounding-lead from 1,400 fathoms!

The shell of the bivalve is ovoid, globulous, trigonal, heart-shaped, elongated like a pea-pod, or flat like the leaves of a tree. In some cases, each valve is exactly alike, in others one is flat and the other convex. The two valves often possess accessory pieces. Such mollusks used to be called *multivalves*.

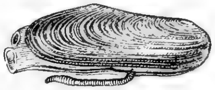
All the bivalves are not destitute of the power of locomotion; for some can change their place by means of a fleshy extensible organ, which is, from one of its uses, called a *foot;* but it resembles rather a large tongue. In the many drawings of these gasteropods, its varied shapes are shown. In some species the tissues of which this organ is composed are spongy, and are capable of being filled with water, and so the creature is enabled to extend and stiffen the foot; by expelling the water, the limb returns to its limp condition, and resumes its place within the shell.

Mollusks use their foot very cleverly. They stretch it out,



TELLINA PULCHERRIMA.

fix it by its point, then contract it, and so pull themselves along. Réaumur compared the advance of these creatures to a man who lies down on the ground, stretching forward his arms, seizes some solid body before him, and then draws himself to it;



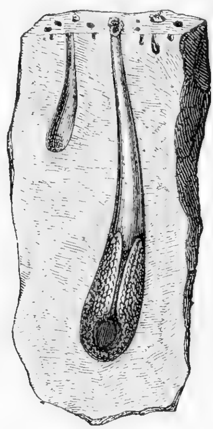
MODIOLA LITHOPHAGA.

the only difference being that, in the case of the mollusk, the member does not double itself up in joints, but contracts in its whole length.

In some few and rare instances, the mode of progression is exactly the reverse: the creature plants the point of its foot firmly against the sand, and then stiffens it, thus pushing itself forward, just as a bargeman urges on his boat by thrusting his pole against the bottom of the river. There are acephalas which progress by leaps. This peculiar species of locomotion is effected by a sudden opening and shutting of the valves. The *Pectens* sometimes dart through the waves to avoid a danger, and the

Limas leap in their watery element like the butterflies in the air. This motion is aided by long, slender, cylindrical, and very contractile tentacles, which are attached to the fringe of the mantle. They are composed of a number of little ring-joints, which can, if necessary, pass one within the other, after the fashion of a pocket-telescope.

The *Razor-shells,* or *Solens,* force themselves vertically some depth into the sand. The place where they are buried is indicated



A PHOLAS IN A PIECE OF STONE.
(*Pholas dactylus.*)

by a hole in the sand which corresponds to the siphon of the animal; when the mollusk is alarmed, it squirts up this hole a jet of watery liquid. It entombs itself with a foot of unusual dimensions, a natural dirk, with whose pointed end it readily excavates a hole; this it soon renders cylindrical, and then draws in the shell. In a very little time the razor-shell can bury itself fifteen or twenty inches deep.

The *Pholadæ* are a family which can bore out for themselves a residence in wood or even stone. They appear to carry with them a graving tool, and the shell is fitted in a hole as in a needle-case. How can these animals bore their way into the very hardest rocks? Aldrovand believes that they were born in the bosom of the rock while it was in a soft state, and Réaumur shares this extraordinary opinion ; but this cannot explain their presence in logs of wood. Others have supposed that the current of water produced in the process of their respiration wore out the cavity by its continual erosion ; but this theory again is not supported by fact, for the pholas finishes its excavation in a few months, which could not possibly be the case if water were the only agent. Another supposition is, that the foot and the edge of the mantle are filled with siliceous particles, like sand-paper, which, by continual friction, rub and wear down the rock, and

MODIOLAS IN ROCK.

file away its substance. Other naturalists suggest that the pholas may have the power of secreting a corroding liquid, by which the rock is eaten away. But then how is the shell itself to escape the action of the liquid ?

To De Blainville belongs the honour of suggesting that a simple movement of the shell, constantly repeated, would in time pierce the stone. Observation has since decided that his opinion is correct ; the shell itself cannot be worn away by this process, because it is composed of aragonite, which is harder than the rock in which the animal burrows. The mollusk bores down a considerable depth, and then hollows out its home to accommodate its increasing bulk. Hence, as the engraving shows, their lithodomes are bottle-shaped—wide at the bottom, with narrow necks.

These little borers cannot but excite our wonder. Here are soft creatures without the slightest consistency, capable of hollowing out for themselves homes in the hardest rocks! Such is the power of life, even in its lowest development, over inanimate matter.

Some of the bivalves produce a brown or golden-coloured silk, which forms the cable, or *byssus,* by which they anchor themselves to the rocks. The mytilus has the byssus short and coarse; in the pinna it is long and silky. Attempts have been made to utilise this filament; indeed, the inhabitants of Taranto make gloves and stockings of it. Cloths of a rich brown have also been fabricated, which are of an admirable texture. Some beautiful specimens of this fabric were exhibited at the French Exhibition of 1855, and in that year M. J. Cloquet presented the Acclimatisation Society with a pair of fine mittens made of the byssus of the pinna. Not only does the byssus serve to fix the mollusks to the rock, but some of them attach by its means stones, pieces of coral, and other solid matters to themselves, thus surrounding their shells with a very invulnerable coat, in which they lie in ambush, waiting for their prey. In constructing this envelope, which is not unlike a miniature rockery, the mollusk, by a singular artifice, spins and weaves the material of its byssus. It then lines its interior with a species of tapestry, thrusts this outside, and mats together by its means the solid bodies within its reach. Thus it in turn plays the part of spinner, weaver, and mason. Clothed in a calcareous covering, or a stony mantle, buried in a rock, or anchored by a cable, the bivalve—the softest and the most delicate of creatures—can exist in a terrible and ever-turbulent element without injury and without inconvenience.

The smallest of the bivalves are scarcely one-fiftieth of an inch long. The giants of their community, the *Tridacna gigas,* are more than a yard wide. A very fine pair of shells of this species is to be seen in the church of St. Sulpice, Paris, where they hold the holy water. These magnificent shells were presented by the Venetian republic to Francis I., and in the time of Louis XIV. they were given to the church. Another but somewhat smaller pair are used for the same purpose in the church of St. Eulala, at Montpellier.

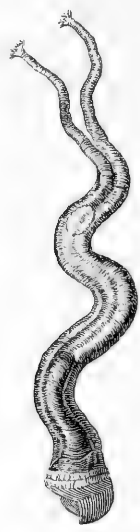
The mantle of the acephalas is a kind of membranous tunic, and is so large as to form folds; its edges are fringed. This mantle protects the mollusks, and in its turn it is protected by a shell. The animal sometimes possesses eyes and ears; but as it has no head, the eyes are placed on the margin of the mantle, and its ears are in its stomach! The *Tellinæ*, the *Pinnæ*, the *Arcadæ*, and the *Petunculi*, have distinct, though very small organs of vision, consequently they are very close-sighted, and are dazzled in the full light of day. The ears are little bladders, which contain a microscopic pebble, suspended in a drop of water.

When we compare the organs of different species throughout the whole range of the animal kingdom, we find them passing from the most simple to the most complicated structures by the gentlest gradations. But all the organs of an animal may not be in the same state of development; some of them appear to have stopped in the upward progress, while others have proceeded to a further state of perfection. Yet there is always a compensating harmony in these inequalities of development, so that a creature deprived of the use of one perfect organ always has the deficiency made up by the superior quality of another. In this manner the budget of nature is always perfectly balanced.

It is among the acephalous mollusks that we find those terrors of the ship-master, the *Teredos.* These Vandals attack every piece of wood within their reach, just as it is the propensity of certain insects to cover all the wood they are able with their larvæ. In months, or even in weeks, they will perforate a plank in every direction; the little miners having the singular instinct never to cut into another channel. The wood externally does not appear injured, but crumbles at a touch. Silently, unwearyingly, the teredo bores, until the pier suddenly sinks, or the planks of the doomed ship crumble beneath the feet of the sailors.

In the beginning of this century, half the coast of Holland was threatened with the invasion of the sea, because the piles which upheld the dykes were attacked by the teredo; and it required an outlay of a large sum of money to secure the country from the disaster of an inundation, caused by a contemptible mollusk. A closer study of the habits of this animal has shown that it possesses an insurmountable antipathy to iron-rust; hence, all wood which is to be exposed to sea-water is first soaked in a solution containing iron. The covering of copper with which ships are armed, renders the appellation Linnæus gave to the teredo—*Calamitas navium*—no longer true.

The body of the teredo is long and worm-like; its colour is



THE COMMON TEREDO.
(*Teredo navalis.*)

greyish white. At one end is a knot, improperly called its head, and the other extremity bifurcates into what may be called two tails. It often attains the length of eight inches. It buries itself in a case which it eats out of the wood; the walls of the case are covered with a coating of a calcareous matter mixed with mucus—this renders them firm and solid. The round part of the mollusk carries two small valves, very thin and fragile; they are not unlike in shape to two halves of a nut-shell. These valves are immovable, and protect the weak part of the animal.

The teredos form the transition stage between the naked acephalas and the bivalves. Their mantle is a kind of fleshy sheath; it divides itself into two tubes, which the mollusk can lengthen or contract at will. One of the tubes carries the aerated water, which contains the oxygen necessary for the life of the creature, and likewise the organic particles which form its food; the other tube carries off the liquid which has been deprived both of its air and nutriment, together with all the refuse of digestion. All the internal organs of the teredo are placed one immediately behind the other, a position which is necessitated by the narrowness of the body, and the repeated elongations which it is required to undergo. When we think of the havoc these little worms are capable of producing, and how they are able in a short time completely to riddle with their holes even the hardest wood, we are at a loss to comprehend how, with their soft bodies, they can possibly do it.

The teredo deposits greenish yellow eggs, which are spherical. As soon as the larva is born, it becomes covered with vibratory cils. It swims with facility, rises and falls in the water, seeking for wood into which it may penetrate. When it has found a piece of wood to suit its convenience, it walks up and down on its surface, like a caterpillar. From time to time it opens its little valves, as if practising for the mining operations it contemplates. At last it fixes upon a place, and makes an incision. In due time it has excavated a hole capable of containing half its body. The young teredo now covers itself with a coating of mucous matter, which, condensing by degrees, at last forms a resisting shell. In this covering two or three holes are left for the projection of the siphons. About the third day the tube has become solid—indeed, calcareous—and it is now the origin of the tube of the animal. We cannot see what is taking place inside, for this coat is opaque; but if we detach some of the young teredos from the wood, at this stage of their development, we shall find that there has been secreted a new shell, similar in all respects to that of the adult animal. It cannot be that this shell is the instrument wherewith the perforation is executed, for it is very fragile; and it would surely show some signs of wear and tear, which is never the case. Some naturalists suppose that the teredo secretes a corrosive fluid which acts on the wood; but this theory cannot account for the smoothness of the walls of the galleries, which are as though they had been excavated with a hard, sharp tool. M. Quatrefages has suggested the most probable solution of the difficulty. We must remember that the wood upon which the animal works is always saturated with water—even a slight mechanical action, especially if continuous, would readily clear away the softened fibre. The cutaneous folds of the cephalic hood, which are covered with a thick coriaceous epidermis, are moved by four strong muscles, and this is doubtless the boring instrument. The young teredo feeds upon the raspings of the wood.

CHAPTER XX.

THE OYSTER.

EVERY quadruped and every bird, even if it find not a friend in man, yet has a protector from the cruelty of man in the Society for the Prevention of Cruelty to Animals. Perhaps it is that this admirable society finds that it has as much as it is able to do in looking after the interests of the terrestrial animals, without searching the world of the sea for fit objects over which to extend its protecting arm; or it may be that the sufferings of the denizens of the sea who have the misfortune to fall into the hands of the lords of creation, have never been brought under the Society's notice. But, so far as we know, no effort has ever been made to defend the marine inhabitants from the ill treatment many of them receive. Let us, for example, tell the tale of the oysters' woes.

The dredge, with a violent wrench, tears them from their native rock. Lifted from the water, they are, especially in France, carried to "oyster parks"—long, canal-like excavations—filled with green, stagnant salt water. The green matter, which makes the water all but offensive, penetrates the systems of the poor mollusks compelled to inhale it. The oyster under this *régime* fattens, and soon attains that state of obesity so relished by the connoisseur, but which is really the result of disease induced by the unwholesome water of the park. Imagine the unspeakable disgust of the bivalve, after living in the beautifully clear and fresh water of the ocean, at being immured in a stagnant pool, whose water is seldom changed, but always charged with filth. When the miserable creature has attained a livid green colour, it is fished up a second time—not, alas! to be returned to its native sea, but packed in a hamper—an ignoble prison-house, without door or window; with only as much of the life-giving water as it can contain between its tightly-closed valves, it is scarcely able to keep off asphyxia. As if they were inanimate merchandise, and not living creatures, they are dispatched by rail, tossed about from one van to another; and terribly shaken, they at length arrive at an oyster-shop. This is a critical moment for the unhappy bivalve. Thrown into a tub of clean water, its hopes are cruelly revived, and for a moment it fancies its tortures are at an end, and once more it is in the sea. If ever it possessed such thoughts, they are soon dissipated, as it finds itself taken for the third and last time out of its native element. It is now in pitiless hands—a blunt knife, in spite of its most strenuous efforts, is thrust between its valves, and with a horrible wrench its shells are forced asunder. The muscle by which they were closed is cut or rather jagged through, and the hinges are violently detached. It is now laid out on a plate, exposed to every current of air, and in this state of suffering it is carried to the table. There the thoughtless being for whose pleasure it has suffered untold woes, powders it with the most pungent pepper, squeezes over its wounded and bleeding body the abomination of its race, the acrid vinegar; and then, alas! with a silver knife, which only jags, but cannot cut, he wounds and bruises it a second time; or, worse still, he saws and tears and rends it from its remaining shell; then he impales it with a three-pronged fork, and—*horribile dictu!*—still living and palpitating, he throws it into his mouth, where the teeth cut, and crush, and grind it.

We have said that oysters have—in common with their family—neither head nor arms; that they are without eyes, without ears, without nose; they cannot move, they cannot cry. Quite true; but all these negatives do not assert that they are insensible to pain. Two celebrated Germans, Brant and Ratzeburg, have shown that the oyster possesses a well-developed nervous system; and if they have organs of sensation they must suffer. "Can an animal with nerves be impassive?" asks Voltaire. "Can we suppose any such impossible contradiction in nature?"

We hasten, however, to tranquillise the minds of the dredgers, the breeders, the sellers, and the consumers of the oysters; and to excuse the indifference of the protecting societies; for there is a great difference between a helpless, imperfect mollusk and the higher class of animals. In the case of the former we swallow the whole animal, scarcely thinking of its animal nature. It is a denizen of another element; it lives in a medium in which we cannot exist; it presents itself in a form we may call degraded; it has an obscure vitality, motions undecided, and habits scarcely discernible. We may, therefore, witness the oyster mutilated—mutilate it ourselves—crush it, and swallow it, without a passing pang, or yet a feeling of remorse, and without laying ourselves open to the charge of cruelty.

It is an open question whether it be judicious to enter into the details of the anatomical structure of the oyster; for, generally, when we dissect an animal it certainly does not improve our relish in eating it; and, moreover, zoologists who know—*ex professo*—the anatomical structure of the mollusk, tell us they try to forget their knowledge when they are eating oysters. This is the reason why we have introduced, with some little hesitation, into our work any structural details of these celebrated, though badly-treated, bivalves. But we warn the reader, if he is about to indulge in an oyster supper, not to read the description we are giving, lest by any chance it should blunt the edge of his appetite.

Suppose, then, we have before us a fat oyster, fresh and well opened, lying in its concave valve. A glance shows us that the animal is flat, compact, soft, somewhat transparent, and of a greyish colour. Its shape may be described to be an oval, one end of which has been cut off. The curved line which lies to the left is the front of the creature, and that to the right, which is much straighter, is its back. Its upper part is slightly puffed out, as a pad, and approaches a quadrilateral shape.

The skin which encloses the oyster is the *mantle;* it is very thin, and so large that it pleats itself into folds, making two distinct tucks—if the ladies will lend the word for descriptive purposes—which run round the greater part of the circumference; the beard is the fringe of the mantle. The mantle may be compared to a cape, whose upper part is attached to the oyster near the hinges of the valves. Its edges are ornamented with a fringe of cilia; on the interior edge there is only one row of cilia; but on the outer edge, which is pleated and festooned, there are three or four rows. These cilia possess some sensibility, for the creature can extend them at will.

If the folds of the mantle which are in front of the oyster be raised up, at the crease of their junction will be found four irregular triangular plates, close together and surrounding an opening. These are the *lips*, and the opening is the *mouth*. These plates are the tentaculæ of the oyster—they choose its food, and introduce it into the mouth, the cils doubtless causing currents of water to flow past them, which bring the nourishment within their reach. The mouth itself seems to be large and dilatable, and opens directly into the *stomach*, which is a pear-shaped, cylindrical pouch. From the other extremity of the stomach a fine sinuous intestine takes its rise, which passes obliquely towards the back of the creature, descends slightly, then reascending, passes behind the stomachal cavity, and finally issues in the centre of the adductor muscle. The stomach and the intestine are surrounded on all sides by the *liver*, which is a dark-coloured body, permeated by a yellow liquid—the *bile*.

Thus we may say that oysters have their stomach and intestine in the liver, the mouth upon the stomach, and the opening of the intestine in the back.

It has long been the opinion that the most tasty part of the bivalve is the cushion, or quadrangular pad. Certain distinguished amateurs have proclaimed the principle of dividing the body of the creature transversely, and eating that part only. Natural history explains this gastronomical discovery—it shows that the bile, secreted by the liver, is contained in this substance; that it accelerates while it exhausts the tasting organs on the surface of the tongue and palate, aiding also the functions of the stomach.

Beneath the liver is the *heart*—for oysters have a heart—which contains two distinct cavities, an auricle and a ventricle. The first is nearly square, its walls are thick, and of a dark brown; the second has the shape of a little pear, its tegument is not so firm as that of the auricle, and its colour is grey. The two anterior angles of the auricle each receive a great vessel. Each of these is formed by the union of three other smaller veins. From the point of the ventricle issues a canal, which soon divides into three divergent branches. One of them is directed towards the mouth and tentacles, the second enters the liver, and the other distributes the blood to the rest of the body. The heart is closely beset—embarrassed, we might almost say—by the terminal portion of the intestinal canal, the *rectum;* so much so, indeed, that it appears to pass without ceremony into the very midst of the noble organ. So do extremes sometimes meet—the spring of life and issue of the useless material are close together.

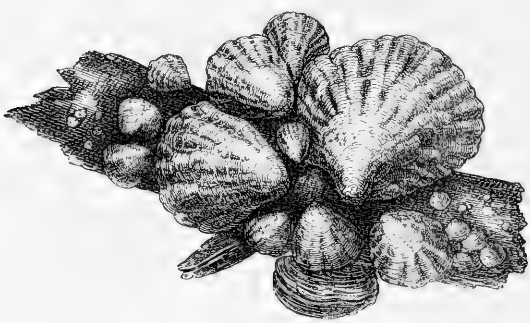
The *blood* is a colourless, limpid fluid ; it enters the auricle to be purified; thence it is driven into the ventricle. This cavity, in its turn, contracts, and propels the fluid through the channels already described.

Oysters breathe at the bottom of the sea. The Creator has given them organs, by which they are enabled to separate from the water the small quantity of air which it contains. They cannot live in water which is not aerated, for the oxygen vivifies, and renews the active power of the blood. The respiratory organs are two pairs of gills, or *branchiæ;* they are curved, and are formed by a double series of very delicate canals, placed close together; their appearance is not unlike the teeth of a fine comb. This apparatus, like the mouth, is hidden under the fold of the mantle.

Having no head, the oyster can have no *brain;* in its place there is a ganglion of nerves—a whitish substance, situated near the mouth. Out of this originate two nerves, which branch off to the regions of the liver and stomach; they again reunite in a second similar ganglion, which is placed behind the liver. The first ganglion furnishes nerves to the mouth and its tentacles, and the second to the respiratory branchiæ. The oyster has no power of seeing or hearing. The sense of touch appears to be the only sensation it enjoys, and that resides in the tentacles of the mouth. Its taste, if it have any at all, must be very faint.

Of all the shelled mollusks oysters seem to have the most limited powers. Condemned to a sedentary life, imprisoned for ever in their shell, and even without a distinction of sex, they cannot have many wants or desires. They must be well-nigh apathetic, living in a calm and quiet indifference; and yet these mollusks are sociable, and gather themselves together in vast numbers; so that, in spite of their feeble intelligence, we cannot say that they have not sympathies which may affect the whole bank.

The oysters' powers of locomotion are exceedingly simple and imperfect; frequently they are riveted to the spot where they were deposited as infants. The only organ of motion is situated immediately beneath the heart. The substance of this muscle is white flesh, which passes through the mantle on each side, and attaches itself to the centre of the valves. This is the muscle which is cut by the fishmonger when he wishes to open the oyster, and we again mutilate it when we consume the delicate mollusk. When the animal chooses to contract this muscle, the shell is



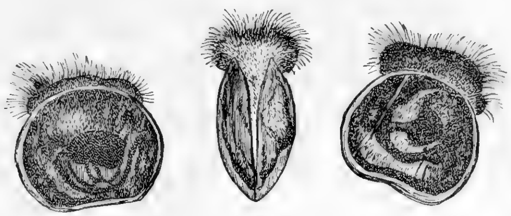
A GROUP OF OYSTERS.

hermetically closed; when it relaxes it, there is an elastic ligament placed at the hinge of the valves which acts precisely as a spring, and opens the shells. It has been asserted that the oyster, by rapidly opening and shutting its valves, is able to change its place, and even to move from rock to rock; but the assertion needs more confirmation.

The mode in which these mollusks propagate their species is very peculiar. The oyster is an hermaphrodite—that is, it unites in each individual both sexes. These mollusks are not even like flowers of the like nature, for the organs of reproduction are only visible at the period of their use.

The *eggs* are placed between the folds of the mantle and in the midst of the respiratory organs. Their number is prodigious. According to Baster, one single oyster can carry 100,000 eggs. Poli says 200,000, and Leuwenhoeck even gives the prodigious number of 10,000,000! However, more modern naturalists consider the limit to be about 2,000,000—a number almost incredibly large. The eggs are yellow; they are hatched in the mantle, and when the embryo leaves the parent it can breathe. The spawning time is usually from June to September. During the period of incubation the eggs are enveloped in a mucous matter, which is necessary to their development; it has very much the appearance of cream, but as the period of gestation proceeds, this mucous material changes its colour, gradually becoming darker. An experienced eye, from the colour of the mucus, can pronounce the stage which the embryos have reached.

The oyster differs from most shell-fish, in that its young do not leave the folds of the mantle until they are capable of living



YOUNG OYSTERS, WITH THEIR NATATORY CILS.

without the maternal protection. Almost all shell-fish throw out their ova, committing them, and the protection of the young, to circumstances. An oyster-bank, in the spawning season, is a most interesting place—every oyster is throwing out a whole nation of descendants, filling the water with living dust; so that, frequently, the sea is clouded by the *spat*, as the young oysters are termed.

The microscope reveals to us that the young oyster has a perfect shell, and is also furnished with vibratory cils, which enable it to swim. When the current carries it against any solid body it immediately adheres, the cils disappear, and the oyster begins to develop; in three years it reaches its full growth. Before it settles down in life it swims about the neighbourhood of the mother; and, we are told, that at any alarm, it again seeks refuge within the maternal shell. This prolific production might well be supposed to be a sure means of the rapid propagation of these mollusks; but the fact is, that the young oysters are destroyed in millions by creatures which prey upon them. Moreover, being but feeble swimmers, they are utterly at the mercy of the currents; and, unless the bank be in absolutely still water, the greater part of the spat is swept away, and thus destroyed.

The favourite habitat of the oyster is the shore, in water not very deep, and not disturbed by currents. In such a locality their development is very rapid, and they accumulate in large numbers, forming what is technically termed an *oyster bank.* Many of these banks extend for some miles, and seem quite inexhaustible. In 1819, one was discovered near Zealand, which provided the whole of the Low Countries with oysters for a year, in such abundance that they were sold at the rate of ten for a penny; but as this bank was very near the level of the sea at low tide, a rigorous winter destroyed it.

The species of oysters usually eaten are the common oyster (*Ostrea edulis*), and the horse-foot oyster (*Ostrea hippopus*), which are natives of our own coasts. On the French Mediterranean shore they also find the rose-coloured oyster (*Ostrea rosacea*), and the milky oyster (*Ostrea lacteola*). Two other species—the crested oyster (*Ostrea cristata*) and the *Ostrea plicata*—are also found, but not so frequently as others. The Corsican coast yields the *Ostrea lamellosa.*

In seaports, the oysters are distinguished by the localities from which they are taken. Those from deep sea banks are not so valuable as those from the more shallow water. There are two principal varieties dredged up on the French coast, which differ in their flavour and size—these are the Cancale and the Ostend oyster. When the first has been fed for some time in the oyster park, it assumes a greenish hue, and is then called the Marenna—so named from the park in the Bay of Seudre. We shall again refer to the nature and the source of this coloration.

The oyster bears the palm from all the dishes of the table, since it is the most digestible, and consists of the very element of all substances capable of giving nourishment. It is peculiarly fitted for the delicate, the sick, and the convalescent. No feast can be worthy of the name where the oyster does not appear among the first dishes. Indeed, it has well been said to be the key to that paradise which we call the appetite. "There is no alimentary substance," says Reveillé-Parise, "even bread not excepted, which, under certain circumstances, will not produce indigestion; but this is a charge which cannot be laid against the oyster."

They may be eaten in almost any quantity without producing any of those evils to which our flesh is heir. We might chronicle the names and deeds of notorious oyster-eaters—men who could eat thirty and forty dozen, without any inconvenience—men who have in their lifetime demolished a whole bank; but we refrain from publishing the degradation of our own kind.

However, every one's experience is ready to testify that this celebrated mollusk is most digestible; but, perhaps, the reason is little suspected. The real secret of the great digestibility of the oyster lies in the fact that, although its substance is most nutritive, yet it contains a very small quantity of azotised matter—or matter containing nitrogen—of which the fleshy parts of the body are composed. An average-sized man requires twelve ounces of such food daily; and if he only eat oysters, he must swallow sixteen dozen of the mollusks to supply the requisite nutriment.

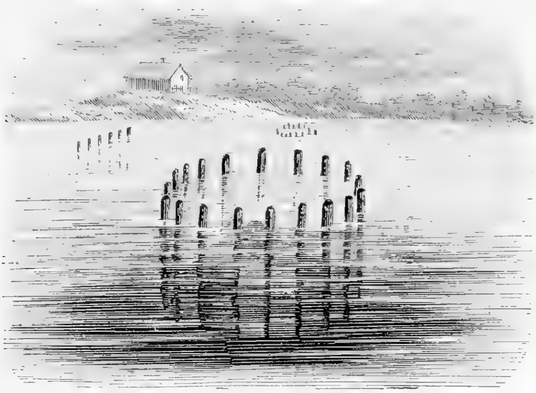
Oyster-fishing is carried on variously in different localities. Round Minorca, intrepid divers, with a hammer attached to their right hand, descend some twelve fathoms, and bring up a quantity of the detached bivalves in their left hand. Two fishermen usually join in the undertaking, and dive in turns until they fill their boat. Upon the coasts of England and France a dredging machine is used, which is a strong net, with an iron rim weighing some twenty pounds; this is attached to the boat by a rope, and as the men pull the boat over the bank, the dredger loosens the bivalves off the rock, and they are caught in the net, and so taken up. The fishers are careful only to dredge certain zones of the bank, leaving those which have been fished time to recruit their loss; yet this mode of taking the oyster is necessarily destructive, and, in fact, our oyster supply is rapidly and seriously diminishing—a result chiefly due to this reckless dredging.

On the coast of Campeachy, in Mexico, the oysters fix themselves to the submerged roots of the mangrove trees; the Indians detach the roots, and thus carry to market branches of oysters.

The idea of cultivating oysters is certainly anything but new. According to Pliny, Sergius Orata was the first who put oyster cultivation into practice, and in the time of the orator Lucius Crassus, he established an oyster park at Baiæ. He noticed the superior flavour of the bivalves of the Lucrine Lake—for then, as now, tradesmen speculated on the weaknesses of human gourmandism—and with these he supplied his customers. Sergius has the honour of being the inventor of a new industry, which to-day occupies thousands; and the centuries which have passed since the Roman lived have not improved upon his plan. As a proof of the perfection to which he brought oyster culture, his contemporaries said of him—in allusion to the hanging banks which he invented—that if he were hindered from rearing oysters in the Lucrine Lake, he would make them grow on the roofs of the houses! What has become of this famous lake, the first oyster park in the world? Alas! it exists no longer; it has all but disappeared. A traveller, who was an accomplished gourmand, paid a visit to the celebrated lake; he says, "It is now nothing but a filthy puddle. The precious oysters which were placed there by Catiline's grandfather—an act which, in our eyes, greatly qualifies the doings of the grandson—are metamorphosed into miserable eels, which wriggle through the mud. A villanous mountain of cinders, and scoriæ, and pumice-stone, which thought proper, in 1538, to leap out of the earth in one night, like a mushroom, reduced this poor lake to its present sad condition."

Rondelet also speaks of a fisherman who understood the art of oyster culture.

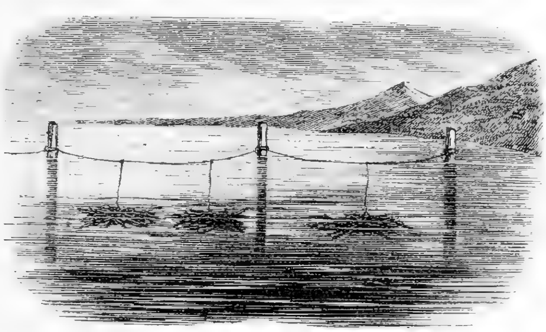
The Neapolitan lake, Fusaro—the terrible Acheron of the poets—is a great oyster park, where Art is made effectually to aid Nature in the multiplication of her products. All along its shores are built up round blocks of rocks, upon which are placed oysters from the Gulf of Taranto, and thus each is transformed into a little bank, round which, for protection's sake, are driven piles of wood; the tops of the piles rise above the water, and so mark the position of the bank, from which the oysters can be taken by the hand when they are wanted. Other piles are distributed in long lines, bound to each other by a cord, from which are suspended faggots of young wood; these are intended to receive the



ARTIFICIAL OYSTER BANKS, SURROUNDED BY PILES.

spat of the oysters when it is given out at the spawning season. At the proper time the faggots are drawn up, and the young bivalves secured.

Last century, Lord Carnarvon scattered a quantity of these



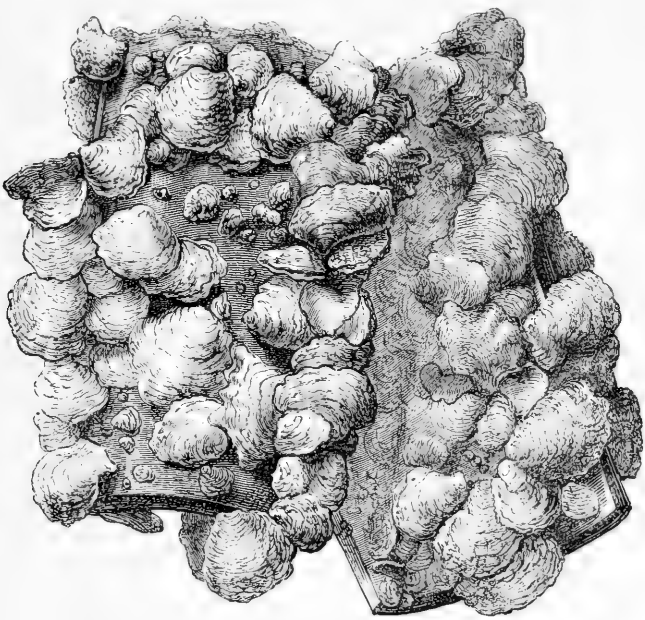
FAGGOTS SUSPENDED TO RECEIVE OYSTER SPAT.

mollusks in the Menai Straits; they increased so rapidly as to become a source of considerable income. Following his example, the government made similar deposits of oysters, at different points round our coasts, with the same effect. This oyster farming thus begun has since increased into a regular business. Upon the coasts of Sussex and Kent it is carried on upon a large scale. The process is exactly that which we have described as in use in Lake Fusaro.

Some twenty years ago the oyster beds of France were well-nigh exhausted by the system of unrestricted and indiscriminate dredging; and had it not been for M. Coste, the French coast would to-day have been utterly destitute of this favourite mollusk. This celebrated academician urged the government to establish oyster farms all round the coast, and to set apart a certain number of vessels for the sole purpose of attending to these artificial banks. In 1858, the same year in which M. Coste presented his report to the Emperor, operations were commenced. The Bay of St. Brieuc was selected for the first experiment, and in the months of March and April about three million oysters, full of spawn, which had been dredged up from "common" grounds, were deposited on shells, fragments of tiles, broken pottery, &c. At the end of eight months the progress of the beds was tested; a dredge which was let down for a few minutes brought up 2,000 oysters fit for use, and three bundles of faggots taken up at random were found to contain 20,000 young bivalves, varying in size from one to three inches in diameter. Two of these fascines, exposed to public view at Binic and Portrieux, greatly excited the astonishment of the villagers; they looked like bundles of leafy branches, each leaf being a living oyster.

Wishful to follow the example of M. Coste, the distinguished naturalists of other countries—amongst whom we ought to mention M. Van Beneden, of Louvain, and M. Eschricht, of Copenhagen—visited the French oyster parks, and urged their respective governments to adopt so admirable a plan. This has accordingly been done on the coasts of Belgium and Denmark.

M. Coste showed that every place reached by the low tide could be utilised for the culture of the oyster; and under his advice the Bay of Arcachon was inaugurated as a vast oyster farm; it increases every day, and gives fair promise of affording an abundant supply. Already 1,200 capitalists employ 1,200 fishermen to look after nearly 1,000 acres planted with oysters. The government formed in the bay two model farms, at which they experimented as to the best material for forming artificial banks. The laying down of tiles and sundry *débris* cost £114, and now the farms are estimated to be worth £8,000. The grounds, which are covered by the oysters, are exposed at low water; this is a great advantage, for the progress of the farm can be accurately watched, and in collecting the oysters only the full-grown ones need be gathered. Four years ago it was estimated that in the Bay of Arcachon there were more than 5,000,000 oysters, and



OYSTERS ABOUT TEN MONTHS OLD UPON A TILE COVERED WITH CEMENT.

these were worth £8,000; which, leaving a wide margin, shows a profit of £4,000 on the outlay.

In the Island of Ré, which originally was surrounded by muddy flats, oyster farming is in full operation. Thousands of men came from the country and took possession of the sterile shores, and in two years they transformed them into rich domains. 1,500 parks are now in active operation, and 2,000 more are in course of construction; these establishments will soon encircle the whole island. Fragments of rocks are strewed over the flats, and upon these the oysters are developed with wonderful rapidity

—they reckon 600 to every square yard; the greater part of these are of a marketable size. The farms, at this calculation, bear at least 378,000,000 of the mollusks.

The ocean is not the only scene of the useful experiments of M. Coste. Nearly 500,000 oysters were transported to the roads of Toulon and to the Lake Thau. A piece of clay pipe taken up from the former place in eight months, was found to be covered with numerous shells. This cultivation of the fruits of the sea is a most profitable undertaking, and ought to be encouraged by every government.

Following the example of the Romans, oysters are placed in reservoirs where they grow larger, and assume a *green* tint. Is this why such oyster plantations are termed *parks?*

At Marennes these reservoirs are called *claires*. They are inundated fields, which stretch on each side the banks of the Seudre for many miles. The claires of Marennes differ from the oyster parks of other localities in this—that while the parks are submerged by the rising waters of every tide, the claires are only covered at spring-tide.

An oyster six or eight months old requires two years before it reaches the point of perfection; but it is very seldom that the oysters eaten in Paris undergo these conditions; generally the adult oyster is placed in the claires, and in a few days it begins to have the characteristic green tint. The green colour is not general, but is particularly shown in the region of the branchiæ, upon the labial feelers, and in the intestinal canal. What this colour is has long been a subject of conjecture. It certainly differs from all other colouring matters; and Berthelot has shown, by a chemical analysis, that it has some peculiarities. Some naturalists believe that it is produced by a disease of the liver, caused by the unnatural position of the oyster; certainly this would give a green hue to the parenchyma. Another opinion is, that the colour is from an accumulation of animalculæ, which are lodged in the tinted parts. Priestley suggests that it is the peculiar green colour which is generally produced in water exposed for long to the action of light; but the most probable solution of the difficulty appears to be that it is in some way due to the soil of the claires.

The green molecules are arrested by the branchiæ, and thus the action of the organ is much impeded. The poor animal, injured in one of its essential parts, seems to dilate and become more tender, and for this—its misfortune—is the more relished.

The chief oyster farm in England is carried on by a joint-stock company, at Whitstable. The extent of the farm is about one and a half square miles. The beds of oysters are arranged along the shores of the estuary which separates the Isle of Sheppy from the main-land. "Natives" are oysters which are produced from these farms; those which are taken from their own beds out at sea are called "Commons."

Yet, in spite of the seeming power of cultivating the oyster *ad libitum*, the mollusk is decreasing in numbers, and consequently becoming dearer. The reason for this is not clear; one set of naturalists blaming the weather, another the currents, while most probably the true cause will be found to be the combined influence of the two; together with the natural desire to supply an increased demand which the rapidity of transit creates, at the expense of dredging the beds before they have recovered from their last thinning. The most evident way of obviating at least two of these difficulties is, to have parks after the French system, which are exposed at low tide.

CHAPTER XXI.

THE MUSSEL.

THE Mussel—or, as this well-known shell-fish is scientifically termed, the *Mytilus edulis*—has neither the delicate flavour nor the reputation of the oyster. Oysters are the aristocracy of the bivalves; mussels occupy a much lower place in their social scale. Yet we must not say too much derogatory of the mussel, for its great abundance and its price bring it within the reach of the humbler classes, and, with much reason, it has been called "the poor man's oyster."

Mussels are easily recognised from all other shell-fish, by the deep violet colour of the valves, and the yellowish-red of the mollusk itself. The three prominent characteristics of the mussel are—the shape, the foot, and the byssus.

1. The shape of the mussel is somewhat triangular, but not inelegant. Its valves are both alike, and are united by a hinge at the vertex of the triangle. The hinge has no teeth, but is a groove, in which lies a binding ligament. The anterior part of the animal is lodged in this sharp angle.

2. The foot of this mollusk, the most striking of its members, is constructed something like a finger; it is capable of great elongation, and sometimes can be stretched even more than two inches. Several pairs of muscles which penetrate it, and are interlaced in its tissue, control all its motions. By the aid of this organ the mussel can move, and in this respect is more favoured than the oyster.

3. The byssus is an assemblage of little cords, by which the mollusk anchors itself to the rock so firmly that it can defy the violence of the storm. If we try to detach the threads of the byssus from their hold, they will break rather than let go. The gland which secretes this animal cable is situated at the base of the foot; it contains a semi-fluid matter, which fills the tube of

the organ, and is moulded by the groove of the foot into a thread such as that which forms part of the peculiar mane of the mussel. When the creature wishes to fix its byssus, it stretches out its foot, feels here and there for a fit object to which to attach it, and, having satisfied itself, affixes the extremity of one of the hairs, immediately retracting its foot. This operation is repeated several times, and each time a new thread is fixed. Four or five are thus fastened in twenty-four hours. When the whole bundle of the byssus is completed, its anchorage is perfect—none of our vessels can boast of 150 cables! When the bivalve has fastened its first thread, it tests it, to prove the strength of its hold and the firmness of its anchorage; the thread is tightened until it well-nigh breaks. The second is also submitted to a similar testing. This process gives evidence that the mussel has more intelligence than the oyster. By the assistance of its byssus our bivalve can suspend itself from over-shelving rocks. It seldom, indeed, touches the ground, and this is the reason that its shell is always smooth and exhibits no signs of the rough usage of the waves. Thus much cannot be said of its aristocratic rival, for the oyster's shell is rough and rugged, and frequently it encloses between its valves the *débris* which the waves stir up from the bottom on which it lies. But it is not the habit which makes the monk.

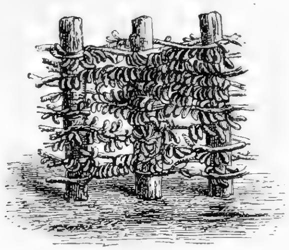
Mussels, like the oysters, are gregarious mollusks. They are widely distributed, and are found on every coast. An estuary, where the fresh water of a river mingles with the sea, is their favourite habitat, and there are few rocks at the embouchure of rivers which are not covered with a flourishing colony. They are also found attached to the branches of the polypiers, to the roots of submerged trees, to the piles which support the banks, and to the keels of vessels.

The mussel may be eaten either raw or cooked, and though every one does not relish its flavour, yet it has by no means lacked admirers. Louis XVIII. was passionately fond of mussels; every week he had a supply for the royal table from Rochelle. It is said that he once gave Talleyrand the recipe of a sauce, which had the effect of placing the mussel in the first rank of the dishes of that day. Yet it is beyond dispute that the oyster is far more palatable and more digestible than the mussel. Still, the latter has one recommendation—it is in season when the oyster is not. The oyster is eaten in those months which have an *r* in their name, whereas those are the very months in which the mussel is least fit for the table.

But, unfortunately, there is a grave accusation against this shell-fish—it is said to be unwholesome! Nay, that even at certain times of the year it is actually deleterious; and what makes matters worse, the exact time of the year is not accurately known. The mussel certainly does produce nausea, colic, and sometimes cutaneous eruptions. But the doctors are at a loss to account for its action. In the middle ages, it was the belief that the phases of the moon, or the evil charms of some witch, suddenly caused the mussels to be unwholesome. Now-a-days we are more rational, but no nearer the truth. The sulphide of copper from the vessels to which the mollusk may have been attached; some peculiar disease of the shell-fish; the decomposition of its tissue; certain parasites which inhabit it; or the young of the star-fish or the medusa which it may have eaten, have all been cited in turn to explain the evil effects sometimes occasioned by eating mussels.

There is a branch of industry known as *mussel culture*, just as there is oyster culture. It is carried on in many localities, particularly at Esnandes, at Marsilly, and at Charron, in the Bay of Aiguillon, near Rochelle. This peculiar industry owes its establishment to that mother of many inventions—necessity. About the year 1235, a bark, in which three Irishmen were endeavouring to transport sheep to England, was driven by a storm to the French coast, and was wrecked in the rocky creek of Aiguillon, near to Rochelle. Exiled upon the wild shore of Aunis, Walton, the ingenious captain of the bark, was driven to many expedients to keep himself alive. The shores of the bay stretched for miles in interminable mud flats, which were frequented by flocks of sea-birds. To catch these, he invented a kind of net, supported upon posts; during the night the sea-birds became entangled in the meshes, and so were secured. In process of time, the observant Irishman noticed that the mussels made his posts favourite places of attachment, and that those which were so elevated above the mud soon became large and fat. Thereupon he determined to commence mussel culture, which has ever since been carried on in the very same manner and in the same locality. Piles are driven into the mud, some five or six feet of their length remaining out of it. Long rows of these are placed, as our illustration shows, running out to the sea, sometimes even for two or three miles. Between the piles wicker-work is interlaced, upon which the bivalves fasten themselves.

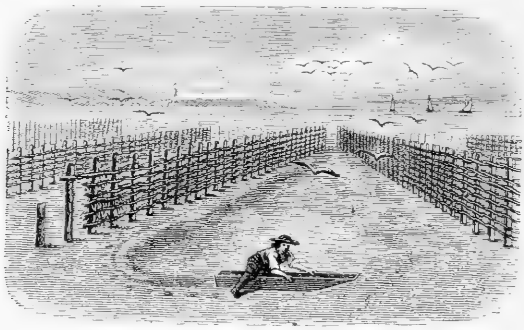
Numbers of these lines of posts are so placed that their seaward extremities are close together, and they diverge as they spread to the shore. Locally they are termed *bouchots*, or parks, while the fishermen who attend to them are *boucholeurs*. These parks belong



PILES WITH WICKER-WORK, COVERED WITH FULL-GROWN MUSSELS.

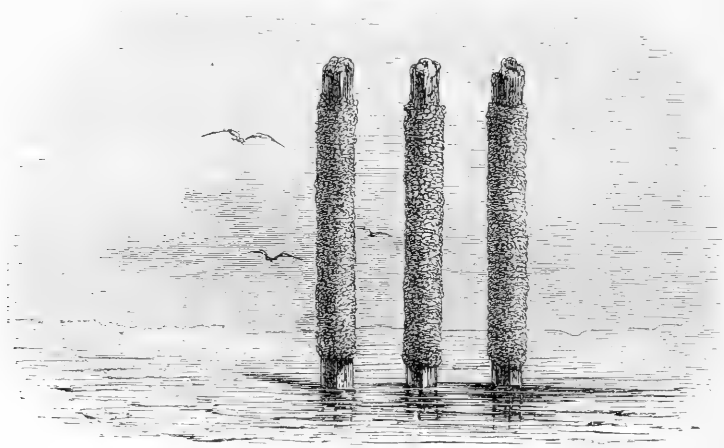
sometimes to one man, but usually they are the property of a co-operative society, every boucholeur having a share in the concern. The shell-fish are gathered in at all times, except during the period of their spawning; and also if the weather be very hot the fishing is suspended. When the tide has gone out, the mud flats are much too soft to bear the weight of the boucholeur. Walton's genius, however, soon found a means of overcoming this difficulty, and he built what is now called an *acon*, which in fact is a light punt, some six feet long, made of four thin planks, two forming the bottom, and two the sides, while the front or prow is finished with a slope. The fisher, as our cut will at once explain, rests upon one knee in his acon, holding the sides with his hands, then with the other leg he pushes himself forward.

Many of the acons are so constructed as to carry two persons; and it is astonishing with what rapidity they can glide over the yielding surface of the mud. It must not be supposed that the whole of the work is completed when the piles are driven, and the wicker-work run between them—that then the mussels attach



BOUCHOLEUR IN HIS ACON.

themselves, and the fishers have nothing to do save to gather those which are full grown. Experience has taught that the process of development is greatly aided by moving the mollusks from one



ISOLATED POSTS COVERED WITH YOUNG MUSSELS.

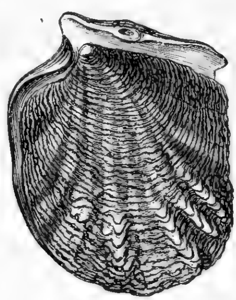
position to another, positions in which they are successively exposed for longer periods to the air. The spat, with which the water of the bay is filled during February and March, collects on isolated posts, placed in deep water for its reception. These posts are only exposed at the spring tides. In fourteen months it has increased from the size of a pin's head to that of a bean, and is now in a condition to bear removal. Agglomerated masses of the young bivalves are taken off from the posts by hooks, and are placed on the lowest parts of some of the palisades, which are never uncovered by the water; here they grow, and when they have attained to a certain size, they are advanced to a higher bouchot. Four times they are thus removed, and in twelve months they are ready for the market.

The Bay of Aiguillon is the scene of a vast industry, a wonderful monument to the genius of one man. Thousands of people are employed in the culture and transportation of the mussels. Some idea of the enormous produce of the bay may be gathered from the fact, that although they are sold at the rate of about ten pounds a penny, yet the revenue of the whole bay is more than £400,000; and why should not a like harvest be gathered in on every coast?

CHAPTER XXII.

NACRE AND PEARLS.

NACRE is that beautifully smooth, white, and iridescent lining with which some shells are internally coated; it is the same material which composes the pearl. Though many shells are lined with nacre, yet one bivalve, the *Meleagrina margaritifera*, which is often called the *Pintadine*, secretes the substance so plentifully that it deserves its name—the mother-of-pearl shell.



PINTADINE, OR MOTHER-OF-PEARL.
(*Meleagrina margaritifera.*)

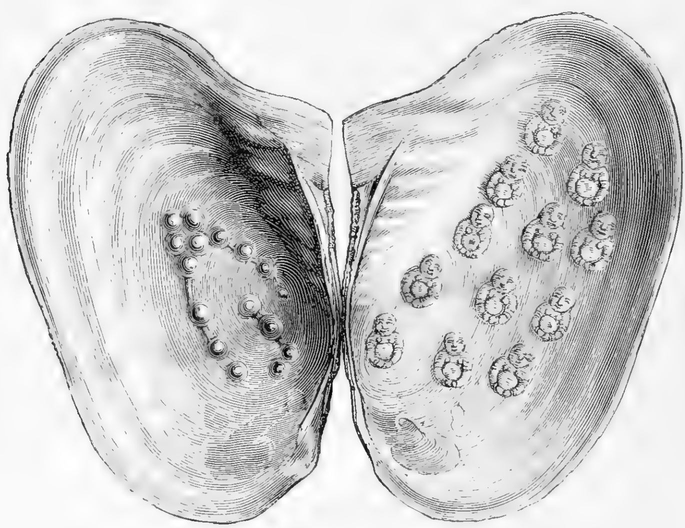
This mollusk moors itself to the bottom of the sea by a strong brown byssus. The valves of the shells are irregularly rounded, and when the animal is only a year or two old, the foliations are thin and even; its shell is streaked with bands of green, which radiate from the summit, and branch off towards the edges of the valve. But as years pass, the shell becomes rugged, the bands disappear, and the whole takes a uniform blackish tint. Eight or ten years bring the mother-of-pearl to perfection; the shell is then about six inches in diameter, and one and a quarter inch thick.

Nacre is very hard, and exhibits a resplendent surface; its appearance is not unlike floss silk, faintly tinted with azure, and usually iridescent. Most of the bivalves are supplied with it, although it generally changes its tint with different species, passing through all shades of blue to deep violet. The nacre of the *Haliotis Iris* is a sparkling emerald green, shot with purple. The mouth of the *Turbo argyrostomus* presents the hue of silver, while that of the *Turbo chrysostomus* is golden. But the pintadine secretes nacre of a pure white, and remarkably thick; and it owes its beauty to the play of colours which makes its surface iridescent. This iridescence is due to the interference of the light reflected from the edges of the plates of nacre. This fact may be proved by pressing a piece of white wax upon the surface of the mother-of-pearl, when it will be found that the wax exhibits the same iridescence, that is, the wax has taken the impression of the innumerable layers, and as their edges reflect the rays of light, the waves of light are placed in a position to interfere, some of them being obliterated; thus the white light is destroyed, and coloured light is the result. A work on light must be consulted for a full explanation of this phenomenon; suffice it to say that the colours of a soap-bubble, and all such thin films, are due to this "interference." For practical purposes the nacre is separated from its bed by a steel instrument, or the exterior of the shell is dissolved away by acids, and thus the precious substance is obtained.

Pearls, those solidified drops of dew, as the Orientals poetically call them, are the product of the organ which secretes the nacre when the mollusk is in a diseased or irritated state. Instead of depositing the substance on the internal surface of the valves, for some reason or other it accumulates in little globules, either within the fleshy matter of the creature, or on the surface of the shell; usually a small grain of sand, or other foreign substance, is found as the nucleus of the pearls. It would seem that this particle irritated the animal; and in order to reduce the annoyance it coated it with nacre to render it smooth; layer by layer the beautiful deposit enlarged the pearl.

The Chinese and other Eastern nations are said to turn this mode in which the mollusk relieves itself of an irritating body to practical account, by introducing into the live creature glass beads, or designs in metal; in course of time the distressed mollusk covers the intruding substance with its beautiful deposit. Thus artificial pearls are produced; in the one case they are loose, and in the other they appear as cameos fixed to the shell.

A single pintadine sometimes contains several pearls. An instance is quoted in which 150 pearls were found in a single shell. The pearls at first are small. They grow by annual depositions of nacre, which are added layer by layer to the original nucleus. The clearness or cloudiness of the pearl necessarily depends on the



A SHELL CONTAINING CHINESE PEARLS.

nacre. Sometimes the pearls are semi-transparent, silky, lustrous, more or less iridescent, but often they are dull, and even smoky.

The most important pearl fisheries are in the Persian Gulf, off the Arabian coasts, in the Bay of Bengal, near Ceylon, and in other parts of the Indian Ocean. Previous to 1795, most of the Indian fisheries were in the hands of the Dutch, but they became ours after the treaty of Amiens in 1802. The Ceylon fisheries are sometimes undertaken by the government, and sometimes they are let to a contractor. Before the commencement of the season, a government inspection of the coast takes place, in order that the banks may not be impoverished by too frequent fishing. The fishing for the pintadines in the Gulf of Manaar, a large bay on the north-east coast of the island of Ceylon, commences in February or in March, and continues thirty days. Upon this ground 250 boats are occupied, which come from different parts of the coast. At ten at night, at the sound of a signal gun, they put to sea; and as soon as the dawn furnishes them with sufficient light, they commence their day's labour. Each boat is manned by ten rowers, and ten divers occupy the deck, which covers half the vessel. Five of the divers rest while the others are gathering the pintadines; and each boat's crew is attended by a negro, who makes himself generally useful. The divers descend usually about forty feet, and the best of them can keep under the water one and a half minutes. To accelerate their descent they attach to their foot a stone of the shape of a sugar-loaf, which weighs about fifty pounds. Arriving at the fishing-ground, a diving-stage, which projects over the sides of the boat, is made by lashing the oars to each other. To the edge of this stage the diving-stones are hung. When a diver descends, he places his right foot in a stirrup, which is attached to the conical point of the stone, or he holds the cord which suspends the stone to the boat between his toes; with the other foot he carries a net in which the shells are to be placed; then seizing in his right hand a signal-cord, conveniently arranged for his purpose, and tightly closing his nostrils with his left hand, he plunges, holding himself vertically over the sinking stone. Lest his descent should be in the slightest degree impeded, the diver is naked, with the exception of a piece of calico round his loins. Upon reaching the bottom he withdraws his foot from the stirrup, and the stone is at once drawn to the top, ready for the use of another diver. He then throws himself upon his face on the ground, and stretching out his arms he gathers all the mollusks within his reach, and places them in his net. When he wishes to ascend he pulls the signal-cord sharply, and is rapidly drawn up. There is always one stone for two divers; one rests and refreshes himself, while the other is in the water. The time the divers ordinarily keep beneath the surface is thirty seconds; and in favourable circumstances they can make fifteen or twenty descents in succession. But sometimes they are unable to go down more than three or four times. Even then, when they come up, water coloured with blood comes from their mouths, noses, and ears. The work is very distressing, and makes sad havoc of the constitution; the pearl-divers never reach old age. The fishing is continued until noon, when a second gun gives the signal to cease. The owners of the boats wait on the shore to superintend the discharge of the cargo, which must be all secured before night, to prevent robbery. Formerly the Ceylon fisheries were very productive. In 1797, they yielded £144,000, and in the following year as much as £192,000. In 1802, the banks were let for £120,000; but ever since they have been less and less valuable, and now are not worth more than £20,000 per annum.

The inhabitants of the shores which line the Bay of Bengal, the Chinese seas, and Japan Islands, and islanders of the Indian Archipelago, are all engaged in the pearl fishery. Their united produce is estimated to yield £800,000 per annum. Farther west, in the neighbourhood of the Arabian Sea, along the coast of Muscat, and also in the Red Sea, pearls are found. In these latter countries the pearl fishing commences in July, for in that month and in August the sea is generally calm. The boats, when they have arrived at the beds where the pintadines lie, cast their anchors at a convenient distance from each other. The water is about eight or nine fathoms deep. The divers, when about to descend, fasten a light cord under their arms, which is attached to a bell in the boats; plugging their ears and nostrils with wool or cork, and tightly closing their mouth, they plunge into the water, and are sunk to the bottom rapidly by a heavy stone. When once on the bed they gather all the shells within their reach, which they deposit in a bag fastened round their loins. When compelled to come up for air they ring the bell, and are drawn up to the surface.

The oyster-bank off the island of Bahrein is very productive, yielding £240,000 per annum; this, with the pearls taken from other fisheries along the Arabian coast, brings in an annual income of about £350,000.

Pearl fishing is also carried on in the South American seas. Before the conquest of Mexico the fisheries were situated between Acapulco and the Gulf of Tehuantepec; but since that time a further exploration of the coast has discovered banks of the bivalves near the islands of Cubagua, Margarita, and Panama. The results were so full of promise that populous towns soon sprang up in the neighbourhoods. In the reign of Charles V. America sent home to Spain pearls to the value of £160,000, and even now the fisheries yield some £60,000 a year. The mode of diving is much the same as in the Asiatic waters. The divers go down naked, and can remain from twenty-five to thirty seconds; in this time they are not able to secure more than two or three shells. They descend eleven or twelve times in succession, and thus gather thirty or forty oysters in a day.

The pintadines are carried to the shore, where they are piled on grass mats in the sun; the mollusks soon die, and begin to decompose. After ten days, when this process is complete, and the tissue of the animal has thoroughly given way, they are thrown into tanks of sea water, where they are opened and washed; in this state they are handed to the dealers. The valves furnish nacre, and in the parenchyma the pearls are found.

To secure the nacre the valves are cleansed, the thick, rough exterior of the shell is removed, either, as we have said, by a sharp instrument like a chisel, or by an acid liquid; in this manner, plates of nacre are obtained, which vary in thickness, according to the age of the mollusk.

Three kinds of mother-of-pearl are known in commerce: silver-face, bastard-white, and bastard-black. The first is brought in cases of 250 or 300 lbs., from India, China, and Peru. The other two kinds are more or less coloured, and are not so valuable.

The pearls are by far the most important product of the work. They are generally found in the fleshy substance of the animal; sometimes, though rarely, they are fixed to the valve, and when this is the case they are detached by pincers. To secure the precious globules which are embedded in the mollusk, the putrified flesh is boiled, and the whole of the contents of the pan is passed through a fine sieve; in this way very few pearls escape detection. Yet some do; for months after the fishing is over miserable Indians may be seen searching the heaps of putrified matter for seed-pearls which had passed the workmen unobserved.

Baroques are the pearls which are found adhering to the valves; these are always irregular in shape, and are sold by weight. *Virgin* *pearls*, or *paragons*, are found in the body of the animal; they are globular, ovoid, or pyriform, and are sold separately.

Cleaning and polishing the pearls is effected by rubbing them together in a bag with nacre powder, and this process renders them round, and gives them a beautiful polish. Then, to separate them into different sizes, they are passed through copper plates, full of holes; these plates are arranged one above the other, the higher ones having the largest holes. The pearls which these plates retain are numbered with commercial numbers, by which their price is indicated; the number being that of the holes which the plate contains. These range from twenty to one thousand, the top plate being pierced with twenty, the bottom one with one thousand, and the intermediate ones accordingly. The pearls which are retained between Nos. 20 and 80 are said to be *mill* pearls. Those which are found on the sieves from 100 to 800 are *vadivoo* pearls; all the smaller ones being *tool* or *seed* pearls. The pearls are next drilled, and the small and medium sizes are threaded on strings of white or blue silk; and in these rows they are exposed for sale, the buyers assorting them according to their shape and colour. The seed-pearls are sold by weight, or sometimes by measure. In America the bivalve is opened with a knife, and instead of going through the putrefying and boiling process, the fresh mollusk is "felt" by the fingers, and thus the pearls discovered. This process is long, and not so certain as that pursued in the East; but the pearls are considered to be fresher and more brilliant when so delivered from their matrix.

Of course there are giants among the pearls, whose size and value render them historical. Julius Cæsar, who was a great admirer of pearls, gave one to Servilia, which was valued at a million sesterces, nearly £48,000 of our money! Cleopatra had two famous pearls, one of which the capricious queen dissolved in vinegar, and drank the precious draught—a cup of acid wine worth £60,000. The other pearl was split in two, and each half became an ear-ring in the statue of the Capitoline Venus. If it be true, the highest price ever given for a pearl was £180,000, with which sum the Shah of Persia is said to have bought one from Tavernier, which that traveller had purchased at Califa. In 1759, one of the earliest transactions of this nature is recorded. A pearl from Panama, worth £4,000, was brought to Philip II., king of Spain. The prince of Muscat possessed one fished up from his waters, which was not large, but so transparent that he refused for it the same sum. In the Zozema Museum at Moscow, there is a pearl called the "Pilgrim," which is quite semi-lucent; it is globular in form, and weighs nearly an ounce. The Shahs of Persia possess a string of pearls, each of which is as

PINNA NOBILIS.

large as a hazel-nut; the price of the string is inestimable! At the Paris Exhibition in 1855, Her Majesty the Queen of England exhibited some magnificent pearls; and the Emperor also contributed 408 of the finest water; their value was more than £20,000.

Pearls have always been held in the highest estimation by the Eastern nations; indeed, they invested large pearls with magic powers, and believed that their possession exercised a mystic influence, guiding their fortunes, and preserving them from evil.

The pintadines are not the only bivalves which produce pearls. Almost all the mollusks are subject to a disease which causes them to produce nacre, in round or egg-shaped globules. M. Lamiral saw a pearl as large as a bantam's egg, perfectly round, and as white as milk, taken from a *Gigantea tridacna.*

The Marine Pinna produces rose-coloured pearls; the *Haliotis Iris,* green ones. Other bivalves form blue or grey, or yellow, and very rarely black pearls. There is a mollusk found in the sand of the river Mourne, at Omagh, in the north of Ireland, in which small pearls are found, and some of them are of a very fine water. It is a singular reflection that the gem so admired and coveted by man, should be the product of disease in a helpless mollusk.

CHAPTER XXIII.

THE CEPHALOUS MOLLUSKS.

HAVING considered the Acephalous Mollusks, which are headless, we now naturally proceed to the higher class, the Cephalous Mollusks, creatures which are endowed with the crowning member of the body. As in the lower class, so here we find some shell-less or naked, and others defended by a protective carapace. The nude cephalas exhibit much diversity of form ; they generally approach an oval, of greater or less length, convex above and flat underneath. Their head is at once recognised, for it is furnished with the sensitive organs or feelers, between which are situated two prominent, watery eyes; besides these, some of the species possess tentacles and feathery projections. A great gulf is fixed between these and the bivalves last considered, for they possess the power of locomotion; they can crawl. They execute this motion by means of a fleshy, abdominal projection, a kind of enlarged disc, which is formed by an interlacing of muscular fibres; by this organ the creature is enabled to execute a series of undulations which may be compared to the motion of a little wave. It was because of this ventral foot that Cuvier named the race the *Gasteropods.*

First, we shall speak of the *Aplysiæ*—the *sea-hares*—little mollusks which have a fancied resemblance to the quadrupeds after which they are named. Their habitat is among marine plants; they have a long neck, and two hollow, horn-like protuberances, like the ears of a hare. Their teeth are not in the mouth, but in the stomach, which is quadruple. The first stomach is an enlarged crop, the next a kind of gizzard, the third a pouch, and the last a sac. The gizzard is constructed of several cartilaginous pyramidal projections, whose edges are partly joined together so that their points are left separate. Several of these approach each other from each side of the organ, and their points are so close as to triturate the food as it passes through the second stomach.

The third cavity is armed in a peculiar manner with pointed hooks bending towards the gizzard. Cuvier could attribute to these no other office than that of preventing the food from passing through the masticating apparatus too quickly, in order that it might have time to be thoroughly crushed.

By a marvellous compensation, the power of the stomach is always in the inverse ratio to the number of teeth the mollusk possesses. This organ is powerful in its digesting action when the dental apparatus is not very perfect, and on the contrary it is weak when the second stomach is well garnished with grinders. As in the case of the *sea-hare*, some of the mollusks, in addition to all this complicated apparatus, have their fourth, or stomach proper, also provided with solid plates which perform the office of teeth. Thus the cavity performs the double function of stomach and mouth.

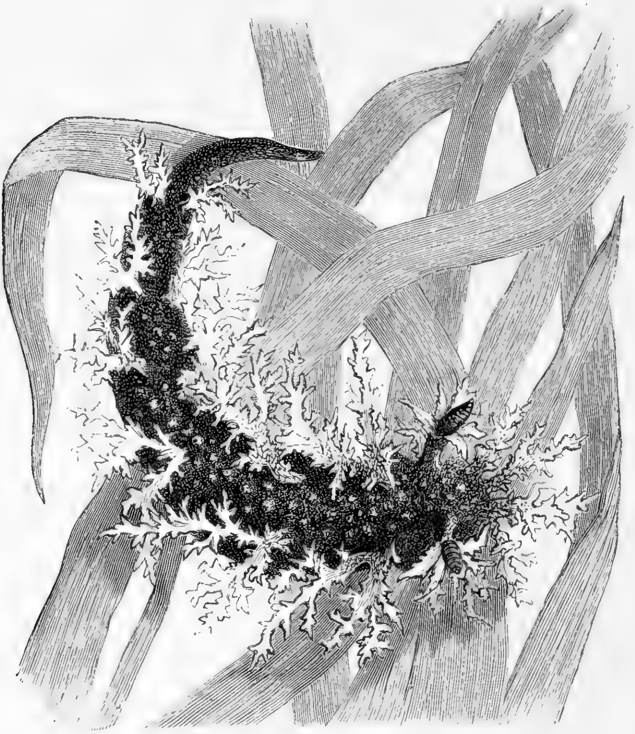
The aplysiæ exhale a disagreeable odour. They secrete an acrid, limpid humour which has a powerful corrosive action, and attacks the hand which incautiously touches them. From the edges of their mantle another secretion oozes, which is a liquid of a dark colour. This the creature ejects into the water around it, thus forming a cloud under the cover of which it escapes the threatened danger.

The ancients regarded the sea-hares as animals of an evil omen; and yet they were held in great repute, because they were supposed to have a power over the female heart. Apuleius was accused of sorcery because he had bought a number of aplysiæ from a fisherman. He had just married a rich widow; his crime was the marriage of the widow, and his principal accuser the widow's son.

The aplysiæ have respiratory organs which, like those of the oysters, are fringes hidden beneath the folds of the mantle. Amongst the *Tritons*—mollusks not unlike the sea-hares—these organs are entirely exposed; they stand above the surface in little tufts. Cuvier describes one of these creatures, inhabiting the French coast, whose colour was a beautiful bronze. Another, a native of the Sicilian waters, is still more brilliant, and has found a eulogist in M. Quatrefages. Imagine a little snail carrying on the ridge of its back a row of very minute shrubs, beautifully delicate; its head ornamented in front with a starry veil, fine as gauze, and surmounted by two long horns, as transparent as glass, the extremity of which opens into a bouquet of pink branches mingled with violet flowers. Next to the tritons rank the *Scyllæa.*

The *Scyllæa pelagica* is well known; it is found on the sea-weeds of all parts of the world. It has a flat body, and clings to the aquatic plants with its narrow, hollow foot. Its respiratory organs are upon its back, rising like two membranous crests, which run parallel to each other, and from whose interior surfaces spring hair-like filaments; the mouth widens out like a trumpet, and, to conclude this complicated organism, the stomach possesses a fleshy ring, armed with horny plates which are as sharp as knives. Förster has described, under the name of *Glaucus*, a gasteropod of the same kind, yet somewhat different from the scyllæa. The glauci, according to his description, are elegant little swimmers; their long, gelatinous bodies are contracted towards their posterior, and terminate in a grey, pointed tail, like that of the salamander. Their colour is a pearly grey, which shades off into sky-blue; their back is covered with nacre, and two bands of the sky-blue pass along its whole length. Their under surface is brown. They possess but a small head, which is furnished with four conical horns, or feelers, arranged in pairs. On each side of the body are swimming organs—oval, fan-like fins—whose purple colour contrasts pleasingly with the rest of the body of this gay little mollusk. Each of the fans is a broad plate, fringed with minute, flexible points. The posterior ones, for there are two on each side, gradually thin away until their projection loses itself in the tail. The animal when at rest is always lying on its back. It is not fond of moving, but when it does it swims with rapidity, and is as much distinguished for the elegance of its motion as for the beauty of its colouring.

Cuvier gave the name of *Eolis* to some naked gasteropods which are also remarkable. The great naturalist described them as little Limaces without either mantle or shell. Their head carries four feelers, and their mouth is fringed with tentacles. Their respiratory organs are placed in bunches of filaments upon the back—not on the ridge of the back, but some way down the side. In one of the members of this species, these organs are so branched that they are characteristic of the animal, and to them it owes its name—*Dendronotus arborescens.* The respirators rise in six or seven pairs; these branch off, and the branches are again subdivided into a great number of twigs. When the mollusk is at rest, the branches hang down on each other like the limp boughs



DENDRONOTUS ARBORESCENS.

of a dead shrub, and their great tentacles curl round like the horns of a ram. When in motion, the feelers are straightened and stretched out, as if to pioneer the animal on its way; the respiratory tubes are all stiffened, as if vigorously to supply air for the exertion of motion.

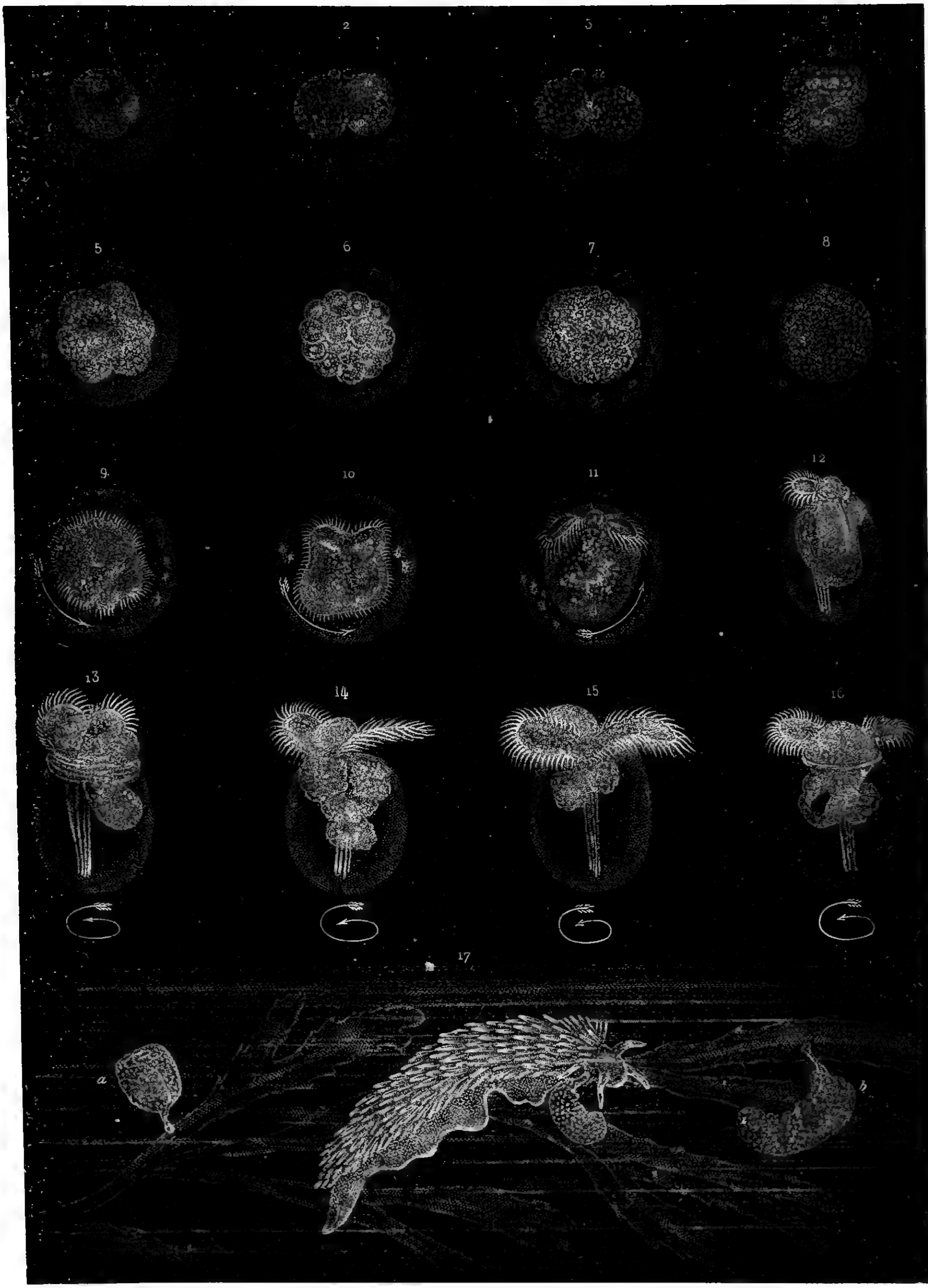
The eolides are an irritable and quarrelsome people. They seize their prey with fury, and fight with each other violently; often they retire from a combat in a sadly dilapidated condition, with their branches tattered and torn, and some even completely off. However, they have the power to reproduce their injured organs. Mr. Rymer Jones watched one of these mollusks replace a damaged tentacle in a fortnight.

These curious creatures are generally about two inches long; their body is yellow, and the respiratory branches pink, passing to flesh-colour at their tips; towards the tail their colour deepens into purple. They have two pairs of horns—the anterior ones are slender and flexible, the posterior are much thicker and of a red hue. Altogether, this mollusk is beautifully coloured, and presents a delicate arrangement of tints seldom met with.

We shall but allude to another of this class. The *Amphorina Alberti* has a long, thin, tapering body. Its head is large, and rises higher than the surface of the back; from the head project two pairs of horns. The hinder are longer and altogether larger than the first ones, and all of them point forward like the ears of a hare when listening to a noise in advance; but the most peculiar feature of the animal are the branchial appendages, which differ from those of every other mollusk. These are four enormous, ovoid bodies attached to the back, and between these are eight others, much less, and of a fusiform shape, which are arranged in two ranks, one on each side the central line of the back. The animal's body, indeed, is like a slender branch, from which hangs a bunch of large-sized fruit, only the fruit stands upright on the stalk. The general colour is grey, the horns and respiratory prominences being tipped with yellow, and down the dorsal line are spots of yellow.

The cephalous mollusks which are covered have a shell in one piece, and are therefore called *Univalves.* In some of the species the mouth of the shell is shut by an *operculum*, a little door, which may in some sense be regarded as a second valve. The *Nerita* offers an example of this construction. The shells of the univalves are usually spiral; the reason of this leads us to the very interesting explanation of their development. When the egg of the mollusk is dropped, if it be examined under the microscope, it is seen to be constructed like a bird's egg; it has a yolk, which is not, however, yellow, but grey. This is surrounded by albumen, the white of the egg; of course there is no calcareous shell, but the whole is encased in a film. In a few days the yolk becomes an embryo, which gives evident tokens of life by continuously turning round; this motion is soon extended to the sides of the envelope, so that the embryo moves from side to side of the egg, in an ellipse. This movement is produced by a number of extremely minute vibratory cils, which are placed irregularly, and hence they cause a spinning motion. These cils take the place of all the other organs which are as yet undeveloped in the minute creature. They absorb the air and the nourishment necessary for its growth. To fulfil these two functions motion is necessary; it is indispensable that there should exist regular currents, by which the required air and food comes in contact with the young mollusk. As the growth continues the cils gradually disappear, and consequently the motion gradually decreases. From their birth no cils had ever appeared upon the places beneath which any organs were in an undeveloped state; and this accounts for the manner in which the cils are irregularly distributed. During the time that the rotatory motion was in progress the development of the mollusk proceeded. As its soft body lengthened, it became twisted like a corkscrew; and since the animal turned upon itself a little obliquely, the body partook also of that characteristic. The firm parts of the body—that is, the foot, the head, and the tail—being too stiff to be affected by the motion, are, therefore, not twisted. The shell, which forms itself slowly, is moulded to this twisted body, and consequently partakes of the spiral form. Spiral shells may be considered as calcareous tubes, which gradually increase from the apex to the base, and whose walls are rolled upon themselves after various fashions. The real or ideal axis about which the revolution is made has been called the *column*. When the column is hollow, its lower opening is the *umbellicum*. The spiral of the univalves nearly always turns from right to left. Charles Bonnet long ago remarked this. If it be asked why this should be the direction of the rotation, we can only answer, that it seems to be a great law of nature that all rotation should be from right to left. The sun, the planets, and the earth, are all subservient to this law.

Men rather use their right hands than their left. If the vertebral column deviates, it is on the right side. Our staircases,



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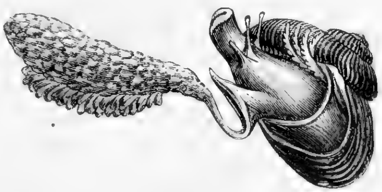
our corkscrews, and all our screws, the thread wound on our reels, and fifty other examples, all show the tendency we naturally have to motion from right to left.

Just as occasionally we have a left-handed screw, so there are a few—but very few—shells whose spirals turn from left to right; but these are only exceptions. Sometimes the right spiral shells become left by a freak of nature; when this is the case, they are highly valued by collectors; and, on the other hand, the left-handed *Testacea* sometimes become right-handed—thus showing a disposition to return to the normal condition of the race. Some shells are not twisted into spirals—for example, the *Patellæ*, which resemble large extinguishers—but, when they are young, there is a very evident twist exhibited, so that even these are no exception to the rule.

There are some univalves which float gracefully on the surface of the water, unaffected by the billows. The beautiful little shell-

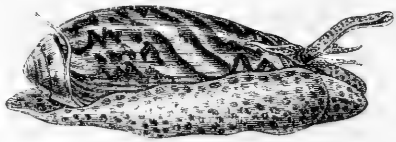


JANTHINA COMMUNIS.

fish, the *Janthina*, is one of these; it is covered by a thin, fragile tunic, of a delicate violet tint. It is suspended to a spongy mass, composed of cartilaginous vesicles, not unlike a lump of soap-suds solidified; this is the float which buoys it up. At the slightest alarm the janthina ejects a quantity of dark red liquid, and sinks to the bottom. Some naturalists think that this liquid distends its swimming apparatus, and that upon ejecting this it sinks.

There are mollusks which spread out a thin veil attached to their mantle, which the wind catches, and so they sail over the surface of the seas. But the greater part of the univalves live always submerged—some of them at great depths. They have been brought up from a depth of 1,400 fathoms.

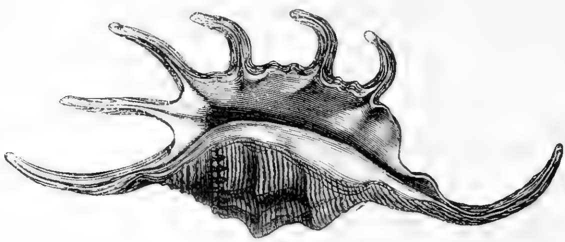
The mollusks which live in shells, are either found on the marine vegetation, or on the rocks; so firmly do they adhere, that a patella has been known to resist a force of 150 lbs. before it could be pulled from its hold. There are others again which burrow holes for themselves in the sand of the sea-bed. The *Natica millepuncta* excavates the sand with its dilated foot, cutting a groove



OLIVA PERUVIANA.

as it proceeds; thus it enters the earth by a decline. Its mantle is so large that it covers its shell, and thus its feelers and respiratory organs are protected; and, at the same time, its shell is preserved from being rubbed by the walls of the channel in which it moves.

The marine univalves exhibit the greatest diversity in their shape and colours. So beautiful are most of them that they are



THE ORANGE PTEROCERA.
(*Pterocera aurantia.*

used for ornamenting our rooms; and their colours have again and again emulated the painter to transfer them to his canvas. All the shells—or very nearly all—are covered with a horny epidermis, which protects their polished surface and their brilliant tints. This covering is found of every shade; the most common is brown, the rarest green.

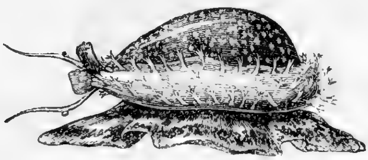
Some shells, instead of being of a uniform colour, are striped, or mottled, or spotted, or traced with curious designs and unreadable hieroglyphics. The colours of some are really brilliant. The beautiful marking and great rarity of some specimens of the *Conus*, or of the *Porcelains*, have caused them to fetch high prices. Amateurs will give £30 or £40 for a rare specimen of a porcelain; and,

CONUS MARMOREUS.

at the beginning of the eighteenth century, a conus was sold for £50; and even now a *Scalaria pretiosa* will sell for £80.

The *Cypræa*, or porcelain shells, are very widely distributed; but the best specimens come from the Indian Ocean. The orange porcelain has long been greatly esteemed. The savage chiefs of Australia wear necklaces of them, as insignia of their rank.

Naturalists have invented a classical nomenclature, which



CYPRÆA CERVINA.

amateurs do not take the trouble either to learn or use. They have given the shells popular names, which are based on some visible peculiarity; or where this is wanting, a fancied superiority in rank has supplied them with terms such as *ambassadors, governors, commanders, captains, soldiers.* There is also an ecclesiastical set—*vicars, bishops, archbishops, cardinals.*

The univalve mollusks have one, two, and even sometimes three jaws. In this last case one is the upper, and the other two combine to form a lower jaw. These jaws are horny, curved instruments, well capable of cutting; in the front they are furnished with sharp little teeth, and the sides are notched. Their tongue is peculiarly constructed; it is covered with a dry membrane, and its surface is striated and rough. This tongue is ever in motion, lapping and licking with energy and strength. Often when it is working against the upper jaw it seems to take the place of the lower jaw. The membrane which covers the tongue is received in a pocket at the back of the mouth, like the heel of a stocking turned inside out; from this pocket it is pushed by the tongue when it protrudes.

In the periwinkle (*Littorina vulgaris*) the tongue appears as a white filament, about half an inch long; it is of a delicate material, and yet it is very resisting, being covered by prickly spines, which have the texture and transparency of glass. The denticles are arranged in three lines. Those which compose the middle rank have three points, while the lateral ones alternate a trifid tooth with a larger one; they are all covered the same way. Compared with this beautiful organ, our files are rough and unsightly.

In some of the mollusks this tongue is of an extraordinary length; for instance, the *Turbo rugosus* rejoices in one three times the length of its own body. As that part of the membrane which is most used gradually wears away, by a special mechanism the ribbon is thrust forward, like the steel shaver of a carpenter's plane. By this means the part which is used is always new, and in the very best condition for its work. Those univalves which have no jaw have no tongue; they are furnished with a muscular horn, which has no solid parts, but is fleshy throughout; the creature can extend it, and its surface is covered with sharp little projections which can cut through the most resisting substances.

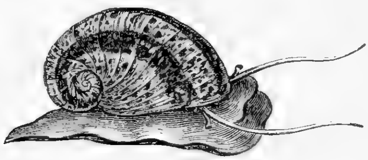
In the *Purpura lapillus* this organ can turn inside out, like a glove-finger. Its extremity is furnished with a species of lips, which the animal can open and shut at pleasure. The surface is armed with little hook-like projections, some of which are taller than the rest. By drawing this singular trunk rapidly in and out, the rough surface is brought in contact with the shell the creature would pierce, acting on the same principle, but far more effectually than a file. In one afternoon, Mr. Rymer Jones saw one of these mollusks pierce the shell of a pecten, and devour the animal within it.

The nourishment of the bivalves is determined by their organisation; some are herbivorous, others are carnivorous. The very small species live on microscopic vegetables or animalcules. The common periwinkles, of which we shall presently speak, live upon those infinitesimal plants which give off myriads of impalpable spores, which are held in suspension in the water. If these minute plants and their spores be placed in an aquarium, in a very short time the walls of the vessel will become coated with a green film, a boundless forest of these vegetables. But if we also place in the aquarium one or two little gasteropods, they soon arrest the vegetable growth, and restore the crystal transparency of the water.

The cephalous mollusks possess a brain peculiarly characteristic. The noble organ is not placed in the head, but in the neck. It is a ring of nerval matter, which surrounds the beginning of the digestive tube. Generally, this ring is loose and movable; it advances or recedes according to the movements of the animal. Sometimes it is very forward, sometimes it is further back; now it enters the head, and again it retreats into the body; its position is fixed by the will of the mollusk. It is usually found at the nape of the neck. This may explain the fact how a snail will live after its head is cut off—the brain, the great centre of the motive power of life, not being injured by that formidable operation. The brain varies its colour in different species; it is found white, yellow or orange, and black.

The univalves enjoy the senses of sight, of hearing, and of smell. The eyes are placed upon prominences at the base of the tentacles. They are simple in their construction, not made for long vision, nor yet for the blaze of the full light of day. The auditory organs are situated at the bottom of the neck. They are not visible from without; they have neither that external appendage which we term the ear, nor yet is there a visible orifice. These curious organs are membranous and transparent pouches, filled with a very limpid liquid, which holds in suspension some minute stones; these are endowed with a peculiar trembling motion. In some species, the cavity is scarcely $\frac{1}{500}$th of an inch in diameter, and yet it contains fifty or sixty of these stones. Their sense of smell resides in the surface of the tentacles. The mollusk is provided with two of these appendages. In our organism the nasal cavities open into the respiratory canal, so that the air which the expansion of the lungs causes to rush through the nose, carries to the olfactory nerve the particles of bodies which produce the sensation of smell. In those univalves where the nasal organs are separate and distinct from those of respiration, they are endowed with great mobility, and so, as it were, go in search of the particles which are to cause them the sensation.

The tentacles are covered with a microscopic down—very short



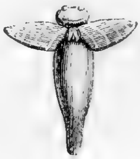
NERITA POLITA.

hairs, which are in restless movement, like vibratory cils. Their office seems to be to produce currents which bring the particles of matter which the water contains in contact with the surface of the organs.

The marine cephala deposit their eggs singly or in masses. When in this latter manner, they cluster them in vast numbers in every possible shape. As varied as the shapes are their colours, which pass through every tint save those which are allied to blue. Many of them are encased in a gelatinous substance, more or less transparent, and enveloped in a membrane. Some of the univalves carry their eggs deposited on their own shell. The eggs of the *Janthina* are suspended in the interstices of that wonderful swimming-bladder which we have described. Frequently more than a million are here deposited.

Some naturalists, especially of the French school, have been much interested in speculating as to the tender feelings which these mollusks exhibit to each other. They have carefully watched their communication among themselves, to discover if it were possible that the flame of love could exist in creatures so cold and slothful. The imagination has generally supplied to these observers that which they were earnestly wishing to see. We know nothing of their feelings, but in this we may rest assured, that the Creator has bestowed on every creature those capabilities of joy or sorrow which are exactly fitted to its organisation and the position it occupies in life.

Allied to the cephala is a small tribe of mollusks which swim on the open seas by the aid of two wings, or membranous fins, which are situated on each side of the head. These expansions serve the double purpose of organs of respiration and also

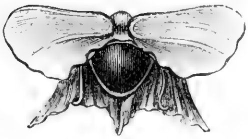


CLIO BOREALIS.

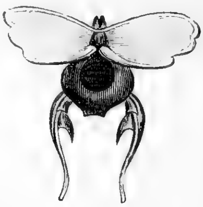
of motion. The creatures, on account of these characteristic members, are termed *Pteropoda* (wing-footed). They have been compared to butterflies with expanded wings, but the comparison is not at all exact. One of the best-known pteropods is the *Clio borealis,* a pretty little creature with which the North Seas sometimes are perfectly swarming. The whales consume them in prodigious quantities; indeed, the sailors call them "*whales' food.*"

Explorers of the Arctic Seas tell us, that often the desolate wastes of the northern waters are enlivened by the shoals and the movements of the clios; they dance and gambol on the surface of the calm seas, jumping out of the water like shrimps. These lively little Arctic people are beautifully tinted with blue, shading off to purple. Their head is a monument to the wisdom of the Great Creator. Six tentacles take their rise from the circumference of the mouth, upon each of which may be counted 3,000 rough spots, under the microscope; these are found to be transparent cylinders; from each of these, twenty minute suckers, or prehensile arms, are thrust out, or pulled in, at will. Therefore, upon the head of the clio there are no less than 360,000 of these beautifully-constructed arms. In the whole extent of nature there is no creature which possesses such an organ with which to seize its prey. The meanest organ on the most insignificant animal, when closely examined, arouses our astonishment and excites our enthusiasm; and again and again observation testifies that there is nothing neglected or imperfectly finished in nature.

Another pteropod—quite as beautiful and remarkable as the clio—is the *Hyalæa tridentata.* This species does not possess



THE TRIDENT HYALÆA.
(*Hyalæa tridentata.*)



THE EDGED HYALÆA.
(*Hyalæa limbata.*)

tentacles, but it is clothed in a shell. Its fins are very widely expanded; they are painted yellow, with a spot of beautiful violet at their base. The upper side of the shell is convex; the under side flat; and the superior part overlaps the lower. In one species the shell has something the form of a trident. Its colour is a yellow amber, and it is semi-transparent. When the pteropod swims, it extends the two wing-like expansions from beneath its shell, out of the lateral slits.

CHAPTER XXIV.

THE PURPLE OF THE ANCIENTS.

In the palmy days of Rome, her patricians and her kings wore togas dyed with the far-famed Tyrian purple. So universally was it the custom for the chiefs of the state to dress in robes of this beautiful colour, that "to be invested with the purple" became the synonym for assuming the royal power. It must not, however, be supposed that the wearing of this colour was positively restricted to men of rank; but it was so costly that only such men could afford to purchase it. Fabric dyed by the Tyrians was sold in the marts of Corinth for its weight in silver.

The colour of the celebrated dye was scarcely that which we know by the name of purple; it was a much deeper tint, and the play of the sunlight upon it made it almost iridescent. It would appear that, at first, a deep violet was given to the fabric, and, by various subsequent manipulations, more or less red was mingled with the original tint; this brighter colour the sunlight seemed to evoke.

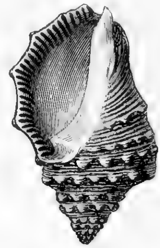
M. Lacaze-Duthiers reports that when, in 1858, he was in Port Mahon, his attendant fisherman, Alonzo, was in the habit of occupying his spare time by marking the sails and his own clothes with a colouring matter from a shell-fish. The naturalist happened to see the fisherman thus amusing himself, pointing a stick, he thrust it into the mollusk, and drew the characters he wished with the liquid which adhered to it; the marks were slightly yellow.

"You can hardly see it," said M. Lacaze-Duthiers.

"It will become coloured," answered Alonzo, "when the sun strikes upon it." And so it did.

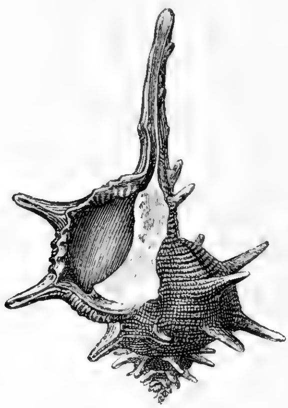
The naturalist requested the man to mark some linen for him, in order that he might watch the process. In about two or three minutes an extremely fetid odour was disengaged, the matter first becoming yellow, then green, and finally a bright purple.

The gasteropods which furnished the purple for the Greeks and Romans were members of either of the tribes of *Purpura* or



THE BLOODY-MOUTHED PURPURA.
(*Purpura hæmastoma.*)

Murex. Of the former tribe, the *Purpura hæmastoma,* of which we have given an engraving, is very prominent for its colouring power; but it is more than probable that every member of the



MUREX BRANDARIS.

species has this property. The *Murex*, or the rock-shells, are remarkable also for their bright colours and their fantastic forms. They are natives of all seas, but are best developed in the warmer latitudes. At Pompeii, some cups made of this shell were found near a painter's shop, as though a colour had been extracted from the mollusk, and kept in the shell for sale.

Lesson thinks that the purple of the Tyrians was also procured from the common Janthina. When one of the mollusks which produce this purple dies, not only is that part which contains the colouring matter tinted, but all the surrounding tissues. It has often been remarked by the curators of museums that alcohol and other preservative liquids in which specimens of these mollusks are kept, become tinted with various shades of purple. Until lately, we have been ignorant as to the whereabouts of the organ which secreted this colouring matter. Many naturalists supposed that the liquid in reality consisted of the juices which supplied the stomach with its digestive property. Others, who were nearer the truth, believed that there was a special organ for its secretion. M. Lacaze-Duthiers has given his attention to the subject, and has discovered that, beneath the mantle between the intestinal canal and the respiratory organs, there is a white band, in which the liquid is secreted. This organ scarcely differs either in position or shape in any of the species. The liquid is faintly yellow, and when submitted to the action of the sunlight, as we have already said, it passes through green to purple, which becomes deeper and deeper. The most disagreeable odour is exhaled during this process, which may be compared to burnt onions or assafœtida. The smell is retained by the fabric for a long time, and even after a year has elapsed the scent is perceived when the material is moistened. When the purple fabric is washed the first time, it loses its colour a little, but this is almost inappreciable, and ever after it is "fast." So the sailor's idea of marking his linen with it was excellent. In its yellow or green condition it can be washed out. M. Lacaze-Duthiers has often, in gathering the liquid from the gland, touched his finger-nail with it; and so strong is the dye, that the nail would remain coloured for five weeks.

Probably the property which rendered the dye so valuable was not only its brilliant colour, but the fact that the sun's light did not injure it. All our purple and mauve colours are almost immediately affected; but the purple cloak of a Roman dandy, as he promenaded along the thronged terraces of the great city, caused him no anxiety; he had learnt by experience that the purple owed its existence to the sun, and that exposure to the bright Italian sky only deepened its rich tints. Duhamel, who has studied this property, thinks that it is due to the same power by which the sun paints the rosy cheeks of the apples and peaches. But this can hardly be; for in the one case the sun acts upon matter which is under the influence of a vital force, but in the other the liquid is acted upon when separated from the mollusk; hence it must possess this property within itself.

The purple is thus entirely a photogenic substance. M. Lacaze-Duthiers has conducted some important experiments upon its *sensitiveness*, and the uses to which it might be put. He advises that the dyeing matter should be gathered with a flat, short brush; the secretive organ should be gently rubbed several times; by this means the brush becomes laden with the viscous liquid. Then the fabric which it is wished to colour should be covered by frequently passing the brush over it; thus a layer of the liquid is spread, which is at first frothy, but soon the air-bubbles disappear, and it becomes uniform. To wholly cover the surface, this process may have to be repeated two or three times. To obtain the colour, the prepared substance must now be exposed to the sun-light. The rapidity with which the tint is developed varies with the actinic power in the rays. In Spain, exposure for two or three minutes will suffice. If the sky be overcast, three-quarters of an hour will be required. The process is quickened if the fabric be moistened with a little sea-water. When only a thin layer of the matter is applied, the deep shade cannot be obtained by any length of exposure.

The mollusks which inhabit the "rock-shells" are capable of furnishing matter which, thus manipulated, affords colours. Some give blue, some purple, some violet. But the subject will bear much further investigation, for M. Lacaze-Duthiers found that, although he used the same matter, and treated it apparently the same way, yet he could not assure the appearance of the same tint, such is the delicacy of this natural dye.

CHAPTER XXV.

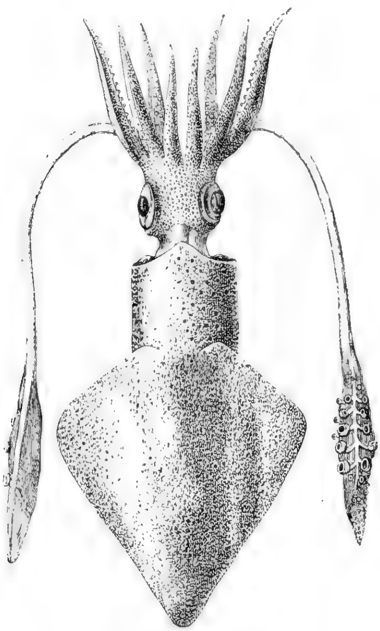
THE CEPHALOPODS.

IF we picture to ourselves a long cylindrical body, flat and flabby, terminating in a great head, the most remarkable part of which is a couple of enormous eyes, one on each side, its summit containing a mouth, or rather, a beak—a horny prominence, sharply bent like the bill of a parrot—around which branch out eight or ten arms, two much longer than the rest, we shall then have a general idea of those curious and ravenous creatures which Cuvier called "*Cephalopods*," that is, mollusks which have their *feet* branching out of their *head*.

The class is divided into three groups:—(1) The *Cuttle-fish*, which have a fin running down each side of the sac; (2) the *Calmars*, which have two distinct fins affixed to the upper part of the body; and (3) the *Poulpes*, which have neither. This difference in the three groups was pointed out by Aristotle. This great philosopher wrote a history of these creatures, and described their anatomy with a wonderful degree of accuracy.

The cephalopods are the princes of the mollusks. In them this great class of marine animals reaches its highest development. They swarm in the waters of the ocean, and in the Mediterranean. Some of them are found upon the coasts; others are inhabitants of the deep water. When we said they were the princes of the mollusks, we might have said they were the ruthless despots, for their love of taking life is only bounded by their power. Not being able to pursue their prey, for their motion is slow, they have resort to craft, and, like hunters of wily game, they lie in ambush awaiting its approach. Ensconsing their bodies in a hole, they leave their long arms ready for action. Their great eyes, always widely opened, patiently watch for the approach of the prey. The instant the unlucky creature is within arm's reach, it is seized; the cluster of arms encloses it, and draws it, without a hope of escape, to the beak, where it is devoured without pity.

The cephalopod is the tiger of the sea, for it destroys for the simple pleasure of killing. Alcide d'Orbigny relates that he saw a small cuttle deserted by the ebbing tide, and left with a shoal of little fish in a pool upon the beach. He seemed to be whiling away the hours, or perhaps venting his rage, by killing



THE COMMON CALMAR.

(*Loligo vulgaris.*)

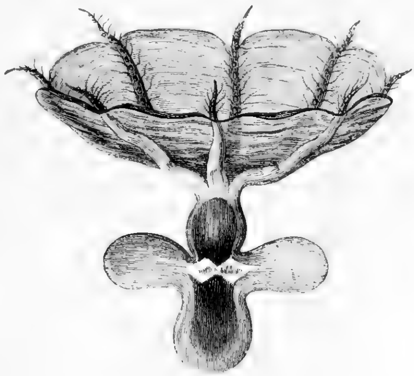
THE WORM-LIKE CALAMARY.

(*Loligopsis vermicularis.*)

all his fellow-prisoners. He had satisfied his hunger, and most probably had only stopped eating because he could eat no longer, and now was wantonly killing the fish for amusement. Yet the cephalopods are strong examples of retributive justice. As they savagely kill, so are they in turn mercilessly destroyed. Their enemies, the dolphins, deal death and mutilation to thousands of their species, and often the shores of the Bay of Biscay may be seen covered with cuttles, with their arms torn off, and other parts of their bodies bitten by the dolphins, who hunt them in sport. Thus Nature has ordained that the balance in life shall be preserved!

Cephalopods expel the residue of their digestion from an orifice in the neck, near the mouth. Their respiratory organs are internal, and bear a striking resemblance to the fronds of a fern. No less curious is the heart; indeed, we may almost say the hearts, for the vital fountain is so distinctly divided into three parts that they appear three separate organs.

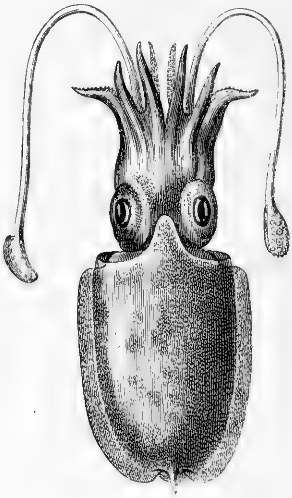
During a storm, the cephalopods anchor themselves to a rock by means of their two long arms, which are stretched out to their



CIRROTEUTHIS MÜLLERI.

fullest extent; they thus have their other arms at liberty to seize any prey which happens to come within reach. It may well be asked, How can straight, thong-like projections hold slippery fish and the other slimy inhabitants of the deep? The secret is that these arms are furnished with a multitude of suckers—orifices which communicate with a general canal; this the animal has the power of exhausting, and thus the arm is tightly affixed to the object. Some of the cuttles have as many as 900 of these suckers. Occasionally the suckers near the extremities are also furnished with sharp, bent hooks; these penetrate the prisoner, and make his capture the more certain. In the *Cirroteuthis of Müller*, the arms are united together by a lilac-coloured membrane; thus the cuttle, when symmetrically expanded, has somewhat the appearance of the corolla of a convolvulus.

Although, according to the derivation of the word, the cephalopod is an animal which has its feet attached to its head, yet we have only spoken of arms. The fact is, that the long members of the head serve many purposes; and, amongst others, they are useful as feet when the creature chooses to promenade along the bottom, or is forced to walk on the beach, when deserted by the treacherous tide. Of course this latter case is altogether an accidental position; but when walking on the bottom of the sea the body floats directly above the head, the arms serve as feet, and



THE ELEGANT CUTTLE-FISH.

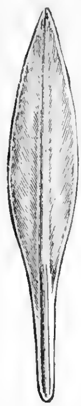
(*Sepia elegans.*)

so the cephalopod progresses. A cuttle-fish which is a native of the Pacific Ocean can make astonishing leaps; some of them have been known to spring so far out of the water as to fall on the deck of the ship. Sir James Ross caught more than fifty in this way, and some were seen to leap completely over the vessel.

Not the least interesting feature in the cuttle-fish is the black, inky liquid which it secretes in a gland communicating with the exterior by a small duct. When pursued, or in any danger, the creature ejects some of this liquid, so making a cloud in the water, under whose friendly covering it eludes its enemy and makes its escape—a stratagem which has been frequently used by nobler creatures than the cuttle-fish. How often does the theologian or the politician, to elude the arguments of his opponent, create a cloud, mistify the subject with words, and retire in the obscurity he has created. From the ink of the cuttle-fish the *sepia*, used in water-colour painting, is prepared.

The beautiful designs with which the great Cuvier illustrated his anatomy of the mollusks, were executed with the ink which he had collected in dissecting many specimens of the cephalopods. It used to be thought that "Chinese ink" was also made from the black secretion of some of the members of this group; but it is now found that that pigment is prepared from soot.

THE BONE OF THE CUTTLE-FISH.



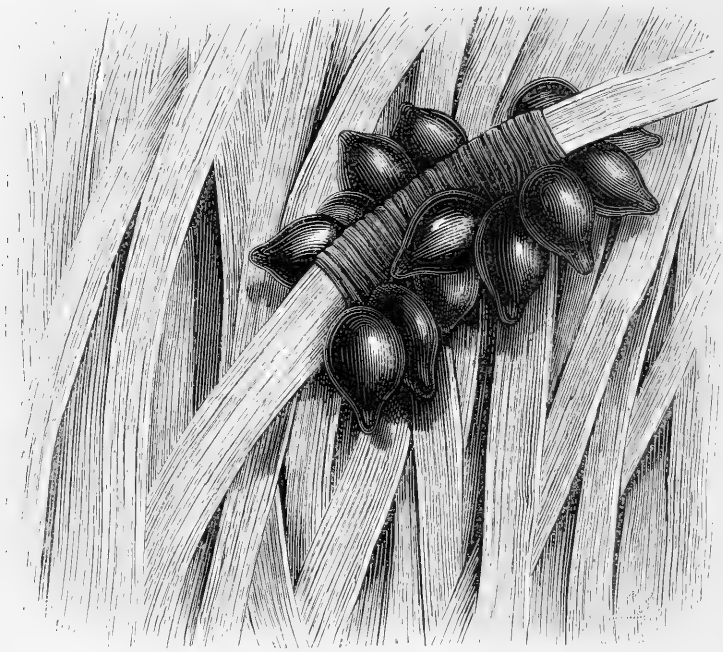
THE BONE OF THE CALMAR.

The most peculiar feature of these animals in an anatomical point of view is the "cuttle-bone," a flat, light, and friable body, which gives to the back of the fish its firmness. It is used whenever a very fine powder of carbonate of lime is required. The jeweller makes use of it; so also does the chemist, who sells it for tooth-powder. But these uses are as rare as the powder itself. In the calmars, the bone is more cartilaginous; indeed, it is semi-transparent, and has somewhat the appearance of a broad feather.

The Belemnites are the fossil bones of cephalopods of this class. There are more than 100 species of the genus known. They are very abundant in the clay of the Oolite period; in one instance the ink-bag was preserved, the black sepia was still there, and the addition of a little water brought it to the same condition in which it had been secreted long ages ago.

The cuttle-fish fixes its large, open eyes with a most peculiar and disagreeable stare. The iris is golden, and the pupil is rectangular; and at night their eyes light up like those of a cat.

The cephalopods are oviparous. They deposit their eggs, stuck together like bunches of grapes. The semblance is so



EGGS OF THE CEPHALOPODS.
(*Sea-grapes.*

evident that the fishermen call them *sea-grapes.* When newly laid, the eggs are enveloped in a glutinous matter, which not only protects them, but which surrounds any solid body against which they are deposited, thus binding them fast to the stem of a fucus or the branch of a gorgonia. The mother in this respect differs from many of the inhabitants of the sea; she does take some trouble in rearing her offspring. She selects a fit place, attaches the eggs to a proper support, and leaves them to the temperature of the water to hatch, which is generally accomplished in a month.

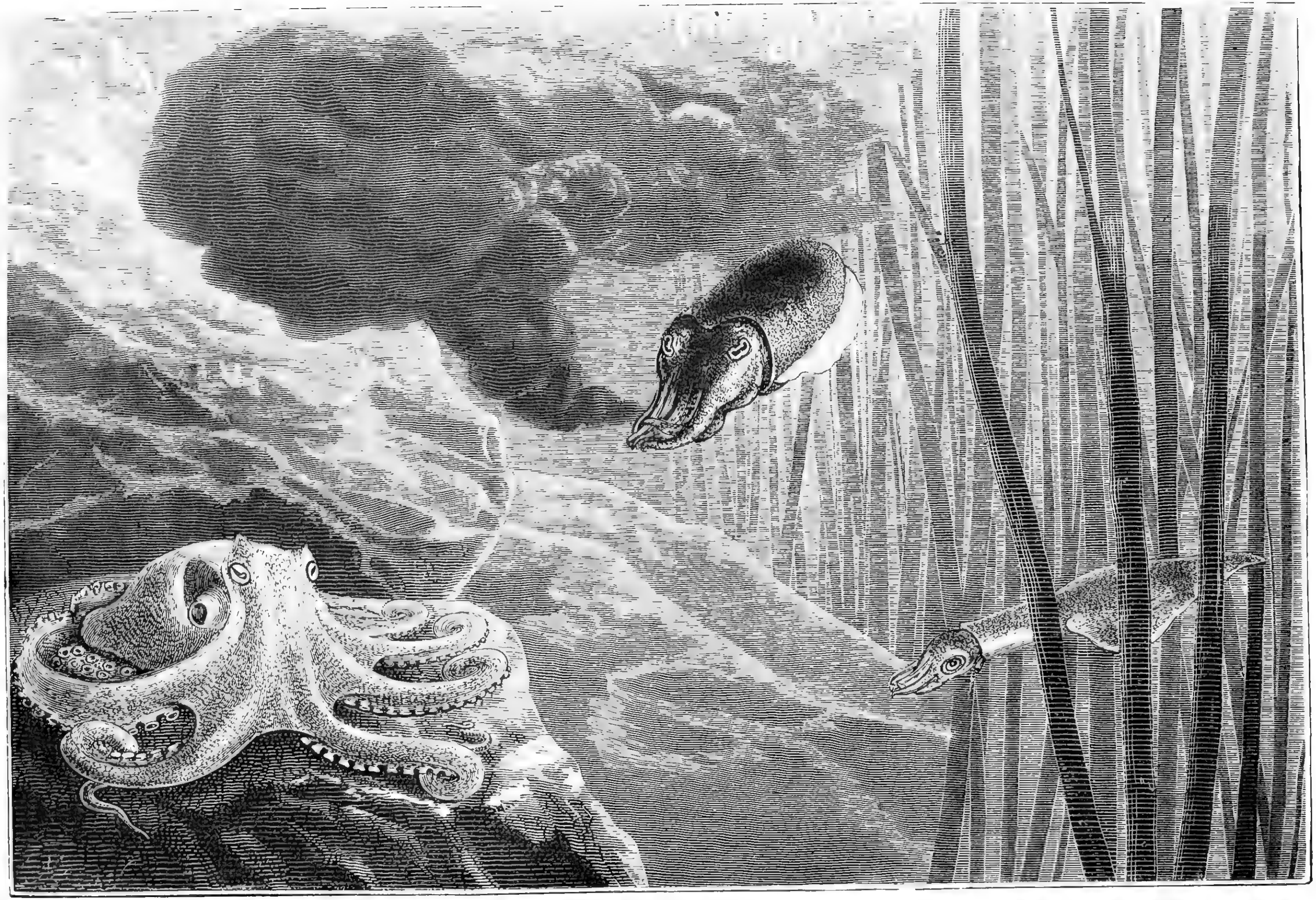


Plate XI. A POULPE. A CUTTLE-FISH MAKING HIS CLOUD. A CALMAR.

Many of the cuttle-fish possess the power of changing colour; they pass from a whitish purple to a livid grey, from a livid grey to a brown; their tints appear and disappear most rapidly. When the animal is irritated or frightened, its spots expand or fade away far faster than the shades of the chameleon. Some naturalists suppose that this power is used by the animal to puzzle its enemies.

Sometimes bathers are extremely inconvenienced, not to say endangered, by the presence of the larger cephalopods—the poulpes. Frequently the legs are tightly embraced, and so firmly are the arms attached, that it is with great difficulty the swimmer

(Its Envelope opened.) *(Its Envelope stripped off.)*

EGG OF THE CUTTLE-FISH.

can disengage himself. Dr. Franklin found that a few drops of vinegar on the back of the creature at once persuaded it to release its hold.

In times long past, we read of calmars and poulpes of sizes far greater than any which now are found upon our coasts; indeed, the naturalists and sailors who narrate the stories, describe them as approaching the gigantic dimensions of the whale. Pliny relates the history of an enormous cuttle-fish which haunted the coast of Spain in the neighbourhood of Castria, devouring all the fish, and destroying the fishing-grounds. At last the monster was captured. Its body was found to weigh 700 lbs., and its arms were more than thirty feet long. Its head was as large as a tun, and the fragments of the creature filled fifteen amphoræ, and were sent to the pro-consul Lucius Lucullus. Olaüs Magnus gives credence to the report that the northern seas were infested by a monster—a colossal poulpe, which was a terror to the mariners. Its length was asserted to be not less than a mile, and when seen on the surface of the water it appeared to be an island. Denis de Montfort gives a description of this monster, accompanied by a representation of the Kraken, as it was called, enwrapping a three-masted ship in its vast arms. Even Linnæus himself seems to have believed this fable, and in the first edition of his "System of Nature," he catalogues the Kraken as the *Sepia microcosmos;* but afterwards he seems to have had cause to discredit his information, for he omitted it in the next edition. Bartholin says that the bishop of Midaros found the Kraken quietly reposing on the shore. Mistaking the enormous creature for a huge rock, the reverend prelate erected an altar upon it, and performed mass. As soon as the bishop had had his say, the respectful poulpe waited until his reverence was safely on shore, and then plunged beneath the waves. Another bishop—Pontoppidan, of Bergen—assures us of the existence of the Kraken, and asserts that a whole regiment could manœuvre upon its back! But, in spite of the Church's authority, the existence of the Kraken is considered fabulous. We no longer live in a time when we could credit, on mere hearsay, that there existed a sea monster capable of rendering the Straits of Gibraltar impassable! Yet, in our own time, really enormous cephalopods have been captured both in the Mediterranean and in the ocean. Although they were not as large as a ship, nor yet an island, neither could block up a strait, still they deserve the name gigantic. Aristotle speaks of a great calmar (τεῦθος) which was taken in the Mediterranean, more than ten feet long. The famous diver, Piscinola, who went down in the Straits of Messina at the request of the Emperor Frederick II., is said to have seen enormous poulpes attached to the rocks, whose arms were some yards long, and quite powerful enough to master a man. But even this statement is not sufficiently scientific to be received as truth.

Modern naturalists have notified the capture of several very large cephalopods. M. Verany speaks of a calmar a yard and a half long, and which weighed twenty-four pounds. One was caught near Nice, weighing fifteen pounds. An equally large one was found in the Adriatic, and its body is still preserved in the Museum at Trieste. Twenty years ago, a calmar was caught off the south coast of France, six feet long; it is still to be seen in the collection of the Faculty of Sciences at Montpellier. Péron, the naturalist, met in the Australian seas a huge cuttle-fish, rolling heavily on the surface of the waves—its arms, more than eight feet long, twisting about like hideous snakes. Rang, in the same part of the world, met a cephalopod with a reddish body, which was the size of a tun cask. Swediaur reports that some whalers took out of the mouth of a whale pieces of a cuttle-fish which were twenty-five feet long! In the museum of the College of Surgeons, there is one of the mandibles of a cuttle larger than a hand. These are scientific accounts, and can be credited; from them we gather that the cephalopods reach a size far exceeding that attained by any other invertebrate animals.

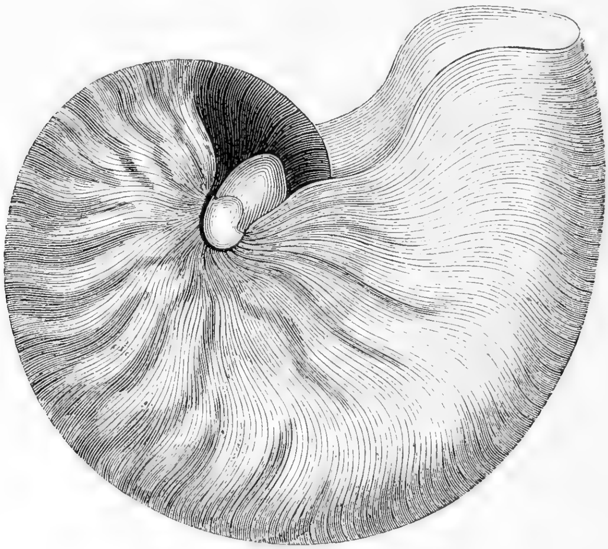
One of the most authentic accounts of the capture of a gigantic cephalopod is communicated by M. Sabin Berthelot, the French Consul at the Canary Islands. On the 30th of November, 1861, the steam corvette, *Alecton*, commanded by Lieutenant Bouyer, was cruising between Teneriffe and Madeira, when she encountered a monster cephalopod, floating on the surface of the water. It was sixteen or eighteen feet long, without taking into account its eight long arms, which were covered with suckers. Its eyes, which were on the surface of its head, were of an enormous size; their glimmering greenness and their fixed stare, rendered their gaze most unpleasant. The mouth, which protruded like the beak of a parrot, opened ten inches. The body, which was fusiform, and terminated in two fleshy lobes or fins of a large size, weighed upwards of 4,000 pounds. This brick-red mass was sighted by the look-out about two o'clock in the afternoon. As the corvette approached, the creature showed signs of intelligence, endeavouring to move out of the way of the steamer. Unfortunately, at the time a heavy swell was running: still the mollusk always remained on the surface. The commander determined to secure the creature for the sake of science. They loaded the guns, made the harpoons ready, with rope nooses. At the first shot, the monster plunged beneath the water, and appeared again at the other side of the boat. Again the guns were discharged, and, each time the creature was wounded either by the harpoons or the shot, it dived beneath the surface, but always came up again after a few minutes. The boat was kept continually at its side, and the chase lasted for three hours. The lieutenant was very anxious to capture the monster, but was unwilling to lower the boat, and so secure his prize, fearing, with some reason, that the creature might upset the boat, and so endanger the lives of the crew. To take the animal was no easy task, for the harpoons entered its flabby body, and came out as they went in, without biting; the shot passed completely through it, and seemingly left it unharmed. However, at last one ball struck a vital part, for the creature vomited blood and froth, with a glutinous matter which exhaled a strong smell of musk. They were fortunate enough to cast a noose over it; the rope slipped down its body until arrested by the caudal fins; and when they endeavoured to hoist it on board, the rope cut into the flesh, and separated the body into two parts; the head, with the tentacles, dropped heavily into the sea, and made off; and the posterior parts were brought on deck, and weighed about forty pounds. It is probable that this colossal mollusk was sick, or exhausted by some recent struggle with a monster of the deep, which would account for its having quitted its native rocks in the depths of the ocean; otherwise, it would have been more active in its movements, or would have obscured the waves with its inky liquid, of which, judging from its size, it ought to have possessed at least a barrel full, unless it had exhausted its store in a recent conflict. M. Berthelot questioned many of the fishers of the Canary Islands, who assured him that they had often seen huge red cephalopods out at sea, but they had never dared attempt to secure any of them. The circumstance is remembered by the crew of the corvette with dread, for there may be, and most probably are, many others of the same kind as that which the *Alecton* encountered. Was this cephalopod a calmar, or a member of a species allied to the calmars? If we are to judge from the figure given by M. Berthelot, the animal possessed two fins at the extremity of the body, like the calmars; but then its eight equal arms would ally it with the poulpes—the calmars, like the cuttle-fish, have ten arms, two of which are much longer than the others. Does it belong, then, to a species intermediate between the poulpes and the calmars, or shall we suppose that its two long arms had been dragged off in an encounter? As it is impossible to settle the question, the naturalists MM. Crosse and Fischer propose to catalogue this monster in a class by itself, under the name of the *Calmar of Bouyer.*

As with the mollusks, so with the cephalopods—some have shells and some are naked. We have seen that the greater number of the acephala and cephala are ensconced in shells; but the reverse is the case with the cephalopods. Most of them are without any calcareous covering, and only two species are testaceous; these are the *Argonauts* and the *Nautili.*

The argonauts have an historical fame. Many a famous pen has been engaged in their description, and many a poet has celebrated them in his verse. The Romans and the Greeks looked upon the argonauts as tutelar deities, who guided the mariner across the trackless deep, and bespoke for him a calm and peaceful voyage. Aristotle called the argonaut the nautilus. Pliny gave to it the name of Pompilius.

The most prominent features of the animal are its eight tentacles; six of these are very long, tapering to points, and are furnished with two rows of suckers. The remaining two are the great characteristic of the cephalopods; they expand themselves out into fan-like membranes, which the creature hoists as sails, and gracefully glides before the gentle zephyrs on the sparkling surface of the calm sea. The shell is very thin and fragile; it is a spiral, but the last turn is peculiarly large. The exterior of the shell is deeply grooved, the channels converging from the edges to the centre of the spiral. Its whole appearance has a graceful elegance, and has often been likened to a beautiful shallop, the sharp curve of the spiral serving as the prow.

Perhaps not one of the least characteristic features of this curious animal is, that it is at no point attached to its shell. Knowing this, for a long time naturalists supposed that it was a parasite seizing upon the shell of another mollusk and appropriating it, after the fashion of the hermit-crab. However, many have been captured, and never was an argonaut discovered in any other than its proper shell, and never was one found too large or too small for its shell; even this would be sufficient reason for asserting that the creature was not a robbing depredator, but a quiet possessor of his own lawful mansion. But, besides this, the egg of the argonaut is found to contain the germ of the shell, which increases with the growth of the creature; and cases have been known where a broken shell has been repaired by its occupant; at once setting the question at rest. Pliny, and the naturalists for long after him, believed that the argonauts spread their sails to



THE COMMON NAUTILUS.
(*Nautilus Pompilius.*)

the wind, and used their other six arms as oars. This, however, is scarcely the fact; the arms seem to be used by the creature to hold itself in its shell; and its chief motive power is the tube from which the water it inhaled for its respiration is ejected, the violent expulsion of the fluid propelling the shell forward. When in fear, it gathers in its sails and its arms; this overbalances the shell, and it sinks to the bottom.

The nautilus is even more curious and elegant than the argonaut. Its shell is a beautiful structure, extremely delicate and fragile; its exterior is ornamented with bands, or tongues, of a reddish yellow; its interior is richly nacred. The shell is spiral, so much so, that the last turn envelops the others; and what particularly characterises it is, that it is divided into chambers by concave walls, which it would seem the creature builds up behind it. These chambers are all connected by a tube which passes through their centre, called the *siphuncle.* The animal lives in the upper chamber of the shell, and by regulating the quantity of air or water the walled-up compartments contain, nicely adjusts the weight of the shell. The structure is so delicate, that if it struck against the ground it would be broken; and as the creature when it moves along the bottom does so by using its arms, it cannot drag its shell behind it, it therefore causes it to have the same specific gravity as the water; as it thus swims above it, it in no way impedes the progress of the cephalopod.

The nautilus was represented in the seas of ages long past by a cephalopod now found in a fossil state, and called after its likeness to the horns of the image of Jupiter Ammon—the *Ammonite.* It differs from the nautilus in having the siphuncle situated at the margin of the shell, and not passing through the centre of the chambers; moreover, the last chamber is not so disproportionately large.

These ammonites have the appearance of snakes coiled up and deprived of their heads; and the popular idea on the coast of Yorkshire, where the fossils are found in abundance, is that when St. Patrick banished the vermin from Ireland, the snakes in the agonies of death coiled themselves up, and are found entombed in the English clay, witnesses to the power of the saint.

CHAPTER XXVI.

UNITY OF COMPOSITION.

THE cephalopods are especially remarkable for the position of their long members. It is to this peculiarity, as we have said, that they owe their name. Those which have eight tentacles are called *octopods;* if they possess ten, *decapods.* The strange and unique position of the arms of these creatures, and the peculiar mode of their progression, has ever invested them in the eyes of naturalists with a great interest. Apparent anomalies are always subjects of much curiosity; but the more carefully they are studied, instead of revealing the vagaries of Nature, and showing any disposition to depart from her own arrangements, the observer can only discover further and further confirmation of the great laws which so inexorably govern the arrangements of the animal economy. A close study soon resolves what at first appeared an anomaly into a pleasing and new example of a different mode of applying the great types on which the organism of life is constructed.

Thirty years ago, two ingenious observers—MM. Laurencet and Meyranx—studied the plan of the arrangement of the viscera of the cephalopods. Their observations led them to conclude that these mollusks were constructed upon the same plan as the vertebrates, and were folded double, bringing their hands and feet together, just as the acrobats, who contort their supple bodies, and walk on their hands, their head being between their legs. Geoffroy St. Hilaire immediately adopted the idea, announced in an elaborate report upon the subject, that the cephalopods exemplified the very truth he had so long advocated, namely, the unity of organic structure. This was diametrically opposed to the opinion which the eminent naturalist, Cuvier, held; and, perhaps with something more than vehemence, he controverted the assertions and conclusions of his learned friend. The Academy of Sciences appointed the 15th of February, 1830, as the day upon which the rival opinions should be argued. Europe watched the contest. The question at issue was, whether the opinion which the scientific men of every age since the days of Aristotle had held, was to be overthrown by a notion just conceived; whether the painstaking labours of Cuvier, his beautiful dissections, his admirable descriptions, his graphic illustrations, all pointed to a wrong conclusion; that, after all, there was no such diversity in the kingdom of Nature as to authorise a stringent classification, but that animals were all formed upon the same type, and that the differences were not radical, but were produced by new arrangements of the same organs. Each view found enthusiastic supporters. The eminent naturalists of the time were ranged on each side, for it was not a question of mere detail, but of great principles. The whole scientific world was agitated by the discussion; and not only the scientific world, but the intelligent world was interested; every thinking man was in one sense competent to enter the lists of argument; so that the interest produced was universal. The journals and periodicals of the day opened their columns to the combatants, and all the leading pens were engaged upon the subject. Even the illustrious Goethe, then only twenty-four, rejoiced "that natural science had opened for itself another channel." France, where the contest originated, was its chief battle-field. Even the Revolution which threw down the Bourbon throne did not eclipse its notoriety. A stranger, newly arrived from Paris, was introduced to Goethe. "Well," said the noted man, "what do you think of the great event? The volcano, you see, has erupted." "It is, indeed, a terrible catastrophe," replied the visitor, "and the mere expulsion of the royal family is not the end of it." "It is not that, I mean," replied Goethe, "but the great debate between Cuvier and Geoffroy St. Hilaire."

The proposition which Geoffroy St. Hilaire brought forward was:—That Nature had constructed all forms of life upon one principle, and never deviated from the general plan, although its various component parts admitted of alteration—the larger development of one organ, or the suppression of another, might depend upon the circumstances and position of a particular animal. This peculiarity was handed down in the generations of the race, the offspring of each generation continuing and establishing the distinctive character of the breed. Or, in the words of Buffon, "All the essential parts of the animal economy seemed to indicate that the Creator had determined to employ only one idea, and to vary that idea in every conceivable way, calling us to admire at once the magnificence and the simplicity of the design." This theory renders it easy to account for the very varied distribution of organs to the members of the animal kingdom. A slightly-altered phase of this idea is at the present time agitating the scientific world. Mr. Darwin has broached what is called "The

ÉTIENNE GEOFFROY ST. HILAIRE.

theory of genetic evolution by variation." Whether St. Hilaire ever conceived that not only were the animals made on one plan, but that they all came from one stock, and that all diversity which we now see around us has been produced in the lapse of ages by the necessities of the position in which the animals were perhaps at first accidentally thrown; whether he conceived this idea or not, is uncertain: he certainly did not venture to bring it into the discussion. But since his day, theorists have grown bolder. However, the world of to-day does not want its Cuviers, men who, by patient investigation, and a calm survey of facts, draw conclusions at once safe and sound. The mere fact that Darwin's theory has found many great names to lend to it their authority, is a sufficient guarantee that many facts and analogies can be cited in its support.

The religious world who have always been accustomed to think that God created the animals after "their kind," need not fear for the truth of the Bible narrative; it is not in the slightest danger of subversion; even supposing that Darwin's theory could be established, yet we all admit that God works by laws, and the law of development may be the very agency he commanded to proceed to do his will in those early days of creation, and if this be the case, it redounds more to his glory that such wonderful diversity as is shown in the animal kingdom should have been the result of such a law, than if he had called into existence each family separately. The creation of life must always remain beyond the power of any law. Even granting that the globe has been peopled with life from a very crude and low type, yet between the sponges and the stone upon which they grow there is a great gulf fixed. In the one, there is that mysterious something called "life," and in the other it is wanting. No ages, no development, can ever—from that which has no power of any alteration, or any growth—produce a superior existence. Life is a power entirely foreign to matter, and to grant it, there must be a Creator!

Cuvier met the new ideas broached by St. Hilaire, with a strong opposition. "If," said the great naturalist, "you mean by *unity—identity*, the evidence of our senses is a sufficient contradiction. If, however, we only are to understand *resemblance*, or *analogy*, the proposition is true within certain limits; but as old, in its principle, as zoology itself. Recent discoveries have added important facts, but these in no way controvert the principle."

Geoffroy replied, that unity of composition was neither perfect identity, nor yet simple analogy, but something midway between the two. It had more to do with the mutual relation of animals than with their individual forms, and treated rather of the general plan than of the particular example of the type. Had not Cuvier acknowledged that there were four distinct types in the animal kingdom? and did not the animals of each of these types—the vertebrates, for instance—offer among themselves both identities and analogies? In other words, the great zoologist accused Nature of leaving—in the evident plan of her organisation—great chasms, which she had not attempted to bridge; and that animals which were plainly the transition from one type to another—the cephalopods, for instance—were not connecting links, but curious existences, without a reason for their peculiarities.

St. Hilaire reminded Cuvier how, when he found a few bones of the Anoplotherium—a species of fossil tapir—he had practically adopted the very theory he now opposed, and with wonderful genius had built up the whole animal from the very analogy which he now contended did not exist; and how wonderfully correct his animal synthesis had been proved by the subsequent discovery of a perfect skeleton.

CUVIER.

Nearly forty years have passed since the celebrated controversy. The predictions of Goethe have in some degree been realised. "Mind," said that profound thinker, "will always govern matter."

We shall discover the great maxims of creation; we shall penetrate into the mysterious workshops of the universe. What are our relations with Nature, if we only occupy ourselves with material individuality, and if we do not recognise that living principle which gives to each organ its direction, and which ordains and sanctions every deviation from the inherent law of growth? Unity of composition and secondary laws thence deduced, found their way into the ideas, the teaching, and the books of the period. That seed has borne great fruit, its latest being Darwin's theory, to which allusion has been made. The new doctrine thus introduced, is merely—as Geoffroy St. Hilaire himself said—but a confirmation of the dictum of Leibnitz, which defines the universe to be "unity in variety." Natural history thus treated is elevated to the first of the sciences.

The two great men who exercised such a different influence upon the progress of zoology worked together in their youth, and published many treatises conjointly, but soon the divergence of their views led to their taking separate paths. Cuvier, whose mind was exact and unimaginative, applied himself to the rigorous observation of facts, and to the consequences immediately resulting.

GOETHE.

He proclaimed the supreme authority of analysis, and feared the premature conclusions of synthesis. He carried his belief in finalism to excess, and was a firm believer in the absolute invariability of species.

On the other hand, Geoffroy St. Hilaire was an enthusiastic and bold thinker. He attached great importance to the conclusions of synthesis, and believed that science ought to be guided by the light of philosophy. He taught that there was a limited variety of species, and these were influenced by surrounding circumstances; including all organised beings under the same law, he allowed to classifications but a very secondary value.

To conclude, Cuvier maintained the doctrine of differences, and represented the analytic school; St. Hilaire supported the doctrine of resemblances, and belonged to the synthetic school. One was the historian of Nature, the other wished to be her interpreter.

CHAPTER XXVII.

THE ANNELIDA.

THE *Annelida* are a group of animals which were for a long time confounded with worms, on account of their long, slender bodies. One would think that they could offer but little interest; and yet, as Aristotle says, there is nothing in Nature either low or despicable, everything is beautiful and worthy of admiration. The annelids, amongst all the marine animals, possess perhaps the most graceful forms, the most elegant appendages, and the most brilliant colours. Cuvier was one of the first who studied them with attention; he called them red-blooded worms, because he found that in most of them the blood was tinted, in which particular they approach terrestrial animals. But since the time of the illustrious zoologist, certain groups have been found whose blood varies in colour—violet, blue, green, and yellow; and there are some, also, in whom the vital fluid is colourless. Lamarck gave them the name which they now possess, from the ring-formation of their bodies. Their rings number twenty, thirty, sixty, or eighty, and sometimes more. In the *Eunice sanguinea* there are three hundred; in the *Phyllodoce laminosa* (an animal scarcely a yard long) there are at least nine hundred rings. These rings are ridges —thick or thin, flat or rising up—and separated from one another by indentations. All the rings are alike, except those at the head and tail, which are slightly modified. The creatures are either naked or are well protected by a firm, solid coating. Those that are naked bear a strong resemblance to worms or grubs. Some of them hollow out for themselves straight galleries in the earth; others congregate by hundreds and thousands in sand-hills; and others construct for themselves habitations which resemble honey-combs. The species which possess a solid envelope inhabit a straight, calcareous tube—some being rigid, others flexible. The creature can entirely ensconce itself in this tube, like a mollusk in its shell. Cuvier remarked that the naked annelids had respiratory organs upon the centre of their bodies; those with a solid covering possess the same organs upon their heads or tails. The first class he termed *Dorsibranchiata*, the other *Tubicola*. The bodies of these animals are more or less cylindrical, and often flattened; towards both extremities they decrease; like earthworms, they can contract and extend at will. They are remarkable for the number of their eyes, some having as many as sixty. Ehrenberg describes a curious species provided with two eyes upon its head, and two upon its tail. Another, a veritable little Argus, has several upon its head, two upon every ring, and its tail is furnished with four. Many annelids have two or more rows of tufts of bristles, running the whole length of their body; others are surrounded by thousands of small filaments, which serve for hands, or feet, or fins, according to the creature's necessity.

The *Cirratulidæ* have long, capillary appendages covering their bodies, which stretch out on every side; they are at once arms and branchial organs; and the blood, which fills and leaves them alternately, tints them a beautiful red, leaving them an amber yellow. They elongate their pointed heads, with eyes like the lamps of a locomotive, as they recoil from the light which bursts upon them. Now they form a knot far more inextricable than the Gordian knot which Alexander cut. But this is a living cable; the folds glide one under the other, ceaselessly tying and untying themselves, throwing from every point bright reflections from their sparkling bodies. The annelids are timid animals, afraid of anything; yet still, strange to say, they live by rapine; they lie in ambuscade, and patiently wait till some imprudent creature passes near them; immediately they surround it with their arms, or seize it with their horns. Others perforate the hardest shells, and devour the most secure mollusks.

It is not to be expected that an animal which is an Ishmaelite of the sea should not have many enemies. Against their frequent attacks, Providence has amply furnished the annelids with defensive weapons. In the armoury of the race there is a far larger assortment of murderous implements than even the cruel genius of man has invented. Here are curved blades, some sharpened on the outer edge, like the yatagan of the Arab; others, like the scimitar of the Turk, have the concave edge in cutting order; they have their short swords, and long swords; their dirks, and their bayonets; and, more wonderful and more deadly still, they have harpoons, and fish-hooks, and fine sharp lancets, slightly affixed to the end of slender shafts. These the creature leaves in the body of its enemy, to his great and lasting discomfort. If, however, the brave assailant receiving, but not heeding, the wounds thus inflicted upon him, comes to close quarters with the annelid, he finds a new set of weapons ready to impale him. Out of every foot comes a sharp spear, to which is attached a distinctive muscle; and, with an astonishing vigour, these the marine worm thrusts into the body of its adventurous enemy.

Foremost among the dorsibranchiata are the *Nereidæ*, or the sea centipedes. They are found upon our coast, hiding themselves in the crevices of the rocks. The larger members of the group are inhabitants of warmer latitudes. Their tentacles are arranged in pairs on each side of the head. Their tubercles and tufts of bristles are impelled by a simultaneous motion; and as the animal thus glides through the water, the ease and grace of its motion can hardly be conceived—a long, beautiful boat sweeping along, with a hundred perfect oarsmen. The dorsibranchial nereids are frequently brilliantly coloured.

The *Pearly Nephthys* has a body of bright orange; a line of a darker hue passes down the middle of the back. The jaws are black and the eyes blue; while a resplendence is imparted to the little creature by the lustre of its skin.

A kindred species—the *Eunice gigantea*—may be considered the king of the nereids. This princely annelid is an inhabitant of the waters around the Antilles. It is a yard and a half long, and its body is composed of 450 rings. The bright tropical light plays upon it with iridescent splendour. The head is richly painted, and out of it rises a rose-coloured horn, which bears on its extremity a pair of prehensile forceps. The respiratory organs are situated on its sides, and, when distended with blood, appear as vermilion patches. It has 1,700 organs of locomotion; they all move simultaneously, and with great rapidity; indeed, so rapidly that frequently the eye is not able to distinguish them. As this splendid annelid contracts and elongates itself, glides through the water, turning quickly hither and thither with the quickness of thought, it looks like a beam of coloured light shooting through the submarine world, and disporting itself amongst the rocks.

The complication of construction in these creatures is something incalculable. Conceive an animal with 280 stomachs, 300 ganglions or nerval centres, and 3,000 muscles! The *Eunice sanguinea* rejoices in this multiplication of apparatus.

Perhaps the most beautiful of the annelids to be found upon our coasts is the *Aphrodita aculeata*—the sea-mouse. Its shape is ovoid, pointed at the extremities, and a little flattened; its back is somewhat convex, the ventral region being flat. The upper part of its body is covered with large membranous scales, which are sometimes distended; they have been called, though without much reason, *clytra* (winged sheaths). These scales are covered with a thick, brown fur, which has the appearance of fine tow. Through this peculiar covering there rise strong spines—the defensive weapons of the annelid. Its bristly tufts, which are its chief organs of locomotion, are usually of a rich golden tint, yet they can change with every colour of the rainbow; the tints being flung back as if by metallic reflectors. Not even can the humming-bird boast of such vivid colours, nor are they inferior to the sparkles of a gem. These tufts are as remarkable for their construction as for their lights; each thread may be compared to a harpoon whose point is doubly barbed. Few of the ocean depredators are brave enough to attack this little porcupine; and, lest that these formidable weapons should wound the annelid itself, a sheath is provided for each bundle, so that when they are not in use the creature draws them back, and they are safely kept for the next time of danger.

The aphrodita is very timid. It is difficult to rouse during the day; it lies ensconced under a stone or shell, drawing in and ejecting a current of water so strong that it creates quite a little whirlpool. When night comes, it leaves its hiding-place in search of prey. The annelids are, as we have said, very voracious, not even sparing their own species. Mr. Rymer Jones speaks of two annelids, not equal in size, probably being of different ages, which were put into an aquarium. For two or three days they lived in harmony, and then the greater of the two attempted to eat his companion. He managed to get part of his body into his great œsophagus trunk; his victim made desperate efforts to disengage himself, and after a time succeeded; but, unhappily for him, during the combat he had had some of his scales torn off, and his rings damaged. The next day there only remained half, for during the night the conquest had been completed, the rest had been devoured; and the conqueror was darting hither and thither his hungry proboscis erect, ready to seize the remainder of the little creature, which had shrunk into a corner of the aquarium.

The dorsibranchiata are wanderers; the tubicola are fixed. These latter are noted for the elegance of their respiratory organs, which are ranged sometimes in plumes, sometimes in crowns, or in fans. The entrance to their habitation is ordinarily small; it is, however, the only opening through which these recluses can have any communication with the world around them. Foremost amongst these annelids we must mention the *hermeles*. They live in the waters of the Mediterranean, lodged in a tube of sand some three inches long. Out of the end of the pipe from time to time there issues a bifurcated head; from the summit of each branch a number of strong, sharp tongues, of a golden yellow, rise; these close over the entrance of the holes whenever the creature is disturbed and retreats into its mansion of sand. The least motion which makes a ripple upon the surface of the water is sufficient to cause the timid animal to shut itself up in its fortification. From the sides of this cephalous defence, fifty or sixty delicate, violet filaments issue, which are in continual motion. Like so many little serpents, they alternately lengthen and shorten themselves, seizing their prey as it passes, and drawing it into the mouth.

To their activity and energy the annelid owes its dwelling-house: they gather the grains of sand, and build up its incasing tube; the solid grains are held together by a kind of mucus, which, in fact, plays the part of an hydraulic mortar. Upon the sides of the body may be noticed mammillary risings, out of the summit of which issue sharp, cutting lances; these are, in fact, the feet of the creature.

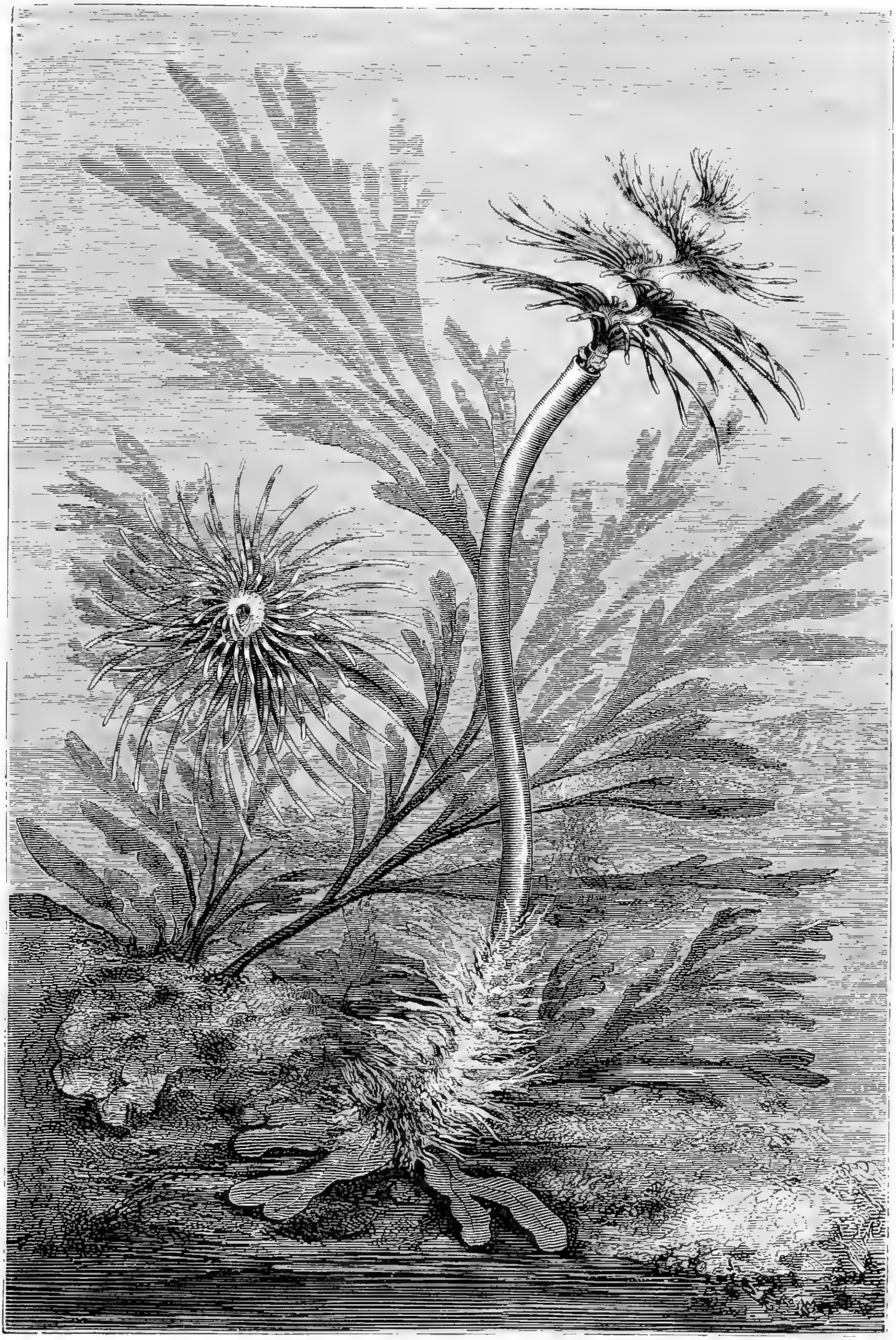


Plate XII. ANNELIDA TUBICOLA.

When the bottom of the sea is dredged, very frequently from deep water old shells and pieces of pottery covered over with tubes are brought up. These are formed of calcareous matter, and interlace each other in every possible manner. They are the abodes of the *Serpulæ*—little inhabitants of the salt water, whose brilliant colouring strangely contrasts with their modest cell. These annelids live in their tubes like moths in the sheath of the chrysalis, its shape varying according to the species of its occupant. When observing serpulæ in an aquarium, the greatest precaution must be used, for at the least motion they retreat into their tubes. At first out of the opening there issues a scarlet bud, borne upon a long stem. This is the valve with which the annelid closes the mouth of its retreat—the porter who waits at its gate to close it against intruders. The button is richly painted with orange and scarlet, striped with white. Its upper surface is divided into sections by lines which radiate from the centre to the circumference, each line ending in a microscopic hook. In some species this valve is quite flat—a round disc; in others it is a cone—the apex pointing down the pipe. The outer surface is not always smooth. The *Serpula gigantea* has two branching horns, like those of a stag. The *Serpula stillata* forms its valve of three plates threaded together, so that this secure little creature closes its house with a triple door.

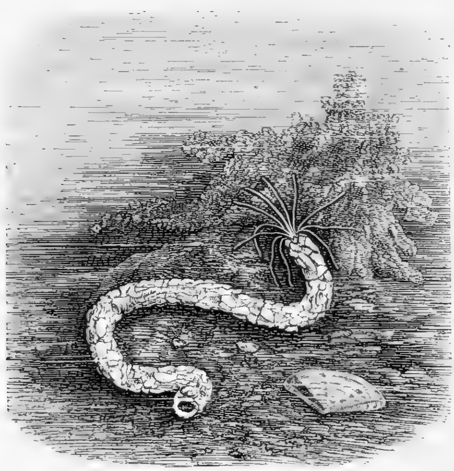
When the annelid comes out of its tube, it gradually unfurls a splendid plume, arranged as a spiral. The filaments which compose the plume are exquisitely coloured; it waves it in a constant and graceful motion. On close inspection, it is found to be completely covered with vibrating cils. In most of the creatures this delicate apparatus rolls itself up spirally as it retreats into the tube.

Properly speaking, the serpulæ have no distinct head. The upper part of the body is covered by a modification of the mollusk mantle, immediately beneath which is the stomach. The central part of the body is composed of seven segments, from each of which issues a pair of tubercles, which perform the office of feet. Out of these fleshy tubes a bundle of bristles can be thrust at the will of the animal. The microscope shows that there are twenty or thirty of these yellow-coloured, horny filaments; at their extremities they thicken, and terminate in four sharp points, one of which projects beyond the others. When the creature feels disposed to go out of its case, it thrusts out of the foremost tubercles these sharp-pointed bristles; these, pressing against the walls of the tube, urge the animal forward; then, contracting its body, it brings up the hindmost feet, and in the same way fixes these, so pushing itself forward. Invisible to the naked eye, there passes from each foot, perpendicular to the body, a fine, yellow ring. Under a strong magnifying power, the ring appears to be a ribbon, upon which rest triangular plates; each plate is armed with seven teeth—six turn in one direction, and the seventh faces them. There are 136 of these plates on each ribbon, and since there are as many ribbons as feet—that is, fourteen—there must be 1,904 of these prehensile plates, and each of them is moved by a distinct muscle. By this truly wonderful mechanism, the annelid can fix at once 13,328 teeth in the membrane which lines its tube. No wonder that it can with rapidity retreat when frightened, and no wonder that it cannot be drawn out of its home against its will! Even the most thoughtless must pause at this lavish expenditure of mechanism upon a mere worm which lives and dies far down in the ocean depths; and who can help exclaiming, "Wonderful are thy works, O God; in wisdom hast thou made them all?"

There is another member of this family—the *Spirorbis nautiloides*—which also makes for itself a calcareous tube; but it is very fragile and weak, and generally is attached for support to some sea-weed or the shell of a mollusk. It secretes its pipe after a much more delicate fashion than the serpulæ, rolling the material round itself, somewhat after the plan upon which that fluviatile mollusk, the planorbis, manufactures its abode. The spirorbis is not much thicker than a pin's head. It comes out of its tube from time to time, spreads its plume, and most gracefully do its tentacles wave its food into its mouth. It has no head, no eyes, no mandibles; but can hermetically close itself into its little mansion, like its larger relative, the serpula.

The *Terebella* is also a tubicole annelid. It is peculiar for the number of yellow filiform appendages which spring from about the mouth; these the animal can stretch to a great length. From their neighbourhood, also, branch out the respiratory organs. They are not, as is general in the annelids, in the form of fans, but arborescent, spreading out like fine branches. The tentacles appear at the first glance to be round threads; but upon a closer examination they are really found to be flat tubes, along whose surface run longitudinal grooves, sometimes so deep as to permit their sides to fold over, by this means enabling them to hold tightly to anything which they touch. In one species, the division between the channels is furnished with seriated teeth. The branchial apparatus is exceedingly beautiful, affording a great number of angles and curves and points; its colours are varied and brilliant. The protective tube of the terebella is formed as most of the others—of sand and fragments of shells; but the walls of its extremity are somewhat extended, to form a sheath for the tentacles and respiratory organs. If a terebella be placed in an aquarium devoid of its tube, it will extend its tentacles on every side, and actively commence to construct a new one. When a little of it has been made, the creature will creep into it, and lie perfectly still during the daylight. At evening it puts out its tentacles, and during the hours of the night works incessantly. How can an eyeless creature recognise the difference between day and night?

In some of the species, the tentacles appear to divide the work: one confines itself to gathering material together, another transports it, a third places it in position and fixes it with mucus, whilst others gather up the *débris* which falls from the work. The building continues for many hours uninterruptedly: the progress, if watched, appears but slow; however, next day, much has been done; for, during the night, the tower of the edifice has been lengthened—particles of sand have been regularly laid in order, and solidly united. With the dawn of the morning, the builder ceases, and rests from his labour, again to commence with renewed vigour when the night hides curious eyes from watching his proceedings. The interior of the tube is lined with a fine coating of silky matter, which binds together the masonry, and at the same time decorates the walls of the mansion. This material is produced from a humour secreted by the skin of the annelid—an excellent and economical liquid, which serves the double purpose of glue and gilt. If a terebella be pulled out of its tube, its resistance is so strong that generally it is much hurt. Some of its tentacles are pulled off, and its rings staved in, but it seems little affected by the injuries, and at once sets to work to rebuild its house, with untiring energy, and exhibits no appearance of disappointment. The *Terebella textrix* adopts a different plan. Instead of gathering about it foreign materials, and of these constructing its tube, it encloses itself in a fabric which it weaves like linen. This covering is very thin, and somewhat irregular;



TEREBELLA CONCHILEGA.

the threads which compose it are so fine and transparent that they are almost invisible. It is a most complicated manufacture, for there are at least fifty threads as long as the little weaver himself.

M. de Quatrefages has described a new and ravenous species, under the name of the *Terebella Emmalina.* The body of this animal is long, and flattened like a ribbon. Its head is an azure blue, shading away through green to orange at its tail, which is remarkably thin. The under part of the body is a golden yellow. The articulations can scarcely be seen in the caudal region, becoming more distinct as the head is approached. Its feet issue from mammillary projections along its sides: the first fifteen pairs are purple, and terminate in a tuft of hairs or hooks; the rest are yellow, and have no tufts. The branchial organs are arranged in six pairs—the foremost being the smallest, those near the tail the largest; their colour is a bright vermilion, which gives them the appearance of miniature coral branches. They have sixty to eighty tentacles rising out of the head, some of these being three times the length of the animal. These feelers are semi-transparent and yellow; frequently they are straight, occasionally spiral; all are hollow, their canals communicating with the general tube of the body. This profuse tentacle arrangement surrounds the whole animal with a capillary apparatus of the greatest delicacy. It is not a net, for each of the threads are distinct, but hangs about the annelid more like a silken cloud, or like that delicate mould which grows round decomposing fruits. In spite of their extreme tenuity, these fine feelers serve the annelid as means not only of supplying itself with food, but also of locomotion; and more than this, they are the defensive organs of the creature: for their surface is found to be covered with irritating vesicles, in the shape of small bottles with short necks; through the orifice passes a finely-pointed dart, which is probably traversed by a canal, through which the venom passes into the puncture made by the point.

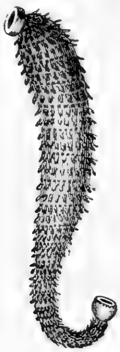
If from the front part of the head of a terebella straws of a golden colour branch out, the annelid is an *Amphitrite*. The *Fan Amphitrite* (*Amphitrite ventilabrum*) is the prettiest found upon our coast. Its tube resembles a leathern sheath, and narrows gradually towards the tail. When the annelid is put into fresh water, for some moments it remains at rest, as if considering the novelty of its position; soon little air-bubbles begin to escape from the tube, and then gradually appears the point of a streaked brush, composed of a multitude of feathery filaments of the brightest carmine. Gradually this plume expands into the fans, which join and form a circle like a peacock's tail. Each filament is edged with fine barbs, arranged with perfect symmetry. The outer rim of the circle is of a reddish purple, shading off towards the centre to a golden yellow; five or six concentric curves traverse it; from this centre two triangular antennæ issue, and above them two kinds of fleshy lobes, which may be compared to trowels. Between these lobes is situated a little tongue in constant motion. The rest of the body is slender, and festooned with bright colours. At the slightest touch they all disappear, the fan is drawn in, and nothing seen but a sombre, uninteresting sheath.

CHAPTER XXVIII.

SALT-WATER LEECHES.

THE sea has its leeches as well as the marshes; but the sea-leeches are always found as parasites, and they offer many other points of difference to the fresh-water blood-suckers. In the first place, their skin, instead of being thin and delicate, like the ordinary leech, is thick and coriaceous. They are strongly and comfortably clothed, doubtless that they may the better withstand the changes of temperature, and the incessant motion of the waters of the sea. They cannot glide so quickly and so gracefully through their watery world as their relations of the marshes; they can but contract and expand themselves, and with that modicum of motion they must rest content. And, moreover, the two species are very different in their shapes.

The marine leech is scientifically termed *Albione*, which is synonymous with *Pontobdella*. There is also another variety, which is called *Branchellion*. The body of the albione, as may be seen from the drawing, is very rough—covered with spiny projections. It has no appearance of branchial appendages; these organs are not required, for the leech breathes through its skin. This is not the case with the branchellion: its breathing apparatus is visible, being arranged down each side of the body in two undulous fringes. The albione is generally found attached to the body of the skate, and is therefore called by the fishermen "the skate-sucker." The branchellion takes up its abode on the body of the electric eel. Each end of its purse-like body is furnished with a sucker, by which the creature makes itself fast to the fish. Instinct causes it to attach itself to the roots of the fins, the neighbourhood of the eyes, or the opening of the gills, for at these places there is the greatest number of blood-vessels, and here the skin is thinner and more easily pierced. The marine leeches do not make the incision with the same instrument as the medical leeches, which operate with three strong, cartilaginous jaws, producing that peculiar bite called "the leech-bite;" but, in the place of these lancet-jaws, we find three slender tentacles. But how can these pierce the skin of the fish? The leech does not cut the skin, and probably the tentacles are only organs of feeling, by means of which the parasite fixes upon the proper place to make his attack. Having fixed his sucker, he exhausts the air so completely, that the skin of the fish bursts at the place where the suction is applied. Hence the marine leech tears the skin; the fresh-water



THE SPINY ALBIONE.
(*Albione muricata.*)

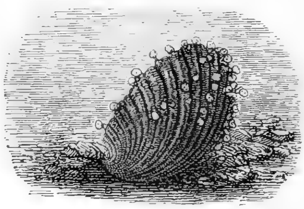
BRANCHELLION.
(*B. Torpedinis.*)

leech cuts it. It would seem that the tubercles which roughen the body are intended to keep the leech from being rubbed too violently against the skin of the fish to which it is attached. The annelids must often stand in need of this defence, for it cannot be expected that the skate or the torpedo will passively submit to be continually preyed upon. During the day-time, these annelids, like the rest of their kind, lie quiet and still; night with them is the time for action, when they awake from their apathetic state, and vigorously suck their unfortunate victim.

The sea-leeches prefer red blood, and therefore always attack fish—never mollusks. They usually choose some member of the ray family, and generally flat fish, probably because their skin is less cartilaginous, and perhaps, also, because these fish live either upon or very near the bottom—a circumstance peculiarly favourable to the necessities of these sanguinary annelids. It is remarkable that these leeches should be capable of taking in so much of that fluid, a very little of which suffices the superior animals for their sustenance. It is still an unsolved question why the *Hirudinidæ* require more nourishment than creatures far above them in the scale of life. We can understand why the silkworm should eat a weight of mulberry-leaves heavier than its own body, at a single meal, because the creature is so rapidly growing and storing that silk which is to compose its winding-sheet. But the blood of a man or of a fish is the very essence of nutriment, and yet the leech will imbibe a large quantity. This cannot be expended on its growth, for it grows but slowly. What, then, can be the reason for its gluttony?

The medical leeches can distend themselves with seven and a half times their weight of human blood; but the sea-leeches can only take in twice their own weight. Why is this? It may partly be accounted for by the difference of their construction. The thicker skin of the sea-leech prevents it from expanding as much as the fresh-water leech. This latter animal rejoices in eleven pairs of stomachs, but the other has only one; and again, the blood of a fish is by no means so nourishing as human blood, therefore the sea-leech ought to take a larger quantity to equal the voracity of its marsh representative; and yet we find the reverse is the case. These questions, and many like them, are, as Pliny says, "impenetrable to human reason, and lie hid in the majesty of Nature." The quantity of blood taken from the fish by its parasite is never sufficient to weaken it, but the only effect it seems to have is that the appetite of the fish increases. Indeed, this gentle "blood-letting" at times seems to improve the condition of the fish, as if the parasite were ordained to remove a superfluity. It has been said that parasites seldom attack an organ, but feast upon the product of that organ; and thus, although they gain their own subsistence from the animals they live upon, yet it is not to their vital injury. There are instances to the contrary, yet happily they are but few. If the parasite always were the cause of the death of the animal it inhabited, parasitism would soon be at an end, and the harmony of Nature disturbed.

The *Albiones* reproduce their species by egg capsules, which are sometimes deposited singly, but generally in groups, in which as many as fifty are now and then found. They are fixed to the exterior or interior of an abandoned shell. Each capsule is a spheroid, one-fifth of an inch in diameter, supported upon a short stem which is fixed to its solid support by an expanded base.



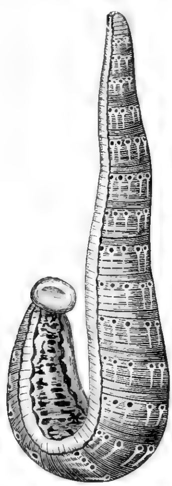
THE EGGS OF THE ALBIONE UPON A SHELL.

The envelope of the spheroid is thin ; the egg is white or flesh coloured, and becomes browner as it approaches the time of the hatching. This capsule has no resemblance to the cocoon of the fresh-water leeches, which only encloses one egg. The young of the albione comes out of the upper end of the egg, but the fresh-water leech breaks both ends at the same time. Of the reproduction of the branchellion we are still in ignorance.

CHAPTER XXIX.

THE ZOONITES.

THE study of the annelids, which has been pursued with great zest since the beginning of this century, has been productive of eminent service both to anatomy and to comparative physiology. These animals, composed of rings placed side by side and each containing the same organisation, present a very curious structure. The

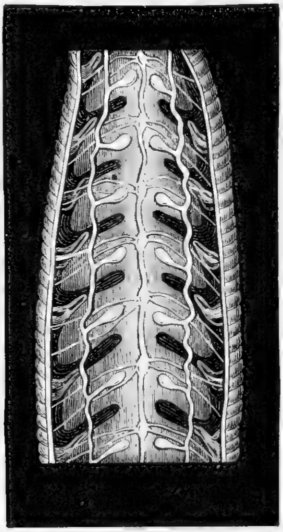


THE DRAGON-LEECH.
(*Hirudo troctina.*)

common leech (*Hirudo medicinalis*) may be considered typical. As every one knows, its shape is like that of a short, thick worm or garden slug, its body attenuates towards each extremity, where it terminates in a sucker; the one is the *oral,* and the other the *anal.* This body is composed of ninety-five rings. On close observation, its back is seen to be marked with triangular brown spots; these are arranged in rows parallel to the rings, and are repeated every five rings. In the dragon-leech, which is here drawn, the form of these spots is somewhat altered, being more like little pins with eyes drilled in large heads.

If a leech be cleaned, and then powdered with flour or chalk, and fixed upon its back so that it cannot move, pairs of spots will be seen on the under surface of its body, the flour which covers them being moistened with a mucous liquid which they exude. These pores in the skin are also found to be upon every fifth ring.

If we now dissect the animal, we shall be surprised to find a remarkable correspondence between the external machinery and



A SECTION OF A LEECH.

the internal anatomy. The *ganglions*—the nerval centres which supply the place of brains in the lower animals—are found distributed beneath the spots on the skin, that is, at a distance of five rings from each other.

The stomach is composed of eleven pairs of pockets, each one having a ganglion; hence, they also are at an interval of five rings. Between the pockets of the stomach are small canals which terminate in the pores whose existence was indicated by the flour. The secretion of these canals lubricates the leech. There are seventeen pairs of them, each at a distance of five rings.

The vessels by which the circulation is completed are arranged in the same symmetrical way. A main canal passes down the back, and at every fifth ring enlarges; out of this enlargement branch on each side two smaller vessels. These knots are, in reality, hearts. The muscular system of the creature observes the same regular order—there is a group of muscular fibres attached to every fifth ring; and the reproductive organs also observe the same regularity. Thus a fragment of the leech which is contained by five rings, possesses a ganglion, a heart, a stomach, and a muscular and reproductive system; that is, a complete organism, sufficient for a distinct individual. In other words, the leech is a series of symmetrical animals joined together. We cannot say that it is a *simple*, but a *compound* annelid.

The common earth-worm, the centipede, and other annelids, are formed on the same principle. We have often said that Nature progresses not by leaps, but by very graduated steps; and that, between one organisation and another, there is generally an intermediate stage. The polypiers are associations of innumerable animals, actuated by a common hope of life, and bound together by indissoluble bonds. But most animals have a solitary existence, and are complete in themselves, having no continued connection with any of their race. The leeches fill up the space between the two—polypes, which have quitted their polypidoms, and have joined themselves into one body.

The leech is the type of this mode of construction, but all the annelids bear some resemblance to the arrangement. In the year 1826, the name *Zoonites* was bestowed upon the class. The zoonites do not necessarily adhere to the plan exhibited in the structure of the leech, having their organs situated in a space included in five rings; but in some, the interval is measured by four, in others by three, rings, and so on, until some have in every ring a complement of organs. When, as in the worm or leech, the rings are arranged in one line, the animals are classed as *Articulata*. The linear composition is not universal: the star-fish and the pyrosoma are constructed on this principle, and yet they are not articulata. The pyrosoma, of which we treated in Chapter XVIII., are the connecting link between the associated polypes and the articulata.

It is often asked, Why is a quadruped instantly killed when the head is severed from the body, and yet a leech will live for a whole year after it has been mutilated? The answer is simple: because a quadruped has only one centre of its nervous system, one centre of life—the brain—and if that be severed from its trunk, death must follow; whereas, in the case of the zoonite, that particular nerval centre only is destroyed which has sustained the injury—the rest continue their action unimpeded.

This idea of the zoonite construction has, of course, met with much opposition. In the first place, it was objected that the two suckers, the *oral* and the *ventral*, were so distinct that they could not possibly be said to have the same construction: one had eyes and mouth, the other one only the anal orifice. Yet these are so alike that the same name is applied to each of them, and in the sea-leech they can hardly be discriminated. Indeed, Baster, an eminent zoologist, actually confounded the two. Again, it is urged that many of the zoonites have absolutely only one organ of a particular kind, hence their several parts cannot possibly be said to have a like organism. Take, for example, the *Planaria*—aquatic animals which inhabit both salt and fresh water—they are closely allied to the leeches. They have but one orifice to their digestive cavity, and in its neighbourhood is a flexible horn, by which the creature seizes its prey, and introduces it into its stomach. Here digestion is completed, and the rejected refuse is taken out again by the horn. The opponents of the zoonite theory cite such an example as this, triumphantly asking if it can be still asserted that the planaria is made in sections which are exactly alike. If, however, the creature be cut in half, either above or below the digestive pouch, each part will continue to live—one having the stomach near its extremity, the other being destitute of that very essential organ. However, in a short time a white spot appears in the centre of each fragment, which gradually extends until an orifice opens as the mouth of a new stomach, the old one, in the fragment above alluded to, closing. There is a time when the planaria possess two stomachs—the new one and the old one. This fact is a sufficient proof to us that, although the creature has only one stomach, yet each of the symmetrical parts of its organism is prepared to develop one when necessity arises; therefore, we may well consider the planaria no exception to the zoonite theory.

Some years ago, a great number of physiological facts were brought to light, which seem to show that the leech had not only a general life—an *associate* life, if we may use the word—but also an *individual* life, each of the zoonites (or associated parts) having its own life. For the sake of general harmony, Nature has provided the annelid with nerves of communication, which join the separate organs to each other. The chief zoonite is the one whose nerval centre is the best developed, and which carries the most organs of sense. This may be considered the governor of the association—the pilot of the vessel. If this be destroyed, the others continue to live, but without order or regularity; the animal is no longer able to provide for its nourishment or its necessities. The subjoined experiments evidently show that the lives of the zoonites are, in a certain sense, independent of each other.

1. If the first zoonites of a leech full of blood be wetted with salt water or weak acid, the stomachs corresponding to them will disgorge their contents, but the rest will retain the blood. 2. If you partially immerse a leech in concentrated alcohol, that part is alone deprived of its vitality. 3. If you cut a leech in two which is three parts full of blood, and still attached to the skin, it will continue to suck while the blood flows from the wound. 4. If by any means a zoonite be killed near the centre of the animal, the anterior and posterior parts will still live, two leeches being produced by the division of one. 5. If you cut on each side of a ganglion the nerves which unite it to its neighbours, you will produce an isolated zoonite between two *multiple* animals. By pricking the various parts this isolation of sensation will be apparent. 6. If the medullary canal, the great nerve which connects the ganglions, be severed in any part of the leech, the two parts of the animal will possess different volitions. All the phenomena of sensation and locomotion will be perfectly distinct in each part. Dr. Vernière experimented upon a leech in this way, and kept the creature for two months after the operation. Nothing could be more singular, he says, than watching the conflicting wills in the two extremities of the same creature. When each sucker was fixed on the walls of

the vase, neither could communicate to the other its intention to move; the consequence was that the one which had the feebler hold was compelled to give way when the stronger chose to alter its position; and when the conqueror, after dragging the other end to the place where it wished to rest, came to a halt, it was easy to see how reluctantly the vanquished half obeyed its stronger companion, and fixed its sucker. 7. If several incisions were made, causing the leech to be cut up into a number of isolated portions, each would live, and even for a considerable time. These fragments have been preserved without nourishment for ten months; and Carena and Rossi declare that they have kept these isolated portions for even two years. At the end of that time, as well they might, they showed evident signs of emaciation; but we may well believe that if they had been fed, if, for instance, by some means or other, drops of blood had from time to time been introduced into the fragment, its existence might have been prolonged indefinitely; and who can say that it would not in time have replaced the amputated organs?

The contemplation of this theory cannot but fill the mind with great thoughts of the mysterious laws of life, and of the unsearchable wisdom of him who is the Life of life. Linnæus, when making his immortal inventory of the treasures of the kingdom of Nature, was asked, What was the great end of natural history? The philosopher replied, "The glory of God." It is indeed true that the observation of the detail of life conduces to raise the thoughts to the Creator, but a great thinker has said with much reason that theory is the only true chain by which we ascend to God from Nature. However much we may admire the works of God in themselves, it is only when we grasp the laws which govern the whole that we gather a true idea of the immensity of his mind. It is theory, the faith of science, which foresees the conclusion, while experience and observation follow with slower pace, and fill in the outline which theory has mapped out. Theory sees the end from the beginning: she is the spirit of philosophy; and gathering the praise of wondering men, she sweeps onward to the throne of God, to present the offering to him who created all things for his praise.

CHAPTER XXX.

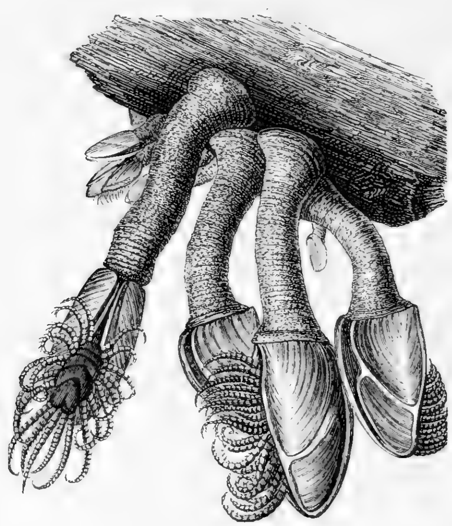
THE CIRRHOPODA.

EVEN supposing that we had reached the limit of our subject, and had chronicled the wonders of the ocean life, enough has been said to show that the sea is far more prolific in variety of forms, and in curiosities of organisation, than the world which is above the waters. But more remains to be recorded, and as we advance, each step brings us to curious forms which excite our wonder and elicit our admiration. None of the animals we have examined are perhaps more remarkable than those which occupy the transition state between annelids and the crustaceans.

The *Anatifera* partake of the characteristics of both, and yet have a physiognomy peculiarly their own. This construction will at once be understood by a glance at the bunch of barnacles in the engraving. A shell, much in the shape of a mitre, composed of five pieces, two on each side and one on its back, is supported on a remarkably thick stalk; this stalk is hollow and flexible, possessing the ring formation of the annelids.

Since the anatifera are unable to move, we pronounce their organisation to be of a lower type than that of either of their neighbours, for it would not be in accordance with that wisdom which is "over all his works," if quicker and finer sensibilities were bestowed upon a creature which did not enjoy the power of locomotion. There is a fine balance and adjustment in everything, and where we find activity of limb and rapidity of motion, they are sure to be accompanied by a lively sensibility; but where, as in the kingdom of vegetation, and in many of the animals, the creature is unable to move from its fixed position—unable to flee from danger, or to go from an unpleasant or uncongenial neighbourhood—there we find that it either exhibits no signs of sensibility at all, or else its perceptions are of the very lowest degree. Therefore, we may justly conclude that a fixed creature, being all but insentient, is of a low type of organisation. Thus the anatifera, being unable to leave the place of their attachment, are considered as a low type of organism, and yet they take the highest rank among the fixed invertebrata, for they are capable of more movement than the rest of the sedentary inhabitants of the ocean bed.

But let us speak of the order of which the anatifera form a class—the *Cirripedia*, *Cirrhipeda*, or *Cirrhopoda*. The exact position of this crustacean order was long a point of dispute. Some



ANATIFERA LÆVIS.

naturalists placed it amongst the mollusks, others gave it a rank with the articulata. Finally this latter position was definitely assigned to it.

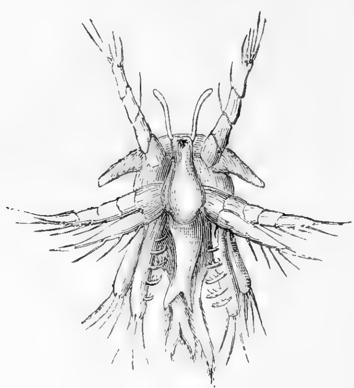
The cirrhopoda, as we have already said, occupy the intermediate place between the annelids and the crustaceans. The pedicle, or stalk, which bears the shelled part of the animal, is flexible, being able to bend in any direction; though its movements are slow, yet they are most certainly voluntary.

The anatifera attach themselves to the submarine rocks, or to pieces of wood, the *débris* of wrecked vessels, which are carried about by the waves. Out of the mitred shell which the thick stalk carries are protruded a number of curled, articulated appenhages—the *cirrhi;* these would be the *feet* of the animal, if it had any use for ambulacral organs, and hence the name of the order—*Cirrhipedia.*

Cirrhi is derived from the Latin *cirrhus,* a curl or lock of hair, and is a term employed by naturalists in every kingdom of Nature to describe any curled filaments or appendages. Upon a close examination of the plate, fine hairs or cils will be seen growing out of the articulations of these cirrhi. When in repose these organs are curled up like the young fronds of a fern; but when the creature requires their use, they are extended and deployed on every side. They are seldom at rest, for the anatifera looks to its cirrhi for its sustenance. Like the rest of the fixed and sedentary animals it lives upon the animalcules and other minute existences which throng sea water; and these are brought to it by currents which are formed by the regular and symmetrical movements of the cirrhi and their cils; but, strange to say, the mouth is not situated, as we might naturally suppose, at the entrance of the shell between the rows of cirrhi, but at the lower part of the shell, and the currents are directed so as to enter it. The mouth is furnished with mandibles and jaws like many of the crustacea.

The name *Anatifera* literally signifies *goose-bearer,* and the appellation is due to a popular belief that these peculiar-looking creatures are the eggs of the bernicle goose, attached to a stem. Whether the idea was originated by an old writer, one Gerard, who enlightened his readers in the year 1636, or whether he only chronicled an existing opinion, we cannot say. He begins his account with the profession, "What our eyes have seen and hands have touched we shall declare;" and then he proceeds to describe the birth of a young bernicle goose from a *ship-barnacle.* "There is a small island in Lancashire called the Pile of Foulders, wherein are found broken pieces of old and bruised ships, some whereof have been cast thither by shipwracke, whereon is found certain spume or froth, that in time breedeth into certaine shells, in shape like those of the muskle, but sharper pointed, and of a whitish colour, one end whereof is fastened into the inside of the shell, even as the fish of oisters and muskles; the other end is made fast into the belly of a rude masse or lumpe, which in time cometh to the shape and form of a bird." According to this observant naturalist the legs come first, then the shell "gapeth" to admit the exit of the body, and the final attachment by the bill giving way. The gosling unfledged swims out to sea, where it completes its development. Absurd as this popular fallacy may seem, it even yet is credited on the coasts of Scotland, where many a fisherman will seriously aver that he has often heard the cry of the young goose out of the shell of the barnacle.

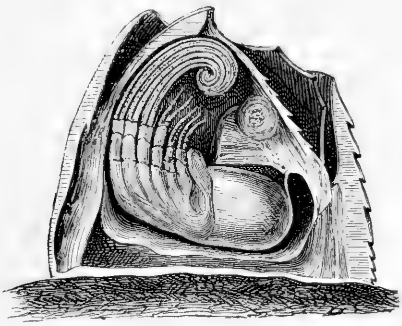
It would have been an anomaly in the kingdom of Nature



A YOUNG CIRRHOPOD.
(*Larva of the Chthalmalus stellatus.*)

had the cirrhopoda not possessed within themselves every requisite both for their own existence, and for the propagation of their species. Hopelessly fixed in one position, they can never go in search of food, nor yet enjoy intercommunion with their race. Hence, as we have observed, they draw their prey towards themselves in the currents they produce, and each cirrhopod includes within itself both genders; that is, they are hermaphrodites, and, consequently, have all the requisites for the production of their species within themselves. But the young cirrhopods are totally different from their parents; for like many of the young of fixed and sedentary creatures, they are not only at liberty, but can swim with great activity, being furnished with rapidly-moving natatory organs. Moreover, like the legendary Cyclops, they possess a great eye in the centre of their foreheads.

When the cirrhopod becomes fixed, having no longer any use for either the fins or the eye, these organs, from disuse, become obliterated. According to that great law, "From him that hath not shall be taken away even that which he hath," that which is possessed, but not exercised, in time becomes useless and obliterated.



AN ADULT CIRRHOPOD.
(*Balanus tintinnabulum.*)

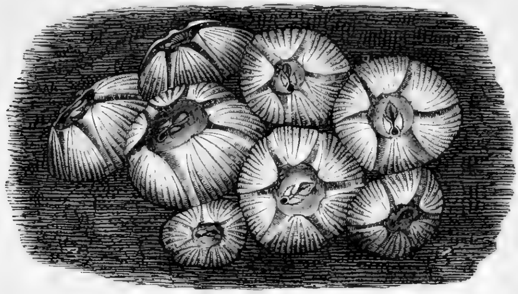
Here we have, then, an example of a reversed law of Nature: the young, instead of reaching a higher development in its adult state, is in possession of a more complicated organism than its parent; and, instead of progressing, actually degenerates as it grows older. We do not express much wonder as we find the swimming organs of the coral larvæ, and other animals of the like kind, either obliterated or turned to other uses when the adult and sedentary stage is reached; but here is a creature possessing an eye which vanishes when it enters upon the fixed state. But why should not the cirrhopod enjoy the sense of vision, even if it be immovable? It would not be more incongruous than a hen with a brood of ducks, whose instinct impels her to follow them into the pond, but whose nature denies her the power to swim! But the analogy is not admissible, inasmuch as a hen with a brood of ducks is unnatural. No such seeming oversight can be charged to the great Creator, who has never, and could never, so disturb the fitness of things! The cirrhopod, when adult, no longer finds the use it had for its eye when it was a roving youth; and as there is no waste in the economy of Nature, no useless organ can be kept in repair; hence the eye closes, and the creature is condemned to a life of blindness. This is not the only instance of this peculiarity: it is often the case with the young of the infusores. Ehrenberg particularly instances the young *Eudorina*, which is furnished with a large red eye—a distinction not enjoyed by its parent.

Many clever naturalists have entertained the idea that man represents the perfect organism of Nature, and that the lower animals are, as it were, embryos of this perfect idea, arrested at different stages of its development. A beautiful theory, but not true; for here we have young animals better developed than their parents. This is not an advancement, but a retrogression. And besides this objection, the different parts of an animal seldom or never exhibit the same phases of advancement: one organ is in a more complete state, and constructed upon a higher model than another. Some creatures are superior to others in the development of their respiratory apparatus, when probably the animal which is inferior in this sense is superior as to the arrangement of its nervous system. The laws which regulate the general harmony of the animal economy are far too complicated to admit of being enunciated in a single sentence. In fact, the organisation of each species seems to have a law peculiarly provided for it.

But to return to our subject. The cyclops larvæ are almost triangular, and are covered with a large shield. In front they put out two little divergent horns, and behind them they drag a double tail. Their sides are furnished with six pairs of oars, the last two pairs being much larger than the others. The larva does not grow very rapidly; but when it reaches its change of life, the eye closes, the oars, the antennæ, the tail, disappear, its vagabond life comes to an end, and, like its forefathers, it finds itself fixed to some solid hold, where it assumes the ringed pedicle and the mitred head-piece of its race.

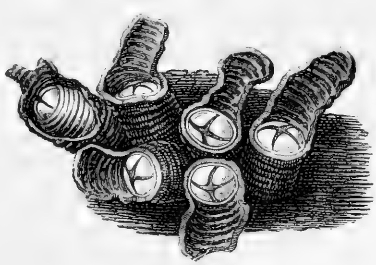
The class cirrhopoda contains other specimens of animal life than the anatifera we have described; and, as in every other family, the features are altered in almost every conceivable manner. Some have no stalk, but the shelled body adheres directly to the rock. The shell is not always composed of five pieces, but sometimes of more, sometimes of less; hence many of the cirrhopods bear an external resemblance to the ship-barnacle.

A very common member of this family, the *Acorn-shell,* is



THE CORONULA OF THE WHALE.
(*Coronula diadema.*)

frequently found covering the rocks of the shore left dry by the retreating tide. Their scientific name is *Balanus balanoides.* The acorn-shells are not particular as to where they locate their colony. They are as frequently found fixed to the shells of living mollusks



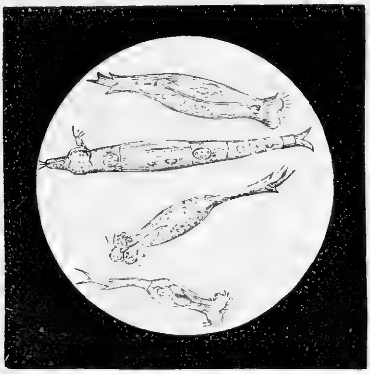
THE TUBICINELLA OF THE WHALE.
(*Tubicinella balænarum.*)

as to the rocks. It is interesting to watch the acorn-shells, which look so uninteresting when grouped upon a dry rock, when they are covered by the water. They may often be found in a little pool upon the beach. The sharp-edged shells gape open, and out come the delicate cirrhi, which, exactly as a fisherman would throw a casting-net, the balanus flings out into the water, and draws back again, capturing all the little animalculæ within its sweep. Some cirrhopods are found as parasites on those hulks of the ocean—the whales. The *Coronula*, one of these parasites, assembles in roundish spots; on a strip of skin an inch long and a quarter of an inch broad, forty-five were crowded. They are arranged symmetrically, as stones in a pavement. The *Tubicinella* are less depressed than the coronula. They also inhabit the whale, preferring to pass their existence in the blubber of the mighty cetacea. These cirrhopods burrow two or three inches through the skin.

CHAPTER XXXI.

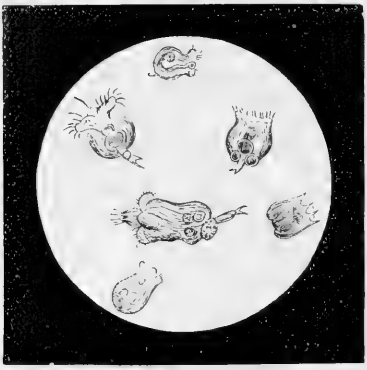
THE ROTIFERA.

THE *Rotifera* are a genus of microscopic animals belonging to the class Rotatoria. They owe their appellation to an organ which when in action has the appearance of a revolving wheel. Originally they were classed among the infusoria, but upon the discovery of



FURCULARIA.

their higher organisation they were promoted from one class into another, until they now occupy a place at the entrance of the class which we are about to consider—the crustaceans. There seems much reason to believe that they are a permanent form of the larva of the crustaceans. The bodies of the rotifers are generally fusiform, and are covered not with a shell, but with a very firm, transparent skin. In those species called *univalves* this hide is all of one piece, whereas the *bivalves* have a division along the ridge of the back. The peculiar organ which has given to the race their appellation, is fixed to the anterior part of the body, and consists of a lobed disc, which is usually furnished with vibratory cils. This organ is the fin or swimming apparatus, and when in motion presents the appearance of one or two wheels rotating in opposite directions. The appearance is very deceptive, so that some naturalists have even described it as a permanent collar, continuously agitated by an undulating movement. This really violent movement for so small an animal often causes the rotifer to twist rapidly round on its own axis, as well as glide through the water, propelled much after the fashion of a screw steamer. The vibratory cils are faithful to the function we have so often found them performing, inducing currents of water to enter the system of the animal, bearing the food and air necessary for its existence. This is



BRACHIONS.

economy indeed, to make one organ perform several distinct offices. The same member which urges the animalcule through the drop of water, likewise causes it to eat and breathe.

The rotifers vary, as all other classes, in the details of their construction, especially in their tails; some are without the caudal appendage, others rejoice in two; some have long tails, some short. The tail is used, as in all other denizens of the watery world, as the helm of the ship; by its inclination this way or that the direction of the creature is determined. Some of these little creatures carry an external horn; of its use we can only conjecture, and the most reasonable supposition is, that it is for defence or perhaps attack. The mouth, which is very large, has the shape of a bell. It is provided with two lateral mandibles, which are horny tubes, furnished near the extremity with one or more teeth. The digestive apparatus is by no means simple; the stomach is long, and has on each side lateral appendages, terminating in a great intestine. The heart of the rotifers is in constant action, and its pulsations are quite discernible. We cannot conceive such an organ unless it be connected with a system of circulation, but this we have not been able, as yet, to decipher. It used to be the opinion that minute creatures had always a very simple organisation, but the revelations of the microscope have caused naturalists materially to alter their views upon this point. Minuteness does not elude that perfection which the touches of the great Creator's hand stamp upon his work. The wheel-bearing animalcules have generally a single eye fixed in the cyclopean position; and, like all the eyes of the minute creation, it is red. Some of them have more than one; even rotifers with four eyes are known. The eye is sometimes placed upon the neck or on the back, so that the animal can only see above it and behind it, but not below it or in advance. We do not know the exact reason of this position; but the animal is so lively that it can matter little where the eye is situated. And, moreover, the rotifers have a peculiar power of retreating, not into their shells, for they have none, but into their skins, and in this form they appear like a ball. The eye may be placed with regard to this position, so that the retired creature may keep a sharp look out.

Ehrenberg declares that he finds indications of the existence of a nervous system. It requires a stretch of imagination to follow the celebrated naturalist, even to conceive a network of nerves in an animal which a grain of sand could effectually bury. Like most of the crustaceans, the rotifers are oviparous, carrying their eggs suspended at the root of their tails.

Spallanzani has brought the wheel-bearers into great repute by proving that they are endowed with a wonderful power of life. He found that they could be dried and folded between the leaves of a book, and kept in this unnatural state for even two years. They seem to be in a state of lethargy, and in apparent death; but when again immersed in water they revive, and seem none the worse for the intermission in their vitality. Many of the eminent naturalists of the day refused to believe anything so extraordinary.

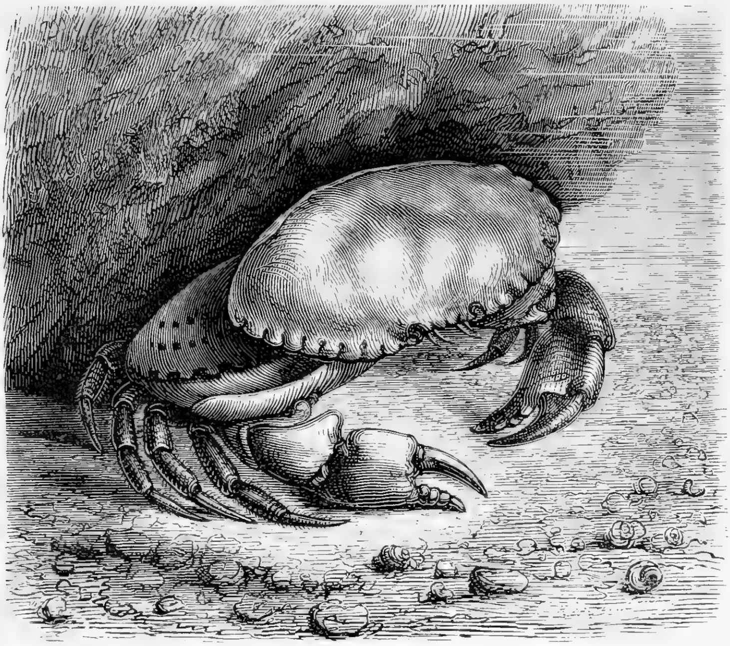
But the exact Spallanzani was not likely to hazard a statement which he had not fully established, and in due time a numerous list of experiments fully confirmed the extraordinary fact that the rotifers were the Rip van Winkles of the ocean community, and could sleep through a lapse of animalcule ages, and again awake to play their part in the act of life then progressing. To cause these little creatures to perform this extraordinary feat, they must be slowly and cautiously dried; they must not be violently pressed, nor submitted to a too-elevated temperature while they are yet moist, and when the awakening time arrives, the process of resuscitation must be slow.

The common rotifer (*Rotifer redivivus*), which exhibits this incomprehensible phenomenon, is an inhabitant of fresh water, or rather of moist moss, which is found on walls and roofs, and has wheels seven or eight times less than its body, which is about one-fiftieth of an inch long. The marine rotifers do not return to life after undergoing the drying process. How is it that the fresh-water species is so very much more retentive of life than its marine representative?

CHAPTER XXXII.

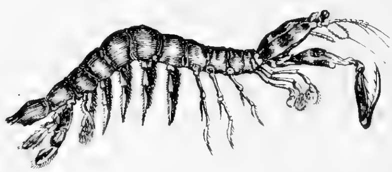
THE CRUSTACEANS.

THE Crustaceans are the insects of the ocean world; but the word insect appeals to our terrestrial experience, and would convey to us a very erroneous impression of these inhabitants of the sea.



A CRAB IN THE PROCESS OF MOULTING.

They are by no means frail and fragile creatures, dancing on gossamer wings, a thousand of which one touch of a finger would crush; but many of these so-called insects of the sea are clad in the hardest mail. The plates of their armour are jointed, and are more invulnerable than the best suit of Milanese steel ever donned by chivalrous knight: for, as a general rule, wherever we find horn in the insect upon land, we find the hardest calcareous secretion in the ocean crustacea. They are generally provided with powerful pincers, which they use either to hold their prey, which has, indeed, little chance of escape when clutched in their formidable grasp, or they are weapons of defence. These knights of the sea live among the rocks, generally in the neighbourhood of the land; but they are also found at great depths. Some of them burrow in the sand; and there are crabs which love the air of the shore as much as they do the water of the sea; and, in order to enjoy both, take up their residence under some moist projecting rock which is washed by the high tides. The solidity of their carapace prevents the crustaceans from growing: for, unlike the shell of the echinus—which is composed of plates, and can be



THE MANTIS CRAB.
(*Squilla mantis.*)

enlarged by additions to their edges—the shell of these crustaceans, once formed, never afterwards alters its size; therefore, as the animal does not reach its full growth at once, the only way it has of solving the difficulty is to cast off the shell, and secrete another adapted to its increased size.

At certain determined periods, Nature despoils the warrior of his cuirass; the creature moults; and the calcareous crust falls off, leaving in its place a thin and delicate tunic. When in this state, the animal does not deserve the name of crustacean, for it is as soft as any mollusk. It is quite conscious of its weakness, and, retiring into some lonely place, seeks to hide its shame in a narrow crevice until its new carapace has had time to grow, when, invested in its new suit of armour, it leaves its place of retirement, and frequents its usual haunts with all the dignity of a crustacean. An evil day is it for the moulting crab if one of his enemies happens to find him in his hiding-place. Helpless and defenceless, he pays dearly for all the cruelties he mercilessly practised in the days of his power.

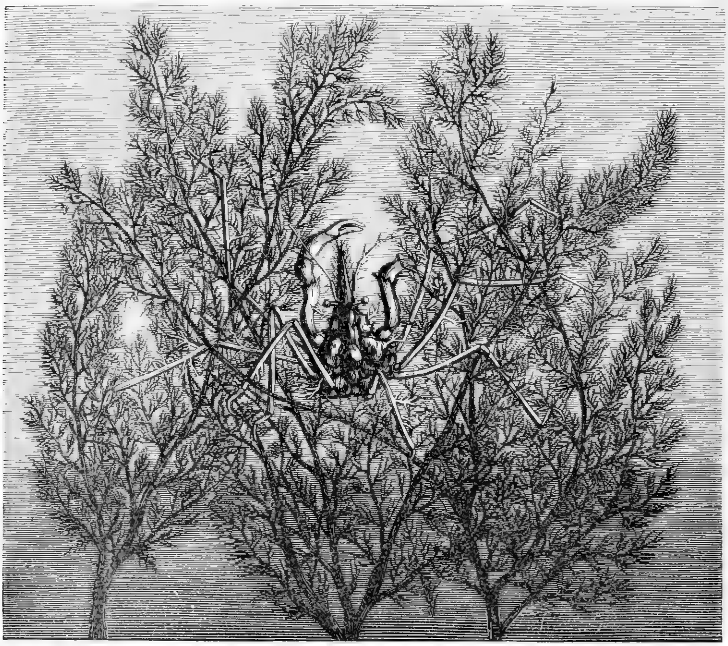
The crustaceans do not possess, like the animals higher in the scale of life, a vertebral column—that is, a stiff, calcareous axis, from which branch out bones of a similar nature, forming the skeleton; but they possess a stony covering, which is secreted by the tegument which covers them, and thus forms an external skeleton. Thus the crustaceans live within their skeleton, and their flesh does not, as in the case of the vertebrata, surround the bones. Such a skeleton is termed *dermal,* or tegumentary.

The armour of the crustaceans is of a sombre hue, here and there a dash of blue enlivens their colour, reminding one of the steel-blue of the knight's corslet. Some few are of a reddish tint, but the race is devoid of gaudy colouring, in spite of the assertion of the poet, who depicted the *scarlet* lobster crawling over the submarine rocks. In the dorsal region the shell is very thick, and capable of great resistance; their members are also remarkable for their hardness, yet in the smaller species the shell is so thin that the processes of circulation and digestion can be seen in operation. Many of the crustaceans are quite microscopic, and in such numbers that they contribute to the colour of the ocean a purple, violet, and even a red tint; such are the *Grimothea D'Urvillei* and the *Grimothea gregarea.*

In the *Sea-spiders,* which have no neck, the head is lost in the breast (*cephalothorax*); the belly, however, remains distinct. The middle of their body is compressed, and yet the form is not ungraceful. Those crustaceans which have no pretence to contour, have their head, breast, and belly all in one mass; thus they are short and squat, and most difficult to seize. Many of these animals have a powerful tail, which consists of a number of ciliated plates, arranged as paddles. This member assists the crustacean in swimming, and with it it beats the water to confuse its enemies.

As aquatic animals, the crustaceans breathe by *branchiæ.* In the larger species these organs are lamellar, or composed of filaments, their supports being traversed by two blood-vessels, one of which directs the fluid to the body, the other to the heart. These lung apparatus are usually enclosed in the body, but in some of the smaller species they protrude and hang like a fungus into the water. Occasionally these organs serve the double purpose of breathing and swimming. However, sometimes, the animal has no special respiratory organs.

Nearly all the crustaceans are strong, hardy, and destructive. They are the marauders of the ocean community, merciless



A SEA-SPIDER.
(*Pisa tetraodon.*)

brigands, ready to do anything to secure their prey. They fight in deadly combat, not only with their enemies or their prey, but with each other, and frequently without any pretext, save only for the love of battle. It is useless for the assailant to shower his blows upon the carapace of his adversary; but when with his powerful pincers he seizes the long slim feet, the tail, or the delicate antennæ, then he wounds and dilapidates his foe. Yet the vanquished crustacean is not maimed for life; in a few weeks the mutilated members recover themselves, and those which were actually pulled off are again renewed. This explains the fact that often crustaceans are met with which have unequal-sized claws; the smaller of the two is only in process of growth, replacing the original member lost in the fortune of war. Nature has willed that the maimed warrior shall not be long *hors de combat.* Lobsters have been known to retire from the encounter wounded, and with the loss of some of their limbs, but after a few months' retirement they again were upon the field of battle, strong and vigorous, with their weapons renewed, and ready for another struggle.

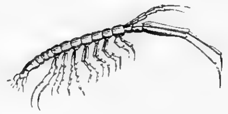
On the Spanish coast there is a crab rejoicing in the high-sounding name of *Boccaccio,* whose claw is considered delicate eating. The creature is caught, and the coveted claw wrenched off; the maimed crustacean is then thrown back into the sea to grow another, which will be similarly taken at some future time. What a noble destiny for an animal to fulfil—to grow claws for its human masters to eat!

The crustaceans are nearly all carnivorous. They are by no means dainty, for it matters little to them whether they eat the flesh of enemies or friends, or whether the creature be dead or alive. It is amusing to watch a crab when he has seized a mussel; with one claw he holds it aloft, and, with the most sedate gravity, with his other pincers detaches the mollusk, putting the pieces quietly into his mouth, just as a human being would do. The crab does not directly bite his prey, but introduces it into his mouth with his pincers. The lobster, however, follows the example of most animals, and attacks his food with his teeth.

A naturalist once surprised, upon the shore, at Royan, a party of crabs at their repast. Upon that particular day they were dining in common—probably it was a family *réunion.* They were in a row, all their heads turned the same way, and all upright on their eight feet. They seized the objects on the shore alternately with each claw, in the most regular and precise manner, like a regiment of soldiers practising a new drill—the dinner drill.

The *Long-horned Corophia* are endowed with many peculiar instincts. They live on annelids and worms. When the tide rises, they may be seen beating the sand with their antennæ; by this means the worms are exposed. When one of unusual size is unearthed, several of these crustacea join in the attack. It is also asserted that they climb the hurdles to which the mussels are suspended, and bite through the byssus, so that the mollusk may drop to the ground, and become an easier prey.

It can scarcely be credited that other crustaceans which are great oyster eaters watch until the king of the mollusks opens his royal valves to enjoy the rays of the sun, or to make a repast, and then adroitly put a stone in the open shell ; the mollusk, unable to enclose himself, becomes an easy prey to the artful marauder. The corophia about whom this strange tale is told, are found in large numbers on the shores of the Atlantic, about the autumn, beating the sands for the worms. They perform an eminent service in the mussel farms of La Rochelle. During the winter, the rough seas throw up vast mounds of mud about the *bouchots ;* when the spring returns, before the cultivation of the mollusk can be proceeded with, these mounds must be removed. This would be a serious undertaking, but the corophia come out in vast hosts, and in their



THE LONG-HORNED COROPHIUM.
(*Corophium longicorne.*)

anxiety to find worms, they harrow up the surface of these mud lumps. This loosened material the waves carry out to sea; so the agent which piled up the objectionable heaps removes them.

We said the crustaceans were no respecters of persons, for often the large ones will devour their smaller brethren—*Rara concordia fratrum !*

Professor Rymer Jones tells us he once put six crabs (*Platycarcinus pagurus*) into his aquarium. They were of different sizes. One of them walked very imprudently, as the event proved, into the middle of the aquarium. It was immediately accosted by another, a little larger, who politely took it in his claws, and commenced, without further ceremony, to break its shell. This proved no very difficult matter, and he forthwith tore out the flesh and ate it. But there were other members of the group not content : for, as Horace says—and he was not the first to say it—

"Nihil est ab omni parte beatum."

Another crab, still larger, advanced to the couple so occupied in deadly work, and seized the murderer and treated him exactly in the same manner as he had his neighbour; first he smashed in his carapace and then proceeded to help himself to its fleshy contents; but the curious part of the story is, that his victim was not in the least concerned that his body was being eaten, but continued enjoying his own repast as though he were in perfect security. This was a remarkable instance of their insensibility to pain, as well as of the law of retaliation. To eat, and to be eaten oneself, is one of the great laws of Nature. "All the marine creatures," says Buffon, "are equally voracious; they live upon themselves and upon others; the work of destruction is always in progress—and yet no species is ever extinguished, for their fecundity is equal to their depredatory propensities, and all the nourishment thus gained is expended in reproduction." The morning following the terrible tragedy, only two of the crabs were alive—these were the stoutest of the party—and each was squatted in a corner of the aquarium, eyeing his rival with defiance. This ferocious meditation the naturalist did not interrupt.

In another instance, four little common crabs were placed in the same aquarium. One of them immediately helped himself to one of his famished brethren, and a second came to share the coveted repast. The poor little crab was with the greatest difficulty rescued from his unnatural brothers; and at last, when he was delivered from their clutches, it was at the expense of seven out of his ten claws; but when put into a separate reservoir he did not seem to bemoan his mutilation, but soon was apparently happily devouring a piece of mussel on the floor of the aquarium. Ninety-four days after, the little invalid changed his carapace and recovered his lost claws; they were less than the three he had retained after his encounter, but in all respects they were perfect.

Though essentially carnivorous, the crustaceans sometimes eat marine vegetables, especially when in want of food; and there are certain of the tribe who appear to prefer fruits to animal matter; such, for instance, is the taste of the *tree-crab*, a native of the Polynesian Islands, which lives on the cocoa-nut. This crab is provided with strong, thick pincers, its other claws being comparatively slender. At the first glance, it seems impossible that such a creature could possibly penetrate a cocoa-nut, surrounded as it is by a massive, fibrous covering and protected by a firm, hard shell; but M. Liesk, who has often watched the operation, tells us that the crab strips off the matted covering, fibre by fibre, always beginning at that end where the dimples so characteristic of the cocoa-nut shell will be found. When the shell is exposed, it strikes it with its great pincer-claws until an opening is made, then, by means of the slender claws, it extracts the white contents of the nut. This adroitness is another testimony to the instincts of the crab tribe.

The crustaceans have eyes of two kinds, simple and compound. The first is sessile and immovable, somewhat protruding, and very convex. The other eye is carried upon a short, calcareous stem, and is composed of a considerable number of little eyes, symmetrically agglomerated together. It resembles a skull-cap which is made up of facets, these being so many distinct eyes. The compound eye of the lobster is thus composed of 2,500 eyes. The simple eye is *myopus*, or short sighted, the composite eye has a longer range. This wonderful organ is found in the fossils of the first crustaceans which lived upon the globe. The characteristic fossil of the earliest formation of stratified rocks—the Silurians—is the *Trilobite*, and here is an argument against the theory of development, for we find almost the first inhabitant of the Palæozoic seas to be in possession of the most highly developed eye.

The crustaceans are endowed with a delicate sense of smell, and by this means discover their prey. If a little dead fish be placed under a stone in a pool of sea-water, the crabs ensconced in the neighbouring holes will soon make their appearance, attracted to the feast by the smell. Many naturalists consider that the sense of smell resides in the antennæ, and if this be the case, the quickness of the sense is explained by the length of the "feelers."

Many of the crustaceans do not swim, but they walk on the ground whether in or out of the water. Their course is often oblique, and they can use their claws as well in going backwards as forwards.

On the Syrian coast there is a crab, the *Ocypoda cursor*, which has, by its rapid movements, acquired the name of the *horseman;* but it may be doubted if its pace be equal to that of a horse.

The *Large-clawed Porcellana* (*Porcellana platycheles*) is a bad swimmer; by certain movements of its abdomen it can just manage to come up from the water and again descend; but usually it lies crouched under a rock for months together, its long antennæ stretched out to examine any object which may be in its immediate neighbourhood. Its jaw-claws are constantly being thrown out, and pulled in towards its mouth. These claws are like reaping-hooks; they are formed of five joints, and on their inner edge are furnished with rows of stiff bristles; the microscope shows that these bristles themselves are provided with fine hairs standing out

THE COMMON SHRIMP.
(*Crangon vulgaris.*)

perpendicularly from their sides. In the movements of retraction, these numerous filaments cross each other so intimately, that they form a minute trellis-work, by which all the animalcules in the water are brought into the mouth of the crab, and when the claws are thrown forward, all the crab ejects is swept away from its neighbourhood; by this means the creature can obtain the nourishment necessary for its existence without changing its place.

Shrimps have at the extremity of their first pair of claws an appendage not unlike a rake. The teeth of this apparatus are fine hairs standing out of the membrane perpendicularly. The creature by this organ gathers together the minute particles which the next pair of claws passes on to the mouth. This rake also serves the purpose of a brush with which the little crustacean cleanses its bent claws and the lobes of its tail. When busy with its toilet the shrimp stands erect on its long claws, and its tail is bent under its body, in order to permit the first pair of claws to brush it.

Crustaceans have separate sexes, the males not differing greatly from the females. This, however, is not universally the case, for there are crustaceans which exist as parasites on certain fish—among which the male is much smaller than the female—and here the order of governance must be reversed, the women must be the directors of the men, for they accommodate their husbands with a lodging in a groove in their backs. The false claws (as we may term the short appendages in the drawing we give) are employed by the female for holding her eggs, which she carries about with her. A shrimp has been known to have 6,807 eggs; a crab, 21,699; other species are still more prolific, producing even as many as 100,000 at once: three or four such crustaceans would be

THE LARVA OF A COMMON CRAB.

sufficient in six months to engender a crustacean nation equal to the population of Portugal. The crustacean eggs are generally red or yellow, and small. They have a property, which although peculiar, is shared by the eggs of many other species: that is, they may be preserved dry for a considerable time, and yet retain their vitality, and under favourable circumstances produce young crustaceans. When the eggs are hatched, they become more transparent and larger; the membrane which encloses being thin and transparent, the eyes of the yellow embryo can be plainly seen within it.

The yellow, or the yolk, does not communicate with the belly of the embryo, as is the case in the embryo of a fowl, but with the back. The larvæ do not bear much resemblance to their parents, indeed, they often appear in most peculiar forms, as may be judged from the drawing we give of the larva of a crab.

Naturalists used to consider these creatures a separate and distinct species. They are all roundish, and have a long projection pointing in advance like the beak of the ibis, and another nearer the tail like the prick of a gooseberry bush. The body is slender, terminating in a tail generally ramified. Its claws are long, and provided with bunches of vibratory cils, by whose aid they can swim with great rapidity. As we know, the adult crab is not organised for swimming; this is another instance of that peculiar law which constitutes the young of certain creatures upon a distinctly different model from their parents.

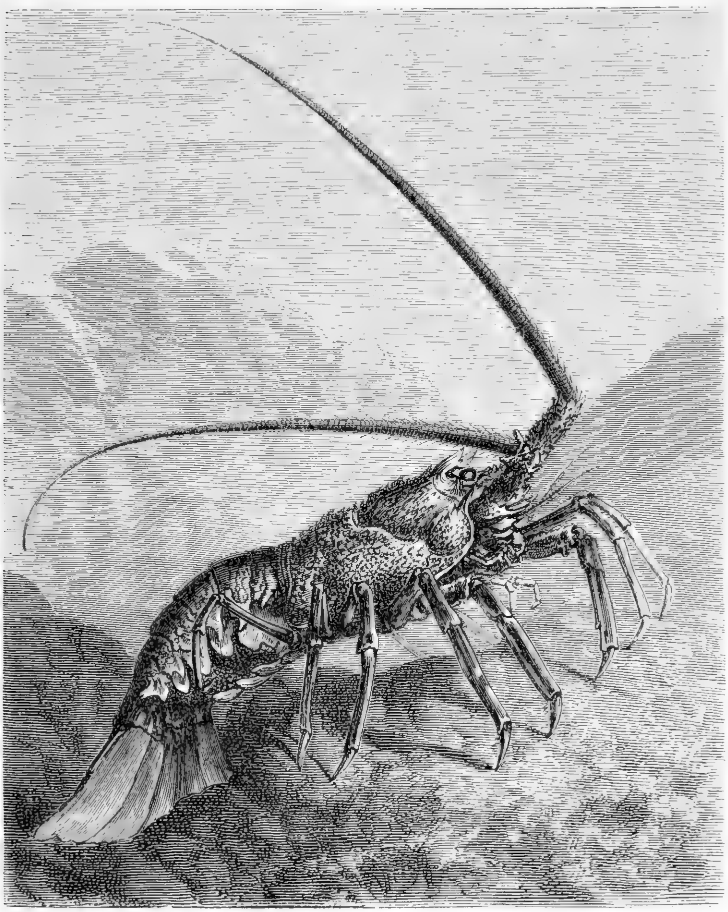
CHAPTER XXXIII.

LOBSTERS, CRAW-FISH, AND SHRIMPS.

THE crustaceans to whose description this chapter is assigned are a source of great income to the maritime populations. The lobsters and the craw-fish are considered to occupy the first rank in the crustacean nation. The first have very long, prehensile claws and a long, slender body; the latter have but small claws, but a larger spiny body, so rough that Tiberius Cæsar lacerated the face of a poor fisherman, by causing him to be rubbed with a craw-fish.

The lobsters commence spawning in October, the craw-fish in September, and they terminate the period of their reproduction with the opening of the new year. The females of both species are very prolific, but it seems that the craw-fish lays considerably more eggs than the lobster—while the one produces 20,000, the other lays 120,000. These eggs are in clusters joined together by a peculiar, humid fluid. The manner in which the lobster arranges her eggs is interesting, for whether she bends or straightens her tail, they are never exposed to the light. Sometimes the eggs are left almost unmoved, and one of the neighbouring claws is used to slightly paint them with the viscid humour. When first emitted from the ovary the eggs are small, and seem to increase during the time they hang under the tail, and before they are committed to the sand or water, they have become the size of small shot.

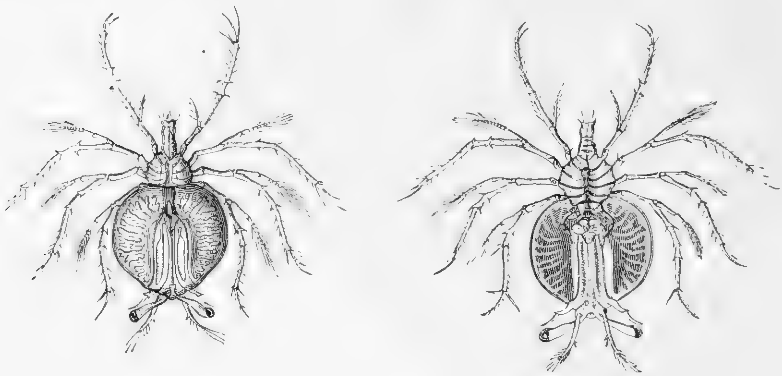
The evolution of the germ is in progress six months. At the moment of the hatching the female, by a movement of her tail, shakes the eggs backwards and forwards, and by this means breaks the shell, and frees the larva; in one or two days she has got rid of the whole of her burden. As soon as born, the young crustaceans leave the mother and rise to the surface of the water in order to gain the open sea. They swim in a circle. This roving life they do not long enjoy, for in about forty days they lose their natatory organs, and, no longer able to keep on the surface, they sink to the bottom, and there betake themselves to the



A CRAW-FISH DISTENDED WITH EGGS.

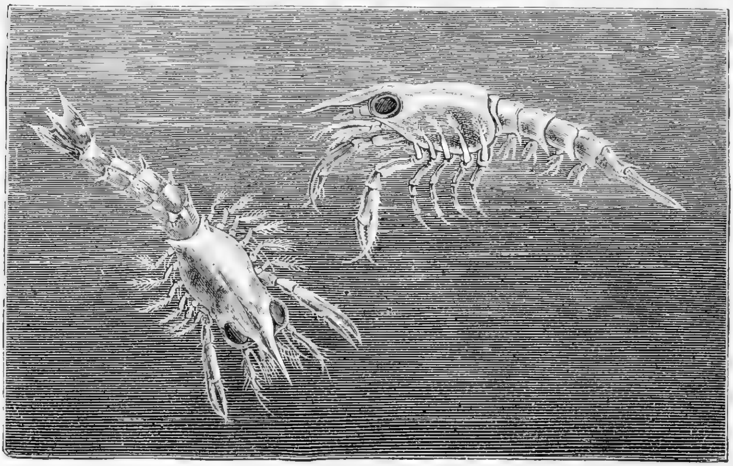
crawling, hiding life of their forefathers. Increasing in size, they gradually approach the shore, and at length occupy the places frequented by their past generations.

The form of the larva differs so much from that of the adult, that it would be difficult, indeed impossible, to determine their species, if we did not almost witness the hatching. Hence we cannot wonder that former naturalists considered the young craw-fish belonged to quite a distinct genus, which they termed *Phyllosoma*.



LARVA OF THE CRAW-FISH.

The larvæ have one peculiarity in common with their parents, that is, they moult; they change their carapace four times in the forty days of their roving life. Each time the carapace is replaced

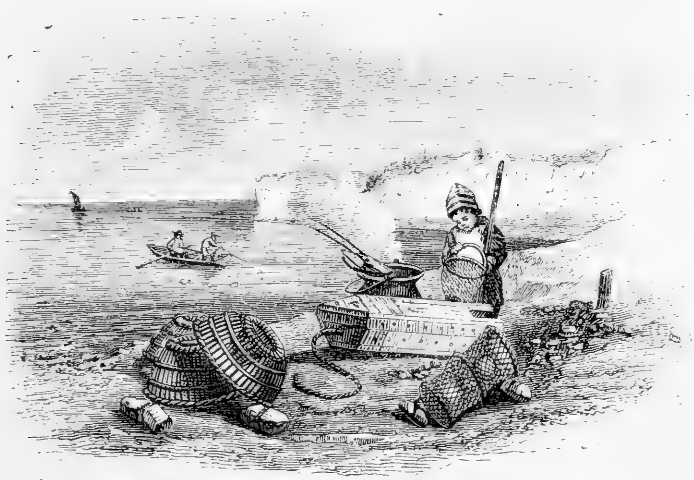


YOUNG LOBSTERS SIX TIMES THEIR NATURAL SIZE.
(At the period of their third moult.)

it is thicker, and as the tail is their chief oar, at last it becomes so stiff as not to be able to make its swimming movements rapidly enough, and so the larva sinks to the bottom.

According to M. Coste, the young lobster casts its shell from eight to ten times in the first year, from five to seven in the second, from three to four in the third, two to three in the fourth, and in the fifth year it reaches its full growth, so that the lobsters which come to our table, have changed their calcareous vest twenty-one times.

Crustaceans are caught in panniers, or baskets of strong wicker-work, which are in the form of two cones joined by their bases. An opening at one end is, as it were, a pipe of willow wands through



LOBSTER CRATES.

which the animal crawls; but when once in the basket it can never again find the hole, for the pipe projects into the basket, and the lobster only crawls on the sides of the pannier and cannot, or does not rise to find the hole at the end of the pipe. The lobster crates are not always of the form described; other shapes are drawn in our illustration; however, the principle is always the same. We have our chief supply of lobsters from Norway. They are brought over in vessels specially fitted for the purpose. The hold of the vessel is so arranged, that sea-water can be admitted into its compartments, and one vessel can carry 7,000 or 8,000 lobsters; the importation is sometimes very great in the season, as many as 30,000 arriving in a day.

When they are caught they can always be preserved until wanted for the market. In the illustration, a wooden box pierced with holes is used for this purpose; the captive crustaceans are placed in this, and it is lowered into the sea.

Mr. Richard Scowell at Hamble, near Southampton, has built a reservoir of brick lined with cement, and the lobsters are not able to climb up its walls. Fifty thousand of them can be kept here for five or six weeks. They are readily fished out of the water by touching them with a stick, which they seize with their pincers. When on land, to prevent them doing harm by their terrible nip, a piece of wood is fixed between their open claws.

Shrimps are very favourite little crustaceans. They are everywhere eaten. They strongly resemble the craw-fish, save that they have no prehensile claws. Fishing for shrimps is simple enough. It is only necessary to enter the water as high as the knee, and push in advance a wide-mouthed purse net; the mouth of the net is fixed to a semi-circular hoop, and a stout stick so fastened that the shrimper pushes the flat side of the hoop along the sand before him. A glance at our plate will, if the mode be not already known, at once indicate the manner of "shrimping." Where the beach is not favourable for the operation of shrimpers the fishing is carried on in boats. A long net is arranged between two boats which are pulled in the same direction, the net at stated times being taken out of the water and the captives secured. This, however, is seldom resorted to, the shore fishing being almost universally followed. Our French friends are gallant enough to consign the catching of the shrimp to the women. During the winter the shrimps abandon the shore, and betake themselves to deeper water. To catch them in their retreat, it is necessary to let down baskets constructed after the fashion of the lobster crates; but, generally they are made not of wicker, but of net, stretched on a frame-work; the water, however, so destroyed the twine that it was found necessary to renew the nets every month; now galvanised iron wire is used, and proves to be an admirable substitute, it being able to resist the action of the sea-water for three years. Like the lobsters, shrimps can be preserved alive in tanks, into which the sea-water rises at the high tides.

Shrimps when boiled redden, but they never take so brilliant a

Plate XIII. SHRIMPING AT LOW TIDE.

colour as the lobsters and craw-fish. There is a species caught at the mouth of the Garonne which do not change their colour when boiled, but remain a greyish white; however, this anomaly appears to be due to the fact that these shrimps inhabit fresh water for some days before they are captured.

Other crustaceans are less sought after than the lobster, the craw-fish, and the shrimp; yet, at Venice, not less than £20,000 worth of crabs are consumed in a year—four or five million crustaceans. In London two and a half millions of lobsters and crabs are eaten annually.

The alimentary use of the crustaceans is everywhere recognised, so that the classification proposed by Count Marsigli for the hard shell inhabitants of the Mediterranean, if not scientific, is eminently practical. He divided the crustaceans of the "Great Sea" into those which are eaten, and those which are not eaten.

CHAPTER XXXIV.

THE HERMIT-CRAB.

THE Hermit, or Soldier Crab, is perhaps the oddest and most curious of the crustaceans which inhabit the sea shore. It differs from the rest of the crustacean tribe in this, that only its head and breast are covered with a thick, calcareous crust, the rest of its body being without protection, and therefore readily eaten by its voracious brethren. But instinct has not deserted the hermit. Fully aware of his vulnerable point, he prudently takes shelter in some empty and deserted shell, whose shape somewhat approaches what his own would have been, had Nature granted him such a protection. But the hermit is by no means disposed to spend much time in searching for a cast-off shell; if there happen not to be one ready for his use, he attacks the first living shell-fish whose coveted shell he fancies will serve his turn. Killing the mollusk he eats the luckless tenant and then inhabits his house. At the feeding or breeding times, the hermit extends his great claws out of the orifice of the shell, as the illustration we append will show. When the crab would change his place, he seizes with his claws the nearest object, and then drags the shell forward; by this mode of progression the undefended parts are never exposed.

When the tide has gone out, all over the shore you may see a great number of shells of all shapes and sizes moving here and there with a much more rapid motion than mollusks are capable of. If you touch them, they abruptly stop, and you discover that the inhabitant of the shell is not a mollusk, but a hermit-crab.

This habit of the creature of occupying a cell so nearly fitted to his own size, has procured for him his names; for the hermit occupies but a hole in a rock, and the soldier as he stands in his sentry-box well nigh entirely fills it.

When the crab grows so that the shell becomes rather uncomfortably tight, he leaves its friendly protection and goes upon an

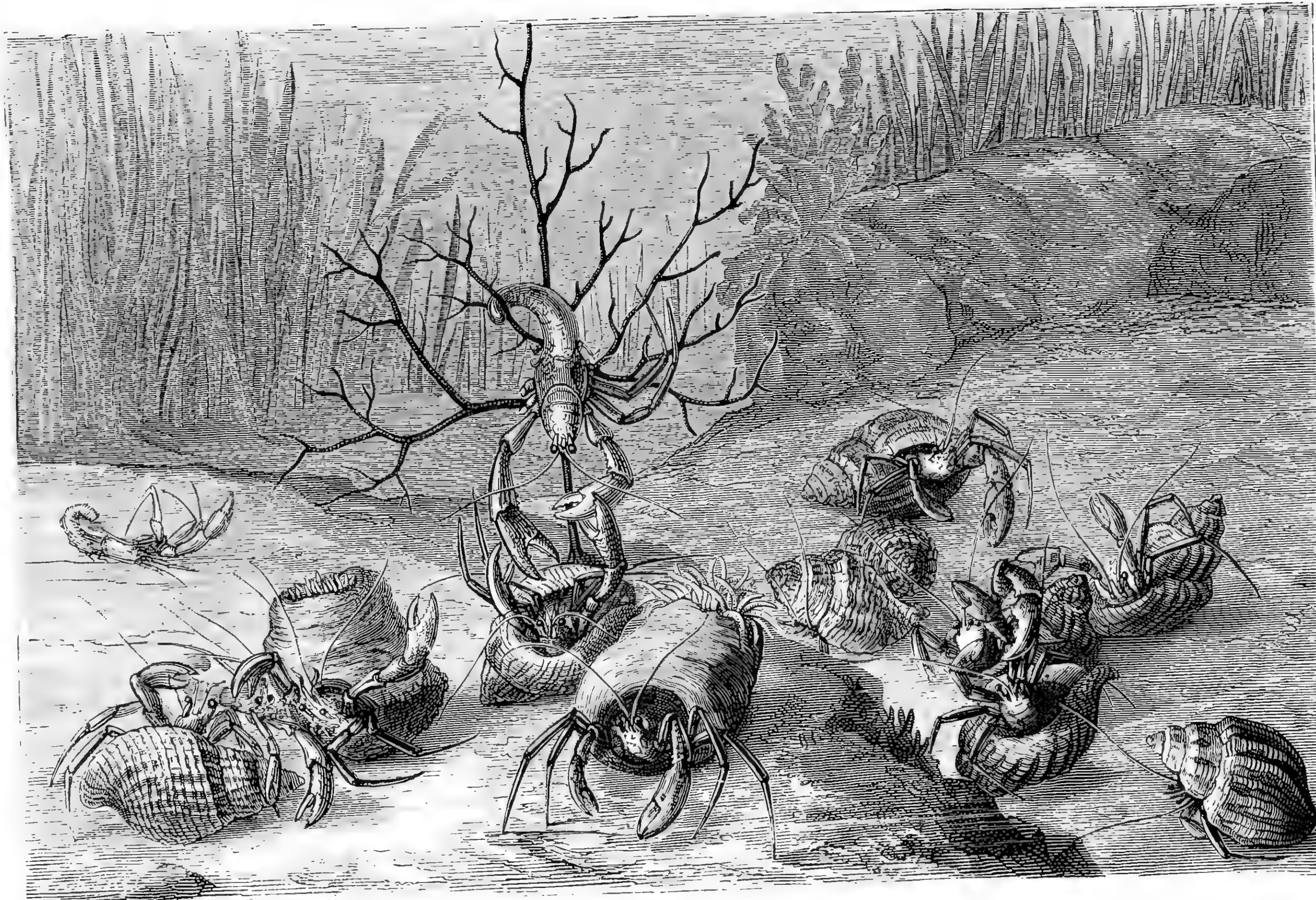
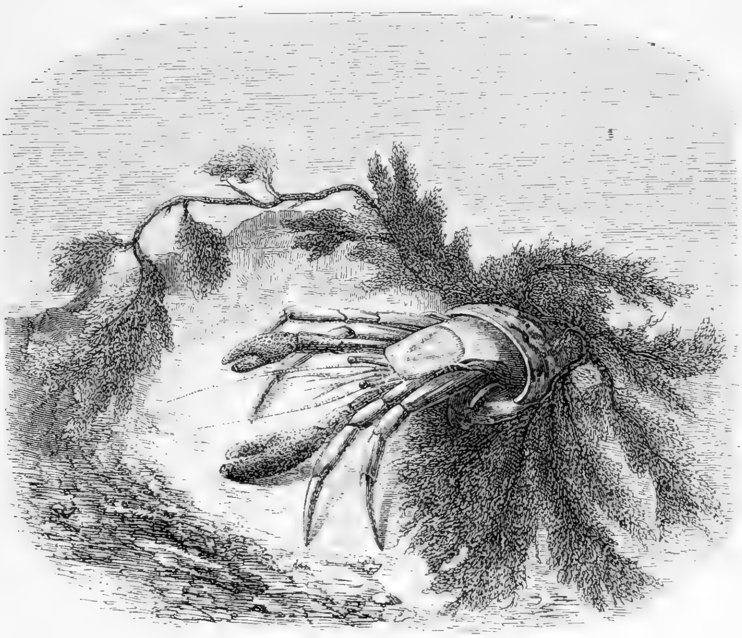


Plate XIV.

COMBAT OF HERMIT CRABS.

expedition to find another more suited to his increased bulk, and being unscrupulous as to the means he uses, he has not long to seek. It is interesting to watch a hermit in quest of a cell. When the tide retires, the operation may frequently be seen. Carefully and even defiantly looking around, to see if any of his many enemies are on the look out, the hermit leaves his domicile; gliding along on his somewhat distorted abdomen, he reaches a



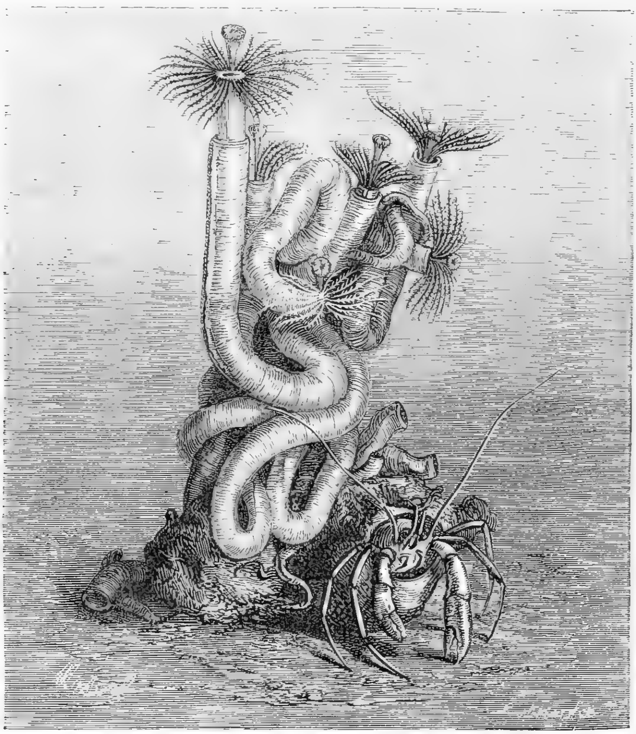
THE HERMIT-CRAB.
(*Pagurus Bernhardus.*)

deserted shell. Like a man wishing to take a new house, he walks round, inspecting it on every side, then he enters. Most probably with his first choice he is not satisfied, and may be seen to try several shells "to be let," always upon the faintest sign of danger hurrying back to his old and well-tried home.

In his successive removals, the little Sybarite chooses a hermitage always larger than the last one he occupied, and does not fail to exhibit a choice as to colour and architecture. The hermits may be found domiciled in almost every species of shell;

but they show a decided preference for habitations which are long and spiral.

The hermit is very timid—most cowards are—and at the least noise he draws himself into his shell, closing the aperture with his large claws, and so tightly does he cling to his stolen house, that



A HERMIT IN HIS CELL.
(*Dredged up from thirty fathoms.*)

you may almost pull him limb from limb before he can be dislodged. One great means of this adherence resides in the tail, which has the power of adhering to the walls of the shell. And yet with all his timidity he is a great glutton, eagerly devouring anything which comes in his way. He does not hesitate to attack live creatures, and when put into an aquarium, he has been known to throw the whole of its peaceful inhabitants into the utmost confusion by his insatiable rapacity.

It has been found possible to keep something like peace among many hermits in the same reservoir; but this was due, not to any love of harmony in the creatures themselves, but only because the cunningly contrived barricades at the apertures of their abodes so well sustain the attack of an aggressor, that experience has taught them that the only hope of conquest is when the attacked is not in his fortress. In reality, the hermits are most quarrelsome; two of them cannot meet without exhibiting signs of bitter hostility. They each extend their claws, and try to find a weak point in the other's barricade; the reconnoitre generally proving to each that an attack would be impracticable, they unwillingly withdraw.

But often such passages of arms as are depicted in Plate XIV. may be witnessed; the claws of the two combatants are extended and the pincers open and shut snappishly; frequently they are locked in each other's embrace and roll over, generally, however, they are more frightened than hurt. Mr. Gosse once witnessed a contest which did not end so harmlessly. A hermit-crab met a brother hermit who was better lodged than himself in a more commodious, and altogether more desirable shell; in an instant, before the hapless crab could throw up his barricades, he was seized by the head, and with a violent jerk, dislodged and thrown on the sand, and with no less rapidity did the victor enter the coveted shell and take possession. Perhaps the combativeness of the hermits is more excusable than that of men, for while the lords of creation destroy each other frequently for no assignable reason, the crabs at least fight for a house.

A pretty species of sea anemone (*Adamsia palliata*) loves to live with the hermit-crab, and exhibits sympathies with this Ishmaelite of the shore, quite inexplicable. In an aquarium the anemone invariably attaches itself to the shell which harbours a crustacean, and it is almost a rule, that where the hermit is, there is its friend the zoophyte. These two creatures seem to live in perfect and intelligent harmony, and Mr. Gosse's observations certainly go far to establish between them a reciprocal friendship. This intelligent observer watched the proceedings of a hermit who required a new habitation. Having fixed upon a shell in which to take up his new abode, he returned to the old home, and with great care detached from it his friend the anemone, he then carried it to the new shell and deposited it on the top, actually giving the zoophyte several gentle taps with his great claw, as though he would say, " There, my friend! be quick and attach yourself."

Mr. Lloyd, when constructing the Portland Road, often witnessed the same bond of union between the crustacean and its parasite the anemone. One hermit he watched, which could not leave its shell, although it had set its mind upon one in the neighbourhood, because it was not able to detach the anemone and remove it also.

Another species of the crab has a companion in the *mantle anemone,* and we are told that when the crab dies, the anemone appears inconsolable and does not long survive his friend.

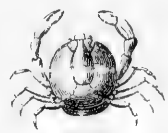
It is also well known that one of the annelids, the *double-lined Nereida,* enters into a more intimate friendship with the hermit-crab, it even lives in the same shell and shares with the crustacean his lodging. The fishers of Weymouth who know this peculiarity, when they want the worm—which is an excellent bait—seek for it by breaking the shell tenanted by a hermit.

A hermit has been known, when he could not suit himself with a shell, to make a home in a sponge. Another was discovered inhabiting a hole in a piece of pumice-stone. In the Zoological Gardens in Paris, in 1861, there was a hermit-crab who had actually taken up his abode inside a living anemone; he trailed it along with him wherever he chose. The anemone, when not very much shaken, extended out his tentacles, and appeared not in the least disconcerted at the strange occupancy of his digestive pouch. But this singular fact is productive of many questions, to which it is difficult even to suggest an answer. How did the anemone eat? Was it fed by the ejectments of the crab? How came it to pass that the strong solvent fluids which the surface of the stomach of the zoophyte exudes, did not take effect on the unprotected body of the hermit?

There is a little creature—a member of this tribe of crustaceans —which selects a flat stone and lying down upon it, so protects its back; it keeps the stone in this position by means of two of its hindmost claws. The *Dromia* belong to the order *Anomoura,* and are generally found covered by the single valve of a shell, which they also hold in its position by their claws, and thus carry about with them a shield.

Mr. Spencer Bate put into a glass of water some *sea-fleas*, along with some green ulva; he was surprised to find that in a couple of hours the little creatures had rolled the sea-weed into a tube, in which they were safely and peacefully housed, thrusting their head and antennæ out of the end of their sea-weed pipe.

The *Amphithoe rubricata* seeks under stones, or in the crevices of rocks, or among the stems of the fuci, a sheltered spot where it constructs a nest, which is composed of a silky material, and when examined under the microscope appears to be woven most delicately, while here and there through the fabric run thicker threads, often spiral.



PINNOTHERES VETERUM.

The *Pinnotheres veterum* is a pretty, bright, rose-coloured crustacean about the size of a pea; he takes up his lodging in the shell of an oyster, and lives on terms of the closest intimacy with the aristocratic bivalve. Pliny believed that the grateful crab returned the hospitality of the oyster by lending the blind mollusk the use of his eyes. Whenever a danger threatened, the guest pulled the mantle of his host; at the signal the valves were shut, and both the oyster and his friend placed in perfect security. Plutarch, however, estimated the services which the pinnotheres rendered the oyster differently. He says that the tiny crab acts as a watchman, and when a little fish comes within the valves of the mollusk, which are always open, the crab pinches the oyster, which immediately closes its shell, and entraps the fish. The prey thus secured, the pair then consume at their leisure. It is needless to say that this is not the truth. The presence of the pinnotheres in the shell of the oyster, is entirely due to the instinct of self-preservation. This timorous little crustacean is found not only with the oyster, but also in the shell of other bivalves, such as the mussels, the modiolas, and the pinnæ—indeed it is from this last mollusk that its name is derived, which literally signifies, *the guardian of the pinnæ.* Mr. Thompson examined eighteen mussels on the Irish coast, and they contained no less than fourteen of these *pea-crabs.* These were all females, but it is not uncommon to find in the same shell a male, with two or three females, and many young ones.

The pea-crab is not selfish, for when it finds a good home it has an immediate desire to share its fortune, and soon the bivalve is favoured with a little colony of parasites. Thus again we are reminded of the harmony of Nature. Nothing is isolated; the order of life is as a chain, all the links fit into each other; not only is this the case in the economy of life, but in the inanimate world there is nothing independent. Every act of Nature has a cause which is not resident within itself, and bequeaths an effect which becomes the cause of a subsequent movement.

With the crustaceans we terminate the invertebrate kingdom, and now we enter upon the highest of the divisions of the animal kingdom—the Vertebrata. Thus we have passed step by step from the simple to the *compound*—a word which we have used in three senses:—first, we applied the term to a moving or a fixed colony made up of a number of individuals so joined that they could not be said to be absolutely distinct. Again, in the case of the zoonites, where a number of distinct organisms were discovered forming the same animal, the creature was said to be compound; and now for the third time we use the word to express a higher and more complicated structure.

CHAPTER XXXV.

FISHES.

FISH are, *par excellence*, the inhabitants of the ocean. They pass their whole existence in its waters; here they are born, here they live, and here they die; moreover, they are the most prominent of its occupants, they are larger, more numerous, and more varied than any other of the marine races. In the first chapter of our work, we stated that seven-tenths of the whole surface of the earth was covered by the seas. It is not surprising that one struck with the vast extent of the waters, exclaimed, "Our globe has been made for the fishes!"

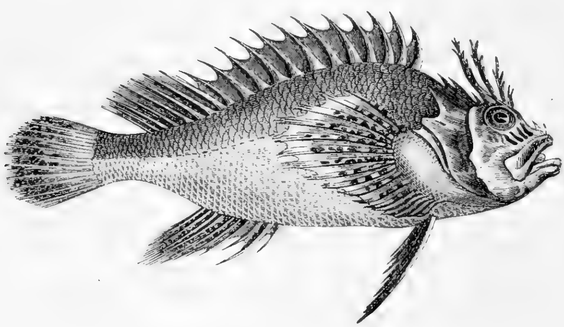
The fish may be considered as the connecting link which joins the vertebrates and the invertebrates. Their organisation is more complicated than any of the animals we have as yet considered. Pliny enumerated ninety-four species of fish, Linnæus increased the number to four hundred and seventy-eight, and now we reckon in the guild of the finny tribes, no less than 13,000 families, one-tenth of which confine themselves to the fresh waters.

The fish are not scattered over the regions of the ocean without any order or regulation, but just as is the case with land animals, instinct teaches them to congregate in those localities best adapted for their existence; the habits of many species are strongly defined, and sometimes the limits of their localities are very restricted, at other times a species is found extending over a large area.

Unlike the land animals whose distribution is regulated by latitude, the fish are affected by the depth of the water; this is another consideration in the regulation of the distribution of species. Some live quite on the surface; others never quit the depths; and some pass their existence in the ooze and mud of the bottom. True salt-water fish dislike the fresh water of the rivers, and are therefore never found in estuaries; however, there are species which prefer an estuary life, and some, as the salmon, pass part of their time in the sea and the other in the rivers. We find the same habits of life in the sea as on the land; some fish live in solitude, others swim in shoals, some occupy the same localities all the year, others congregate in vast numbers and migrate to warmer waters.

The typical form of the fish is too well known to need description; it is perfectly adapted for the element which it inhabits, and its shape is the most favourable for gliding through a dense medium.

Belonging, as we have said, to the highest class of the animal kingdom, their construction is very much more complicated than



SCORPÆNA OF THE ISLE OF FRANCE.
(*Scorpæna nesogallica.*)

any which has attracted our attention; yet it is remarkable that, throughout the very numerous species, scarcely any variation is made; an evident relationship runs through the whole; still, though their anatomical structure is so remarkably similar, their physiognomy is often very different.

Whether these animals inhabit the ocean abysses, the shallows of the shore, or the river estuaries, whether they are scaly or shagreened, osseous or cartilaginous, their organic composition remains the same, or almost the same, in its essential elements.

Amongst the fish, as in all other natural groups, we find exceptional forms, curious and strange anomalies. Some are corpulent monsters, round as bottles; some are as thin as boards and the shark represented by our artist rejoices in a head like a

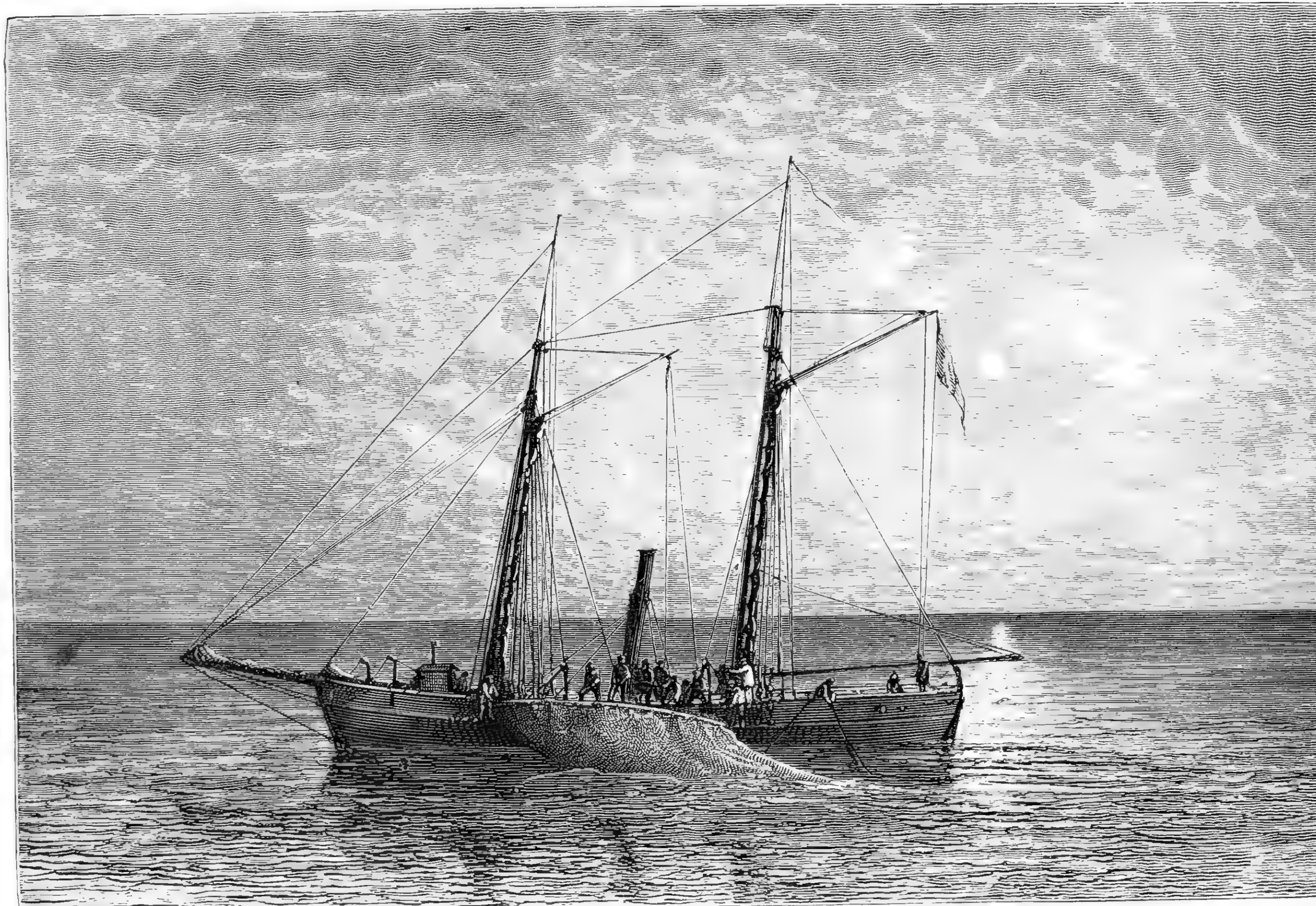


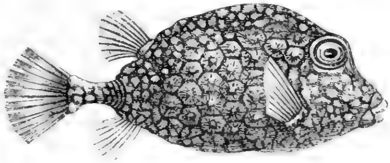
Plate XV.

NIGHT FISHING; HAULING IN THE NET.

mallet. Some are as broad as long; some unusually thin, with scarcely a difference between their head and tail, while their gills

THE HAMMER-HEADED SHARK.
(*Zygæna tudes.*)

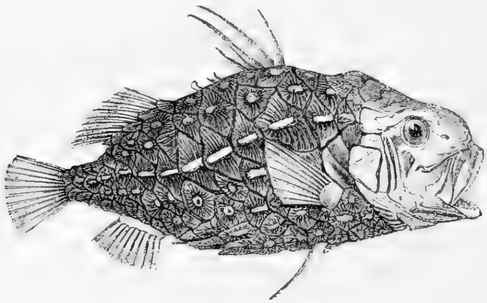
are not unlike the holes in a flute. Then there is as much diversity as can possibly be imagined in their scales—they are of all shapes,



THE TRIANGULAR TRUNK-FISH.
(*Ostracion triqueter.*)

sizes, and colours. They vary from a point to a plate; but are always placed symmetrically, and generally overlying each other like the tiles of a roof. The skin of the fishes is always lubricated with a viscous secretion, and their tissue is penetrated by an oily fat, upon which the salt water has no action.

Some of these creatures are painted with brilliant colours, and are robed in elegant costumes. They need not fear comparison with the butterflies or birds of the gaudiest plumage. The mullet and perch are clothed in scarlet; the mackerel and dolphin wear coats shot with emerald; the pike has his breast mailed with silver plates; while the salmon glides through the waters with a metallic lustre. In fact, the finny tribes can find representatives to furnish all the colours of the rainbow. However, for the most part, the tints, vivid and bright though they seem, are evanescent,

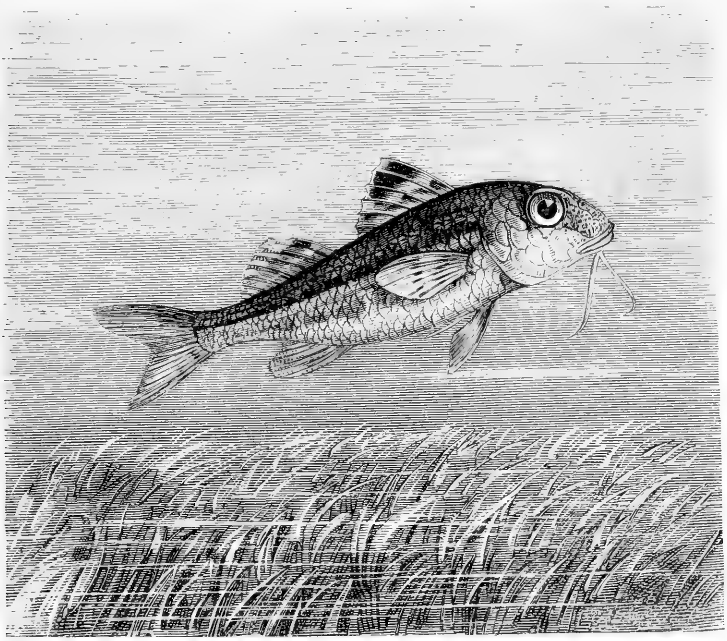


THE MONOCENTRIS OF JAPAN.
(*Monocentris Japonicus.*)

and the least cause changes them from brilliancy to dulness; the time of the year, the health of the fish, taking it from its native element, all having their effect upon its colour. It was one of the pleasures of the Romans to watch the rapidly changing hues of the red mullet as it struggled in the agonies of death.

The property of phosphorescence seems to be enjoyed by some of them; and, according to Borda, fish of this kind can be seen at three fathoms depth in a calm sea.

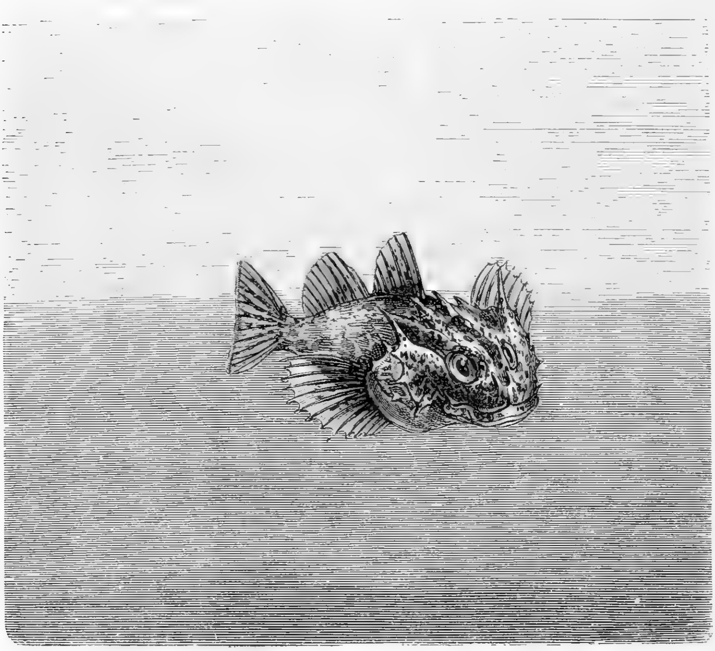
Bennet describes a shark which emits a green, phosphorescent light from the whole of the under surface of its body. He found one individual whose light came as it were from one chamber. The appearance of this monster was hideous enough in the daylight; but in the dark, when luminous with an unearthly glow, it can be better imagined than described. When the shark dies, which happens in some three hours after it is taken from the water, the light gradually fades, the gills and fins retaining the phosphorescence longer than the rest of the body. The only part of the whole lower surface which was not luminous was a band on the throat. In this peculiar species the fins are very small, and therefore the motions of the shark are not quick. Bennet conjectures that the phosphorescence is given to the fish in order that its prey may be



THE RED MULLET.
(*Mullus barbatus.*)

attracted to its neighbourhood at night, for we know that fish always do approach a light. Salmon and other fish are frequently caught on the lakes by burning lights on the prow of the boat, from which the fishermen spear the fish thus attracted.

Fish subsist upon the succulent plants of the marine vegetation, on worms, shell-fish, and small crustaceans; some of them devour other fish and even members of their own tribe. Might here is right; the great ones eat the small ones: irrespective of their race, they will eat the junior members of their own family. They swallow their prey without mastication, and frequently without even biting it. A bull-head has been known to swallow a young mullet, one and a half times as long as himself! John Barrow reports that a dog-fish harpooned near Java had in its stomach a number of bones which belonged to the head of a buffalo and a calf, as well as fragments of a large tortoise. Brünnich, when



FATHER LASHER—THE MARINE BULL-HEAD.
(*Cottus bubalis.*)

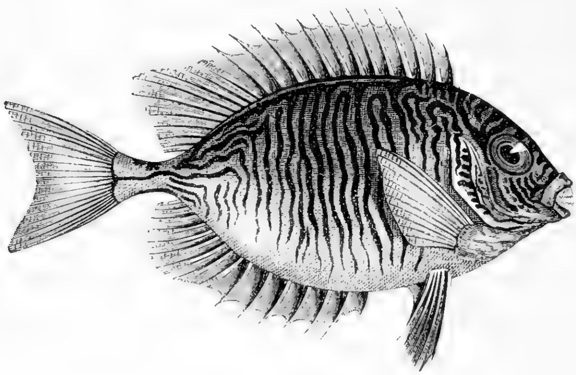
studying fish at Marseilles, found a dog-fish in whose stomach were two tunnies and a sailor dressed in all his clothes. Tales even more remarkable than these are told, but we fear to trespass upon the credibility of our readers. However, every book of travels contains accounts of the ferocity of sharks, and how that many a poor sailor has met his end from these marauders of the sea, which generally follow in the wake of the ship.

Fish not only have their teeth set upon their jaws, but frequently the roof of the mouth is also covered. The mammalia have only three bones which are able to bear teeth, but fish have eight. Their teeth vary in form ; generally they are conical and pointed, sometimes they are depressed and flat. The members of the ray family have their mouths furnished with small ivory plates which are arranged like tesselated pavement. Some teeth are long and curved, indeed more like hooks than teeth. Perhaps of all the sea monsters the *Sea-wolf*, which frequents the northern seas, has the most formidable dental array. It has two kinds of teeth—incisors which are triangular and serrated upon their edges, and flat grinders. Steller recounts an adventure with a sea-wolf off the coast of Kamtschatka, in which he says that the creature seized an iron lever between its jaws, and snapped it like a rod of glass. Schœnfeld assures us that the wolves can even leave the mark of their teeth upon the anchors. It is said, but we have no absolutely authentic account, that there is a fish in the southern seas which can browse upon the stony coral stems as a cow crops the meadow grass. We know that some fish have so many teeth, that they are so close together, that to the touch of the finger the mouth seems lined with velvet.

The respiratory organs, or branchiæ, exhibit very varied organisations. They are generally filaments, or little tubes, fixed in parallel series to a kind of bony arch, and so forming a species of fringe. In the *Sea-pipe* (*Syngnathus acus*) and in the *Sea-horse* (*Hippocampus*) the branchiæ rise in tufts.

The continued movements of the mouth and gills have induced the popular idea that fish are constantly drinking water, hence the proverb, "To drink like a fish." This notion is, however, erroneous, for the fish is not employed in drinking water, but in breathing the air the water contains. The gills are apparatus fitted for the separation of the small quantity of air the water holds in solution from its liquid solvent. The truth of this is easily proved. If gold and silver fish be placed in water which has been boiled, and which therefore is not aerated, the suffocating creatures come up to the surface of the water, finding that there the liquid contains some little air.

It is the general notion that fish have no means of making any sounds. This is not strictly true ; though the most of them are mute, yet some are capable of making noises. The *Pristipoma anas* makes a groan which may be imitated in pronouncing the syllables *coin-coin.* The *Wrasse* gives a similar though a more shrill cry. The *Tunnies* cry like children when taken from the water. The *File-fish* at the breeding time make a noise like drawing a stick over the head of a drum. There has lately been discovered in South America, in the Bay of Panguapi in the province of Esmeraldas, a little white fish, with blue spots on its back. Not only has it a voice, but it can sing. M. O. de Thoron stayed a day at the place; he was pulling in his boat near



THE CIRCULAR AMPHACANTHUS.
(*Amphacanthus doliatus.*)

the water's edge, when he was struck by hearing several prolonged, musical notes. Looking about, and seeing nothing, he asked a boatman what the noise was. The man replied that it was the singing of the fish, of which there were two kinds—the *Sirenæ* and the *Musico.* Stopping the boat, he listened more attentively, and heard a concert of voices; the tones were deep and sonorous, much resembling the sound of a distant organ. They commence their singing as the sun sets, and sing on—like the nightingale—through the night; the presence of an audience does not deter their performance.

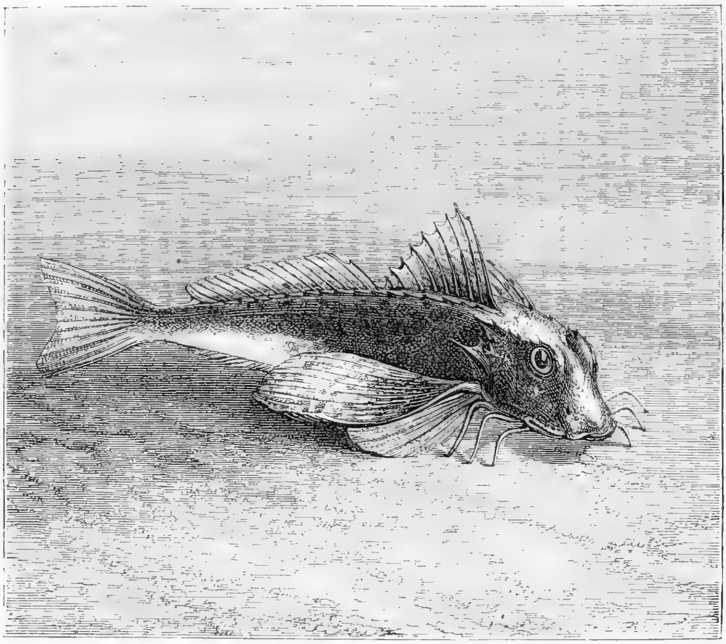
Fish are provided with *fins,* by which they are sustained and propelled through the water. The *pectoral* fins take the place of arms, and the *ventral* fins are in the position of legs. The relative position of these pairs of fins admits of some variation in the different species; sometimes the pectoral fins are just above the ventral, and sometimes the latter approach the tail. The other fins are usually single. The *caudal* fin is the tail; the *anal*, which is sometimes double, is on the under surface, near the tail; while from the ridge of the back rise the *dorsal* fins, of which there are sometimes one, two, or three. Hence the maximum number of fins is ten—four in pairs, and six single. The fins are traversed by rays, which vary in their consistence in different species.

It is needless to say that fish are perfect swimmers, being able to turn in any way with the greatest rapidity, to dart forward, or to stop suddenly at will, and with the greatest ease and precision. The "gait" of their motion differs just as the walk of the members of our species; this is mainly owing to the different positions and size of the fins as well as the shape of the body. They do not all swim with the same strength. Some can resist the rush of the most violent waves; while others, like the tunny and the diodon, are borne upon the breast of the currents, and transported, even against their will, from one place to another.

A great variation is found in the form of the tail. Indeed, from the mode in which this caudal appendage is formed, the fish tribe is divided into two great classes. When the backbone is prolonged into the tail, one lobe of the caudal fin is much larger than the other, and therefore such fish are said to be *heterocercal* (unequal lobed). This construction will be noticed in any of the illustrations given of sharks. Upon this type were formed all the Palæozoic fish, which are now found fossilised in the geological formations below the new red sandstone. It was when the heterocercals were predominant, in the old red sandstone period, that fish-life on our globe reached its maximum. Ever since that now remote age, the fish have gradually retreated from the supremacy they held.

The heterocercals are now the exceptions, most of the members of the finny race being *homocercal*, that is, having tails with equal lobes; the fact being that the tail is a veritable fin, appended to the end of the vertebral column; the backbone does not enter the tail.

There is great diversity in tails. The *Sea-horse* (*Hippocampus*) has a long, lithe tail, which can be wrapped round the stems of the algæ and the coral, and even by its means many of these singular creatures can hold themselves together. Some—like the *Gurnard*—have very broad, thin fins, which look like sails. These extended fins are used by some fish to make aërial flights, for there are flying fish just as there are swimming birds. These fish rise some



THE GURNARD.
(*Trigla gurnardus.*)

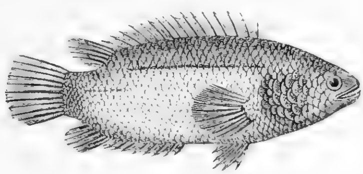
few feet above the surface of the sea, and some of them can even fly a mile; but as soon as their fins become dry they lose their flexibility, and the fish falls down into its native element.

When the flying fish are pursued by a John Dory or a dolphin, the poor creatures in their terror leap out of the water, only to find an albatross, or some other of their winged enemies hovering above to seize them; dangers surround them on every side, and in flying from one they run into another, and with difficulty is it that they escape an untimely end.

The *Trigla lucerna* is a flying fish, the interior of whose mouth is luminous, so when a number of them at night, fly above the surface of the water, they seem like shooting stars. At Malabar is

A SENNAL-FISH UPON A PALM TREE.

found a small fish called the *Sennal*, which loves to leave the water, not, however, on wing, but it climbs two or three feet up the stem of a palm tree which grows on the water's edge.

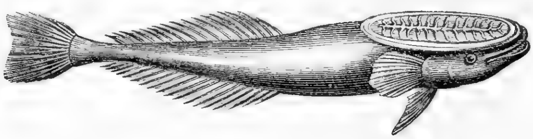


THE SENNAL.
Anabas scandens.)

Its respiratory apparatus must have the power of retaining a certain quantity of water, and thus enable the animal to live some time out of its native element.

The *Hassar* (*Doras costata*) of Central America, when the swamp it inhabits dries up, makes even long journeys across the country by the aid of its scales and fins, in search of water. It is said that it can endure even the hottest sun for many hours. If it find that all the water has evaporated, like the leech, it forces itself into the moist earth, and there remains until the water returns; a proof that fish are by no means wanting in intelligence.

The *Remora*, or *Sucking-fish*, has upon its head a flat disc, made of a flexible and contractile material, and crossed by several ridges. By means of this organ, the animal can attach itself to submarine bodies, and so can put itself under the protection of a larger fish, who carries his little *attache* with him wherever he goes. So the



THE SUCKING-FISH.
(*Echeneis remora.*)

remora passes through the water in perfect safety, and without the slightest danger.

It was the belief of the ancients, that this curious fish could impede, and even arrest the progress of a large vessel; nay, their credulity and love of the marvellous was such, that they asserted—no amount of rowing, no sails, not even a tempest, could move the ship from the spot where the remora first attached itself. At the battle of Actium—Pliny seriously relates—the vessel of Antony was held by this invisible object firmly in its place, and from this cause Augustus gained the battle and the empire. In speaking of this nautical wonder, the historian says, "Let the winds blow as they will, let the tempests exert their rage, this little fish commands their fury and sets a bound to their power."

The *Rays* lie in ambush to seize little animals which happen to come within their reach.

The *Epibulus* resort to the same stratagem, and when a young fish comes in its neighbourhood, it has the power to shoot out its jaws and so to engulf the imprudent wanderer.

The *Angler* possesses some flexible appendages, which take their rise just above its mouth; at their extremity hang lumps of flesh. This peculiar arrangement is precisely as if a number of fishing-rods with baits at the ends of their lines, had been stuck into the head of the fish, in such a position that the baits hung some little distance before its mouth. The angler lies hid in the sedge, and he exhibits these lumps of flesh to attract the attention of any curious passers-by, who come to nibble, and are caught.

The *Scorpæna* audaciously attacks, and even cruelly tears the largest cod-fish, which is often twenty times larger than itself. So that it is not invariably the case that the greater eat the less.

The *Chelmons*, which are found on the Asiatic coasts, are remarkable for their long, tubular snout. They live on insects, which they capture in a most peculiar manner. When a chelmon observes a fly seated on a leaf overhanging the water, he cautiously approaches, and elevating his snout above the water, brings down the fly with a well-directed jet of water.

The *Archer-fish* of Java employs the same means, with the same success in securing its food.

Nature has furnished fish with different means for resisting their enemies. Some have their bodies covered with horny plates, or garnished with sharp hooks. Some have the rays of their fins so long and sharp, that they pierce the hand which incautiously seizes them. Others have their whole body so covered with spines, that they approach the appearance of a hedge-hog.

The *Spiny Globe-fish* or *Diodon* is defended in this manner.

The *Sword-fish* acquires his descriptive name from the fact that the upper jaw is prolonged and flattened out into a species of sword—a terrible weapon—with which he attacks the largest of the marine inhabitants. In the British Museum there is a piece of the keel of a vessel pierced through by the sword of a Xiphias.

The *Saw-fish* (*Pristis antiquorum*) has not a sword, but a saw, a blade sometimes nine or ten feet long, projects out of its muzzle. This weapon is very strong, and its edges are armed with strong-pointed, sharp, osseous spines, placed at regular distances from each other. These saw teeth might be supposed to be the teeth of the animal fixed in a prolongation of the jaw; this, however, is not the case, the true teeth are small plates which pave the interior of the mouth. With this terrible weapon the monster can rip open the stomachs of the whales, or make horrible gashes in the flanks of the seals.

The *Surgeon* (*Acanthurus chirurgus*) and the *Doctor* (*Acanthurus cæruleus*) are also armed with sharp blades; but these do not spring out of their head, but are attached to the tail; the blades are not long, and have some resemblance to lancets.

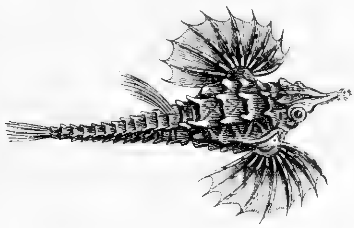
Almost all fish are furnished with a means of attack or defence. But one—the electric-eel—has borrowed from the heavens one of its destructive powers, and has taken into the world of the sea a charge of that mysterious fluid which flashes from cloud to cloud, terrifying the world beneath with the loud voice of its thunder.

The reproduction of the fish, we may almost say, is left to chance; this is the reason why out of such multitudes of eggs comparatively only a very small number of fish are hatched. At the season of spawning, the females, led by instinct, make for the shore, or for sand-banks which occupy shallow water, through which the rays of the sun can penetrate, and here they deposit their eggs; guided by the same mysterious power, the males soon after arrive and impregnate the ova. It is not necessary that the males and females should come together, or even see each other.

The *Tittlebats* (*Gasterosteus aculeatus*) are exceptions to this rule; and although they are not members of the ocean society, but live in fresh water, yet we ask permission to leave our path since they have left the ordinary track of fish production. When the proper period arrives—their St. Valentine's day—the male begins to construct a nest of vegetable fibres, artistically interlaced. The nest has two entrances, and when the work is completed Mr. Tittlebat sallies forth in search of a wife. He soon finds some belle of the stream, to whom, in a most unceremonious manner, he offers his hand and heart, for, dispensing with all unnecessary forms, he seizes the lady fair by her fins and drags her into the nest, escaping himself by the second opening. The eggs being laid, the lady leaves her room, and again joins the life of the stream. The husband now enters, and gliding backwards and forwards over the eggs impregnates them; if he considers that there is not a prospect of a sufficient number of little tittlebats, he goes in quest of a second lady, and compels her to go through the same process. If now satisfied with the prospect of his family, he closes one end of his nest, and places himself above the other orifice, where, as a sentinel, he guards his treasure from any passing marauder.

Pellicier, Bishop of Montpellier, some time since, found that the *Gobies* and the *Sea-horses* also construct nests for the reception of their eggs.

Certain kinds of fish are not able to spawn in salt water, therefore they leave the sea, and run up the streams, where they



THE FLYING HORSE.
(*Pegasus volans.*)

deposit their eggs. The most noted of this class are the *Sturgeons*, which leave the Caspian and Black Seas, which they inhabit in vast shoals, and ascend the Danube and the Volga, and other rivers which flow into them.

The *Shad-fish*, whose flesh is not esteemed when it is in the sea, is considered a delicacy when caught in the fresh water which it periodically enters to spawn.

The most prized of these emigrating fish, however, is the *Salmon*. The firm consistence of its flesh, its fine flavour, and its rosy colour, make it preferred for the table perhaps more than any other fish. The salmon seems to have the same instinct as the storks and swallows; it returns year after year to the same river. Some salmon were taken near Brest, and copper rings thrust through the membrane of their tails; by this means they could be recognised, and it was found they regularly returned each year.

The fecundity of fish is marvellous, and were it not that a thousand causes tended to destroy their offspring, they would multiply beyond all conception. An immense number of eggs never hatch; the currents disperse them, the tempests injure them, the sun dries them, and other animals destroy them. Hardly one egg out of a hundred produces an embryo, and thousands of the little fry are devoured. The chances of existence are so much against them, that in this we can see the reason why they are so prolific. It has been calculated that—

The red mullet produces	81,586 eggs.
The sole	100,362
The mackerel	546,681
The carp	700,000
The sturgeon	1,467,856
The plaice	6,000,000
The turbot	9,000,000
The grey mullet	13,000,000

Soon after the egg has been laid, there appears upon the surface of an interior globe a white spot, which upon close examination appears like several small drops of oil; in some eggs one or two hours are sufficient to produce this spot, but in salmon roe it does not make its appearance for eight or ten. The interior membrane begins to fold itself, at first enwrapping half the egg; this coat increases until only about a tenth of the interior globe is visible, and this begins to give signs of organisation. In a little time the embryo can be discerned occupying a quarter of the circumference of the egg; gradually the form of the little fish appears, with its eyes as black points. After this the hatching is soon completed. This process requires a week in the case of the carp, twenty days in the roach, and two or three months in the trout and salmon.

Generally, the young fish swim off as soon as they are hatched. The salmon fry, when they come out of the egg, carry a large bladder-like vesicle attached to the abdomen. This seriously encumbers their flight from their many enemies, but it contains nourishment by which the young fish is supported until it can feed itself. Until this time, it hides itself away, even from the light, dwelling in seclusion five or six weeks. Ordinarily, the mother takes no care of her progeny, and yet there are exceptions to the rule.

The *Hassar* (*Doras costata*), whose travelling propensities we have noticed, constructs a flat nest something like the magpie's. This, however, is only the roof, for the real nest is in the centre of the structure, a hole being left for the entrance of the fish. When the natives wish to catch the fish, they surround the nest with a net, then tap it; the hassar, enraged at the disturbance, bristles his spines, darts out, and is caught. The male fish shows much affection even for the eggs before they are hatched, and consequently before they exhibit any signs of life. It is said that the tittlebat, after having defended his nest and its eggs, undertakes the protection of the young progeny, just as a hen looks after her chickens.

The *Pipe-fish* (*Syngnathus acus*) presents a still more remarkable instinct. Beneath the tail of the male fish are two soft projections, so close together that they form a pouch. In this are deposited the eggs of the female. Thus in this remarkable fish the eggs are submitted to a process of incubation. When the young are hatched they follow their father, and whenever a danger threatens they seek protection in the pouch, like the young kangaroos, only the marsupials fly to their mother, not their father.

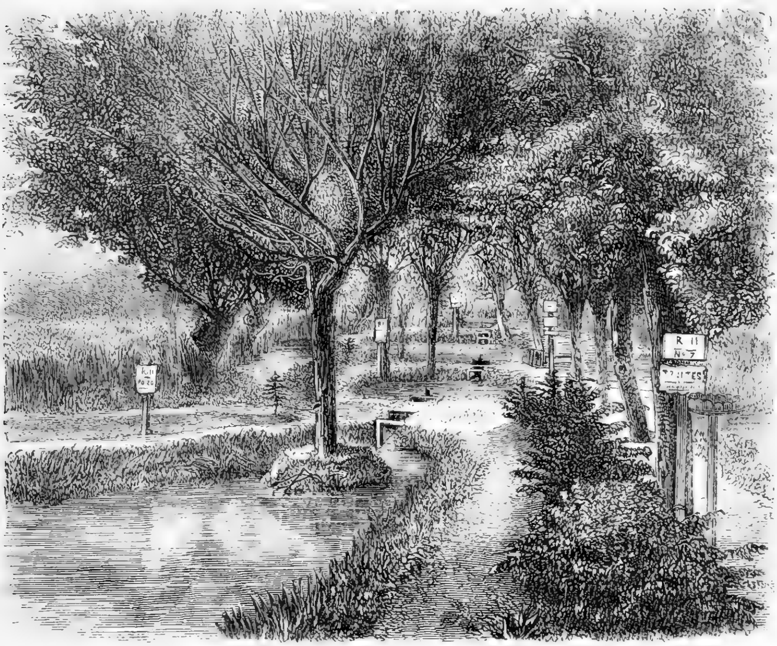
We can hardly believe Plutarch when he says that the shark takes as much care of its young as any living creature. He asserts that the parents even dispute who shall feed, and teach their offspring to swim, and when an enemy bears down upon them, the little creatures retreat for protection into the mouth of the parent. Happily, the historian's account of the habits of the shark do not affect his credibility when he describes the habits and lives of great men.

The sea is full of treasures which she gives out of her ample bosom to the inhabitants of her shores. With fishing lines, nets, drags, and numberless implements, the denizens of the ocean world are secured. No laws are made to regulate the pillage, and a source of great wealth is permitted to be abused. Many millions of fish and crustaceans are yearly caught, which are either too small for use, or are perhaps gravid with spawn, and thus a reckless waste of a valuable commodity goes on. Our French neighbours are alive to the evil, and are engaged in finding a remedy, in framing restrictive laws, which may regulate the taking of fish, and what is probably of more use, large establishments are being erected for pisciculture. This branch of industry is not new. The Chinese have pursued it from time immemorial, and the Romans bred fish, partly for amusement, and partly to supply their tables. There is but one method. Reservoirs are built near the shore, so that the waters of the high tides can sweep into them; in these tanks the fish are kept, looked after, fed, and preserved, precisely as we do with our cattle.

GENERAL VIEW OF THE PISCICULTURE ESTABLISHMENT AT HUNINGUE.

There are many of these establishments upon the French coast, and we are slowly following the good example. As yet our attention is chiefly turned to salmon and trout culture. Already the attempts have been crowned with great success, and we have been enabled to increase the number of river fish materially; besides stocking the rivers of New Zealand and Australia. This idea of preserving and watching over the hatching of the eggs of salmon and trout, dates back to the middle of the seventeenth century.

It is known that when the salmon ascend the streams from the sea, they do so in order to deposit their eggs in the fresh water. The female fish by means of her nose and tail, hollows out a furrow, throwing up the gravel in such a position, that the force of the stream is broken and cannot carry away the roe which she deposits. By adopting this plan, she secures for her eggs a constant change of fresh water, which is absolutely essential for



THE EXTERIOR RESERVOIRS, HUNINGUE.

their development. Guided by unerring instinct, the male fish discovers the deposit of eggs, and covers them with "soft spawn," or "milt;" this matter disseminates itself in a milky cloud through the water and coming in contact with the eggs, imparts to them the power of development, and immediately the process of life commences its wonderful course.

The clever naturalist Jacobi, conceived the idea of placing the eggs thus impregnated in an artificial stream of water, so that the process of their hatching could be closely watched, and the

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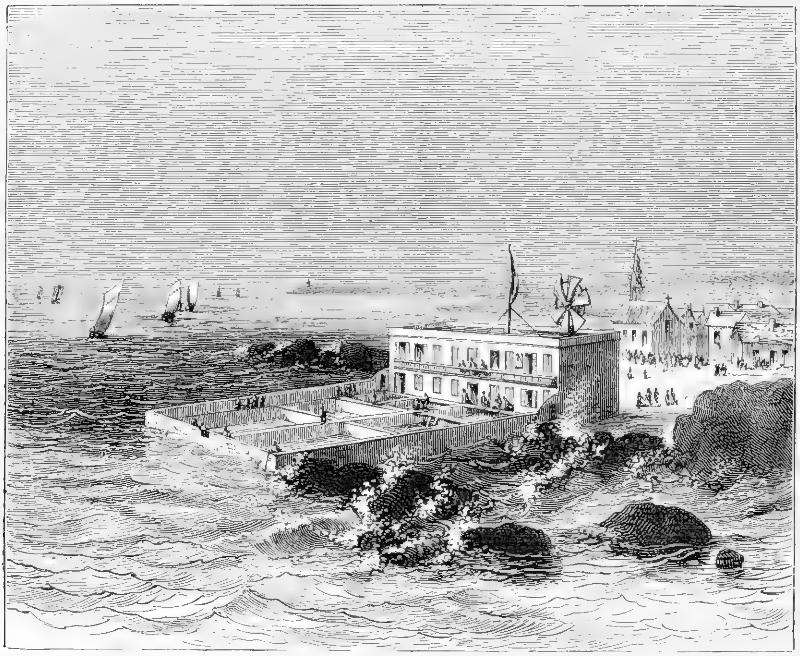
young fish perfectly protected from harm. This was the origin of pisciculture, a branch of industry which is daily being pursued upon a larger scale. Many experiments were made under the direction of the French Academy of Sciences, in the streams which flow down the valleys of the Vosges, and models were made from the apparatus sent from all parts of the world to our Exhibition in 1862. The

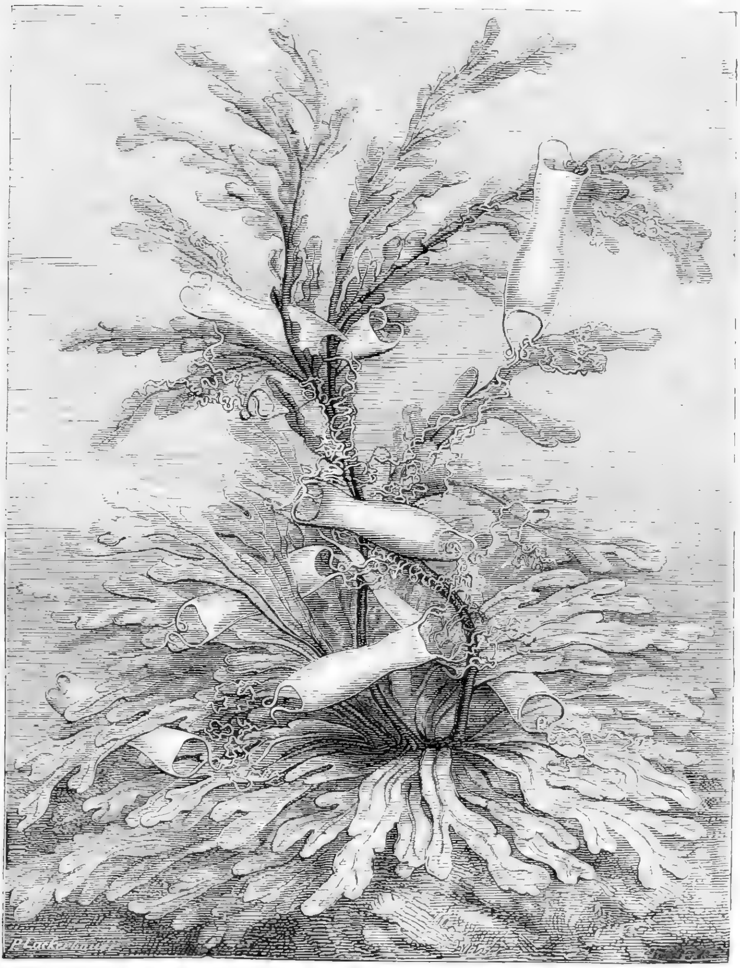


A GENERAL VIEW OF THE FISH-PONDS OF CONCARNEAU

best suggestions of these were embodied in an apparatus erected in the laboratories of the College of France. Upon the success of this experiment, M. Coste was commissioned to plan upon a large scale, an establishment for the culture of fresh-water fish at Huningue, and for salt-water fish at Concarneau.

The former establishment is really a large hatching apparatus. The buildings contain tanks for incubation, and basins for the reception of the embryos just hatched. Reservoirs outside the building are provided for the fry, in order to harden them to the changes of temperature.

A great number of young fish are sent from this establishment to the rivers and lakes of France, as well as to neighbouring countries.



EGGS OF THE BLACK-MOUTHED DOG-FISH.
(*Squalus Catulus.*)

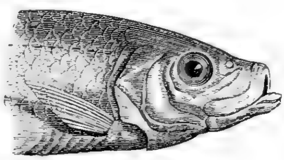
The fish-ponds of Concarneau are for the rearing of salt-water fish. There are some reservoirs in which the fish are preserved, and others still larger for rearing crustaceans, which seems to be the most profitable part of the undertaking. In the aquariums, every possible phase of marine life may be seen in full vigour—the voracity of cuttles; the moulting of the crabs; the incubation of the plaice; the nests of the sea-horse, and all the wonders of the world of the sea, may here be witnessed. We give an illustration taken from the aquarium at Concarneau. The black-mouthed dog-fish lays some eighteen eggs, these it attaches by tendrils to the rocks, or to the submarine vegetation, and here they are anchored until they are hatched.

Nothing can be more interesting than to watch the process of submarine life, every day bringing something new to rivet our interest or excite our wonder. An attempt is being made to raise a company for the purpose of building similar reservoirs at Brighton. We sincerely hope they will succeed, and thus bring before the public the wonders which the water shields from ordinary observers. It is only by observation that we can arrive at the habits of the inhabitants of the sea, and close observation is only possible when the animal is enclosed within the transparent walls of an aquarium; and when we remember that our success in pisciculture is entirely measured by our knowledge of the wants and habits of the fish, we at once recognise the absolute necessity of closely attending to the life of the aquarium, and by this means we shall arrive by the shortest route at the commercial success of the undertaking.

CHAPTER XXXVI.

THE HERRING.

THE constant demand made upon the boundless resources of the sea, yields every year to fishermen an enormous income. It is said that the product of our English fisheries amounts to no less than 60,000,000 sterling. A large proportion of this immense sum is yielded by the herring, a fish so common, that it is unnecessary to describe it, for every one has seen it, if not in its native element, at any rate, in its dried and salted condition. The dark blue of the back, the silver of the belly, only need a little freshening, and the fish as it was taken out of the water is easily imagined.



THE HEAD OF A HERRING.
(*Clupea harengus.*)

The herrings congregate in shoals so immense, that their number defies all calculation. At certain times of the year, they leave the northern seas and descend upon the coasts of Europe. Philippe de Maizières wrote to Charles VI.—"The herrings in their passage from the North Sea into the Baltic, during the months of September and October, are in such numbers, that they may be cut with a sword."

The herrings glide rapidly upon the surface of the water, and the light flung back by their scales seems reflected from bands of nacre or strips of burnished metal, contrasting pleasingly with the azure of the sea, and covering the whole surface with a glimmering light.

From our engraving, it will be seen that the lower jaw of the herring protrudes a little beyond the upper, both being furnished with small teeth; and the tongue is covered with papillæ strong enough to retain a hold on their prey. They love to thrust their noses out of the water, as if to inhale the air, and as the millions of their hosts rush along, a sound is produced as if a shower of heavy rain were falling.

Certain species of whales and flocks of sea-birds accompany the migratory shoal, destroying the fish in great numbers. Wherever they go, they always find a warm reception; they are universal favourites; and yet, in spite of the triple alliance of men, birds, and fish, whose powers of destruction are all levelled against them, they seem not in the least diminished, but come on in interminable phalanxes. Their powers of reproduction are quite capable of coping with the vigorous efforts made to destroy them. When we find some of these fish carrying 70,000 eggs, we can very well imagine that as many are born as are captured, and thus the population of the herring nation is always kept up to its complement. And is it not something more than chance which has ordained that a fish so admirably adapted for the sustenance of man, should exist in inexhaustible numbers?

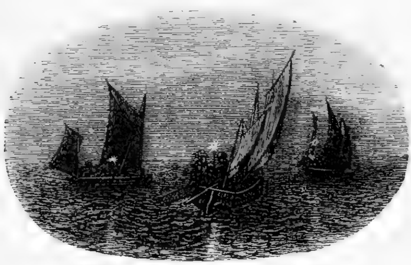
From the earliest times the herring-fishery has been a source of wealth to maritime people; as far back as 709, we find from a chronicle of the monastery of Evesham, that the fishermen of that time were occupied in it.

Authentic accounts record, that in 1030, fishing-smacks left Dieppe for the North Sea to catch herrings, and in 1195, the city of Dunwich equipped vessels for the same purpose. It was in the twelfth century that the Dutch discovered the mine of wealth the sea brought to their very coasts; ever since that time, the herring-fishery has been to that persevering people the main source of their income.

It was a Dutchman named Benkel who first discovered the art of herring-curing, and laid the foundation of the great industry of his country; in recognition of his services, 200 years after his death, the Emperor Charles V. did him the honour of eating a herring on his tomb.

The quantity of herrings taken in our seas is astonishing. The fishermen of Yarmouth equip 400 boats, from forty to seventy tons each; the largest of these are manned by a dozen men. The produce of the season yields as much as £700,000. Three boats in 1857, belonging to one man, had taken 3,762,000 fish. The Scotch fishers are not behind the English in their war upon the herrings. Even as far back as 1826, there were 40,000 boats sent from the Scottish ports to the fishery. In 1854, from Wick alone 920 boats were sent. In 1603, the value of the herrings exported from Holland was £50,000,000; 2,000 boats were employed in the undertaking, and 37,000 sailors.

Block says, that in his time the Dutch salted nearly 624 millions of herrings, and it is a saying in the Low Countries, that Amsterdam is founded on the heads of these fish. But with the decay of the nation, this branch of industry has fallen off.



FISHING FOR HERRINGS.

However, the herring-fishery still holds its position as the first of the sea industries. The fishers of Northern Europe call it the *great*, and that of the whale the *little*, fishery. There is some reason in the transmutation of the terms; for, although the size of the individual herring is not to be compared to that of the cetacean monsters, yet the numbers of the herrings compensate for their size. Cuvier tells of a Dieppe fisherman, who in one night captured 280,000, and threw as many back into the sea—560,000 herrings would bear a favourable comparison with a whale.

In 1781, the village of Gothembourg, in Sweden, exported 136,649 barrels of herrings, each containing 1,200 fish, giving a total of 163,978,800.

The fishing is conducted during the night. Each boat carries a lantern, not only to avoid collisions, but also to attract the fish. It is right to say, that the idea of herring migration, although still popular, is giving way to observation which tends to prove that the fish inhabit the open sea, and approach the shore at the spawning season. As proof positive that the migration theory is incorrect, herrings may be found at some point or other round our coasts at all seasons of the year; but when they come in vast shoals, they are gravid with roe, this accounts for the fact that the herrings we eat are usually full of eggs or milt, as the soft roe is called.

As soon as the eggs are deposited, they again swim out to the open sea, and frequently, as their visit to the shore is but short, the shoal retires before the boats have time to assemble from the neighbouring villages. This proved so often the case in Norway, that constantly the inhabitants of a fiord, who almost depend on the herring-fishing for their living, were left in destitution till the next season. To remedy this, in 1857, the Norwegian government erected an electric telegraph along the coast, so that one village might communicate with the rest, when a herring-shoal is discovered in the offing.

The people who live in the interior, leave their farms and wood-cutting, and migrate to the shore to gather in the harvest of the sea; they carry with them nets, which they have made in the winter evenings. When a shoal of herrings runs up one of their narrow fiords, they place a long net over the bar at its mouth, and so entrap the whole. The fish are sold either to merchants in the neighbourhood, or taken in the boats to Bergen, where there are great storehouses for the salted and dried herrings.

As the season advances, the shoals go southwards, where they find the population on the alert for their arrival; finally, having deposited their spawn, they leave the coast and make off into the deep sea. When not enclosed in the fiords, they are taken in the ordinary manner, that is, a net two or three hundred yards long, is let down in the midst of the shoal; it is supported on floats, a large skin float, "the dog," being attached to its end. The meshes of the net are of such a size, that the fish as they thrust their heads against the perpendicular wall of net, find themselves caught by their gills, or fins, so that they cannot extricate themselves. The nets are allowed to remain all night, and in the morning the fishers haul them in. Sometimes from the number of fish entangled, it is necessary to use the capstan. They are packed in casks, which are made of oak—for other woods impart a flavour to the fish—each layer being completely covered with salt. *Red herrings* are those which are opened and then smoked.

In 1862, the Norwegian fisheries produced 659,000 tons of herrings; about a quarter of this was used for home consumption, and the rest exported, bringing a return of about £360,000.

Oil can be extracted from the herrings as well as from the whales. They are boiled for five or six hours in fresh water, and upon cooling the oil rises to the surface. It is purified by filtering, or by simple decantation, and then put into barrels. The residue is called *tangrum,* and is considered an excellent manure.

CHAPTER XXXVII.

THE SARDINE.

THE *Sardine* (*Clupea Sardina*) is the commercial name of the *Pilchard;* a name which it derives from the Island of Sardinia, around whose shores it is taken in great abundance. This little delicate fish has long been a favourite, even in times before the present mode of preserving it came into vogue. It is mentioned by the ancient mythologists, as forming one of the many dishes which graced the wedding breakfast of Hebe. It is an elegant fish, has a slender graceful body, generally three or four inches long. When in the sea, its back is a bright greenish blue; but, when life has gone, the freshness of its colour fades; the lower part of its body is a silvery white, and as it darts through the clear, blue water in the sunlight, it forms a pretty object, its graceful motions, its clear colours, its glittering sides—covered as if with nacre—all combining to give it a place among the beauties of the world of the sea.

The pilchards are found, not only in the Mediterranean, but in the North Atlantic and the Baltic. Like the herring, they traverse the seas in huge columns; but whence they come, or whither they go, no one can tell. They inhabit the deep seas, approaching the shores at the spawning season, yet, like the herring, the pilchard is to be found at every period of the year. On the coast of Cornwall, pilchard fishing is one of the staple industries. The whole line of coast is on the *qui vive* from the appearance of the first shoal, which generally finds its way to the shore about the beginning of October. The Cornish villages employ a man as a look-out, or "huer;" he is posted on a cliff, where he commands an extensive sea view. A shoal of pilchards in the distance appears like the shadow of a cloud upon the sea; as it approaches the shore, thousands of fish may be seen jumping from the water and spangling the surface with the tiny reflections from their silvery

Plate XVI.

FISHING FOR SARDINES OFF THE COAST OF BRITTANY.

sides. At a signal from the huer, the village boat is manned and put out into the bay, carrying the great net—the seine—which is five or six hundred yards long, and about twelve fathoms deep. This net has a very small mesh, and costs some £120. The "shooters" who man the boat, keep their eye upon the huer, who stands with a bush in his hand, by which he guides the boat; as soon as the shoal is well in the bay, he gives the signal, and the men begin to pay out the net; the lower side is weighted with lead and rapidly sinks, while a line of cork floats keeps the other edge on the surface of the water. Cautiously and silently, the seine is cast outside the doomed shoal. Now all anxiety is at an end, the extremities of the net are gradually pulled near the shore and made fast, and an impassable barrier is between the pilchards and their native sea.

Another boat, with another net—the "tuck"—now arrives upon the scene of action. This net is cast inside the seine, in order to bring the fish to the surface. When all is ready, a flotilla of boats and barges puts off from the shore, every man, woman, and child, full of excitement, either finds a seat in the boats, or stands upon the beach. The men shout, the dogs bark, and above the din rises the steady chorus of the haulers, "Yo! heave ho!" At last the shoal is borne upon the surface, a glittering mass of captives, each one in a frenzy of fear making leaping efforts to escape; but their captors dip amongst the thick live mass, buckets and baskets, and empty the fish into the boats; laden to the very gunwales, they are rowed to shore, and again go off for another load; thus the whole shoal is secured, and the villagers celebrate their day's success in drinking prosperity to the nation of pilchards.

On the opposite side of the Channel, the mode of fishing is more like that which we have described in taking the herring; they cast their nets at night, the meshes being just large enough to admit the head of the sardine, but not allowing the fish to pass, it is thus detained by its fins or gills. The net having been cast in a curve, they frighten the fish towards it, and as soon as the corks which are attached to its upper edge sink beneath the surface, it is a sign that a great many pilchards are entangled in the meshes. The fishers then haul in their nets and secure the fish. This operation is exhibited in Plate XVI.

When the sardines are plentiful, a ton can be taken at one sweep of the net, and after one expedition, a boat will return with 25,000 or 30,000 fish. The pilchard fishing continues five or six months, and in this time the Bretagne fishers have been known to take 7,500,000,000 of the fish, which when sold fresh, would realise £300,000. The Basque fishermen use a net of a different description, a sack net with a ring of horn, which is drawn through the water.

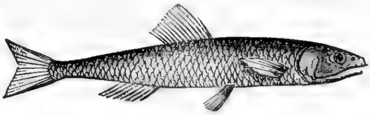
Sardines are prepared in many ways; sometimes they are merely salted, sometimes they are packed in cases, and between each layer a quantity of salt is strewed, and in this way they are sent to the market. Or, again, after remaining packed in barrels for a month, they are then washed, and submitted to pressure, and by this means the oil and brine they contain are squeezed out.

Sardines prepared with salt mixed with red ochre, are frequently sold for anchovies.

Generally, however, sardines are preserved in oil. The mode in which they are thus prepared, is as follows:—When they come from the boats, they are packed in baskets, 200 or 300 in each, women receive them, and with a dexterity acquired by practice, they cut off the head, open the fish and clean out the interior with one cut; they are then tossed into brine, where they are left for a few hours; and on being removed they are thoroughly washed and then laid on wicker panniers to dry, when dry they are plunged into boiling oil, where they cook for some minutes; they are then packed in the well-known tin boxes, filled with oil and the lid soldered down. In order to ensure perfect preservation, the boxes are boiled in water. In some of the Arabian countries, according to Marco Polo, the inhabitants dry the sardines, and after reducing them to powder, make them into cakes.

But to enjoy the delicate flavour of the pilchard, it must be eaten a few hours after it has been caught. When quite fresh the skin easily peels off, and the flesh leaves the bones in two small fillets. These are perhaps the most delicate eating of all fish.

We cannot leave our subject without mentioning the *Anchovy*, a little fish of great eminence in the culinary science. The anchovy accompanies the sardine. However, it is seldom found in the ocean, the Mediterranean being its proper habitat. Upon the south coast of France the anchovy trade is vigorously plied. The women prepare the little fish, taking off the head and tail, and



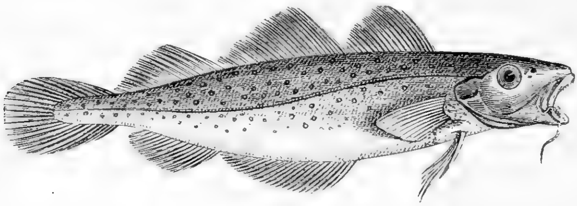
THE COMMON ANCHOVY.
(*Clupea encrasicholus.*)

completely clearing the inside with their thumb-nail. The fish then pass through a pickling process, and packed in miniature barrels, are sent off to Beaucaire, where the merchants from all parts of the country congregate to buy them.

CHAPTER XXXVIII.

THE COD.

THE herrings and the pilchards may be classed among the small inhabitants of the ocean; but their importance is advanced by the vast population of their tribes, and though lilliputians in the oceanic world, yet they are a notorious people. But the Cod-fish



THE COD.
(*Morrhua vulgaris.*)

are both large and numerous. They frequent the northern seas, and every year, about the middle of January, arrive in vast numbers among the Lofoden Islands, to spawn; but when they reach the neighbourhood of the shore, instead of enjoying a quiet time of retirement, they are attacked on every side, and a terrible slaughter awaits them. Yet no amount of destruction seems to thin their ranks; they yearly reassemble in incredible numbers on the summit of that submarine mountain, the Newfoundland Bank, where, for a space of 600 miles long, and 680 broad, the sea is all but alive with them. The appearance of the cod is too well known to need description. It belongs to the *Gadidæ,* a family characterised by their slender and pointed ventral fins. We have already cited the cod as an example of extraordinary fecundity. Leuwenhoeck has calculated that a moderate sized female can carry 9,384,000 eggs. The mind is lost in interminable numbers, when we endeavour to calculate what would be the offspring of the millions of fish which frequent the Newfoundland Bank. No wonder they are found in huge shoals when they can so greatly add to the numbers of their species in a single season.

The cod-fishery is a source of revenue to every maritime nation. The right of fishing upon the Newfoundland Bank is a matter of international treaty, and many times has the infringement of this treaty threatened to disturb the peace of Europe. Formerly, it was a matter of greater moment to England than it now is. In the war in 1844, the French were not able to pursue the fishing, and that year the produce was more than £2,800,000. This was the highest sum ever received by our fishermen for their labours on the bank. Since that year our income has steadily decreased, until in 1851, it only reached £920,117, and this included the salmon and seals, which are often found with the cod. The reason of this decline, is not only the aggression of the fishermen of other nations; but it is ascribed to the fact, that there is not so strict an observance of fasts in the Catholic countries. In the Low Countries, and Spain especially, large quantities of dried cod were consumed during Lent; but the faithful have found other means of obeying the Church; or, perchance, they even dare to disobey. We now employ about 2,000 vessels, and 30,000 men in cod-fishing, the Americans have 3,000 smacks, and 45,000 sailors engaged in the same undertaking.

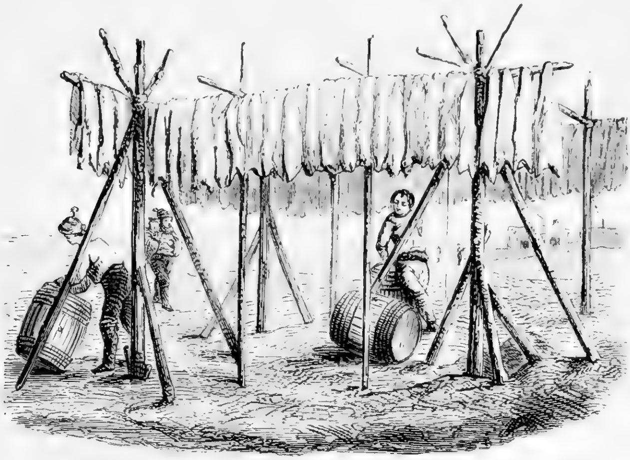
The Norwegians have a fishery of their own off Cape Lindesness, where it is said they take annually 20,000,000 fish. It was officially reported to the king of Sweden, by the chief inspector of the fisheries in the neighbourhood of the Lofoden Islands, that in 1856, 4,623 boats put to sea, and in 1860, 5,675; these carried 7,775 line fishers, and 13,038 who employed the net. According to the same report, they salted on the east of Lofoden 10,080,000 flat cod, and 2,640,000 on the west coast of the islands. They disposed of 9,000,000 not opened and cured; making a total of more than 20,000,000. The roe filled 16,000 tuns, and the cod-liver oil 40,000.

As we have already hinted, two modes are employed to take the fish, the net and the line. On the Newfoundland Bank, the net is chiefly in vogue; it is constructed like a herring net, but of stouter twine; one end is fastened to the shore, the other carried seaward, the boats then cause it to sweep a curve and gradually bring the one end to the other, they then make the haul, and often enclose a number of fish sufficient to fill many boats.

The Norwegian boats carry about sixty nets, some fifty yards long, and eight or nine deep; these are cast at night and taken up in the morning, twenty or thirty are strung together, buoys are attached to the upper side of the net, and heavy stones to the other. Upon some of the buoys the name of the owner is painted. The English boats are clipper built and constructed with wells in the hold, so as to preserve the fish alive; they cost some £1,500 each, and are manned by ten or twelve men; each of the men has a line fifty fathoms long, to which are fastened at different places along the line, one hundred hooks, baited with mussels or pieces of herring. On arriving at the fishing ground, a float carrying a flag-staff six feet high, is heaved overboard, and is kept in its place by a line called the "pow-line," which reaches to the bottom of the sea, where it is held either by a stone or a grapnel; the lines are then fastened to each other, and the end of the long line made fast to the float. As the boat sails, the men pay out; when the whole length is in the water, they return to the flag-staff, and haul in the line. Very often eight hundred fish have been found on the eight hundred hooks.

Almost anything will do to bait for cods; they are most voracious. Their chief food, however, is the capelan, a little fish which descends in the spring from the north seas. Shoals of cod charge amongst them, and in their terror the capelans even rush on shore. The Newfoundland people catch them, and carry them to St. Pierre, where the fishers come in for fresh bait. Some of the cod-fish are carried to England, and to the ports from which their smacks hail, but the greater portion are cured at Newfoundland. St. Pierre and the Miquelon Islands are granted to the French for this purpose, on the condition that they build no fortifications, and that they afford no rendezvous for the French fleet. The capital, St. John's, is the resort of the English boats.

The fish are opened, the interior cleaned out, the liver being put on one side. The opened fish have the vertebra taken out, and then they are salted, being placed in vats covered in salt and submitted to pressure; when taken from the vats they are washed to remove any impurities, and then exposed in long sheds, or built up in stacks on the shore, in order to expose them to the united action of the sun and wind. They soon dry,



DRYING COD-FISH AT NEWFOUNDLAND.

and when they assume the white, bleached appearance which is termed the "bloom," they are ready for the market.

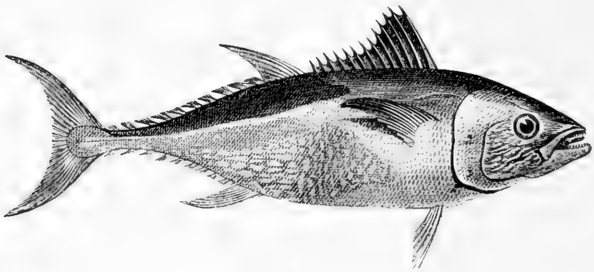
The livers are put in oak tanks, where they are allowed to decompose. The first oil which strains from them is the cod-liver oil used in medicine; a second quantity is obtained by pressure, but this is of a darker colour, and less valuable.

In the Lofoden Islands, a fish guano is made of the dried heads and entrails of the fish.

CHAPTER XXXIX.

THE TUNNY.

THE tunny and the mackerel are both members of the same family, the Scomberoides. The tunny is larger and rounder than the mackerel, indeed it is larger than the cod, as generally it is between 100 and 200 lbs. in weight. It is common in the



THE TUNNY.
(*Scomber thynnus.*

Mediterranean. Its back is a deep blue, the rest of its body being a silvery white. Its dorsal rays are a golden colour, and its anal fins have six or eight iridescent zig-zags. The spinous rays of the fins are strong, and denote great swimming power. The large dorsal fin is armed with a strong spine, which can be used as a weapon of defence in case of need. As the drawing represents, the fish is provided with a range of little fins, which connect the dorsal and anal fins with the tail. Thus the system of natatory organs is very complete, and at the same time symmetrical.

Like the other members of their family, the tunnies have the habit of leaping out of the water, seeming to swim with rapid bounds. When a number of them are together in a shoal, they follow the example of the wild duck, and advance in a triangular body, the vertex being in front. Like the herrings and the cod, they move through the Mediterranean waters in large shoals, and at stated periods. At one time of the year they are going west, at another east. Although the Mediterranean is the chief residence of the tribe, yet they are found in the ocean.

Various means are employed for their capture. The Basque fishermen use the *grand couple*, which is a huge line, carrying hundreds of baits; this is attached to a boat manned by eight or ten men. The fishers of Provence enclose the tunnies in nets some miles long. These are cast in a long line, and gradually their extremities are brought together; the enclosure is then dragged to the shore, a purse net is attached, into which the tunnies rush, and are thus secured. But the most curious mode of taking these fish is by the *madrague*, or as the Americans term it, "the pig catcher."

The *madrague* is a vast enclosure of net walls permanently fixed in the sea, cork floats support the upper edge, lines attached to heavy stones resting on the bottom, anchor the lower side of the net. The nets are arranged so as to form a kind of labyrinth leading into a chamber at the further extremity of the structure. A straight net is run to the shore, the tunnies swimming against it, and not being able to pass—for they invariably swim near the surface—run along the net wall until they reach the enclosure, which they enter; they are soon entangled in the labyrinths and unable to find their way to the open sea. The enclosure is so constructed, that by following the outer wall at length, the *chambre de mort* is reached; this has a net for a floor, so that it is impossible for the fish to escape even by diving. Here the doomed tunnies may remain for even weeks. When the fishers arrive to secure their prize, they raise the floor of the prison, and as the captives are brought to the surface of the water, there ensues a scene which defies description. A yawl has been allowed to pass the nets and floats in the chamber of death. As soon as the tunnies reach the surface and find themselves close to the boat, terrified out of their lives, they bound and leap with violent desperation; but the boatmen with unerring aim transfix them with harpoons, others are felled with the blows of poles, and bleeding fall back into the writhing mass of their fellow-prisoners. The blue water becomes stained with blood as the slaughter proceeds, and the wounded and terrified fish cry like children. It is a sad massacre, and the sight is described by those who have witnessed it, as most painful. Finally, the fish are secured, and the laden boats bear their prize to the land. The undertaking is not devoid of danger; indeed, when there is a large "take," the fishermen dare not approach; but they row near the wall of the enclosure, and after a fashion, lasso the fish; it often requires two or three men to drag on board a tunny thus secured.

In 1861, in the Bay of Porto Ferrajo, one hundred and sixty tunnies were taken in a *madrague;* many of them weighed 300 lbs., so that altogether there were some four or five tons of fish.

When Louis XIII. visited Marseilles, for the diversion of the monarch a tunny fishing was inaugurated, and His Majesty witnessed the haul we have briefly described, and was pleased to remark, that it was the most enjoyable thing he had witnessed on his tour.

The flesh of the tunny is exceedingly firm, and is even preferred to that of the salmon. We cannot, however, but regret that the fishing is not conducted more humanely.

CHAPTER XL.

THE TURTLES.

THE Reptiles have but few representatives inhabiting the ocean world, and yet those which are found are celebrated as much for their peculiar construction, as for their culinary eminence. As the land tortoise, the marine tortoise or *Turtle* is enclosed in a

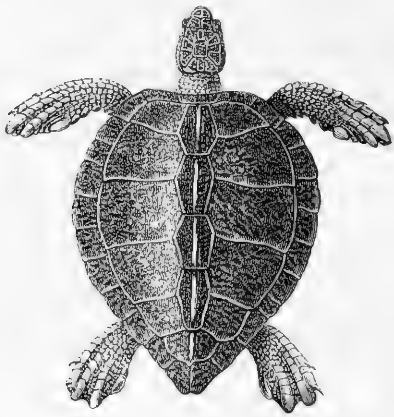
TURTLES.

wonderfully hard cuirass. This is not calcareous but horny. It is so constructed that the creature is very secure against the attacks of any of the marine marauders.

The appearance of the Chelonia, for such is the family name, is most peculiar. A countryman once saw in the market fair of his village, a merchant who offered for sale some land tortoises. "How much are these queer things?" asked Roger. "Eighteenpence a piece," answered the dealer in live curiosities. "Eighteenpence! It's a good deal for a thing like a frog; and what will you take for one *without the box?*"

The *Logger-headed Turtle* (*Caouana caretta*) is often cast up upon our coasts; it is common in the Mediterranean, the Red Sea, Madagascar, and the Maldive Islands. It is the queen of the turtles; it is usually about four feet long, and weighs 400 or 500 lbs. Its carapace is covered with horny plates, the well-known tortoise-shell.

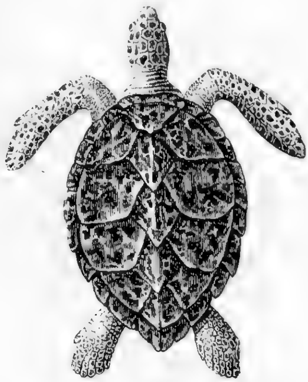
The *Green Turtle* (*Chelonia viridis* or *midas*) is a native of



THE LOGGER-HEADED TURTLE.
(*Caouana caretta.*)

the Atlantic Ocean. It is met with sometimes a great way from land, and may be easily taken when asleep on the surface of the water, where it has come to breathe. This turtle attains a larger size than the logger-headed turtle, being often found six feet long. Its carapace is a chestnut colour, shot here and there with green patches.

Many have been the fables about the size of turtles. Pliny writes that there are found in the Indies turtles whose shell can completely cover a house, and that the inhabitants of the shores of the Red Sea frequently make their ships of the carapace of a turtle. Some travellers assert that in the Antilles it is not an uncommon occurrence to find a turtle upon whose back fourteen men could stand at once; but these are travellers' tales. The nearest authentic approach to such exaggerations is related by Dampier, who saw a fisherman who had actually constructed a boat from a turtle's shell large enough to hold his little son, who was some ten years old. As is the case with the cuttle-fish, many accounts of remarkably large turtles are in existence. In 1752 a specimen was cast up near Dieppe, which measured eight feet. Two years later, not far from the Island of Ré, a similar-sized turtle was captured. When its head was cut off, it bled twelve pints of blood. There were 100 lbs. of the far-famed



THE HAWK'S-BILL TURTLE.
(*Caretta imbricata.*)

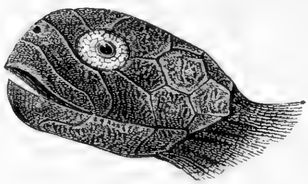
green fat, and if we are to believe the reports, its liver was so enormous that it was sufficient for the repast of more than a hundred.

The *Hawk's-bill Turtle* (*Caretta imbricata*) is a native of the Atlantic and Indian Oceans. It does not reach the large dimensions of the logger-headed, and its carapace is made, not in one piece, but of several plates, which overlie each other like the slates of a house.

There are two other species which have their shells constructed on this principle. There is also a very rare species which inhabits the Mediterranean and the Atlantic, which has its carapace enclosed by a coriaceous skin, and down the back appear three long parallel ridges or blades. This turtle is the *Sphargis coriacea.*

The sea turtles have jaws which are destitute of teeth, their gums are of a hard, horny material, sharp at the edges, like the beaks of the birds of prey. The utility of this form of mouth will be at once recognised, when we remember that the turtles feed on submarine vegetables; the fronds of the algæ would be more easily severed by these scissor-like jaws, than even by teeth. Some of the Chelonia are not entirely herbivorous, for they eat mollusks, and also cuttle-fish, and other soft, pulpy creatures.

From the clumsy appearance of the turtle, we might well conclude that the motions of the creature were slow and lazy; but this is by no means the case; when in its native element, its arms are powerful oars, and with their assistance it can glide easily and swiftly through the water. The turtle can remain under water a



THE HEAD OF THE TURTLE.

long time, the orifice of its nasal canal, through which the air enters to the lungs, is covered by a lump of flesh, which acts as a valve, and at the will of the creature can hermetically seal the orifice, thus effectually preventing the entrance of any water, or the exit of the air.

Often, hundreds of miles away from land, a number of turtles may be seen floating on the surface of the sea, perfectly motionless; they are asleep, more gently rocked than even an infant in its nurse's arms. Although protected to a great extent by the horny covering of their carapace, yet the turtles are not invulnerable, neither when attacked are they capable of resistance, but are at the utter mercy of their foe. To compensate for this, they are endued with a peculiar tenacity of life, and a turtle will show signs of sensibility, even after it has been decapitated.

These creatures are oviparous, producing their young by eggs. At the time of depositing her eggs, the female comes on land, and by means of her hind fins, makes a hole in the sand. This process is very rapid, and a hundred eggs have been known to have been deposited in less than ten minutes. The number of eggs laid by a turtle is exceedingly various; the maximum, however, seems to be two hundred and sixty. After all the eggs are laid, the creature throws sand over them, and so completely covers them and smooths the disturbed surface, that it requires a practised eye to discover the nest. The eggs, which are much sought for, have no calcareous shell, but are enveloped in a thick skin; their shape is not the ordinary "egg-shape," but they are somewhat flat.

Instinct has taught the turtle that her eggs so deposited, will be hatched by the heat of the sand, and without a shade of maternal longing, she dives into the sea; contented that Dame Nature should nurse her progeny. In some three weeks, the young turtles make their appearance; they are not unlike frogs, and immediately make their way to the water.

Although the turtle professes no interest in her family, yet the fishers assert that she invariably returns to the same place to deposit her eggs, and even if she be carried away hundreds of miles, true to her instinct, she will either immediately come back to her home shore, or appear there the next season.

Different modes are pursued in taking the turtle. Generally, at the time of depositing the eggs, expeditions are made to the desert islands, or to lonely and unfrequented parts of the beaches. As soon as the sun is set, and the brief tropical twilight faded into night, a party of men walk along the edge of the water, and by the marks on the sand, find the path of a turtle which has passed up the beach. Following the tracks, the creature is readily found, and by dint of their united efforts, or by the help of levers, it is turned on its back. When once in this position it is safe, not being able to regain its feet. In this manner, many turtles are secured in one night, which are taken off to the ships in carts or boats in the morning.

Between Vera Cruz and Tampico, there is a little desert island, about a mile square, called *isla de los Lobos.* Why it should merit the name of "the island of the wolves," is difficult even to conjecture, for certainly no wolf ever placed his foot upon such a desolate shore. This island is a favourite retreat for the turtles. It is surrounded by reefs, which prevent the approach of their enemies, and the shores are gently sloping, admirably fitted for receiving their eggs. In 1862, a party of sailors, under the cover of night, made a descent on the island. They found on the shore a huge female turtle, evidently in search for a place to deposit her eggs. Six men seized her to attempt to prevent her return to the sea, but their united efforts only had the effect of slightly retarding her progress, and she would have easily escaped, had it not been that another party came to their assistance, and they managed to turn her upon her back. By tying the fins to a spar, they were able to convey their captive on board, and found it weighed nearly 300 lbs. It had 347 eggs, and furnished food for the whole crew.

The logger-headed turtle having a more convex carapace than the green or common turtle, is more rapid in its movements and is capable of turning itself back upon its legs; therefore, to keep it in its upturned position, a heavy stone is placed upon it.

Another mode of taking these reptiles is to stretch a net made of thick ropes across the passage by which they seek the shore to lay their eggs. In the meshes of this net, they manage to entangle their heads and fins, and thus being prevented from rising to the surface of the water to breathe, they are drowned. It is necessary to dye this net a dark colour, for if it be grey or light-coloured, the reptiles are frightened, and return into the sea.

Some turtle fishers seek them in the open sea. Knowing they must come up to breathe, they watch for the opportunity, and with great expertness fling a harpoon which penetrates the shell of the creature. A line is attached to this weapon, by which the wounded turtle is kept at play until exhausted, it is then drawn to the boat and secured.

In the southern seas, expert swimmers softly approach the animals as they are asleep, and when close upon them, plunge the harpoon through their carapace. If the turtle be not of large size, the harpoon is dispensed with, and the creature secured by its fins.

A story is related of an Indian slave, who when out fishing in his canoe, near Martinique, happened to find a turtle asleep on the water; paddling cautiously until he was close to it, he passed a running noose over its fins, having previously fastened the other end of the line to the prow of his canoe. The turtle was not long in awaking to the new situation, and made off, dragging the boat as if it were a straw, this the Indian had not bargained for; but had hoped that with his paddle he would be an equal match for the creature; however, he soon found himself compelled to give all his attention to steering his boat, as it met the waves. At last he was capsized, and lost in the accident his lines, his paddle and his knife, and had he not been a good swimmer he could not have regained his canoe. Fortunately, however, he managed to retain his hold of the fugitive boat, and to reseat himself; being now without a paddle he had no command over the canoe, and was unable either to cut the cord, or untie it. Frequently the waves capsized him, and for two nights and a day, the turtle held on its course; but at last began to show signs of fatigue, as it neared an island. The Indian himself, almost famished with hunger, was just able to secure his prize and reach the shore, where the flesh of his captive revived his failing strength.

In the neighbourhood of Cuba, a most peculiar method of securing the turtle is pursued. They train, or, at least they take advantage of the instinct of a fish, a species of remora, only larger than the one we described in Chapter XXXV. This fish is called by the Spaniards *Revé* (reversed); because its back is generally taken for its belly. Like the remora it has an oval plate attached to its head, whose surface is traversed by parallel ridges; by this plate it can firmly adhere to any solid body it may choose. The boats which go in quest of turtle each carry a tub containing some of these revés. When the sleeping reptiles are seen, they are cautiously approached, and as soon as they are judged to be near enough, a revé is thrown into the sea. Upon perceiving the turtle, its instinct induces it at once to swim towards it, and fix itself firmly upon it by its sucking disc.

Colomb, who is accountable for this almost incredible narrative, asserts that the revé would allow itself to be pulled in pieces before it would leave its hold. A ring is attached to the tail of the fish, to which a cord, made of the fibre of the bark of the palm tree, is fastened. As soon as the revé is firmly affixed to the turtle, the fishermen haul in the line, bringing the fish and the turtle. By a peculiar manipulation, the revé is induced to let go his hold, and is returned to his tub ready for the next hunt.

Turtle-fishing, as is the case with oyster-fishing, is carried on regardless of the future, and without any discrimination, the consequence is, that turtle is becoming scarce, and unless, as we English say, there is something done, there will be great difficulty in supplying the aldermen of London with that celebrated soup, upon which, according to the popular belief, the aldermanic existence depends.

In some way to obviate such a terrible disaster as the extinction of turtles and aldermen, turtle parks have been established in different parts of the world; but these reservoirs are more for keeping the turtle, than for encouraging their breeding, and will do little, therefore, towards the propagation of the race. The plan pursued in the Isle of Ascension is of far more practical importance. There, the authorities strictly protect the turtle eggs, and also the young reptiles, until their carapace is so grown that they can protect themselves.

Admiral Anson, in 1752, brought the first turtle to England, and ever since that day, the importation of the turtle has been a commercial undertaking; but it is gradually becoming dearer, and "mock turtle soup," in which the gelatinous parts of a calf's head take the place of the green turtle fat, is becoming more general, and the real turtle soup more rare.

The carapace of these reptiles supplies the "tortoise-shell," which at one time was greatly used for combs; but the discovery of vulcanite has almost excluded it from the market. According to Pliny, Carvilius Pollio, an extravagant but ingenious gentleman, was the first to apply the shell of the sea-tortoise to ornamental purposes. The fashion for this style of decoration increased, and in the days of Augustus, the patricians ornamented their doors and the columns of their rooms with tortoise-shell. Julius Cæsar found in Alexandria such a collection of these shells, that he had them carried in his triumphal entry.

The best tortoise-shell is brought from China and the Philippine Islands; it is from the carapace of the caretta. The plates of the caouana are not so much prized, being more like horn. The green turtle gives shell which is thin and flexible; its general colour is yellow, streaked with patches of black.

CHAPTER XLI.

THE SEA-BIRDS.

BIRDS are children of the air, just as fishes are of the water; yet there are many of the feathery tribes which ought to have a place amongst the creatures of the ocean, seeing that they live upon the water as much as they do in the air. The sea-birds are said to be one-fourteenth part of the whole bird family; a family which can number 9,400 species.

Since aquatic birds generally have their toes connected by a

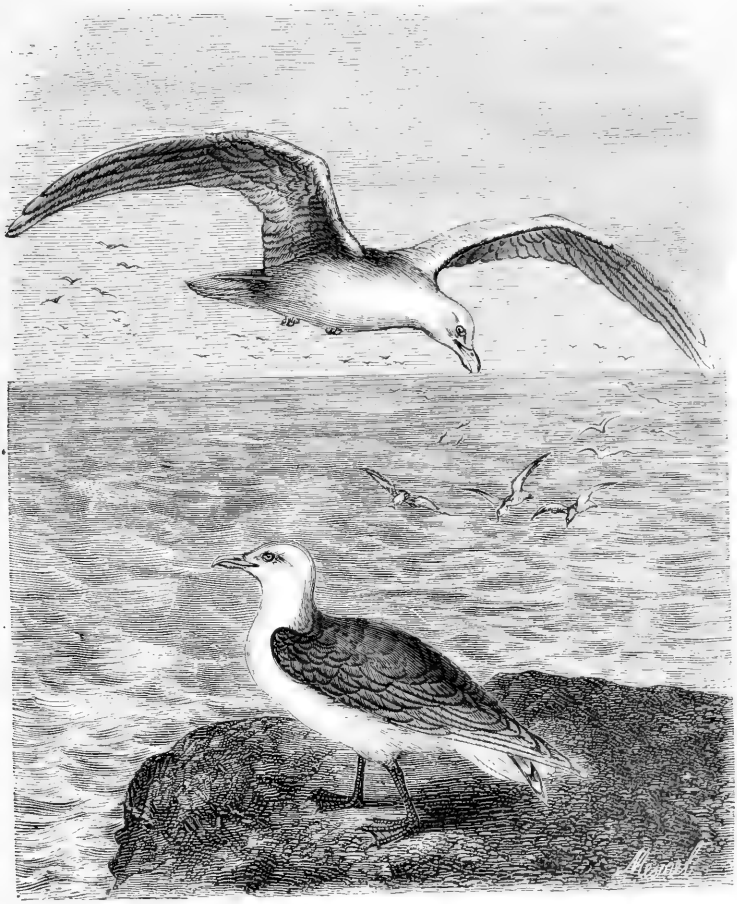
THE TWO KINDS OF WEB FEET.

thin web, or skin, they are said to be web-footed. Nearly all the marine species are thus distinguished. Generally only three of the four claws are connected by the web, as in the case of the duck; but sometimes the skin extends to the fourth claw; this formation is exhibited in the cormorant.

A glance at our illustration of these two kinds of web feet, will show that the latter form is the more powerful oar. These natural oars are greatly superior to the blades by which we propel our boats, for they need not be lifted out of the water to repeat the stroke. When the leg has reached its furthest stretch, the foot collapses, and is thus brought forward without offering any resistance to the water, and again spreads out to make another stroke.

The marine birds may be divided into groups, according to the waters they frequent.

The *Long-wings*, such as the albatross and the petrel, live on the



SEA GULLS.

(*Larus argentatus.*)

open sea. They are found at great distances from land, and seldom approach the shore.

The *Ordinary sea-birds*, such as the gulls, never are seen far from land, because they always roost on shore.

The *Riverside-birds*, such as wild ducks, which prefer the ponds and marshes to the sea, and are usually found in flocks near the mouth of a river; they always make their nests on the bank.

The *Swimmers,* such as the penguins, who never are found but close to the shore; they are not able to fly, save for short distances.

THE ALBATROSS.
(*Dromedea exulans.*

The *Gulls,* or the *Laridæ,* are the best known of the sea-birds. Their general appearance is almost too well known to need description; their bodies are white, touched here and there with lavender, while their wings and tails are sometimes tipped with black. Their beaks are yellow, and their eyes peculiarly beautiful; but in their extensive tribe there is much diversity of shade, varying from a pure white to a dark grey.

THE STORMY PETREL.

(*Thalassidroma pelagica.*)

Gulls are shy birds, and are caught with difficulty. They fly in flocks, and carry on their fishing avocations in the sea near the shore. Sometimes they cover the rocks, and when disturbed they rise with frightened screams. Occasionally, they may be observed on the shore, crouched with wings half extended, and apparently enjoying the warmth of the sand. They walk with a most dignified carriage. On water they swim with ease, but seldom dive, preferring to take their prey as it appears at the surface. In the air they fly slowly yet gracefully, and often sweep in circles, as if displaying their agility. The web-footed birds glory in the agitations of the sea; nothing gives them so much delight as a violent storm, for instinct or experience has taught them that a storm casts up the mollusks, and other of the sea inhabitants which are usually beyond their reach, and brings them to the surface or leaves them on the beach.

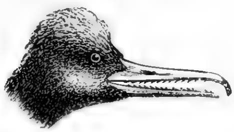
How often, as we have watched the horizon darken, and the storm-clouds gather, have we marked the striking contrast, as the white gulls and sea-swallows now rose and now fell above the waves, waiting in eager expectation for their coming feast.

The largest of the sea-birds is the *Albatross*. No species of it exists in the North Atlantic, but it is abundant below the tropic of Capricorn. From the tip of one wing to the tip of the other, it often measures more than twelve feet. Strange to say, the largest of the sea-birds is nearly allied to the smallest, the *Stormy Petrel*, and both of them tread the waves in the manner indicated in the accompanying illustration.

Those birds which remain long on the wing have small, light bodies, long tails, and large, powerful wings. The swimmers, on the other hand, have large bodies, small wings, and an apology for a tail. Their feathers are very downy, and they are lubricated with an oily secretion which prevents themfrom being wetted.

The sea-birds, taking their whole nourishment from the water, live on marine vegetables, mollusks, and fishes. Fishermen hail the appearance of the Skua gulls, for they are the constant accompaniers of the herring-shoals. The gulls and the petrels throw themselves upon the sperm-whale and the dolphins, and tear out of them pieces of oily flesh. The albatross, the vulture of the ocean, can scent a dead whale from a great distance, and soon is found enjoying the carrion.

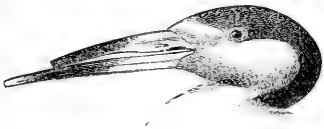
The ducks have broad, flat bills, which are edged with rows of minute teeth, with which they tear the food they find on the surface of the water. The *Mergansers* are intrepid fishers, near relatives of the ducks. By means of the jagged edge of the bill, the bird can hold live fish with ease, and especially as the teeth are bent inwards, so that the prey in its struggles only brings itself nearer the bird's throat. The gulls have the extremity of the bill bent into a sharp hook. This they strike into the fish, and so retain it. Frequently, they may be seen



THE HEAD OF THE MERGANSER.
(*Mergus serrator.*)

to descend like an arrow into the trough of a wave, and come up with a struggling captive.

The *Sea-swallows* do not strike their prey by coming down vertically upon it, but as they skim along the waves, they dexterously pick up the fish as it happens to show itself on the surface. They may often be seen following in the wake of a porpoise, and as the creature frightens its prey near the surface,

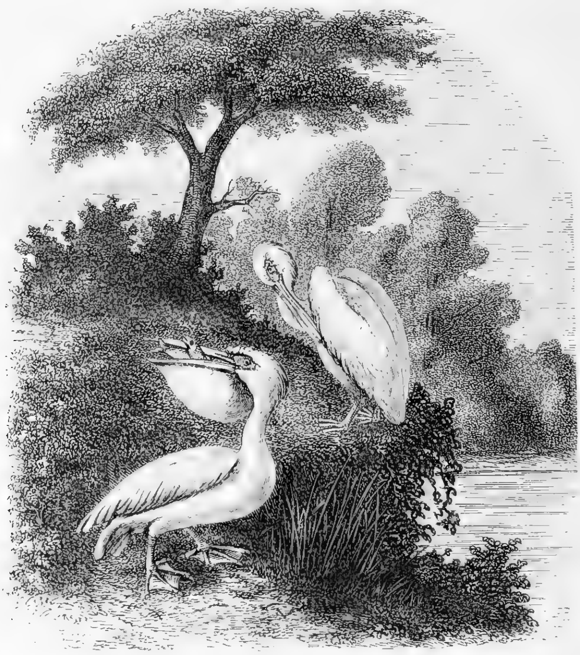


THE HEAD OF THE SKIMMER.
(*Rynchops nigra.*)

the sea-swallow, which is hid for a moment in the seething water, snatches the fish from the very mouth of the porpoise.

The *Skimmers* have their bills arranged like a pair of scissors. They skim the surface of the water, and absolutely cut in two any fish which has the misfortune to come in their path.

The *Pelicans* have a large, extensible bag attached to their under bill. In this they carry the fish they take to their young. M. Nordmann relates a singular fact concerning these birds. They are very plentiful on the shores of the Black Sea, especially in the lagoons, or salt-water lakes which line its banks. Early in the morning, great numbers of the pelicans gather together for a fishing expedition. They arrange themselves in a horse-shoe form, looking towards the shore, and they place themselves at regular intervals from each other. As soon as the cordon is complete, they commence striking the water with their outstretched wings, and thus frighten the fish shorewards. With neck outstretched, the pelicans gradually near the land. The



WHITE PELICANS.
(*Pelecanus onocrotalus.*)

fish are thus hemmed in, and as soon as the space is sufficiently narrowed, then begins the feast. M. Nordmann, speaking of one of these fishing expeditions, says:—"Besides the forty-nine pelicans which made up the company on that occasion, there were assembled on the sea-weeds, shells, and other *débris* thrown up by the waves and collected on the beach, hundreds of gulls, jackdaws, and sea-swallows, ready to seize the fish as they were driven out of the water, and to devour the remains of the meal. Finally, some grebes swam into the space circumscribed by the half-circle, before it was too much enclosed, and took their share of the feast, plunging frequently after the frightened fish. When all were satisfied, the whole company assembled on the shore while the work of digestion was going on. The pelicans smoothed their plumage, and bent back their long necks to rest them on their backs, their colossal forms in strong contrast with the little gulls. The troop comprised birds of all ages; some were entirely white, some streaked, and some grey. Now and then, one of these birds would empty his well-filled pouch, spread the contents before him, and enjoy the contemplation of it. Those fish that were still struggling soon had their heads crushed by one stroke of the beak."

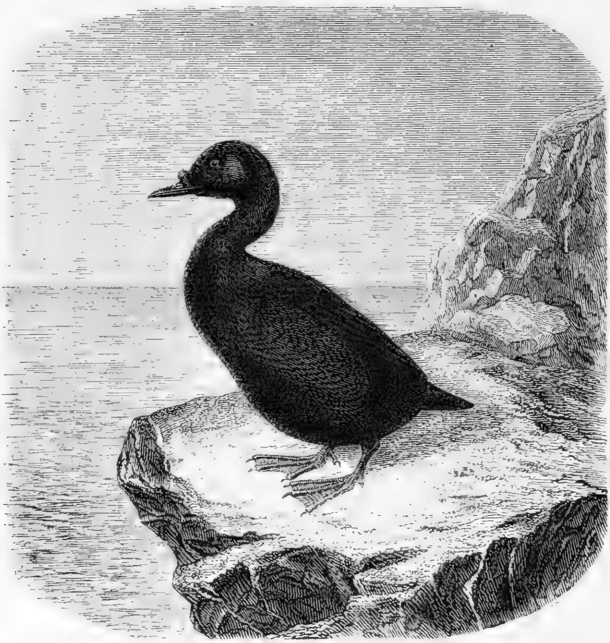
Cormorants have a pouch of the same kind as the pelicans, but much less developed. The Chinese train these birds, and employ them in fishing. They put tight rings round their necks to prevent their swallowing the prey that they seize, but when the birds have worked for some time for their masters, the rings are taken off, and the cormorants are allowed to fish on their own account.

There are some aquatic birds possessing neither a guttural pouch, nor a sharp bill, which feed on shell-fish, and when these fish are tightly barricaded and shut up in an impenetrable shell, they have the sense to carry them high up in the air, and let them fall on a rock to break them open.

Petrels, which eat nothing but fish, become so oily that the inhabitants of the Faroe Islands kill them and put a wick through their bodies, thus using the bird as a lamp.

Many fish-devouring birds are full of fat, which is hardly in a state of consistency; this is due to the food they eat. From this circumstance certain kinds are called *Penguins*, from the Latin *pinguis*, signifying oily. On the coasts of Patagonia, where they are abundant, these birds are stripped of their skin; under the skin is a lining of fat; by means of a heavy weight all the oil is expressed, and nothing left but the down and outer cuticle. Nearly a pint of oil is thus obtained from each bird. It would take 2,000 of these penguins to supply a tun of oil.

When the *Fulmar*, or stormy petrel, is seized, it vomits an oil the colour of amber, which is highly valued by the inhabitants of St. Kilda as a good external remedy in many disorders, particularly rheumatism. This oil is also burnt, the best being procured from old birds. They catch the fulmars at night,



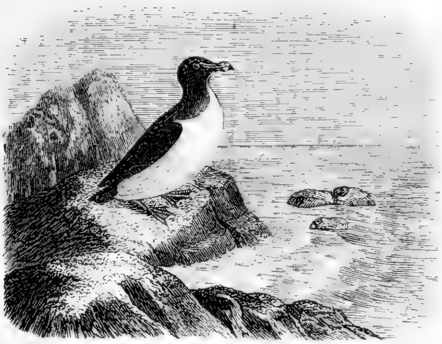
THE BLACK DUCK.
(*Anas nigra.*)

and press their beaks, when each bird yields about two spoonfuls of oil.

The valuable material known as *guano*, or, properly speaking, *huanu*, so prized by agriculturalists, is a product of aquatic birds. Guano is a mass of excrements deposited far out at sea on rocks and islets. It is calculated that a bird of average size furnishes about one ounce a day. Now, on certain rocks, beds of guano are formed as much as 100 feet deep; it must have taken hundreds of years and millions of birds to form these deposits.

The Island of Cincha, near Peru, 100 miles south of Callao, is one of the richest sources of guano. The upper layer of these beds is of a greyish brown, and the inner part is the colour of iron-rust. The hardness of the guano becomes greater as the depth increases.

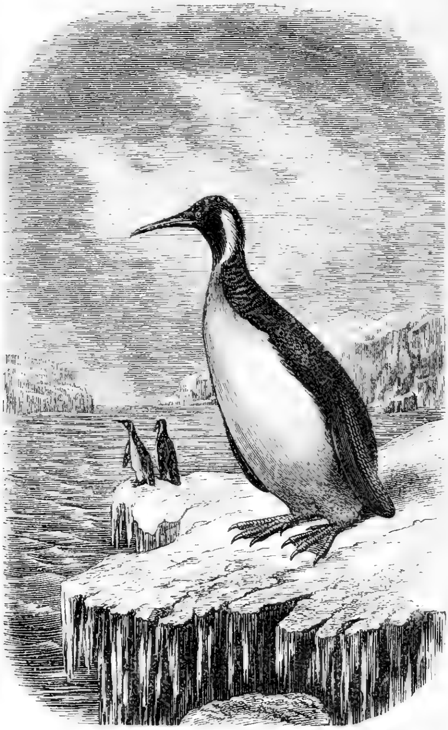
The voice of sea-birds is never soft and harmonious, like that of many of the songsters of our groves; it is nasal and ringing, and often hoarse and lugubrious. Gulls and sea-mews utter sharp cries, which are heard above the roar of the tempest. Some ducks send forth a piercing clang like a clarion. There are water-fowl which, owing to their wide and curved windpipe, are able to imitate



THE COMMON PENGUIN.
(*Alca torda.*)

exactly the sound of a trumpet. Some seem to cry like little children, or to chuckle like old women. The Greeks designated the pelican, "onocrotalé," or "bray of the ass," because this bird seems to imitate that inharmonious noise. Penguins make a croaking as melancholy as it is disagreeable. Lesson says, that in the Falkland Isles, towards sunset, they utter in chorus a loud cry which reverberates to a great distance, and resembles the clamour of a tumultuous army.

A very original observer studied the language of the sea-swallow for eight years, and compiled a dictionary on the model of Dupont's "Dictionary of the Raven." He has distinguished fifty words, expressing, he considers, each of them a distinct idea:—"Ici; là; en avant; en arrière; à droite; à gauche; plus vite; plus lentement; halte; garde à vous; nourriture; danger; je t'aime; moi de même; méchant; marions-nous; quel bonheur; un nid; nos œufs; couvons; nos petits; maman; papa; j'ai faim; tais-toi." The beginning of the dictionary is as follows:—"Kia, kié, kii, kioi, kioui. Djia, djié, djii, djioi, djioui. Tsia, tsié, tsii, tsioi, tsioui."

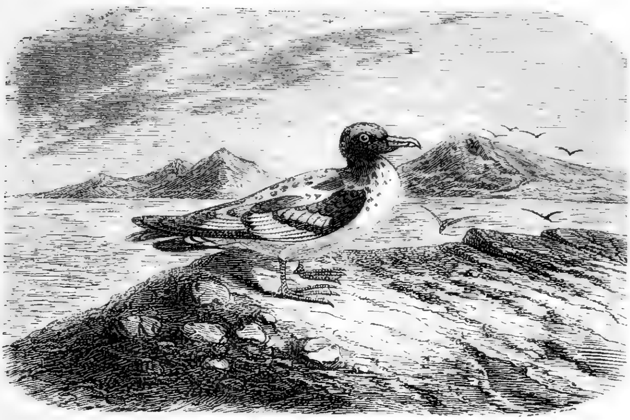


THE PATAGONIAN PENGUIN.
(*Aptenodytes Patagonica.*)

Sea-birds often have short legs, placed far back; they necessarily walk ungracefully, balancing their bodies with difficulty, and some even appear to be lame. The swimmers, when standing upon their feet, are quite upright. The Patagonian penguins, seen at a distance, look as if they were seated on their tails; they might be taken for a party of young choristers with hoods. Others drag themselves with difficulty over the sand, crawling almost on their breasts. Sometimes they use their small wings as feet, which converts them for the moment into quadrupeds.

There are species which live constantly on the water. The *Cape Pigeon*, which is distinguished by alternate black and white marks on its back, follows in the wake of a vessel for days together, where, in the eddy, he finds numberless little mollusca. The name of petrel, or *little Peter*, contains an allusion to the miracle of St. Peter walking on the water.

All web-footed birds can swim with equal elegance and ease.



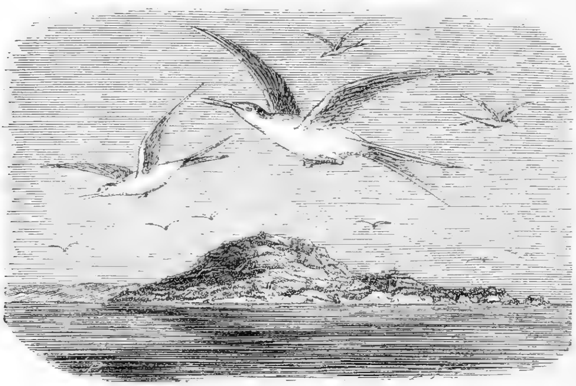
THE CAPE PIGEON.
(*Procellaria Capenis.*)

Ducks and goosanders balance themselves gracefully on the surface of the water, and play tranquilly in the midst of the most rapid streams. These birds have tails shaped like the keel of a boat; their feet, as we have seen above, serve for oars, and their wings, partly spread, furnish sails for this little living vessel.

Those species of birds which have not the faculty of flight are the most dexterous in swimming and diving. Their wings, which are usually short, act as fins, so that the bird possesses four oars, two in front and two behind, exactly like a fish. By this arrangement their swimming powers are not very inferior to the fish upon which they prey, save that they cannot remain long under water, nor yet dive deep, unless, like the northern geese, they can descend from great heights, and gathering a vast momentum, shoot beneath the waves like an arrow.

The power of flying is the distinguishing function of birds. The atmosphere is to them what the ocean is to fish. Flight and swimming are only, says Lacépède, the same motion carried on in different fluids. The bird swims in the air, and the fish flies in the water.

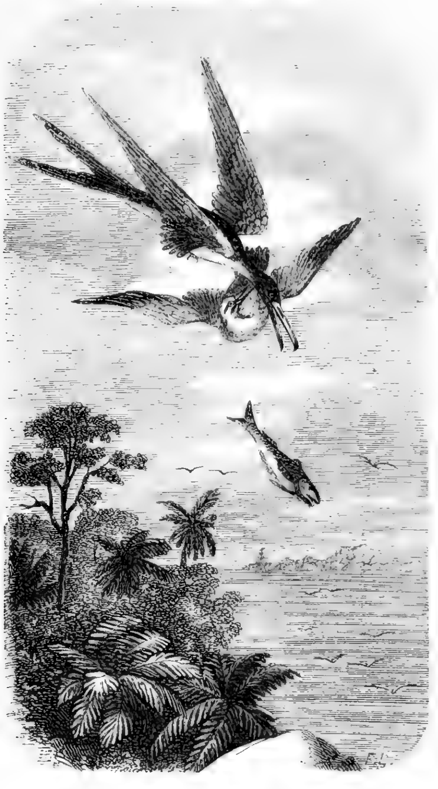
Those sea-birds which are fitted for flying always excel in the art, and are capable of being a long time on wing. The *Sea-swallows* are remarkably agile, rivalling their terrestrial repre-



THE SEA-SWALLOW.
(*Sterna hirundo.*)

sentatives in describing aerial labyrinths, and crossing each other's paths with dangerous velocity. But the great master in the art of flying is the *Frigate-bird* (*Tachypetes aquila*); its body weighs only a few ounces, while its wings have a great expanse. The frigates keep mostly in the higher regions of the atmosphere, and precipitate themselves like an arrow, regaining their balance with ease and rapidity; one moment they may be seen resisting the most violent wind, at another, drifting with the lightest zephyr. They are bad fishers, but they compensate for their want of skill by bold and fearless robbery. They are the highwaymen of the sea. From his aerial height the frigate watches an honest, laborious gull seize a fish, and mount into the air, either to carry its prey to shore or to enjoy its feast. In an instant the frigate is upon him; the terrified gull either lets go his hold, or disgorges the fish, which is caught long before it reaches the sea by the marauder.

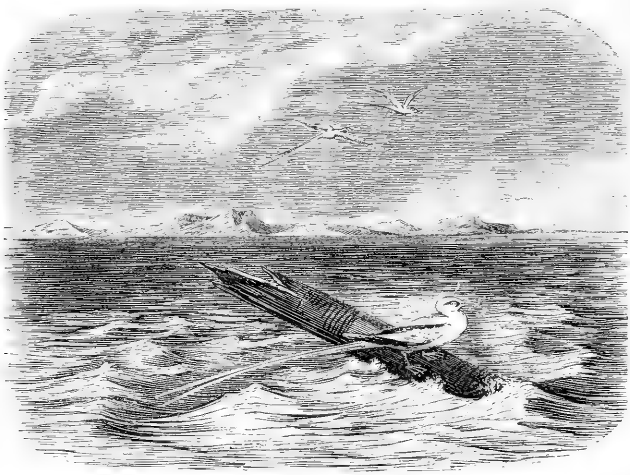
Audubon one day observed a frigate which had just carried off rather a large fish from a sea-swallow. The bird was carrying



AN ARCTIC GULL IN PURSUIT.

his victim cross-ways in his beak. He threw it into the air, in order that he might swallow it head foremost; as it fell, he caught it, but by the tail. Three times he threw it, and each time caught it again by the tail, the weight of the head always causing that end to descend foremost. Once more the attempt was made, and this time perseverance rewarded the robber, and he swallowed his booty.

But it would seem that retributive justice exists in every part of the kingdom of Nature. Nowhere can a marauder enjoy his ill-gotten gains in peace. When an albatross or a frigate-bird has seized the fruit of a poor gull's toil, he generally makes off with it to the upper regions of the air, but here he encounters many of his friends on the look out, who have been anxiously awaiting his arrival. They evidently consider it no robbery to rob a thief, and immediately the whole troop are upon him; the wretched fish, tossed from beak to beak, torn, and killed,



THE PHAETON OR TROPIC-BIRD.
(*Phaeton phœnicurus.*)

often ends by falling into the waves, while the robbers are fighting with each other.

The *Arctic Gull*, the pirate of the air, chases birds smaller and weaker than himself, giving them a blow with his beak, he makes them disgorge at least part of their prey, and greedily eats the disgusting morsel.

The flight of the *Tropic-bird*, or *Phaeton*, is calm and peaceful, performed by frequent strokes of the wings, at times interrupted by a brusque movement or kind of swoop. These birds defy the fury of the storm; in the midst of the most horrible tempest, they retain their composure. Tranquil and serene, they rise with the wave, and descend again into the abyss. Phaetons travel more than 500 miles out to sea, and yet return every evening to the islands or rocks where they make their home. In fact they scarcely stop even for necessary sleep. They seem made to fly and fly for ever.

Birds are commonly looked upon by mariners as indicating land. Old seamen know how to interpret their appearance, and are rarely mistaken. The petrel announces the neighbourhood of the Cape of Good Hope. The phaeton indicates that the tropics are near. The frigates, gulls, and sea-swallows, predict according to the direction and height of their flight, fine weather, a rough sea, or the rising tempest. The book of Nature is an inexhaustible source of instruction.

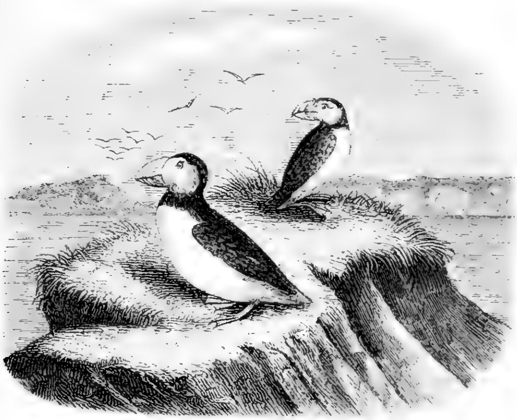
CHAPTER XLII.

NESTS AND EGGS.

In the pairing season, sea-birds abandon the waves and waters, and come to the shores and rocks. Many species assemble in large flocks on rocks or on desert islands. Faber considers that these birds obey an instinct of sociability. Boje thinks that they are attracted thither by the abundance of food. Both reasons may be equally true; but probably there are others also; for instance, the aspect of the rocky fortress, in whose clefts and cavities excellent shelter is to be found; the absence of all carnivorous animals, and safety from their enemy, man; in short, solitude, tranquillity, and security.

Graba observes that water-fowl always choose rocks turned westward or north-west, for their nests, and disdain every other situation. Amongst the islands most frequented by nest-building birds, the little archipelago of Faroe, between that island and the Shetland Islands, ranks first. This archipelago is formed of twenty-five great rocks, called *Vogelberg* (Bird-rocks). These have often been described. One amongst them deserves special notice. Imagine a black rock composed of horizontal layers, rising 1,600 or 1,800 feet above the level of the sea, which roars and seethes at its foot. The water dashes up to the height of one hundred feet during tempests, and rebounds from the face of the cliffs, falling in foaming cascades. In calm weather, the waters undulate gently and ripple softly round the rocks. The steep sides of the cliff present a very singular appearance; millions of birds are perched side by side on the projecting ledges; the females on their nests, the males close to them, or at no very great distance. An amphitheatre full of spectators would give but a meagre idea of the prodigious number of birds thus symmetrically placed, their heads all turned towards the sea. The arrival of man hardly troubles them, and the report of a gun only makes the male birds fly away; the hens remain on their eggs, which they never leave, unless the nests themselves are approached, and they generally allow themselves to be taken as they are sitting.

The different species of birds congregated on these rocks are not scattered promiscuously; each kind appears to have its own encampment. Highest above the water are to be found the *Larus marinus*, black-coated, or black-backed gull, and the sea-parrot, or black monk. In the second rank, on spots covered with plants, are the silver gull (*Larus argentatus*). Above these, on the most unsheltered rock, slumber the stupid cormorants (*Phalacrocorax*



THE SEA-PARROT.
(*Mormon fratercula.*)

carbo). A little further, on the rocky beach washed by the sea, the elegant three-toed gull (*Larus tridactylus*), and the white guillemots (*Uria grylle*), assemble in large flocks. Close by, among heaps of sea-weed, the capuchin guillemot (*Uria troile*), and the penguins (*Alca torda*), may be seen pluming themselves. All these birds live together on good terms. Females of different species are often seated on their eggs, side by side, and it might be imagined from their movements, and the clacking of their beaks, that they were whiling away the long, tedious time of incubation by agreeable and animated conversation.

The general rendezvous, or meeting-place of the marine birds, is the Hebrides, and particularly the Island of St. Kilda, which is about one hundred miles in circumference. It rises perpendicularly from the bosom of the water, and forms at its eastern extremity the highest promontory of the British Isles, being 1,430 feet high.

On approaching the Island of St. Kilda, a sight presents itself that well-nigh baffles description. The rocks are almost hidden by myriads of aquatic birds, all busy on their nests. Numberless swarms of the white gannet (*Sula alba*) absolutely whiten the summits on which they congregate; so that from a distance the crests and slopes appear to be covered with snow. The three-toed gulls and the blue-footed gulls have taken possession of all the less elevated peaks; lower down, the fulmars, or northern petrel, the puffins, and guillemots, have established themselves on all the slopes and declivities, and every spot where grass is to be found. On the edge of the sea, at the mouth of caves or hollows, perch the cormorants, upright and still, like sentinels at their posts. All around in the water, millions of birds of every species plunge, and dabble, each gathering its daily bread. Others fill the air with their harsh, sharp cries, flying from their nests to the sea, or from the sea to their nests; calling their mates, and whirling in the air above them; or caressing their little ones, playing with their comrades, and manifesting in a clamorous and lively manner their wants and fears, their joys and griefs.

When a fragment of rock becomes detached, and rolls from the top of the island into the waves below, it becomes the signal for an extraordinary tumult. The whole colony is seized with alarm. The falling of the mass crushes the unlucky fulmars as they sit on their nests, and as it bounds along, it drags with it grass and sand, eggs and young chicks. The frightened birds rise into the air in clouds, but they soon come back to their nests, and all resumes its habitual tranquillity. In Holland, innumerable troops of gulls and sea-swallows make their nests every year in the Island of Eierland (*land of eggs*), and in other southern islands of the Texel, and also in Schleswig and Jutland. In the season for laying eggs, water-fowl arrive by millions. Many waders join the troop, and the rocks are literally covered with the eggs of gulls, sea-swallows, guillemots, penguins, and ducks, and even of oyster-catchers, plovers, and lapwings.

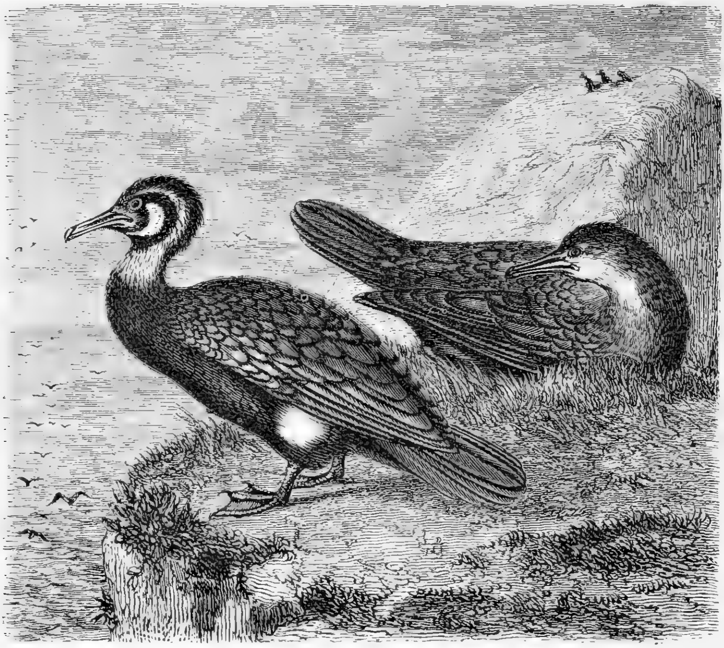
Aquatic birds place their nests either in a simple recess behind two or three stones, or among grass and rushes sheltered by a shrub, or sometimes in the hollows of the rocks. The three-toed gull instinctively chooses the most inaccessible spot for her retreat, and she is rarely disturbed by the collector of eggs. Penguins and Patagonian penguins dig a horizontal hole in the sand. Puffins take possession of rabbit-burrows; they love society, and a number of them make their nests together, and hatch side by side. The place which they choose for their abode is often so perforated, that any one stepping on it would sink in to the knee.

Sheldrakes (*Anas tadorna*) also have the custom of burrowing under the earth. The ancients gave these birds the name of "*oies-renards*," or fox-geese. Naumann saw in the little island of Sylt, a great number assembled in groups in artificial excavations. He counted as many as thirteen nests in a square space, with an entrance common to all. Above each nest was an opening, covered by a tuft of grass. When this tuft was lifted up, a sheldrake was found seated on her nest. Every inhabitant of the village appropriated several of these subterranean nests, from which he took twenty or thirty eggs every day for three weeks, taking care to leave six in each nest for incubation.

In the neighbourhood of the Cape of Good Hope, albatrosses assemble in colonies to make their nests. They divide the land into regular squares, one for each nest. These squares communicate with each other by means of roads, and the whole is defended by a wall of stones.

Cormorants make their nests in the midst of reeds and rushes, or sometimes on the trunks of old willows, or on rocks, but always in the immediate neighbourhood of the sea. They build large, irregular nests, made of branches and pieces of wood roughly put together. Many of these nests may sometimes be seen on the same tree.

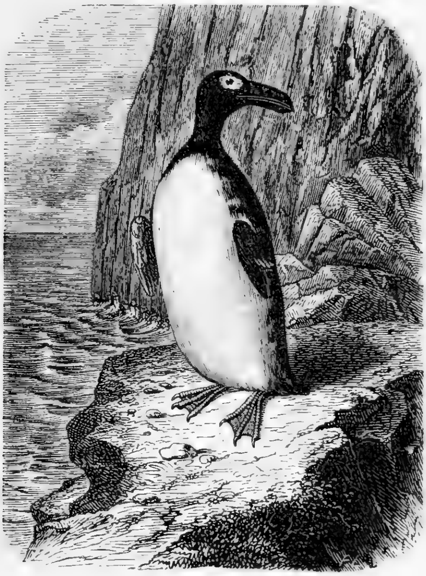
At the beginning of this century, cormorants were rarely seen on the shores of the Baltic Sea. About the year 1810, several couples came to the neighbourhood of the Isle of Fioni, and built their nests among the rocks of the coast or in the woods. They gradually increased in number. In the spring of 1812, four pairs of these birds took up their abode in the country of Neudorf, near the town of Leutjenbourg, and settled in a wood close to the sea, on some large beech trees, which for many years had been the resort of a number of herons and rooks. These the cormorants drove from their nests, and they laid their own eggs in May and again in July; in the autumn they quitted the country. The



THE COMMON CORMORANT.
Phalacrocorax carbo.)

number then had increased to thirty. During the spring of 1813, and for some years after, they returned regularly, and it was soon calculated that there were 7,000 pairs. In the month of June, 1815, hundreds of nests might be seen on different trees, and innumerable flights of cormorants, mingling with herons, filled the air with their hoarse cries. Their excrements destroyed the foliage of the trees; and the refuse of bad fish, with which they strewed the land, poisoned the atmosphere for some distance around. By order of the government, they were driven away. Five hundred were frequently killed in one day, and it was not till the next year that they were exterminated.

In some islands the nests of marine birds are so close together that it would hardly be possible to take a step without crushing an egg; and it often happens that a bird will lay its egg in another bird's nest. Thus, Naumann found the egg of a long-tailed sea-swallow in the nest of an oyster-catcher, and the egg of the latter bird in a penguin's nest. Yet every mother knows

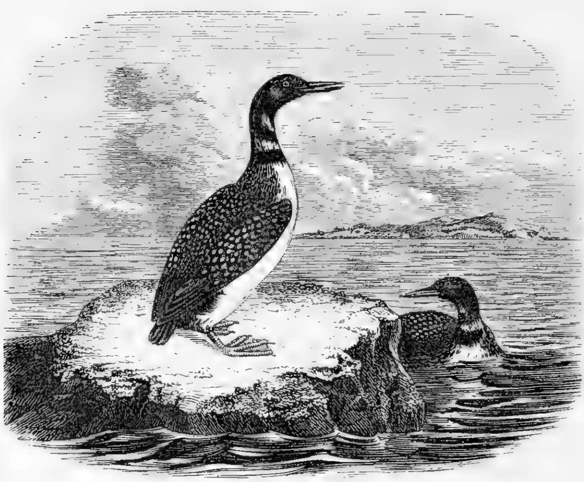


THE GREAT PENGUIN.
(*Penguinis impennis.*)

her own eggs, and never makes a mistake. We should think this incredible, if the instinct of animals had not accustomed us to marvels.

Most of the eggs of aquatic birds have one end larger than the other, resembling in this respect the egg of the common fowl. Those of the cormorant are long, and both the ends are small. But the eggs of some of the penguins are quite round. The eggs of the cormorant are small compared to the size of the bird; those of the guillemots, on the contrary, are large. The capuchin guillemot, which is a little smaller than the wood-pigeon, lays an egg larger than that of a goose.

Of all European birds the great penguin lays the largest egg. It is eagerly sought after by amateurs, and is becoming every day more rare. At the present time £20 or £30 is paid for a specimen. Petrels lay white eggs, goosanders yellow, and those of the duck are greenish. Gulls lay olive-coloured eggs, with a brown marbling which is generally closer and darker towards the thicker end. The great penguin, just mentioned, lays an egg of a yellowish-white tint, with rays and spots, not very numerous, which, Temminck says, remind one of the singular forms of Chinese characters.



THE NORTHERN DIVER.
(*Colymbus glacialis.*)

The guillemot produces an egg still more remarkable for the lines or zigzags with which the shell is decorated. The eggs of the northern diver are the darkest of all that are known. They are chocolate, with an olive tint, and are marked with irregular black spots. The eggs of the cormorants and gannets are covered with a white cretaceous, or chalky plaster, which may be easily removed with the nail. This plaster is so friable on the egg of the red cormorant (*Phœnicopterus ruber*), that if the shell be gently passed along the sleeve of a coat, it will be whitened as if it had been rubbed with a piece of chalk.

When a bird has prepared its nest, the young mother must be much surprised, after the trouble she has borne, to find in her nest, instead of a delicate little chick resembling herself, an inanimate spheroid, which can say nothing. She has brought into the world a sort of ball, white like chalk, or light blue like turquoise, or perhaps it may be red, and streaked like mahogany, or dotted and veined like marble or agate. An egg is not a bird, any more than a grain is a tree; it is something antecedent, something which contains the rudiments of an animal; but which, as yet, shows no signs of life; resembling a mineral production, rather than an organic germ. The instinct of the mother comes to the help of her inexperience. She attaches herself to this inanimate body with a devotion that we do not and cannot understand. Is it maternal affection? certainly not. It is a kindred feeling very nearly related to it, and possibly preliminary to it, but certainly different. Maternal love does not exist yet, it will come later, and will be first felt when the little ones are hatched. This attachment to their eggs, induces the birds to remain seated on these peculiar productions, and to keep them warm. They press these stones to their hearts. When parents are hatching for the first time, do they know what the results of their long incubation will be? Doubtless the thought never troubles them, for instinct is their director and motive power. The female and, what is still more astonishing, the male, may actually be seen to forget to eat and drink, so great is their love for an egg. During the time the sea-swallow is sitting on her eggs, her mate comes from time to time, and rests near the nest. There he disgorges a little fish within reach of his partner, he then looks at her tenderly, the pair make various inclinations of the head, sometimes, rather singular movements, but no doubt in this manner they assure each other of their tender affection, and their happy content.

The development of the young bird is not a mystery; for if a number of eggs, in different stages of incubation, have their shells delicately broken, the process is easily seen. At the commencement of incubation the ball of yolk is surrounded by a thick layer of albumen, which is enclosed first in a skin, and then in the calcareous shell. This yolk or *vitellus* is suspended by two filaments, and is really the germ which contains all the organs of the young bird in an undeveloped state. At one point of its circumference a white spot appears. This gradually expands until about a quarter of the yellow ball is white; this may be distinctly seen to be divided into two parts. The upper layer soon begins to give signs of organisation—a red vein runs round its edge, from which numerous branching vessels are given off, and tend towards, not a point in the centre, but a long, dark line, which is surrounded by a white border. All the veins collect into four main branches, which enter this lineal opening in pairs, one on each side. As the wonderful process goes on, the outline of the brain and heart appears, from which organs the blood-vessels take their rise. The respiration had hitherto been conducted by the vascular net-work of the yolk, but now a temporary lung is established, and the development proceeds rapidly; the contour of limbs begins to be traced, and the eye is defined at an early period. The scales of the legs and the germs of the feathers are very visible. The air-chamber, with which all are familiar, which is situated at the thick end of the egg, has gradually increased, so that when the young bird is fledged, and ready to make its *début*, it occupies almost one-quarter of the whole egg. This is a wise provision in order that the little prisoner may have room to move in the shell when its instinct prompts it to break the walls. The bird, at the right moment, tears the membrane of the air-chamber, and enters this open space. Now more at ease in its prison, it attacks the shell, striking it with a little hard substance, fitted at the extremity of the beak, the prison walls are broken, and the captive emerges into the external world.

Sea-birds defend their eggs and their little ones very bravely. When Captain Ross discovered the Island of Possession, he found there an immense quantity of penguins, covering even the tops of the hills. These birds advanced towards the shore in close columns, and with their beaks bravely attacked the Englishmen who wished to take possession of the land in the name of Victoria! All honour to the courage and patriotism of the penguins!

The female of the wild duck, when going to her nest, alights a hundred paces or more away from it. When on land she moves towards her nest obliquely and tortuously, with her eye fixed on any one who may be standing near, to make sure that there is no enemy watching her. What pleasure may be enjoyed by those who study Nature! We are assured that the plover, "If she sees a child or a dog approach her nest, does not wait for their arrival, but advances resolutely; then suddenly takes flight, with a loud cry, as if surprised upon her eggs, when in fact they may be thirty paces off. Then she will flutter and let one wing fall; or she will run dragging a leg; in fact, will actually feign lameness, till she has decoyed the intruder to a safe distance from her nest, and thus averted the danger."

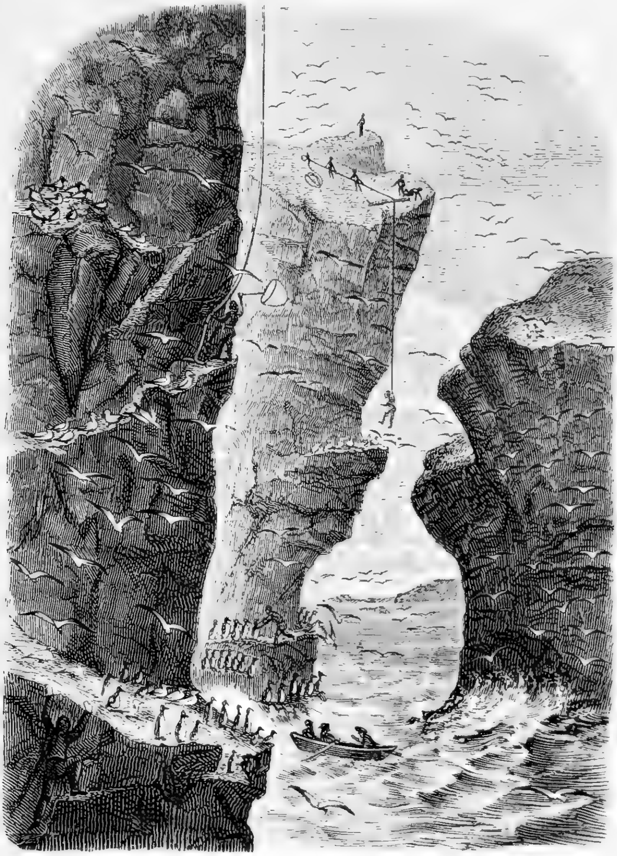
Collecting eggs forms a branch of considerable industry in many countries. The poor inhabitants of the Faroe Isles feed on the eggs of almost all the waterfowl which frequent their shores. They eat the young chicks also, and the parent birds when they can manage to catch them. They will hang by a rope, at the peril of their lives, or climb the perpendicular sides of the rocks, or walk along the narrowest ledges, on which the birds make their nests. In this perilous position one false step must be inevitable death; and every year many of the Faroese fall victims to this dangerous sport. This pursuit may be carried on without danger in a canoe. The fowler takes a conical-shaped net, not unlike those used to catch butterflies, but it is woven of wool, and consequently stronger. As these birds are not wild they suffer themselves to be approached; the net is thrown over their heads, they are entangled in it, and easily caught. In this way birds swimming on the surface of the water, or fishing on the rocks, can be seized with equal facility. But the greatest number of birds are to be found on the craggy points of the steep rock. In order to reach these, parties of at least four men set out together. One armed with a pole, at the end of which is a small horizontal shelf, pushes his companion up to the level of a ledge, who then hoists him up with a rope. There they seize the birds as they are brooding, or catch them with the nets as they fly off their nests. They partly kill them and throw them to the men below, who stand ready in a boat under the cliff. In this way they go from point to point, and often in a few hours catch hundreds of birds.

The most profitable though the most dangerous of all methods is the following:—The fowlers provide themselves with a cable two inches thick, and 600 or 1,200 feet long, on which is fastened a kind of seat. A beam is placed at the edge of the rock, to prevent the rope being cut by the rough stone; the bird-taker (*fugelmand*) is let down by six other men, and holds a small cord in his hand, by means of which he can make certain signs agreed upon, and understood by his comrades. It requires a peculiar skill to prevent the cable being twisted, and turning the man round and round, by which he would be knocked and bruised against the rocks. The *fugelmand*, on reaching a ledge, lets go the cord, ties it to any convenient projection, and kills as many birds as possible, catching them in his net, or seizing them with his hand. If he should spy a hollow, or a niche, beyond his reach, where many water-fowl are perched, he sits down again on his little plank, and jerks the rope, so as to give an oscillation of sometimes as much as one hundred feet, and thus swings himself to the spot he wishes to explore.

It is said, that in one little rocky islet of the Faroe group, as many as 2,400 sea-parrots are caught every year. The governors of the Isle of Texel have the exclusive right to all the eggs taken there; but they pay a considerable sum to secure this monopoly. It is asserted that 300 or 400 eggs, of the silver gull alone, are gathered every day. After St. John's Day, no more eggs may be taken, the birds being allowed to hatch in peace any they may lay after that period. Naumann says, that 50,000 eggs of the large gulls are collected annually in the little island of Sylt, and quite as many of smaller species, and of sea-swallows. Among the larger eggs, there are at least 10,000 of the silver gull.

Three men are engaged in collecting these eggs from eight in the morning till late at night. They receive in payment the eggs of all the smaller kinds of birds.

The fulmar is to the inhabitants of St. Kilda the most precious production of their island. The bird-nesters risk their lives to take these birds. Two men generally go together; one firmly tied round the waist with a thick cord, is let down by the other to some steep rock thickly peopled with fulmars. He collects all the eggs and birds he can, and is then drawn up by his companion. The dexterity of these men is very great, and the smallest surface is enough for them to stand on. They may be seen loaded with their booty crawling on hands and knees, and treading on the narrowest ledges, and on the least possible projecting points. The strength of the man who holds the cord is such, that if the bird-nester



SEA-BIRD CATCHING.

makes a false step, and falls into the air, he is able to bear the shock and save his companion. In the Hebrides, it is calculated that more than 20,000 gannets are killed annually, and in Greenland, 200,000 eggs of aquatic birds are consumed in the year.

Audubon has seen collectors of eggs from Havannah, in the *Ile aux Oiseaux*, Gulf of Mexico, carry off a cargo of about eight tons of eggs, of two species of the sea-swallow. He inquired what they calculated was the number of eggs, and they replied that they never counted them, even when selling them; but they sold them at the rate of seventy-five cents per gallon. By one cargo they make sometimes two hundred dollars, and the following week, they would return and collect another ship-load. Other dealers who arrived from the west, sold their eggs at twelve and a half cents per dozen.

Before concluding, we will say a few words about the famous eider-duck. This remarkable bird is nearly twice the size of the common duck. Its neck is comparatively short, and its legs are rather long. It lays its eggs chiefly in Iceland, where it is protected by law. Any one who is tempted to kill a wild duck during the breeding season, is liable to a fine of not less than thirty dollars. A safeguard is thus provided for one of the most lucrative productions which we owe to marine birds. Of the collection and sale of the soft down, known as eider-down, Mackenzie relates in his "Voyage in Iceland," that, when his boat approached the island, he had to make his way among troops of this much-prized fowl. They did not take the trouble to move out of his way, but were quite calmly unconcerned, as if they knew they were under the protection of government. From the shore to the house of the bailiff, the ground was literally covered with birds, so close together that the visitors had to walk very cautiously to avoid treading on them. The eider-ducks were sitting on their eggs, upon the tops of walls, on roofs of houses, even in the houses, and actually in the church! When approached, they never stirred, but allowed themselves to be touched, and would peck the stranger's hand lightly with their beaks. The nests of these ducks are round, and rather deep; they are built of small dead branches, carefully interlaced with moss and marine plants. The bird lays five or six eggs, and occasionally, though rarely, eight. Audubon once found ten in one nest. They are larger than those of the common duck, smooth, and of a clear olive-grey colour, and are considered a great delicacy. Every nest is lined and carpeted with down, which the bird tears from her own breast, and in which the eggs are completely buried; while around and above them are more feathers, with which the bed can be covered, when the parent leaves her nest at low tide to go and seek for food.

One can hardly contemplate without emotion that Divine goodness which gives industry to the feeble, and forethought to the ignorant. The nest is robbed of its down twice, and sometimes a third time. The poor mother has to replace it from her own breast. She reproduces her plumage, and again robs herself to keep her nest at the right degree of warmth. When her provision of brownish down is exhausted, her mate comes to her help, and sacrifices, in his turn, his beautiful snow-white or rose-tinted eider-down. Each nest furnishes, on an average, half a pound of down.

When we consider the immense swarms of aquatic birds that inhabit the coasts of all the islands of Northern Europe, we are really lost in wonder! The most arid sands, the steepest rocks, the most inaccessible clefts, all are invaded, and even crowded, by nests and brooding birds. Many birds lay only one egg, and often place it in such a spot that it is difficult to understand how incubation can be accomplished. Sea-eagles, falcons, gulls, suck the eggs, or carry off the young birds. The arctic gull nourishes her brood with young gannets, penguins, and fulmars, which she steals from their parents. Many large fish, too, feed on more than one kind of bird, large as well as small.

Hundreds of birds die of cold during winter. Whole colonies are destroyed by the tides, or swept away by hurricanes. And who can say how many are sacrificed to our wants and our pleasures? Notwithstanding all these calamities, the number of marine birds is undiminished, and the dreary expanse of the ocean is ever animated and enlivened by their presence.

CHAPTER XLIII.

THE CETACEA.

In animals of a simple construction the tissue of their substance is homogeneous, all their organs being composed of the same kind of matter; the functions of these organs, moreover, are reduced to the lowest limit, their exercise being expended upon that only which is absolutely necessary to existence. As we ascend the scale, we find that the functions of the various organs become more definite or localised, that is, one organ only performs a special office, and does not undertake several functions.

The *division of labour* in the body, among the various organs, is one of the most curious and interesting of the laws of Nature, and the higher the position occupied by an animal in the scale of creation the more organs it possesses. Just as in the humbler position of our society the work of the household is done by a "maid of all work," and as a higher grade is reached, more numerous become the domestics, the several duties of an establishment being allotted, each to a separate servant; and thus the number of retainers is a good measure of the position of the householder.

In the higher orders of life—in those animals which approach the master-piece of creation, man—the various functions of the body are performed by organs which are either single or double. The brain and heart, the essential organs of vertebrate life, are single, while the organs of vision and hearing are double.

In the annelids all the organs are repeated an incredible number of times. Some species have ten jaws, some 300 claws, and in some the eyes are legion, even reaching 30,000.

As we saw in Chapter XXIX., the Zoonites are composed of an assemblage of organs, so arranged that the animal is built up of segments, each segment having a complement of organs; and yet the zoonite is far below the vertebrates in the scale of life; a single zoonite is a very imperfect creature, but the joining of many together makes an animal which takes a somewhat high rank. Thus the *division of labour* in the animal economy may be classed under four heads:—1. Where many individuals are joined together to do the work of an association, as the corals and polypiers. 2. Where these individuals are in a yet closer union, as in the zoonites. 3. Where many instruments are concerned with the performance of the same functions. 4. Where special organs, single or double, are designed for special functions.

The mammifers, or as they used to be called, the viviparous quadrupeds, are the vertebrates which most nearly approach man. Those members of the class which are inhabitants of the world of the sea form three classes, according to their construction and habits. 1. The mammifers having anterior members, which are transformed into fins, but are devoid of hind limbs—these are the *cetacea.* 2. Those which have all their limbs converted into flappers and fins, such are the *sea lions* and the *morses.* 3. Those which possess members like ordinary quadrupeds, as the *white bears.* The first two classes are the marine mammals proper; the construction of the cetacea being the least complicated.

The cetacea are essentially aquatic; the greater number never leave the water; but since they breathe by lungs they are compelled to rise to the surface to respire. The head of the cetacea is joined to the body by a neck so short and thick that there appears no contraction, but it seems as though the head grew out of the body. The trunk terminates in a thick, fleshy tail, which is horizontally flattened, not vertically, like the tails of fishes, so that the cetacea strike the water, not from right to left, but up and down. On the head the whales have a hole which communicates with the mouth: through this channel the animal ejects the air which it has inhaled; and as it carries with it a large quantity of water, a fountain jet rises from the surface of the sea; the sailors then say the whales are "blowing." The best divers are not able to remain under water more than a minute and a half, but the cetacea can keep beneath the surface for some hours. The French anatomist, Professor Breschet, discovered that the whales possessed a net-work of veins running in the neighbourhood of the vertebral column. It would appear that these veins serve the purpose of a reservoir for the blood, during the time that the animal is beneath the surface of the water, thus keeping the most important organs from being overcharged. As soon as the whale reaches the surface and breathes, the veins discharge themselves, emptying their contents into the lungs, and the full process of circulation is renewed. The whales live in troops, or "schools," frequently very numerous. There are about 100 species. The cetacea are either carnivorous or herbivorous; the latter kind frequent the neighbourhood of the shore, moving gently among the marine vegetation. They graze like ruminants, thus forming an exception to the general rule.

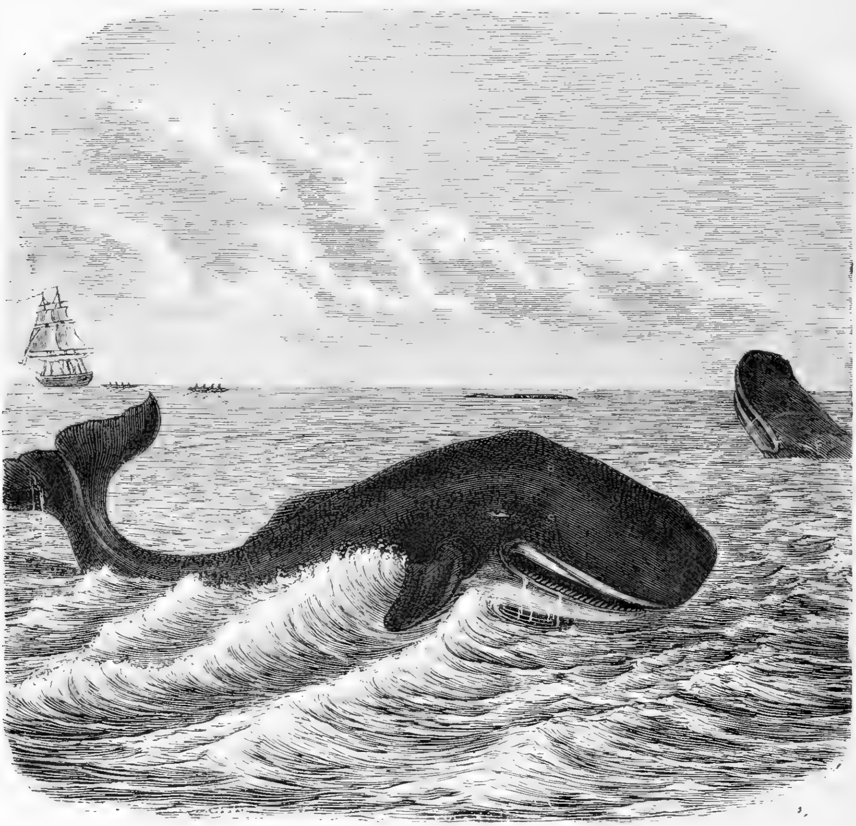
Most of the species when they suckle their young—for strange as it may seem, the whale performs this office—place themselves in an upright position, with their upper part above the water; they then embrace their offspring in their fins, holding it to their breast. So much does this resemble the mode in which our infants are nourished, that whales have been called *sea women, marine nymphs, sirens, &c.*

CHAPTER XLIV.

THE SPERM-WHALE.

THESE creatures are among the largest of the cetacea, being characterised particularly by the remarkable size of the teeth of the lower jaw. Their size often reaches eighty feet, of which the head occupies thirty. Although these cetacea are so large, they are not so well known as many of the smaller members of the animal kingdom, for it is yet an undecided point whether there be ten different species, or only one.

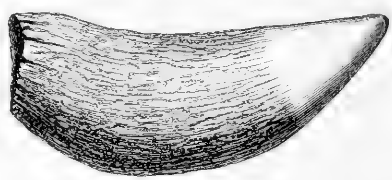
The sperm-whale is also known by the name of *Cachalot.* It is scientifically termed *Physeter macrocephalus.* Its habitat is widely extended, for the sperm-whale is an inhabitant of almost every sea. Its colour is bluish-black, darker upon the back. The upper jaw is destitute of teeth, or has only the rudiments covered by the gums. The lower jaw is narrower and three feet shorter than the upper, looking much out of proportion. We shall notice presently the formidable teeth with which it is furnished. The cachalot has only one spiracle. Its eyes are prominent. Its dorsal fin is reduced to a mere scaly protuberance, and its tail is bi-lobial. The body is thick, heavy, and ungraceful; in its ungainly appearance there is more resemblance to a gigantic bull-head, than any other fish. The blunt-headed cachalot swims chiefly on the surface of the water, showing his back and the fleshy hump about the spiracle. He thus gives vent to the water drawn into the nostril while feeding, just as a Dutch peasant comes into the sun to smoke his pipe! The movements of the cachalot are not rapid, and in shallow seas he may sometimes be seen to raise the whole of the upper part of his body upright out of the water. When these animals journey, the largest and strongest takes the lead, and keeps at the head of the phalanx. It is his duty also to give the signal for attack. In the year 1741, an enormous sperm-whale was stranded at the mouth of the Adour, near Bayonne. In 1769 another was cast on shore a short distance from St. Valery, in the Bay of the Somme. In 1784, thirty-two of these monsters were grounded in the Bay of Audierne, on the coast of Lower Brittany. A skeleton, bought in London in 1821, is preserved in one of the



THE GREAT-HEADED SPERM-WHALE.
(*Physeter macrocephalus.*)

courts of the Museum in Paris. Very recently (November, 1862) a small cachalot was found by some custom-house officers, amongst the breakers of the Darmon (Var). Its length was forty feet and its girth twenty-six feet. The mouth when opened would admit of a man standing upright, and he could be swallowed without any difficulty. The weight was estimated at forty tons. It was bought by M. Bienvenu, ex-master of the port, for fifty francs, and the skeleton was sold to the Museum of Draguignan.

The capture of the sperm-whale is a source of extensive employment. We are indebted to Commander L. Hautefeuille for some details of this interesting and lucrative fishery. Every captain has on board his ship two men keeping a look out from the mast-head, and four or five canoes, pointed at both extremities, called whalers. The moment an unfortunate whale is perceived, the canoes are launched, each one being manned by four strong rowers, an officer who steers the craft by means of a paddle, and also an experienced harpooner, generally a well-seasoned tar, gifted with presence of mind, a keen eye, and a strong arm. The animal no sooner feels the harpoon than he plunges rapidly towards the bottom of the sea. Before many minutes, he comes to the surface to breathe. The column of air and water which he spouts is frequently dyed with blood. He again plunges, but taking with him a second or third harpoon, thrown from other canoes. The fishermen sometimes use a peculiar harpoon, which is shot like an arrow by a powerful spring from a copper tube penetrating far through the skin of the whale. In recent times, another and still more terrible means of destruction has been invented —a kind of shell, which explodes after having sunk into the flesh! These new plans are not, however, much adopted. In the meantime, the animal rises again to the surface; but he is becoming exhausted, and he appears more frequently, and at last can scarcely plunge a few fathoms to prolong his life for some minutes. Now the canoes all join in a circle and surround the victim, and dispatch him with lances. But it often happens that a whale defends himself, and sells his life dearly; then woe betide the unhappy canoe which has advanced too rashly: with one blow of his mighty tail, the monster sweeps to destruction all that are within his reach. The whale, when dead or dying, is dragged by the boats to the ship, where it is taken on board and fastened to the fore-part by the tail. The crews then celebrate their victory in the true English fashion— by a dinner—and afterwards proceed to cut up the carcase, an operation carried on amid songs and bumpers of spirits. The first thing is to take from the body the large rolls of fat in which it is enveloped; these are melted in huge copper vats. The oil or fat is then extracted from the body, and especially from the head, where it is gathered up with pails. The oil from the cephalic region is the thickest, and alone forms one-third of the total produce. When all is extracted from the body, it is severed from the head, and abandoned to the birds and sharks. The head only is hoisted on to the deck, where it is soon stripped of its fat. This can only be effected with animals of a moderate size. The cutting up, boiling, and preparing, occupies from twenty to thirty men for forty-eight hours. When purified, the oil is put into tuns. One sperm-whale will furnish from 80 to 150 tuns of oil, according



A TOOTH OF THE SPERM-WHALE.

to its size. One sixty feet long, and weighing sixty tons, was found to yield 100 barrels. More than this is seldom obtained from any single whale. A three-masted vessel can take about fifty whales, which may be caught in the space of one or two years. This fishery is carried on in the present day by the English, French, Portuguese, and Americans.

The sperm-whale furnishes for art and commerce not oil only, but also ivory, spermaceti, and ambergris. Ivory is obtained from the teeth, but is of inferior quality. The lower jaw has on either side, from twenty to five-and-twenty large teeth, they are cylindrical, and conical at the summit, slightly curved inwards, sharp, and not closely set in the jaw. We have seen one that was seven inches in length, and another that weighed more than thirty-one pounds. Spermaceti is found in the large cavities in the upper part of the head, beneath the brain, which is small, compared to the bulk of the head. Camper discovered, that in a head twenty feet long, the cavity of the cranium was only ten inches. While the fish is alive, the spermaceti is in the form of an oily fluid, and it solidifies after death. The spermaceti is obtained pure by compressing this secretion in a woollen bag, and then boiling it in an alkaline liquor, to separate the remaining oil. It is then washed and poured into jars.

M. Quoy calculated, that a cachalot from the Moluccas, sixty-two feet long, yielded twenty-four barrels of spermaceti, each one containing two and a half cwts. Consequently, this one animal furnished three tons.

Spermaceti is a solid white substance, glistening like mother-of-pearl. It is very soft to the touch, and breaks easily into flakes. It is used in making candles; it is also one of the ingredients of pomatum, and of the cold-cream so much recommended for softening the skin. Ambergris is nothing more than a kind of intestinal calculus, or a portion of the food of the whale imperfectly digested. This substance, which is in such demand for perfumery, and is so valued by fair ladies, has a very ignoble origin. The unpleasant source whence it is derived makes the delicacy of its scent the more astonishing; for ambergris, the most valuable product of the cachalot, is a morbid secretion or disease.

Some zoologists consider that all whales in their normal state furnish this substance; others suppose it to be only the result of certain diseases, and therefore an accidental product. Ambergris is frequently found floating on the water, or deposited on the beach. The places where it is most collected, are the coasts of Japan, the Molucca Isles, India, Madagascar, and Brazil. The food of the cachalot appears greatly to influence this substance. It seems that it is produced by pulpy mussels, cuttle-fish, and even offensive refuse, agglomerated and ill-digested. Many of the secretions of the inhabitants of the ocean world exhale the strong odour of musk, for which ambergris is noted. The whalers learn the shores frequented by the animals, by this excrement which the waves cast upon the beach. It is a solid fatty substance, resembling wax, tolerably hard, and lighter than water. Its colour is dark or ashy grey, it is sometimes of a yellow, or brown tint, and often covered with a white efflorescence which forms on the surface, and even exists to some depth in the interior. It possesses a soft, agreeable scent, capable of imparting its perfume to an unlimited extent.

It consists of irregular masses, composed of concentric layers, one over the other, or sometimes granulated, the grains being unequal and more or less rounded. As a central nucleus are often found the solid remains of mussels and fish. These masses weigh, commonly, from two to twenty ounces; but some have been found weighing as much as twenty pounds.

The cachalot grounded near Bayonne in 1741, had in its inside a piece of ambergris of twelve pounds weight. A whaler obtained forty pounds from the entrails of one single whale, and more than 100 pounds from another. The East India Company possessed one mass of 150 pounds. Valmont de Bomare saw a pile in 1695, weighing two hundredweight. It is said that foxes have a great partiality for ambergris, and that they come to the sea-coast in search of it. They eat it and return it exactly in the same state as they swallowed it, as regards its perfume, though changed in colour. To this taste is due the existence of white ambergris, which is found at some distance from the sea, in the province of Aquitaine, and which the inhabitants call *ambre renardé*. This second produce of perfumed substance has thus travelled through the digestive systems of two different mammals, and still retains its delicate odour!

CHAPTER XLV.

THE DOLPHINS.

AMONG the smaller members of the cetacean family are the *Dolphins.* According to Oppien, they are "the pride and delight of the waves." In every sea they are found, glancing through the water, darting hither and thither with great agility, and at the same time flinging back from their shining skins a play of colours, pleasingly mixing with the spray which flies as they bound and play upon the surface. The common dolphin (*Delphinus delphis*) is distinguished by its long, pointed snout from the porpoise (*Delphinus phocæna*). Its mouth is furnished with a regiment of teeth. There is the head of a dolphin preserved in the Paris Museum, which exhibits no less than 104 teeth in the upper jaw, *i.e.*, fifty-two on each side; and ninety-eight in the lower jaw, forty-nine on each side, making altogether 202! These teeth are very small and even, white, sharp, and slightly curved. Dolphins are not deficient in intelligence, but Greek and Roman writers have singularly exaggerated their talents. They believed that they were sensible to the charms of music, and that they often rendered signal services to man. Pliny relates very gravely, that, in his own time, on the coast of Narbonnensis, dolphins used to help the fishermen in their work by catching fish for them, and were rewarded for their trouble by a portion of the fish, and often by bread soaked in wine. It is even said that dolphins have been known to carry men on their backs; and a tale is told of one which was very tame, and upon losing sight of the child it loved, died of grief.

Dolphins swim more rapidly than a bird can fly. They are often harbingers of a fresh wind, and flock from the farthest point of the horizon, gambolling upon the waters, as if to salute the vessel. Sailors look upon their arrival as a happy omen. Whole troops will follow ships for many days, bounding along in front, chasing each other, diving under the keel, and re-appearing to begin afresh their gambols. These shoals consist of five or six, rarely of more, though troops of twenty may occasionally be seen. When they are hunting their prey, they always go in packs, like wolves.

They show to each other a sympathy which is truly remarkable, and far more real than their supposed affection for the human race. As soon as one of a party is taken, the rest come near and surround it till it has been drawn up on deck. Then they all go off together, and will not eat anything, whatever may be thrown to them. This is the case only with old ones that have grown cunning and suspicious. If a troop of little dolphins are met with, they will all remain feeding round the vessel, as if they were curious to ascertain for themselves what had become of their companion, and by this means they are all captured.

The largest known kind is the *Delphinus orca.* One was caught in the Thames in 1787, twenty-six feet long, and another in the Loire in 1793, twenty feet long. It is asserted that they sometimes measure even thirty-four feet. A female and its young were cast on shore near Ostend in 1844. This fine dolphin was black on the upper part of the body, and white underneath. It had a white spot, in the shape of a cross, on the head, above the eyes. Its teeth were conical, and rather hooked. This dolphin is considered the most formidable of the cetacea which visit our shores, and will attack the largest animals of the sea: it will even pursue the whale; a troop will torment the king of the cetacea till he open his mouth, and then they will devour his tongue (Cuvier). Nothing is more interesting than to hear the tales of the ferocity and gluttony of these dangerous animals related by the fishermen of Greenland and Spitzbergen.

On the 1st of August, 1862, a fine dolphin was stranded on the coast of Jutland. Information was immediately sent to Professor Eschricht, of Copenhagen, who repaired to the spot. The first thing the naturalist wished to discover was how the monster had been fed during the last hours of his life; and, on examining, *thirteen porpoises* and *fifteen sea-calves* were found in his stomach!

The dolphin fishery is one of the most important and lucrative occupations of the inhabitants of the Faroe Isles. The species chiefly frequenting these islands is the *Delphinus globiceps,* or round-headed dolphin—remarkable for the extreme projection of its forehead, which has the appearance of an ancient helmet. This dolphin lives in large flocks, headed by one great leader. Lemaout, Professor of Pharmacy at St. Brieuc, found seventy cast on shore near Paimpol. In 1806, ninety-two were washed on shore in the Bay of Scapay, in Pomona, one of the Orkneys. As many as three hundred were driven on the coast of Shetland the year before. Scoresby has seen a thousand in one single troop.

No sooner does a fisherman on the Faroe Isles discover a shoal of dolphins, than he immediately makes known the fact to the inhabitants of the coast by hoisting a particular flag. They hasten to the top of the mountain, light a turf fire, and by this telegraphic signal, announce the joyful news to all the islanders. Columns of smoke float in the air, fires gleam from point to point; their number and position indicate to the farthest dweller in those islands where the dolphins are to be found. The fisherman instantly launches his boat from the shore, his relatives and neighbours hasten to join him; women make ready their provisions, and they eagerly rush on board. To this day, at Thorshaven, the capital of the Faroe Isles, there is a commotion excited on these occasions, which no stranger would imagine. Women and children run wildly through the town, crying out, "Gryndabud! gryndabud!" (News of the dolphin). At this welcome cry, every door opens, and every family is in uproar. Each one tries who can first reach his boat, who will first spread sail, and whose oar shall be the first to cut the wave. The governor and the "Landfogde" hasten also, heading the expedition in their barge, manned by ten huntsmen in uniform, and with the Danish flag flying at the mast.

When all the fishermen are assembled at the place indicated, they arrange themselves in order of battle, and advance, according as the position of the ground permits, either in a close column, or in a semi-circle. They enclose in this barrier the astonished dolphins, pursue, and drive them till they reach the end of the bay, where the circle closes upon them, and they are captured between the boats and the land. On one side, they are attacked by the fishermen armed with lances or pikes, and on the other side is the shore, where the first imprudent movement will inevitably strand them. Soon follows a horrible carnage. The fishermen strike, strangle, massacre by any means; blood pours till the sea becomes quite red, and those fish which might have a chance of escape, lose their characteristic agility in the poisoned waters, and perish like the rest, by the thrust of the harpoon. The victims may often be counted by hundreds. When all are killed they are dragged to the beach. The "sysselmand" estimates the value of each animal, and chalks his estimate on the back. The governor makes the division of the spoil; first, a portion, which is called *tithe*, is taken for the king, the church, and the priests; another for the authorities and functionaries; a third for the poor; and a fourth for those who join in the fishery, so much for each man, and for each boat. The man who was the first to discover the shoal, has a right to choose the finest dolphin. Those men who have been wounded, or who have suffered any loss during the expedition, have an additional share; another portion must be reserved for the proprietor of the land where the fish were caught, and this portion generally falls also to the king, who is the supreme owner of the whole land. When the division is over, the animals are cut into pieces; the skin is taken off to be made into leather, the flesh and fat form the best provision for the Faroene household. Oil is procured from the fat; and the bladder, when dried, serves as a vessel for the oil. The entrails are carried by the boats out to sea, to avoid any infection arising from their decomposition on the land. A dolphin of average size yields usually a tun of oil, which sells at Thorshaven for twenty-five or thirty shillings. The flesh and fat are worth about as much.

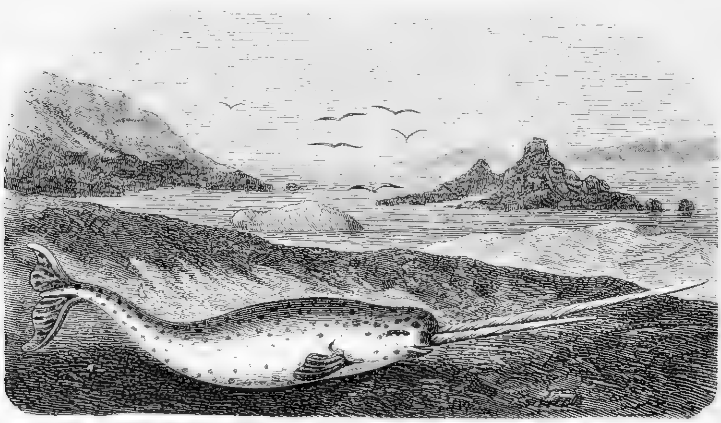
Audubon relates that during a long calm a troop of splendid dolphins played about the sides of his ship, sparkling in the light like burnished gold, and equal in brilliance to meteors at night. The captain and sailors cleverly contrived to catch some of them with hooks, or by piercing them with an instrument with five points, called a pike. When the dolphin feels the hook he struggles violently, and rushes impetuously to the end of the line, when, finding himself suddenly stopped, he leaps high up out of the water, and often manages to detach himself. When he has been fairly caught, the experienced fisherman allows him to play, when he soon becomes exhausted, and is drawn upon deck. Some people prefer to draw up the fish at once, but they seldom secure him, for his rough jerks, when out of his own element, generally enable him to escape.

The most common of all the cetaceans is the *porpoise* or *porpesse*—a name derived from the Italian *porco pesce*—hog-fish. It appears in almost all the European seas and on the American coast. It is about six feet long, bluish black on its back, and white underneath. The dorsal fin is placed in the middle of the back; both jaws are furnished with numerous small teeth. The whole body of the porpoise is covered with a layer of fat an inch thick, and the flesh which is found beneath is pink, and eats not unlike pork. The porpoises swim in shoals, called *schools* by the sailors; and thus in company hunt mackerel, herrings, and salmon, spreading terror and consternation wherever they appear. They frequently approach the shore, where they are found rooting up the marine vegetation with their snouts, like pigs.

The *grampus* is a larger though less common cetacean than the porpoise. Though a native of the north seas, it is frequently found on the coasts of these islands. Its length is some twenty-four feet; it is extremely fierce, and proves a destructive enemy to its relations the dolphin and porpoise; it is said even to attack the giant of the tribe—the whale.

Narwhal or *Sea Unicorn,* an inhabitant of the Arctic seas, is a huge cetacea, bold and active, armed with a powerful and terrible instrument of attack. The narwhal is from twenty to thirty feet long. He has projecting from his snout a sort of great halberd, a long sword of ivory, spirally drawn to a point. This enormous tusk springs from a socket in the maxillary bone of the upper jaw, and measures often six feet from the end of the snout. This weapon used formerly to be called the unicorn's horn. There are two preserved in the Museum of the Faculty in Paris, the larger is six or seven feet long, and at the base measures twenty inches in circumference. These tusks were formerly part of the treasure in the Abbey of St. Denis. With what object these unicorns' horns were preserved by the abbots we are not informed. The corresponding tusk, that is, the one in the under jaw, is never so much developed, and frequently remains hidden in the jaw.

The narwhal is of a greyish white colour, with white spots which seem to penetrate the skin. In the stomach of one the arm of a cuttle-fish was found, and also pieces of a flounder. Scoresby relates that during his voyage to Greenland he met a great number of these animals, which swam near the vessel in troops of fifteen or twenty. Most of them were males. They seemed very lively, and often lifted their weapons above the water and crossed them, as if presenting arms. They produced a most



NARWHAL.
(*Monodon monoceros.*)

extraordinary noise, resembling the gurgling of water in the throat. Most of the troop followed the ship, and seemed led by curiosity. The water being transparent, they could be seen dipping down as low as the ship's keel, and playing with the rudder. The narwhal is hardly to be recognised in the passages in which Pliny describes the sea-unicorn. He attributes to it the head of a stag, the feet of an elephant, and the tail of a wild boar, all which, he adds, does not prevent its resembling a horse! Its horn, he says, is black, and springs from the middle of the forehead!

Some kinds of dolphins are eaten. What, indeed, is there that man does not eat? The smallest are reckoned the most delicate.

In the middle ages, the flesh of the porpoise was much esteemed. In 1426, several were bought for the table of Henry III. The Bishop of Swinfield, who lived at that period, feasted upon porpoises whenever he had an opportunity. At a sumptuous banquet prepared for Richard II., at Durham House, some of these animals were served. It is said that, at the solemn installation of Archbishop Neville, four of these cetacea occupied a prominent place in the feast. In 1491, the bailiffs of Yarmouth presented a fine porpoise to Lord Oxford, accompanied by an address, in which they said that they made him this present because they thought nothing could be more acceptable to his lordship. At the wedding banquet of Henry V., many highly-flavoured dishes appeared, prepared from the flesh of the dolphin. At the coronation feast of Henry VII., porpoises were again found in the *menu;* they were both boiled and roasted, and pies and puddings were made of the flesh. Queen Elizabeth herself, who had a very refined taste, was fond of porpoise. It was sold in English markets up to the year 1575, when it ceased to be esteemed.

CHAPTER XLVI.

WHALES.

WHALES are the largest of all the inhabitants of the sea, and the greatest of all known animals. The Greenland whale (*Balæna mysticetus*) in very early times attracted the attention of mariners and naturalists. It has been observed that this gigantic beast must necessarily have been aquatic. If it had been a terrestrial animal, what legs could have supported it? If it had been aerial, what wings could have borne its weight? Providence therefore placed the whale in the water, and gave it the form of a fish, to enable it to move with ease and celerity. The dimensions of the whale are such, that we may compute them by the greatest terrestrial measurements. Authors declare that specimens have existed whose length equalled the hundred thousandth part of an arc of the meridian! Lacépède affirms that a whale placed upright against Notre Dame would be one-third higher than the tower. Making allowance for the exaggerations of sailors and naturalists, we may consider that the largest whales are from 80 to 100 feet, and even sometimes 130 feet long. Quite recently —April, 1863—on the coast of Dunkirk was found an enormous whale, cast on shore by a violent gale from the south-east. This leviathan of the deep was ninety-seven feet long, and sixty-five feet in circumference. The agony of the poor animal lasted nearly two hours after he was thrown on the land. In his last struggles he made the sand fly 300 feet from the shore, and a frightful hissing announced that nature had at length succumbed. It has been asserted that the weight of this prodigious creature reaches even 250 tons. A whale which was found by Scoresby to be more than sixty feet long, weighed seventy tons.

The body of the whale is a colossal and irregular cylinder, the diameter of the smallest part being about one-third that of the

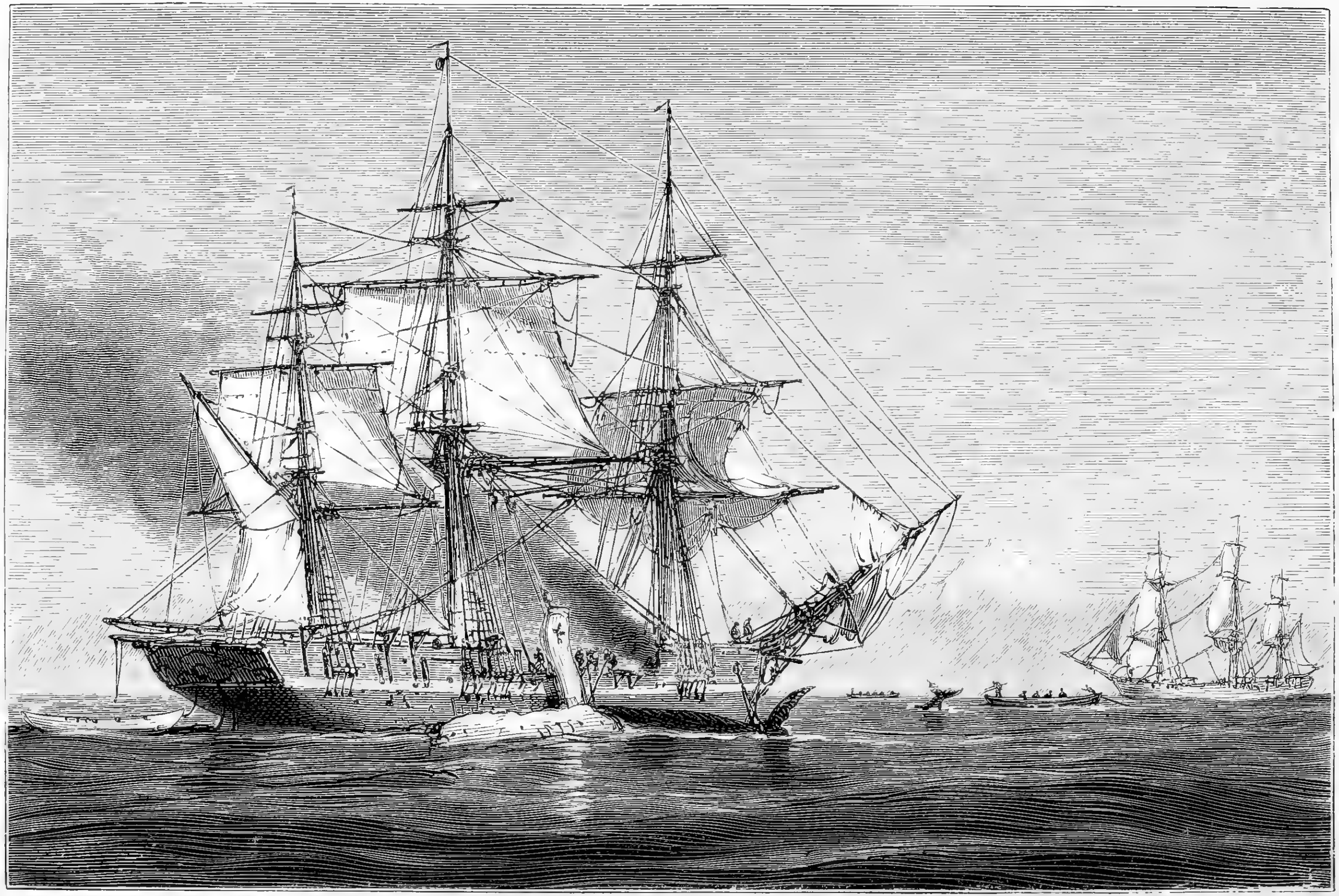
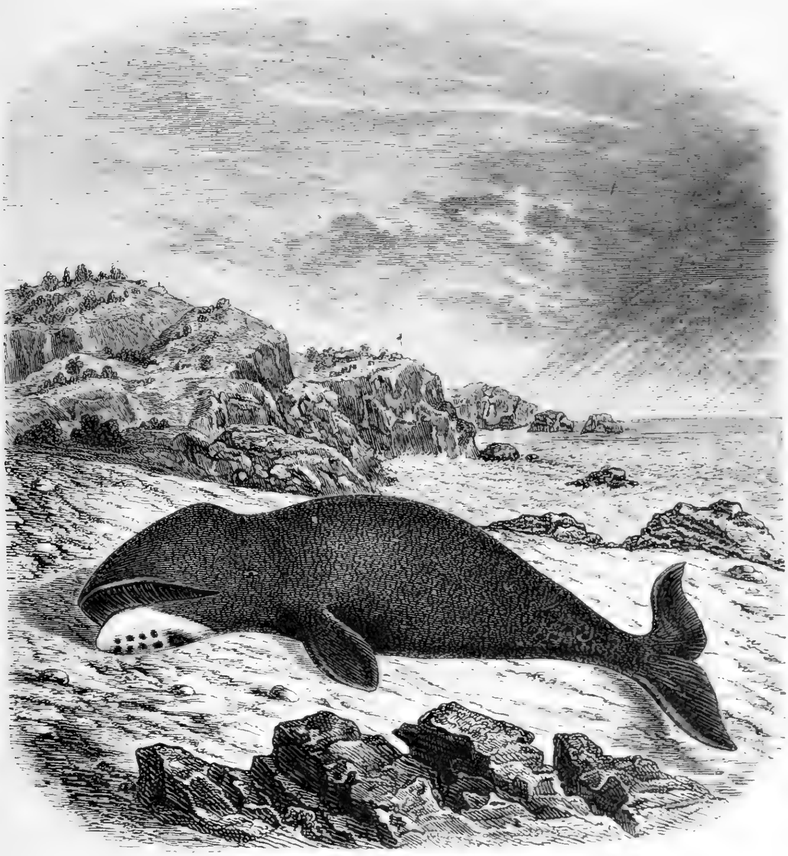


Plate XVII. CATCHING AND CUTTING UP THE WHALE.

greatest. It has no hair or scales, but is covered with a smooth black leather, hard and thick, under which there is a cushion of fat one foot thick. There are, however, some hairs on the skin of this giant of the ocean, particularly when young. The head is so



THE GREENLAND WHALE.
(Balæna mysticetus.)

enormous as to form one-third of the total weight of the animal; it is in the form of an arch. This truly colossal head, when seen at a distance rising above the surface of the sea, resembles a dark brown hillock.

The mouth is prodigious; so huge is it that two men were able to stand without stooping inside the mouth of a whale seventy-eight feet long, caught in the Bay of the Somme. The upper jaw has about 700 vertical plates of a horny substance, edged with a pendant fringe on each side of the mouth. These plates, known in science by the name of *barbs,* and in commerce by that of *whale-bone,* are often twelve or fifteen feet in length. The tongue is monstrous; it is said to be often twenty-four feet long, and twelve wide, and the oil expressed from it fills five or six hogsheads. Properly speaking, it is not a tongue, but a thick, soft, heavy mattress, consisting entirely of fat, spread out on the lower jaw. It is fastened down throughout the whole length, and is consequently immovable. We can hardly imagine a tongue that cannot be put out of the mouth.

The whale feeds upon medusa, mollusks, and other small marine animals, which are washed into his mouth by the water. The monster swims on the surface of the sea, with his mouth open; he has only to close the huge portals, and he imprisons a whole population; the water, strained through the sieve or net formed by the barbs, which are like a forest of close fibres, leaves behind it all the small fish and other animals which form his prey. For each meal thousands of victims are required. It is a law of Nature that large animals feed upon small ones, and sometimes the very large consume the minute, as in the case we are considering, for the animalculæ swallowed by this giant of the deep are only a few inches long, but the number consumed compensates for their diminutive size. It has been shown that these tiny inhabitants of the waters multiply by millions; and if their destruction were not so provided for as to counteract their fecundity, their numbers would in a few generations absolutely crowd the ocean. It is a strange sight to see this huge leviathan pursue pitiful creatures made of gelatinous matter, without shape, without consistency, and so small as to be barely discernible. It is supposed, however, that from time to time the whale does eat fish, and even tolerably large fish; a tunny was once found whole in a whale's stomach.

Though whales live like fishes yet they breathe like quadrupeds. It is said that their breath is tainted with an insupportable odour, putrid, and almost cadaverous, and that their snoring can be heard from afar! Their circulation is on no less gigantic a scale. In the

Museum of the Faculty, in Paris, there is a vertical section of the aorta, one of the large blood vessels of a whale; it is so immense that a child might pass through the pipe, which is eighteen inches in diameter, the walls being two inches thick. What an enormous column of blood must this vast channel have conveyed.

The weight of the brain of a whale is scarcely the twenty-five thousandth part of his total weight. Though endowed with tremendous strength, this animal is very timid; and when pursued, he invariably tries to escape and will not fight. He has many tormentors, from which he cannot always escape, or even defend himself. Sword-fish pierce him, and porpoises tear away large pieces of his flesh.

The diameter of the eye is equal to the one hundred and ninety-second part of the total length. Professor Carus compares the whole volume of the ocular globe to an orange, and Dr. Gros, to the head of a new-born child. The pupil is transversal, and oval like that of a ruminating animal. Though these immense mammiferous fish have no legs, they swim with great swiftness, and they gambol in the mountains of water lashed up by the storms. They use their two arms admirably, as fins, or oars, and their enormous tail, which is composed of two great lobes, is a tremendous power to propel them through the water. Accordingly, when the whalers wish to lessen the speed of a whale which they have harpooned, they aim all their blows at the tail; with a very sharp triangular pike they inflict sometimes as many as fifty vigorous slashes in the root of the tail, and thus lessen by one half, the speed of the retreating animal. When the whale strikes the water with its tail, it causes a loud clapping.

A whale is said to swim on an average ten miles an hour; but when pursued or wounded, he moves much more swiftly. Sometimes he will lift himself entirely out of the water, and fall down violently, thus producing a miniature waterquake—if we may be allowed to coin a word—which may be felt at a considerable distance.

Whales are not insensible to affection; the male always accompanies his mate. In 1723, a pair were met travelling through the ocean; perhaps it was their honeymoon! They were attacked and wounded; one being killed, the other threw himself upon the beloved body, uttering frightful moans. At the mouth of the Elbe, the same year, eight females were stranded on the bank; soon after, their eight husbands arrived to visit their corpses. The male always follows his wounded partner and remains with her. The female does not show the same tenderness or care.

Like all mammalia, the whale suckles her young. How much of the precious nourishment does she give at each meal? She exhibits for her nursling very ardent and courageous attachment. When a little whale has been harpooned, the mother will not be long in coming to his help; she comes close to him when he rises to the surface of the water to breathe; she seems to excite him to flee; sometimes she dives beneath him, and bears him on her back; while he, slipping, and often upset by the action of the waves, tries hard to support himself, by clinging to his mother with his two fins. She very rarely abandons her young while he lives. While so engaged, the mother whale may easily be wounded, for she forgets entirely her own safety, that she may devote herself to the preservation of her offspring. She rushes amongst the enemy, disregarding all dangers; even, after being several times wounded, she will stay near her young one, if she cannot drag him away with her. In her maternal agony, she swims to and fro, beats the sea violently; and the wildness of her movements is a certain sign of the poignancy of her grief.

Those species of whale which have a fin on their backs, and large folds on the belly, are called *Rorquals*, or razor backed. The body is not so cumbrous as that of the ordinary whale; hence they swim more rapidly, and when they dive, they can remain longer under water, for these reasons the fishermen seldom give them chase.

Rorquals are, as a family, still larger than whales; Scoresby speaks of one that was one hundred and twenty English feet in length. These animals are the real giants of creation. In 1828, a very fine rorqual was cast on shore at St. Cyprien, in the eastern Pyrenees, which has been described by M. Companyo.

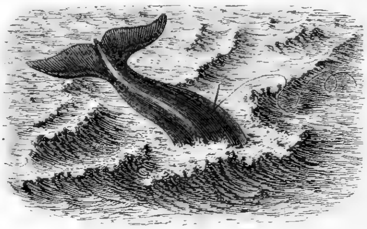
Of all the great fisheries which are carried on in different parts of the ocean, that of the whale or the rorqual is without doubt the most famous, difficult, and perilous. Formerly, large whales used to be caught in the temperate regions of the ocean, and in the Mediterranean Sea. We learn from various legislative enactments that until the twelfth century, these animals were found in tolerable numbers in the Bay of Biscay, and were the source of a regular fishery. At the present time, these large mammals have become so scarce that their appearance in these very seas is looked upon as an actual phenomenon.

Cuvier believed the whale of the Bay of Biscay to be the same as the polar whale, but Professor Eschricht, of Copenhagen, has decided that they are two different species.

The first whalers appear to have been Basques; subsequently the Asturians joined in the fishery, then the English, and afterwards the Dutch. The scene of these fisheries has frequently changed shores, and has passed from the south to the north. In ancient times, the eastern coast of Greenland was considered one of the best stations, but that part of the sea is now entirely deserted. For a long period the Esquimaux have ceased to depend upon these colossal animals, for they only resort now to the neighbourhood of Holsteinborg, and that very rarely. English fishermen have entirely banished the whale from Baffin's Bay. Thirty years ago, as many as one hundred ships, belonging to different nations, were employed in whale-fishing in Davis' Straits. Now, hardly five or six vessels visit those shores, and their booty is very uncertain. The fishery has travelled gradually from the Azores to Brazil, from Brazil to the south coast of Africa, thence to Chili and Terra del Fuego, and then to New Holland and New Zealand. At present it is carried on in the Sea of Japan, and on the shores of Kamtschatka.

The ships employed in the whale-fishery are generally of 350 or 450 tons, and their crew consists of from thirty to five-and-forty men. Each canoe is provided with a harpooner, who stands in the prow, four rowers, and a steersman who takes the hindmost oar; they carry with them four harpoons and two lances. The harpoon is about three feet long; the shank is of iron, its lower end is flattened into a triangular shape, with two diverging points turning inward like a hook. To this shank is fixed the handle by means of which the weapon is hurled. This handle is a stick about three feet and a half long. Below the socket is fastened a ring of twisted hemp, in which runs a line or rope 300 fathoms long and an inch thick. The spear or lance is of iron, ten or twelve feet long, including the shaft; at the extremity it is flattened into a pointed oval, with very sharp edges.

When the ship has arrived in the regions frequented by the whale, two sailors are generally appointed to keep watch on the main-topmast, and the mizen-mast. The moment either watchman perceives one of these animals, he gives the signal. Small boats are immediately launched, and the whale is approached quietly, so as not to alarm it. Whichever boat first gets to a convenient distance, commences the attack. The man standing



A HARPOONED WHALE.

in the bow, hurls his harpoon, which he must do with all the skill and strength that he can command. The giant of the waves, on feeling himself wounded, gives a violent blow with his tail, and plunges into the depths. The line attached to the harpoon runs out with tremendous rapidity, and drags the boat with frightful swiftness, ploughing the waters which rise in mighty waves, and shut out the horizon from the sailors' view. The boats are very carefully kept away from the posterior part of the whale, for this dangerous neighbourhood might prove fatal to the expedition. When the whale plunges, he erects his tail, which vibrates for a moment in the air, and falls flat upon the water with a crash which would dash a boat in pieces. Imagine for a moment, the huge monster wounded and enraged, and there can be no doubt that these convulsive movements are very formidable. The line runs out with such force and rapidity, that the sides of the boat would catch fire, if water were not poured over it from time to time. If by any mischance, the cord is stopped or entangled, the boat is instantly upset and the crew thrown into the water. After awhile —ten or fifteen minutes—the whale reappears on the surface; often at a great distance from the place where he was last seen. A terrible accident sometimes happens at the moment when the whale rises. The boat may be thrown up from below and upset; but this rarely occurs. Scoresby relates, that Captain Lyons, in 1802, when fishing on the coast of Labrador, perceived near his ship, an enormous whale. He immediately sent four boats to give chase, two of which overtook the animal at the same time and darted their weapons into him. The whale, feeling himself wounded, plunged, but quickly rose to the surface immediately under the third canoe, which had endeavoured to take the lead, and hurled it into the air like a bomb. The boat was flung more than fifteen feet out of the water, and being turned completely over, came down keel upwards. The men clung to another boat that was within reach, and one only was drowned. When the whale comes up to the surface he is struck by a second or third harpoon. Finally, he is dispatched by blows of the lance. No sooner is the animal dead than he is towed to the ship, made fast to the side, and cut up into pieces. First, the fat portions of the head, the lips, throat, and tongue, are taken off with the bone of the upper jaw, and the barbs. Then a strip of fat, about two feet broad, is torn off round and round the body, and hoisted up by means of proper tackle. This operation may be illustrated by peeling a pear spirally, from the large end to the stalk. When the strip is hoisted to the top, a longitudinal incision is made with a double-handled knife, into which the second hook of the pulley is fixed, and this again is drawn up to the top. The strip, when entirely cut off, is lowered into the hold, and cut into small pieces for melting. In order to peel off the strip of fat, two of the officers of the whaler stand outside the ship, on small scaffoldings. The foremost one marks the band round and round the body, the other helps in separating it from the flesh; the remains are finally abandoned to the porpoises, bears, and aquatic birds.

The whale-fishery has still greater perils to encounter than those we have mentioned. It is related, that an American ship, the *Essex*, in November, 1820, when in the South Seas, descried a number of whales, and directed its course towards them. Having arrived in the midst of these animals, according to custom, the small boats were let down into the water. The little fleet advanced rapidly, and the ship followed at a short distance. Suddenly, the largest of the whales, which seemed to consist of a family party, left the rest, and disdaining the small boats, rushed straight at the ship, which he justly suspected to be his principal enemy. At the first shock, a portion of the keel was broken; the animal then endeavoured to seize the ship in several places, with his gigantic jaws, but not being able to manage this, he retreated about six hundred feet, and dashed with all his strength against the prow of the vessel, driving it with a velocity of four knots a second. This caused an immense wave to rise, and the water pouring into the windows, filled the cabin, and laid the ship on her side. The boats vainly tried to save her; when they arrived it was too late. All they could do was to break in the deck, and snatch a small quantity of bread and water, for the supply of the boats' crews.

In the northern seas, the capture of a whale is quite a fortune. When the Esquimaux catch sight of one of these monsters, they at once put on all their best clothes. These are probably the only occasions on which men and women indulge in washing and adorning themselves. It is asserted that they are specially careful not to put on any garment which has ever been in contact with a human corpse. If this precaution were not observed, the whale would instantly take flight when the wearer of the garment approached, even if it already had several harpoons in its body. We venture to question this assertion! However this may be, all suitable arrangements being made, the little fleet starts; they harpoon the animal, perforate it with blows from javelins and spears, till it becomes exhausted and dies. The whale is then dragged to the coast and divided, while half the body is under water. Those who have been present merely as spectators of the struggle have a share in the partition, as well as all those who have actually taken part in it. Men, women, and children, scramble round the prize, each one tries to help in cutting it up, and every one is anxious to seize the largest piece. For some days the whale becomes a sort of larder, to which every one comes to take his daily portion.

Linnæus says that the oil furnished by a single whale is often so abundant as to form the cargo of a vessel. This quantity is estimated at twelve tuns. The fishery of this valuable animal in the polar seas has yielded in 1859, 2,078 hogsheads of oil; in 1860, 1,909 hogsheads, and in 1861, 1,710. These last 1,710 hogsheads were all taken by ships from Dundee, except 697 belonging to ships from other ports.

In 1861, a great change was made in the material of the weapons and vessels employed in whale-fishing. Screw-steamers were substituted for sailing vessels, and the results of the second season were sufficiently encouraging to induce fishermen to continue their attempts. In consequence, a great number of sailing vessels were sold, and it seems acknowledged now that the question is settled, and that in future operations will be carried on by screw-steamers. Thus the polar seas have not been inaccessible to the onward march of science.

CHAPTER XLVII.

SEALS.

SEALS are less aquatic than whales, coming on land from time to time. They possess four fins, and have a thick, hairy skin; being but little removed from quadrupeds. The form and habits of the seal have given rise to the fables of tritons, and sea-nymphs. The legend of Proteus keeping the flocks of Neptune sprang doubtless from the imperfect observation of these aquatic mammals, for they may be seen in large numbers sporting in the waves, or scrambling up the shores when the tide is out, or resting on the rocks which lift their peaks above the water, as if enjoying the pleasant rays of the sun.

The *Phoca vitulina*, or common seal, is pretty abundant in our latitudes. Many are found in the Adriatic Sea, and the Archipelago, and in some parts of Africa. They are also to be met with in the Atlantic; troops of them live in the estuary of the Somme. Fishermen give the names of sea-wolf and sea-calf to the seal.

The body of the seal is long and slender, covered with a close and silky fur. Its head is like a dog's head with the ears cut off. It has strong whiskers, a moustache like a cat, fine eyes of the greenish hue of the sea, soft and limpid like a child's. Its sight and hearing are very keen. The nostrils are provided with a sort of tiny door or valve, which can be shut or opened at pleasure, and which prevents the water running into the nose. Two strong and very long pairs of fins serve instead of arms and legs; the hind fins are united to the tail and form on each side a flap resembling two great ears. The food of the seal consists principally of naked mollusks, crabs, and fish, but it will readily eat vegetables and fruit, and exhibits a decided partiality for moistened bread.

Though the seal is a wild and timid animal, yet he has a very gentle and soft expression, and a pleasant countenance. He is not wanting in intelligence, and is capable of being tamed and even educated. A poor, unhappy seal may sometimes be seen in a menagerie, kept a prisoner in a tub, looking badly fed, sick, and pitiful; but the keeper will boast of its fine qualities, which consist, after all, in knowing the voice of the keeper and coming familiarly to take a fish or bit of bread when he offers it.

The cry of the seal is soft and flute-like, and recalls certain sounds common to all languages, such as the syllables *pa-pa*, or *ma-ma;* hence the credulous conclude that these animals have learned, or might learn to speak. It is quite incredible that they can pronounce words—"Cake," "Coffee," "Eat," "Thank you;" and still more that they should say, "Vive le Roi," "Bonjour, monsieur," "Je suis français," as a seal exhibited in Paris was declared to be able to do.

Seals may be kept alive for many years, if they are fed with fresh fish, and allowed water enough to swim in.

Some modern naturalists believe that it would not be impossible for man to subdue these agile animals completely, and make them useful. Frederick Cuvier says it is astonishing that fishermen have not trained seals to fish, just as the huntsman trains dogs for the chase. M. Babinet, recently, has dwelt upon the numerous services which seals might, with proper training, be taught to perform. He would like to see them even in our rivers.

For many years, two seals have lived in the Zoological Gardens, at Amsterdam. They are kept in a large pond of salt water, and we are told that they have twice had young ones. They not only distinguish the voice of their keeper, but they hear afar the sound of his footsteps; and no sooner do they recognise his approach, than they utter joyful cries, and rush to meet him. An old man, accompanied by a little girl and a tiny French poodle, often came to see these two seals, and brought them delicacies to eat. The seals would come out of the water, crawl to their friends, and sit down with them, and enjoy themselves on the sand. They would frolic about, play tricks, and share like brothers the fruit or cakes from the little girl's basket. One day in the midst of these games, the dog missed his leap, and jumped over the seal's head and fell into the pond. The poor dog struggled for a moment, and disappeared. The two seals instantly uttered a cry, crawled as fast as they could to the water's edge, and plunged in. In the twinkling of an eye the male reappeared, holding carefully in his mouth the half-drowned dog, which he placed at the little girl's feet.

The seal swims well, is an excellent diver, and can hold his breath for a considerable time. His movements are remarkable for their elegance and swiftness. He comes occasionally to lie down or sleep on the sandy beach, but takes care not to go further than eighteen or twenty feet from the water's edge. On the slightest alarm he leaps into the sea, and swims out to deep water.

The seal has an ugly, ungraceful gait on land; he drags himself rather than walks, advancing by means of frequent, short jumps, produced by the contraction of the whole body, the front fins being pressed tightly against his sides.

Each seal repairs to one portion of the rocky shore, with his family, and makes it his home and exclusive property; the intrusion of any stranger leads at once to a terrible fight. Every family lives at some distance from its neighbours. The male assembles together a sort of harem of females; he seems to have great affection for them, and defends them boldly; he has sometimes as many as fifty.

When young, the males fight with fury for their mates, but when they are old, the females abandon them. When the female is about to bring forth her young, her mate conducts her to the shore, to some spot carpeted with marine plants. Here the mother deposits her young, and evinces towards it a devoted attachment. The little ones play and gambol together. But when they have attained the age of five or six months, the father considers them strong enough to live alone, and he drives them away to find a home for themselves.

The seals of the Somme are the objects of a sport full of attractions for those who are fond of it, and they furnish a branch of maritime industry which is of some importance. M. de Rylé has published very interesting accounts of these hunts. The most favourable season is the month of June, when the females are accompanied by their young. The little ones are not so cunning as their parents, and are easily surprised; the old ones being reluctant to abandon their young, are thus decoyed within the hunter's reach. There are two ways of hunting seals, either on water or on land. In order to shoot them on land, the hunter must seize the moment when the animals happen to be at a short distance from the shore, which he is seldom able to do. The hunters pull down the stream in boats, and fire on any seal they may surprise on the shore. Guns of great precision and of long range are used, for the animal, frightened at the sight of the boats advancing towards him, runs off very quickly, and it is necessary sometimes to fire at a distance of 200 or 300 yards. At other times the hunter silently steps on shore, leaving a sailor in charge of the boat. He creeps along the beach, crawling like a savage who wishes to take his enemy by surprise; and often goes in this way for a mile or more, pushing his rifle in front of him. He stops at intervals to give the animal he is aiming at time to recover itself if it has been disturbed, and, in fact, takes every precaution to conceal himself, till he finds that he is within range. M. de Rylé has graphically described the cunning and patience necessary for a successful expedition. The pursuit of the seal in water is more simple, but not so certain. The seal is fired at the moment he shows his head above the surface. But it must be remembered that the animal only raises his head for one minute, and immediately dives again; and even where the huntsman is skilful enough to make sure of hitting him, there is still risk of losing the prize; for if the seal be only wounded, he makes for the open sea; and if he is killed outright, he sinks to the bottom of the water, and is not easily recovered.

Seals are classed in two different groups:—The *Ottary* has an external ear, an aperture of a peculiar form. This species may be met with in the Pacific Ocean. Seals, properly so called, have no external ear, and have a pointed incision or aperture. Greenland is frequented by many different kinds of the common species of seal—the *Hooded Seal* (*Phoca cristata*); the *Muller* or *Greenland Seal* (*Phoca Grœnlandica*); the *Schreber* or *Ursine Seal* (*Phoca hispida*). These northern seals are hunted in the open sea, with harpoons. The harpoon is about six feet long, and has at the end a movable point of iron, set in bone, and fastened by a leather strap which can be loosened the moment the harpoon strikes the animal. A bladder floats at the end of the line, which is attached to the loose point, and thus marks the spot where the wounded seal has dived. The harpoon slips on a swivel of highly polished wood, this gives it more force, and ensures its following the right direction. Other projectiles are arranged in the same way, and are darted by similar means.

The seal is obliged to come to the surface of the water in order to breathe; the moment he shows himself, the Esquimaux tries to surprise him by keeping on the windward side, and turning away from the sun, so as to be neither seen nor heard. He crouches down in his little boat, to conceal himself as much as possible behind the waves. When within thirty yards, he snatches his paddle in his left hand, adjusts the harpoon upon the swivel, and hurls it with all his might. If his aim is correct, and the seal is struck, the iron head detaches itself from the shaft, and the rope unwinds from the bobbin. The bladder at the end of the line is instantly thrown into the water. The seal, when pierced, plunges with extreme velocity; for, like all marine animals, it seems to be impelled by instinct to dive when wounded. The fisherman gives a turn to his paddle and draws up his floating harpoon. It happens sometimes that the seal drags the bladder with him, but as he must come up for breath, it will soon be seen again, and there is no fear of his escaping. The Esquimaux makes his way up to the animal, and wounds him deeply with his lance, and finally dispatches him with blows from his javelin.

When the seal is dead, the wounds are stopped up with small wooden plugs to prevent the loss of blood. The Esquimaux then inflates the body by blowing between the flesh and skin, makes it fast to the side of his canoe, and paddles home.

This sport is not without danger. Sometimes the line in unwinding gets twisted round the arm or neck of the fisherman. At other times, in the contortions of his agony, the seal leaping upon the kayack, overturns it, and often the man is drowned. Again, it may happen that when the pursuit is over, the seal is not dead, and throws himself upon the Esquimaux and tears his arm or face. These animals are particularly terrible when they are defending their young; they will then rush upon the kayack, and tear it in shreds. The waves then fill the boat, and the fisherman has little or no hope of escape.

Seal fishing is carried on in winter in the same country in quite a different manner. The Esquimaux discovers openings in the ice which the seal contrives to make when he comes up

THE SEAL.
(*Phoca vitulina.*)

to breathe. He watches till the animal makes his appearance, and then crawls softly along the ice, imitating the cry of a seal, and thus deludes the creature, who takes him for a brother, and only discovers his mistake on receiving a mortal blow.

The skin of the seal is much valued. The Esquimaux use it for making boats, kayacks, and tents; they also make of it belts, clothes, and shoes. An oil is made from the seal, much in request for burning, and it is frequently sold as cod-liver oil! The flesh of the seal serves the Esquimaux for food; of the blood a thick, substantial soup is made; its sinews are twisted into thread; of a transparent skin from the intestines they make curtains to their tents, shirts, and bladders for their fishing tackle. The bones are used to point all their instruments.

CHAPTER XLVIII.

THE MORSE.

Is there such an animal as the sea-horse, the sea-cow, or the sea-elephant? Certainly not, but there is a huge marine mammal, the morse (*Trichechus rosmarus*), which has been called by all these names more or less appropriately.

The morse inhabits the Arctic Regions, amid ice and icebergs. It is to be met with in Behring's Straits. It is larger and more ugly than the seal. Some have been known as much as twenty-five feet long; it may therefore justly be ranked amongst the monsters of the deep. The skin of the morse is thick, corrugated, and thinly covered with short hair, of a reddish, fallow colour. Under the skin is a thick layer of fat. The eyes are small. Its lip bristles with yellow hairs, semi-transparent, and of the thickness of straw. Out of its strong, heavy muzzle spring two large ivory tusks, long and slightly greenish, which form very hard and strong weapons of defence. These tusks are bent back like the head of a pick-axe; and the animal uses them to grapple solid bodies, or to root up plants in the sea, or even to scrape the ground at the bottom of the sea, and turn up the small animals which furnish its food. The morse has also grinders, and strange to say, the teeth in the upper jaw fit into the lower teeth like a pestle into a mortar. This animal evidently has nothing which claims for it any affinity to the horse, cow, or elephant. In fine weather hundreds of morses may be seen gambolling in the water, rending the air with their roars, which are like the bellowings of a bull. Others may be seen dozing or reclining idly in the sunshine. When they sleep there is always a vigilant sentinel, watching with outstretched neck and open eyes, who gives instant alarm to the troop if any danger threatens.

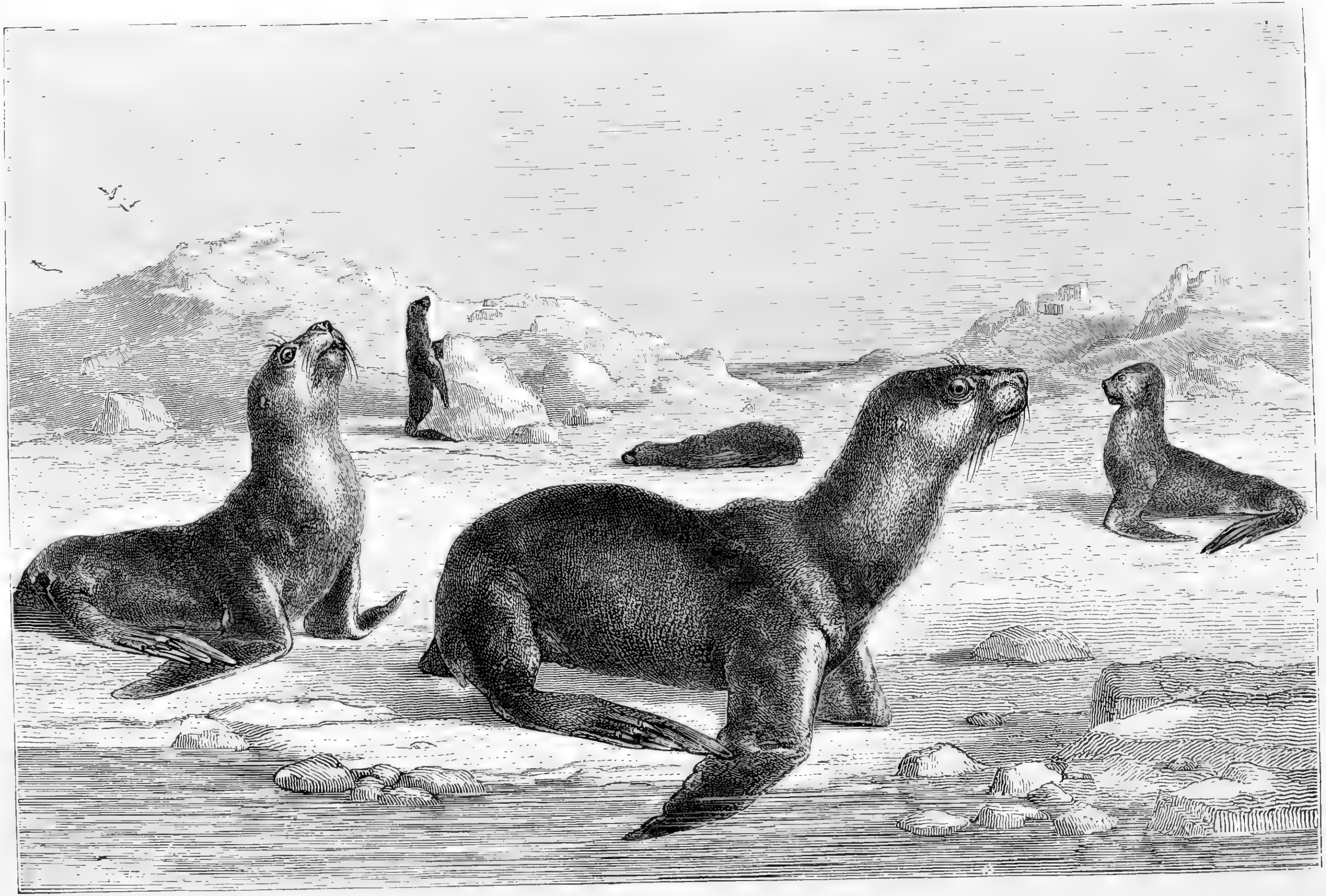


Plate XVIII. SEA LIONS UPON THE ICE.

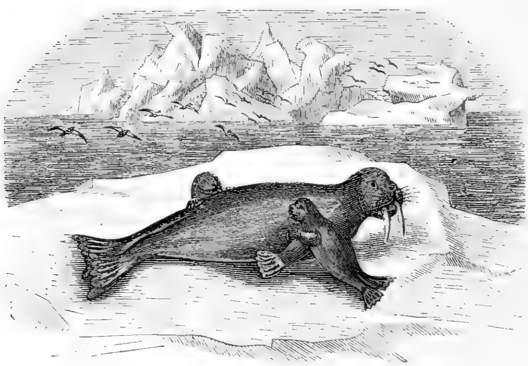
Several morses have been bred in the north of Europe. Their food was always oats or millet boiled in water. Some years ago one was brought to London, but he only lived a few days. He was fed on crabs, which seemed to be better food than oats or grain. A young morse of three months old also reached England. He used to be very angry—even furious, whenever he was touched, and the only thing that he could ever be taught was to follow his keeper, growling when he offered him anything to eat. All agree that the morse has less intelligence and gentleness than the seal. He is not fierce, and never attacks man, but he defends himself with indomitable courage. When pursuing the morse in the open sea, great caution is necessary, for a troop of these animals will often rush boldly against a vessel, surround, and overturn it.

In 1818, Captain Buchanan sustained a fight—a real battle—with some morses on the coast of Spitzbergen. One evening, a great number were seen from the vessel, moving in the direction of a plain of ice. Boats were immediately equipped to follow them. The herd in advance took to flight, but those behind arranged themselves on the ice so suddenly that the plans of the attacking party were thwarted, and they could not intercept them as they intended. The morses were in great force, and the battle began with serious preparations. When the first shots were fired, they rushed towards the sailors, growling and roaring with rage, and seized the boats with their long tusks, or struck them with their heads. During this violent struggle, which was very dangerous for the fishermen, the morses were led, or, as it were, commanded, by one large male, more powerful and terrible than all the rest. The sailors aimed all their blows at this leader, but he received their heavy clubs without flinching, and the lances, which, unfortunately, were not sharp, could not penetrate his natural armour. The troop was so numerous, and their attacks so quickly repeated, that the sailors had no time to reload their carbines. Happily, the purser had not discharged his gun; he skilfully aimed at the chief morse, and the huge animal, mortally wounded, fell on his back in the midst of his companions, who immediately abandoned the combat, and assembling round their general, kept him from sinking by supporting him with their tusks.

Probably they acted thus from natural instinct, to prevent his being suffocated.

There is a tale told of some fishermen, who, having discovered a little morse at Spitzbergen, in a cave on the edge of the sea, seized it and put it in their boat. The father and mother, furious at the loss of their offspring, followed ; and one of them, fastening on to the side of the boat, made it incline so much towards the water, that one of the fishermen slipped into the sea. The other morse flung himself upon him with such rage, that it was impossible to save the unfortunate man.

On another occasion, also at Spitzbergen, a canoe attacked



A MORSE AND ITS LITTLE ONES.
(*Trichechus rosmarus.*)

a pair of these animals. The female was wounded while she was suckling her young, which was clinging to her breast. The male, to avenge her, gave the boat a tremendous shake. The mother made her way, in spite of her wounds (and she had three lances deep in her breast), towards a block of ice, all the while clasping her little one with her left fin. Having reached the ice, she set down her burden, but the little creature instantly returned to the boat with such fury that he would certainly have upset it if he had had strength. He received a wound on his head, and went back to his mother, who was crawling painfully from block to block. The male, dreading a second attack, took his unfortunate mate with his teeth, and dragging her to the water swam away until they were beyond the reach of their enemies.

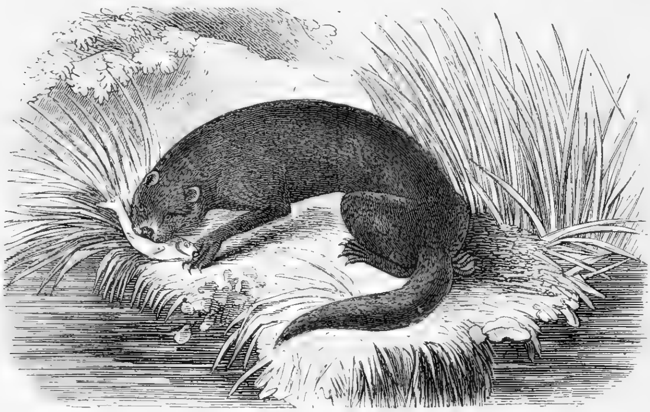
Generally, however, these poor animals suffer themselves to be killed without showing much skill or cunning in evading their assailants. A fishing-boat takes usually from two to three hundred in one season. In 1608, the crew of the *Welden* killed more than a thousand on the coast of Cherry Island. According to Gmelin's account, the English took in 1705 and 1706, seven or eight hundred in six hours; in 1708, nine hundred in seven hours, and in 1710, eight hundred in a week. It is asserted that in the northern seas three or four thousand of these animals are destroyed every year. When a morse is caught on the land and wounded, he becomes really dangerous, and often breaks the arms of the incautious hunter, or even tears them off. If he cannot reach his enemy, he will strike the sand from side to side with his tusks, and, at last, as if driven to desperation, he will put his head between his fins, and, taking advantage of the sloping ground, will roll into the sea.

Like the seal the morse furnishes a quantity of oil. Part of the skin is peeled off, and used for traces for carriages. The skin was formerly much prized in navigation; it was cut into thongs and twisted, and thus a strong cable was obtained, capable of great resistance. The teeth of the morse are preferred to ivory because they are harder, and less likely to turn yellow. Unfortunately they have not the size or weight of elephants' tusks, though some are found forty inches long, and nearly ten inches in circumference at the root. The ivory of the morse is compact, susceptible of a fine polish, but not striated. Most of it has the appearance of little round grains accumulated without regularity, like pebbles in the conglomerate known as pudding-stone. These tusks are useful in a variety of ways. Russian prisoners work them very skilfully, in the same way that the galley-slaves at Toulon chisel cocoa-nuts. They make little boxes, cases, chains, and other little elegant knick-knacks, which are really master-pieces of patient work.

CHAPTER XLIX.

THE SEA-OTTER.

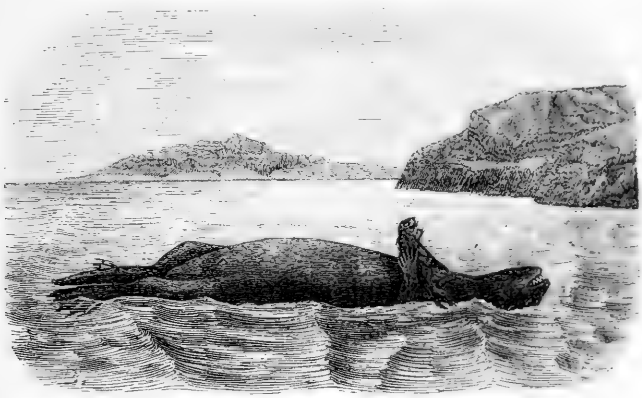
MARINE mammals, as we have explained in preceding chapters, have not the same organisation as the terrestrial mammalia. The body is more or less in the form of a fish, and the limbs resemble fins. We have now to speak of a little quadruped which scarcely differs in structure from those which live on land, and which is nevertheless exclusively a marine quadruped, and perhaps is the



THE SEA-OTTER.
(*Enhydris marina.*)

only one that exists. Everybody knows the common otter (*Lutra vulgaris*), a little carnivorous animal with palmated feet, furnished with claws, and a long tail, broad and rounded.

The sea-otter is somewhat larger, being three or four feet long. Its head is moderately large, round, and not unlike a cat's. It has short ears, eyes black and almost circular, and white, long, pendant moustaches. The tail is less developed than in the common otter, the paws are smaller, and adapted for marine life; the hind limbs resemble fins rather than feet, yet they differ considerably from the fins of the seal or morse; though the toes are joined together by a membrane, thus making serviceable oars with which they can strike the water, the sea-otter, in its structure and organisation, is actually more a terrestrial mammal than a marine animal. This little creature inhabits a great portion of the North Pacific Ocean, between fifty and sixty degrees of north latitude. It is found even on the shores of Japan. It may often be seen lying on the floating banks of the nereocystus, basking in the sunshine, or watching for its prey.



THE FEMALE OTTER AND HER YOUNG ONE.

From this circumstance these vegetable productions are called otter-cabbages (*choux aux loutres*). The otter feeds on fish, crabs, shell-fish, and, if compelled by necessity, it will eat marine plants. It plunges like the seal or morse, but does not remain so long under water. It is of a chestnut brown on the back, but more light and silvery underneath. The sea-otter lives in couples; the female has but one young one at a time, which she seldom leaves, rearing it with much tenderness. A mother may often be seen with her nursling, and also the young one of the preceding year. She plays with them on the ice and in the waves, throws them into the sea, and teaches them to swim and dive. When she sleeps on the surface of the water, back downwards, and abandons herself to the play of the waves, she takes her little one upon her, and holds it in her paws. Steller has represented a mother in this position. Hunters very frequently surprise these poor creatures thus asleep, and almost always succeed in killing them.

When robbed of her young the sea-otter utters plaintive cries. She follows the spoiler from a distance, calling her little one in a supplicating manner, and it often replies by similar wailing.

The fur of the otter is very close, soft, and glossy. It is of great value, and justly so, for it is one of the most beautiful furs known. The male adults are called *bobry*, the female *matka ;* little ones of one year old are called *koschloki ;* and small ones of a few months old, *medwieki*. The Russians and Americans, who chiefly carry on the trade in these skins, sell them principally to the Chinese, by whom they are worn as an ornament or as a distinctive badge by functionaries of high rank. Very few are brought into Europe; but many Russian noblemen value this remarkable fur as much as Chinese mandarins. These skins are worth, in China, from £30 to £50 a-piece, according to their state of preservation, and the glossiness and fineness of the hair. It is stated that the number of sea-otters is yearly diminishing in those parts where formerly they abounded ; therefore, the price must rise considerably. We are assured that recently many skins have been sold at St. Petersburg for as much as £80.

In the time of Steller, the crew of one ship might kill 800 otters in a single season. In the present day, the otter-fishers are not so fortunate. They have a good deal of trouble in procuring a few couples. On some coasts, particularly in Japan, the sea-otter is no longer seen, except accidentally. The capture of this valuable animal should be regulated by law, lest at no very distant future the species should completely disappear.

The sea-otter has an historical interest. It was chiefly in pursuing this chase that the Russians arrived first on the coast of Kamtschatka, and afterwards in America.

This otter is rarely to be seen in museums ; the reason is evident. In the cabinet of Munich there is a skeleton, given by the Duke of Leuchtenberg. The Museum of Natural History in Paris was enriched in 1853 by two skeletons, of a male and female, presented by Professor Nordmann.

Male otters have teats, but imperfectly developed. This is commonly the case with all mammalia. Often has the use of this formation been a subject of conjecture. The organs of animals have usually distinct functions—the wing for flight, the eye for sight, the ear for sound. In some circumstances, the want or the excess of development modifies the constitution of the parts, and adapts them to a different purpose. Thus, the wing with only one joint becomes a fin, while the fin of two joints becomes a wing. Frequently the modified organ retains the old use, while it becomes, also, capable of serving another purpose. The nose of the tapir and the elephant are still furnished with olfactory nerves, though they are used as arms; that is to say, they serve to dig or to seize. But when the development is arrested at an early stage, and the organ appears only as a rudiment, what is its object or use? Can it serve any purpose? What is the use of eyes covered with skin, as the mole's? or how does the leech profit by his ocular tubercles? How is it we find stunted organs amongst many quadrupeds? Etienne Geoffroy St. Hilaire looked upon these incomplete developments as the elements of a primitive plan of organisation, and therefore as the signs of general symmetry, preserved in particular cases. Many eminent zoologists have wished to trace in these rudiments a tendency of Nature towards some determinate end, which, in fact, would mean schemes abandoned and efforts unsuccessful! Is this explanation preferable to that of St. Hilaire? The activity of Nature—in other words, creative power—does not resemble human intelligence, which tries and makes attempts, but does not always succeed. God never makes any attempt, or tries any experiment, even for the most transcendent combinations or the most ingenious organisms. With him to will is to do, both *as* he pleases and *when*—whether the result be complicated or simple, whether the effect be a union of organs or defective organs, or even the deceptive appearance of organs. There is, however, in the word *tendency*, a philosophical idea. It would be perfect if animals were the creation of man. What word shall we use to express it, as animals are the work of God?

If it be asked, then, what is the use of these imperfect organs, we can only frankly acknowledge that we do not know.

CHAPTER L.

THE WHITE BEAR.

THE dreary wastes of the Arctic Regions are not destitute of inhabitants. There is even a joyous and happy population amid mountains of snow and interminable fields of ice, amid the coldest waters and the thickest fogs. The white, or polar bear, the *Thalarctos maritimus,* is the king of these wilds, and reigns like a cruel despot over the animals of the Arctic Regions; dwelling in all the northern seas, he is found on every ice-bound shore.

There were in ancient times so vast a number in Cherry Island, that it was called "Beeren Eiland," or Isle of Bears. The white bear is really a terrestrial quadruped, it differing chiefly from its namesake, the bear of the Alps, by its superior size. It is more upright, and has longer limbs, stronger feet, a longer neck, and a narrower and straighter head. Its size is sometimes enormous. Some have been known as much as seven feet long. In 1596, the traveller William Barentz killed two and preserved their skins. One was four feet long, and the other about five feet. We are assured that large ones sometimes weigh ten hundred-weight.

The polar bear is covered with a coat of close, soft, long hair, generally perfectly white, but occasionally of a light yellow colour. The Norwegian fishermen call him the "great man with a cloak." One can understand that with this excellent coat he may resist the extremely cold temperature of his country. His eyes are dark, his nose, the inside of his mouth, and his nails are black.

The white bear feeds upon seals, fish, and many other marine animals. He is said to attack young whales. He also eats vegetable substances, particularly in summer. He can endure very long periods of abstinence. To catch seals he squats down on his fore-paws, advances gradually his hind legs without stirring his body, and when within a few feet, he springs upon his victim.

The whiteness of his coat, which prevents his being distinguished amid the snow and ice, enables him to approach the timid seal. When the thaw begins, springs of water collect in the southern regions, and glide silently down the snow, looking like silver ribbons upon white velvet, and here these fierce animals resort to slake their thirst.

Unlike his brown cousin, the white bear has his toes united by a membrane, an addition to the foot by which he is enabled to swim with force and rapidity. However, he shares with all his tribe the peculiarity of walking upon the flat of his foot, and can stand erect on his hind-quarters.

In the summer he leaves the water and returns to the woods.

THE HEAD OF THE WHITE BEAR.
(*Thalarctos maritimus.*)

Although not so active on land as among his native bergs, yet he can run at the rate of about three miles an hour. During the winter, when the snow covers the ground, the bear returns to the sea, accompanied by a little family. As the cold increases, they may be seen prowling about the ice, climbing over the huge blocks, and plunging into the water which is still unfrozen. They congregate at this time in considerable numbers, being the only mammals of this kind that show any inclination to sociability. This is the more remarkable as they are extremely cruel, and animals of ferocious natures generally live more or less isolated.

Sometimes white bears will repose on floating ice, permitting themselves to be carried, like drifting timber, to other countries. Thus bears have been drifted to the coasts of Iceland and Norway; and it is said that some have in this way crossed Behring's Straits, and even travelled as far as the Japanese Archipelago. It has happened that they have been borne along to the open sea upon an iceberg, and, being unable to get to land or to leave their island, they have died of hunger or devoured each other.

This animal is more terrible than the Alpine bear. The strength of its jaw is such that it has been known to bite in two a bar of iron half an inch thick. When a bear lands on an island with a scattered population, he attacks flocks, and even their owners, with ferocity. He strangles and devours all that is so unfortunate as to come in his way; and will even sacrilegiously rob a graveyard, where the corpses, preserved by the cold, furnish him an abundant meal.

> "Rien n'est sûr en son passage,
> Ce qu'il trouve il le ravage."

On the appearance of a white bear in Iceland, the inhabitants assemble to fight the depredator, and to protect the cattle. The coasts of Greenland are most exposed to the invasions of these rapacious animals. Captain Scoresby saw so many on these shores that he compared them to flocks of sheep.

Some years ago, three young hunters, who were spending the winter together in Labrador, left their hut to go and look at some traps they had set in the forest. On their return, they were astonished to find the door of their hut torn down and laid upon the snow. At first they thought that some neighbour had played them a trick in their absence. Everything was turned topsy-turvy; the stove and the chimney were on the floor; the cupboard empty; the store of bacon gone; the sack of flour had disappeared; even a tin cup, a paletot, and a pair of boots were taken. There had been robbery and burglary. The three young men set out in quest of the robber or robbers. They searched, and discovered that all this destruction had been committed by two white bears. At a little distance from the hut they found the sack empty and torn; a little further lay the cup, bearing the marks of strong teeth. As for the cloak and boots, the thieves had carried them off!

White bears do not usually attack men; unless they are famished, they even avoid meeting them; but if provoked, or obliged to defend themselves, the combat may prove dangerous to the assailants; on this account, the bears are greatly dreaded by small boats. Yet it is asserted that these animals are not really so brave as one would be inclined to suppose, and that they quickly desert the field of battle when they feel themselves wounded.

A whaling vessel was once blocked in by the ice in Davis' Straits, on the coast of Labrador. A white bear approached within a few yards of the ship. A sailor was tempted to attack it alone, while his comrades were at dinner. He got down upon the ice, armed with a javelin, and ran to the animal. The bear did not retreat, but disarmed his feeble enemy, seized him by the middle of the back, and bore him off so swiftly that it was impossible to rescue him.

Another whaler was lying off the coast of Greenland, moored to an iceberg. The sailors saw a bear a long way off, watching for some seals. One of the men, whose courage had been warmed by a strong dose of rum, took it into his head to go and attack this formidable animal. No remonstrance could cool his warlike ardour, and he set out across the snow with no other weapon than a harpoon. After a tedious run of half an hour over the broken ice and crisp frozen snow, he suddenly found himself face to face with Bruin. His run had worked off the valorous ardour inspired by the fiery rum, and for a moment he wished himself back at the ship. But the thought of the jeers with which his comrades would greet him, made him hesitate before he took to his heels. However, with a loud growl, the bear came towards him. The huge lank monster, with his white glistening teeth contrasting with the black skin of the mouth, was much too terrible to be attacked with a small harpoon. The bravery of the sailor vanished, and in hot haste he beat a retreat. The bear, being more accustomed to a journey on ice than his enemy, easily gained on him. In his hope to escape, the sailor threw away the harpoon. The bear's curiosity being excited, he stopped to examine the weapon, turning it over with his paws, and biting it. This gave the sailor time to put some distance between them, but his advantage was soon lost. However, he had learnt a lesson, and flung away one of his mittens. This occupied the curiosity of the bear some minutes—precious minutes to the sailor, who was nearly exhausted. Again the bear approaches, and again a mitten is thrown to distract his attention. The crew, who had been intently watching the chase, saw matters were becoming serious, and sallied out to their comrade's assistance. The bear was again in chase, and the man had parted with his cap when his friends arrived. Having received a wound from a rifle, and, thinking that discretion was the better part of valour, the bear retreated to hunt the less dangerous seals, having taught the adventurous sailor a lesson he was not likely to forget.

In the month of September, 1596, a Dutch vessel, commanded by William Barentz, had arrived on the further coast of Nova Zembla, and was overtaken by a drift of ice, and so enclosed on all sides, that no human power could extricate it. Barentz was reduced to the sad prospect of spending the winter in this desolate region. The vessel, shaken and tossed by the movement of the ice, was cracking in many places. It was resolved, therefore, to drag the small boat to land; and, with this object, the crew moved into it all the biscuit, wine, powder, and weapons. A tent was erected near the boat; subsequently, a hut was built. On the 15th of September, while they were at work, three bears of different sizes were seen coming towards them. The smallest remained behind a large block of ice, the others advanced. One dipped his head into a tub where some meat was soaking. The men fired, and the animal fell dead. The other bear stopped short, as if amazed, snuffed his companion, and then, as if he perceived the danger, decamped. By the order of the captain, the bear was opened, disembowelled, and then placed on his four legs, that he might be frozen in that position, and taken to Holland if the vessel should ever be released. On the 23rd, the crew had the misfortune to lose the carpenter; he was buried in a cleft of the rock, as it was not possible to dig a grave in the hard, frozen ground. The crew now consisted of only sixteen. On the 27th, the frost was so intense that if one of them put a nail into his mouth, as workmen do, he could not take it out without the skin of his lip coming with it! On the 25th of October, as they were carrying some rigging upon sledges, Barentz saw behind the ship three bears coming towards them. They all shouted and hallooed, but the bears were not to be so easily frightened, and the sailors made up their minds to fight. Fortunately, they found two halberds; Barentz took one, and Girard de Veer the other. They all ran towards the ship; but, in crossing the ice, one of the men fell into a crevasse; this accident made them tremble for him, for they felt sure he would be the first devoured. But the bears followed those who were running to the ship. Barentz and De Veer made a circuit, in order to enter on the other side. The sailor who had fallen, got up and joined the crew, and all reached the ship safely. The bears furiously tried to climb up to the deck. This was prevented by throwing pieces of wood and various utensils at their heads; as each thing was thrown, they rushed at it, as dogs do when stones are flung at them. There were no weapons on board except the two lances before mentioned. Some one proposed to light a fire, and let off a few handfuls of powder. But in the confusion nothing that was suggested could be done. In the meanwhile, the bears returning to the assault with renewed fury, there were no longer any pieces of wood or anything to divert them. The Dutch owed their safety to the most unexpected good fortune. Barentz, reduced to extremity and acting in despair rather than with prudence, hurled his lance against the largest of the animals. The bear was struck on the nose, and so much hurt that he gave a loud cry, and retreated. The two others followed him, though with slower steps. The bears did not appear again until day-break, when they found the sailors prepared to receive them. On the 6th of April, one came up to the door of the hut which stood open. It was immediately shut and held tightly, and the bear departed. But he returned two hours afterwards, and mounting on the top of the hut, made a frightful noise. He tried to knock down the chimney, and the poor men thought he was master of the situation. He tore the sail with which the hut was surrounded, and left at last after doing irreparable damage. The following month, when the ship was being prepared for sea, an enormous bear appeared. The sailors instantly shut themselves up in their hut, and the most skilful shots placed themselves at the door, firmly awaiting the animal's approach. One of the men climbed up the chimney gun in hand. The bear marched on boldly to the hut. One shot from a musket knocked him over, and he was soon killed. In his stomach were found whole pieces of seal, with the skin and hair. On the 30th, the sailors while at work re-fitting the ship, were interrupted by a bear coming boldly up to them. They all fled immediately into the hut. The bear followed, but a salute of three guns laid him dead upon the snow. This victory nearly cost the poor mariners their lives, for having cut up the creature, they cooked the liver, and ate it, but it proved poisonous, and some of them laid for hours in a state of insensibility.

In Manby's voyage to Spitzbergen, Captain Lewis wished to attack a white bear. Four sailors fired at forty paces distance, and wounded the animal. Upon which the bear, infuriated, ran towards his assailants with open mouth. As he approached with frightful howling, a sailor and the captain, who had not yet fired, took aim and wounded his shoulder; before they could re-load the bear was close upon them. They made for the shore, the animal following, though lame; he was on the point of catching them, when two of them jumped into the boat, and the others hid themselves behind some blocks of ice, and fired as soon as they could. The new wounds only increased his rage. At last he came so near that the sailors leaped into the water from a perpendicular rock of some height. The bear leaped in after them, and he had almost seized one of the men, when his strength became exhausted, and he breathed his last. When his body was dragged to the coast, it was found that he had received eight balls.

The cry of the white bear is said to resemble the hoarse barking of a dog rather than the low growl which other bears make. This quadruped has both intelligence and sagacity. A seal was once lying on the ice close to a hole into which it intended to retreat if a danger threatened. A bear, discovering it, approached, silently and under cover, as near as he could; he then plunged into the sea, swam to the hole which was to secure the safety of the seal, and making his way through it, he seized his prey.

The captain of a whaling vessel wished to have the skin of a white bear whole and perfect; and to obtain this, it was necessary to kill the animal without shooting him. He thought he would lay a cord on the snow with a running knot, within which was put a bait. A bear, climbing about on the ice, was attracted by the bait; he seized the treacherous cord, and was caught by his paw; however, he managed by the help of his other paw to get away, and bore off his prize to eat in security. The snare was laid again. The bear came a second time, and remembering what had happened before, he put aside the cord, and snatched the bait. A third attempt was made; the cord being hidden with snow; but this did not succeed. For a last trial, the bait was put into a hole, so deep that the bear could not take it without putting in his head; a noose was arranged round the opening, concealed by snow. Success seemed certain; but alas, vain hope! the suspicious animal began by delicately removing the snow, discovered the cord, put it carefully aside, took up the prize, and disappeared.

Scoresby believes that when a bear is wounded, but is able to get away, he retires behind some height, and applies snow to the wound with his paw, as though he knew the styptic property of cold.

The female has her young in the month of March. She usually has one or two at a time, very rarely three. The little ones are remarkably small. The attachment of the female for its young inspires her with a courage well worthy of admiration.

The following occurrence was observed by the frigate on which the famous Nelson began his naval career. This frigate was in the polar regions in 1773. At daybreak one morning, three bears were seen from the top of the mast coming very quickly over the ice towards the vessel. The men made out that it was a female, accompanied by two young bears almost as strong as their mother. All three ran to a stove, into which some remains of a porpoise had been thrown; they drew out the pieces of flesh which the fire had not consumed. The mother distributed the pieces, giving the largest share to her young ones. The sailors seized this moment to fire at the two young bears, who remained at the stove, and also at the mother, whom they wounded without killing. Her despair would have touched the hardest hearts. Without paying attention to her own wounds, or to the blood she was shedding, she only attended to her two little ones; she called them with sorrowful cries, put before them her own share of food, and broke it up for them. As they remained motionless, her groans became still more melancholy. She tried to lift them up, and finding her efforts useless, she went away a few steps and renewed her calls; then returning to the two dead bodies, she licked the wounds, and would not leave them until convinced that life was quite gone; then, with frightful howlings towards the vessel, she seemed to accuse the murderers, and they answered with another discharge from their guns. Fatally wounded, the poor mother came to die by her young ones, licking their wounds to the last.

White bears easily become accustomed to our menageries. As they always suffer from heat, pails of cold water are continually thrown over their bodies, and a tank is always arranged in their den, in which they can constantly bathe.

These animals are often seen panting like a dog in hot weather after running. They keep up with their head, neck, and the fore part of their bodies an incessant swaying, which attracts the attention at first by its singularity, but fatigues by its monotony.

During captivity, the bear does not seem to be susceptible of instruction or attachment; he retains always a brutal and stupid ferocity. We find this species was known to the ancients. Cuvier considers that it was a white bear which Ptolemy Philadelphus sent for to Alexandria, and which is alluded to by Athenæus and Callixenus the Rhodian.

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THE END.

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