SHELLS

AND THEIR INMATES.

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FRONTISPIECE.

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SHELLS

AND THEIR INMATES.

Art's finest pencil could but rudely mock
The rich grey mosses broidered on a rock,
—And those gay watery grots he would explore,
Small excavations on a rocky shore,
That seem like fairy baths, or mimic wells,
Richly embossed with choicest weed and shells:
—As if her trinkets Nature chose to hide
Where nought invaded but the flowing tide.

JANE TAYLOR.

LONDON:
THE RELIGIOUS TRACT SOCIETY;
Instituted 1799.
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1841.

DESCRIPTION OF THE FRONTISPIECE.

The reader must suppose a perpendicular line drawn through the centre ; then the order, proceeding in each case from the top, will be as follows :—

LEFT HAND.

Eburna glabrata,
"Ivory shell."
Pteroceras chiragra.
Conus tertile,
"Gold brocade."
Subula (Terebra) maculata,
"Spotted needle."

CENTRE.

Hippopus maculatus,
"Spotted horse-hoof."
Triton variegatus,
"Trumpet."
Argonauta argo,
"Paper sailor."
Arca pilosa.

A LITTLE TO THE RIGHT.

Murex palma rosæ,
"Rose-bud murex."
Solarium perspectivum,
"Stair-case."
Tellina virgata,
"Striped tellen."

RIGHT HAND.

Murex regius,
"Royal or rocky murex."
Conus marmoreus,
"Marbled cone."
Terebra subulata,
"Awl."
Scalaria pretiosa,
"Wentle trap."
Murex tenuispina,
"Venus's comb."

EXPLANATION OF SCIENTIFIC TERMS.

Acephala.	Headless mollusks.
Adductors.	Muscles by which the shells of mollusks are rapidly closed.
Bivalve.	A shell, consisting of two parts or valves.
Brachiopoda.	Mollusks, so called in allusion to two fleshy-fringed arms, one on each side of the mouth.
Branchiæ.	Gills, or aërating organs.
Calcareous.	A substance is said to be calcareous when lime forms a principal component part.
Cephalopoda.	Head-footed mollusks.
Cilia.	Filaments of a bristly or horny texture.
Cirrhi.	Jointed arms.
Cirrhopoda.	A class of mollusks, of which the barnacle is an example.
Dorsal.	Belonging to the back.
Gasteropoda.	Mollusks, having the under surface of the body formed as a foot.
Laminæ.	Plural of lamina, a layer.
Mammalia.	A class of animals which suckle their young.

EXPLANATION OF SCIENTIFIC TERMS.

MOLLUSK.	A soft-bodied animal, as a snail, or an oyster. Plural, mollusca.
MULTIVALVE.	A shell consisting of several pieces.
OPERCULUM.	Lid of a shell.
OVIPOSITOR.	The instrument by which the eggs are conducted to their appropriate place.
PALLIOBRANCHIATA.	Animals which breathe by means of the mantle.
PEDUNCLE.	A fleshy substance or foot-stalk, by which animals fix themselves to various bodies.
PTEROPODA.	Wing-footed mollusks.
SERRATED.	Like the teeth of a saw.
TENTACULA.	Parts of an animal acting like the horns of a snail; arms by which prey is seized. Plural, tentaculæ.
UNIVALVE.	A shell complete in one piece.

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SHELLS AND THEIR INMATES.

CHAPTER I.

THE MOLLUSCA—THEIR STRUCTURE, USE, AND ARRANGEMENT.

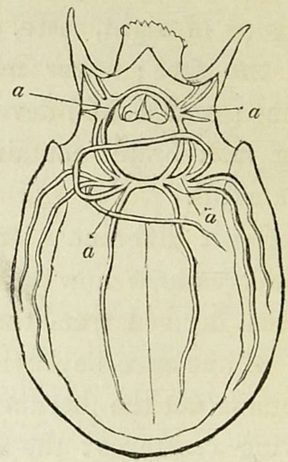
"ALL thy works," says the psalmist, "shall praise thee, O Lord." They clearly bear the impress of the Divine wisdom and goodness, and should receive the attention of intelligent beings, that they may offer the great and glorious Creator "the tribute which is due to his name." In the hope of aiding the study of one department of animated nature, and of directing the mind to Him who has formed such curious creatures, the Mollusca, as they are called by Cuvier, are now brought before the reader.

The number of these animated beings almost exceeds our imagination; nor is the variety of form, of structure, and of habits, which they exhibit, less astonishing. Here the inquirer beholds diverse assemblages of creatures, chiefly aquatic, but some terrestrial; some capable of locomotion, others fixed to one spot for life; some inert and destitute of the organs of vision, others furnished with eyes, and others with arms for seizing their prey. Among all, such striking organic differences, modes, and appearances, meet us, that, on a superficial glance, the characters which bind them into a common group would seem to be altogether unsettled.

When we look at the class of mammalia, or that of birds, of fishes, or of reptiles, we at once perceive an uniformity of the plan on which the creatures of each class are modelled, and from which they do not essentially depart. The extent to which the farthest from the standard diverges is limited; the intermediate links conduct us to it, and we merely behold in it a modification of the common type of structure. Still further, if we consider mammalia, birds, reptiles, and fishes, to be comprehended, as they are, under one sub-kingdom, embracing their respective classes, we shall then find that they all agree in certain leading characteristics, which are never failing, however great the variation may be in the form and modifications of other parts of the structure. For example, all have an internal skeleton, affording a support to the body, and attachment to the muscles; red blood; a muscular heart; a mouth with jaws, one placed above the other; organs of sight, taste, and smell, seated in the cavities of the face; never more than four limbs, sometimes none; and a well-developed nervous system, converging in a brain, contained in a bony chamber forming the skull.

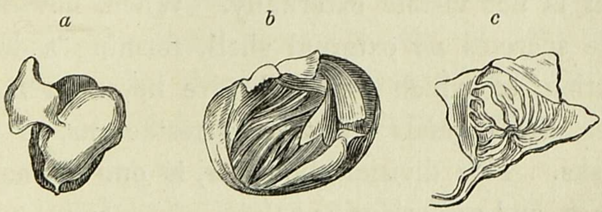
Great differences are apparent, on the contrary, in the creatures now to be considered. The term mollusca, derived from the Latin word *mollis*, soft, imports, as will at once be obvious, those animated bodies which possess not the hardness of substance common to other living creatures: the snail and the oyster may be mentioned as familiar specimens. It is easier to say what the mollusca have not, than what they have. The absence of a true internal skeleton renders their forms variable; one plan does not run through all. The muscles are attached only to a soft contractile skin, which forms a common envelope, and which, in some groups, secretes a calcareous shell, the dwelling of the living animal. This shell, when composed of two portions, or valves, is opened by means of an elastic hinge, and closed by a muscle or muscles passing from valve to valve.

The nervous system consists of little knots, or ganglia, variously distributed, but connected together by nervous threads, a large central ganglion being situated on the gullet, or œsophagus, near the stomach, and to it the rest appear subordinate. This chief ganglion has been termed the brain; a term, however, by no means appropriate. With respect to the senses, that of feeling is at a low ebb, though in most the irritability of the surface, or muscular tissue, is extreme, and continues long even after the animals have been divided. Some possess organs of taste and sight; in others they are not to be discovered. One family only, that of the cephalopods, (of which the common cuttle-fish is one,) is provided with organs of hearing; but these animals, it may be observed, rise so high in structure above the ordinary mollusca, that it is doubtful whether naturalists are not warranted in removing them altogether from that sub-kingdom.



a a a a, ganglia, or knots, joined by nervous threads.

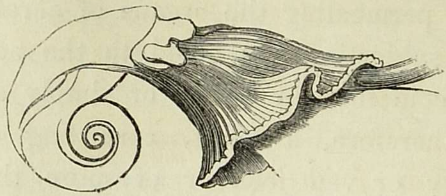
The blood of the mollusca is white, or bluish, and the circulation is always double: in other words, they have a systematic circulation through vessels ramifying over the body, and a pulmonary circulation. By this is meant, a circulation distinct from that of the system, and permeating the organs of aëration, for the purpose of subjecting the blood to the action of the air, either contained in water, or simply atmospheric. There is, therefore, a heart, consisting either of a single cavity or ventricle, or of more than one, in which case the two cavities do not form one compact organ, as in warm-blooded animals, but are often separated and at a distance from each other, as if they were distinct hearts.



Heart of Buccinum undatum; *a*, auricle, raised to show the ventricle; *b*, heart, enlarged, opened to show interior; *c*, heart and auricle in their cavity.

The mollusca are usually enveloped in a skin, termed the mantle; but this mantle differs greatly in its development and form. The groups in which it is simply membranous or fleshy, are termed naked mollusks;

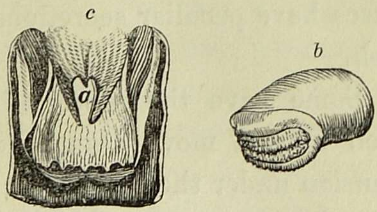
but it often forms, in its own substance, calcareous laminæ, or plates of various degrees of density, and which are deposited in layers, as in the mantle



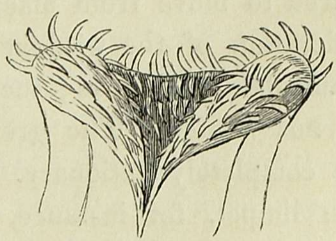
Mantle of Dolium galea, with the spiral part of the animal in outline, to show the position.

of the slug; but the term is still retained, as this deposit is not visible externally. When, however, the mantle secretes an external shell, forming a defensive habitation, of which we shall give hereafter many instances, the animals are termed testaceous, or shelled mollusks. This division, however, is one of mere convenience, and not scientific.

The mouths of each species of mollusca, like all their other organs, are fully adapted to their respective circumstances. Some need only a little opening, to admit the animalcules borne to them by the water; and this, therefore, we observe. Those which subsist on vegetable productions have mouths provided with jaws, which are horny, or furnished with teeth. Such as are carnivorous, have commonly a fleshy pliable tube, which can be protruded or drawn in at pleasure, with a round opening at the end, edged by a strong substance, and armed with little teeth. Various means are also possessed for bringing their food to the mouth; sometimes this proboscis is stretched out, and at others it pierces the shells of other mollusca, that it may suck out the flesh of the inhabitants. They are, moreover, provided with tentacula, a word derived from the Latin *tentare*, to try, or feel, denoting parts acting like those projections of the snail called horns, with which the little animal tries and feels about; they vary in number, and have muscles and nerves. There are also instances in which the lips of the proboscis are furnished with spinous cilia.



b, mouth of Ianthina; *c*, the same opened and enlarged. *a*, tongue.


Cilia of Buccinum undatum.

The stomach of some is simple, of others complex.

The alimentary canal varies in structure. Salivary glands are generally observable; and a liver, often of considerable magnitude, is always present. Many mollusca have peculiar secretions, as the ink of the cuttle-fish.

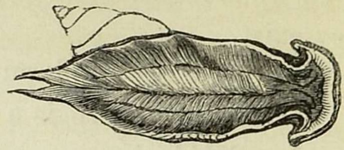
Some have the power of locomotion. Snails, as is well known, move along the ground; for a fleshy expansion under their bodies is full of muscles, which are dilated or contracted at pleasure. This adheres, like the sucker which the school-boy (little aware of the means by which he effects it) fastens to a stone, by the pressure of the atmosphere above after its removal from beneath; and thus the creature advances, by fixing the fore part to the ground, and drawing the remainder after it.

Excepting a few, however, among the higher orders of these creatures, the mollusca are but imperfectly prepared to move from place to place. With a due consideration of the wisdom of God, the reason will be immediately obvious; such a power to its full extent is not wanted. The greater number are intended to be completely stationary. The oyster, the mussel, and the limpet, for instance, usually adhere to rocks at the bottom of the sea, and are consequently nourished by the food providentially brought within their reach by the waves and currents of the ocean, in which they exist.

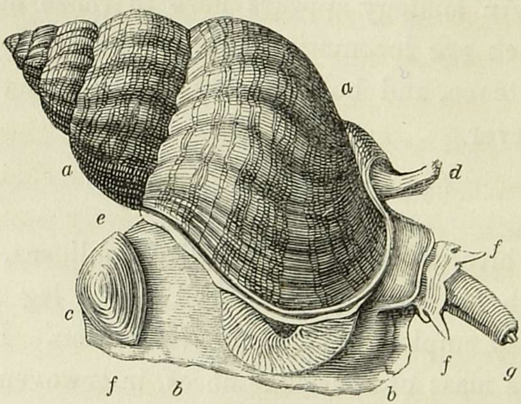
Even here we find an illustration of the saying, "To all things there is a time." For this attachment to the solid body on which they fix their permanent abode, does not take place till they have reached a certain period of their growth. As, immediately after they begin to live, they are free to move in the water, they roam abroad in quest of a habitation; and hence we discover a power of selection even in creatures of so humble an order, directing them doubtless to circumstances the most favourable to their peculiar condition. An analogy appears here to those other creatures which are locomotive only in the early stages of their existence, and both classes proclaim to the attentive observer

"The hand that made us is Divine."

Many bivalve, or double shelled mollusca, are provided with an instrument shaped like a leg and foot, which they employ for progressive motion. It is composed of a mass of muscular fibres, interwoven together in a very complex manner, and which may be compared to the muscular structure of the human tongue. In both, the effect is the same—the conferring a power of motion in all possible ways, so that this member may be readily protruded, retracted, or inflected at every point. In some bivalves, or two-shelled creatures, the expansion of the foot is effected by a curious mechanism: the interior of the organ being formed of a spongy texture, capable of receiving a considerable quantity of water, which the animal has the power of injecting into it, and of thus increasing its size.



Under side of the foot of a species of Nassa, with part of the shell in outline.



Mollusk with shell; Buccinum undatum. *a a*, shell; *b b*, foot; *c*, operculum; *d*, posterior syphon; *e*, edge of the mantle; *f f*, tentaculæ; *g*, proboscis, with the mouth.

To every creature, indeed, the beneficent Creator has given some advantage. The free shells, as they are called, are directed by their inhabitants hither and thither in pursuit of food; but are tenants of fixed shells left without provision? No; on the contrary, food comes to them; the continued motion of the waves, or the flowing of the tide, brings them a fresh supply of the little animals on which they subsist. Truly, "the eyes of all wait on thee, O Lord, what thou givest they gather; and thou satisfiest the desire of every living thing."

Molluscous animals are a part of the provision made for various other creatures. Not only do the different species of walrus, inhabitants of the ocean, feed partly on them; but ourang-outangs and preacher monkeys often descend to the sea to devour what they can find strewed on the shores. The former, it is said, consume in particular a large species of oyster; and, fearful of inserting their paws between the open valves, lest the oyster should close and crush them, they first place a tolerably large stone within the shell, and then drag out their victim with safety. The latter are no less ingenious. Dampier saw several of them take up oysters from the beach, lay them on one stone, and beat them with another till they demolished the shells. Even the fox, when pressed by hunger, will eat mussels and other bivalves; and the racoon, whose fur approaches in value to that of the beaver, lives much on them, especially on oysters, when near the shore. We are told that it will watch the opening of the shells, dexterously insert its paw, and tear out the contents; or else it will break the hinge with its teeth, thus loosen the shells, force them apart with its fore paws, and then hook out their contents: it appears to relish them exceedingly. Crabs, fish, and insects are also acceptable. In some parts of England, snails are considered to contribute much to the fattening of sheep.

Among birds, the mollusca have also many enemies. Several of the duck and gull tribes derive from them at least a portion of their subsistence. The pied oyster-catcher takes its name from feeding on oysters and limpets; and its bill is so well adapted to the purpose of forcing asunder the valves of the one, and raising the other from the rock, that Derham remarks, "The Author of nature seems to have framed it purely for that use." Several kinds of crows find here their food. A friend of Dr. Darwin's, it is said, saw above a hundred of them at once, on the northern coast of Ireland, preying on mussels. Each crow took a mussel up in the air, twenty or forty yards high, and letting it fall on the stones, thus broke the shell. Land shells furnish a few birds with a part of their sustenance; and the principal of these are the two well-known songsters, the blackbird and the thrush. They break those on which they depend in great measure when winter has destroyed their summer food, by repeated strokes against some stone; nor is it uncommon to find a great quantity of fragments of shells together, as if brought to one particular stone for this very purpose.

Of fishes, molluscous animals are also the frequent victims. Thus it is said:

> The prickly star creeps on with fell deceit,
> To force the oyster from his close retreat.
> When gaping lids their widened void display,
> The watchful star thrusts in a pointed ray;
> Of all its treasures spoils the rifled case,
> And empty shells the sandy hillocks grace.

So well indeed does the star-fish know how to succeed in this capture, and so destructive is he to numbers of these creatures, that every dredger who observes one of these animals, and does not tread on and kill it, or throw it on the shore, is liable to some penalty. When, indeed, we remember the vast and incalculable numbers of molluscous animals which crawl on the bottom, or swim on the bosom of the ocean; and the indiscriminating and almost insatiable appetites of the fish which everywhere traverse it, it may be reasonably concluded, that their utility is very great, in this respect, in the economy of nature.

Man is often indebted, moreover, to these animals for food. The poor inhabitants of the western isles of Scotland find their daily, and sometimes their only fare, in the periwinkles and limpets which so profusely stud the rocks of their shores. In the isle of Skye, it is said, there is almost annually a degree of famine, and here is found "the casual repast," as Pennant calls it, "of hundreds during part of the year." Captain Cook saw no appearance of the people of Terra del Fuego having any other food; "for though," he says, "seals were frequently seen near the shore, they seemed to have no implements for taking them. The shelly animals are collected by the women, whose business it seems to be to attend, at low water, with a basket in one hand, a stick pointed and barbed in the other, and a satchel at their backs; they loosen the limpets, and other fish that adhere to the rocks, with the stick, and put them into the basket, which, when full, they empty into the satchel."

The demand for oysters, wherever they exist along our shores, creates a profitable source of employment for a class of men who, in consequence, become experienced seamen; and the sale of them is an important part of the business of many. At the opening of the oyster season, in August, the line of dealers extends, as do the vessels, a considerable distance.

The term mollusca, it should be remarked, was first employed by Cuvier; but as it is applicable to other groups of beings, the structure of which is soft and which have no true skeleton, later naturalists have exchanged it for terms designating the peculiar characters of the nervous system, which are so remarkable in this great section, and on which the bond of union between its different classes alone depends.

Cuvier divides the mollusca into the following classes:—

CLASS.	EXAMPLES.
1. CEPHALOPODA,	Cuttlefish, nautilus, belemnite, etc.
2. PTEROPODA,	Clio, hyalea, etc.
3. GASTEROPODA,	Slugs, aquatic and terrestrial snails.
4. ACEPHALA,	Bivalve mollusks, as oysters, mussels.
5. BRACHIOPODA,	Terebratula, orbicula; fixed bivalve mollusks, with peculiar characters, separating them from the acephala.
6. CIRRHOPODA,	Barnacles, etc.

It must be here observed, that Cuvier places two families, which he terms, "Acephala, destitute of shells," (namely, salpa, ascidia, etc.) and aggregated acephala, (botryllus, pyrosoma, etc.) under the acephala, but with an acknowledgment of the propriety of separating them into a distinct class: to this class has been given the title of tunicata.

Retaining the cirrhopoda, or barnacles, in the present sub-kingdom, the arrangement of the classes will stand as follows, reversing the order of Cuvier, and ascending, instead of descending, the scale of organic being.

SUB-KINGDOM, MOLLUSCA, OR HETEROGANGLIATA.

CLASS.

1. Cirrhopoda.
2. Brachiopoda. (Palliobranchiata. Owen.)
3. Tunicata.
4. Conchifera, or Acephala.
5. Gasteropoda.
6. Pteropoda.
7. Cephalopoda.

In these we shall find an abundance of interesting and instructive objects. We must glance at the land, but we shall have to do chiefly with the ocean, of which a poet has said:

The floor is of sand, like the mountain drift,
  And the pearl-shells spangle the flinty snow;
From coral rocks the sea-plants lift
  Their boughs, where the tides and billows flow;

The water is calm and still below,
  For the winds and the waves are absent there ;
And the sands are bright as the stars that glow
  In the motionless fields of the upper air.

There, with its waving blade of green,
  The sea-flag streams through the silent water,
And the crimson leaf of the dulse is seen
  To blush like a banner bathed in slaughter.

There, with a light and easy motion,
  The fan-coral sweeps through the clear deep sea,
And the yellow and scarlet tufts of ocean
  Are blended like corn on the upland lea.

And life, in rare and beautiful forms,
  Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
  Has made the top of the waves his own.

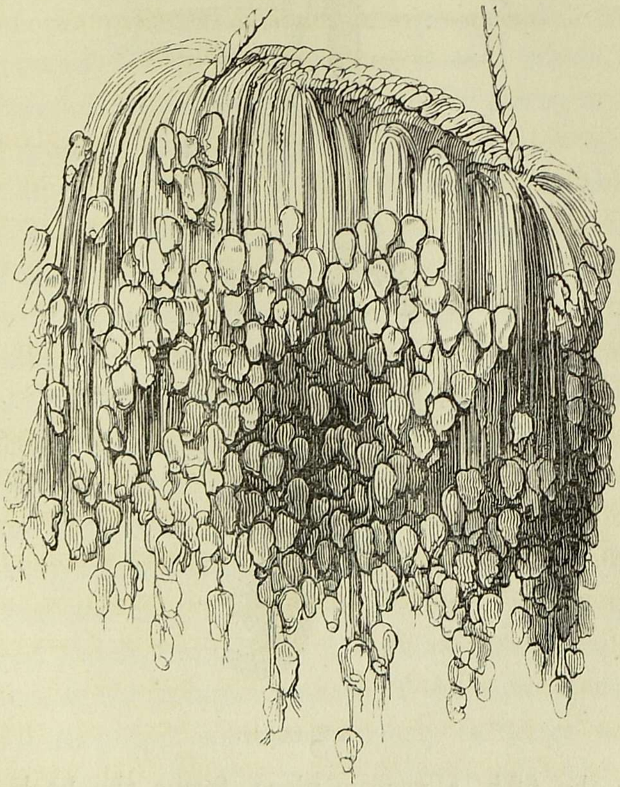
We should, however, look far above the imaginary beings with which poetry has peopled the deep. "O my God," said Fenelon, "he who does not see Thee in thy works, has seen nothing. He who does not confess thy hand in the beautiful productions of this well-ordered world, is a stranger to the best affections of the heart. He exists as though he existed not, and his life is no more than a dream."

CHAPTER II.

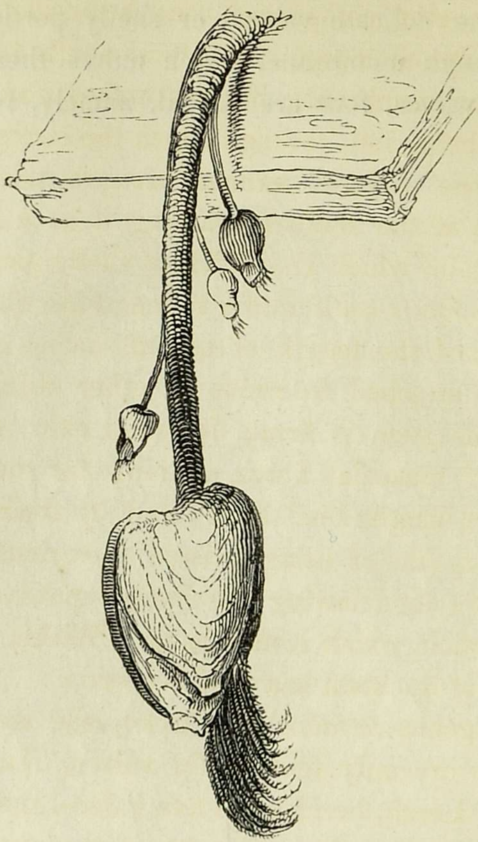
THE BARNACLE — ITS EXTRAORDINARY CHANGE — SINGULAR INSTANCE OF IGNORANCE.

In the sketch of the mollusca now to be given, there is no intention of entering elaborately into each class, or to follow it throughout its orders or genera; our aim is to give a few succinct details, expressed in plain and untechnical terms — in fact, to present to the reader a popular and discursive, rather than an abstrusely scientific work.

The cirrhopoda, of which the barnacles present us with an example, first require our notice. These have only a doubtful claim to a place among the mollusca, being an intermediate link between this great section and the articulata, (annelides, insects, and crustacea, such as crayfish, lobsters, etc.) The barnacle *(pantalasmis)* is a marine animal, often found attached by a fleshy peduncle to rocks, stones, the keels of ships, and masses of floating timber, torn off from wrecked vessels. If we take up one of these animals, and examine it, we find it to consist essentially of a body, enclosed within fine delicate valves, or shelly portions, spread upon a tough membrane, which unites them together. Of these valves, four are lateral, namely, two on each



Block of wood covered with Barnacles.



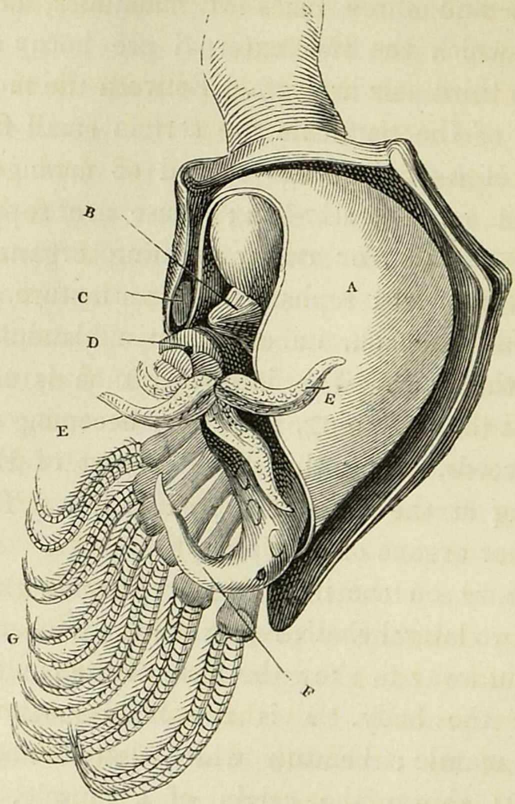
A Barnacle.

side; the fifth, a narrow piece, forms the back of the compound shell, being placed between the posterior edges of the four lateral portions; the general form of the whole being compressed, and somewhat triangular. At their exterior margin the lateral shells are cemented together by membrane; but not entirely, an open space or fissure being left, through which the cirrhi, or jointed arms of the enclosed animal, are protruded. At the upper part of the shell, (regarding it as a whole,) the membrane on which the different shelly pieces are deposited prolongs itself into a round stem, which in some species is of the length of several inches; by this the animal is attached to rocks or other objects. In its texture this stem is firm; the outer skin is lined with a layer of muscular fibres, running for the most part in parallel longitudinal lines; and by their action the stem is capable of being twisted in various directions, the animals thus having the limited power of altering the position in which it may hang. Within the muscular tissue of the stem is a fluid secretion.

In the genus *tetralasmis*, Cuvier, the stem is hairy, and there are only four shelly valves. In the genus *pollicipes*, Leach, besides the five valves, there are several others at the commencement of the stem, generally of small size, but sometimes nearly as large as the principal valves. In the genus *balanus*, of which one species is common on our shores, the tubular stem is exchanged for a cone, composed of shelly pieces, accurately joined together, and having the base formed of a calcareous plate, closely fixed upon the substance to which the animal is attached. Within this cone the animal lodges, while the pieces that represent the valves of the barnacle, four in number, form a curious operculum, or lid, which the animal, by means of certain muscles, can shut at pleasure. The balani, in short, are fixed cirrhopods, lodged in a shelly cone, attached by a basal plate to the rock, and capable of being closed by four folding valves above.

The structure of these creatures requires a few observations. If the two shells of one side of the barnacle be removed, the body of the animal is observed to be a soft mass enclosing the viscera, dilated at its dorsal part, and covered with a delicate membrane, beneath which is a layer of white granular substance. From this body proceed two rows of stems, six in each row, and each of these stems supports two jointed arms, or tentacula, with hair-like appendages springing from each joint, forming a fringe along each fibril. Between the stems on which the tentacula are supported, the body is prolonged into a conical tubular process, which Cuvier regards as the ovipositor of the animal. The mouth is placed on the anterior part of the body, at the commencement of the opening in the shell-covered mantle through which the tentacula pass. It terminates an elevation or raised tubercle; it presents a lip, furnished with minute palpi, or feelers, and three pairs of mandibles, or seizing organs, of which the two external are horny and serrated; the third pair are soft. Between the mouth and the stems of the tentacula are certain small fleshy appendages of a conical figure, and so arranged as to resemble a minute star-fish; these are supposed to be the respiratory, or rather aërating organs. From the mouth, a short œsophagus, of firm texture, leads to a capacious stomach, imbedded in a glandular mass, which is the liver. The intestinal tube is simple; it is large at the beginning, and runs, becoming narrower as it proceeds, along the dorsal aspect of the body, terminating at the base of the ovipositor. There are no eyes, nor organs of hearing.

The figure on the next page represents the animal with the two lateral shells removed; the tentacula of one side are cut away to show the form of the conical termination of the body. A is the body partly invested with its mantle; beneath which latter, and arising from it, is shown the origin of a muscle, B, which spreads over the entire surface of the body, and sends forward fibres to the tentacula; its action is to draw the body forward, in order that the tentacula may be protruded. c is a muscle, by which the shell is



Structure of the Barnacle.

closed; D, the mouth, with its fleshy aërating processes E, E. F is the conical termination of the body; G are the tentacula, or many-jointed arms, set on their peduncles. These arms are covered with a slightly horny investment, and at each joint are furnished with hair-like appendages, forming a sort of fringe.

The animals can retract or protrude these organs at pleasure, and move them about with great facility; it is by their means that the seizure of food is effected. Their delicacy of touch is extreme; they feel the contact of the minutest bodies, and enfold them in their grasp. While the barnacle is on the watch for its prey, these many-jointed arms are all protruded, and are themselves, together with their fringes, in perpetual motion, acting the part of a sweeping-net. The moment some minute tenant of the water is touched, it becomes entangled in their folds, is carried to the mouth, is there crushed by the jaws, and transferred to the stomach. When fully expanded and in motion, these arms present a very elegant appearance: besides being organs for the seizing of food, it is very probable that they are also agents in the aëration of the circulating fluid, co-operating with the fleshy oral processes, regarded as exclusively employed for this important purpose in the service of this animal.

One extraordinary circumstance connected with the history of these cirrhopodous creatures is, the transformation which the young undergo, from active animals, endowed with the powers of locomotion and the organs of vision, to fixed beings, destitute of sight, and enclosed in a multivalve shell. Cuvier observed that the barnacle deposits its eggs in layers, between the body and the mantle; and Mr. Thompson, to whom science is greatly indebted for many important discoveries relative to the mollusca, the zoophytes, etc., states that the eggs, at a certain period, are found forming a pair of leaf-like expansions on each side of the body of the animal, and the living membrane of the shells. These leaves or plates of eggs are at first small, but as the eggs advance in progress, they extend in every direction, and lap over each other on the back: during their increase they pass from a bluish colour, through paler tints, to a delicate pink; and become when ready to be hatched of a dull white.

When excluded from the egg, as was first discovered by Mr. Thompson, with respect to the young of one of the balani, or sessile cirrhopods, the newly-hatched beings rather resemble some of the minute crustacea, than the mature of their own species, being endowed with locomotive organs, and swimming freely about.

They are enclosed in a translucent shell, consisting of two valves, united by a hinge at the back, and in figure much like that of a common mussel, but only one-tenth of an inch in length; within this shell the limbs are capable of being completely withdrawn, and when the valves are opened the animal can protrude its limbs, and bring them into action. They consist of an anterior pair, which are large and strong, and provided with a cup-like disc or sucker, and also with hooks, and serve as organs by which the creature can attach itself to various objects; behind these graspers, come six pairs of limbs, organized as oars, which act in concert, and propel the animal along, while swimming, by a series of impulsive movements, giving to the animal a leaping mode of progression, as in the water-flea, (*daphnia.*) The tail also takes part in these movements; it is ordinarily bent under the body, and terminates in four setæ, or bristle-like appendages.

It is still more remarkable, that the young cirrhopod has large eyes set on peduncles, or footstalks, (as in the lobster and other crustaceous animals,) and it sees its way, and pursues by sight the almost microscopic animalcules on which it preys. This condition of existence is, however, only temporary; after a few days of liberty a change takes place. The shells are thrown off as useless coverings, the arms and oars become ciliated organs, and the eyes gradually disappear; in the meantime the form and character of the adult animal are assumed. The fixed conical shell of the balanus, with its curious lid, becomes developed, and forms at once a prison and a retreat. In the barnacle, the five shelly valves are produced; and the long stem emerges, by which the animal is permanently attached to the rock, on which it hangs by this living cable. Thus, then, in this animal does a wonderful transformation take place, by which it loses some organs, and has others modified, so that were it not known in both stages of existence, and proved by experience to be identically the same being, the young and the perfect animals might be regarded, as indeed they have been, as totally unallied to each other. Mr. Thompson at first considered the young fry of the balanus to be crustaceous animals, and it was by observation only that he discovered the truth.

The name of *anatifa*, sometimes given to these creatures, is an abbreviation of anatifera, and owes its origin to a strange fable. As it was believed some analogy existed between the most extended species of the anatifa and the numerous wild-geese or bernacles which abound on the maritime shores of the west and north of Europe, their inhabitants imagined that the mollusk gave birth to these birds, and it therefore was called the anatifera, or bernacle.

It is indeed a singular fact that, not very long ago, it was supposed that a particular species of goose grew in shells depending from trees within reach of the tides. Even the most learned writers of Europe, from the fifteenth to the eighteenth centuries, repeat the same strange story. Gerard, for instance, proceeds to describe what, he says, he had actually beheld and examined; and then mentions a small isle on the coast of Lancashire, in which is found, on pieces of old timber, "a certain spume or froth, which in time breedeth into certain shells," like those of the mussel, and out of these shells, in due time, he says, "come the legs of a bird hanging out; and as it groweth greater it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill; in short space after it cometh to full maturity, and falleth into the sea, where it gathereth feathers, and groweth to a fowl bigger than a mallard, and lesser than a goose." The bird, he says, is spotted something like a magpie, and is sometimes called by the people a pieannet, and sometimes a tree-goose. Thus far Gerard appears to speak from report, but he also declares that he found, near Dover, a shell with similar contents, but slightly differing from the preceding. On breaking several, he observed in some, living things without shape, but, says he, "in others, which were nearer come to perfection, I found living things that were naked, in shape like a bird; in others the birds were covered with soft down, the shell half open, and the bird ready to fall out, which, no doubt, were the fowls called bernacles."

Bishop Pontoppidan, the author of "The History of Norway," discovers similar credulity. "This peculiar creature," he says, "is about a finger's length and a half in length, and an inch broad, and pretty thick." He describes it as consisting of two parts, the one end being composed of a soft, spongy, brown substance, attached by a hollow neck to the timber on which it is usually found; and the other end covered by a shell of two plates, smaller in size than a mussel shell. He then continues:—"When this shell is opened, there is found in it the little creature supposed to be a wild goose. Almost its whole substance, which is composed of small toughish membranes, represents some little crooked dark feathers, squeezed together, their ends ending in a cluster; hence it has been supposed to be of the bird kind. At the extremity of the neck, also, there is something that looks like an extremely small bird's head; but one must take the force of imagination to help to make it look so. This I have constantly found on many examinations; and in all mine inquiries I cannot learn that any one has ever seen anything more."

The doctors of the Sorbonne in Paris, a body comprising the most learned men of France, employed in this case the ingenuity so often practised by the church of Rome, to alleviate the burdens imposed on its members. They declared that bernacle geese were not to be considered as birds, and that therefore their flesh might properly be eaten on every fast. Thus they availed themselves of prevailing ignorance, as papists have done in former times, and do still, and would everywhere keep the mass of the people from acquiring general knowledge. From the grossest ignorance of natural history we have but very recently escaped. More truth than appears at the first glance will be found in the statement of one of the correspondents of "The Idler," in reference to the time in which he wrote. "All the faults of my life," he says, "were for nine months circulated through the town with the most active malignity, because I happened to catch a moth of peculiar variegation; and because I once outbid all the lovers of shells, and carried off a nautilus, it was hinted that the validity of my uncle's will ought to be disputed." The pursuit of natural history was once considered a species of insanity ; and it has been stated, that on one occasion a will was declared invalid because the testator had been a naturalist. We owe much to the labours of Ray and Linneus.

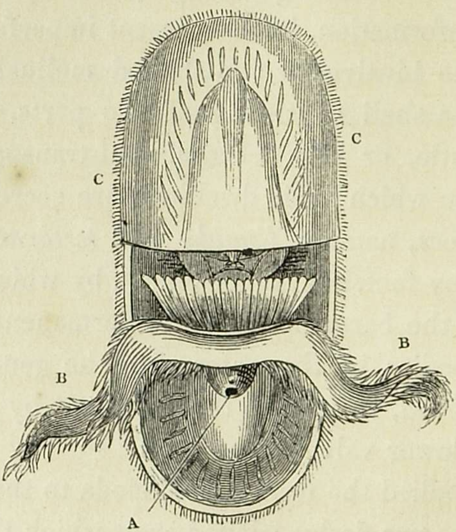
We close this chapter by remarking, that the balanus of the tortoise, *(lepas testudinaria,)* and that which lives parasitically on the whale, are the only species which are isolated. Some of them are to be found in all the known seas, and many are scattered through very remote latitudes. Their fecundity is almost beyond what imagination can conceive. They lay their eggs in summer; and Poli states, that the little ones which issue from them are filled at the end of four months with similar eggs ready to disclose.

CHAPTER III.

VARIOUS MOLLUSKS—THEIR STRUCTURE—WONDERS OF CREATIVE POWER.

The brachiopodous mollusks, so called from two words, meaning an arm and a foot, consist of only a limited number of beings; they are comparatively singular in conformation, but at present imperfectly understood. Like bivalve, or two-shelled mollusks, they are inclosed in a shell consisting of two parts, covering a double mantle, or two delicate semi-transparent membranes, from which their dwellings are secreted. Two of the genera, namely, *lingula* and *terebratula*, have a tubular fleshy footstalk, or peduncle, by which, as in the instance of the barnacle, they are permanently attached to various bodies in the water; but the genus or group termed *orbicula*, is fixed to the rock, not by a peduncle, but by the lower valve of the shell.

Cuvier applied the term brachiopoda to these animals, in allusion to two fleshy-fringed arms which they possess, one on each side of the mouth; and which in most can be protruded to a considerable distance out of the shell, acting either the part of oars in slightly altering the position of the body, or rather of sensitive tentacula, and therefore to be regarded as organs of touch and of seizure. In lingula these fringed arms are moderately developed, as seen in the annexed outline, which represents the animal with the shell removed; the mouth, A, is a simple orifice at the apex of an elevated tubercle; and on each side are the fringed arms, B B.

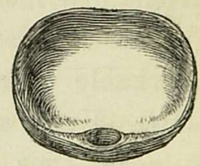


The Lingula.

In one species of terebratula, these arms are developed to a most extraordinary degree; when withdrawn and at rest, they are contracted into six or seven spiral folds, and when protruded, are at least twice as long as the shell in which the animal is inclosed. They are hollow, and contain a fluid, which, being acted upon by muscles spirally disposed round the canal, is forcibly driven upwards to the extremity of each arm, and by this singular method they are expanded and protruded. It is to Professor Owen that the discovery of this remarkable apparatus, so simple and yet so efficient, is due. Every species of terebratula, however, has not the arms thus free and lengthened: in *terebratula chilensis* they are attached throughout their length to certain thin semicircular elevations on the inside of one of the valves, and their movements are consequently limited.

In all, differing as the arms do in development and liberty, they are the sole agents by which food is procured; and without them, the animal, fixed and incapable of seeing, pursuing, or seizing its prey, would necessarily perish. Furnished with cilia, or fringe-like filaments of a horny texture, and ever in motion, they produce a continuous current of water revolving round the mouth, a simple orifice, which opens to receive the animalcules, or minute beings, upon which the mollusk subsists, and which are carried to it by the current.

It has been said, that the arms of one species of terebratula are united to certain complicated elevations on the inner surface of one of the valves; this is called imperforate: and it may here be observed that, of the two valves inclosing the animals of this genus, one valve, more convex than the other, is perforated at the top to give passage to the peduncle, covered with a prolongation of the mantle, by which the animal is attached to the rock.



Terebratula truncata.

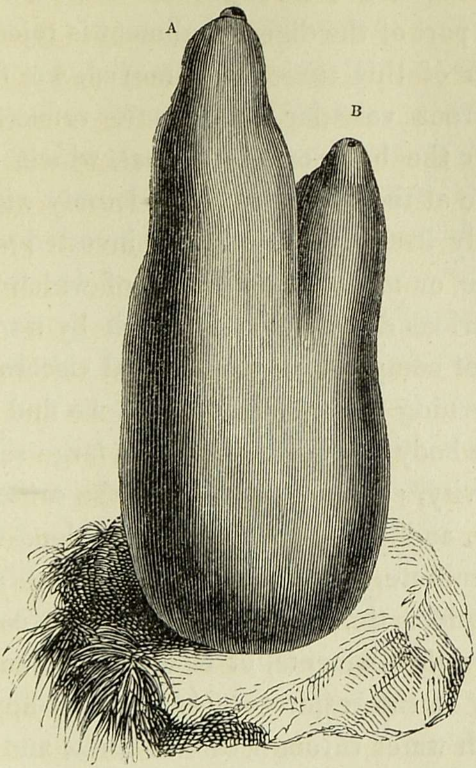
The brachiopods exhibit a curious modification of the respiratory or aërating apparatus peculiar to themselves, and which has induced some naturalists to term them *palliobranchiata;* that is, mantle-gilled animals; for, instead of possessing an apparatus exclusively devoted to this important function, as the other mollusca have, the mantle itself is adapted for this office. It is traversed by large vessels, and fringed all round its circumference, as seen in the preceding figure of the lingula, with vibratile filaments, c c, which by their action drive a current of water over the mantle, on which the vessels ramify, and in which the circulating fluid becomes subjected to the oxygen. As to the general circulation of the blood, and the arrangement of the nervous system, little is correctly known.

In the genus *orbicula,* of which one species is found in our seas, the animal is inclosed in two shells, one of a rounded conical figure, resembling that of a limpet; the other, covering the mouth of the limpet-like shell, is flat, and attached to the rocks. The arms of the mollusks of this genus are fringed, and curled up spirally when at rest.

It has sometimes been supposed, that animals of an apparently inferior order, have no particular claim on attention. But this is an error; not one is there unworthy of the great Creator's power to produce and to sustain it; and, consequently, every one, however humble it appears, will abundantly repay the notice it receives. It is hoped that one result of the perusal of the present volume will be, the direction of the mind to this fact, of which it will afford many illustrations.

Among the mollusca, few animals are more singular or interesting than the *tunicata,* or, as Cuvier terms them, "*acéphales sans coquilles.*" Their internal structure is elaborate, and the external forms which they present are almost infinitely varied. Some, as the salpæ and ascidiæ, are simple isolated beings, having no organic union with others of their race; but one group consists of aggregated beings—a multitude of individuals being organically united together, and thus forming a common vital mass; and in this respect they approach the zoophytes, or coral-forming polypes, excepting that they have no external or internal calcareous support, as their own production. Some of these strange compound beings are luminous; and when shoals are seen floating at night on the surface of the ocean in the warmer latitudes, they present a most brilliant spectacle.

In order to give a general idea of the structure of the tunicata, let us take one of the *ascidiæ* as an example, of which many species are met with on our shores. We find it to be a shapeless being, fixed by a base to the surface of a rock or a fragment of coral, and destitute of beauty or attraction. It appears to be a helpless, inert, fleshy mass, scarcely claiming a place among living creatures; but this idea vanishes when its internal structure is investigated, and the laws of its economy are found, so beautiful, so admirable, so full of appeal in favour of the Divine hand by which it was created. We do not, in fact, on looking at this mollusk, see more than the flexible external tunic or bag in which the body is encased, and which, like the shell of a bivalve mollusk, sheaths the mantle-covered animal within.



The Ascidia.

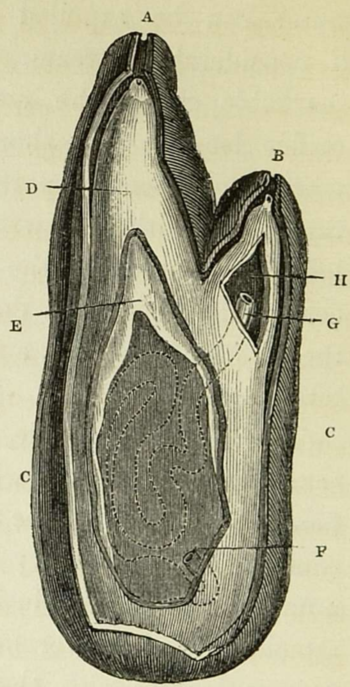
On a more attentive view, we find that there are two orifices, each placed upon a projecting portion of the body, one at A, the other at B, of the above figure.

Through the orifice A, both the water required for aërating the circulating fluid, and also the particles of food, are taken in; through the orifice B the excrementitious part of the digested aliment is rejected. Now, if a portion of this tunic be removed, we find it lined with a serous vascular membrane, reflected at each orifice over the body of the animal, which, united only to the tunic at these points, hangs loosely within.

The body itself is immediately invested with a muscular tissue or mantle, the fibres of which cross each other in various directions, and which by its contraction is capable of compressing the internal viscera with great force. Opening the muscular tissue, we find the greater part of the body to be occupied by a large sac, or membranous cavity, communicating with the orifice A. This sac is fine, and exquisitely vascular, blood-vessels, exceedingly minute, ramifying and forming a net-work over it; besides this, its inner surface is covered with minute vibratile filaments, or cilia, in constant agitation. This cavity is the respiratory or aërating apparatus; it is filled with water through the orifice A, and the action of the cilia effects a current in it, fresh portions being thus perpetually brought into contact with the blood-vessels. By the muscular action of the mantle, the water can be expelled through the same orifice in a considerable stream. At the bottom of this remarkable sac is the mouth of the animal, a simple orifice leading to a short gullet, and open to receive whatever alimentary particles are taken into the respiratory sac with the water imbibed. These particles, being deposited on the inner surface of the sac, are conveyed in a stream down the front of the cavity by the action of the cilia, and entering the oral orifice, pass into the stomach.

This organ is simple, and admits through tubes the secretion of the liver, which organ adheres to its surface, and to that of the adjacent part of the alimentary canal. The alimentary canal varies in length, and the number of its convolutions, in different species; it is attached to a membrane, and terminates in a cavity, communicating with the orifice B. The annexed diagram will convey a clear idea of the visceral arrangements described. A, the imbibing orifice; B, the excretory orifice; C, C, the external tunic or sac in which the body is inclosed, laid open; D, the muscular tissue covering the body laid open, so as to expose the membrane of the aërating cavity, E, also laid open to show the true mouth at F, leading to the stomach and intestinal folds, represented by dotted lines, as supposed to be seen through the membrane. G is the termination of the intestine in the cavity, laid open.

The heart in these animals is a simple elongated tube, receiving at one end the blood from vessels of the aërating sac, and at the other branching out into vessels for the supply of the system.



Internal structure of the Ascidia.

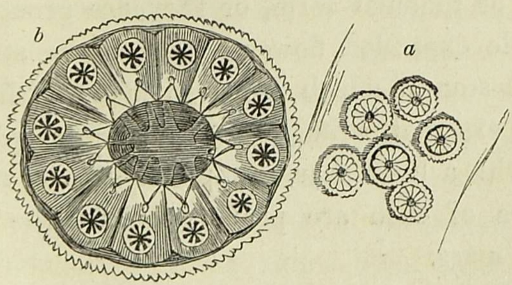
Such, then, are the fixed inert ascidiæ, animals destitute of locomotion, and in which the principal sign of life is displayed in the absorption and discharge of the fluid in which they live. Belonging to the tunicate group, however, are a number of curious marine animals, not like the ascidiæ, but free and swimming about in the ocean, the warmer latitudes of which are their principal abode. One species, *holuthuria ananas*, found in the South Seas, is prized by the natives of the Molucca islands as an article of food. Some of these animals are so transparent as scarcely to be seen while floating on the water; and when captured and examined, the viscera may be readily distinguished through their coverings. Their form is oval or cylindrical, and open at each extremity. Of these orifices, one is large, and furnished with a valve, which permits the ingress, but not the egress, of water, which, taken into a cavity for the purpose of aërating the blood, is expelled by the forcible contractions of the body through the anterior aperture, so as to propel the animal along, and in this manner it swims, proceeding in a backward direction. The cavity in which the water is received, is a wide membranous canal, traversing the body from end to end; and, as in the ascidiæ, it is here that the blood is aërated, not, however, through the medium of a diffused net-work of vessels, but by two beautiful arborescent branchiæ, traversing this tube on each side. These ramified branchiæ are themselves said by some naturalists to be tubular, and to open into the common cavity, whence they receive the imbibed water; but Cuvier denies this.

The viscera occupy a cavity between the receptacle for water and the soft gelatinous internal tunic, which often glistens with the most brilliant hues. The mouth is simple, and placed near the upper orifice, from which the water is expelled; and it is supposed to receive food from the currents of water, traversing the aërating cavity, as in the ascidiæ. The stomach is covered with rows of long filaments, regarded as analogous in their office to the liver; the intestinal canal terminates near the posterior orifice, or that through which the water is imbibed.

The history of these animals is very obscure. Cuvier states that sometimes the creature is seen completely protruded from its investing tunic without appearing to suffer; and, according to M. de Chamisso, some species live, under certain circumstances, aggregated into one mass, numbers of distinct individuals being united together by suckers, and forming long chains, which swim in concert, the arrangement of the chain varying in each species. The union in this case is not organic, still it is a curious circumstance: but what is more remarkable is, that these aggregated salpæ produce beings of very different forms and habits to themselves, which live isolated; and that these isolated beings in turn produce aggregated salpæ resembling their parents, which again produce isolated creatures; alternate generations of animals of dissimilar form and habits thus resulting from one origin. Cuvier, who alludes to Chamisso's account, adds, "It is certain that in some species small individuals may be observed adherent to the interior of large ones, by a peculiar kind of sucker, and these are of a different form from that of the animals containing them." Should future observations confirm the correctness of Chamisso's statement, the physiologist will then have one of the most extraordinary phenomena connected with organic existence to contemplate, which the whole range of nature presents.

The aggregate tunicata have already been mentioned — creatures, which, like the zoophytes, form, by an organic union, one common whole. Cuvier divides these into three groups, botryllus (or alcyonium), polyclinium, and pyrosoma.

The *botrylli* form little starlike bunches or tufts,



Botryllus stellaris; *a*, natural size; *b*, a single group magnified.

attached to sea-weed or other marine substances, each bunch consisting of ten or twelve individuals diverging from a common centre. The figure of each distinct being is oval, with an imbibing orifice at the apex, the excretory orifice opening into a common central cavity. Cuvier observes, that if the imbibing or external orifice of one of these beings be irritated, the animal to which it belongs only contracts; but that if the centre to which they converge be irritated, they all shrink in unison.

Still more curious and wonderful is the *pyrosoma*, one of the luminous tenants of the ocean, of which an account will be given in the next chapter.

The aggregate tunicata, constituting the group termed *polyclinium*, closely resemble in individual structure the ascidiæ, but are collected into conglomerate masses of a conical or globular form, or they are grouped so as to resemble expanded flowers. These are attached to rocks and stones, which they ornament with a living tuft; the external orifice of each individual is surrounded with a little star, composed of six rays; and the viscera of each are prolonged into the common gelatinous mass.

So far have we endeavoured to give an idea of the structure of the tunicate mollusca; and who can contemplate life under the organic forms they assume—who can examine the wonderful organs with which they are endowed to meet their necessities, the curious structures which they present, and the general laws of their economy—without acknowledging the wisdom and power of God? Who can consider the aggregate groups, in which we find distinct individuals (having each their own organs — their own life) organically arranged into a common vitalized whole, no part of which is independent of another—cemented into a complex unity—without a deep feeling of our own ignorance of the laws of organic existence, and without confessing how small a part of His ways, even as it respects creation, the most studious philosopher understands? These, indeed, are some of the wonders of creation, which serve to show how infinite is the power of the Almighty, to teach us our own insufficiency, our own littleness, and to read us lessons of humility. But how often do we presume, from the little we know, to talk as if the ways of the Almighty could be comprehended by our limited minds! "Who is this that darkeneth counsel by words without knowledge?" Instead of presuming on our own understanding, let us adore Him, who, "by his spirit, hath garnished the heavens," whose hand has created every living thing; and let us attend to his revealed word, which so plainly sets before us not only the path of duty, but the way of salvation through a crucified Saviour.

Proud, scornful man! thy soaring wing
  Would hurry towards Infinity:
And yet the vilest, meanest thing
  Is too sublime, too deep for thee;
And all thy vain imagining
  Lost in the smallest speck we see.
It must be so:—for He, even He
  Who worlds created, formed the worm:
He pours the dew, who filled the sea;
  Breathes from the flower, who rules the storm:
Him we may worship—not conceive;
  See not and hear not—but adore,
Bow in the dust, obey, believe;
  Utter his name, and know no more.

CHAPTER IV.

PHOSPHORESCENCE OF THE SEA—ITS VARIOUS CAUSES—ABUNDANCE OF MOLLUSCA.

One of the most interesting and beautiful phenomena presented by the sea, is the occasional luminosity of its surface. This, although occurring in northern latitudes, especially during the hot months of summer, is far more brilliant in the intertropical ocean, where the waters, like waves of molten metal, roll around the vessel in her course, and a lurid track marks the line of her passage. All who have seen this spectacle, describe it as truly magnificent; indeed the fainter luminosity of the waves (as the writer has often seen them) on our own shore, as well as that of the continent, flashing as they roll upon the pebbly beach, or gilding the oars of the boat, itself scarcely visible amidst the darkness of the night, (for it is only by night that this effulgence is manifest,) produces a pleasing effect. It leads the contemplative mind to a consideration of the wonders of that ever-moving ocean, in whose depths are the wrecks of "ten thousand royal argosies," "pale glistening pearls, and rainbowcoloured shells," and the myriads of living creatures that make the liquid element their home.

It is also still more glorious to see all around, far as the eye can stretch, a flood of fire, a sea of glowing water, from which, the vessel ploughing on her course, throws up the spray, falling like a shower of stars to be lost in a boundless ocean of effulgence. A writer, whose opportunities of observing this sublime spectacle have been very frequent, gives us the following interesting details:—"As the ship sails with a strong breeze through a luminous sea on a dark night, the effect then produced is seen to the greatest advantage. The wake of the vessel is one broad sheet of phosphoric matter, so brilliant as to cast a dull pale light over the after part of the ship; the foaming surges, as they gracefully curl on each side of the vessel's prow, are similar to rolling masses of living phosphorus; whilst in the distance, even in the horizon, it seems an ocean of fire, and the distant waves breaking, give out a light of inconceivable beauty and brilliancy. Sometimes the luminosity is very visible without any disturbance of the water, its surface remaining smooth, unruffled even by a passing zephyr; whilst on other occasions, no light is emitted unless the water is agitated by winds, or by the passage of some heavy body through it. Perhaps the beauty of this luminous effect is seen to the greatest advantage when the ship, lying in a bay or harbour in tropical climates, the water around has the appearance of a sea of milk. An opportunity was afforded me when at Cavité, near Manilla, in 1830, of witnessing, for the first time, this beautiful scene. As far as the eye could reach over the extensive bay of Manilla, the surface of the tranquil water was one sheet of this dull pale phosphorescence; and brilliant flashes were emitted instantly on any heavy body being cast into the water, or when fish sprang from it, or swam about. The ship seemed, on looking over its side, to be anchored in a sea of liquid phosphorus, whilst in the distance, the resemblance was that of an ocean of milk. The night to which I allude, when this magnificent appearance presented itself to my observation, was exceedingly dark, which by the contrast gave an increased sublimity to the scene." To read by this phosphoric light "is possible, but not agreeable; and on an attempt being made, it is almost always found that the eyes will not endure the peculiar light for any length of time, as headaches and sickness are often occasioned by it."

The causes to which the luminosity of the sea is owing have, from time to time, excited much speculation among naturalists, and various experiments have been made in order to explain it. After all, however, the solutions of the problem have been based rather on hypothesis, than on fixed and solid data; facts have been ascertained bearing upon the question, but too much stress has often been laid upon them. It is not, we conceive, to one and the same cause that the luminosity of the sea is invariably to be attributed; indeed, it would positively appear, that several causes alike operate to produce it, in different situations, and under different circumstances. To a consideration of them, the attention of the reader is now directed.

The light of the sea, as displayed during the night, appears, according to the accounts of all who have witnessed it, to be phosphorescent; its appearance precisely resembles that given out by a piece of phosphorus in the dark; it has the lurid hue of this substance, which every person must have remarked. Now we know that this luminosity is not produced by solid phosphorus alone, but that fluids containing phosphorus in their composition also gleam with a pale bright lustre. There are, however, other sources of phosphorescent light, or light regarded as connected with this principle. Many of the lower tribes of animals are luminous.

Among the acalephæ, (sea nettles,) the medusa, and beroe; and among the zoophytes, the pennatula, (sea-pen,) and sertularia, are vividly phosphorescent. Many of the crustacea, (crabs, etc.) are also luminous, as the *cancer pulex*, of Linneus, and the *cancer fulgens* of Sir Joseph Banks. "In a species of cancer observed by Captain Tuckey, in the Gulf of Guinea, the luminous property resided in the brain, which, when the animal was at rest, resembled a most brilliant amethyst about the size of a large pin-head; and from this there darted, when the animal moved, flashes of a brilliant silvery light." Numerous animalcules are peculiarly brilliant, giving a phosphorescent radiance to the water in which they abound. Fishes, as it would seem, are also among the tribes endowed with the power of emitting light. The dorado, the mullet, the herring, and the sprat, are examples in point. The sparus chrysurus, an inhabitant of the seas of Brazil, is said to be luminous in such a remarkable manner, that when a few individuals are swimming in company they emit so much light, that in a dark night a person may see to read by its aid. "But considerable suspicion," observes Dr. Fleming, "may be entertained on this subject, whether the light is emitted by the bodies of fish themselves, or by the number of minute parasitical animals which adhere to the surface of the skin."

There is another source of this phosphorescent light remaining to be noticed; this appears to be certain animal matters in a state of decomposition. Fishes, lobsters, etc. when putrescence has commenced, are, as is well known, luminous in the dark.

Now, in the water of the ocean, there is no lack of animal matter, every drop has its inhabitants: of the myriads of fishes, articulata, mollusca, etc. imagination cannot conceive an adequate idea; and death reigns in the waters, as well as on the land. But is it to the decomposition of its animal substances that the sea in all cases owes its luminous appearance? Certainly not; but this is probably the most extensive and prevailing cause. However, it is doubtless also to be often attributed to the presence of dense shoals of luminous marine animals spreading over a greater or less extent of surface. Of these animals the pyrosoma seems to be that most usually productive of the phenomenon in question. Collected in shoals, often covering miles of the ocean, and consequently in number beyond human calculation, these animals illuminate the gloomy deep with beaming radiance. Some idea of their numbers, however, may be formed from the following account, in Mr. G. Bennett's narrative of his "Wanderings."

"On June 8, being then in 00° 30′ south, and longitude 27° 5′ west, having fine weather, and a fresh south-easterly trade wind, and range of thermometer being from seventy-eight to eighty-four degrees, late at night the mate of the watch came and called me to witness a very unusual appearance in the water, which, on first seeing, he considered to be breakers. On arriving upon the deck, this was found to be a very broad and extensive sheet of phosphorescence, extending, in a direction from east to west, as far as the eye could reach; the luminosity was confined to the range of animals in this shoal, for there was no similar light in any other direction. I immediately cast the towing-net over the stern of the ship as we approached nearer the luminous streak, to ascertain the cause of this extraordinary and so limited a phenomenon. The ship soon cleaved through the brilliant mass, from which, by the disturbance, strong flashes of light were emitted; and the shoal (judging from the time the vessel took in passing through the mass) may have been a mile in breadth: the passage of the vessel through them increased the light around to a far stronger degree, illuminating the ship. On taking in the towing-net, it was found filled with pyrosoma, which shone with a beautiful pale greenish light. After the mass had been passed through, the light was still seen astern, until it became invisible in the distance ; and the whole of the ocean then became hidden in the darkness as before." Other instances are also detailed of a similar nature ; and Mr. G. Bennett observes, that after removal from the water the light of the pyrosoma soon subsides, but may be renewed by moving the animal about, for some time longer.

The pyrosoma is a molluscous animal, and consists of a simple semi-transparent gelatinous tube, rather larger at one end than at the other. In size and length this tube varies in different species. The tube itself is hollow, with a distinct aperture at the larger end, and also at the opposite end ; but that of the latter is smaller and contracted. The substance of the tube is not homogeneous, but is dotted all over with granulations, or small buds, closely set together in the substance of the gelatine : these examined minutely will be found to have open mouths : they are, in fact, each distinct animals, so that a single tube is made up of an aggregate of beings cemented as it were together ; a condition of organic life occurring in the zoophytes. According to the observations of MM. Audouin and Milne Edwards, these beings are at first free, and live and swim independently of each other ; they are conglomerated into a mass only at a certain period of their existence. In this condition, the pyrosoma swims on the sea by the combined contractions and dilations of the aggregate of individuals which enter into its composition. Several species are described, as pyrosoma atlanticum, pyrosoma elegans, pyrosoma giganteum, etc.

Enveloped in a flame of bright phosphorescent light, gleaming with greenish lustre, the pyrosoma presents a most brilliant spectacle: when quite at rest, however, the light is but sparingly given out, increasing when the water in which it floats is agitated, or when the animal is taken into the hand. A shoal of these animals not only illuminates the sails of a vessel, but a book may be read near the windows of the stern cabin, and the sea-birds which hover around, are enabled to search for their finny prey. The splendour of the pyrosoma fades and vanishes with death, the general colour being then a dull yellowish white.

From what has been said, the reader will collect enough to discover that the luminousness of the ocean is not owing to one, but to various causes ; that the paler but more extensive effulgence of its waters is generally to be attributed to putrescent animal substances, while the more brilliant but defined illumination, spread in patches or long lines, is produced by masses of luminous animals, and chiefly by the pyrosoma. Nor let us pass hastily from the conclusion at which we have arrived.

Light diminishes rapidly in passing through water, as it does in glass and other transparent bodies. At a certain depth the sun would be invisible, as if a mass of stone had been interposed. On the land absolute darkness is a very rare occurrence, while nocturnal animals, with a large pupil and highly sensible nerve, have a peculiar provision for discovering their prey. But under the entire want of light in the sea, no such power could be a compensation; while the great velocity of the tribes that inhabit the ocean, and the frequent distances between the pursuer and the pursued, must also be an obstacle to distinct vision.

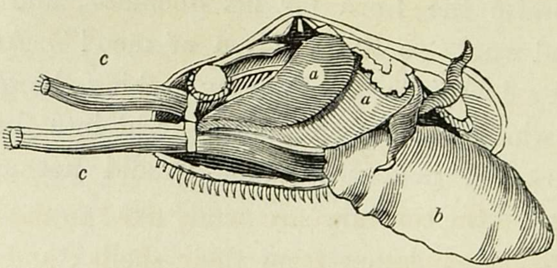
As the sea has been beheld, how rarely has the thought arisen, *There* is a world without light, yet there are myriads of the most active and rapacious animals, often social, performing various functions, moving over great distances with the rapidity of birds, and above all provided with organs of vision. Still more rarely has the inquiry been proposed, How can this difficulty be met; how can light be scattered over this vast abyss? Day could not be brought into the depths of the ocean; it was forbidden by the laws of light; yet it was indispensable to enable the inhabitants of the sea to obtain their prey. The wisdom of God has, therefore, provided an independent source of light beneath the ocean, and in a manner precisely adapted to its intended purposes. Animals were to be seen amidst utter darkness, and they are rendered luminous, or become themselves sources of light. The great pursuit of all animals is food, and the food has here been rendered luminous, that it might be discovered.

And may not another reason be also assigned? The phosphorescence of the sea, vivid in proportion to the surrounding darkness, often solaces the mariner in his course over the mighty mass of waters, and serves as a beacon-light, warning him against unknown coasts, and sunken rocks, against which his vessel might strike and perish. The contemplation of the Divine wisdom in nature may well lead us to exclaim, "Oh that men would praise the Lord for his goodness, and for his wonderful works to the children of men!" And how shall they do this aright, but by seeking the guidance of Him who said: "I am come a light into the world, that whosoever believeth on me should not abide in darkness!"

CHAPTER V.

HEADLESS MOLLUSKS—THE PINNA—ITS CABLE—THE CLAM—THE OYSTER.

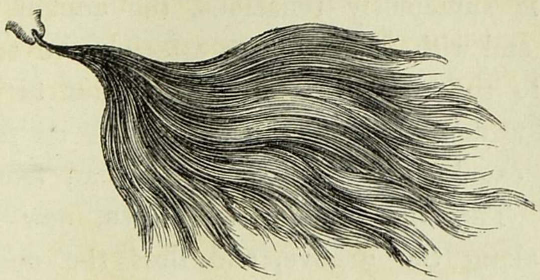
We now proceed to notice the conchiferous, shell-bearing, acephalous, or headless mollusks. These animals are invariably aquatic, and are inclosed in two valves, forming a shelly habitation, to which they are affixed by means of an adductor muscle, stretched from valve to valve. This muscle by its contraction closes



Headless Mollusk. *a a*, adductor muscles; *b*, foot; *c c*, posterior tubes.

them, and by its relaxation permits them to open, according to the action of its elastic hinge.

Headless mollusks have, from their structure, little communication with objects around them, and but very limited powers of locomotion. Some, it is true, raising themselves on the edge of their valves, urge themselves along by means of the foot, as we see in the fresh-water mussel, and leave a furrow in the soft mud, the index of their progress. Some, by this organ, bury themselves in the mud, and others, by the alternately opening and smartly closing their valves, can remove themselves from one situation to another.



The cable of the Pinna.

Many, on the contrary, are firmly fixed to the rocks by a calcareous exudation from their shells ; and clusters are often thus cemented together, forming greater or smaller masses. Others attach themselves to the rocks by a cable, or byssus, as the common edible mussel, and the pinna. This cable consists of threads, which exude in a glutinous state from a particular organ at the base of the foot. They are not spun out by being drawn from the secreting apparatus, but are modelled, so to speak, by the foot itself. The structure and the process here apparent are alike remarkable: from the root of the foot to its extremity runs a long groove, the sides of which are so constructed as to fold over, and thus complete a minute canal. Along this canal, as a mould, the glutinous matter runs, soon acquiring consistence, and appearing as a thread. When this thread is sufficiently tenacious, the animal protrudes its foot, and with its extremity attaches the end of the thread to the substance on which it is to be fixed. This being done, the pinna now expands its foot, opening the canal so as to free the thread from its inclosure. The foot is then withdrawn, new matter is poured along the groove, and thus the operation is repeated till the cable is secure. Is not here a claim on our high admiration? It is said that the pinna is only capable of producing four or five threads in the course of twenty-four hours, the production and hardening of the glutinous fluid being a tedious process. Security against storms and rolling waves is evidently the design aimed at, both in the immediate union of shells to the rock, and in their anchorage by means of this natural cordage. Reaumur states also, that the marine mussels are able to form these threads from the earliest periods of their existence; for he saw them practising this art when their shells were not larger than a millet seed.

Poli says, with respect to the byssus of mussels, which have all of them this power, that it is of the same structure with hair, and that, at the extremities, it is furnished with little cups or suckers, by which it adheres so firmly, that the mussels can only be drawn from the water in great bunches. Some species are entirely enveloped with this substance.

The shell of the *pinna ingens* is said to be often two feet long, and the threads are scarcely inferior in beauty and fineness to those of the silk-worm. Separately, they possess but little strength; but their great number is sufficient to secure the creature in a fixed situation.

The cuttle-fish is the enemy of the pinna; but she has a friend in a little crab which lives in her shell, and as an old writer says, "Pays her a good price for his lodging." The crab has red eyes, and sees very sharply; and whenever he observes the foe at hand, he gives a warning, which is attended to at once. Dr. Walsh, chaplain to Viscount Strangford, when he was our ambassador at Constantinople says:—"The harbour of Smyrna abounds with this large mussel, and also with the cuttle-fish. I was one day crossing in a boat; and as the water was very clear, I saw several at the bottom, and some pinnas opening, while others were closing their shells. As I was curious to examine them, one of the sailors leaped overboard, dived down, and brought up several of the mussels, in every one of which was a little crab. As soon as the pinna opened her shell he appeared like a sentinel; and when anything approached he ran in, seemed to warn his friend, and the shell closed." To this allusion is made in the following lines:

One room contains them, and the partners dwell
Beneath the convex of one sloping shell;
Deep in the watery vast the comrades rove,
And mutual interest binds their constant love.
That wiser friend the lucky juncture tells
When in the circuit of his gaping shells
Fish wandering enter; then the bearded guide
Warns the dull mate, and pricks his tender side;
He knows the hint, nor at the treatment grieves,
But hugs the advantage, and the pain forgives;
His closing shell the pinna sudden joins,
And 'twixt the pressing sides his prey confines:
Thus fed by mutual aid, the friendly pair
Divide their gains, and all their plunder share.

In one genus, *anomia*, there is in the upper valve of the shell near the hinge, an aperture, closed by a kind of operculum or lid, formed at the dilated extremity of an internal muscle; and it is by this part that the animal fixes itself. In another, the beak of the lower valve turns up, overhanging, in some degree, the upper valve; and in this beak is a notch or aperture, through which the fixing tendon passes. What an admirable instance have we here of variation in the means, when required by circumstances, to gain the same end! Nor is this all; it was necessary that the valves should not be reversed: a tendon through the lower valve secures this in the first of these animals; but in the second, when the overhanging beak would interfere with this purpose, the tendon issues from the beak itself, so as to enable the animal still to fix itself with the proper valve downwards.

The great clam is a very remarkable creature. We are told by Linneus, that one specimen weighed 498 English pounds; that the inhabitant furnished 120 men with provision for a whole day; and that the sudden closing of its valves was sufficient to snap a cable asunder. A manuscript in the library of the late Sir Joseph Banks, also notices the dimensions of a specimen brought from Sumatra, and preserved at Arno's Vale, in Ireland: the weight amounted to 507 pounds;

the largest valves measured four feet six inches in length, two feet five inches and a half in breadth, and one foot in depth. A shell of the same species forms the baptismal font at the church of St. Sulpice in Paris; it was presented by the Venetians to Francis I. And yet these shells suspended their vast bulk by means of a strong byssus. Below the hinge is a large opening, through which the animal passes a bundle of tendinous fibres, by which it is suspended to the rocks, however large and weighty its shells; and thus it is enabled, under the direction of instinct, to fix itself securely! Who then will refuse a tribute of praise to the all-wise God, who thus so marvellously provides for the welfare of his creatures?

Let us proceed now to a closer examination of the bivalve mollusca. One of these demands particular notice. The oyster has long been a favourite; indeed, from time immemorial these mollusks have constituted part of the food of man, fresh, dried, or cooked, and particularly in the former state. The Greeks, and more especially the Romans, when they levied contributions far and wide to cover the table of an Apicius or a Lucullus, held them in very high estimation, and attached no small importance to the localities from whence they were obtained. Those of the Dardanelles, of Venice, of the bay of Cumæ, and of England, were preferred; but they especially attached great value to those which, brought from various places, were deposited in the Lucrine lake, where they grew remarkably fat. Sergius Orata, at Baiæ, was the first Roman who entertained the idea of establishing this sort of oyster-bed.

If we take one of these animals, and open the valves of the shell, we immediately find each valve to be lined with a membrane, in some species bordered with a fringe of filaments arising from a thickened edge, which is, indeed, of a glandular structure; this membrane is the mantle, and excepting at the back where the two valves are united, it is free, enclosing the body of the mollusk as if between two leaves. It is from the outer margin of the mantle that the outer layers of the shell are secreted, so as to effect its extension, according to the growth of the animal. Between the leaves of this mantle lie four other leaves, composed of delicately fine fibres; these membranes attached to the centre of the body, are the branchiæ, gills, or aëra-ting organs, for the purpose of preparing the blood for general use. Between the two innermost of these leaves is the mouth. The mass of the body contains the heart; the stomach, imbedded in a liver of ample size; and the other viscera. It has been said, that the gills are the aërating organs, but they also serve another important purpose. It must strike every one who sees an oyster, and considers how inertly it lies, attached to its native rock, or to the bed whence it has been taken, that some special means of procuring food must be possessed, since the animal has neither the power of perceiving nor of following its prey; and herein the branchiæ fulfil a secondary but essential office. The water which traverses these branchiæ contains abundance of animalcules, on which the animal subsists; and by the action of minute cilia, to be seen only by means of a microscope, with which the filaments of the branchiæ are thickly covered, the water is kept constantly agitated, the element in immediate contact with the branchial surfaces being thus perpetually renewed, and as necessarily so as is the air we breathe. Let us mark how wise and beautiful a provision is made for the creature's good: the action of these cilia produces strong and rapid currents, the course of which is directed to the mouth, and with them are carried the nutritious particles on which the mollusk lives. The lips of the mouth are endowed with an amazing sense, which rules them as to what particles to receive, and what to reject; and thus a constant supply of food is obtained. The action of the cilia seems to be incessant, and goes on, when the shell is closed, acting on the water previously taken in; nay, even when a portion of the branchiæ is cut away, they continue their movements in the detached piece so long as vitality remains, and row it rapidly through the water, as if indeed it had independent existence. The branchial filaments consist of minute vessels, running a parallel course, and enveloped in a most delicate tissue; they communicate with each other, and ultimately merge into two principal trunks, conveying the pale blood to the heart.

Our wonder is not limited, however, to the internal structure; the shell of the oyster is not a little remarkable, consisting as it does of concentric layers of membrane and carbonate of lime, and the marks of the successive layers appearing in its rough outer surface. That which now forms the centre and utmost convexity of the shell was, at an earlier stage, sufficient to cover the whole animal. But as the oyster grows, it throws out from its surface a new secretion, composed of animal matter and carbonate of lime, which is attached to the shell already formed, and projects farther at its edges. Thus the animal is not only defended by this covering, but as it grows, the shell becomes thicker and stronger by successive layers. Marine vegetables are the food of oysters. They become green in three or four days, if put into small pits in the salt marshes where the water is about three feet deep.

Oysters are amazingly fruitful. Poli, styled by Kirby "the great luminary of conchology," states that one of these animals contains 1,200,000 eggs, so that a single oyster might yield enough to fill 12,000 barrels. Here we discover the care of Providence, that the demands made upon them to gratify the human appetite, shall not destroy the race.

The eggs are expelled in the form of spawn, or white fluid, very similar to a drop of grease, in which, aided by the microscope, may be observed innumerable minute oysters. Fishermen give the name of "spats" to this substance. The matter in which they swim, doubtless serves to attach them to the submarine bodies, or to individuals of their own species. Then the new ones, in being developed, smother, as it were, the old ones, not permitting the water to reach them, or hindering them from opening their shell. In this way are formed immense banks of oysters. These beds, as they are called, are kept up principally by collecting the spawn at sea, and in different places along the coasts of England

and France, and depositing it in the sheltered and shallow waters selected for "oyster layings," which usually are kept untouched for two or three years till they have arrived at some size.

We know nothing certainly of the manner of growth in the oyster, or the duration of its life. The inhabitants of Marennes, on the coasts of the Atlantic, affirm that it does not live more than ten years. In three days after depositing the spawn, the shell of the little oyster is three lines in breadth; in three or six months, it is nearly the size of a half-crown piece; and at the end of a year, as large as a dollar. The fishermen just mentioned, distinguish the age of oysters by the marks of growth on the shell. When they approach the term of their maturity, the shell is very large in proportion to the animal, which grows thin, and diminishes more and more. As the oysters can completely shut their shell, and thus enclose a large quantity of water in their interior, they can live a long time out of this fluid, especially if the drying action of the air be prevented, and they are placed in their natural position.

As we pass along the streets we cannot fail to observe, that at the fishmongers the oysters are laid with their flat sides uppermost; were it not for this precaution they would die. The animal breathes and feeds by the opening of its shell, thereby receiving a fresh portion of water into the concavity of its under shell; and did it not thus open the shell, the water could neither be propelled through its breathing apparatus, nor sifted for its food. In this manner they lie in their native beds: were they on their flat surface, no food could be gathered, and if exposed by the retreating tide, the opening of the shell would allow the water to escape and leave them dry, destitute alike of respiration and of food.

The "native" oysters among us in the highest repute, are obtained at Milton in Kent, about forty miles from London, and are consumed throughout England. The beds at Colchester, Maldon, Queenborough, and Rochester are among those that are much esteemed, and from whence the London market is supplied. Large quantities of oysters are procured from beds in the isles of Wight and Jersey, and on the coast of Wales, to be consumed in the neighbouring districts. They are found also in beds in the Frith of Forth: the Musselburgh oysters are, however, considered the best, and are called "pan doors," from being taken close by the doors of the salt-pans.

As the beds lie within a comparatively small space, dredging for oysters is carried on in fleets. The vessels are about fifteen feet long, and usually carry a man and a boy, or two men. Each boat is provided with two dredges; the dredge is about eighteen pounds weight, and must be heavier on a hard than a soft bottom.

CHAPTER VI.

THE PEARL—FISHERIES OF CEYLON—THE MUSSEL—THE SOLAN.

With the oyster is associated that singular natural production called the pearl, to which there is supposed to be an allusion in Scripture. The learned Bochart concludes that the word rendered, in imitation of the original, bdellium, was the pearl. This opinion is countenanced in the Arabic version, and, by a reference to the place where it is said by the sacred writer to have been found, in the land of Havilah, which bordered upon the Persian Gulf, or Erythrean Sea, from whence the largest and best oriental pearls are obtained at this day. Pearls, though procured in great numbers about Cape Comorin and the island of Ceylon, are generally smaller in size than those brought from the Persian Gulf. Those that are found in different parts of America, and in the islands of the South Sea, as well as those which are met with in oysters and mussel shells on the coasts of France and Britain, have a milky coat, and are very inferior to such as are brought from the shores of Havilah. There is, therefore, a great propriety in attributing the production of pearls to a country which has not been equalled in this respect by any other yet discovered. Moses had not circumnavigated the globe in scientific visitation, to spy out the varieties of each particular sea and strand, nor sent collectors to fetch pearls from all the sounds and friths on the face of the earth, to make a comparison between them; but God who made them, knew the relative kind and value of each, and communicated a part of that knowledge to his servant.

The inside of the mussel and oyster which produce the pearls, bears a certain resemblance to the pearls themselves; and hence it appears that they are but the misappropriation of that matter which is secreted by the animal to form the shell. It is worth remarking, that the deviations of nature are thus instrumental in producing a jewel which has always held a second place to that of the finest gems. The pearl, when cut through, is found to consist of several laminæ, or coatings laid one over the other, as if formed by a successive deposition of layers of pearly matter. The material of which shells are compounded consists of a stony substance, and a glutinous one, which binds the particles of the former together. If this material, while floating in the body of the animal, meets with a particle which has, by some accident, been removed from the proper passages and become stationary, we may suppose that it will adhere to it, and form a layer about it; which operation being successively repeated, produces in course of time those white pellucid balls which we call pearls.

Pearls are found throughout the whole substance of the animal; in the head, the coat that covers it, the circular muscles that terminate it, the stomach, and, in general, in all the fleshy and musculous parts of the body. And, in confirmation of that account, which we have briefly given of the mode of their formation, some foreign particle is often found in the middle of the pearl when cut through, which served as a nucleus or centre for the commencement of that process.

Unio was a name given by the Latin writers to the pearl; whence we sometimes meet with "union" as synonymous with pearl. The origin of this word seems to have been a persuasion that each pearl oyster produced only one pearl, which is contrary to observation, as many of different sizes are often found in different parts of the body of the same animal. The celebrated Linneus stated, that he possessed the secret of rendering a shell productive of pearls at pleasure. This was, perhaps, by drilling a small hole in the shell, and then introducing through it a minute grain of stony matter into the body of the wounded animal. It is well for the cause of humanity that no attempts have been made to turn this singular nostrum to any practical account.

Of the finest pearls, the weight of one carat or four grains is worth eight shillings; but this is the price when the pearl weighs only one carat, for the price increases in what arithmeticians call the duple proportion. If, for example, the pearl weighs four carats, then to find its price you multiply eight shillings by four times four, or sixteen, which amounts to six pounds eight shillings. Calculating their worth in this geometrical progression, it increases at a wonderful rate, so that a solid pearl, whose dimensions equalled the gate of a fortified city, would be reckoned worth a price which would, at the lowest computation, far more than pay our national debt. In the vision seen by the beloved disciple, each of the gates or portals of the New Jerusalem is said, most impressively, to have consisted of one entire pearl. But our idea of the preciousness of these gates is greatly increased when we remember that the wall was upwards of eighty yards in thickness, to which the frame of the gate must be adapted. And if we add to this, that the city occupied a site of two hundred and twenty-five thousand square miles in extent, and that the entrance of each gate must have been of an extraordinary breadth, to allow its vast population room to go in and out, we infer that the "world's wealth" would not have been equivalent to the value of one of them. A pearl brought, in 1574, to Philip II., though no bigger than a pigeon's egg, was valued at fourteen thousand and four hundred pounds sterling; and one a little larger, belonging to Cleopatra, was priced at eighty thousand pounds. Another, now in the hands of the king of Persia, mentioned by Tavernier, was bought of an Arab for one hundred and ten thousand four hundred pounds,—an enormous sum for a jewel less than a common hen's egg.

The pearl fisheries of the East are, the island of Bahrein, or Baharem, in the Persian Gulf; and Catiscer, on the coast of Arabia Felix, over against Bahrein; and Kondátchie, in the island of Ceylon. The pearls fished in the latter place are remarkable for their roundness and the fineness of their water, or clearness, but they seldom exceed two carats or four grains in weight; hence those found in the Persian Gulf greatly surpass them in value.

The village of Kondátchie is the chief station of the boats now employed in the pearl fishery, and gives name to the bay in which the principal oyster-banks are situated. Here at the fishery may be observed natives sitting near, or sleeping under two or three palmyra leaves, supported on one side to the height of three feet; to such a shelter is given the name of a house, and lines of the same are miscalled streets. No wonder, then, at the disappointment of the traveller, who has heard that the people assembled at the fishery cause a large town to start up as if by magic from the barren plain. Such disappointments, however, are not uncommon.

Very few of the assembled multitude appear to possess much property, but every one speculates as ar as he can command either money or credit. Two or three natives were observed by Major Forbes; they had come from the continent of India, and were reputed to be rich, the signs of which were gaudy palanquins; one of them had moreover a gorgeous umbrella, covered with purple velvet and embroidered with gold.

The arrangements for each day's fishing commence at midnight, at which time a gun is fired as a signal, and all the boats start, having the land-breeze to waft them to the fishing-bank; on reaching which they anchor until the day is sufficiently advanced and the water smooth, in which state it remains during the interval between the land and the sea-breezes. The diving then commences, and is continued with extraordinary exertion and perseverance until the sea breeze sets in;

then a signal gun is fired, and the boats returning with the government vessel, form an animated and pleasing scene, which is succeeded by the bustle of selling the oysters by auction, and distributing the shares to the several temples, various subordinate officers, the boat-owners, and shark-charmers.

The last-mentioned persons are always attendants at the pearl-fishery; they belong to one family, and no one who does not belong to it can aspire to that office. The natives believe that they have power over the monsters of the sea, nor would they descend to the bottom of the deep unless they knew that one of them was present in the fleet. Two of them are constantly employed; one goes out regularly in the head pilot's boat, the other performs certain ceremonies on shore. Stripped of his clothes he is shut up in a room, where no person sees him from the period of the sailing of the boats until their return. He has before him a brass basin full of water, containing one male and one female fish full of silver. Should any accident happen from a shark at sea, it is supposed that one of these fishes will be seen to bite the other. The shark-charmer is called, both in the Malabar and Hindostanee languages, a binder of sharks. The divers likewise imagine that if the conjuror should be dissatisfied, he has the power of making the sharks attack them, on which account he is sure of receiving liberal presents from all quarters. Sharks are often seen from the boats, and by the divers when they are at the bottom of the sea, but an accident rarely occurs. Many fisheries have been completed without one diver being hurt; and perhaps not more than one instance is to be found in the course of twenty years. Thus, most probably, the prevailing superstition is fostered. Oh, when will it end for ever, and men recognise in Jehovah the only and almighty preserver!

The diver's tackle consists of a large stone, suspended by a rope, with a strong loop above the stone, to receive one of his feet, and having also a slip-knot and a basket formed of a hoop and net-work, which receives the other foot. When he has fixed himself in this apparatus, he holds his nostrils with one hand, and pulling the running-knot with the other, instantly descends; and when he reaches the bottom, he disengages his foot from the stone, which is immediately drawn up to be ready for the next diver. He remains under the water a minute and a half or two minutes.

Sometimes the oysters are piled in great heaps, but in general they are purchased and divided among the speculators, who immediately open them, and if successful, sell their prizes, and continue their speculations on a larger scale.

The pearl oyster, though neither palatable nor wholesome, has no poisonous quality, and is said to be sometimes eaten by the poorest of those people who frequent the fishery. In digging anywhere near Kondátchie, the extraordinary depth of oyster shells shows the length of time in which the same difficult, dexterous, and persevering pursuit of these delicate baubles has taken place. The greatest number of oysters, according to Major Forbes, brought in by one boat in a day, was thirty-eight thousand; the greatest number of boats employed in one day was one hundred and sixty-two, and the greatest length of time any diver that he heard of remained under water was seventy seconds. The fishery to which he refers commenced on the 5th of March, and continued until the end of April, 1828. Only one large and one small bank were fished; the oysters of the former sold as low, at one time, as seven rupees (about fourteen shillings) for a thousand; and for a short time those of the small bank rose to eighty rupees; but having been much overvalued, soon fell to one-third of that price. This fishery realized about thirty thousand pounds to the government.

Pearls change, and are greatly deteriorated by time. They alter the more quickly, when worn immediately upon the skin. There they soon tarnish, and lose their brilliancy. Redi states, that on the opening of the tomb, where the daughters of Stilicho had been interred, with all their ornaments, eleven hundred and eighteen years before, every thing was found in high preservation, except the pearls, which were so brittle as to be very easily crushed by the finger.

As we muse on the pearls, a voice addresses us—it is that of our Lord Jesus Christ :—" The kingdom of heaven is like unto a merchantman, seeking goodly pearls : who, when he had found one pearl of great price, went and sold all that he had, and bought it," Matt. xiii. 45, 46. It may easily be gathered, from the prices of pearls already mentioned, that a merchant man might give all that he was worth for one pearl, and yet be a vast gainer by the bargain. We have here, therefore, a merchant seeking after pearls, by sea and by land, who meets with a pearl, by the purchase and resale of which he is sure to make his fortune. The story in the parable might easily be true in experience, for in ancient times especially, a merchant might in his travels meet with a pearl, the price of which amounted to the value of his whole stock. But still the price it might be sold for, where its value was better understood, might be so great, that the profit would be equivalent to a retiring fortune. If, for example, he gave ten thousand pounds, and sold it for sixty thousand, fifty thousand pounds would be a large fortune. He might then feel it no longer necessary to forego the comforts of home, to brave the dangers of the deep, or encounter the perils of robbers. He might return and spend the remnant of his days in peace and ease in the bosom of his family. Thus it fares with him who finds a pearl of great price in the spiritual blessings offered in the gospel.

And truly are they, in the inmost heart,
As the deep waters of a hidden well;
Whose living freshness have a power to impart,
Far more than e'en the poet's page can tell,
Of pure enjoyments inexhaustible,
Valued beyond old Ocean's rarest gem;
For they have power to bid the bosom swell,
With feelings of delight that flow from them,
E'en as the morning's rays from the sun's diadem.

He who earnestly pursues these spiritual blessings, will renounce all that is incompatible with salvation. Nothing indeed can be given as the price of salvation, yet much must be given up for the sake of it. Hence this man is represented as purchasing the pearl. Receiving Christ, in all respects, to be enriched and saved by him, he becomes a subject of his kingdom, and enjoys its inestimable privileges. And who can describe the exultation of his soul? Then, indeed, he enters into the force of the apostle's language respecting Jesus Christ, "whom having not seen, ye love; in whom, though now ye see him not, yet believing, ye rejoice with joy unspeakable and full of glory." May such be the well founded exultation of every reader!

The mantle has been mentioned as the organ by which the shell is elaborated, and described as a double membrane, of simple arrangement; and indeed so it is in the oyster and other allied mollusks, the two leaves being unconnected with each other round their free edges. But in other groups it is more complicated, the two leaves being united more or less at their edges, inclosing the body, as in a sac. This is the case, to a certain extent, in the mussel and its allies, the edges of the mantle being so joined as to envelope the body, leaving an aperture for the rejection of the digested element, and another for the protrusion of the foot.

The foot of the common mussel, (*mytilus edulis,*) can be advanced to the distance of two inches from the shell, and applied to any fixed part within that range. By attaching the point to any such body, and retracting the foot, this creature drags its shell towards it; and, by repeating the operation, it continues slowly to advance.

This organ is of great use to such shell-fish as conceal themselves in the mud or sand, which its structure is admirably adapted for scooping out. The *cardium* continually employs its foot for this purpose. It first lengthens and directs its point downwards, and insinuates it deep in the sand; it next turns up the end, and forms it into a hook, by which, from the resistance of the sand, it is fixed in its position, and then the muscles which usually retract it are thrown into action, and the whole shell is alternately raised and depressed, moving on the foot as on a fulcrum. Thus the shell is dragged onwards; the animal is moderately active, and these movements are made two or three times in a minute.

The apparent progress is at first small; the shell, which was raised on its edge at the middle of the stroke, falling back on its side, at the end of it; but when the shell is buried so far as to be supported on its edge, it advances more rapidly, sinking visibly at every stroke, till nothing but the extremity of the tube can be perceived above the sand. The instinct which thus secures a shelter for the animal, is said to operate at the earliest period of its existence.

The shell of the mussel is connected with an interesting fact. Among the Indian tribes all matters of importance transacted in solemn council between themselves or their white neighbours, is confirmed or commemorated by the delivery or interchange of symbols, which are chiefly strings or belts of wampum. A string consists of a series of square flat pieces of mussel shell, fastened breadth-wise on a cord or wire : a belt is composed of several of these strings joined side by side, and from three to four inches wide. When a string is delivered the speech may be verbose, because to recollect the general meaning is enough ; but when a belt is given, every word must be remembered. The white is used at amicable meetings ; the black and blue when the occasion is one of doubt ; but when the pieces of shell are marked with red, and have in the middle the figure of a tomahawk, defiance is held forth.

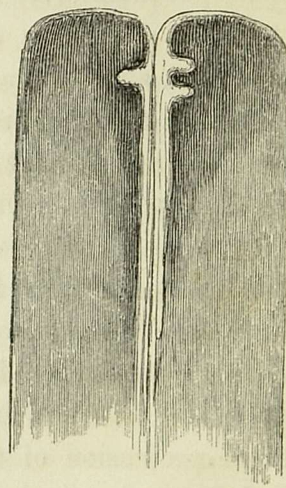
Such strings and belts are also registers of the public events of the Indians, and preserve the verbal terms in which treaties, agreements, and pledges were made between tribes, and families, and private persons. These records are carefully deposited in chests as public property. On certain festival days they are brought forth to refresh the memory of the aged, and that the young may learn their interpretation. At such times a large circle is formed of the initiated and their scholars, all sitting on the earth under the shade of forest-trees around the chest. One length of wampum is brought forth at a time, and held up to view, while one of the initiated not only explains the circumstances of its reception, but recites the very speech delivered with it. It is then handed round the whole assembly, each marking the length, breadth, colours, and devices it bears, and connecting with them in his own mind, the sentences of which it is the memorial. When all are satisfied, this is laid by, and another and another produced, till the whole are gone through.

In some mollusks the mantle is prolonged into two membranous tubes, varying in length in different species, and termed syphons, through one of which the water is conveyed to the branchiæ, the refuse matter being rejected through the other. This arrangement exists, in a certain degree, in the cockle, (cardium.) Its mantle, which is open anteriorly for the egress of the foot, is prolonged into two tubes, at one extremity, but these tubes are short; in an allied genus, however, (mactra,) they are of much greater length, and indeed are capable of being protruded to a considerable distance. These are burrowing mollusks, scooping, by means of their foot, a retreat in the sand or mud;

and hence the lengthening of the tube of the mantle, which is protruded to the mouth of their burrow, for the purpose of aquatic respiration ; in other words, for the transmission of water to the branchiæ ; water, full of animalcules, being driven to the mouth by means of the minute vibratory cilia. It has been observed, that one creature, *mya truncata*, when fully grown, will not attempt to burrow ; but on placing two young ones, which were scarcely more than a line (the tenth of an inch in length) on sand, in a glass of sea-water, they buried themselves immediately.

Another process is also remarkable. By doubling up the foot, and pushing with it downwards against the sand below, the shell may be again made to rise by the same kind of efforts which before protruded the foot. Thus the animal is enabled quickly to retreat when danger presses ; and when this is past, it can, with equal ease, come forth from its refuge.

We have hitherto only spoken of shells, of which the valves when closed, fit each other so as to leave no aperture, and which therefore require to be opened for the protrusion of the tube ; but there is a group, called *les infermés* by Cuvier, because the mollusks are so completely enveloped in the mantle, in which the closed valves always remain open, from their shape at each extremity. Such are the lutraria, the solen, the pholas, and the teredo. In the lutraria, the posterior orifice between the valves is very large, and gives passage to a double tube of considerable size; one the respiratory canal, the other for the rejection of the digested element: from the anterior fissure is protruded the foot, which is small and compressed. The shell of the solen is long and cylindrical, open at both ends, the double tube being protruded from the posterior orifice, the foot from the anterior, near which on the back edge of the valves (see the annexed figure) are two or three tooth-like prominences fitting into each other. The rapidity with which the solen, or razor-shell, (called by the French, *manche de couteau,* or knife-handle,) can burrow into the sand, is very remarkable; its foot is the instrument employed for this purpose; and the depth to which the animal penetrates, is often several feet, baffling all endeavours to capture it. Its foot is of a cylin-



The Solen.

drical shape, tapering at the end, and in form much more like a tongue than a foot.

It seems, however, to assume different appearances. Thus, when the solen is preparing to form a dwelling in the sand, it takes the form of a shovel, sharp at one end, and ending in a point, by the aid of which, a hole is dug: it then alternately assumes the shape of a hook, and of the spade already mentioned; one assisting the animal in his descent, the other shovelling out the sand. When he wishes to change his abode, the leg is again employed; and it then takes the shape of a ball. This ball prevents the creature from slipping back, while the reaction of the muscles throws him forwards. He has also a mantle in front, a curtain before the opening of his cell, which enables him to exclude the rough beating of the tide.

Supposing these appendages were wanting, the solen would be among the most helpless of creatures; for he cannot moor himself to a rock, nor run on his feet, nor raise himself from off the ground. But here a full compensation is made him, and in each of these provisions the Creator has deviated from the ordinary construction of such creatures, and that with an obvious reference to the peculiar habits of this animal.

The inhabitants of the coast where the solens are found, proceed to search for them, either as food for the very poor, or as baits for the catching of certain fish. It is when the sea is considerably withdrawn, especially after high tides, that they are able to obtain them with most facility, and in greatest abundance. They mark the place where any are to be found, by a transverse aperture, widened at each extremity in the form of a key-hole, above the hole which they inhabit. To draw them out, which is often very difficult, the animal being sometimes sunk very deeply, they throw in some pinches of salt. This so irritates the solen, that it immediately ascends out of the hole to get rid of it. It is then seized, but some address and dexterity are necessary, lest the animal should re-enter as rapidly as it came forth. Should it do so, the fisherman has recourse to a long iron crook, which he sinks pretty deeply, and drawing it out obliquely, carries away the sand and the solen also.

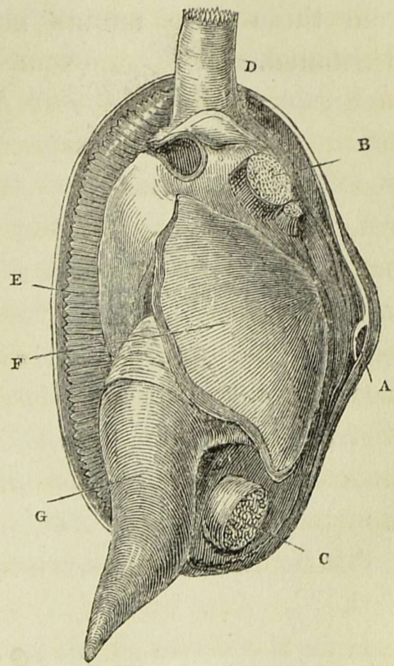
In the pholas, the two valves of the shell are convex — broad anteriorly, and become narrower and elongated posteriorly; a large oblique fissure being left at each extremity. Through the fissure at the larger end the foot is protruded, the double tube through the other. The boring habits of the pholas, so common on our coast, are well known; but the process by which rocks and stones are thus penetrated is not satisfactorily ascertained. The foot is large, broad, and flat, and constitutes a sort of sucker, by which the animal firmly attaches itself to the walls of its chamber, which fits the size of the shell. Whether this foot bores mechanically, (an impossibility as it would appear,) or whether it applies some solvent to the stone, and thus works by chemical agency, has yet to be ascertained. The formidable teredo, which has more than once threatened Holland with destruction, penetrates the wood-work of dams, breakwaters, and other structures on the shore, beneath the water, as well as the undefended hulls of ships, and by its unceasing labours makes a complete sieve or riddle of the mass attacked. As the animals grow, they enlarge the gallery, as it is supposed, by the aid of the valves of the shell; but this is not certain. The position of the teredo in its gallery is with the tubes toward the entrance of the gallery, for the sake of water and food; and the walls of its habitation are lined with a calcareous incrustation, produced by the mollusk, and which constitutes a sort of extra shell of a tubular form.

We have said that the hinge of bivalve shells is so constructed, and possesses such elasticity, as to act as a spring, opening the shell without any effort on the part of the inclosed mollusk, but that its closure is effected by means of a muscle passing from valve to valve. In some bivalve mollusks, this muscle, as in the oyster, though composed of two portions of different texture, is single; but in other bivalves, as in the mussel, there are two distinct muscles, separated from each other, but acting, at the same time, as adductors.

This is a structure well deserving attention. While the animal is alive, the common and natural state of its shell is that of being very partially kept open, so that the water required for respiration and nourishment may freely enter and pass out. But to secure the creature from danger, it was necessary to provide it with the means of rapidly closing its shell, and of keeping the valves together. These efforts, though only occasional, require considerable force, and are made by a muscular power, to obtain which sometimes one, at others two, or even a greater number of strong muscles are placed between the valves. These are called, from their office, adductor muscles.

When these muscles are not in action, the elasticity of the cartilage attached to the hinge is sufficient to separate the valves; but as they were designed to open only to a certain extent, it was necessary to limit by some means the action of the cartilage. Were this done by the adductor muscle, it would require, from the exertion demanded, a great expenditure of vital force. The economy of means, so apparent in the works of God, is therefore displayed, in uniting with the muscle an elastic ligament, which allows the valves to separate only to a proper distance.

Even when the mollusk dies, and these muscles cease to act, the elastic ligament of the hinge does not lose its property ; and hence the shell opens, leaving the body of the tenant to be devoured by small crustacea and other animals, which soon clear it away. The annexed diagram will serve to show the parts to which we have previously alluded, as seen in one of the mactra, of which one valve of the shell is removed with all its mantle, that of the other valve being left. A,



The Mactra.

the elastic ligament of the hinge ; B, C, the two adductor muscles ; D, the double tube or syphon ; E, the mantle ; F, the branchiæ ; G, the foot.

With respect to the nervous system of the bivalve mollusks, it consists of small ganglia, or knots ; one of which is placed near the mouth, another in the vicinity of the syphon, and others near the adductor muscles ; from these arise minute nervous filaments variously distributed.

CHAPTER VII.

GASTEROPODS—THE STRUCTURE OF SHELLS—VARIOUS EXAMPLES.

THE gasteropoda next demand our notice; these animals constitute a numerous class, comprising groups both aquatic and terrestrial, and therefore constructed, some for the respiration of air, others of water. But it is interesting to find that many aquatic species, as the limneus and the planorbis, are organized for the respiration of air, for which purpose they come to the surface of the ponds or stagnant waters in which they habitually dwell. The term gasteropoda, which means animals having the under surface of the body organized as a foot, is given to this class, because, as we see in the common snail, they creep along upon a fleshy disc, placed under the body, by means of the expansive and contractile movements of the muscular fibres of which it is composed.

The limneæ, or slug, too, as it pursues a similar course, emits a viscous matter, which serves to attach it to the bodies over which it moves. By means of this sort of spittle, when become friable or shining, one of these creatures may be traced, frequently many days after it has passed. Various substances, such as tobacco and salt, cause the animal to eject this matter so largely, that it swells, stiffens, and dies, when a little is put on its head.

The slug is very mischievous in our gardens, especially kitchen gardens, and also in orchards and fields. Slugs chiefly seek out for their food the young shoots of esculent plants. They attack, without distinction, the young buds of trees, and vegetables of all kinds, when they are young and tender ; and when the soil is rich and humid, planted with herbs of which they are fond, and free from the visits of animals which make them a prey, they multiply to excess. They have been known completely to devastate in a single night a very large seed-plat, the plants of which had just begun to shoot forth. Hence the earth, or the edges of the plants, should be covered with ashes, slacked lime, or fine sand; and they should always be kept in a pulverized state. These substances act mechanically on the animal, and, by attaching themselves to its body, hinder it from walking.

In their organization, the gasteropoda rise far higher in the scale of being than the acephala, or bivalve mollusks. They do not, indeed, possess organs of hearing, because they have no internal skeleton ; but they have organs of vision, and of taste. The mouth is furnished with teeth and a tongue ; and it would appear, though no apparatus has been detected, that they are capable of smelling. Most are covered with a shell, the product of a delicate mantle, and into this shell they have the power of retracting themselves entirely, and some of closing the orifice with a horny, or a calcareous lid, or operculum. To describe the variations of form which the shell assumes in various groups and species, is impossible in a cursory review like the present ; nor, indeed, is it necessary, for every observer must have been impressed with the fact, and have been delighted with the beautiful colouring so often exhibited. All the gasteropoda, however, are not thus furnished with a transportable habitation. In the slug, a little plate, the rudiment of a shell, is embedded in the substance of the mantle, but to which it is not adherent ; and in one group (the *nudibranchia* of Cuvier, of which the doris is an example,) not even this is to be found. In the cyprea, or cowrie, belonging to the *pectinibranchiate* group, the glossy porcelain-like shell is, at a certain period, enveloped in an ample mantle, which, extending from the aperture, falls over the shell on both sides, meeting in the middle so as to conceal it; but in most genera the mantle is altogether within the shell, its marginal portion exuding the calcareous matter of which the latter consists. In many cases, the foot, or ventral disc, often secretes a calcareous or horny plate, forming an operculum; this is exemplified in the common periwinkle.

The limneæ move along like the mollusks lately mentioned; the contraction of the foot takes its hold of a very slight stratum of the water, which they leave above them. Their strength is not great, for the slightest wind is often sufficient to accumulate them, thus floating, towards the opposite side from which it blows. When danger comes, they withdraw all their parts into the shell, become of a greater specific weight, and fall to the bottom. To return to the surface they are obliged to crawl along the bottom as far as the bank, or to follow the stem of some aquatic plant. The limneæ are only to be found in the water, and chiefly fresh water; and as this fluid cannot serve for respiration, they come to the surface from time to time to respire the atmospheric air. If they are found out of the water, it is always close to it, on some aquatic plant.

Of the glaucus, very little is known. It appears these mollusks are found only in the high seas, at a considerable distance from the shore, and that they often remain at the surface of the water, where they swim, like those just mentioned, with the assistance of their small foot. It is said, that the middle line of the belly appears like a leaf of silver, and is in a continual undulatory movement. This little creature, scarcely more than an inch in length, from its fine blue colour, and the silvery hues which adorn some of its parts, has a very elegant appearance when swimming in calm weather at the surface of the sea.

Another interesting creature is the janthina, the name of which indicates the colour of the handsome shell, which is a fine violet. The foot is distinguished by a vesicular mass, which is said to be a sort of gelatinous or sub-cartilaginous froth, composed of small cells, which can swell or contract at the will of the animal. This creature inhabits the deep parts of the sea in all warm latitudes. When the water is calm, they may be seen floating on the surface, and sometimes in pretty numerous bodies.

Over the vesicular buoy of the janthina, the animal called the Portuguese man-of-war manages to cast his thread; and, like a spider entangling his prey in his web, separates the shell from its buoy, and feeds on its spoil. When taken, the janthina emits about a tea-spoonful of a deep purple fluid, in order, perhaps, like the cuttle-fish, to darken the water around, and thus elude the pursuit of his enemies.

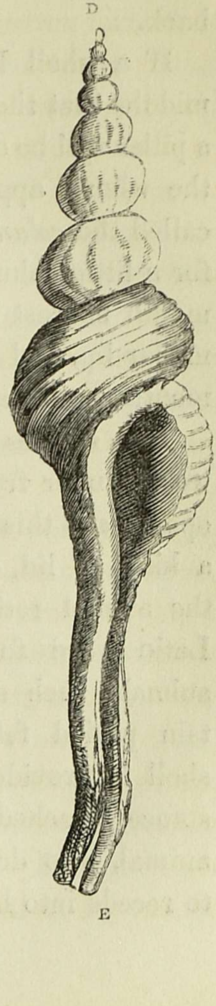
Shells have long excited interest. In many a humble dwelling they may be seen; while, in habitations of a higher order they often appear as the result of a choice directed by intelligence and taste. Many a specimen, too, is associated with the remembrance of a delightful search on the sands when the tide was out; of intercourse which gladdens and improves the heart; and of scenes which have left impressions on the mind not to be effaced. What interesting materials for conversation might be found, were an acquaintance with their circumstances more general!

The shells of the mollusca are formed either of one piece, or of several; the separate pieces, in either case, being termed valves: so that shells may be univalve when they consist of one, bivalve of two, and multivalve of a great number of pieces.

The univalves are the most simple. They have two principal parts: one of which is distended, called the body, and the other tapering, called the spire, as in the engraving on p. 103. The latter is formed by the parts which roll round, and are called whorls, from an old

Saxon word meaning a round. As they successively roll round one another, they gradually increase in size; and hence the set of them is called the spire, from a Greek word signifying convolutions, gradually increasing in diameter, like a rope coiled up.

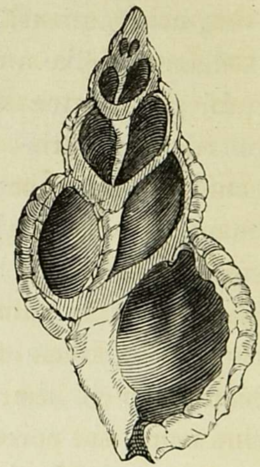
D



E

If the centre whorl is gradually raised above the rest, it assumes a conical form; when the whorls are all, or nearly all, on the same plane, the spire is said to be *retuse*, from the Latin word meaning beaten back, because they seem to be so, into the body; but if the whorls taper to a fine point, the spire is said to be *subulate*, from the Latin term for a pointed tool. The lines formed where the whorls meet, is called the suture, that is, the seam or joining.

The point of the spire, or top, is called the apex, D; and the opposite, or bottom part, the base, E. The opening is the aperture or mouth. When the shell is placed on its base, with its mouth turned towards the spectator, the part nearest the right hand is called the right side, and that nearest the left hand the left side; the part facing him is called the front, and the reverse the back.



If a shell be so cut down the middle that the inside may be seen, a pillar will be observed, round which the whorls appear to wind; this is called the *columella*, from the Latin for a little column; the edge of the mouth nearest it is called the columellar lip, and the one outside the mouth the outer lip.

The species of mollusca which would suffer from the mouth being open, have this organ provided with a kind of lid, closing the entrance to the shell when the animal retires into it: it is called *operculum*, the Latin word for covering. The operculum for land animals, such as snails, is temporary, and after a certain period falls off; but that with which a marine shell is provided, is either a calcareous or horny substance, attached, not to the shell, but to the foot of the animal, who draws it over his mouth when he pleases to recede into his dwelling.

Many shells have projections: some like thorns, others have ridges, and others rounded protuberances. Those which have spines are said to be spinous; the ribs, which are longitudinal, rounded sutures formed at the various growths of the shell, are called *varices,* from the Latin for a swollen vein; and those having rounded projections are called tuberculous.

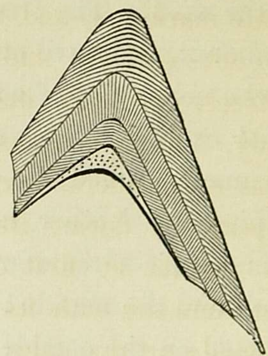
All shells are composed of particles of carbonate of lime and of what has the character of an animal substance, resembling in its chemical properties either albumen or gelatine. The mode in which they are united, as well as the nature of the animal portion, differ much in various kinds of shell; and these coverings have, in consequence, been divided into two classes—the membraneous and porcellaneous shells.

The two substances of which shells are composed may be separated from each other by an easy chemical experiment. If, for instance, a sufficient quantity of nitric acid, considerably diluted either with water or spirits of wine, be poured on a shell, or the fragment of one, contained in a glass vessel, it will soon exhibit a soft floating substance, constituting the animal part of the shell, and consisting of innumerable net-like membranes, retaining the exact figure of the shell. They satisfactorily prove that this substance is, in fact, an appendage to the body of the animal, or rather a continuation of the tendinous fibres that form the ligaments, by means of which it is fixed to the shell. They also show, that the shell itself owes its hardness to the earthy particles perspired through the vessels of the animal, which gradually incrust the meshes formed by the filaments of which this membranaceous substance is composed.

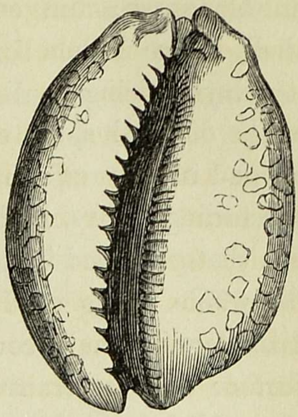
The eminent naturalist, Reaumur, established two facts in reference to the mollusca; namely, that the growth of a shell is simply the result of successive additions made to its surface; and also, that the materials forming each layer, so added, are furnished by the organized fleshy substance, which he termed the skin of the animal, but which is now known by the name of the mantle; and not by any vessels or other kind of organization belonging to the shell itself.

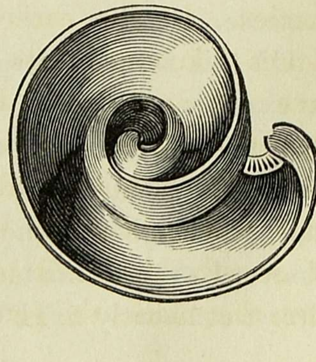
To illustrate the process of forming a shell:—If the portion of the shell of a living snail be removed, which can be done without injury to the animal, since it adheres to the flesh only in one point, there is formed, in the course of twenty-four hours, a fine pellicle, resembling a spider's web, which is extended across the vacant space, and becomes the first stratum of the new shell. This web is found, in a few days, to have increased in thickness, by the addition of other layers to its inner surface; and this process goes on until, in about ten or twelve days, the new portion of shell has acquired nearly the same thickness as that which it has replaced. Its situation, however, is not exactly the same, for it is beneath the level of the adjacent parts of the shell. The fractured edges of the latter remain unaltered, and have evidently no share in the formation of the new shell, of which the materials have been supplied exclusively by the mantle of the animal. This Reaumur proved, by introducing through the opening a piece of leather underneath the broken edges, all round their circumference, so as to lie between the old shell and the mantle: the result was, that no shell was formed on the outside of the leather, while, on the other hand, the inner side was lined with shell. The calcareous matter which exudes from the mantle in this process, is, at first, fluid and glutinous; but it soon hardens into the substance of the shell.

Some shells, called porcellaneous, have a more uniform and compact texture than those which are membranaceous. The animal matter which unites the carbonate of lime is more equally blended with the earthy particles, to which it appears to act as a cement, binding them strongly together. In shells of this kind, the carbonate of lime assumes more or less of a crystalline arrangement; the minute crystals being sometimes in the form of rhombs, and sometimes in that of prisms. In the former case, they are composed of three distinct layers, each of which is formed of very thin plates, marked by oblique lines, which show the direction of the crystalline fibres, so arranged as to give strength to the shell; and, what is remarkable, on a principle which has been latterly applied to the building of ships. When the form of the crystals is prismatic, the fibres are short, and the prisms are generally hexagonal. In one shell, brought from Sumatra, the crystalline appearance was so perfect, that some fragments of it were mistaken for a mineral production. In the earliest state of a shell, called the cyprea—known by its lips being rolled inwards, and both of them being toothed—its substance is very thin, almost colourless, and dull; the mouth is rather wide, the outer lip not rolled inwards, but having a sharp edge, and neither lip toothed. In the second period of growth, the shell begins to approach the general form that marks the genus; the lips are curved inwards,



and the teeth become apparent; but the substance is still thin, the colour faint, and the markings indistinct. But in its third and perfect state, the cyprea has received an additional coating of testaceous or shelly matter, the pattern appears with its vivid tints and delicate markings, and the spire, if not entirely hidden, yet scarcely projects out of the body. The animal itself undergoes a considerable change in appearance during its growth; its mantle at first is small, but increases with its age, and expands at the sides into two ample wings; and from these is deposited the final layer, which completes the shell. This new plate completely envelops the original shell, giving it a new covering, and disguising its former character. A transverse section, shows the steps by which these changes have taken place.





The shape of the shell depends altogether on the extent, particular form, and position of the secreting organ. On its exclusion from the egg, the animal has already a small portion of shell formed. The simplest case is that in which this rudiment of a shell is a concave disc. We may conceive the animal, covered by its mantle, to expand the border of this organ, and extend it beyond the edge of the shell, where it then forms a new layer of shell; and this new layer, being applied to the inner or concave surface of the original shell, will, of course, extend a little way beyond its circumference. The same happens with the succeeding layers, each of which, being larger than the one that preceded it, projects in a circle beyond it; and the whole series of these conical layers, of increasing diameters, forms a compound cone, of which the outer surface exhibits transversed lines, showing the successive additions made to the shell in the progress of its increase.

Of this form of structure, the patella, or limpet, is an example. This animal lives on the shores of the sea, and constantly on those parts which are alternately covered and left dry by the waters. None appear to be known belonging to the fresh water, nor have any been observed even in the mouths of large rivers. They are almost constantly fixed on rocks, and sometimes in excavations, tolerably deep, which they have hollowed in the substance of the rock. Its adhesive power is truly astonishing; if, prior to removing a patella, it is first touched, and thus, as it were, apprized of the intent, it is impossible to get it away, and the shell might sooner be broken, unless a plate of iron be passed between the foot of the animal and the rock. This power is owing to the great quantity of the vertical fibres of the foot, which, by raising the middle part, form a hollow in the centre, and consequently a sort of sucker.

Well, then, has it been said :—

In nature's all-instructive book,
Where can the eye of reason look,
And not some gainful lesson find
To guide and fortify the mind?
The simple shell on yonder rock
May seem, perchance, this book to mock;
Approach it then, and learn its ways,
And learn the lesson it conveys.
At distance viewed, it seems to lie
On its rough bed so carelessly,
That 't would an infant's hand obey
Stretched forth to seize it in its play:
But let that infant's hand draw near,
It shrinks with quick instinctive fear,
And clings as close as though the stone
It rests upon, and it, were one:
And should the strongest arm endeavour
The limpet from its rock to sever,

'Tis seen its loved support to clasp
With such tenacity of grasp,
We wonder that such strength should dwell
In such a small and simple shell.
And is not this a lesson worth
The study of the sons of earth?
Who need a Rock so much as we?
Ah! who to such a Rock can flee?
A Rock to strengthen, comfort, aid,
To guard, to shelter, and to shade;
A Rock, whence fruits celestial grow,
And whence refreshing waters flow.
No rock is like this Rock of ours:
Oh! then, if you have learned your powers
By a just rule of estimate;
If justly you can calculate,
How great your need, your strength how frail,
How prone your best resolves to fail,
When humble caution bids you fear
A moment of temptation near,
Let wakeful memory recur
To this your simple monitor,
And wisely shun the trial's shock
By clinging closely to your Rock.

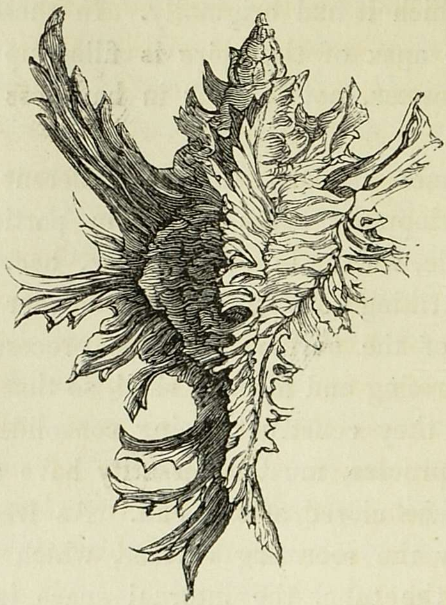
Need it be told who that Rock is? It is the only Mediator between God and man. Cleaving to him with "full purpose of heart," we are safe for time and eternity. For "who," says the apostle, "shall separate us from the love of Christ? shall tribulation, or distress, or persecution, or famine, or nakedness, or peril, or sword? As it is written, For thy sake we are killed all the day long; we are accounted as sheep for the slaughter. Nay, in all these things we are more than conquerors through him that loved us. For I am persuaded, that neither death, nor life, nor angels, nor principalities, nor powers, nor things present, nor things to come, nor height, nor depth, nor any other creature, shall be able to separate us from the love of God, which is in Christ Jesus our Lord." It would be digressing too far from the object before us to pursue the subject, though of infinitely the greater importance; but let not the reader neglect the highest wisdom, which is, to "cleave to the Lord with full purpose of heart."

To return to the subject we have left: in by far the greater number of mollusca that inhabit univalve shells, the formation and deposition of the earthy materials do not proceed equally on all sides, as happens in the limpets. If the increase takes place in the front only, that is, in the fore part of the mantle, the continual deflexion which thence arises necessarily gives the shell a spiral form, the coils being simply in one plane. Most commonly, however, the deposit of shell occurs laterally, and more on one side than on the other; hence the coils produced descend as they advance, giving rise to a curve, which is continually changing its plane.

A common snail has a shell of this form. And here another circumstance is worthy of remark: in consequence of the situation of the heart and great blood-vessels relatively to the shell, if we consider the animal as resting on its foot, the head being in front, the left side of the mantle is more active than the right, so that the lateral turns of the spiral are made in the contrary direction, that is, to the right. There are, however, a few species in which, in consequence of the heart being placed on the right side, the turns of the spiral are made to the left. Such shells have been termed *sinistral*, or reversed; but this form seldom occurs in the shell of fresh-water or land mollusca.

Already instances have been mentioned of the benevolence of the universal Father, and here may be added another. From the mode of forming shells, just described, it follows that the apex, both of the simple and of the spiral cone, is the part which was formed the earliest, and which protected the young animal at the moment of its exclusion from the egg. This portion may generally be distinguished by its colour and appearance from that which is afterwards formed. The succeeding turns made by the shell, in the progress of its growth, enlarging its diameter as they descend from the apex, form, by degrees, a wider base. During the growth of the animal, as the body extends towards the mouth of the shell, its posterior end often quits the first turn of the spire, and occupies a situation different from that which it had originally. In these cases, the cavity at the apex of the spire is filled up with solid calcareous matter, not inferior in hardness to that of marble.

It sometimes happens, that, at different periods, a sudden development takes place in particular parts of the mantle, which, in consequence, become rapidly enlarged, striking out into long slender processes. Every part of the surface of these processes has the power of secreting and forming shell, so that the portion of it which they construct, being consolidated around each fleshy process, must necessarily have at first the shape of a tube closed at the end. As fresh deposits are made by the secreting surface, which are in the interior of the tube, the internal space is gradually filled up by these deposits ; the process of the mantle retiring to make way for their advance towards the axis of the tube. In the course of time, every part of the cavity is obliterated, the process of the shell becoming entirely solid. Thus originate the many curious projecting cones or spines which several shells exhibit, and which have risen periodically during their growth from their outer surface. In the murex these processes are very numerous.



Remarkable changes also occur in the interior of the shell at different stages of its growth. On the inner surface of the mitra, the volute, and other shells of a similar kind, a layer of a hard, semi-transparent, calcareous material, having a vitreous appearance, is deposited. The thickness of the layer which thus lines the cavity of the shell, is greater as it approaches the apex; and where the spire is much elongated, or turreted, as it is called, this deposition entirely fills the upper part, which, in the early condition of the shell, was a hollow space with thin sides. What then is the purpose answered by this deposit? Evidently to give solidity and strength to a part which, by remaining in its original state, would have been extremely liable to be broken off by the action of the sea.

In other cases, an interesting expedient may also be observed. Instead of fortifying the interior of the apex by a lining of hard shell, the animal suddenly withdraws its body from that part, and builds a new wall or partition across the cavity, so as to protect the surface thus withdrawn. The portion of the shell thus abandoned, being very thin and brittle, and having no internal support, soon breaks off, leaving what is called a decollated shell.

The young of one genus, (magilus,) has a very thin shell, of a crystalline texture; but when it has attained its full size, and has formed for itself a lodgement in a coral, it fills up the cavity of the shell with a glassy deposit, leaving only a small conical space for its body; and it continues to accumulate layers of this material, so as to maintain its body at a level with the top of the coral to which it is attached, until the original shell is quite buried in this vitreous substance.

The forms of the cone, fig. 1, and olive shell, fig. 2, are such as to allow but a small space for the convolutions of the body of the animal, which consequently

Fig. 1.

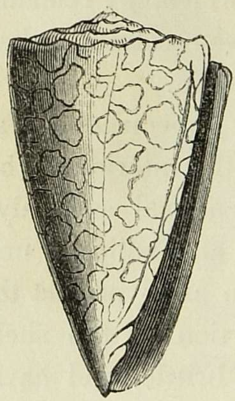
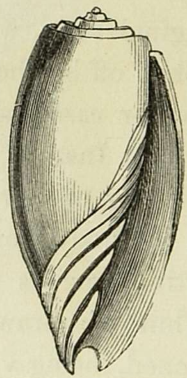


Fig. 2.



becomes exceedingly cramped in the progress of its enlargement. What then would be the expedient of human wisdom? One, doubtless, infinitely inferior to that adopted. In order to obtain more space, and, at the same time, to lighten the shell, the whole of the two outer layers of the inner whorls of the shell are removed, leaving only the interior layer, which is therefore very thin when compared with the other whorl, that envelopes the whole, and which, retaining its original thickness, is of sufficient strength to give full protection to the animal. That this change has actually been effected, may be seen distinctly in the cone fig. 3. Fig. 4, is a transverse section of a shell of this kind,

Fig. 3.

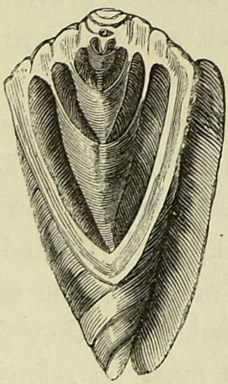
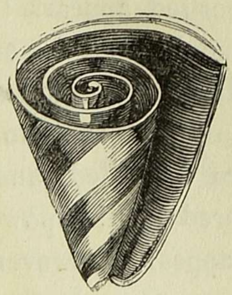


Fig. 4.



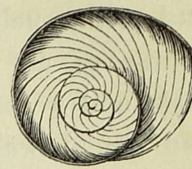
showing the spiral convolutions and the comparative thinness of the inner portions.

Instances indeed occur among shells of the total removal of the interior whorls. This is the case with the genus *auricula*, which are molluscous animals, respiring by means of pulmonary organs. In the young shell of this tribe, the partitions which separate the cavities of the whorls are incomplete, and twine parallel to each other; but they wholly disappear as the animal approaches maturity. In other cases, the animal removes exterior portions of shell formerly deposited, when they are in the way of its farther growth, and when the mouth of the spire is advancing over the irregular surface of the preceding whorls. In other instances, no such power of destroying portions of shell previously deposited appears to exist; and each successive whorl is moulded on the one which it covers.

It has long, indeed, been a prevailing opinion among naturalists, that no portion of a shell which has been once deposited, and has become consolidated, can be altered by the power of the animal which formed it. It appears, however, that on some occasions the creature removes large portions of its shell, when they produce inconvenience; but these cases must be regarded as exceptions to the general rule. The connexion between the animal and the shell is mechanical rather than vital; and the shell itself must be considered as an extraneous body, forming no part of the living system. Whatever share of vitality was possessed at the time of its deposition, all trace of that property is soon lost. Thus the holes made in shells by parasitic worms are never filled up, nor even the apertures of the cavities so made covered over, unless the living flesh of the animal be wounded. In this instance, calcareous matter exudes, and a pearly deposit is produced. The worn edges of shells and their fractures are never repaired, except so far as they can be by the addition of materials from the secreting surfaces of the mantle. Still, it were erroneous to suppose that there is no closer connexion between the shell and its inmate, than between the mason and the house he has built. On the contrary, the connexion between them is inseparable during life, but it is made merely through the medium of muscles which go from the animal to be inserted in the parietes or walls of its dwelling. The mollusca of bivalved shells are thus attached by one or two large and powerful muscles; sometimes called transverse, because, passing through the body, they are inserted into both valves at opposite points; and sometimes adductions, because their office is to close the valves, and keep them shut; and the astonishing force with which they act is felt whenever there is extreme difficulty in opening those of an oyster.

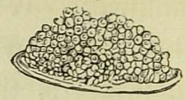
In some univalves, as the limpet, the body is fastened to the circumference of the shell by a ring of fibres, which are attached all round the shell, and which, after piercing the outward covering or cloak, are inserted in the edges of the foot, and interlaced with its circular fibres. This muscle, by its contractions, brings the foot and the shell closer together, and compresses the body; on relaxing, it allows the shell to be raised by the elasticity of the body. The snails of spiral shells are bound to them by two muscles, which arise from the pillar; and, having penetrated the body below its spiral part, run forward under the stomach, and spread their fibres in several slips, which interlace with those of the muscles proper to the foot, the substance of which they enter.

A limit has been assigned to the growth of shells and of their inhabitants; and at a certain period considerable changes take place in the disposition of the mantle, and in its powers of secretion. Frequently it suddenly expands into a broad surface, and adds to the shell what may be termed a large lip. No sooner is this accomplished than sometimes the same part again shrinks, and the mantle retires a little way within the shell, still continuing to deposit calcareous layers, which give greater thickness to the adjacent part of the shell, and at the same time narrow its aperture, and materially alter its general aspect and shape. Thus it happens that the shells of the young and of the old individuals of the same species are very different, and would not even be recognised as belonging to the same tribe of mollusca. When the animal which inhabits a spiral shell retires within it, the only part of its body exposed to injury is that which is situated at the mouth of its dwelling. But the Creator has not designed that it should be without defence. In order to its protection it is, in many instances, prepared to construct a separate plate of shell, adapted to the aperture, and called an operculum. This engraving exhibits the lines which appear on the inner side of that of the turbo, and which show the successive deposits by which it has been formed.



A clausium is another kind of covering, and consists of a thin spiral plate of shell attached to the columella by an elastic spring, by which the plate is retracted when the animal retires into its shell. It thus exactly corresponds with a door, opening and closing the entrance as occasion requires.

An epiphragma is a partition made merely for temporary use. On the approach of winter, the helia, or garden snail, prepares itself for passing that season in a torpid state, choosing a safe retreat, retiring completely within its shell, and then forming the defence just described, of which the following engraving is a representation of its outer surface.



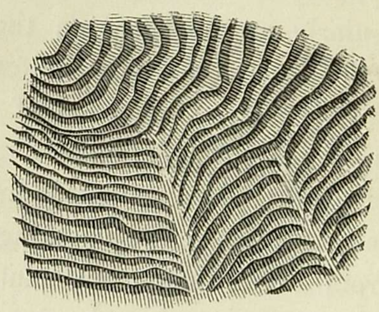
Nor is this all; for when this first barrier is formed, it afterwards constructs a second, of a membraneous nature, placed more within, and at a little distance from the first. If, too, at any other season, while the snail is in full vigour, it be surrounded, for the sake of experiment, with a freezing mixture, it will immediately set about constructing a covering for its protection from cold; and with such diligence does it work, that in the course of an hour or two it will have finished its task, and a complete epiphragma will be formed. On the genial warmth of spring penetrating its abode, the snail prepares to emerge from its prison, by secreting a small quantity of a mucous fluid, which loosens the adhesion, and the defence is thrown off by the pressure of its foot. On every occasion when another covering is required, this process of construction has to be renewed. By means of it snails and other creatures may be preserved for months, and even years, in a torpid but living state, ready to be restored to their most active functions when sufficient warmth is applied.

The argonaut, nautilus, and creatures of like habits, require shells as light as may consist with the requisite strength; and, consequently, the relative specific gravity of such shells is small. The greatest observed density was that of a helix; the smallest, that of an argonaut. The shell of the janthina, a floating molluscous creature, is among the smallest densities; the specific gravity of all the land shells examined was greater than that of Carara marble.

Nor let it be overlooked, that while the mollusca are able to construct, they can also adorn their habitations. The skin of the little artist is full of ropes; these contain colouring fluids, which, penetrating the calcareous substance before it is hardened, form its various tints. Nor does it appear that these pores occur at random. On the contrary, they are arranged in the skin of the mollusca as regularly as the spots on the leopard, or the stripes on the tiger; and the uniformity in the patterns of shells, is the consequence of the order in which the pores are placed in the mantle.

The providence of God is strikingly manifest in the colours of these creatures. The coverings of such as move readily from one situation to another, and are consequently able to choose the places of retreat, are generally varied with brilliant tints. Some exhibit the glowing colours of the rainbow, or those of the finest tulips, while a considerable number appear as if clothed in silver armour, as they walk under the shades of the madrepore. When the mollusca rarely move from the place of their abode, they are of the same colour as the sites they occupy, or the parti-coloured stones or sea-weeds to which they cling.

Many shells exhibit, on several parts of their inner surface, a glistening or silvery appearance. It is caused by the peculiar thinness, transparency, and regular arrangement of the outer layers of the membrane, which, in conjunction with the particles of lime, enter into the formation of that part of the surface of the shell. This has been dignified by the name of "mother-of-pearl," it being supposed to be the material of which pearls are



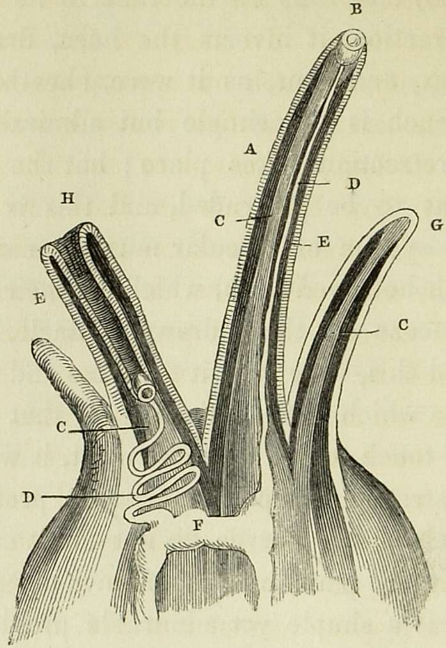
formed. It is true, indeed, that pearls are actually composed of the same materials, and have the same kind of structure; but it has been proved that these bright colours are the effect of the parallel grooves that arise from the regular arrangement in the successive deposits of the shells. The same shining property may be given to shell lac, sealing-wax, gum arabic, or fusible metal, by taking an accurate cast or impression of the surface of mother-of-pearl with any of these substances.

CHAPTER VIII.

THE SNAIL AND ITS HORNS — STRUCTURE OF THE MOUTH OF VARIOUS GASTEROPODS—TYRIAN PURPLE.

Allusion has been made to the eyes, the mouth, and aërating apparatus of the gasteropoda; and on these and other points of general interest, a few observations are here necessary. All are acquainted with the common snail, but few are aware of the beauty of its structure. When we look at one of these creatures, quietly creeping along in quest of food, we see four soft horns, as they are called, protruded from its head; of these, the two upper are the longest, and it is upon the tip of each that a minute but distinct and perfect eye is seated; the other pair are destitute of eyes, and are only organs of touch of exquisite perception. These four horns are well supplied with nerves from a large ganglion, and are hollow tubes, capable of retraction by very curious means. Each horn resembles the finger of a glove, and is retracted by its being inverted, as if the tip of the glove-finger were pulled in. To effect this, a muscular slip, given off from the fibres of the foot, and the expanse by which the snail draws itself into its shell, accompanies the optic nerve, (in the larger horns,) and runs up the tube to its termination. By its contraction, it inverts the horn, drawing down first the apex, and thus, as it were, sheaths the organ in itself. Such is the simple but admirable mode in which the retraction takes place; but the organ thus retracted has to be protruded, and this is effected by means of a system of circular muscles composing the walls of each hollowed horn, which, by their contraction, evert or squeeze out the indrawn tentacle, and, having accomplished this, they give it firmness and motion.

The nerve which runs to the eye, or that which gives the sense of touch to the tentacle, must, it would at first appear, be stretched when the horn is protruded; but such is not the case: nerves do not admit of such rude treatment without pain and loss of their peculiar powers. Here, then, is a simple yet admirable provision indicative of design, which, indeed, every part of the structure of these animals clearly exhibits. The nerve is as long as the horn when stretched to its uttermost, and so far its safety is provided for; but when the horn is inverted, the nerve is then thrown into a beautiful series of coils, lodged within the cavity into which the horn is retracted. The annexed diagram will explain the character of the apparatus which has thus been described; it is, of course, a magnified representation of



a longitudinal section of each horn. A, one of the larger horns protruded, showing B, the eye; C, the retractor muscle; D, the optic nerve; E, the muscular wall of the tube, composed of circular fibres; F, the ganglion from which the nerve of the eye arises; G, is a smaller horn, with its retractor muscle, C, but the nerves are not here shown; H is one of the larger horns partially inverted; C is the retractor muscle; D, the nerve folded up; E, the muscular tube inverted like the finger of a glove. To insist on the fitness and exquisite simplicity of such an apparatus—to endeavour to enforce the exemplification it displays of design, involving the wisdom and power of an Almighty framer, —or to show how His care in thus providing these beings with the most sensitive and delicate organs, both of sight and touch, and in endowing them with the power of concealing and protecting them from injury, may well be deemed superfluous. To every reflective mind, the structure of the apparatus, the arrangement of its mechanism, and the purposes to which it is adapted, will not fail to speak, and that more eloquently and forcibly than the most eminent naturalist.

The eggs of snails are usually rounded, tolerably large, and of a white colour: at first they are a little glutinous, especially so in the species which drop them one after another, and in the form of a chaplet. They are frequently deposited one by one, or in an irregular mass, in holes which the animal excavates in a soft earth, more usually in natural cavities, fractures more or less deep in the ground, in the holes of trees, rocks, or old walls; but generally in places where drought cannot reach them, and where moisture is constant. The number of these eggs does not appear to be very great.

At the end of a time, varying more or less according to the species, and probably, also, according to circumstances, the eggs open, and young snails come forth, already covered with a shell, which is extremely thin. They are, therefore, very much afraid of the drying action of the air, and especially of that of the sun, and do not issue from the holes in which they have been born, except during the night. They grow a good deal at first, but afterwards much more slowly.

The growth of the body of the snail requires a proportional growth in the shell. The animal now remains in a state of repose, sinks into some lcavity, and there issues from all the parts of the mantle, and especially from its thick edge, a stratum of matter, which is applied within the preceding, out-edging it a little. It is this part of the junction of this new stratum which forms the stria that marks the growth. It is so much broader in proportion as the animal is better nourished, and more vigorous. When the shell has reached its utmost growth, it merely becomes thicker, and forms in most of the species a sort of pad, more or less thick; and there is deposited on that part of the spire which modifies the aperture, a calcareous matter, generally not very thick, which can join the two edges. This is named a callosity, and thus the complete or terminated shell is constituted.

The shell of the same individual, however, differs much according to the period of life of the animal which is examined. Generally, the spire is so much the less raised when the animal is younger, and, consequently, the last whorl is larger in proportion, the aperture is wider, and the shell is thinner. But when it is terminated, the last whorl comes out from the line of the spiral, and becomes falling, which renders the aperture more narrow. A knowledge of these differences will prevent our considering individuals of different ages as different species.

Very variable, according to the food on which they are appointed to subsist, is the structure of the mouth in the gasteropoda. In the snail and its allies the mouth is placed on the under part of the head, and is furnished with an instrument well adapted for cutting the leaves which constitute the animal's food. The oral cavity, which is muscular, has affixed to its upper part a horny plate, the lower margin of which is extremely sharp, cutting like a minute knife, and easily dividing leaves, or biting into soft fruits, when these are worked against it by the action of the lips; the lower part, or floor of the oral cavity, is provided with a small tongue, of a cartilaginous texture, and having its surface marked by transverse ridges and depressed lines, so disposed as to render it effective in assisting to propel the food into the gullet. In some species the tongue is covered by minute horny recurved hooks, which are, doubtless, of use.

In other groups the mouth is much more simple, and is merely a muscular tube, capable of being protruded or contracted, and destitute of teeth; the lips, or moveable margins of the tube are, however, equal to the seizing of the food on which the animals live.

A more singular structure of the mouth is that which is found in the tritonia, one of the shell-less gasteropodes, (order, *Nudibranchia*, Cuv.) The mouth, of an oval figure, is furnished with large fleshy lips, and a tongue covered with spines; within the lips are two lateral horny jaws, resembling two sharp-edged blades, those, for example, of a pair of shears, and working upon an elastic hinge; the edge of one blade opposes and glides over the edge of the opposite, (as in shears or scissors,) and both are acted upon by powerful muscles, so that they are capable of biting very hard substances with great facility. The spines, or papillæ of the tongue, are all directed backward, and serve, by a slight continuous movement of the tongue, to force the food down into the gullet, whence it is carried to the stomach.

In the pectinibranchiate group, a still more complex and surprising structure of the mouth exists, in which the tongue takes the part of a boring instrument, by which the animal is capable of piercing the shells of other mollusks, so as to enable it to suck out their contents. This structure is seen in the whelk, (*Buccinum undatum.*) The mouth may be described as a flexible proboscis, moveable in various directions by the action of muscles, and capable of being completely retracted. This is effected, as we have seen in the horns of the snail, by inverting the proboscis into itself: but the action now referred to, is not so complete as in the horn of the snail, half of the proboscis only being drawn into the basal half, which thus forms a sheath ; this, however, can be retracted into the head of the animal by muscular fibres. To the end of this tubular proboscis, enclosed within it, is carried the tongue, which is cartilaginous, together with the gullet, or œsophagus, opening near the tip of the former. The tongue is supported by two cartilaginous slips, the extremities of which are formed into a sort of lip ; these lips are capable of being opened and closed, and the cartilages can be moved upon each other by the action of muscles. The tongue is armed with hard spines, rendering it a pointed file; and when it is applied by the proboscis to any shell the animal desires to drill, the supporting cartilages by their movements alternately depress and elevate these spines, which rasp away, on a small surface, and soon penetrate through the substance. Perhaps, in this operation the saliva, which is carried by long ducts to the tongue, assists, by some solvent quality it may possess; but though this is very probable, it is not positively ascertained: certain it is, that with this slender rasp-like tongue, worked by its supporters, the whelk will pierce shells of great solidity.

Such are the principal conditions of the structure of the mouth in the gasteropoda; but the modifications of each pattern are nearly as numerous as the species themselves; in all, however, the mouth is a positive and direct agent in obtaining food. A very marked difference may here be seen between these creatures and the bivalve mollusks, in which a syphon, and the cilia of the branchiæ propel a stream of water, laden with nutriment, to the mouth of an inert being; the mouth opening for the reception of such particles as are fitted for the animal's digestion.

Another remarkable fact must not be overlooked.

From one of the *Buccini* a purple colour has been derived, long esteemed of great value. According to Pliny, the artists began by removing the vein containing it, and adding to one hundred pounds of this substance twenty ounces of salt, the whole being allowed to macerate for exactly three days. It was then boiled in a leaden caldron until greatly reduced. A moderate heat was then kept up by means of a long stove, after which the flesh, which remained attached to the veins, was skimmed off; and the tincture being completely liquified on the tenth day, and afterwards strained, the wool was plunged into it. They continued to keep it warm until the desired hue had been obtained. A lively red was less valued than a blackish one.

The wool was left to steep for five hours, for after being corded it was re-plunged into the bath, until it had imbibed as much of the liquid as possible. The buccinum was not employed by itself, because the dye it produced would not hold, or rather, perhaps, because it did not preserve the lively red; but by mixing it with the purpura, it gave to the too dark tint of the latter the solidity and brilliancy of the scarlet, which was greatly valued. "By this mixture," says Pliny, "that superb colour is obtained which is named amethyst."

"Another tint," he says, "is yet obtained by saturating a stuff, which was at first amethystine, in a bath of the Tyrian purple, so that they tint at first conchylian, to facilitate the Tyrian tincture, which then becomes, as is said, softer and more agreeable."

The price of these colours varied according to the supply of animals; but, in consequence of the small quantity of juice extracted, and the long process of dying, the purple was so dear that, in the time of Augustus, one pound of wool dyed with the Tyrian purple, could not be bought for thirty pounds. It is supposed that the opulence of the city of Tyre was much increased by the commerce of this costly dye.

In 1686 the buccinum was found by Cole in great plenty on some of the Irish shores, on that of Somersetshire, and on the opposite shores of South Wales. Its juice was profitably employed to mark linen of a fine durable crimson; a small species was also found by Jussieu on the French coast. Cole found the juice of the buccinum, when taken out of the vein, to be white and clammy; and if it were then squeezed on linen or silk, it immediately, on exposure to the sun, acquired a pale yellowish green hue, then changed to a blue, and lastly to a deep purple red. These changes, though very rapid, were quicker or slower in proportion to the heat of the sun.

On washing the cloth with scalding water and soap, and again exposing it to the sun, the colour changed to a beautiful crimson, and then no further alteration took place from any of the means usually employed to dry colours. The linen marked with the white juice, always yielded while drying for the first time, a strong smell, resembling a mixture of garlic and assafœtida. A similar scent was attached to the purple of the ancients. A knowledge of this fact is valuable. From not being aware that the ancient purple was nearly our scarlet, many readers, especially among the young, have been not a little puzzled. The fact is, that the Tyrian purple, so far from being one particular colour, was a class of animal dyes, as distinguished from vegetable, varying in their shade, of which one peculiar tint of red was the most esteemed.

As it has been stated, that some of the gasteropoda respire air, as the snail; and others water, as the whelk, the doris, etc., it will be expected that a great difference must exist between the structure of the branchiæ or aërating organs in the one set of animals and in the other. Beyond this, however, a great diversity obtains in the structure of the branchiæ of the aquatic races; and upon these differences Cuvier has established his orders. Without attempting a full exposition of this part of the subject, a few of the principal points may be explained, serving to show the plan pursued, and also the marvellous resources, not of nature, but of nature's God, whose wisdom and power are alike incomprehensible.

Let us, then, take one of the air-breathing gasteropoda, for instance, the common snail. If we watch it crawling along, its body being protruded from the shell, we may observe on the right side of the body, near the margin of the shell, a circular orifice: this is the mouth of a breathing tube, and it leads to a capacious chamber on the back of the animal, above the visceral cavity, and separated from it by a partition. The roof of this cavity is lined with a network of blood-vessels, of exquisite delicacy and most beautifully disposed, and in these the blood undergoes the purifying influence of the air. The muscular floor of this cavity, already noticed, is the agent by which the air is drawn in and expelled, by a series of alternate movements, analogous to those of the diaphragm of quadrupeds. Hence, Cuvier has given to these animals the title of *Les pulmonés*, or *Pulmobranchiata*, that is, having their branchiæ like lungs; and the similarity is very remarkable.

Leaving these mollusks, we come to the first of the aquatic orders, which Cuvier terms *Les nudibranches*, or

Nudibranchiata, (literally, having the branchiæ naked.) In these animals the branchiæ form appendages, on the external surface of the body above. Sometimes they extend along the whole of the back, and at others they are confined to the posterior extremity of the dorsal surface, as in the doris, where they form a radiating flower, each petal having a beautifully fringed, or rather arborescent, margin.

Closely allied to this order is the next, termed *Infero-branchiata,* (having the branchiæ below the mantle.) In the animals of this group the edge of the mantle covers on each side a row of leaf-like appendages, which are the organs of aquatic respiration.

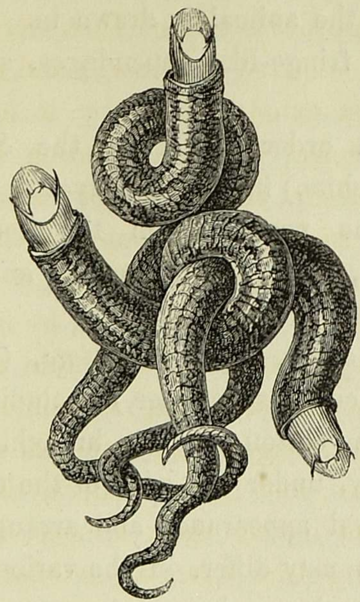
In the *Tectibranchiata* (having concealed branchiæ) the respiratory appendages form a fringe along one side of the body only, buried in a deep furrow between the mantle and the ventral disc or foot: of these the pleuro-branchus and the bulla are examples.

In the *Heteropoda* (so called because the foot, instead of forming a disc upon which to creep, is modified into a vertical muscular swimming apparatus) the branchiæ constitute plume-like appendages seated on the posterior part of the back, and directed forwards. The body is of a gelatinous transparent composition, and in swim-ming, the back is downwards, the swimming organ above. These animals, by some means not understood, are capable of distending the body, by filling it with water.

The *Carinaria*, of which one species (*Carinaria cymbium*) is found in the Mediterranean sea, may be selected as an example.

Cuvier's sixth order is termed *Pectinibranchiata*, (having fringed or pectinated branchiæ,) and is without comparison the most extensive of all: it includes all the inhabitants of spiral shells, inhabiting the sea. Like the *Pulmobranchiata*, the respiratory organs are on the roof of an internal cavity, occupying that part of the body within the last or widest whorl of the shell: this cavity communicates with the water, by means either of an orifice, or a syphon formed by a fold of the mantle; the branchiæ usually constitute a double or triple line of fringe-like appendages. In some, however, there is only a single row; and in two genera, the roof of this cavity, instead of having these fringes, has its surface lined with an exquisite vascular net-work. But these genera, namely, *Cyclostoma* and *Helecina*, respire air; the first is terrestrial in habits, the second aquatic. M. Férussac ranges these genera with the pulmobranchiata, and perhaps correctly.

From the *Pectinibranchiata* a group has been separated as distinct, under the name of *Tubulibranchiata*, (having branchiæ in a tubular cavity.) The animals of this group inhabit long irregular shells, spirally contorted, but without a definite figure; and these shells, as in the vermetus, are often twisted and interlocked



Vermetus.

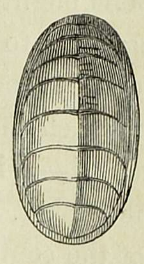
with each other and with foreign substances. The above sketch shows the character of the vermetus, of which three intertwined shells are exhibited, the animal appearing at the aperture of each. Thus formed into masses, they are necessarily incapable of moving about; and the foot, which ordinarily serves the purpose of locomotion, projects beyond the head, its extremity expanding into a disc furnished with a lid, closing the aperture, when the animal is drawn in. The branchiæ form a row of fringe-like appendages, along a narrow cavity.

The seventh order of Cuvier, the *Scutibranchiata*, (shielded branchiæ,) including halyotis, fissurella, etc., agrees with the preceding in the condition of the aërating organs, but differs in certain anatomical points of importance.

The eighth order, *Cyclobranchiata*, (with branchiæ disposed in a circular manner,) including the limpet (patella) and the chiton, has the branchiæ like a fringe around the body, under the edge of the mantle. However, the general appearance and arrangement of the aërating organs may differ, in the various groups—in all, the blood, having undergone its necessary change, is carried, by a vein, or by veins, to the auricle of the heart; it is then transferred to the ventricle, and thence sent through an arterial system to circulate generally.

Numerous are the modifications displayed by the digestive organs of the gasteropoda; we shall, therefore, not attempt a description, which, if applicable to one group, is not so to another. Suffice it to say, that a large liver, sometimes consisting of distinct portions, and salivary glands are always found; the stomach is sometimes a simple cavity, and sometimes furnished with a crop at its commencement.

The gasteropoda have been denominated univalve mollusks, in contradistinction to others, from their being enclosed in a shell consisting of two valves, united by a hinge. One genus, however, among the gasteropoda, scarcely merits the title of univalve; it is the genus *Chiton*, which is protected above by a series of shelly plates, overlaying each other, and resembling plates of armour. On examining these animals, we find the back covered with a tough leathery mantle of an oval figure, extending considerably beyond the body of the animal beneath. Along the central part of this mantle are arranged the plates, usually eight in number, and partially imbedded in the substance of the mantle, by which they are secreted: they do not, however, extend to the edge of the mantle, which is left free and



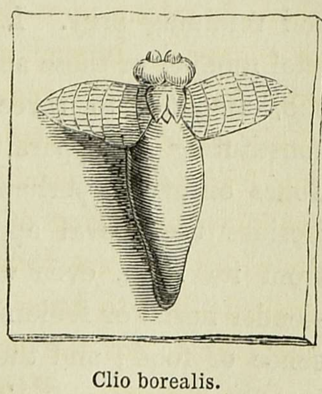
Chiton.

uncovered, and which has various patterns in the different species.

Thus has an outline of the structure of the gasteropoda been attempted, so far, at least, as is warrantable in a cursory notice like the present; and this plan has been followed the rather, because in no department of natural history does so mistaken an idea generally prevail as to the mode in which these animals ought to be studied. It is customary, indeed, to attend to their shells alone—to collect them, and arrange them according to their form, and to keep them thus arranged in cabinets—the study of these outer vestments being dignified with the name of Conchology. But what science is there, in taking up a shell, and calling it helix, or bulla, or cypræa? In such a pursuit a child of good memory will make rapid progress. We do not say that the shells ought to be neglected, for their form and colouring lead to the establishment of species; but unless we know something of the organization of the animals by which they are formed, our information is very contracted—it is to know the house, but not the inmate—the casket, not the jewel—the cover of a volume, but not the contents. Pursued as a true science, the study of the shelled mollusks is one of great interest; it introduces us to a world of wonders, from the contemplation of which we rise to meditate on the power and goodness of Almighty God, who commanded the waters to "bring forth abundantly the moving creature that hath life," and the earth, every "creeping thing," "and it was so," Gen. i. 20. 24.

An advance may now be made to the class termed pteropoda, (or wing-footed mollusks,) because they are constructed for moving through the water by means of expanded fin-like membranes placed on each side of the head. Some are naked and destitute of a mantle, as the clio, so abundant in the northern seas; others, however, as the hyalea and cleodora, have a mantle covered with a shell.

The *Clio borealis* (see the annexed figure,) is, in fact, a sort of marine slug, with a pair of wing-like fins or oars, attached one to each side of the neck, by means of which the animal rows itself merrily along, and plays amidst the foaming waves, rising or descending at pleasure. These oars are made up of muscular fibres, which pass through the neck from one expanded appendage to the other; so that the organ is, in fact,



Clio borealis.

single, and may be compared, as Professor Jones has well remarked, to the double-paddled oar, with which the Greenlander propels and steers his kajak through the seas, which the clio itself navigates. The head of the clio is enveloped in a mantle, which can be retracted at pleasure, so as to expose the mouth, surrounded by three conical appendages on each side, like fleshy tentacula. Examined by means of a microscope, each of these appendages is seen to be regularly and numerously covered with red points, which, when inspected by a lens of great power, are found to be distinct, transparent cylinders, sheathing about twenty minute suckers, capable of being protruded, and acting as organs for seizing and retaining prey. It has been calculated, that the total number of these suckers, upon the head of a single clio, amounts to three hundred and sixty thousand, constituting an apparatus for prehension, as Professor Jones observes, perhaps unparalleled in the creation. Besides these oval appendages, the clio can protrude from its head, even when the mantle is closed, two slender horns or feelers, in order to ascertain the presence of food; and thus informed, it prepares its prehensile instruments. The mouth of the clio is found to be furnished with a tongue, covered with sharp horny spines; and its jaws are provided with pointed horny teeth, set in a fleshy base, and so arranged as to be capable of seizing prey, and dragging it into the mouth. Cuvier regarded the oars of this animal not only as organs of locomotion, but as a respiratory apparatus: the correctness of this view is denied by Eschricht, and we are, therefore, doubtful as to the laboratory in which the circulating fluid undergoes its necessary aëration. Much more, in the economy and structure of this mollusk, remains to be cleared up. In this slight sketch of the *Clio borealis*, no one can fail to behold the power of the Creator, who, in the minutest, as in the hugest of living beings, displays infinite wisdom, adapted to overwhelm us with wonder and admiration.

In the *Hyalea* there are two large wings, but no tentacula; the body is covered with a mantle, having a fissure at the sides; at the bottom is lodged the aërating apparatus, a circle of vascular leaflets. The mantle is invested in a shell, which has a corresponding opening at the sides; its ventral face is very convex, its dorsal surface flat, and longer than the other; presenting at its posterior part, on the transverse line, where it is united to the other, three sharp tooth-like projections. From the lateral fissures of this shell the living animal can protrude certain processes, the productions of the mantle. One species, the *Hyalea cornea* of Lamarck, which has a little yellowish semi-transparent shell, is found in the Mediterranean.

Closely allied to the hyalea is the genus *Cleodora*, in which the shell is of a conical, and sometimes a globular figure, without lateral fissures. On account of the form of the shell this genus has been subdivided by M. Rang into several sections.

And now, with a question from one of our poets, this chapter may be concluded.

Hast thou heard of a shell on the margin of ocean,
  Whose pearly recesses the echoes still keep,
Of the music it caught when, with tremulous motion
  It joined in the concert poured forth by the deep ?

And fables have told us, when far inland carried,
  To the waste sandy desert, or dark ivied cave,
In its musical chambers some murmurs have tarried
  It learned long before of the wind and the wave.

Oh ! thus should our spirits, which bear many a token
  They are not of earth, but are exiles while here,
Preserve in their banishment, pure and unbroken,
  Some sweet treasured notes of their own native sphere.

Though the dark clouds of sin may at times hover o'er us,
  And the discords of earth may their melody mar,
Yet to spirits redeemed some faint notes of that chorus
  Which is borne by the blessed, will be brought from afar!

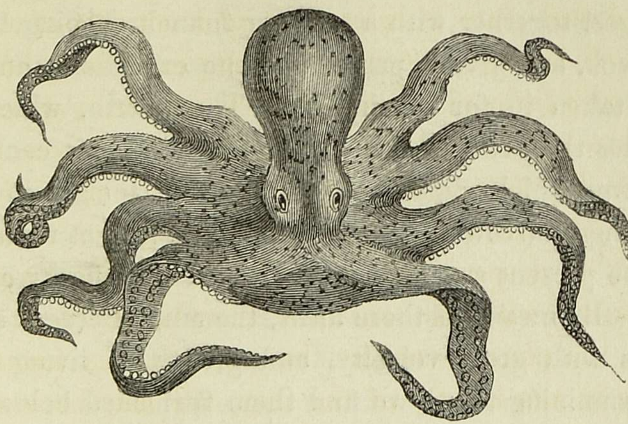
CHAPTER IX.

THE CEPHALOPODS—SINGULAR FACTS IN REFERENCE TO THEIR STRUCTURE AND HABITS—THE NAUTILUS.

The last class of the mollusca, namely, the cephalopoda, now invites our notice. This term, which means head-footed, alludes to the arrangement of the complex and wonderful organs of locomotion around the head of the animals, to which they are, as it were, so many flexible, but powerful appendages, by means of which they not only creep along at the bottom of the sea, but grasp their prey and force it to the mouth.

It is in these animals, the highest in the scale of the mollusca, that the rudiments of an internal skeleton are to be found. This is cartilaginous, but still it cannot be mistaken: one portion encloses and protects a large ganglion, which may, indeed, be termed a brain, and surrounds with a ring the œsophagus itself; it gives a firm attachment to the muscles of the tentacula, or arms, and it encloses an auditory apparatus. Other portions are met with at the lower part of the body, and in the fins of such as possess these appendages — the calamary for example. But this commencement of a skeleton must not be confounded with a corneous or calcareous structure contained in a large cavity within the dorsal portion of the mantle, and there secreted by the sides of the chamber itself. In the cuttle-fish (*Sepia officinalis*) this dorsal plate is calcareous, and consists of a multitude of laminæ, not closely compacted together, but kept at a little distance apart, by minute, but very numerous pillars; the whole being a light and porous mass. In the calamary (*Loligo*) this plate is a long horny substance, (somewhat resembling the blade of a sword, or a spear head,) deposited layer by layer, and increasing with the animal's growth. In both these cases, the plate resembles the small lamina found in a cavity of the mantle of the slug, and may be regarded as a rudimentary shell; the lingering relics of that structure which is in its perfection in the lower mollusca. In the argonaut and the nautilus, we find it assuming the form and structure of a true shell, over which the mantle is more or less reflected, but in which the animals are housed; the difference between the cuttle-fish and these animals being, as far as this shell is concerned, analogous to the difference between the slug (*Limax*) and the snail (*Helix*).

In order to convey an idea of the general characters of the cephalopoda, let us take one of them and examine it—say the common poulpe, the polypus of the ancients, (*Octopus vulgaris*,) an animal common on the coasts of

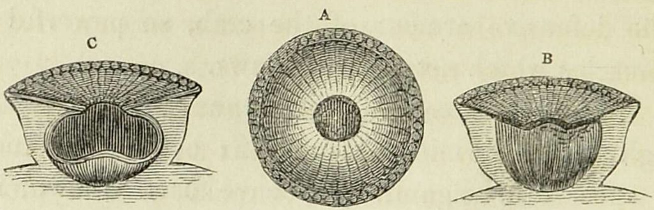


Octopus vulgaris.

southern Europe, and found on our own shores. There is something strange and uncouth in the figure of this creature; its long flexible arms moving and curling in all directions, and its large eyes, which stare with a fixed gaze, render it even repulsive. A cursory observer would say that it was of a fierce nature, and that its appetite was voraciously carnivorous, nor would his opinion be incorrect; it is indeed one of the tyrants of the waters, and fishes and crustacea are its prey. The body, which, when the animal crawls along, is elevated, with the head downwards, is of a globosely oval form, and is invested in a tough bag or mantle, constituting a sort of sheath, from which the head with its long arms emerges, together with a tube, or funnel, opening before the neck, and giving passage to the excretions, and the fluid taken in for respiration. The mouth, which resembles the beak of a parrot, is placed in the centre of the arms which radiate from it; these are eight in number, long, narrowing to a point, and united at their base (in the present species) by a thick web, or fleshy expansion. By means of these arms, the animal creeps along, swims with great velocity, and grasps its living prey. On examining them, we find them furnished below with rows of suckers crowded together, there being about one hundred and twenty pairs—thus there are two hundred and forty distinct suckers on the under surface of each of these muscular, flexible, but most vigorous arms. None for this purpose can be more formidable. Let but one arm be thrown round the swiftest fish, the strongest lobster, or crab, and it is enough. Vain is resistance;

the suckers adhere with such tenacity, that the arm may be wrenched off sooner than they will yield. In an instant, all the arms are brought into work; they enfold the fated victim, struggling uselessly in the gripe of its destroyer; closer and closer is it forced to the mouth, and there retained as by a vice. And now begins the feast; with its strong hooked beak, the cephalopod easily demolishes a fish, and even breaks up and strips off the defensive armour of the crab, so powerful are the muscles which act upon the jaws.

In our seas, none of the cephalopods are large enough to be formidable to man; but in the Indian seas, species of gigantic size have been known, it is asserted, to entwine their dreaded grasp round persons while bathing, and to drag them, vainly struggling, to destruction. But how, it may be asked, do the suckers of the arms of these animals act? Each sucker is a self-acting cupping-glass, or rather air-pump, of most precise and beautiful construction. It consists of an adhesive disc, composed of a muscular membrane, with a thick fleshy circumference, and presenting, when expanded, a number of radii, converging to surround the circular mouth of an inner cavity. At the bottom of this cavity is a moveable muscular piston, which, when the sucker is not in action, appears level with the circular aperture ; but which, when the disc is closely applied to any object, is strongly drawn back, the cavity it filled being now a large vacuum. When the animal releases its hold, it relaxes the contractor muscles of the piston, which returning, fills the vacuum, and the suction ceases. This structure will be readily understood by reference to the annexed diagrams. A shews the ex-

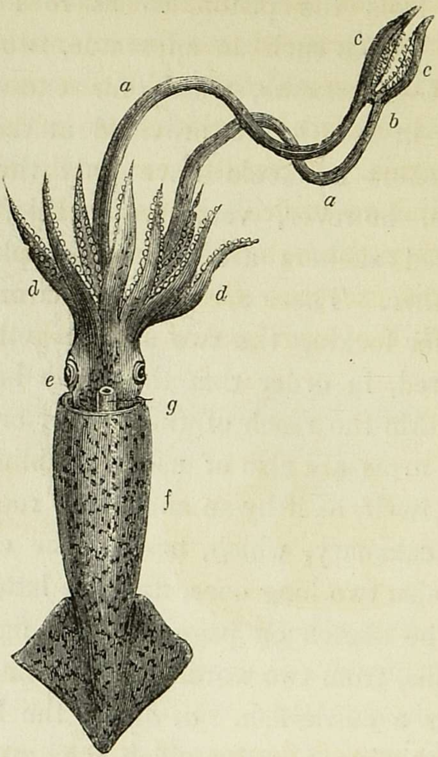


Suckers.

panded disc of the sucker, with a central orifice, stopped up by the piston when not in action ; B is a longitudinal section of the sucker at rest, with the piston up to the orifice ; C is a longitudinal section of the sucker in action, showing the piston retracted, and the large vacuum thus produced.

In some species, the prehensile power of these suckers is still more increased, or, perhaps, rendered more efficacious in securing slippery prey, by a strong sharp hook, projecting through the central orifice of each disc from the piston, so as to act like a grappling iron. With such an apparatus, two additional arms of the *Onychoteuthis,* which far exceed the other eight arms in length, are provided at their extremity, while the short tentacula have only the ordinary suckers. It is, however, very remarkable, that below these hooked suckers are several simple ones, set closely together. These are not used as organs of prehension, but for locking the two arms together when a victim is secured, in order that they may both act in dragging it within the reach of the shorter arms. Perhaps these long arms are also of use in enabling the animal to attach itself, as if by an anchor, to rocks, or heavy stones: the calamary, which, besides the eight ordinary arms, has also two long ones, uses the latter for this purpose.

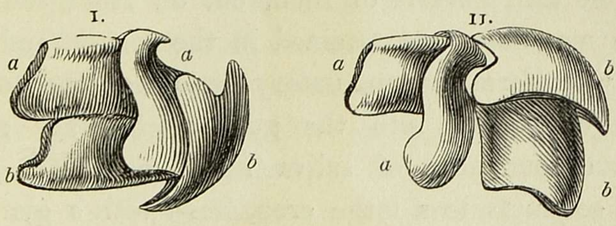
The sketch on page 158 is a figure of the onychoteuthis, from two words, one meaning a claw, or nail, the other a cuttle-fish. *a, a,* are the longer arms; *b,* the group of suckers by which they are themselves locked together; *c, c,* are the dilated extremities furnished with hooked discs; *d, d,* are the short arms; *e,* the head; *f,* the mantle-covered body, terminating in a broad, fin-like expansion, which does not exist in the common polypus, (*Octopus vulgaris,*) but occurs in the calamary (*Loligo*) at the extremity of the mantle; while in the common



Onychoteuthis.

cuttle-fish (*Sepia officinalis*) a similar expansion is continued down each side of the mantle throughout its whole length; *g* is the funnel. The preceding figures will serve to convey a general idea of the form and proportions of the ordinary shell-less cephalopods, and we may now proceed to a few interesting details.

It has been already said, that the mouth of the cephalopods is placed in the centre of the space enclosed by the arms. It consists, externally, of a thick circular lip, around an orifice. Beneath this lip, and partially appearing through the orifice, is a beak like that of a parrot, excepting that the short mandible is the uppermost, the long hooked mandible the lowermost, as in



Jaws of Cephalopod.

the annexed figures, of which I exhibits them open, II closed; and in both instances cleared from the lips, and the powerful muscles in which they are imbedded. *a*, *a*, is the upper mandible; *b*, *b*, is the lower, and most hook-like. When closed, the point of the lower mandible overlaps that of the upper.

These mandibles do not cover bone, as do those of birds, but their interior is filled with a hard fibrous substance, adding to their general strength and solidity. They are worked by muscles, fitted to enable them to destroy such captives as are infolded in the animal's arms. In the nautilus, the mandibles are blunt, and of a calcareous texture, and are calculated for crushing the shells of mollusks. The mandibles of the cephalopods enclose a muscular tongue; it is invested with a membrane of a delicate structure, but it is armed besides with recurved, horny, hook-like papillæ, by means of which the morsels of food, cut off from the mass by the mandibles are retained in the mouth, and then by a vermiform or undulatory action of the tongue, forced backwards into the gullet. Salivary glands pour an abundance of saliva into the mouth. The gullet conducts to a large crop, lined with a glandular folded membrane; and from this crop a short tube leads to a strong muscular gizzard, not unlike, in structure and lining, to that of a common fowl. Here the food is ground to a soft mass. From this gizzard proceeds the intestinal canal, receiving the bile from a large liver divided into numerous lobules. The intestinal canal is simple, and terminates at the base of the funnel; into which latter (excepting in the nautilus,) is also poured the inky secretion of a capacious pouch, situated differently in the various genera, and commonly termed the ink-bag.

All have heard of the ink of the cuttle-fish, which has been regarded as the basis of true China ink, and which certainly may be used as a tint, for it mixes readily with water; a circumstance of importance to the animal itself, as it is to the discoloration of the surrounding fluid, by its admixture, that it trusts for concealment when threatened with danger.

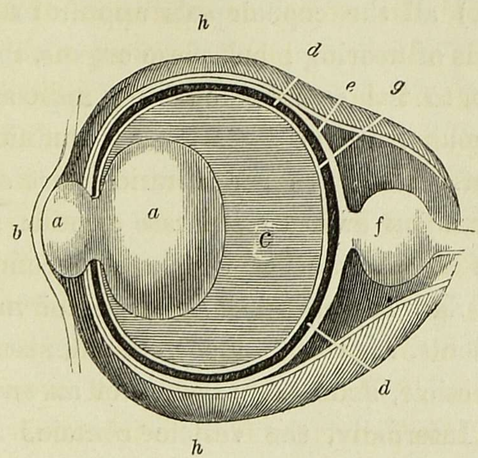
In the calamary, the ink-bag is placed near the funnel; but in the octopus it is surrounded by the liver; in the cuttle-fish, it is at the bottom of the general cavity containing the viscera, below the branchiæ. It is always large, and pours out a great quantity of its dark ink through the funnel.

Among the remarkable modes of defence against enemies with which animals are endowed by a wise Providence, this is one of the most so: strong and rapacious as are the cephalopods, they have their foes from which to escape—foes, doubtless, as active as themselves, and capable of swallowing them at once. Among these the cachalot may be numbered, the grampus, and others. To escape by speed is out of the question; concealment is their object. No sooner do their quick eyes behold an advancing enemy—no sooner are they alarmed, than they sink to the bottom of the sea, and there throw out from the funnel a stream of ink, which, like a black cloud, enshrouds them in welcome darkness, concealing them from the gaze of their foe. It is some time before the opaque and murky cloud dissipates: if the danger be passed, they recommence their activity in search of prey; if not, they pour out another volume of ink, and remain quiet, enveloped in its shelter.

Allusion has already been made to the branchiæ of the cephalopods, or, in other words, to their breathing apparatus. As these animals are organised for the respiration of water, not of air, we find in a distinct chamber on each side of the body, separated from the viscera by a membraneous partition, a beautiful aërating or branchial apparatus, consisting of a single stem, with foliated appendages, excepting in the nautilus, which has a double gill, or two stems with their fringe-like or foliated appendages, in each lateral cavity. These appendages are exquisitely vascular, and the blood circulating through the inconceivably minute vessels, is there subjected to the action of the oxygen. Into each chamber or branchial cavity the water is admitted through a valvular aperture, and is drawn in by the dilatation of the muscular investment of the body; but the contraction of this investment cannot force the water back through the same aperture ; it is expelled through the funnel, and that with considerable force—so much so, indeed, that it is, in a great measure, by the expulsion of the water taken into the respiratory cavities, that the animals propel themselves along. As the funnel (see the figure of the onychoteuthis, p. 158) points towards the head, and the water is thrown out in that direction, it must be evident that they swim with the head backwards ; this is indeed their mode of aquatic progression, the arms being either closed together and projected, so as not to impede them, or acting as oars in unison with the branchial cavities. Such species as have paddles, or fin-like expansions of the mantle, are aided by them in their aquatic movements ; but in those species which have not these paddles, as the octopus, the arms of which are connected together by thick basal webs, (see figure, p. 153,) these arms, by their flapping, take an important part in the act of swimming, and enable the animal to shoot along with great velocity. Thus in the act of swimming, they not only use the arms and the fins as paddles, but they also employ a water-throwing machine, for the purpose of propelling them onwards.

The cephalopods, as already stated, have organs of vision ; on each side of the head an eye is seated, expressly adapted for discerning objects in the water. In the octopus, loligo, etc. the eye-ball is placed in an orbital cavity, of which it occupies the anterior portion: it is remarkable for being destitute of a cornea, the transparent skin being continued over the eye, so as to supply the place of that tunic in mammalia. Beneath this skin is seated the crystalline lens, which is large and very convex; and posterior to this is the vitreous humour in its own membrane; between this vitreous humour and the retina, or expansion of a large optic ganglion, is a layer of black pigment, such as in mammalia is behind the retina; and it is difficult to imagine how thus placed before the retina, it can admit the rays of light to that nervous membrane. It cannot, indeed, be supposed that it does; and the question arises, How is vision effected, or is this so called retina truly so? That it is an expansion of a large nervous ganglion there can be no doubt; but it would seem, from the observations of Professor Owen, that over the anterior surface of this pigment a filmy membrane is spread; and it is not impossible that this, although no connexion has been discovered between it and the nervous membrane, or the optic ganglion, may be the true retina, and that some connexion, not discovered, may exist between it and the large nerve in question. There is no true iris;

there is no chamber before the crystalline lens filled with aqueous humour; the lens is of short focus, and, instead of being simply convex on each side, it is divided into a sort of double lens, or into two portions, (the anterior being the smallest,) by a circular furrow, into which is fixed the post-pigmental retina with its anterior lining of pigment. The globe of the eye is covered with an outer coat, which is tough and fibrous, and may be regarded as the sclerotic. The diagram



Eye of the Octopus.

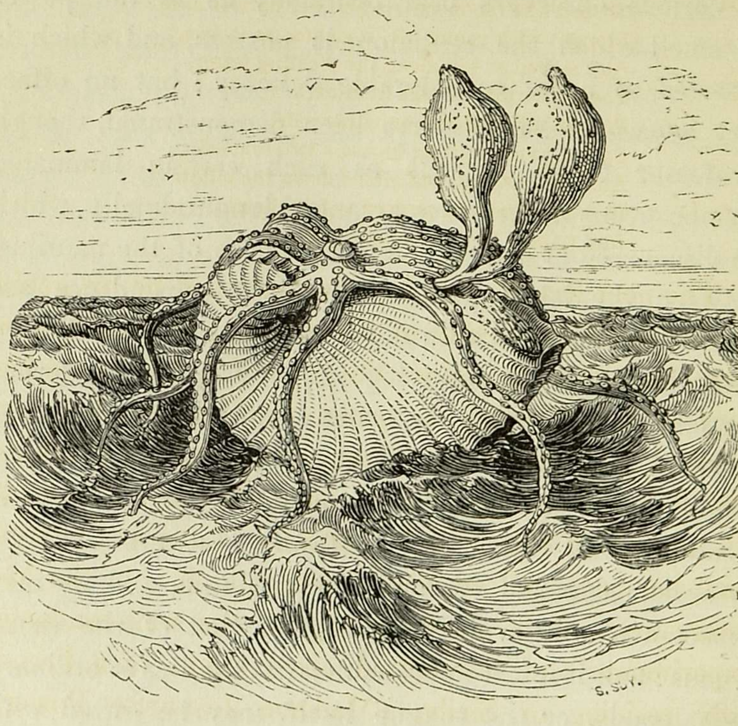
a, *a*, the crystalline lens; *b*, the transparent skin supplying the place of the cornea; *c*, the chamber containing the vitreous humour; *d*, *d*, the black pigment; *e*, the post-pigmental retina, expanded from *f*, the optic ganglion; *g*, the pre-pigmental retina; *h*, *h*, the sclerotic, or external tunic of the globe of the eye.

will enable the reader to understand this description: much, however, remains to be ascertained.

According to Professor Owen, the eye of the nautilus is far more simple, the light being admitted through an anterior transparent membrane into a chamber lined with black pigment, which covers a nervous expansion of the optic ganglion, and has an anterior or pre-pigmental retina, as in the octopus; but no crystalline lens has been found. Excepting in the nautilus, (*Nautilus pompilius,*) all the cephalopods appear to be endowed with organs of hearing; but these organs, the first steps, as it were, to the complex auditory apparatus of birds and mammalia, are in their lowest condition—in their simplest structure. In the anterior part of the cartilaginous cranion are two separate cavities, and in each of these is a membraneous vesicle, of a rounded or somewhat oval figure, suspended by means of numerous minute filaments, regarded by some anatomists as vessels; over the vesicle, delicate branches of an auditory nerve ramify. Internally, the vesicle contains a gelatinous fluid; and, externally to its posterior part, a small calcareous body is attached. Such is the ear of the cephalopods, an organ useless for the appreciation of the vibrations of the air, but no doubt qualified for receiving or being affected by the oscillations of the aqueous medium in which the animal exists ; it is an aquatic, not an atmospheric ear, and is destined to receive sonorous impressions in a dense medium.

Various observers bear testimony as to the power of smell which the cephalopods possess, and which is asserted to be of considerable delicacy ; but no olfactory apparatus has hitherto been demonstrated, though Professor Owen regards as such certain laminated membraneous appendages arranged longitudinally, which he discovered at the entry of the mouth of the nautilus, between the labial processes. These appendages are abundantly supplied with nerves, which may be endowed with the power of receiving impressions from odorous particles contained in the water around them, and thus serve to aid the animal in the choice of food. The conditions of an olfactory apparatus for an aquatic medium, must differ greatly from what are required by organs destined for an aërial medium, and we may expect a simplicity here parallel to that of the visual organs ; and it is not improbable, that the lips of ordinary cephalopods, or the tongue itself, may be gifted with the sense in question, which is, in fact, but a kind of taste—a taste of odorous particles of bodies diffused in air or water.

So far, then, a summary of the general structure of the ordinary cephalopods has been given; but there are three genera belonging to this group,—we allude to the nautilus, (*Nautilus pompilius*,) the spirula, and



The Nautilus.

the argonaut, (*Argonauta argoa*,) of which the living animals are the tenants of a shelly domicile.

The reader has probably been much pleased with the following description of the nautilus by one of our poets :—

> Light as a flake of foam upon the wind,
> Keel upwards, from the deep emerged a shell,
> Shaped like the moon ere half her horn is filled :
> Fraught with young life, it righted as it rose,
> And moved at will along the yielding water.
> The native pilot of this little bark
> Put out a tier of oars on either side,
> Spread to the wafting breeze a two-fold sail;
> And mounted up, and glided down the billow
> In happy freedom, pleased to feel the air,
> And wander in the luxury of light,

The poet has, in this instance, adorned by his genius the common statements of naturalists. It should, however, be known, that since the days of Aristotle, the history of the argonaut, or paper nautilus, has been enveloped in a tissue of misconceptions and difficulties ; and it is only of late that we have obtained an accurate knowledge of this singular animal. Long as the argonaut has been noticed, and abundant as it is in the Mediterranean, it is chiefly owing to the well-conducted experiments and unremitted observations of a French lady residing in Sicily, (Madame Jeannette Power,) who has transmitted the results of her researches, with collections of specimens in illustration of them, to the different learned societies of Italy, France, and England, that we now understand its true nature.

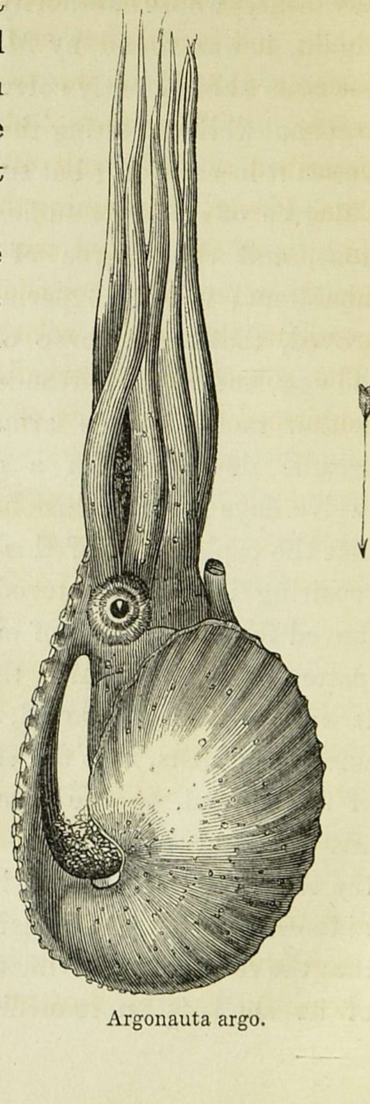
First, then, naturalists have been greatly in doubt, as to the claim of the animal cephalopod to the shell it is found to inhabit, and many arguments have been adduced, that, like the hermit crabs, (pagarus,) this cephalopod was an intruder into a habitation not constructed by itself; but either usurped during the life, or taken possession of after the death of its lawful and natural proprietor—a proprietor, however, undiscovered. Among scientific men who have adopted these views, are to be enumerated some of the most eminent (certainly not all) both in France and England.

Secondly; From the earliest times to the present, it has been a commonly received opinion, that the arms, usually called the sails, were used by the animal to catch the breeze as it floated on the calm surface of the sea, and that thus it was propelled on its voyage.

Now, with respect to the first point, it is incontestably proved, that the cephalopod of the argonaut is truly the maker of its own dwelling; and that, consequently, it is not a parasite, like the pagarus. Specimens in every stage of growth, from young individuals, the shell of which only weighed a grain and a half, up to those of the ordinary size, have been transmitted to England by Madame Power, and accurately examined by Mr. Owen, Hunterian Professor of the Royal College of

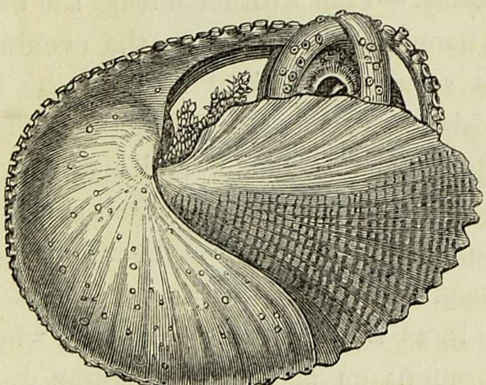
Surgeons, whose authority is of the highest value. Again, it was found by Madame Power, (and the fact has been subsequently corroborated,) that the shell of the argonaut while investing the living animal, is not hard as we see it in cabinets ; but soft, yielding, and flexible, with a degree of elasticity sufficient for the respiratory functions, and the degree of locomotion required by its inhabitant; it is also permeable to light. It was also proved, that the embryo of the argonaut, while yet in the egg, and at an advanced stage of development, had neither membraneous arms nor shell ; but that both became developed, in a given time, namely, ten or twelve days after exclusion. It was further discovered, that the cephalopod of this shell possessed the power of repairing it when fractured, or when portions were removed for the purpose of experiment, and with the same matter as that of which the rest of the shell consists. It was still further proved, contrary to the assertions of some naturalists, that the shell is moulded on the body of the animal, to the form of which it is beautifully adapted; and that in every instance the animal maintains the same relative position in its shell. Again, contrary to the statements of M. Blainville and others, it was found that the result of depriving the cephalopod of the argonuat of its shell, is an immediate loss of vital power, and death within a few hours at farthest. Some anatomical data bearing immediately on the subject might here be adduced, but we shall not enter into abstruse details.

With respect to the use and position of the arms, or sails as they have been termed, of this curious animal, it may be stated, that Madame Power, in reference to their relative position, describes them as "being placed next the involuted spire of the shell, over which they are bent, and expanded forward so as to cover and conceal the whole of the shell; and from which they are occasionally retracted in the living argonaut." She further made the important discovery, that these expanded membranes are the organs of



Argonauta argo.

the original formation and subsequent reparation of the shell; and ingeniously and justly compared them in her memoir (1836) to the two lobes of the mantle of the cowry. "These facts," observes Professor Owen, "are described as the result of actual observation; but Madame Power, entertaining the common belief of the action and use of the velated arms in the sailing of the cephalopod, enters into considerations respecting their proportional strength in relation to that hypothetical office. The subsequent observations of M. Rang have fully confirmed the accuracy of Madame Power's description



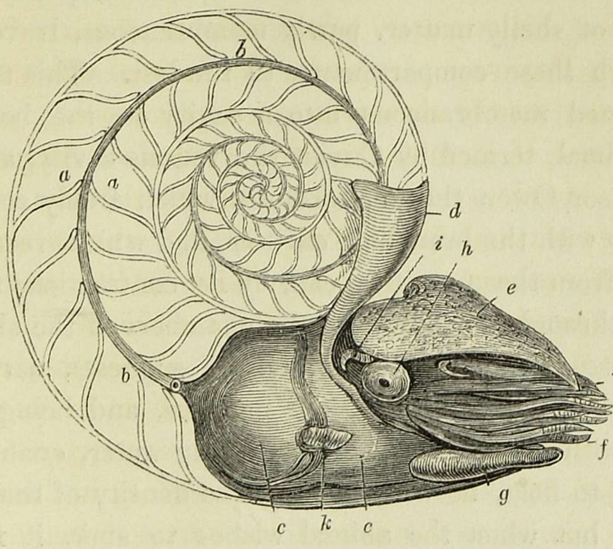
Argonauta argo.

of the relative position of the so-called sails of the argonaut to the shell; and he has published some beautiful figures illustrative of this fact." Of these figures, the engravings are copies. The arrow in the former shows the course of the animal.

In 1832, Professor Owen gave to the scientific world his memoir on the pearly nautilus, founded on a minute anatomical investigation of the individual in question. This memoir, replete with new and valuable information, is our authority with respect to every detail as far as concerns this curious being and its shell. George Bennett, Esq. F.L.S., by whom this animal was secured, thus describes the circumstance of its capture.

"Island of Erromanga, New Hebrides, August 24, 1829. Monday.—Fine weather during the day. Thermometer at noon, 79 degrees. In the evening a pearly nautilus was seen in Marekini Bay, on the south-west side of the island, floating on the surface of the water, not far distant from the ship, and resembling, as the sailors expressed it, a dead tortoise-shell cat in the water. It was captured, but not before the upper part of the shell had been broken by the boat-hook, in the eagerness to take it, as the animal was sinking when caught. On being brought on board my attention was directed to possessing the inhabitant, which I succeeded in procuring. I immediately detached the animal from the fractured portions of the shell, (to which it is attached by two oval muscular attachments on each side,) and placed it in spirits, after making a pen and ink sketch of its external form." On his arrival in England Mr. Bennett consigned this prize to Professor Owen.

The shell of the nautilus has been long known, and is common in cabinets; but before describing its inhabitant a few observations respecting it are necessary.



Pearly Nautilus,

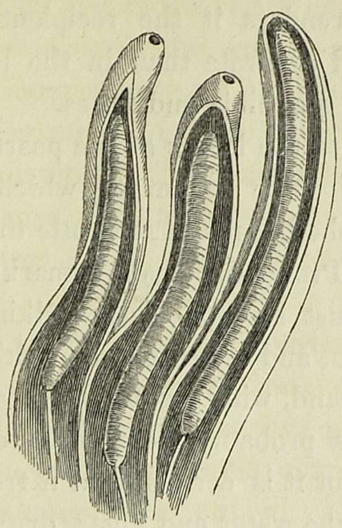
Showing a section of the shell, and the general appearance of the cephalopod in the ultimate chamber. *a*, *a*, the chambered shell, divided by walls into distinct partitions; *b*, *b*, the syphon traversing the chambers; *c*, *c*, the mantle, of which a fold, *d*, is reflected over the shell; *e*, the hood covering the head; *f*, *f*, the tentacular organs; *g*, the funnel; *h*, the eye; *i*, one of the orbital tentacula; *k*, one of the muscles fixing the mantle to the shell; this being removed.

The shell of the nautilus is camerated, as it is termed, or chambered, instead of being simply hollow; and if a section be made, (see the sketch on p. 175,) it will be found to be divided internally by numerous regular partitions into distinct compartments, the last or largest of which only encloses the body of the animal; but besides these, we find a tube, or siphuncle, partly composed of shelly matter, partly membraneous, traversing through these compartments, to the last. This tube is continued membraneous into a cavity on the body of the animal, termed by Cuvier the venous cavity, and by Professor Owen the pericardium, which freely communicates with the branchial cavities, and which, receiving water from those cavities, can, by its contraction, transmit it through the tube into the chambers of the shell.

These chambers, as Dr. Hooke suggests, naturally contain air, generated by the nautilus, and being thus filled with a fluid more buoyant than water, enable the animal to float, notwithstanding the density of the shell itself; but when the animal wishes to sink, it forces water through the tube or syphon, thereby compressing the air, and thus at once becomes heavier than the surrounding medium. It would appear, that the retraction of the head and tentacula into the shell, involve the contraction of the pericardium, and consequently the forcing of the water through the siphon; while the protrusion of the head and tentacula, by relieving the pericardium from pressure, permits the air of the chambers to expand, and drive back the water—the buoyancy of the animal accordingly returning. Surely no comments are needed to enforce upon the attention of the reader the beauty and fitness of such a contrivance — a contrivance which enables the pearly nautilus to float on the surface of the deep, enjoying the light and warmth of the sun, and to luxuriate in its rays; and then, in a moment, when danger threatens, to sink to the bottom, and there find a shelter and a hiding place.

The mantle of ordinary cephalopods is thick and tough; in this shell-covered species, however, it is very delicate, and is fixed by a lateral muscle on each side to the inner aspect of the shell, over the external surface of which, to a certain distance, an expansion is reflected: a tougher and firmer membrane covers the head, and forms, when the animal is withdrawn into its shell, a sort of leathery operculum; the funnel, as in other cephalopods, is large and distinct, and gives passage to the water discharged from the branchial cavities, and also to the digested aliment. To the eyes of this animal reference has already been made.

So different in structure are the arms or tentacula of the nautilus, from the analogous organs in the ordinary cephalopods, that a particular notice of them is required. The first thing which strikes the observer is their great number; the next, their want of sucking discs. Descending to particulars, it is to be remarked, as Professor Owen states, that the hood covering the head is thick, and of a triangular form, with an anterior orifice; its upper part is wrinkled and covered with papillæ, and from its sides are given off numerous round tapering processes: these are nineteen on each side, or thirty-eight altogether; but, as the hood itself consists apparently of two very broad digitations conjoined along the mesial line, twenty pairs (in all forty) of these lateral appendages may be enumerated. Each of these appendages consists of a longitudinal canal, in which is lodged an annulated tentacle, about two inches and a half in length, and capable of being protruded from its sheath (see the figure on p. 179, representing the sheath opened). In the specimen dissected by Professor Owen, some of these tentacles emerged to the extent of half an inch from their sheaths; the others were retracted, and did not reach the aperture of the sheath by a quarter of an inch. Besides these forty tentacula, are four others of a different structure, beneath the margin of the hood, one before and one behind each eye. These consist of a series of compressed circular discs affixed to a lateral stem. In addition to this tentacular apparatus, is a series of oral appendages; four labial processes are situated around the lip which encloses the beak, and each of these is pierced



Tentacula of Cuttle-fish.

by twelve canals, the orifices of which are disposed in a single but rather irregular row along its anterior margin; these canals contain each a small tentacle, similar in structure to those sheathed in the processes of the hood. All these tentacula, whether oral, or belonging to the hood, receive large nerves, and are evidently endowed with an acute sense of touch; and when we consider the number of these moveable worm-like feelers, we cannot but be convinced that their presence raises the animal to the highest point in the scale of the mollusca, and renders it the recipient of impressions more varied and accurate than in the lower vertebrata, as, for instance, amphibia and fishes.

With regard to the habits of the pearly nautilus, little is ascertained. The extent to which the animal is covered by its shell, caused Aristotle to compare it to a snail; and, as Professor Owen remarks, "the general resemblance must be sufficiently striking when with his house above him, and in the supine position, he makes his way along the sand, with a moderate degree of rapidity." This, indeed, is probably the animal's ordinary mode of progression; but it is certain that it frequently rises to the surface of the water and floats, drifted along by the current or the breeze. This navigation is indeed only passive, or at most influenced by the jets of water expelled from the branchial cavities, through the funnel, at regular intervals.

Rumphius, alluding to the fact of the floating of the pearly nautilus, says, "When he thus floats he puts out his head and all his tentacles, and spreads them upon the water, the poop of the shell rising above the surface; but at the bottom he creeps in the reverse position, with his boat above him, and his head and tentacles on the ground, making a tolerably quick progress. It is upon the ground that he chiefly keeps himself, creeping sometimes into the nets of fishermen; but after a storm, as the weather becomes calm, troops are seen floating on the water, being driven up by the agitation of the waves; whence it may be inferred, that they congregate in troops at the bottom. Their sailing, however, is not of long continuance, for having taken in all their tentacles, they upset their boat, and so return to the bottom."

With regard to the genus *Spirula*, the shell is concealed under the mantle, at the back part of the body; it is spiral, but the whorls are separated from each other, instead of being contiguous: internally it is divided into chambers, perforated by a siphon; and the last turn of the spire is prolonged to a straight line. Our information respecting the animal itself is very limited. It appears to form the link between the ordinary cephalopods and the pearly nautilus.

Here then we close our cursory review of the living mollusca—the multiform mollusca—a division of the animal kingdom replete with interest, and pregnant with overwhelming proofs of design and wisdom. The study of these creatures is, happily, not restricted within narrow limits; on the contrary, opportunities for engaging in it are widely extended. Climate operates on the geographical distribution of particular species; but, as there is more uniformity of temperature in the waters of the ocean than in the air of the land, the diffusion of many marine mollusks is extensive.

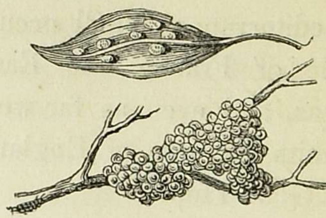
Some of these creatures become most fully developed in warm latitudes, and to these most of their species are exclusively confined. Two instances are mentioned in which mollusks diminish in size as they follow the coasts of New Holland to King George's Sound, and entirely disappear beyond them. Nearly all the species of South American shells differ from those of the Indian Archipelago in the same latitudes; and peculiar species have been obtained on the shores of many of the islands of the South Pacific. Means of limitation, in certain cases, may be easily traced. The mollusks of the West Indian seas cannot enter the Pacific, without passing round through the inclement climate of Cape Horn. Currents constantly flowing in a particular course, and the influx of great bodies of fresh water at certain points, limit the extension of many species.

Those which love deep water, are arrested by shoals: others adapted to shallow seas cannot traverse unfathomable abysses.

A few species have an immense range: one is found in the West Indies, Brazils, the Red Sea, Trancobar, the Chinese Sea, and in one of the South Sea islands: a Mediterranean shell occurs also in South Africa, the Isle of France, the East Indies, China, the South Seas, and even as far west as Tahiti; and another inhabits the seas of England, Guadaloupe, and the Cape of Good Hope.

The janthina, mentioned in a former page, has wandered into almost every tropical and temperate sea. Admirably adapted to float, it has not only dispersed itself thus universally, but it has disseminated other species, which attach themselves or their eggs to its shell. An eminent naturalist possesses specimens bearing more than one species of barnacle; and one of them is so laden with these creatures and numerous eggs, that all the upper part of its shell is invisible.

The mode in which some of these creatures are diffused is worthy of attention. Snails and mollusks generally are slow in their movements, but they are not without means of extending themselves rapidly over a wide space. Some lay their eggs in a sponge-like nest, wherein the young are covered for a time after their birth, and this buoyant substance floats as readily as sea-weed; in other instances the eggs adhere to various substances. In rivers and lakes aquatic univalves usually attach their eggs to leaves or sticks, which have fallen into the water, and which are liable to be swept away during floods from tributaries to the main streams, and from thence to all parts of the same basins. In this way particular species may migrate during one season from the head waters of the Mississippi, or any other great river, to countries bordering the sea, at the distance of many thousand miles. The habit of some mollusks to adhere to floating wood, appears by their fixing themselves to the bottoms of ships. Some previously known in the Danube and Wolga, have thus been brought to the commercial docks in the Thames, where this species has found a home.



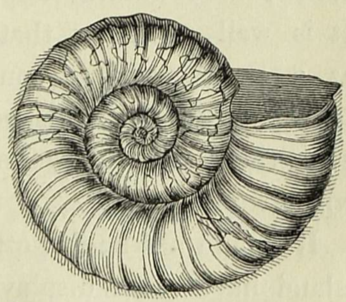
Migration of Eggs.

We trust that this interesting portion of the works of God will receive far more attention than has yet been given it; and we shall rejoice, if the contents of this volume are the means of stimulating many of the young to further inquiry. Here is, indeed, an ample field for our research. Unexpected structures, wonderful organs, elaborate contrivances, meet us at every stage of our progress, as we pass from the cirrhopodous barnacle, to the highly organized and voracious cuttle-fish; and in thus tracing the series of organic developments, in contemplating the structure and uses of various pieces of vitalized mechanism, and in discovering the fitness and skilfulness of every contrivance, as we call it, are we to forget Him who is the Creator and Designer of all?—the God of eternity and infinity, whose works, while they proclaim his praise, teach us how little we are, how little we know, and how much even as respects organic creation is beyond our comprehension. How variable are the beings which we have been examining—how wonderful their organization—how complex their structure! All this we see and admire; but let not our admiration end here. Let us carry our thoughts to Him who is life in its abstraction—power in its essence—wisdom in its mysterious perfection—to God, all good, who has given to us the mind to contemplate His works, and to draw lessons of instruction from them, but who has not left us here; for, in mercy, He has given to us a still brighter and more glorious revelation of Himself and his attributes, especially in the cross of Christ; so that we, unlike the lower orders of creation around us, may be animated by views, and hopes, and desires, to be realized in another state of existence—a life never to terminate, when the organic structure of our bodies shall return, with that of all living things, to the dust from whence they were taken. The way, the truth, and the life are before us, and God our Maker, is our Redeemer and our Guide.

CHAPTER X.

FOSSILS—THEIR GREAT VARIETY—ABUNDANCE OF FOSSIL SHELLS —REMARKABLE FACTS RESPECTING THEM.

Fossils present a very interesting subject of inquiry to the student of nature. The term fossil, in its general acceptation, signifies that which is dug out of the earth; it has, therefore, been applied to antiquities as well as to natural, metallic, and mineral bodies. It is now sometimes used to designate simple and compound mineral bodies; but, more properly, the plants and animals which occur in the strata that compose the surface of the globe. Most of these fossil species, many of the genera, and some of the families, are now extinct.



A Fossil.

In the darker ages fossils excited some attention. The ancients, accustomed as they were to observe nature, could not fail to notice them, but they were sadly puzzled to account for the origin of these remains. Some supposed them to have grown, in an extraordinary way, in the places where they were found; while others described them as resulting from a plastic power with which they considered nature to be endowed. Such theories were not merely adopted to solve the difficulty as to animal fossils, but even the vegetable forms of bituminous wood were gravely traced to tendencies to such formations in the bitumen!

Another idea was, that a certain fatty matter, made to ferment by heat, gave rise to fossil organic shapes; and Fallopio of Padua not only imagined that petrified shells arose from fermentation, but also, that certain curious antique vases dug up at Monte Testaceo, near Rome, were natural impressions stamped in the soil! It is well to know that such errors have prevailed, as a check to that confidence which we are prone to repose in distinguished men. How plain is it, that even those reputed to be wise, may become chargeable with gross folly!

It should not be forgotten that the natives of our own island have often displayed their ignorant superstition. Alluding to some of their notions, one of our poets says, that the nuns of Whitby—

—————————— told
How, of thousand snakes, each one
Was changed into a coil of stone,
  When holy Hilda pray'd;
Themselves within their holy bound
Their stony folds had often found.

Nor did Saint Cuthbert's daughters fail
To vie with these in holy tale.
—————— On a rock by Lindisfarn
Saint Cuthbert sits, and toils to frame
The sea-born beads that bear his name.
Such tales had Whitby's fishers told,
And said they might his shade behold,
  And hear his anvil sound:
A deadened clang, a huge dim form,
Seen but and heard, when gathering storm
  And night were closing round.

Nor let it be supposed that some who were better taught were far from error in reference to fossil remains. A statement from a valuable work by Mr. Parkinson will place the opinions entertained not very long since respecting them in a clear light. Having set out to visit the most interesting parts of our island, his first day's journey was not completed before he discovered that his previous knowledge was insufficient to enable him even to conjecture the origin of the very first object that particularly attracted his attention and that of his companions.

When they were within about ten or twelve miles of

Oxford, one of his companions exclaimed, "Well, I never before saw roads mended with such materials as these;" nor was his own astonishment scarcely less than that of his friend, when he beheld a labouring man, with a large hammer, breaking in pieces a stone nearly circular, half as large as the fore-wheel of the chaise, and bearing the exact form of a serpent closely coiled up. On inquiring of the man the name of the stone, and from whence it came, the answer received was, "This is a snake stone, and comes from a pit in yonder field, where there are thousands of them." They all alighted, and with surprise examined some of the same species; which, though evidently bearing the form of some strange animal, were undoubtedly formed entirely of stone.

Sauntering along, followed by the chaise, they came to a small "hedge ale-house," which they entered, hoping to gain some further information, and were shown into a very neat room; the casement of which, surrounded by roses and honeysuckles in full bloom, opened into a garden which was exceedingly productive. The contents of the mantel-piece greatly puzzled all the visitors, but their hostess readily offered to describe her "collection of curiosities," made in the neighbouring parts of the country. Taking up a stone resembling those which had been observed in the road, but much smaller, "This," said she, "is a petrified snake, with which this part of the country abounds. These," pointing to others, she continued, "were fairies, and once the inhabitants of these parts, who, for their crimes, were first changed into snakes, and then into stones. Here," she said, pointing to a stone of a conical form, "is one of the fairies' night-caps, now also become stone. Do, madam," she said, addressing a lady of the party, "pray observe; is it possible that lace-work, so beautiful as this, should ever be worked by human hands? This," said she, "and this, are pieces of the bones of giants, who came to live here when the race of fairies was destroyed." These bones, she stated, were frequently dug up in various parts of the country, as well as innumerable thunderbolts, some of which she also showed her visitors; stating, that these were the very thunderbolts with which these people were, in their turn, also destroyed.

Nor were such notions confined to any particular locality. Hugh Miller, who has written in a most interesting manner about the old red sandstone — one of that class of men who have acquired great knowledge in humble stations — describes himself, about twenty years ago, as engaged in working a quarry in a lofty wall of cliffs that overhangs the northern shore of the Moray Frith. The interest he displayed in the objects around him, is strikingly contrasted with the ignorance and superstition to which he refers.

"In the course of the first day's employment," he says, "I picked up a nodular mass of blue limestone, and laid it open by a stroke of the hammer. Wonderful to relate, it contained inside a beautifully finished piece of sculpture—one of the volutes, apparently, of an Ionic capital. Was there another such curiosity in the whole world? I broke open a few other nodules of similar appearance — for they lay pretty thickly on the shore — and found that there might be. In one of these were what seemed to be scales of fishes, and the impressions of a few minute bivalves, prettily striated: in the centre of another, there was actually a piece of decayed wood. Of all nature's riddles, these seemed to me at once the most interesting and the most difficult to expound. I treasured them carefully up, and was told by one of the workmen to whom I showed them, that there was a part of the shore about two miles farther to the west, where curiously shaped stones, somewhat like the heads of boarding-pikes, were occasionally picked up; and that in his father's days the country people called them thunderbolts, and deemed them of sovereign efficacy in curing bewitched cattle." The reader will at once perceive that the various objects referred to on this and the occasions just cited were of precisely the same character—they were, in fact, fossils.

It is natural to inquire in what way such substances are formed; and in answering this question it will be desirable to state some interesting facts in reference to what is called petrifaction. Most fresh water, it may be remarked, holds in solution a greater or smaller quantity of lime, and various causes occasion the calcareous earth to be partially or wholly precipitated. An instance of this kind occurs when a kettle or boiler long in use becomes furred, the fur being the calcareous matter which the water had contained. At the temperature of 60°, lime is fusible in 700 times its weight of water; and, if there be added to this solution a little carbonic acid, a carbonate of lime is formed, and precipitated in an insoluble state. When there is an excess of carbonic acid, the lime again becomes soluble in water, and thus carbonate of lime is commonly found in all waters. When, therefore, the portion which exists in excess is lost, the calcareous earth is set free, and precipitated on any substance in the water.

Some springs contain so large a portion of this earth when they first issue from the rocks, that incrustations of leaves, moss, baskets, nests containing eggs, and even old wigs and hair-brooms have been readily obtained. In Derbyshire there are springs of this kind, one of which is near the western bank of the Derwent, at Matlock.

Matlock Incrustation.

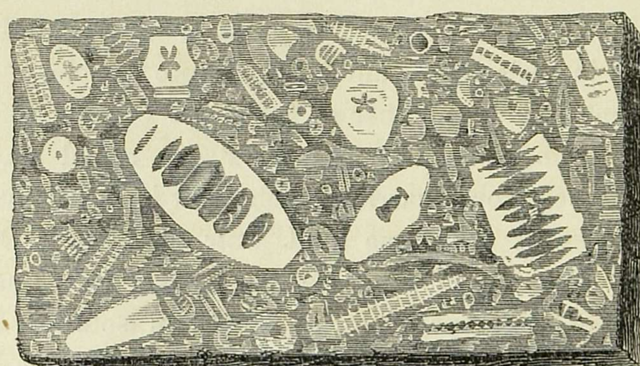
Italy and many other countries have such springs also. At the baths of San Filippo, in Tuscany, the stream is directed against moulds of medallions and other bas-reliefs, and very beautiful casts are thus obtained.

Another of these springs exists in Persia; it issues from the earth in bubbles, and falls into a basin of about fifteen feet in diameter. On flowing over the edges of this receptacle, the water spreads over the ground, forming numerous ponds and plashes, and in these it becomes hard, and produces a beautiful transparent stone, commonly called Tabreez marble. The petrifying process may here be traced from its beginning to its close. In one part the water is clear; in a second it appears thicker and stagnant; in a third quite black; and at last it is white, like hoar-frost.

The petrified ponds look like frozen water; a stone slightly thrown upon them breaks the crust, and the black water issues forth; but, when the operation is complete, a man may walk upon the surface without wetting his shoes. A section of the mass appears like sheets of rough paper in accumulated layers. Such is the constant tendency of this water to form stone, that the bubbles become hard, as if they had been arrested in their course and changed into marble.

A considerable number of buildings of ancient and modern Rome are built of a substance called travestine, obtained from quarries which must have originated from a lake of the same kind. Sir Humphrey Davy says, "The waters of these lakes have their rise at the foot of the Apennines, and hold in solution carbonic acid, which has dissolved a portion of the calcareous rocks through which it has passed; the carbonic acid is dissipated by the atmosphere, and the marble, slowly precipitated, assumes a crystalline form, and produces coherent stones. The acid originates in the action of volcanic fires on the calcareous rocks of which the Apennines are composed; and carbonic acid being thus evolved, rises to the source of the springs derived from the action of the atmosphere, gives them their impregnation, and enables them to dissolve calcareous matter."

When objects are exposed to the action of a petrifying spring, there is often only an incrustation. On breaking the specimen, the substance enclosed has undergone no change but that of decay, to a greater or less extent. In a true petrifaction, on the contrary, the

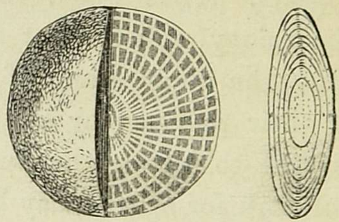


Genuine Petrifaction.

substance is saturated throughout with mineral matter; every part of it has undergone a change; sometimes flint has filled up every interstice, and on slicing and polishing it, the most delicate texture of the original appears. Thus wood, commonly petrified by flint or chalcedony, may be cut so thin, that, with a powerful glass, the ramifications of the vessels and the structure of their tissues may be seen, and the particular kind of tree to which the specimen belonged determined, although for ages it may have been cased up in stone.

Genuine petrifactions, in which the parts of an organized body are changed into mineral matters, are supposed to have been frequently effected suddenly by the combination of gaseous fluids with the principles of the body thus transmuted. It seems, indeed, certain that the change of animal and vegetable substances into silex, must, in the majority of instances, have been almost instantaneous, for the most delicate parts are often preserved, such as the soft bodies of mollusca, and even the pollen of plants.

Having made these general remarks, we may now proceed to fossil shells, commencing with the nummulites, which form a singular genus; they are so called from their resemblance to a piece of money. They vary in size from that of a crown-piece to one exceedingly minute; they are often piled on each other almost as closely as the grains in a heap of corn; and they occupy an important place among fossil shells, because of their prodigious numbers in certain circumstances. Closely piled together, they form a considerable portion of the entire bulk of many extensive mountains. They abound in the Alps and the Pyrenees, and some of the pyramids and the sphinx of Egypt are composed of limestone loaded with these remains.



Nummulite.

Minute examination, indeed, discloses occasionally vast masses of microscopic shells, that surprise us as much by their minuteness as their abundance. The mode in which they are sometimes crowded together may be gathered from the fact, that Soldani collected from less than an ounce and a half of stone found in the hills of Casciana, in Tuscany, 10,454 microscopic chambered shells. Of several species of these, four or five hundred weigh but a single grain; of one species he calculates that a thousand individuals would scarcely weigh so much. He further states that immense numbers of them passed through a paper in which holes had been pricked with a needle of the smallest size.

Similar accumulations have been found in deposits of fresh-water formation. Animals of one genus (*Cypris*) are enclosed in two flat valves, and now inhabit the waters of marshes and lakes. Some clay beds are so abundantly charged with minute shells of one species, that the surfaces of parts into which the clay is easily divided, are often entirely covered with them as with small seeds. The same shells occur also in the Hastings sand and sandstone, in the Sussex marble, and in the Purbeck limestone.

The Altain chain of mountains in Siberia is flanked on each side by a chain of hills enclosing marine shells. On a comparison of these shells in form and substance, no difference can be detected between several varieties of them and those which still inhabit the sea. At Tourraine, in France, a hundred miles from the coast, and about nine feet beneath the surface, a bed of fossil shells has been found, nine leagues in length, and about twenty feet in thickness. Such beds exist in various parts of Europe, and in South America they are said to be very frequent.

In the limestone rocks of Dovedale, in the county of Derby, and in the calcareous region which forms so large a portion of the district called "The Peak," marine shells are continually found incorporated. The grey marble of Derbyshire is, indeed, an entire mass of marine productions.

Most remarkable is it that such mountain masses of the remains of a single family of shells should be added to the solid materials of the globe. But it should not be forgotten, that each individual shell had once a place within the body of a living animal, and that then the waters of the ocean which covered Europe were filled with floating swarms of these beings which are now extinct. The *Clio borealis*, referred to in page 147, is now so numerous in the Northern Ocean, that in calm weather the surface of the water swarms with such millions of them, rising for a moment to the air at the surface, and again instantly sinking towards the bottom, that the whales can scarcely open their huge mouths without gulping in thousands of them; yet the nummulites must have rivalled them in number.

These creatures are divided into air chambers, which act as a float, but the last chamber is not sufficiently large to contain any part of the body of the animal. The chambers are very numerous, but they have no siphon. In each species of this genus the essential parts vary in form, but the principles of their structure and operation appear in all to have been the same.

If, however, these animal bodies have contributed to form the crust of the earth, there are more minute species of chambered shells which have also produced great and very remarkable effects. There is, for instance, one small shell, no larger than a grain of millet, which in several parts of Europe is employed by the poorer classes as a substitute for rice or sago, yet this has been so abundant that it is largely interspersed in the strata of many quarries in the neighbourhood of Paris. "We scarcely condescend," says Lamarck, "to examine microscopic shells, from their insignificant size; but we cease to think them insignificant when we reflect that it is by means of the smallest objects that Nature everywhere produces her most remarkable and astonishing phenomena. Whatever she may seem to lose in point of volume in the production of living bodies, is amply made up by the number of the individuals, which she multiplies with admirable promptitude to infinity. The remains of such minute animals have added much more to the mass of materials which compose the exterior crust of the globe, than the bones of elephants, hippopotami, and whales."

The fact is, that the greater portion of the island on which we live, and of the globe, with its nine hundred millions of inhabitants, teems with fossils, the remains of those beings which existed many ages since in this earth, and which now prove their Creator to be wonderful in his works. We should have liked the distinguished philosopher, whose reference to them has just been quoted, to have alluded distinctly to that almighty and gracious God, whose works they are.

> The Lord of all, Himself through all diffus'd,
> Sustains, and is the life of all that lives.
> Nature is but a name for an effect,
> Whose cause is God. He feeds the sacred fire
> By which the mighty process is maintain'd,
> Who sleeps not, is not weary; in whose designs
> No flaw deforms, no difficulty thwarts,
> And whose beneficence no change exhausts.

We may now glance at a large family—that of the ammonites—an extinct genus, the name of which is derived from their resemblance to the horns on the statue of Jupiter Ammon. This family is very extensive and remarkable. They greatly vary in size; some are only a line—the twelfth part of an inch; but others have been recently measured in the chalk near Margate, which exceeded four feet in diameter. All of them, in the beauty, symmetry, and delicacy of their structure, demand attention, revealing as they do the power of Him,

> Who calls for things that are not,
> And they come.

Like a nautilus, an ammonite has an external shell, a series of internal air-chambers, and a siphon passing through them to the innermost extremity of the shell. The place and use of these shells have caused much perplexity; but there is good reason to believe that they were entirely external, and that the position of the body of the animal was within, like that of the nautilus, page 175.

It is worth while dwelling on the admirable adaptation of these shells to their circumstances. As they were to act as floats, they must be thin, or else they would have been too heavy to rise to the surface; but they were also to afford protection, and thus they must be made strong, to resist the pressure of the water at the bottom of the sea. The provision in the latter case is as complete as it is in the former.

That this may be clearly understood, it will be desirable to notice the depth of the ocean, and the pressure of its waters. As to the depth of the sea our information is very imperfect, and perhaps accurate information is not very likely to be obtained. Still, there has been a sounding of six thousand feet in the Caribbean Sea; and a line of four thousand six hundred and eighty feet did not reach the bottom of the Northern Ocean. Now far short of these depths the pressure of the water is very great. If a bottle containing only air be tightly corked, and sunk by means of weights to a considerable depth in the sea, the pressure of the surrounding water will either break the bottle, or force the cork into it through the neck. On drawing up the bottle, it will be found to be filled with water, and to have the cork within it below the neck.

This was verified by the late Rev. J. Campbell, in his voyage homeward from the Cape of Good Hope. He forced a cork into the neck of a bottle, so thick as to fit it very tightly, and so that half the cork remained above the edge of the neck; a cord was then tied round the cork, and fastened to the neck of the bottle, and the whole was covered with pitch. When the bottle was sunk to the depth of about fifty fathoms, it was suddenly felt to have increased in weight, and on being drawn up, the cork was found inside, and the bottle filled with water. At only the depth of fifty fathoms the water had forced in the cork and filled the bottle.

In another experiment a bottle was similarly corked, but a sail needle was passed through the cork across the edge of the neck, so as to resist the passing of the cork into the bottle. It was now immersed to the depth of fifty fathoms; the same sudden increase of weight was felt, and on drawing up the bottle it was found to be filled with water, but the cork was not displaced.

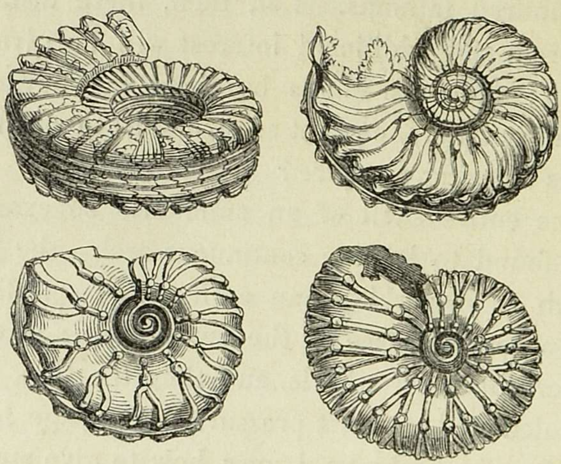
The water, in this instance, must have been forced through the cork.

Other cases are mentioned in which a copper air-tube was crushed quite flat under a pressure of about three hundred fathoms; and a claret bottle, filled with air and well corked, was burst before it had descended four hundred fathoms. Let, then, these instances be considered, and additional interest will be given to the question: How can shells be made so buoyant as to float on the waters, and yet so strong as to resist effectually this amazing pressure?

If the entire shell of an ammonite be examined, it will be found to be one continuous arch—the strength of which is proverbial—an arch coiled spirally round itself, so that the base of the outer whorls rests on the crown of the inner whorls, and thus the back is peculiarly calculated to resist pressure. See page 187.

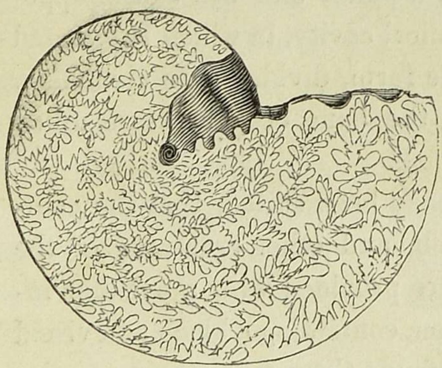
A scientific workman knows how to give strength to an arch; and the shell of the ammonite gains strength also from the arrangement of the ribs by which it is beautifully adorned. Many illustrations of this might be given; for the artisan who makes around the margins, or on the convex surfaces, of tin and copper moulds for domestic use folds or flutings, or gives them to a silver pencil-case, or to the iron intended to form a self-supporting roof, pursues the same course that is adopted to give strength to the shells of ammonites.

A further mode of answering the same end, is by introducing at the different parts of these ribs bosses, far more efficient for the purpose than those which architects have added to their Gothic roofs.



Flutings and Bosses.

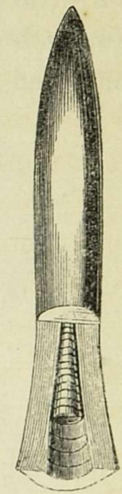
Thus far we have observed instances of admirable arrangement; another must not be passed over. The engraving exhibits a longitudinal section of an ammonite, bisecting the transverse plates in the central line: here their curvature is most simple; but on each side of it the curvature becomes more complicated, until, as they terminate in the external shell, they resemble the edges of a parsley leaf. Now, the edges of these plates becoming foliated, as it is called, at their junction with the outer shell, distribute their support more equally beneath all its parts, than if they had been continued as simple curves.



Section of an Ammonite.

More than two hundred species of ammonites are known in which strength is gained by this means. The nautili are not thus defended, and why is this? Most probably because the greater thickness of the shells renders such aid unnecessary. The comparative thinness of the outer shells of many ammonites, made more internal support under the pressure of deep water needful; and here it appears.

One of the most common fossils of the chalk is a conical stone, generally of a brown colour, called belemnite. Every locality of the chalk contains these bodies, and some limestones on the continent are almost wholly composed of them. The belemnite greatly varies in form, but always terminates in a point, and has at the opposite end a conical cavity, in which is situated a shell of like form, divided into chambers. It is, in fact, the bone of a creature allied to the cuttle-fish.

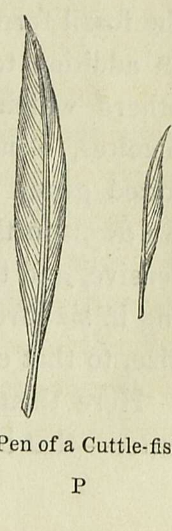


Belemnite.

It has already been stated, that the common cuttle-fish, and other creatures of the same class, are provided with a peculiar internal provision, containing a black and viscid ink, which defends them from their enemies by rendering the water opaque. Now, it could scarcely be supposed that so delicate a substance as the ink could be preserved in a fossil state, yet numerous specimens have been recently discovered in the lias of Lyme Regis, in which the ink-bags are thus preserved, still distended, as when they formed parts of living bodies.

Cuvier describes the ink of the recent cuttle-fish, as being a dense fluid of the consistence of pap, suspended in the cells of a thin net-work that lines the ink-bag, and very much resembling common printers' ink. So completely, however, are the character and qualities of the ink retained in its fossil state, that when Dr. Buckland gave a portion of it to his friend Sir Francis Chantry, requesting him to try its power as a pigment, and he executed a drawing with a portion of it, the drawing was shown to a celebrated painter, who immediately declared it to be tinted with sepia of excellent quality, and begged to know by what colourman it was prepared. The common sepia used in drawing is from the ink-bag of an oriental species of cuttle-fish.

Some considerations worthy of notice, as Dr. Buckland has remarked, arise out of these facts. In the union of a bag of ink with an organ resembling a pen, we have a peculiar compensation for the want of an external shell to a creature much exposed to destruction from its fellow tenants of the deep ; and the combination apparent in the living animal appears in the petrified remains of extinct species of the same family. Cuvier drew his figures of the recent sepia with ink extracted from its own body. Dr. Buckland says,



Pen of a Cuttle-fish.

"I have drawings of the remains of extinct species prepared also with their own ink." He argues, too, that the creatures thus found must have been instantly destroyed, because they contain the fluid which the living sepia emits in the moment of alarm; and that they must have been immediately buried, because the membranes continue distended. Exposed but a few hours to decomposition in the water, they would have speedily decayed, and have spilt their ink. It was, therefore, by a sudden death and quick interment in the sediment that formed the strata, that the petrified ink and ink-bags were thus preserved.

The shells of cephalopods, allied to the pearly nautilus and spirula, are extremely abundant among the fossil forms which the surface of the globe entombs. In addition to those we have hastily noticed, there are others which have received the names of turrilites hamites, baculites, etc. They prove that the now limited group of chamber-shelled cephalopods, on which we dwelt in the last chapter, was at one period most extensive, and that it abounded in forms and species, varying in size from that of a pear, and even from a smaller size, to that of a cart-wheel.

Here then is evidence — on other proofs we do not enter—that innumerable beings have lived, of which not one of the same kind any longer exists. It is equally true, that immense beds, composed of animal remains, extending for miles underground, are met with in many parts of the globe; that enormous chains of mountains are as vast monuments in which these remains of former ages are entombed; and that though laying thus heaped together, they are hourly suffering those changes, by which at length they become the limestone which forms the humble cottage of the peasant, or the marble which adorns the mansion of the noble or the palace of the prince.

In concluding these various statements we are reminded that Cowper has truly said—

> Full oft
> Our wayward intellect, the more we learn
> Of nature, overlooks her anchor more;
> From instrumental causes proud to draw
> Conclusions retrograde and mad mistakes.

Men have unhappily often indulged in vain and wicked speculations in connexion with this subject. Many an infidel has thus aimed his envenomed darts at the bosoms of his fellows; many an injudicious friend of truth has caused it to suffer, when avowedly advancing to its advocacy or defence. But whatever are the malignant designs of the ungodly, or the unhappy errors of even good men, let us remember the words of our Lord, "Heaven and earth shall pass away, but my words shall not pass away." Of this fact we may be fully assured, that as the volume of nature and the volume of revelation are given by the same Author, so there is between them a perfect harmony.

Let us take, then, the volume which God has given us, for our constant guide:

> For if his word once teach us, shoot a ray
> Through all the heart's dark chambers, and reveal
> Truths undiscern'd but by that holy light;
> Then all is plain. Philosophy, baptiz'd
> In the pure fountain of eternal love,
> Has eyes indeed; and viewing all she sees,
> As meant to indicate a God to man,
> Gives him his praise, and forfeits not her own.

Such a philosophy, however, must be that of one whose heart is renewed. In other words, he must be "born again:" for, "if any man be in Christ, he is a new creature; old things are passed away; behold, all things are become new." Under the influence of new principles, he is the subject of new hopes and fears, new joys and sorrows, and he pursues thenceforward a new course.

This all-important change, which is absolutely necessary to our present and eternal happiness, is invariably ascribed in the Scriptures to the Holy Spirit, thus showing that he acts on men as moral and accountable beings, while the word of God is as clearly and constantly referred to as the instrument by which this change is effected. Taking revelation as our guide, nothing is more obvious than that the word of God and the Spirit of God are absolutely necessary to the conversion of a sinner, and that whenever it takes place, it is the effect, not of their separate, but their combined influence.

The operation of the Spirit without the word would produce no explicable effect; the operation of the word without the Spirit would leave the sinner as guilty and polluted as before. The one is the revealed remedy, the other is the power which disposes to receive it. The one makes known the pardon, the other applies it. The one presents the light of Heaven, the other unscales the eye to behold and enjoy it. The one testifies of Christ and pleads his cause, the other opens the mind to receive him, and stamps his image on the heart. With the words of the Saviour these remarks may, therefore, be properly concluded: "Ask, and it shall be given you: seek, and ye shall find; knock, and it shall be opened unto you. For every one that asketh receiveth: and he that seeketh findeth; and to him that knocketh it shall be opened. If ye, then, being evil, know how to give good gifts unto your children: how much more shall your heavenly Father give the Holy Spirit to them that ask him?" Luke xi. 9, 10, 13.

THE END.

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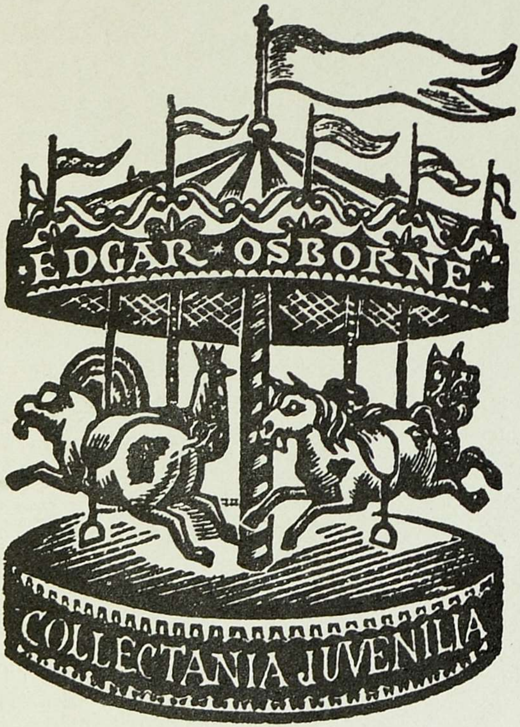
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